

City of Markham

2019

# Corporate Energy Management Plan



Corporate Energy Management Plan

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Corporate Energy Team

Sustainability & Asset Management

City of Markham

7/1/2019

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# 1 Introduction

## 1.1 Executive Summary

The City of Markham is a dynamic and change-oriented leader among Canadian municipalities. The recipient of multiple environmental awards, we are recognized for our innovative sustainability and urban planning initiatives as much as for our fiscal accountability. More than 350,000 residents call Markham home and benefit from our rich heritage, culturally diverse environment, vibrant local economy and focus on quality of life.

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*The successful implementation of the 2014 Corporate Energy Management Plan (CEMP) has resulted in recognition for developing an award-winning energy program by highly esteemed industry leaders including Natural Resources Canada (NRCan), Independent Electricity System Operator (IESO), Federation of Canadian Municipalities (FCM), Toronto and Region Conservation Authority (TRCA), and Mediacorp Canada. The energy team implemented in excess of 200 energy-efficiency projects that are saving the City over \$2 million per year in utility costs, garnered over \$1.2 million in utility incentives, and reduced greenhouse gas (GHG) emissions by 14% per resident. Those utility savings have allowed us to maintain the lowest tax rate increases in the GTA.*

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Between Markham’s growing population and increasing fuel prices, energy consumption and greenhouse gas emissions are more important than ever to fully understand and manage. To address these issues, the City established the following goals for our 2019 Corporate Energy Management Plan:

1. To position the City to move toward the goals from the Municipal Energy Plan and Greenprint of “Net-Zero Energy Emissions by 2050”.
2. To support the Corporate Goal of a “Safe and Sustainable Community” where “We will protect the public and respect the natural and built environments through excellence in sustainable community planning, infrastructure management, and programs.”
3. Develop an updated CEMP that meets the requirements for Ontario Regulation 507/18: Energy Reporting and Conservation and Demand Management Plans, and Partners for Climate Protection Milestone’s Four and Five.



The Energy Management Pyramid summarizes our energy strategy of how we will build upon the progress made from the 2014 CEMP, and where we will focus our efforts for the next 5 years via the 2019 CEMP. Analyzing when and how energy is used is the foundation for establishing an energy strategy. Effectively managing the energy required to operate as a municipality through conservation, and investing in people by educating and engaging the individuals who use that energy, is the next most important (and least expensive) method of controlling utility costs.

Figure 1: Energy Management Pyramid



According to the IESO’s 2018 Annual Report on Energy-Efficiency Activities, “energy-efficiency continues to be the most cost-effective resource for Ontario’s power system at only 1.69 cents per kilowatt-hour.” With that in mind, we have developed a three-pronged approach to tackling energy management:

- 1) Improving energy-efficiency in our existing municipal building portfolio,
- 2) Designing and constructing new facilities with energy-efficient technology and controls, and
- 3) Investing in renewable energy to expand on community resilience and reduce energy & GHG emissions.

We intend on using the CEMP framework for multi-year project planning, budgeting, energy and cost forecasting, and policy setting. The preliminary cost and savings estimates are based on several initiatives planned over the next few years that are prioritized according to return-on-investment, lifecycle of the asset, low risk/ease of implementation, repeatability, and resolving persistent issues.

Figure 2 outlines the estimated expenditure in order to save the estimated cumulative annual savings in the CEMP proposed time-frame. All of the savings accumulated by each measure will carry over into subsequent years. The Energy Capital Projects follow the City’s procedures of requesting project funding through the annual Capital Budget process.

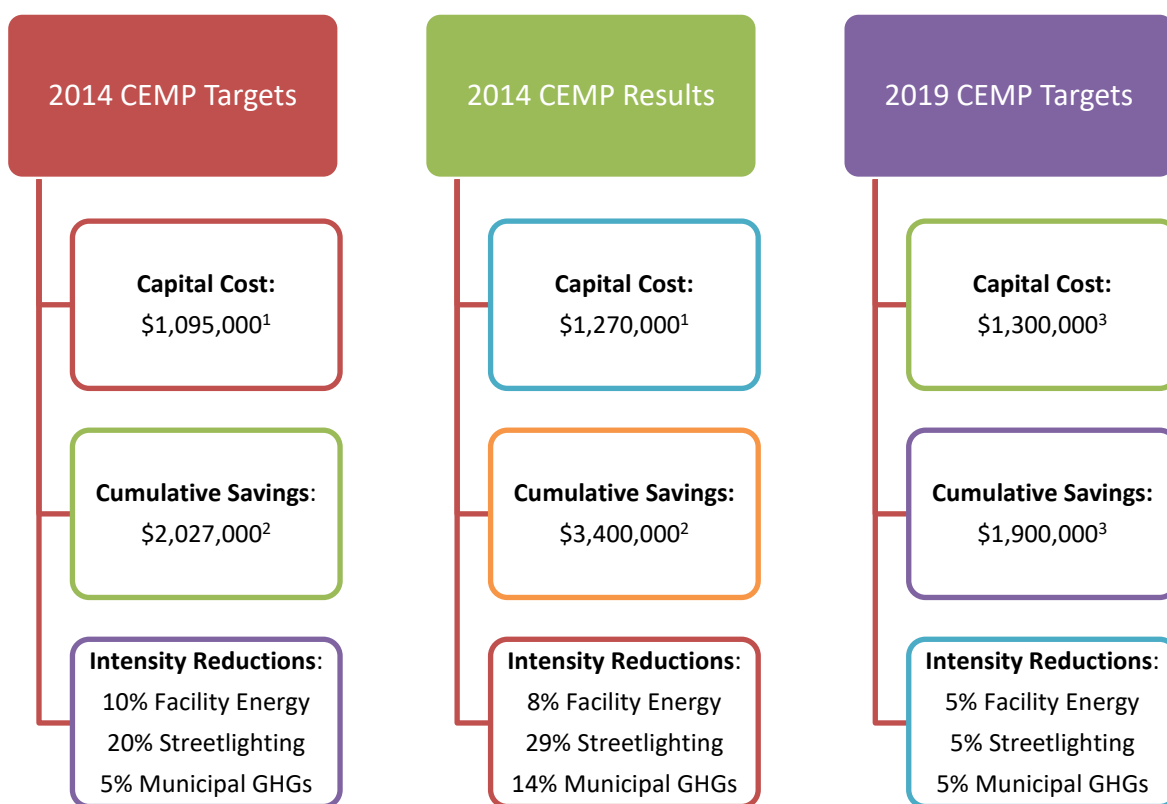


Figure 2: CEMP Financial and Performance Summary

<sup>1</sup>Capital Budget costs to fund energy initiatives with attractive paybacks (excludes utility incentives/rebates)

<sup>2</sup>Cumulative savings from 2013-2018 (excludes Streetlighting project). We saved over \$6M of cumulative cost savings including Streetlighting project

<sup>3</sup>Excludes CHP cost and savings. Estimated CHP cost is \$2.4M and cumulative cost savings (2020-2023) is \$1M

The 2019 CEMP's ambitious quantitative and qualitative goals are summarized in the figure below. Details on how we will achieve (or exceed) those goals are described throughout the CEMP in the relevant sections.



The CEMP will use the following template to highlight the energy conservation and demand management measures proposed in the plan along with estimated costs, energy/cost savings, and length of time to initiate and execute the measure. The measures in the template are recommendations in each major section of the plan to aid in achieving the goals, targets, and objectives defined in the plan.

Measure	Cost	Savings	Length
Proposed energy initiatives	Proposed cost	Proposed savings	Proposed length



## 1.2 Purpose and Progress of Markham's Corporate Energy Management Plan

### 1.2.1 Purpose

The 2009 Green Energy Act called for all public agencies to annually report energy consumption and greenhouse gas emissions beginning July 1st, 2013 and every year thereafter with Ontario Regulation (O.Reg) 397/11. Additionally, O.Reg 397/11 mandated that all public agencies prepare, report, and implement energy conservation and demand management plans by July 1, 2014 and update that plan every 5 years thereafter. On January 1, 2019, the Green Energy Act, 2009 was repealed, along with its regulations. Select conservation and energy efficiency initiatives, such as the Broader Public Sector (BPS) energy reporting regulation, were moved to the Electricity Act, 1998. O. Reg. 397/11 was replaced by O. Reg. 507/18 (BPS: Energy Reporting and Conservation and Demand Management Plans). This plan serves as the update to progress made through the 2014 CEMP.

We created the CEMP to improve energy management strategies, resources, and effectiveness. Money not spent on energy bills is money that can be better spent on innovative and financially beneficial corporate energy initiatives. The CEMP illustrates key areas for actions that the City intends on pursuing to better manage energy, as well as meet (or exceed) all criteria established by: O.Reg 507/18: Energy Reporting and Conservation and Demand Management Plans; International Organization for Standardization (ISO) 50001; and Partners for Climate Protection's (PCP) Corporate Milestones Four and Five. All three standards pertain to:



The CEMP aligns our vision, skills, incentives, and resources into a strategic action plan that encourages an environment for holistically improving energy management best practices. The CEMP is also an excellent platform to highlight our successes, reflect on our missed opportunities, and recognize the teams that contributed to building an exceptional energy management program.

## 1.2.2 Progress

Markham’s energy team supported major and minor energy projects, programs, and policies ranging from energy retrofits, awareness & training programs, Lifecycle asset upgrades to more energy-efficient technology, studies, technical support, renewable energy, energy-efficient new construction, and monitoring tools. The results from the 2014 CEMP speak for themselves (2012 baseline):

2014 CEMP Progress Highlights	Exceeded Energy Management, Greenhouse Gas, and Revenue Targets	Developed an award-winning corporate energy management program
<ul style="list-style-type: none"> <li>• <b>Launched the Battle of the Buildings Competition</b> – competition challenging facility users to save energy through low/no-cost operational changes,</li> <li>• <b>Created Sustainability &amp; Energy eLearning</b> – overview of citywide sustainability &amp; energy initiatives available to existing and new staff,</li> <li>• <b>Implemented a Utility Management System</b> – converted paper bills to electronic and consolidated utility data using an accessible web-based software suite,</li> <li>• <b>Developed &amp; implemented Corporate BAS Design Standards</b> - minimum design standards deployed for replacements, retrofits, and new construction,</li> <li>• <b>Increased solar portfolio</b> from 1.4MW to 1.8MW,</li> <li>• Designed &amp; constructed <b>(2) new LEED facilities</b>,</li> <li>• <b>Developed &amp; implemented a Lifecycle Asset Renewal framework</b> with minimum energy-efficiency requirements,</li> <li>• <b>Converted 50%</b> of streetlights &amp; <b>100%</b> of arena <b>lights to LEDs</b>.</li> </ul>	<ul style="list-style-type: none"> <li>• 15% GHG reduction per resident,</li> <li>• 29% Streetlighting intensity reduction,</li> <li>• 34 of 39 (87%) Energy initiatives proposed in the 2014 CEMP were completed or are on-going,</li> <li>• &gt;\$6 million of cumulative energy savings,</li> <li>• &gt;\$2 million/year of annual utility cost savings,</li> <li>• &gt;\$1.2 million from utility incentives and Demand Response revenue,</li> <li>• \$1.6 million in solar revenue; 1.8 MW installed solar capacity.</li> </ul>	<ul style="list-style-type: none"> <li>• FCM's "Partner's for Climate Protection Milestones 2 &amp; 3" awards,</li> <li>• First municipality in Canada to receive (2) NRCan's "ENERGY STAR" awards,</li> <li>• First municipality in Canada to receive (2) TRCA's <u>Gold</u> "Living City Energy Efficiency Leadership" awards in Community Centre Challenge,</li> <li>• TRCA's <u>Silver</u> "Living City Energy Efficiency Leadership" award in Town Hall Challenge,</li> <li>• IESO's "Energy Manager of the Year – Most Innovative Project" award,</li> <li>• Mediacorp's "Canada's Greenest Employer" award.</li> </ul>

Please see Appendix I for a list of energy measures identified in the 2014 CEMP that are completed, on-going, or not started.

## 2 City of Markham Background

Energy Management is an increasingly important topic with respect to the environment, residents, and organizations as society progresses and resources become more limited. The conventional finite energy resources – natural gas, coal, and oil – are extracted and generated at a high price economically, socially, and environmentally. Consequently, we put a strong emphasis on creating and implementing strategies to mitigate these costly effects.

**2005 – MECO formed.** The City of Markham established the Markham Energy Conservation Office (MECO) in 2005, through funding support from the City of Markham and its local distribution company Alectra (formerly PowerStream), with a vision to position the City of Markham as a leader and municipal champion in energy conservation.

MECO is responsible for leading, developing and implementing energy conservation programs that deliver realistic demand shedding and cost avoidance results, and are in line with the Provincial goals of creating a ‘culture of conservation’.

MECO’s portfolio of programs is broad-based and includes initiatives that are focused on improving internal operations by implementing retrofit projects in existing facilities as well as working to ensure new facilities are built to a higher, more efficient standard. In addition, MECO provides employee engagement and awareness programs for City staff.

**2009 – MECO joined Sustainability.** In 2009, MECO joined the newly formed Sustainability Office and was better positioned to play a key role in the preparation and implementation of the Greenprint, Markham’s Community Sustainability Plan.

**2012 – Markham enrolled in the Energy Manager Program.** In 2012, Markham was one of the first clients (and first Municipality) to enroll in the Energy Manager (EM) Program - a program offered through Alectra and the Independent Electricity System Operator that annually funds up to 80% of the energy manager’s salary, subject to several criteria that collectively reduce our energy consumption. Due to our exceptional performance, leadership in Sustainability, and commitment to consistently exceed energy targets, our Energy Manager is one of the longest-running in the province still funded through the incentivized EM Program.

**2017 – Sustainability & Asset Management departments merged.** In 2017, the Sustainability and Asset Management departments transferred to the Corporate Services Commission and merged to form the Sustainability & Asset Management (S&AM) Department, in a strategic move to more-effectively centralize/corporatize and sustainably manage our new and aging facility infrastructure. The department merge was a natural next step to advance our energy management strategy, as it shifts us from a project-based to more of a strategic energy management approach that reviews our whole portfolio, evaluates our processes, and advances the culture of incorporating energy efficiency in everything we do. Strategic energy management is a long-term approach to energy efficiency that allows for continuous energy performance improvements by providing the processes and systems needed to incorporate energy management into daily operations.

**Markham's energy program strengths and opportunities.** The Corporate Energy Team (CET) re-evaluated where the City's strengths and opportunities for improvement were in the energy planning process. The City used high-level matrices to analyze its performance and investigate opportunities for improvement. CET rated each category on a scale from zero to four; with zero having the greatest room for improvement and four equating to high proficiency with little room for improvement. The figures below outline the high-level matrices findings – see Appendix II: CEMP Self-Assessment Tool for definitions and detail on how the ratings were derived. The area with greatest opportunity for improvement was in the Monitoring & Targeting, staff engagement/training, and tracking sections. The CEMP was designed to improve on all categories with particular focus on its areas for largest growth.

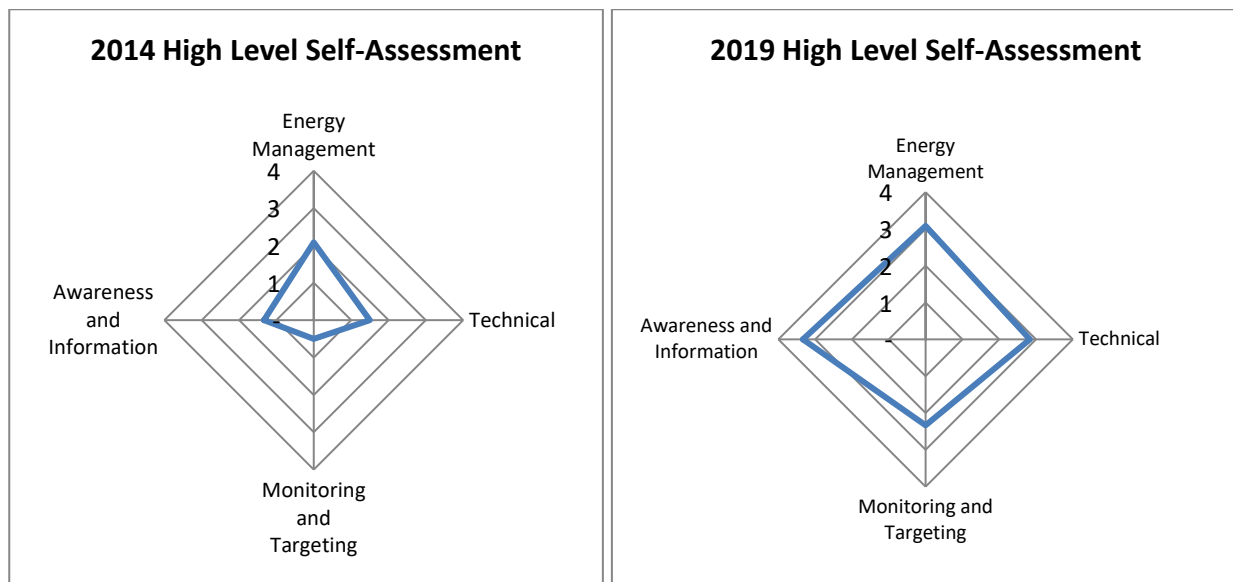


Figure 2: 2014 and 2019 Energy Management Assessment Results

We made significant progress in all of the key energy management areas in just 5 years since the last CEMP.

## 2.1 City of Markham Profile

The City first needed to determine its energy baseline in order to develop an effective and efficient energy management plan. We reviewed and compared the best and worst performing facilities to identify transferrable best practices, potential retrofit measures, and areas to further reduce energy consumption and greenhouse gas emissions.

In collaboration with Sheridan College, we developed comprehensive summaries of the City’s building data, energy consumption, intensity metrics, and greenhouse gas emissions for 2017. The City focused on the buildings defined by the criteria outlined in the Green Energy Act, which were mainly buildings that are occupied, heated and cooled. We created new baselines for the 2019 CEMP due to the addition of new facilities and Markham District Energy data relative to the 2014 baseline.

### 2.1.1 Building Information by Gross Floor Area

Using all existing and confirmed records available for 2017, the following tables and graphs illustrate the divisions sorted by gross floor area, facility type, and quantity. Overall, community centres occupy the highest percentage of gross floor area, which may include indoor ice rinks, open community centre space, indoor fitness areas, and indoor swimming pools.

City of Markham Facility Type Relative to Gross Floor Area		
Category	Number of Facilities	Gross Floor Area (ft <sup>2</sup> )
Community Centres	14	941,992
Administrative Offices	4	265,869
Indoor Ice Rinks	4	171,825
Gyms and Indoor Courts	3	97,733
Fire Stations	10	95,945
Cultural Facilities	1	68,009
Public Libraries	3	37,484
Art Galleries	2	28,116
Storage Facilities	4	12,229
<b>Total</b>	<b>45</b>	<b>1,719,202</b>

Table 1: Facility Type Relative to Gross Floor Area

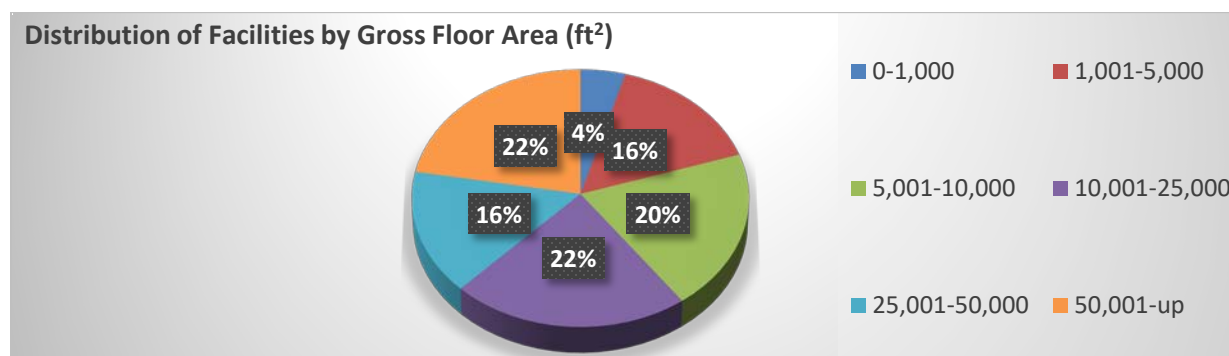


Figure 3: Number of Facilities by GFA Distribution

### 2.1.2 Building Information by Age, Gross Floor Area, and Energy Intensity

The facilities were then ranked by building age to determine the quantity of new versus older buildings as well as when the highest percentages of buildings were constructed. Between the years of 1980 to 1989, the City of Markham opened the doors for 22 new facilities marking that timeframe as the period of largest building construction. The summaries can be viewed in the tables and figures below.

City of Markham Facility Age Relative to Gross Floor Area and Energy Intensity			
Building Age Category	Number of Facilities	Gross Floor Area (ft <sup>2</sup> )	Energy Intensity (ekWh/ft <sup>2</sup> )
Before 1920	4	13,784	16.79
1920-1959	3	44,949	29.30
1960-1969	3	52,104	23.64
1970-1970	4	72,649	20.28
1980-1989	10	321,868	34.90
1990-1999	12	657,365	33.39
2000-2010	4	228,815	56.39
After 2010	5	327,668	66.31
<b>Total</b>	<b>45</b>	<b>1,719,202</b>	<b>41.89</b>

Table 2: Facility Age Relative to Gross Floor Area

Once the City of Markham’s 45 major facility background information was determined, the City calculated energy use intensity (EUI) in equivalent kilowatt-hours per square foot, and grouped the buildings by facility type. The results can be viewed in the table and figures below. The community centres account for the largest energy intensities in the City’s portfolio.

City of Markham Facility Type Relative to Energy Use Intensity Per Year						
Category	Number of Facilities	Electricity EUI (ekWh/ft <sup>2</sup> )	Natural Gas EUI (ekWh/ft <sup>2</sup> )	District Cooling EUI (ekWh/ft <sup>2</sup> )	District Heating EUI (ekWh/ft <sup>2</sup> )	Total Energy EUI (ekWh/ft <sup>2</sup> )
Community Centres	14	22.36	19.05	5.37	8.69	55.47
Storage Facilities	4	11.86	30.15	0.00	0.00	42.01
Public Libraries	3	21.35	19.47	0.00	0.00	40.82
Art Galleries	2	15.49	22.52	0.00	0.00	38.01
Fire Stations	10	11.30	19.64	0.96	2.39	34.29
Indoor Ice Rinks	4	16.97	9.31	0.00	0.00	26.28
Administrative	4	11.62	2.76	3.51	6.20	24.08
Cultural Facilities	1	10.02	9.53	0.00	0.00	19.56
Gyms and Indoor	3	2.48	8.95	0.00	0.00	11.42
<b>Total</b>	<b>45</b>	<b>17.72</b>	<b>14.78</b>	<b>5.85</b>	<b>3.54</b>	<b>41.89</b>

Table 3: Facility Type Relative to Energy Use Intensity



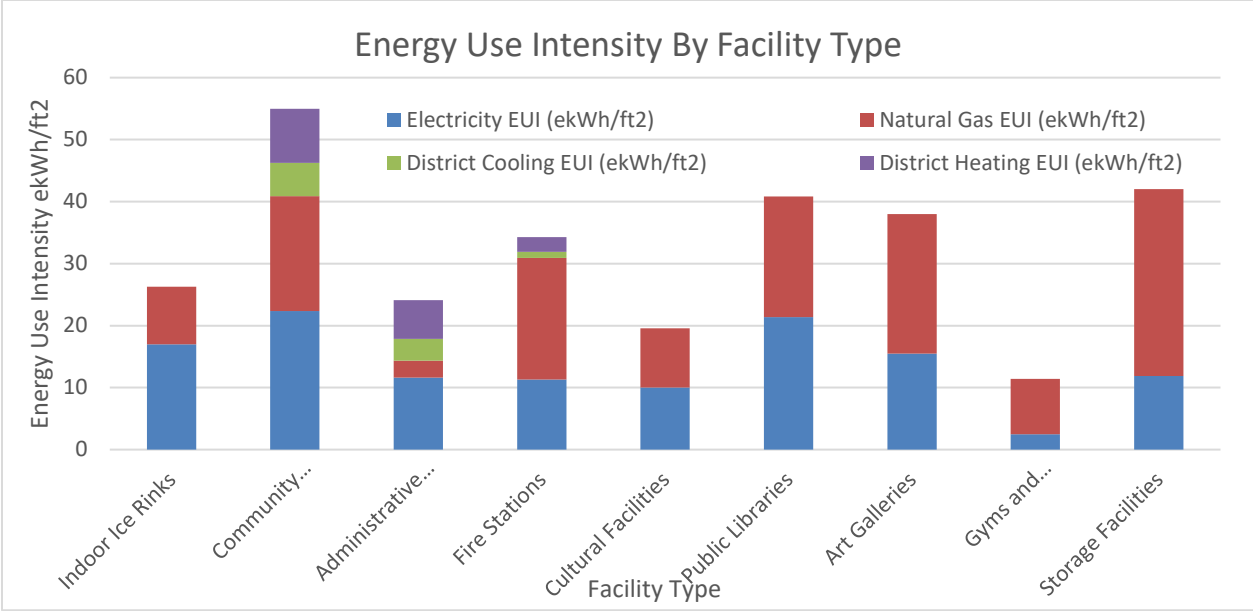
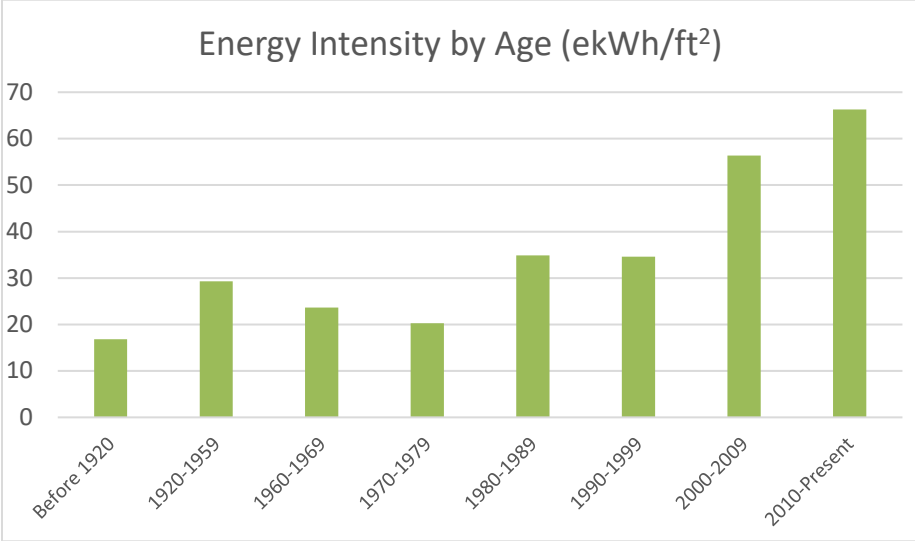


Figure 4: Energy Use Intensity by Facility Type



Dissecting the data confirmed that our newer facilities containing higher ceiling, larger windows, and increased electronic equipment are more energy intensive, on average

Figure 5: Energy Intensity by Building Age

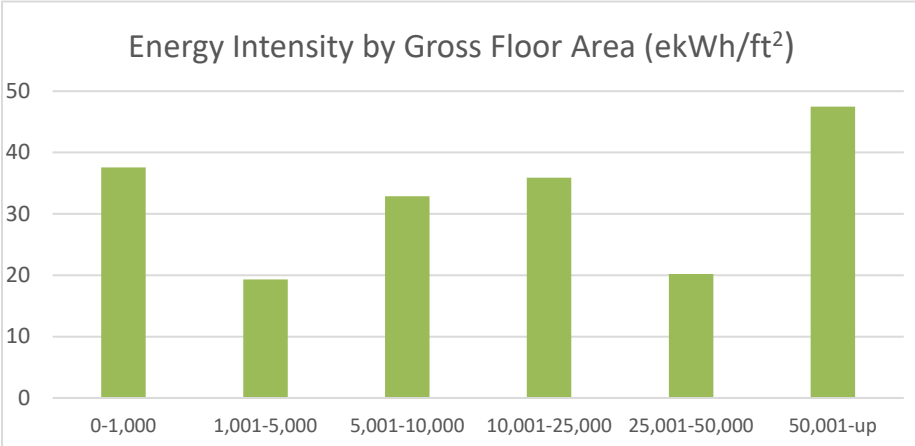


Figure 6: Energy Use Intensity by Building Size

### 2.1.3 Greenhouse Gas Emissions

We tallied our fuel inventory and analyzed each fuel source’s greenhouse gas (GHG) emissions in kilograms per year. Facility natural gas emissions dominated the total GHG emissions produced by the City, with district hot water as the second main GHG emissions source.

2017 Corporate Greenhouse Gas Emissions by Source		
Source Category	Total CO <sub>2</sub> e(Kg)	GHG Emissions by Source (%)
Facilities - Natural Gas	5,700,000	50
Facilities – District Hot Water	1,660,000	15
Facilities - Electricity	1,410,000	12
Fleet - Unleaded Fuel	1,060,000	9
Fleet - Biodiesel B5	560,000	5
Traffic & Street Lights	550,000	5
Fleet - Biodiesel B20	280,000	2
Propane (Zamboni)	70,000	1
Facilities – District Chilled Water	60,000	1
<b>Total</b>	<b>11,360,000</b>	<b>100</b>

Table 4: Corporate GHG Emissions by Source<sup>1</sup>

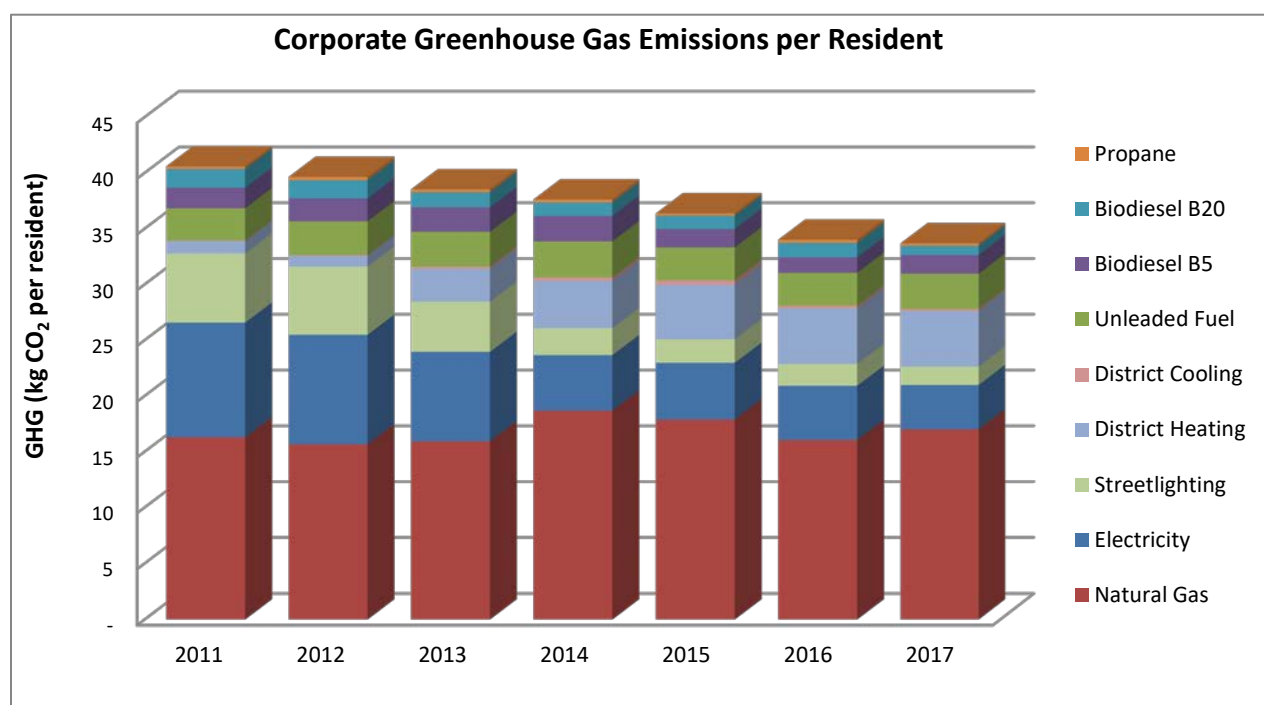


Figure 7: Corporate GHG Emissions per Resident

<sup>1</sup> CO<sub>2</sub>e emissions are calculated using the Partners for Climate Protection Milestone Tool developed by ICLEI Canada ([www.icleicanada.org/pcptool](http://www.icleicanada.org/pcptool)) and Ontario Regulation 507/18 GHG Calculation Spreadsheet

## 2.2 Energy & Environmental Management Policies

Council endorsed the Greenprint in 2011 and the Municipal Energy Plan in 2018 as plans for Markham over the next 100 years to become one of the most sustainable communities in North America. The energy objective is to achieve net-zero energy emissions by 2050. Through energy conservation and renewable energy production, we are anticipating reaching our net-zero energy emissions goal by 2050. Additionally, the intent of the plans are to provide community leadership and encourage innovation in the sustainability field. The table below summarizes recently added policies and programs that pave the way for us to continue achieving our sustainability goals.

City of Markham Energy & Environmental Management Policies		
Policy/Program	Purpose	Benefits to the City
MEP	<ul style="list-style-type: none"> <li>- A citywide energy plan that engages all sectors of the City to achieve the goal of net-zero energy and emissions by 2050</li> <li>- A GIS-based map was developed to identify the City's overall baseline energy consumption to provide short, medium and long term recommendations to reach net zero by 2050</li> </ul>	<ul style="list-style-type: none"> <li>- Increases stakeholder engagement and partnerships in all sectors to educate on energy conservation and production opportunities, reducing overall GHG emissions</li> <li>- Encourages the incorporation of innovative energy projects to implement new and efficient technology across the City increasing local job opportunities</li> <li>- Reduced GHG emissions results in a cleaner City operating more effectively</li> </ul>
Monarch Friendly city	<ul style="list-style-type: none"> <li>- Canada's first Monarch friendly city</li> <li>- Raise awareness about the decline of the monarch butterfly and the species' need for habitat</li> <li>- Public communication effort to encourage citizens to plant monarch gardens (native milkweed and nectar-producing plants) at their homes or neighbourhoods</li> </ul>	<ul style="list-style-type: none"> <li>- Increases pollinator population, which fertilizes food needed for people and wildlife</li> </ul>
Community/ Allotment Gardens	<ul style="list-style-type: none"> <li>- Community group governed space where collaborative growing, cleaning, maintenance and harvesting is done.</li> <li>- Program supported by Markham's Community Sustainability Plan</li> </ul>	<ul style="list-style-type: none"> <li>- Increases local food production</li> <li>- Provide space for residents to do their own organic farming by leasing plot of land for the city for a set fee</li> <li>- Provide right tools and knowledge on how to grow own organic garden</li> </ul>
Markham's Battle of Buildings	<ul style="list-style-type: none"> <li>- Challenges participating facilities to reduce energy consumption by at least 15% of electricity consumption relative to 2014 baseline</li> </ul>	<ul style="list-style-type: none"> <li>- Energy conservation</li> <li>- Lower electricity bill</li> <li>- Positive impact to the environment</li> <li>- Education and awareness of the occupants, staff, participants etc.</li> </ul>
Utility Monitoring &	<ul style="list-style-type: none"> <li>- Web-based utility database tool that assists building operators, Finance, and the energy team with tracking energy and bill management</li> </ul>	<ul style="list-style-type: none"> <li>- Benchmarking similar facilities</li> <li>- Improves managing energy usage, cost, and data availability and integrity</li> </ul>

City of Markham Energy & Environmental Management Policies		
Policy/Program	Purpose	Benefits to the City
Management System	<ul style="list-style-type: none"> <li>- Converted paper bills to electronic billing for time and paper savings, as well as improved data integrity, trending capability, and benchmarking</li> <li>- Consolidation of electronic and paper utility bills into one central database, accessible to all staff</li> </ul>	<ul style="list-style-type: none"> <li>- Information readily available to building managers and supervisors for analysis and reporting</li> <li>- Auditing of historical operations and bills</li> <li>- Budgeting and targeting versus actuals</li> <li>- Early detection of increased energy consumption and faulty meters</li> </ul>
Textile Recycling	<ul style="list-style-type: none"> <li>- Textile diversion by banning textile waste from curbside collection service</li> <li>- Landfill diversion strategy</li> <li>- Supporting Charitable organizations by donating reusable clothing</li> </ul>	<ul style="list-style-type: none"> <li>- Diversion of more 1.4million kilogram of clothing waste from landfills in less than a year</li> <li>- Donations proceeded to Markham’s registered charitable partners to create jobs and support communities in need</li> <li>- Gently used clothing sold by Salvation Army’s Thrift Store and Value Village locations, and the proceeds are used to help support local food banks, shelters, children’s camps, addiction treatment facilities and medical research.</li> </ul>
Alectra Drive for Workplace /EV Charging Stations	<ul style="list-style-type: none"> <li>- 2 year pilot program to assess the impact of Electrical Vehicle (EV) charging on Ontario’s grid at multiple workplace</li> <li>- Collection of real time data by Demand Energy Resource Management System (DERMS) to optimize electric load of the EVs and building service equipment.</li> <li>- Encourage the adoption of EV technology while helping businesses manage energy costs,</li> <li>- Demonstrate the value of smart EV charging systems that manage the flow of electricity needed to serve the building &amp; EV charging stations</li> </ul>	<ul style="list-style-type: none"> <li>- Reduced battery range anxiety for participating drivers.</li> <li>- (16) Level 2 EV charging stations (ten outdoor and six indoor) for program participants at no cost to City,</li> <li>- (1) Level 2 charging station for public use,</li> <li>- Alectra Utilities owns and operates the charging equipment and associated electrical infrastructure, and will be responsible for all maintenance costs during the pilot program.</li> </ul>
Lifecycle Asset Renewal Framework using ASHRAE Standard 90.1	<p>Establish minimum energy efficiency requirements for new equipment in existing buildings by:</p> <ul style="list-style-type: none"> <li>- Applying energy efficiency principles from the latest edition of ASHRAE Standard 90.1;</li> <li>- Adopting the Province’s and City of Markham’s energy efficiency standards currently in place for new construction, major renovations, and community development projects.</li> </ul>	<ul style="list-style-type: none"> <li>- Leverage existing processes and funding to improve energy efficiency</li> <li>- Ensures consistent, cost-effective, and organized approach to upgrading equipment while maximizing utility incentives and minimizing operating costs</li> <li>- Energy &amp; GHG savings, improved grid reliability, and job creation</li> </ul>

Table 5: Energy and Environmental Management Policies

## 2.3 Leadership

**Energy Teams unite!** Senior staff from the Sustainability & Asset Management, Finance, and Recreation departments formed a Corporate Energy Team (CET) in 2013 that meets on a quarterly basis to discuss the City’s forefront energy management opportunities. The CET played a crucial role in the development and endorsement of the CEMP, acting as stakeholders for their respective departments. The information is then relayed to facility teams responsible for implementing the changes.

**Greening Markham through the Greenprint.** The City of Markham strives to be a leader in all merits, with Climate Change initiatives being no exception. We developed and published the Greenprint, a long-term Community Sustainability Plan outlining the key priorities and key performance indicators to improve sustainability in our City. At the time of its release, the Greenprint was one of the few and more aggressive sustainability plans directed by a municipality with a target of net zero waste, water, and emissions by 2050. More recently, Council endorsed our Municipal Energy Plan, a comprehensive long-term city-wide energy plan with the ambitious goal of achieving net-zero energy emissions by 2050.

**FIT for Solar.** The City of Markham was the first municipality in the province to participate in the Feed-In-Tariff (FIT) program, offered by the Ontario Power Authority, and to install a solar photovoltaic (PV) system. Currently, we have two of the largest solar arrays in York Region, and 1.8 Megawatts of total solar installed across nine municipal rooftops. Of the 1.8 Megawatts solar installations, we own two microFIT systems, one FIT system, and leases six of its rooftops to Alectra Solar. All new municipal buildings owned by the City are designed and constructed to be solar PV-ready, with proper structural, mechanical, and electrical configurations to support a “plug and play” rooftop solar system.

**It’s raining awards!** Markham was also one of the first clients (and first Municipality) to enroll in the Energy Manager (EM) Program, which has continued to exceed corporate energy targets and has one of the longest running energy managers in the province still funded by the EM Program. The City is honoured to be a recognized leader in Climate Change; we have received several awards from well-respected industry leaders for our efforts in demonstrating energy-efficient leadership, environmental stewardship, and reducing GHG emissions. The table below summarizes the key measures the 2019 CEMP proposes for this area.

Measure	Cost	Savings	Length
Obtain FCM’s PCP Milestones 4 & 5 awards	N/A	N/A	2019-2020
Earn industry-esteemed awards	N/A	N/A	Ongoing

## 2.4 Past Projects and Successes

Since forming MECO in 2005, the City implemented a number of energy management initiatives that have greatly reduced energy consumption, maintenance, and greenhouse gas emissions at several facilities. The table below provides a high-level overview of the recently completed projects and areas that benefited from the 2014 CEMP improvements. For a list of all measures completed since 2010, please see Appendix IV. In the past, we manually calculated energy savings based on best known assumptions and data. As of 2013, a meter is installed on any new project that has an annual energy savings greater than \$10,000 per year, to more easily track and report energy and cost reduction performance.

City-Wide Energy-Efficiency Initiatives		
Energy Initiatives	Locations	Completed Date
<b>Energy-Efficient Lighting Retrofit</b> (pools, gyms, changerooms, hallways, exterior, fitness, etc)	Citywide	2014- 2018
<b>Utility Monitoring and Management System (UMS)</b>	City-wide	2014-2015
<b>LEED Design Standards</b>	Pan Am CC, Aaniin CC (to be confirmed)	2014, 2018
<b>Energy-Efficient Server System Upgrade</b>	8100 Warden	2015
<b>Battle of the Buildings competition</b>	All community centres and Admin facilities	2015-2018
<b>Cobra-Head Streetlighting Retrofit</b>	City-wide	2013- 2015
<b>Arena Energy-Efficient Lighting Retrofit</b>	All community centres with ice rinks converted to LED lights	2013- 2018
<b>Sustainability and Energy eLearning</b>	City-wide	2015
<b>BAS Optimization</b>	Thornhill CC, Milliken Mills CC	2016, 2018
<b>Re-Commissioning</b>	Cornell CC, Milliken Mills CC, Pan Am CC	2016-2018
<b>Energy-Efficient HVAC</b> (air-conditioning, furnaces, dehumidification, BAS scheduling, DCV, VFDs, etc)	Citywide	2014-2018
<b>Solar PV system</b>	Pan Am CC	2016

Table 6: Energy-Efficiency Initiatives



## 2.5 Energy Procurement

The City is taking action to reduce utility pricing impacts by actively managing energy consumption, demand, awareness, and incentive resources, as well as investigating procurement options. From 2012 to 2018, we received over \$1.2 million in utility incentives for completed energy-efficiency projects.

### 2.5.1 Electricity Source

Alectra Utilities supplies the City with electricity through various rate structures, depending on building and service type. The majority of Markham's electricity consumption and billing structure is on the variable Hourly Ontario Electricity Price (HOEP) and susceptible to Global Adjustment (GA). Most of the City buildings have been, and will continue to be, impacted by the electricity rate increases.

Alectra is partially owned by the City of Markham, and has a strong energy partnership designed to improve energy management, with a set of clearly defined annual electricity reduction goals. We also lease our rooftops to Alectra, who owns and operates 1,555kW of solar PV systems spanning six facilities. Two of the largest incentives received from Alectra involved retrofitting the streetlights with light-emitting-diodes (LEDs) and funding our Energy Manager.

### 2.5.2 Natural Gas Source

Enbridge Gas is the natural gas distribution company for the City of Markham. Markham and Enbridge have a collaborative relationship for improving corporate and community energy management. Enbridge offers incentive funding and Energy Specialist consultations for our conservation efforts pertaining to upgrading less efficient boilers to high efficiency or condensing boilers, improving gas equipment controls, energy recovery ventilators, and many more. Enbridge is proposing hydrogen storage by splitting water into hydrogen and oxygen atoms as well as injecting small amounts of hydrogen atoms into the natural gas grid to produce a "greener" (fewer emissions) gas mixture in the City of Markham.<sup>2</sup>

### 2.5.3 Water Source

The City of Markham is supplied by drinking water from Lake Ontario purchased through the City of Toronto and Peel Region. Additionally, Markham pipes the wastewater, from its wastewater collection system, to a Pickering treatment facility where it is processed and released back into Lake Ontario. The City's water is billed through Alectra, where both electricity and water appear on one bill per facility.



<sup>2</sup> <https://www.enbridgegas.com/Natural-Gas-and-the-Environment/Enbridge-A-Green-Future/Hydrogen-Storage>

### 2.5.4 Fleet Fuel

In 2017 and 2018, the City purchased one Ford Focus Electric Vehicle (EV) and six Mitsubishi Outlander Plug-in Hybrid Electric Vehicles (PHEV) as a first step in transitioning our fleet towards zero GHG emissions. We are participating in the ‘Alectra Drive for the Workplace’ pilot that assesses the impact of daytime EV charging at workplaces on Ontario’s electricity grid. The pilot includes 16 Level 2 (L2) EV charging stations (10 outdoor, 6 indoor), one L2 EV charging station for public use and an energy management system to balance the electricity demand between the building and charging stations. We were also the first municipality in Ontario to install a L3 EV charging station, which offers an 80% charge in 30 minutes.

The rest of the large fleet vehicles are fuelled by either regular unleaded gasoline, biodiesel B5, or biodiesel B20. Biodiesel is predominantly derived from vegetable oils and is a cleaner burning, renewable fuel alternative to petroleum diesel. Biodiesel B5 is comprised of 5% biodiesel and 95% petroleum diesel, with biodiesel B20 (20% biodiesel, 80% petroleum diesel) as the most common biodiesel blend in Canada and the United States.

Biodiesel B20 is most popular because it balances cost, greenhouse gas emissions (GHG), cold-weather performance, materials compatibility, and does not require engine modifications.

The GHG reductions are roughly proportionate to the biodiesel-to-petroleum diesel blend level: a biodiesel B20 (20% biodiesel, 80% petroleum diesel) would have roughly a 20% reduction in GHG emissions.

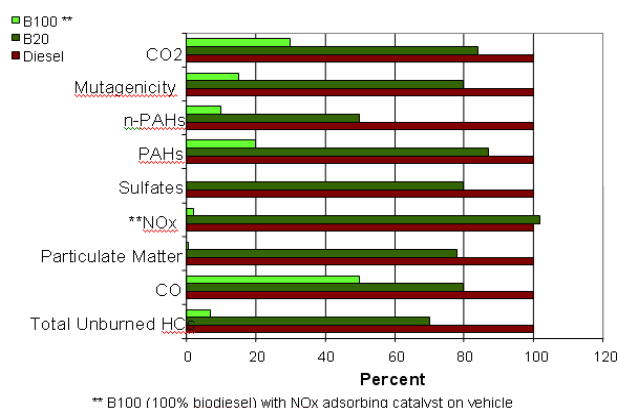


Figure 8: Diesel and Biodiesel Emissions Comparison<sup>3</sup>

The zamboni machines that act as ice resurfacers for the indoor and outdoor ice rinks use propane as its fuel source. Propane is a cleaner burning fuel that can be removed from the atmosphere by precipitation or natural oxidation, which reduces its impact on climate change. Figure 9: End-Use Carbon Dioxide Emissions by Fuel illustrates propane’s emissions effects relative to other common fuel sources

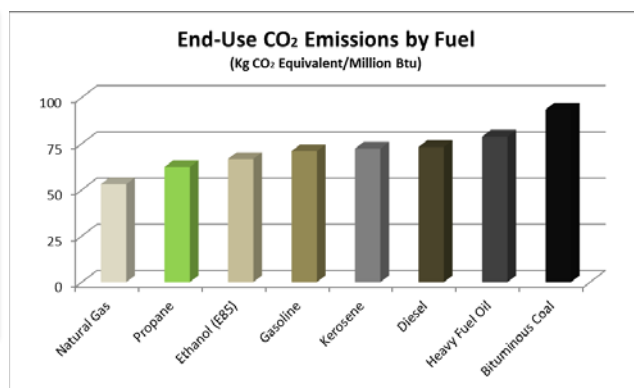


Figure 9: End-Use Carbon Dioxide Emissions by Fuel<sup>4</sup>

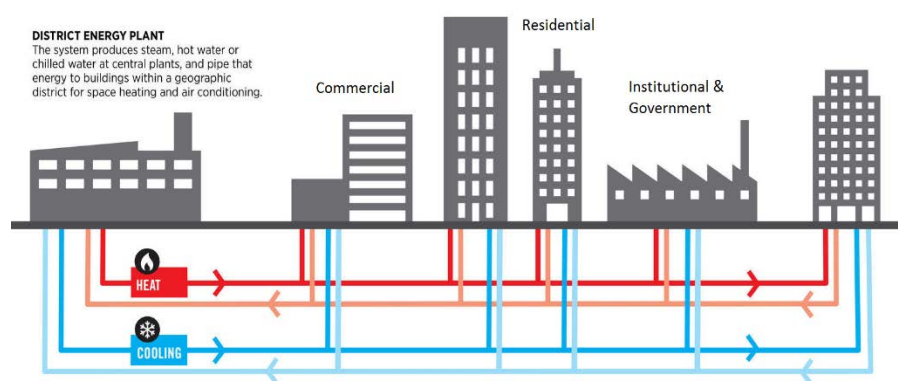
Measure	Cost	Savings	Length
Study and Model Fleet Vehicle Net-Zero Carbon Emissions	\$100,000	TBD	2019-2020

<sup>3</sup> Biotechx Energy International Ltd, CO2 Emission Comparison, 2014

<sup>4</sup> Canadian Propane Association, Emissions by Fuel Comparison, 2014

### 2.5.5 Markham District Energy

Markham District Energy (MDE) is a thermal energy utility wholly owned by the City of Markham. MDE owns and operates an award-winning community energy system supplying heated and chilled water via an underground piping network (known as a thermal grid) to public and private facilities in Markham. Not only is MDE the fastest growing district energy utility in Canada, but it has become a leading example for new district energy system development.



Our district energy systems are continually expanding to meet the needs of growing demand, while also supplying electricity to the grid as needed.

Figure 10: District Energy System

*Using a centralized heating and cooling system is comparably more efficient than installing custom heating and cooling systems in each facility* because MDE can purchase, maintain, and operate larger equipment, which is typically more efficient than installing several smaller units. MDE owns and operates four combined heat and power (CHP) units that recover waste heat, which is used in the system, and generates electricity for the local grid and back-up power needs. MDE reduces greenhouse gas emissions by 50% in the Markham and Cornell urban centres it serves and has capability to maintain power and heat to over 4 million square feet of selected buildings in Markham including its regional hospital, two high schools and a community centre. MDE has recently partnered with Pond Technologies, a company that uses sophisticated lighting and growth systems to grow algae from the carbon dioxide emissions of industry. Pond and MDE plan to construct a facility that will significantly reduce MDE’s stack carbon emissions to grow algae for the nutraceutical market; it is expected to be operational in 2020.

*In 2013, MDE received the International District Energy Association’s System of the Year Award, the highest honour the association can confer on a district energy system.* MDE is EcoLogo Certified, and received awards for Donald Cousens Conservation and Environmental Leadership and Association of Municipalities of Ontario (AMO) Federal Gas Tax Award for investing in a more efficient and economic fuel source, MDE. The City evaluates and targets all new construction buildings in the MDE service areas for district energy, with Pan Am Community Centre as the most recent addition.

Measure	Cost	Savings	Length
Improve system efficiencies and expand MDE to buildings, where feasible	Cost neutral	5% to 15% energy per building	Ongoing
Investigate and implement district energy carbon reduction strategies, where feasible	TBD	TBD	Ongoing

### 3 Corporate Goals and Objectives

#### 3.1 Goals, Objectives, Measures of Performance, and Targets

The City of Markham’s Corporate Energy Management Plan (CEMP) has three goals:

1. To position the City to move toward the goals from the Municipal Energy Plan and Greenprint of “Net-Zero Energy Emissions by 2050”.
2. To support the Corporate Goal of a “Safe & Sustainable Community” where “We will protect the public and respect the natural and built environments through excellence in sustainable community planning, infrastructure management, and programs.”
3. Develop an updated Corporate Energy Management Plan that meets the requirements for O.Reg 507/18: Energy Reporting and Conservation and Demand Management Plans, and Partners for Climate Protection Milestone’s Four and Five.

We aim to learn from our missed opportunities, improve performance of our core energy management practices, and apply innovative approaches to solving existing challenges that will fundamentally improve the way we use, produce, and manage energy. To achieve our goals, we developed the following objectives outlined in Table 7: CEMP Objectives.

City of Markham CEMP Objectives
<b>Reduce energy consumption, demand, cost, and greenhouse gas emissions</b>
<b>Reduce maintenance resources and costs, and extend equipment life</b>
<b>Increase equipment reliability and efficiency</b>
<b>Demonstrate leadership in renewable energy and efficient fuel sources</b>
<b>Enhance the existing culture of energy management and sustainability</b>
<b>Improve quality and comfort for facility users</b>
<b>Reduce risk of volatile energy prices</b>
<b>Increase energy supply security and community resilience</b>
<b>Promote local economic development</b>
<b>Leverage the Lifecycle asset renewal process to integrate sustainable technology</b>

Table 7: CEMP Objectives

With a comprehensive corporate energy management plan, Markham is positioning itself to benefit in the above key areas.

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Since the 2014 CEMP, we’ve implemented in excess of 200 energy conservation projects that are annually saving the City over 13 million kilowatt-hours, \$2 million per year, and reduced greenhouse gas emissions by 14% per resident. We’ve received over \$1.2 million via utility incentives and generated \$1.6 million from solar revenue that is reinvested to fund energy initiatives.

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Each 2014 CEMP performance metric is outlined in the table below; we exceeded our Streetlighting and GHG Emission Intensity targets but fell 2% short on our Facility Energy Intensity target.

2014 CEMP Performance Results					
Measure Description	2012 Baseline	Target Reduction	2017 Target	2017 Actual	Achieved Reduction
Corporate Facility Energy Intensity	35 ekWh /ft <sup>2</sup> /year	<b>10% Reduction</b>	31 ekWh /ft <sup>2</sup> /year	32 ekWh /ft <sup>2</sup> /year	<b>8% Reduction</b>
Streetlighting Energy Intensity	694 kWh/ fixture/year	<b>20% Reduction</b>	555 kWh/ fixture/year	491 kWh/ fixture/year	<b>29% Reduction</b>
Municipal Operations GHG Emissions Intensity	39.7 kg GHG/person/ year	<b>5% Reduction</b>	37.7 kg GHG/person/ year	34 kg GHG/person/ year	<b>14% Reduction</b>

Table 8: 2014 CEMP Performance Results

The targets for our 2019 CEMP were determined based on projected savings of projects and programs outlined in this plan. We selected 2017 as the baseline year for our 2019 CEMP because it was the last full year with complete energy data and is 5 years after the 2014 CEMP’s baseline. **We are targeting a 1% reduction per year in energy intensity and GHG emissions over the next 5 years.** The baseline, which the objectives are based off, is illustrated in the table below.

As per our strategic plan of Building Markham’s Future Together (BMFT), we are focused on delivering Exceptional Services by Exceptional People and building a Safe & Sustainable Community. We are a growing municipality that continues to expand our services and facility reach. We developed a new 2017 baseline as several new municipal facilities were added to our portfolio since the 2014 CEMP and we have access to more complete and accurate data that is readily available through our Utility Management System, Facilitydude. The new CEMP baseline was developed to include the new facilities, data that was previously only available through paper bills, and Markham District Energy data.

2017 Baseline Performance Measures	2017 Baseline	Target Reduction (%)	2022 Target
Corporate Facility Energy Intensity	42 ekWh/ft <sup>2</sup> /year	<b>5% Reduction</b>	40 ekWh/ft <sup>2</sup> /year
Streetlighting Energy Intensity	491 kWh/fixture/year	<b>5% Reduction</b>	466 kWh/fixture/year
Municipal Operations GHG Emissions Intensity	34 kg GHG/person/ year	<b>5% Reduction</b>	32 kg GHG/person/year

Table 9: CEMP Performance Measures, Baselines, and Targets

The City achieved Partners for Climate Protection (PCP) Milestone 1 by creating a greenhouse gas inventory and projecting future emissions. Senior management endorsement of the CEMP enabled us to achieve Corporate Milestone 2 and 3 by setting municipal operations emissions reduction targets (defined in Table 8: CEMP Performance Results), and developing an action plan to achieve those targets as outlined in the CEMP. Implementing the measures from the 2014 CEMP and reporting back on the results through the 2019 CEMP are predicted to fulfill PCP’s Milestones 4 and 5 criteria.





### 3.2 Energy Efficiency’s Role in Increasing Community Resilience

Community resilience is defined as a community’s reduction of, and preparation for, risk. Energy efficiency can support community resilience by strengthening local energy systems and delivering more reliable and affordable energy for the local governments, households, and businesses.<sup>5</sup>

**Table 10: Energy Efficiency Resilience Benefits**

The adjacent table outlines the resilience benefits to a community by investing in energy efficiency.

Energy efficiency offers several benefits for emergency response and recovery, climate change adaptation and mitigation, as well as social and economic benefits.

Benefit type	Energy efficiency outcome	Resilience benefit
Emergency response and recovery	Reduced electric demand	Increased reliability during times of stress on electric system and increased ability to respond to system emergencies
	Backup power supply from combined heat and power (CHP) and microgrids	Ability to maintain energy supply during emergency or disruption
	Efficient buildings that maintain temperatures	Residents can shelter in place as long as buildings’ structural integrity is maintained.
Social and economic	Multiple modes of transportation and efficient vehicles	Several travel options that can be used during evacuations and disruptions
	Local economic resources may stay in the community	Stronger local economy that is less susceptible to hazards and disruptions
	Reduced exposure to energy price volatility	Economy is better positioned to manage energy price increases, and households and businesses are better able to plan for future.
	Reduced spending on energy	Ability to spend income on other needs, increasing disposable income (especially important for low-income families)
Climate mitigation and adaptation	Improved indoor air quality and emission of fewer local pollutants	Fewer public health stressors
	Reduced greenhouse gas emissions from power sector	Mitigation of climate change
	Cost-effective efficiency investments	More leeway to maximize investment in resilient redundancy measures, including adaptation measures

As detailed throughout this CEMP, Markham values the importance of increasing community resilience and prioritizes initiatives that enhance our ability to build a more reliable, healthy, and sustainable future.

Energy Efficiency Measure	Resilience implications	Markham examples
<b>Mircogrids</b>	Can provide cost-effective heating, cooling, and/or electricity using local energy sources. Can reduce peak power demand, GHG emissions, and provide backup power during emergencies. Cost savings	Markham District Energy, net-metered solar, CHP, geothermal
<b>Energy efficiency programs</b>	Increases reliability and indoor air quality. Reduces energy consumption, costs, GHG emissions, and exposure to rate fluctuations	Over 200 energy initiatives implemented since 2013
<b>Demand Management programs</b>	Decreases stress on utility grid, ability to respond to system emergencies, reduces costs, can provide revenue source	Demand Response, peak reduction initiatives, EV Workplace Charging Pilot

**Table 11: Energy Efficiency Measures that Reduce Vulnerability and Increase Capacity**

<sup>5</sup> Enhancing Community Resilience through Energy Efficiency

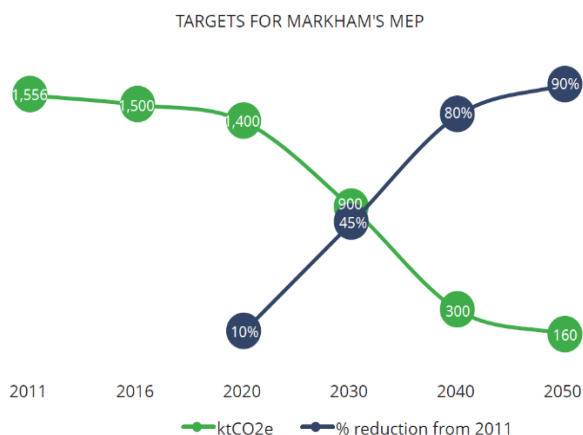


### 3.3 Net-Zero Energy Emissions

**Council endorsed our Municipal Energy Plan (MEP) in 2018, with a goal for the entire City to achieve net-zero energy emissions by 2050.** Markham’s MEP is a comprehensive long-term citywide energy plan that will improve energy-efficiency, and reduces energy consumption and greenhouse gas emissions in established and new community areas.

As part of the development of the MEP, a 2011 baseline energy and emissions inventory was created for all sectors. Our MEP provides a roadmap to achieve the objective of Net-Zero Energy Emissions (NZEE) by 2050 as outlined in the Energy & Climate priority in the Greenprint, Markham’s Community Sustainability Plan.

Figure 11: GHG Reduction Targets for the MEP



To achieve NZEE 2050, Markham needs to decrease energy consumption in all sectors; switch to low carbon renewable energy sources; and increase local renewable energy generation.

**Markham's Municipal Energy Plan (MEP) strongly supports re-commissioning and retrofitting existing buildings to achieve energy savings and GHG reductions.** Our MEP is estimating 15% energy savings resulting from re-commissioning existing buildings, and 40% thermal energy savings and 30% electrical savings by retrofitting existing commercial buildings.

We are ambitiously targeting all of our largest energy-consuming municipal facilities with the most savings potential to follow the energy pyramid structure outlined below including undergoing energy analysis and audits, conservation/engagement campaigns, re-commissioning, energy-efficiency retrofits, intelligent building controls upgrades, demand management, and finally renewable energy generation. Our goal is to lead the community by example, through our City assets, towards a sustainable future.

The Energy Pyramid approach is advantageous because it prioritizes energy management measures in a hierarchical manner, focusing the most time at the bottom of the pyramid (energy analysis, conservation), then transitioning to increasingly more expensive/complex (load shifting, renewable energy) opportunities as we move up the pyramid.

Each step represents the foundation upon which the next step may be constructed, with particular focus of utilizing existing assets/equipment to their maximum potential prior to moving on to the next step.

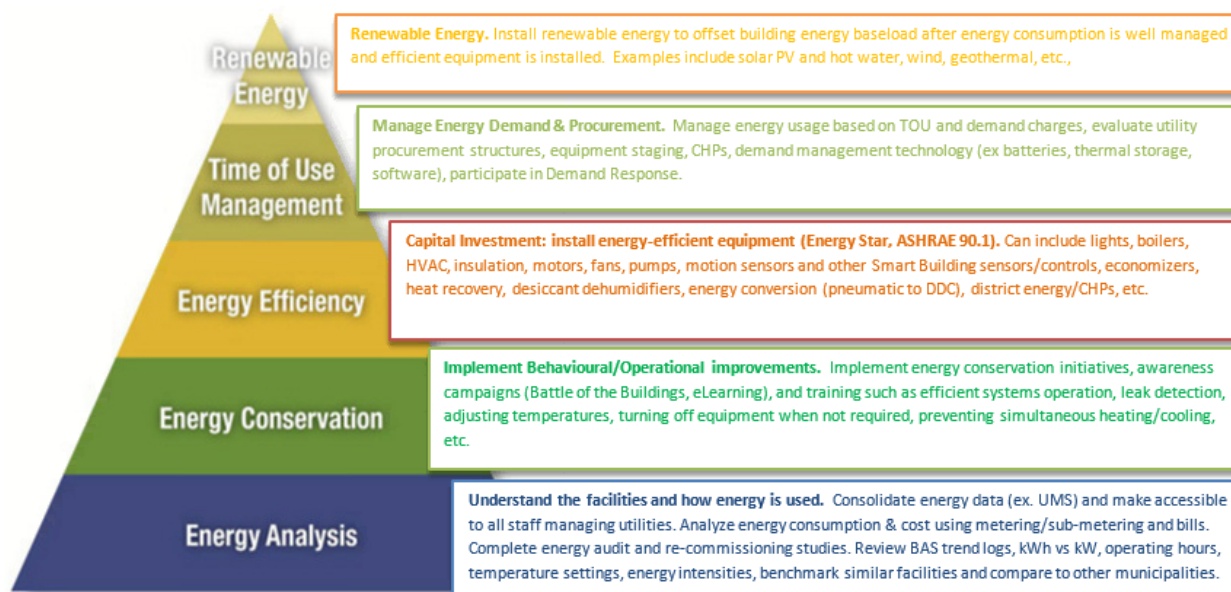


Figure 12: Markham's Energy Pyramid Strategy

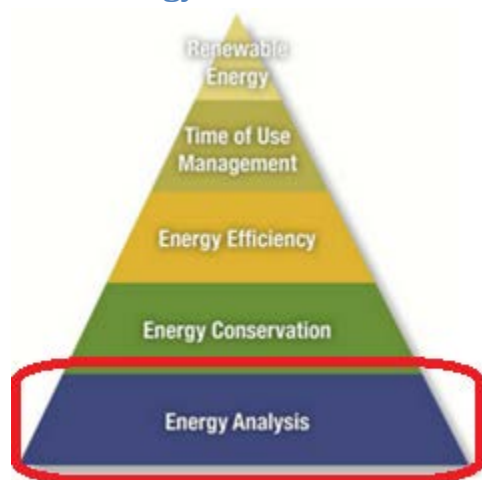
Once we have achieved significant energy and cost savings through operating the facilities as efficiently as possible, installing high-efficiency equipment, and balancing energy demand, then we will we look at adding renewable energy to tackle the remaining energy consumption and GHG emissions. It is the most resource and fiscally responsible approach, as an efficient building will require less renewable energy to achieve net-zero relative to an inefficient one. The City will also consider carbon offset and/or sequestration for the final emissions to achieve NZEE 2050.

Measure	Cost	Savings	Length
Develop Corporate NZEE 2050 study scope with short to medium to long-term reduction strategies including recommendations and solutions	N/A	N/A	2020
Launch Corporate NZEE 2050 study and identify resources (ie. Staff, funding) required to implement the NZEE 2050 plan	\$100,000	TBD	2021-2023

## 4 Energy Analysis, Metering, Monitoring and Verification Program

Energy analysis is the foundation of the energy management pyramid; we cannot expect to be as effective at managing energy without first understanding the what, when, where, why, and how energy is being used. As the management adage goes, “you can’t manage what you don’t measure”. It’s prudent to invest the most time in energy analysis as it lays the groundwork for subsequent investment, resource allocation, and decision-making. In other words, knowing where and how the energy is being used guides our strategies on whether we should be expending more resources on energy conservation, efficiency, or demand management.

### 4.1 Energy Audits and Commissioning



Energy audits and commissioning studies primarily fall under the “energy analysis” step of the pyramid, and can help us assess existing building conditions and benchmarking. The studies direct where we should focus our resources and are inputs to the energy conservation and efficiency steps of the pyramid.

Commissioning is performed to ensure that building systems are operating in accordance with facility requirements and design intent. Retro-commissioning is a type of commissioning that refers to existing buildings that have not been previously commissioned. Re-commissioning is returning facility performance back to its original or revised design intent.

Commissioning mainly focuses on improving operation, maintenance, and energy performance through no/low-cost opportunities.

An energy audit seeks to reduce the energy consumption of a building without compromising performance. It involves a building inspection just like commissioning, but the purpose is to identify capital upgrades that improve energy performance, exceeding the operating conditions specified in design documents. Energy audits often focus on capital energy-efficient equipment investment and identification of no/low-cost energy savings opportunities as outlined in the figure below.

Service	Operations and Maintenance (O&M) Improvements	No-Cost / Low-Cost Savings Opportunities	Capital Retrofit Savings Opportunities
Recommissioning (RCx)	Primary	Primary	Secondary
Energy Audit	Secondary	Primary	Primary

Figure 13: Re-Commissioning vs Energy Audits

Adapted from: Jim Poulos. “Existing Building Commissioning,” ASHRAE Journal, Sept. 2007, pp. 66-78.

### 4.1.1 Energy Audits

Energy use is often one of a businesses’ most substantial operating expenses – it is our 3<sup>rd</sup> most expensive operating expense in Markham. People, process, and technology are essential for optimal building performance. An energy audit determines the amount of energy used in the facility (by major equipment) and identifies the specific conditions that are affecting the facility’s performance and comfort.

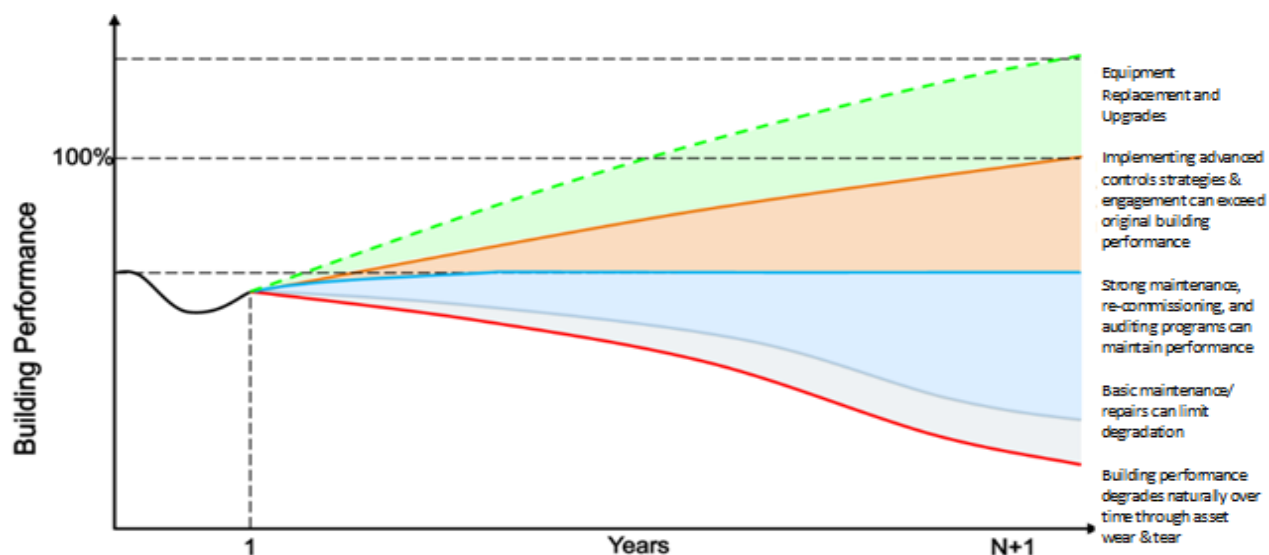


Figure 14: Building Performance over time

In recent years, we’ve included energy audits prior to installing new building automation systems (BAS) and major facility overhauls. Markham benefits from energy audits by:

- Reduced energy consumption, cost, and greenhouse gas emissions,
- Reduced operation and maintenance costs,
- Identified equipment replacement and operational improvements,
- Modernized mechanical and technological systems/solutions,
- Improved project implementation,
- Updated equipment inventory lists,
- Enhanced building occupant comfort levels,
- Utility incentive eligibility with measured and verified savings,
- Benchmarked and analyzed energy data.

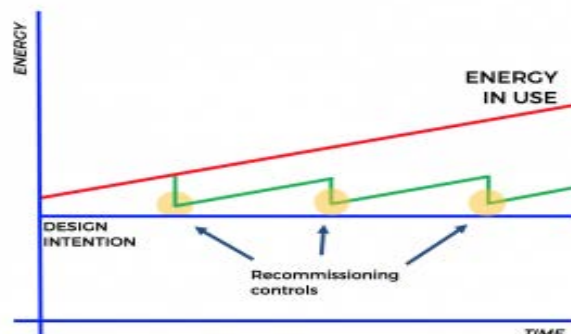
Measure	Cost	Savings	Length
Evaluate feasibility of adding facility Level 2 energy audits and/or re-commissioning studies to Capital Lifecycle Plan, and	\$0.15 to \$0.24 per ft <sup>2</sup>	5% to 20% per building, often included with BAS, Lifecycle, and re-commissioning projects	2023-2024
Perform energy audits prior to major facility upgrades, as necessary			Ongoing

### 4.1.2 (Re/Retro)-Commissioning

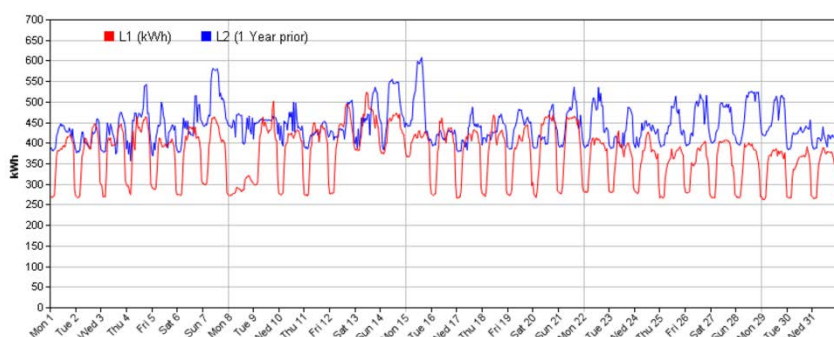
Re-commissioning, or retro-commissioning, is a cost-effective process to optimize existing building performance and identify operational improvements to: increase occupant comfort, reduce maintenance, extend the life of building equipment, increase operator knowledge, and reduce energy costs. Building priority was sorted based on the following criteria:

- ✓ Largest Energy Use Index (EUI),
- ✓ Persistent equipment and/or control system issues,
- ✓ Unexplained increase in energy consumption,
- ✓ Occupant comfort complaints

Re-commissioning is important in any business due to the fact that: occupant variances may require adjusting buildings system functions, opportunities to improve comfort and performance increase as buildings age, and building automation systems are growing increasingly complex and difficult to manage without expertise.



Lawrence Berkeley National Laboratory (LBNL) built the world’s largest database of commercial building commissioning experience to characterize project performance and cost-effectiveness. The commissioning projects’ data revealed over 10,000 energy-related problems, resulting in 16% median whole-building energy savings in existing buildings and 13% in new construction, with average paybacks of 1.1 and 4.2 years, respectively. ***This demonstrates that commissioning is arguably the single-most cost-effective strategy for reducing energy, costs, and GHG emissions in buildings today.***



We completed re-commissioning projects at Cornell and Pan Am Community Centres totalling over 15% energy savings in each facility.

**Figure 15: Pan Am Community Centre before & after Re-Commissioning project**

Additionally, Milliken Mills Community Centre identified and implemented nine (9) energy conservation measures that are saving the facility over 5% of their gas consumption through Enbridge Gas’ Run it Right Program. The program provided a free high-level energy audit to identify no/low-cost operational improvements, implementation incentives, and a free gas meter upgrade to see real-time hourly data.

Measure	Cost	Savings	Length
Re-commission buildings, as applicable	\$0.15 to \$0.30 per ft <sup>2</sup>	5% to 20% per facility, included in BAS savings	Ongoing
Enroll eligible facilities in Enbridge’s Run it Right program	N/A	3-5% gas savings per facility	Ongoing

## 4.2 Project Metering

We created a basic measurement and verification (M&V) strategy for energy conservation projects and operational management that closely follows the International Performance Measurement and Verification Protocol. The size, scale, and complexity of the projects dictate which M&V process the City pursues. This was an area identified in the 2014 CEMP with significant room for efficiency gains, and even though we achieved the results outlined in the sections below, this remains an area with a lot more room for improvement.

We install an electrical meter on any energy retrofit project that has a total energy cost savings greater than \$10,000 for the purpose of tracking energy performance. This simplifies the M&V as well as the reporting process for energy conservation measures. We are now able to monitor 17 energy conservation projects in total, 13 of which were added since the 2014 CEMP.

Measure	Cost	Savings	Length
Apply for utility incentives on eligible projects	N/A	\$100,000/year average revenue	Ongoing
Recruit staffing resource to effectively utilize and manage metering tools to identify energy and cost savings	N/A	5-10% per facility	2019 - Recruit Ongoing
Develop M&V plans, and utilize/add metering tools for project M&V to secure incentive funding	\$1,000 per project	Included in utility incentive revenue	Ongoing

## 4.3 Sub-Metering

In new large buildings, such as recreation complexes, the City installs a sub-metering system to improve its understanding on when and how the energy is being used inside the facility. To date, buildings with an advanced sub-metering system include: the Civic Centre (2012), Cornell Community Centre (2013), Pan Am Community Centre (2016), and Aaniin Community Centre (2017). Although the systems are very useful when an experienced individual is working with them, the City currently has limited staffing resources to adequately monitor and manage energy consumption with these powerful tools.

Measure	Cost	Savings	Length
Study and develop city-wide metering program and standardized specifications	N/A	N/A	2019-2020
Standardize and centralize metering monitoring and management at largest facilities, if feasible	N/A	N/A	2021-2024



### 4.4 Hourly Interval Metering

Interval, or hourly, metering is a valuable tool to analyze energy consumption at various points in the day and week. Interval metering can assist in identifying and differentiating where the largest opportunities for improvements are available. Hourly meters assist in determining load factor, peak demand, occupied versus unoccupied consumption, holiday consumption, and if the systems operate according to their programmed scheduling.

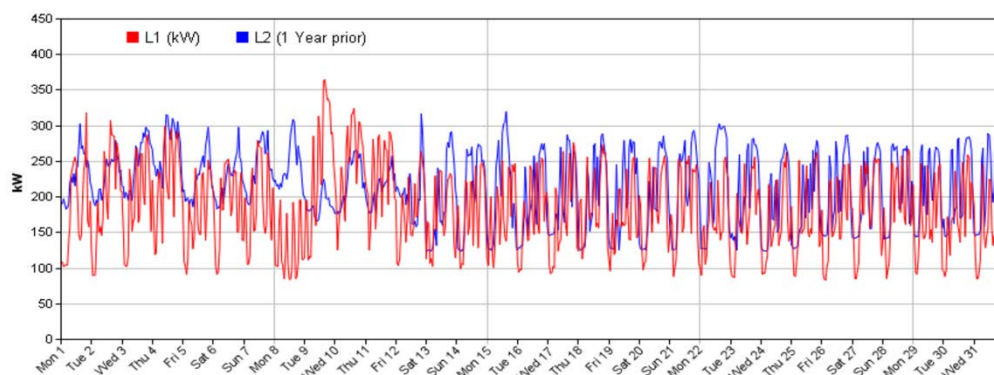


Figure 16: Milliken Mills Community Centre before & after BAS retrofit (~10% savings)

In the 2014 CEMP, we had obtained access to 9 facilities using Powerview, Alectra’s web-based portal to view hourly electricity data. Since the 2014 CEMP, we obtained access to an additional 3 meters through Powerview and one hourly natural gas meter through Entrac, Enbridge’s web-based portal. This data is also extremely useful in tracking energy performance through Markham’s Battle of the Buildings Competition, which is described in detail in Section 5.

Measure	Cost	Savings	Length
Upgrade whole-building Alectra electricity meters to hourly interval meters, and obtain remote access capability	\$500 per building	Included in metering analysis savings	Ongoing
Upgrade whole-building Enbridge Gas gas meters to hourly interval meters, and obtain remote access capability	\$1,000 per building	Included in metering analysis savings	Ongoing

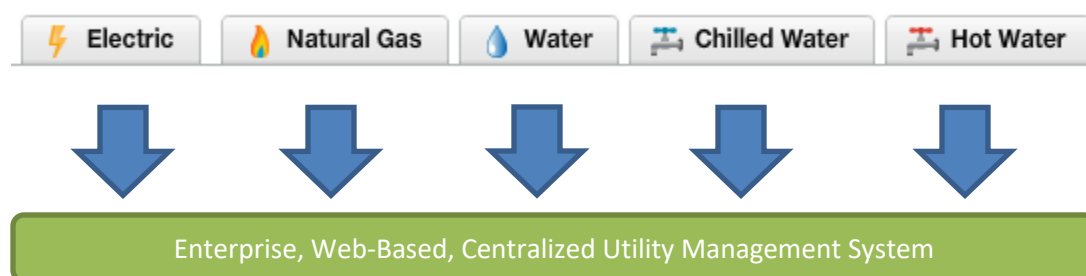
### 4.5 Financial Data

Financial data is used in the absence of a sub-metering system or project specific meters. Monthly financial data can perform rough monitoring and verification for the building. Monthly financial data is typically used for building operational savings projects when a sub-metering system does not exist and installing meters to track savings is cost prohibitive. Large buildings are more difficult to verify savings relative to small buildings.



## 4.6 Utility Monitoring and Management System

*The Utility Monitoring & Management System (UMS) is a database and Key Performance Indicator tool combining all of our utility billing data into one centralized, online platform that streamlines energy consumption and cost information to all key stakeholders.* Prior to embarking on this process improvement, obtaining up-to-date and complete utility data on a timely basis was a challenge. Utility data was managed by several staff, multiple excel files, webpage downloads, and paper bills. We began working on database solutions once we were able to pull all of the data into one centralized location.



- City of Markham
  - ▼ Top 50 Bldgs.
    - ▶ Administration
    - ▶ Community Centres
    - ▶ Culture
    - ▶ Fire
    - ▶ Library
    - ▶ Maintenance
    - ▶ Other
    - ▶ Waterworks

We created a two-phased approach to our UMS. In the first phase (2014-2015), we incorporated the 50 highest energy-consuming buildings into our UMS, which encompassed the top 50 buildings' electric, water, and gas billing data (approximately 150 utility accounts).

In the second phase (2016-2018), we expanded our UMS beyond the Top 50 Buildings to include 65 major facilities, several small facilities/parks, and district energy data that equates to over 400 utility accounts in the system. Additionally, we converted the majority of our manually-processed paper bills to electronic, and now exclusively use our UMS when reviewing historical utility data and creating utility budgets by facility and utility type.

*The introduction of our UMS had cross-commission benefits including: providing timely, accurate and complete energy information to facility staff, auditing historical operations and bills, energy project tracking, comparing budgets to actual consumption and cost, benchmarking similar facilities, best practice development, cost avoidances due to early variance detection, faulty meter discovery, and improved occupant habits.*

We've made a lot of progress over the years in gradually improving data quality and accuracy in our UMS; with a complete dataset, we are leveraging this opportunity of revising the CEMP to re-baseline our energy consumption, GHG emissions, and targets. Improving accuracy and completeness is imperative to improving energy budgeting and external reporting.

Measure	Cost	Savings	Length
Complete utility bill audits; identify and implement cost savings	\$5,200 per year UMS software	N/A 1-5% cost savings	2019-2020 Annual

## 5 Energy Conservation, Engagement & Operational Best Practices

Energy conservation and efficiency are related but not the same: energy conservation involves only using resources when required, usually by adjusting behaviours and habits (ex. turning off lights, setting back temperatures overnight), whereas energy efficiency often involves using technology and tools that require less energy to perform the same functions (ex. LED bulbs, ENERGYSTAR equipment).

Energy conservation is the second major foundation of energy management and an effective method of cutting consumption, cost, and pollution through no to low-cost approaches. When building owners are knowledgeable, engaged, and have access to organized and concise data on their building's operation and performance, they gain the necessary tools and understanding of what opportunities are most beneficial to pursue.

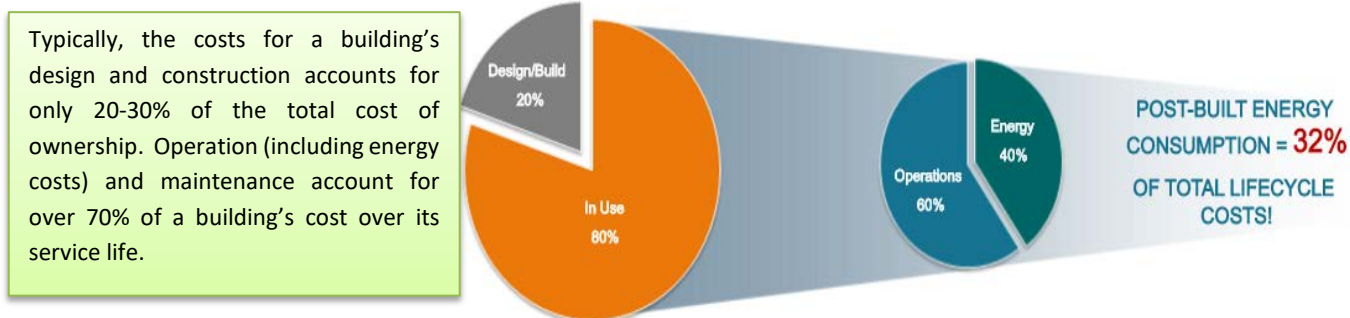


*Aside from benefits such as facility performance improvements, system reliability, and cost savings to Markham, energy-efficiency empowers and invests in people.* We are increasing focus of our energy awareness programs to further promote energy conservation and efficiency. The awareness programs include an online energy awareness program, operator recommendations that can be shared across facilities, and integration into the lifecycle asset renewal process. The energy team developed a Sustainability and Energy eLearning series (included in on-boarding), Paper Reduction Challenge, Battle of the Buildings Competition, and updated our Sustainable Purchasing Guide.

The results of building a strongly engaged and supportive team is that staff are more informed, educated, and more likely to consider energy while operating their buildings or replacing equipment. The sections below outline the key tactics we utilized to improve energy communication and awareness.

### 5.1 Providing Tools and Resources to Educated Staff

Energy conservation plays a crucial role in cost avoidance, and often goes hand-in-hand with best practice operating procedures. Operating equipment more efficiently is normally directly proportional to prolonged equipment life due to reduced operating hours, operating speeds, heat generation on mechanical and/or electrical equipment, loads on equipment, and improved control schemes. In our experience, there has been a strong correlation between reduced energy and maintenance costs upon completing energy management projects.<sup>6</sup>



<sup>6</sup> Siemens' 12 Things You Need to Know About Monitoring Based Commissioning

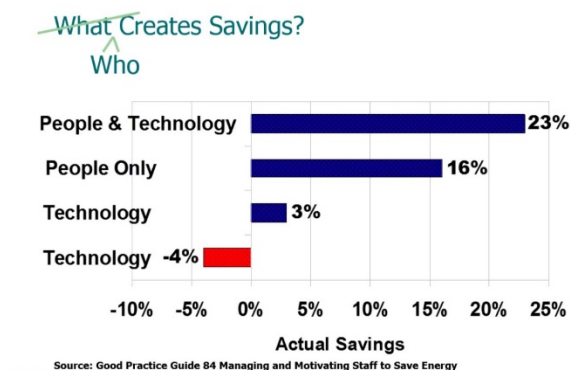


Figure 17: Who Creates Savings?

As depicted, the first case is people engaged, trained and using technology optimally, second is trained people engaged in energy conservation, the last two cases are using energy-efficient technology without adequate training and engagement. The results show that engaged people using the technology optimally is the best combination to achieve the deepest energy savings.

## 5.2 Energy Skills Training

Building design is increasingly focused on intelligent, energy efficient and high performance technologies that improve energy performance and reduce building operating costs. Optimizing building performance requires an understanding of how to successfully integrate independent systems. HVAC and related mechanical building systems require dynamic attention to address issues, comfort, energy performance, repairs and maintenance on an on-going basis. The BAS can be our operator’s #1 tool to manage the facility and performance. Without training, the BAS can also be our #1 hurdle in addressing concerns.

One of the reoccurring suggestions from facility staff was to offer technology-specific training and attend in-depth energy management courses to expand on their system and energy management knowledge. A few of our facility staff now have Building Environmental Systems (BES) Operator training, which is designed to train technicians in the operation of today's complex buildings. These programs focus on the concept that "buildings are systems", in which heating, air conditioning, refrigeration, ventilation, electrical power, lighting, water and air supply are not isolated, but connected and interdependent<sup>7</sup>.

The energy team coordinated and funded BAS training via the site’s BAS providers to implement training on their own systems that educated and engaged staff to better understand and manage the BAS inside their facility. Since launching the Battle of the Buildings competition, our utility management systems and metering systems are also used more frequently. Our goals are to not only increase training, but also resources (ex. videos, guides, reports) that will empower facility staff to make informed decisions on how to most effectively and efficiently operate their facilities.

Measure	Cost	Savings	Length
BAS and HVAC training	\$1,000 to \$4,000 per session	Included in engagement savings	Annual, Ongoing
Utility Management System and metering training	N/A	Included in engagement savings	Annual, Ongoing

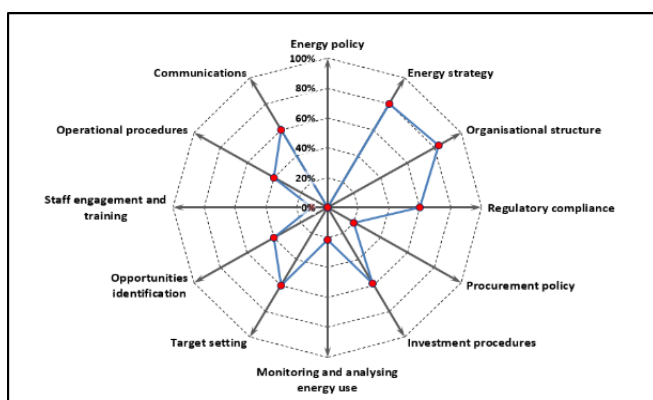
<sup>7</sup> Seneca’s Building Environmental Systems (BES) Program.

### 5.3 Battle of the Buildings

Markham launched the Battle of the Buildings Competition in 2015 that challenges participants to cumulatively reduce their facility’s electricity consumption by at least 15%, and maintain those savings year-round. The intent is to inspire, educate, and motivate facility users to:

- 1) Raise awareness, and take ownership, of each facility's utility consumption and associated costs,
- 2) Engage and educate staff and residents on their environmental impact at public facilities,
- 3) Identify low-cost/no-cost operational improvements,
- 4) Share operational best practices among similar facilities,
- 5) Recognize and reward individuals that take initiative to continuously improve, and
- 6) Save money by decreasing energy consumption and GHG emissions.

Ten community centres participated in the 3-month 2015 pilot competition. The competition was so successful, that in 2016 it expanded to included four additional facilities, the timeframe was extended from 3 months to 6 months, and real-time interval metering was incorporated to improve data processing and reporting time.



The competition addresses key opportunities for improvement identified in our 2014 CEMP including: monitoring, analyzing and reporting energy usage; establishing and tracking energy targets; identifying energy-efficiency opportunities; engaging and training staff; developing operational best practices; and communicating and celebrating successes

Figure 18: 2014 CEMP Opportunities for Improvement

As of 2018, we have (14) competing facilities totalling 1.3 million square feet that are saving over \$100,000 per year by implementing low-cost/no-cost improvements and energy retrofits since the 2014 competition baseline!

Qualitatively, we have strongly engaged and educated facility staff that are:

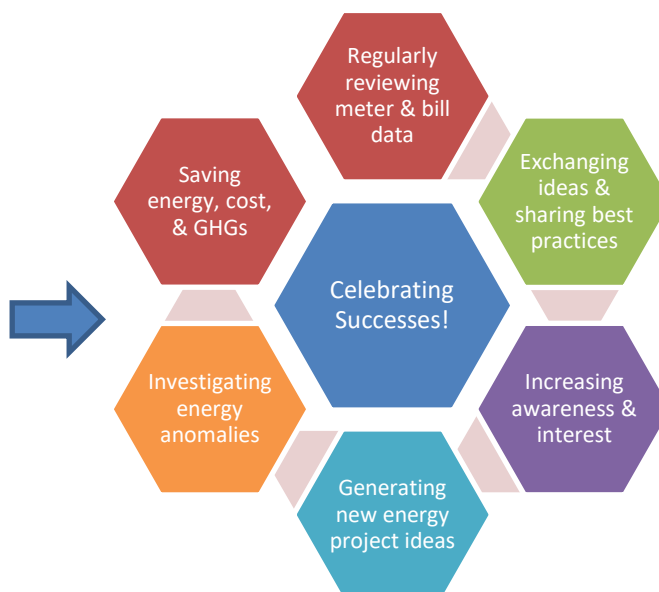


Table 12 summarizes the results from the 2018 Battle of the Buildings competition.

AWARD CATEGORIES	AWARD CRITERIA	RESULTS
Most Energy-Efficient Building  Lowest electricity intensity  (kWh/square foot)	Large Multi-Use	Milliken Mills Community Centre
	Small Arena	Markham Village Arena
	Fitness and Administrative	8100 Warden
PLATINUM	Largest Energy Reduction	Centennial Community Centre
GOLD	At least 15%	Centennial Community Centre, 8100 Warden
SILVER	At least 10%	Markham Village Community Centre, Crosby Arena, Clatworthy Arena
BRONZE	At least 5%	Angus Glen Community Centre, Civic Centre, Pan Am Community Centre, Cornell Community Centre

Table 12: 2018 Battle of the Buildings Competition Results. Please see Appendix V for collage.

We are planning to revamp the competition by aligning baseline and targets with our 2019 CEMP using 2017 as the new baseline, adding more real-time metering (electric and thermal), and reporting out on total energy consumption rather than exclusively electricity. We will continue to improve the competition as more real-time metering is added and best practice operating procedures are updated.

Measure	Cost	Savings	Length
Study best practice operating procedures for major equipment, and Update Battle of the Buildings engagement tools	\$5,000	N/A	2020
		N/A	2021
Re-launch competition with new baseline, improved measures and tools	\$10,000 per year	1-5% per year	Annual, 2021-2024

## 6 Energy-Efficiency through Capital Improvements

*Energy-efficiency is using tools and technology that require less energy to perform the same function.* It typically includes physical upgrades such as adding insulation, replacing inefficient lighting, upgrading to smart building controls (ex thermostats, sensors), and replacing appliances with energy-efficient models.



### 6.1 Lifecycle Asset Renewal Framework

We developed a minimum energy-efficiency asset renewal framework in 2015 that leverages existing funding from the lifecycle process when replacing equipment that is at the end of its service life.

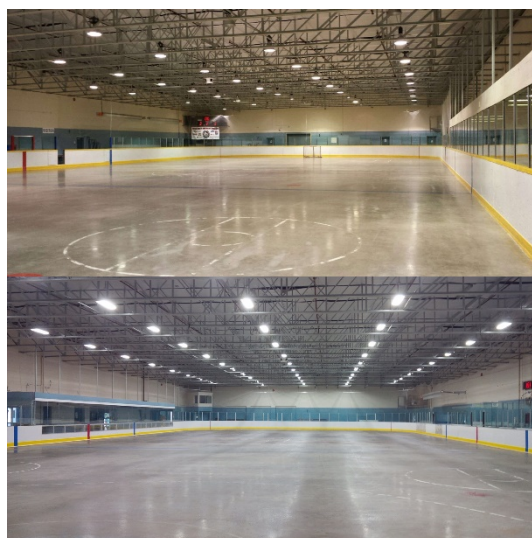
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*Rather than simply replace the equipment with a new model of equivalent value and efficiency, we evaluate the incremental cost, savings, incentives, and payback of upgrading to more energy-efficient technology and equipment.*

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When specifying replacement products, we reference the latest version of ASHRAE Standard 90.1: Energy Standard for Buildings and the minimum efficiency requirements that are eligible for utility incentives.

The results are even better than expected: almost all new equipment purchased at the City is energy-efficient with little-to-no additional cost the City (typically, utility incentives offset the incremental cost). Furthermore, the on-going energy and maintenance savings over the life the equipment far outweighs any additional initial capital expenditure.



**Figure 19: Before/after LED retrofit at our Clatworthy Arena**

Our arena lighting retrofits achieve 65% energy reduction, 60% maintenance reduction, and almost double the lighting performance.

Because our team has actively adopted and embraced the conservation culture, we consider efficiency improvements during several critical steps in our capital asset replacement process:

- Lifecycle training for new and existing staff,
- Investigating existing conditions and evaluating energy-efficient replacement options,
- Requesting funding and building the business case (cost, savings, incentives),
- Developing minimum energy-efficiency scopes and applying for utility incentives,
- Drafting staff award reports that include energy, maintenance savings and utility incentives.

Measure	Cost	Savings	Length
Support lifecycle upgrades with funding, incentives, and studies	\$100,000 to \$150,000 per year	5% to 20% on new equipment	Ongoing



## 6.2 Building Automation Systems Standardization

*Building Automation System (BAS) improvements tied together key initiatives identified in the 2014 CEMP that addressed multiple areas for advancement* including energy auditing, re-commissioning, staff engagement, training, and harnessing our powerful automation tools correctly to improve building performance. We had 8 BAS “brands” across 18 facilities of various age, performance, functionality, usability, and user-friendliness levels, which proved to be challenging for accessibility, operation, maintenance, and training. Also given no two buildings are systematically alike, with the added mix of new or rotated operating staff, the foundation for knowledge and experience becomes difficult to stabilize. These various factors brought significant user friction and fatigue, and presented as an obstacle to control and monitor a plethora of building systems, let alone energy management. Thus this was an opportunity for improvement to increase efficiency and alleviate user pain points.

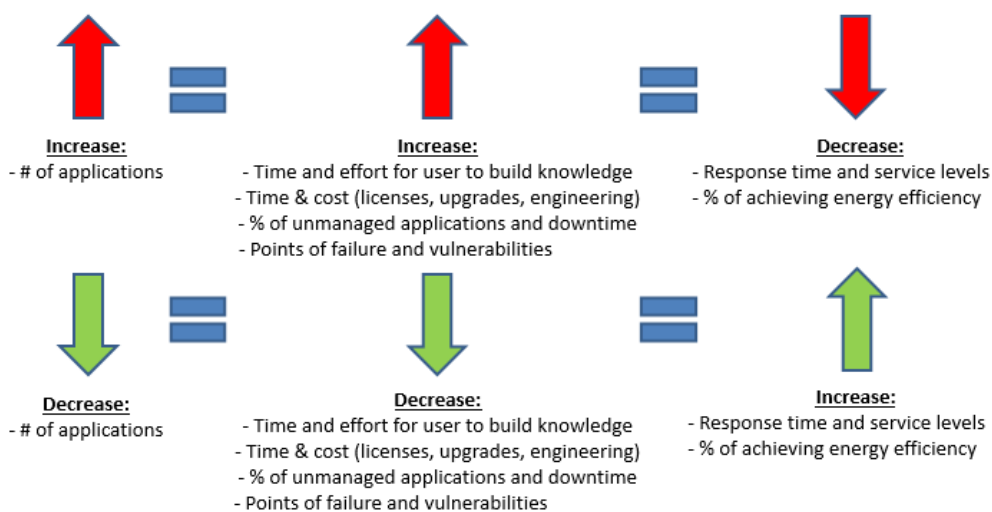


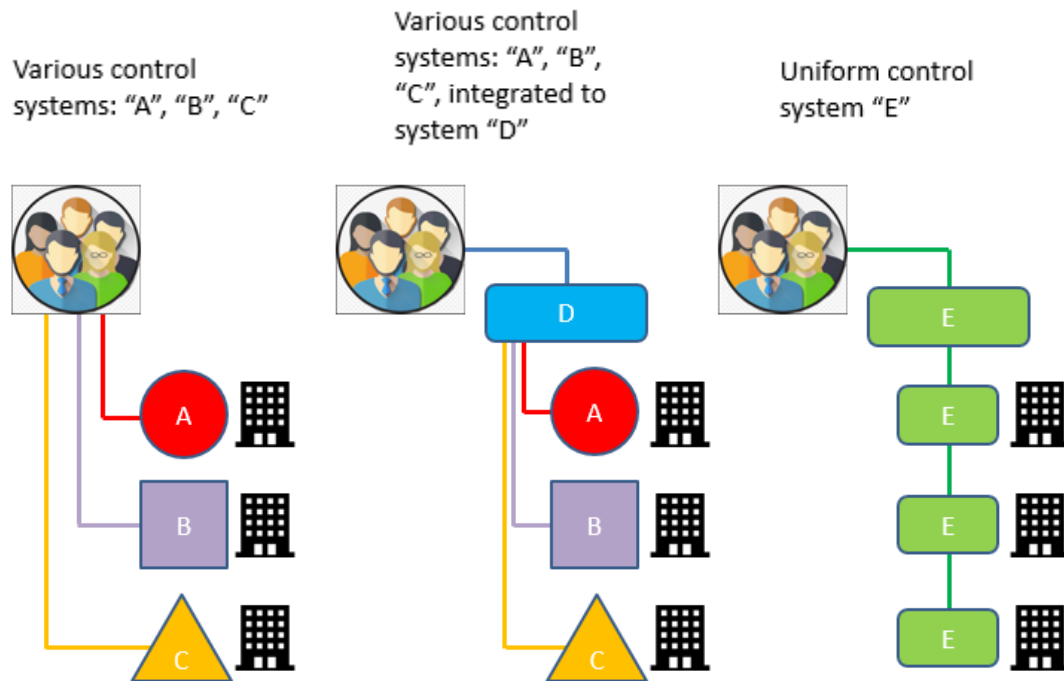
Figure 20: Less is more!

The energy team conducted an automation study in 2015 and concluded that rolling all 8 “brands” up to a 3<sup>rd</sup> party platform would be cost-prohibitive, reduce functionality, and would not achieve energy or GHG savings. The result would yield a common front-facing graphical user interface, or high level SCADA model (Supervisory Control and Data Acquisition) but deeper engineering features and programs still reside on the building’s native control system or “brand” the SCADA layer integrated to. This method only solves part of the problem, and brings forth new complexities such as interaction and cost to engage such parties (the base brand, and the SCADA layer) for every system or modification that occurs.

*To achieve effective functionality, a true centralized platform should be consistent and comprised of matching hardware/software offerings from the top supervisory level down to the field level directly in control of the equipment.* Progressing towards this goal, we decided to design a “BAS Control Room” environment that allowed our team to gain remote access capability to the various co-existing BAS platforms not up for immediate replacement but remains in active service, while we designed and implemented new BAS Design Standards that selected at maximum 2 BAS brands going forward. The strategies outlined above helped build the business case to bring on a BAS staffing resource in 2016.



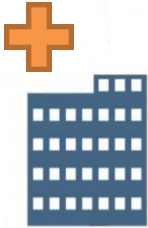
Figure 21: BAS architecture models



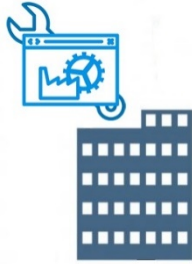
*In 2017, with our BAS Coordinator leading the charge, we formulated a BAS replacement strategy, minimum design specifications, and operation & maintenance (O&M) best practices.* Simultaneously, the Lifecycle Asset Renewal framework outlined in section 6.1 ensured evaluation of energy-efficiency improvements for all new equipment and major retrofits/replacement. Rather than replacing the existing BAS equipment with like-for-like, we evaluated the entire building integration strategy and redesigned the systems (leveraging Lifecycle funding) to increase energy-efficiency and system performance. We gained efficiencies through intangible cost and time savings, developed a centralized enterprise BAS platform that removed redundant elements, and decreased complexity resulting in reduced user friction, staff time (or outsourcing costs), re-engineering, licensing, hardware/software procurement, training efforts, and contract management.

*Our next big area of focus is Analytics: an analytical layer designed to assist users in making sense of dynamic and historical "big data" from BAS/metering systems by highlighting actionable insights.* Analytics does not replace the functionality of a BAS, but enhances it. The tool empowers owners with fact-driven decisions and proactive repairs in environments lacking time for manual analysis or resources with relevant expertise. Analytics benefit multiple stakeholders such as the energy team, facility operations, as well as outsourced service providers (i.e. HVAC, BAS). To avoid creating a new portfolio of disparate software, we are moving towards systems that provide a streamlined experience, such as those embedded within our BAS.

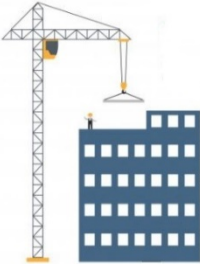
### 6.2.1 Standardization Framework



**RETROFITS**  
(Installation in existing buildings)



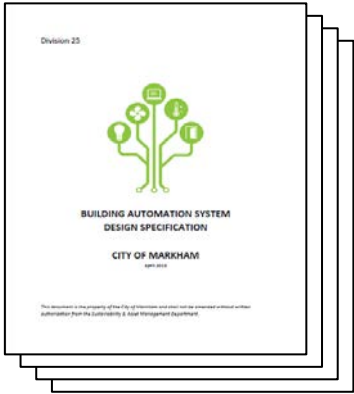
**REPLACEMENTS**  
(Replacement of existing systems)



**NEW BUILDS**  
(Installation in new construction)



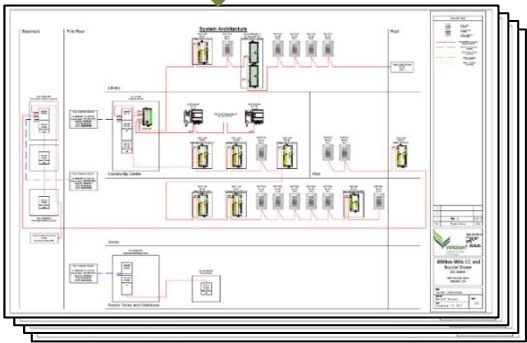
**Corporate BAS Standards**  
"The Building Code"



Markham developed a BAS technical design standard based on the Master Format Specification as utilized in the construction industry. The purpose is to standardize types of system(s) in a consistent manner in replacement or installation projects, across applicable new and existing City facilities. It is also to ensure BAS are furnished to a higher standard of user experience, product quality, and workmanship to support energy management initiatives.

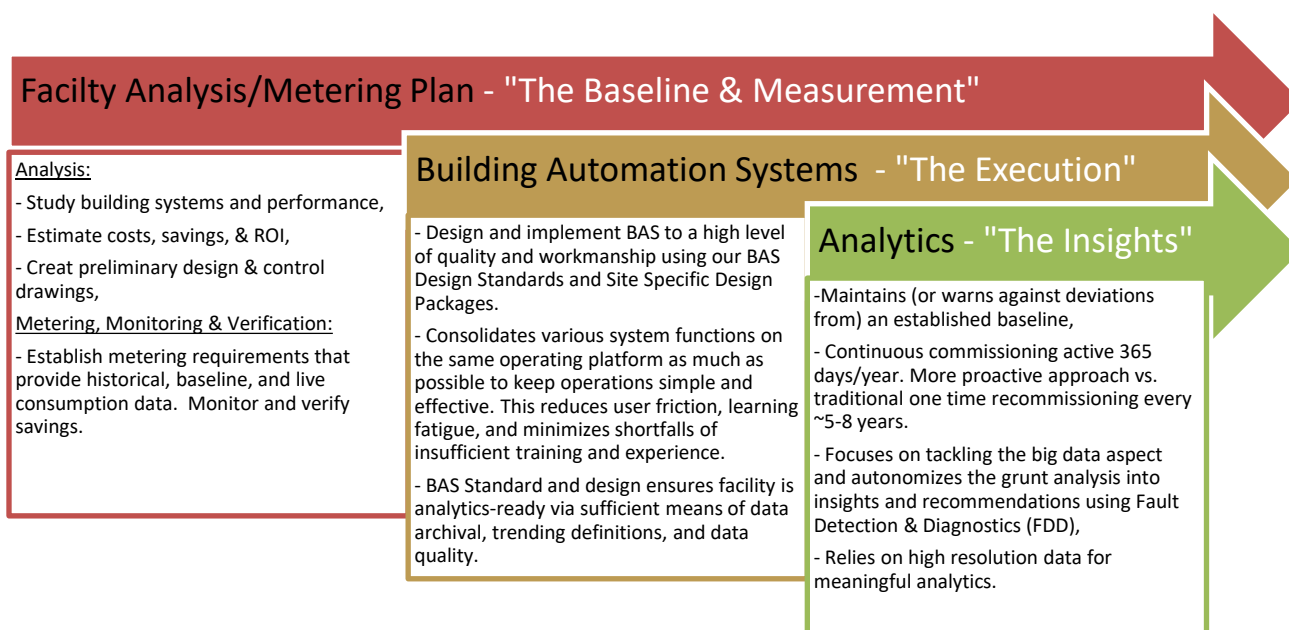


**Site Specific Design Package**  
"The Plans"



Design elements developed by key stakeholders, such as subject matter experts, facility managers, building operators, energy personnel, designers (consultant and/or BAS integrator). The process that defines what systems are involved, functionality, features, and purpose.

## 6.2.2 Implementation Framework



*In 2017/2018, the Milliken Mills Community Centre & Soccer Dome BAS project was the culmination of our efforts as the first true implementation of our BAS Design Standards* and a breakthrough for Markham in terms of holistically improving building performance, multi-department collaboration, and long-term planning (energy auditing, re-commissioning, O&M, training, Lifecycle Asset Renewal framework, cost-competitiveness).

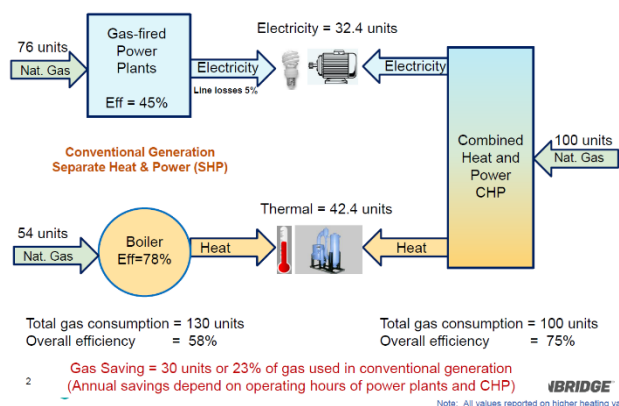
The team identified 12 opportunities (through a 2016 energy audit) that included: adding standalone equipment (i.e. basic equipment thermostats that require physical intervention by users manually) to the new BAS design, consolidation of several existing building systems working in silos (i.e. CIMO refrigeration plant, standalone lighting circuits, solar pool heating) and bringing it to a single seat user experience on BAS (a first for Markham), and optimization of operating parameters. The new modular, centralized BAS platform is hosted on City's in-house server resources for faster service needs and resiliency, and is expected to grow with more sites added to it as replacement/retrofit/new construction scenarios come up. *Reviews by site staff are very positive; the project is saving approximately 10%/year for a facility that started with an energy efficient status* (Winner of Mayor's Megawatt Challenge 2016) and has gained a lot of attention in the energy community including an Energy Manager of the Year award for Most Innovative project.

Measure	Cost	Savings	Length
BAS Preventative Maintenance Contracts	Included in maintenance budgets	5% cost savings	Ongoing
Implement BAS Standards and optimize BAS at major facilities	Included in Lifecycle (LC) and LC support costs	5-25% per facility	Ongoing

### 6.3 Combined Heat and Power

**Cogeneration, or Combined Heat and Power (CHP), is the use of a heat engine to generate electricity and useful heat simultaneously from a common fuel source.** While all thermal power plants produce heat as a by-product, the CHP process reclaims “waste” heat and reuses it in the facility rather than releasing it into the environment. Electricity generated by the CHP will be consumed by the facility, and heat recovered from the CHP will be utilized to produce hot water at the facility. Therefore, CHPs reduce energy bills and allow the facility to generate their power independently, thereby improving community resilience. Additionally, the CHP will enhance grid reliability and flexibility, and help protect public health and the environment. CHP systems are strong examples of how energy-efficient technologies can help achieve these significant benefits for end-user facilities, utilities, and communities.

#### Energy Saving - CHP vs. Separate Heat and Power (SHP)



#### CO2 Emissions Reduction: CHP vs. Separate Heat and Power (SHP)

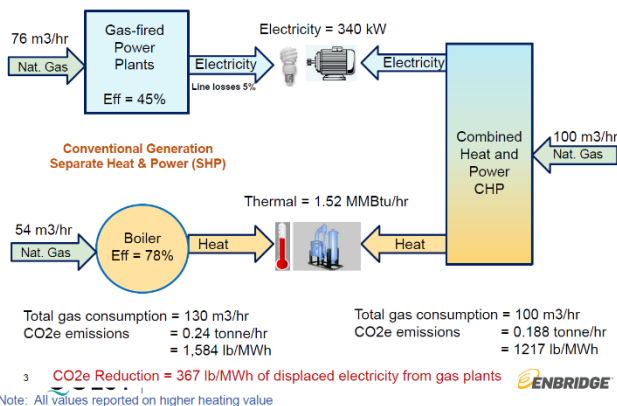


Figure 22: Energy & GHG Savings Comparing CHP vs SHP

CHPs are most well-suited to facilities that have consistent electrical and thermal load profiles so they can operate continuously through the year. Angus Glen Community Centre (AGCC) was selected as the pilot in 2016 for a CHP Detailed Engineering Study because it was determined to have the best business case through a preliminary analysis of electrical and thermal loads. AGCC is our largest community centre among the City’s owned facilities and has the largest electrical and thermal energy demands that are most closely matched. *Installing the 400kW CHP will result in an annual energy cost savings as well as meeting more than half of AGCC’s base electrical and thermal loads (59% and 67%, respectively).*

Measure	Cost	Savings	Length
Install CHP at Angus Glen Community Centre	\$2.4M	Net savings \$270k/yr	2019
Review CHP performance against study baseline	N/A	N/A	2019-2020
Evaluate CHP business cases, and install where feasible	\$40,000/facility study TBD	N/A TBD	2021 Ongoing

## 6.4 Demand Response and Peak Demand Management

*Demand Response (DR) is a program available through the Independent Electricity Systems Operator (IESO) that enables companies with large energy consumption and demand to reduce their load during peak demand events in Ontario.* Peak demand events occur just a few times a year, so peaking power plant assets run at a fraction of their capacity most of the time during the year. DR is a way for utilities to reduce the need for large capital expenditures, and thus keep electricity rates lower overall.



*Electricity consumption and production must balance at all times; any significant imbalance could cause grid instability or severe voltage fluctuations.* The IESO offers financial incentives to companies that reduce stress on Ontario’s overburdened energy infrastructure by creating and implementing an electricity curtailment plan to reduce their load during peak demand events. Instead of adding more generation capacity to the system, the IESO pays energy users to reduce demand because it is cheaper and easier to procure. DR events can occur all year around during weekdays that do not fall on holidays. The IESO updated DR program rules in 2015 to include annual auctions for both summer and winter DR capacity, and transitioning from a fixed-price to a competitive auction.

We currently have the Markham Civic Centre and Thornhill Community Centre enrolled, with intent to potentially include other recreation facilities that have year-round and seasonal ice rinks, and buildings with natural gas generators.

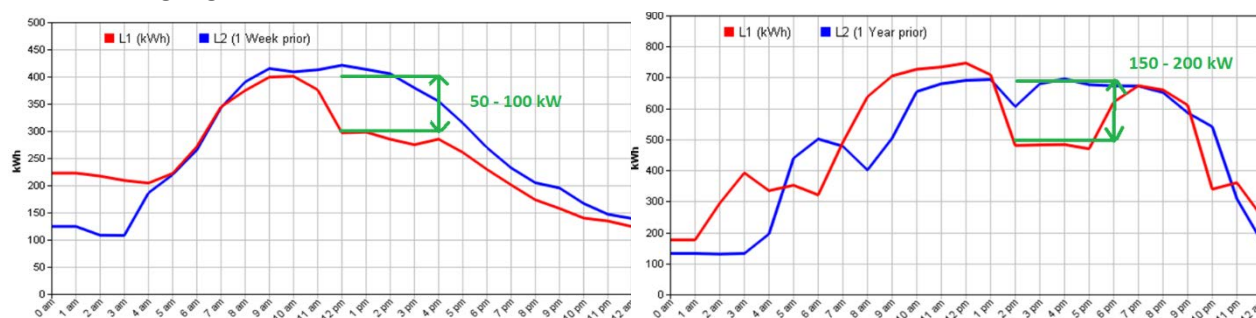


Figure 23: Markham Civic Centre and Thornhill Community Centre Demand Response Tests

*The City is committed to achieving net-zero greenhouse gas (GHG) emissions by 2050 through energy conservation, demand management, and renewable energy generation.* DR is an effective counter-measure to the ongoing rise in energy consumption and GHG emissions, as it allows grid operators to respond to capacity or reserve shortfalls by reducing the demand for electricity without the need to build additional generation or fire up fossil-fuel based peaking plants. DR reduces demand on the grid, and improves grid stability, in emergency response situations that can help avert brownouts or blackouts.

Measure	Cost	Savings	Length
Increase Demand Response participation, where feasible	\$5,000 per building	\$60/kW enrolled	Ongoing
Investigate demand management opportunities	TBD	TBD	2022

## 7 New Construction

New buildings constructed for a growing population will result in increased energy consumption, water, waste and GHG emissions in the City. To minimize the impact, we design and construct new energy-efficient buildings that are solar-ready and take advantage of district energy where possible.

### 7.1.1 Ontario Building Code

As of January 1st, 2017, new construction projects must follow compliance with the energy-efficiency requirements referenced in the Ontario Building Code (SB-10). New prescriptive compliance packages are 15% more energy-efficient than previous packages. Table 13: Ontario Building Code Compliance Requirements defines the energy-efficiency criteria to comply with the updated Ontario Building Code.

Ontario Building Code Compliance Requirements:		
Compliance Path	-OR-	-OR-
Exceed the energy-efficiency level of the National Energy Code of Canada for Buildings 2015 and Chapter 3 of SB-10	Exceed the energy-efficiency level of ASHRAE Standard 90.1-2013, “Energy Standard for Buildings Except Low-Rise Residential Buildings”, and Chapter 2 of SB-10	Exceed the energy-efficiency level of Section 7 “Energy Efficiency” of ASHRAE 189.1-2014: “Standard for the Design of High-Performance Green Buildings except Low-Rise Residential Buildings”, excluding Sections 7.2b, 7.4.7.2, 7.4.8, and 7.5 as described in SB-10

Table 13: Ontario Building Code Compliance Requirements

### 7.1.2 High Performance New Construction

We investigate and pursue all avenues available to construct sustainable buildings with high environmental and energy management standards. The High Performance New Construction (HPNC) program offered through the IESO’s saveONenergy program is one such avenue that offers the City with incentives and design assistance. The HPNC program offers to fund 100% (up to \$10,000) of the cost for an energy model of a new building with options to help make optimization decisions and receive incentives on energy-efficient equipment through the engineered or custom approaches. To date, we’ve received HPNC incentives for Cornell Community Centre, Pan Am Community Centre, and Aaniin Community Centre.

Unfortunately, these incentives were recently cancelled but will be considered if they are made available in the future.



### 7.1.3 Minimum LEED Silver Certification

**LEED (Leadership in Energy & Environmental Design) is a voluntary sustainability rating system that evaluates and represents exceptional environmental and energy performance for a building over its lifecycle.** LEED provides a comprehensive list of Canadian building standard guidelines to improve building performance, which falls into six categories with associated credits: Material and Resources, Innovation & Design Process, Water Efficiency, Energy and Atmosphere, Indoor Environmental Quality, and Sustainable Sites. York Region’s New Construction Policy, Sustainable Development Through LEED, was adopted at the City of Markham and requires a minimum of LEED Silver rating for all new corporate facilities and major renovations. **Markham wants to take it a step further by ambitiously designing and constructing new facilities with net-zero energy emissions targets.**

**Buildings that are built to the LEED Silver standard in the City will have less of an impact on the environment and have been shown to be productive workplaces.** This will result in efficient use of energy, water and materials including better indoor air quality and reduced emissions over the life of the building. The energy avoidance is determined by comparing how much energy the buildings would use by designing to the National Energy Code for Buildings versus how much energy the buildings would use when designed to LEED Silver (or better) standards. Our registered LEED Certification buildings are outlined in Table 14: City of Markham LEED Buildings with the verified and desired certification levels.

City of Markham LEED Buildings		
Building Name	Certification Level	Certification Date
Markham Museum Collections Building	Gold	2014-03-06
Cornell Community Centre & Library	Silver	2014-02-10
Markham Fire Station 99	Silver	2014-02-04
Markham Pan Am Centre	Gold	2015-06-12
South East Markham Community Centre and Library	Gold (Target)	TBD

Table 14: City of Markham LEED Buildings

Measure	Cost	Savings	Length
Design all new buildings with at minimum LEED™ Silver	Varies by building	Varies by building	Ongoing
Study and model Net-Zero business cases for proposed new construction projects	\$40,000/study	TBD	Ongoing



## 8 Streetlights and Traffic Lights

In 2014, the City initiated a large-scale project to convert approximately half of its 26,000 inefficient high-pressure sodium (HPS) streetlights to energy-efficient Light Emitting Diode (LED) streetlights.

The 12,300 new cobra-head style LED lights are saving 6 million kilowatt-hours per year, attracted over \$300,000 in utility incentives, and reduced our streetlighting energy intensity by 29%.



The team also developed construction standards comprised of requirements that ensure all new streetlights and signals are equipped with LEDs.

Our LED streetlights reduce the amount of light pollution and meet the requirements of the International Dark-Sky Association (IDA) as dark-sky friendly, thus eliminating up-light that produces obtrusive sky glow from streetlights. The natural LED light provides a safer light source with better visibility to both pedestrians and motorists, and offers better clarity and improves the ability to identify colours at night. Additionally, LED street lights have a life expectancy of 20 years compared to the five-year life span of traditional HPS streetlights. The team is still investigating feasible options for the approximately 12,000 remaining HPS decorative streetlights.

Measure	Cost	Savings	Length
Investigate converting the remaining HPS decorative streetlights to LED	TBD	TBD	Ongoing

## 9 Renewable Energy

By definition, renewable (or clean) energy comes from natural sources that are constantly replenished. Most renewable forms of energy ultimately come from the Sun. While renewable energy is often thought of as a new technology, harnessing nature’s power has long been used for heating, transportation, lighting, and more. Wind has powered boats to sail the seas and windmills to grind grain<sup>8</sup>. Some examples of renewable energy can include solar, wind, geothermal, tidal, and hydroelectric.

Renewable energy expansion plays a crucial role in helping us achieve our NZEE 2050 targets and is the final step in the energy pyramid. Additionally, our solar revenue sustainably funds our corporate energy initiatives. We embrace piloting new sustainable technologies that are environmentally beneficial and have favourable return-on-investments. *This is the last step in the energy pyramid as it is important to optimize energy usage in facilities first to accurately and cost-effectively size renewable energy systems to meet the remaining demand.*



### 9.1 Solar Photovoltaic

*Markham was the first municipality to participate in Ontario’s Feed-In-Tariff (FIT) program and to install a solar photovoltaic (PV) system.* Solar PV systems use cells to convert sunlight into electricity. Currently, we have two of the largest solar arrays in York Region, and 1.8 Megawatts of total solar installed across nine City rooftops. Of the 1.8 Megawatts solar installations, we own two microFIT systems, one FIT system, and leases six of its rooftops to PowerStream Solar. The Markham team designs and constructs all new corporate buildings as solar-ready, with proper structural, mechanical, and electrical configurations to support a rooftop solar system.



Markham’s Solar projects generate ~\$300,000 of non-tax revenue for the City that is reinvested to fund our energy conservation initiatives. The solar projects generate over 2.3 million kWh per year of clean renewable energy, offsetting over 100,000 kilograms of GHG emissions!

Figure 24: Pictures of Markham’s Solar PV systems

<sup>8</sup> Renewable Energy: The Clean Facts. <https://www.nrdc.org/stories/renewable-energy-clean-facts>

A summary of our solar assets is outlined in the table below.

City of Markham Installed Solar Projects		
Property Description	Project Type	Array Size (kW-AC)
Pan Am Community Centre	Lease to Alectra Solar	625,000
Thornhill Community Centre	Lease to Alectra Solar	454,000
Mount Joy Community Centre	Lease to Alectra Solar	361,000
Angus Glen Community Centre	Lease to Alectra Solar	326,000
8100 Warden	FIT	272,000
Clatworthy Community Centre	Lease to Alectra Solar	158,000
Milliken Mills Community Centre	Lease to Alectra Solar	133,000
Fire Station 99	microFIT	12,000
Markham Civic Centre	microFIT	11,000
	<b>Total</b>	<b>2,352,000</b>

Table 15: City of Markham Installed Solar Projects

Measure	Cost	Savings	Length
Evaluate solar PV system business cases, and install where feasible	\$1,100/site - study TBD	0 TBD	2019-2020 Ongoing

## 9.2 Solar Thermal

Solar thermal panels work on the same principal as a car in the sun on a hot day. Sunlight hits the car and interior, heating up all the materials inside. Heat is trapped inside by the structure of the car and the glass which allows sunlight in, but keeps the heat from getting out. A pump circulates that renewable, clean heat to desired locations.

In 2007, an 18-collector seasonal solar thermal pool heating system with Drain Waste Heat Recovery (DWHR) was installed at Milliken Mills Community Centre. In 2010 a similar, but larger, 24-collector seasonal solar thermal and DWHR system was installed at Centennial Community Centre. The City is interested in adding additional solar thermal and heat recovery projects with favourable business cases.

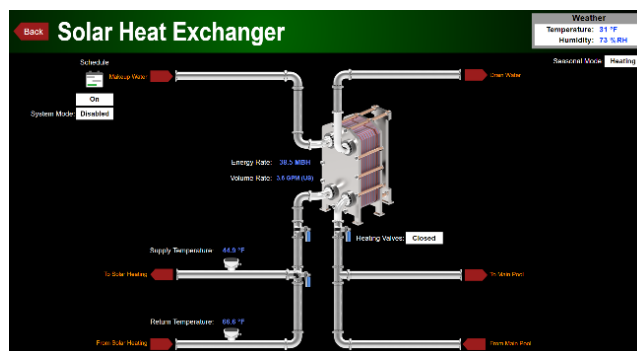


Figure 25: Milliken Mills Community Centre Solar thermal system - BAS Screenshot

Measure	Cost	Savings	Length
Evaluate business cases and install solar thermal systems, where feasible	\$10,000 study	TBD	2019-2020 Ongoing

### 9.3 Geothermal and Ground Source Energy

Geothermal Energy is heat (thermal) derived from the earth (geo). It is the thermal energy contained in the rock and fluid that fills the fractures and pores within the rock of the earth's crust. Geothermal heat comes from the earth's core and often involves digging very deep (thousands of meters) to extract high-grade energy. This form of heat tends to be used directly by very large-scale applications. Geothermal energy is renewable, reliable (can operate 24/7), has a small land footprint, is clean (almost no GHG emissions), and is versatile (heat by-product from power plants can be used in greenhouses, food processing, etc).

A ground source heat pump (GSHP) system can take advantage of the constant temperature of the upper layer of the Earth's surface (heated primarily by the Sun) to heat a building in the winter, while extracting heat from the building and transferring it back to the relatively cooler ground in the summer.<sup>9</sup> The heat pump upgrades this low-grade energy for use in domestic and commercial applications.

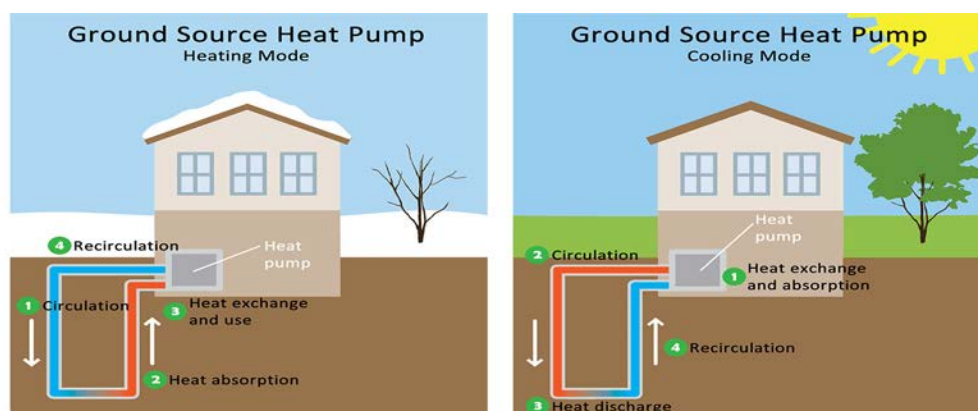


Figure 26: Ground Source Energy

*The City has two GSHP systems installed: one supplies thermal energy to Fire Station 93 and the other to the Museum Collections Building.* Fire Station 93's system was installed in 2010, and the facility has seen an energy reduction of approximately 64%. The Museum's system is similar in size to Fire Station 93's but there is insufficient utility data available to analyse the savings at this facility. As a result of longer payback terms from rising electricity prices and low natural gas prices, the City is not actively pursuing additional GSHP systems.

Measure	Cost	Savings	Length
Evaluate business cases and add renewable energy, where feasible	Varies depending on energy source	Varies depending on energy source	Ongoing
Evaluate business cases and install heat recovery, where feasible	TBD	TBD	Ongoing

We will continue evaluating and adding renewable energy and heat recovery projects with good business cases; however, no new installations are anticipated due to lack of incentives and favourable ROIs.

<sup>9</sup> Geothermal Energy. <https://www.enbridge.com/energy-matters/energy-school/geothermal>

## 10 Sharing our Successes

Celebrating successes can be helpful in sharing accomplishments, challenges, and opportunities that others may benefit from. It nurtures a learning environment, generates creative and innovative ideas, and attracts more success. Celebrating as a team can also be a great source of pride and inspiration, as shown in *Appendix V*.

### 10.1 Special Events

Special events focused on sustainability and energy is another effective method of communicating energy conservation and raising the energy management culture. In advance of all major energy events, the event is advertised through the use of posters, articles, flyers, and emails on how the City is participating, how the community can participate, and the benefits surrounding the event.

Measure	Cost	Savings	Length
Support additional special events to promote energy awareness	Varies	N/A	Annual, Ongoing

### 10.2 Projects

The teams involved in completing energy projects gained valuable knowledge and lessons learned that are periodically shared in the organization. Project successes have been communicated through electronic news articles, on our webpage, with posters around the facilities, and during energy meetings. Successful projects can lead to best practices, behaviour change, idea generation and development, confidence in the programs, and improvement suggests. We are planning to increase communications related to sharing our successes and best practices as more staffing resources join our team.

Measure	Cost	Savings	Length
Share project successes, awards, and best practices	N/A	N/A	Annual, Ongoing

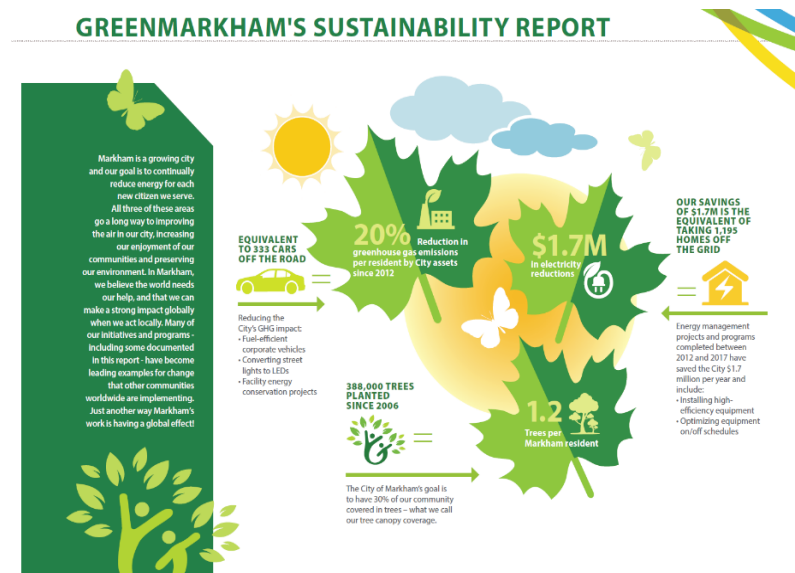
### 10.3 Webpage Awareness and Resources

An online campaign was established with several useful tips and links in an effort to promote energy awareness. The focus was on a blend of work and home conservation material to improve energy conservation and efficiency in everyday life. Some key elements were: conservation tips for the home and office, the Battle of the Buildings competition, SaveONenergy incentives for business and home, recently completed energy projects throughout the City, and the CEMP. The motivation behind home conservation is that if individuals conserve at home then it will become instinctual and natural to conserve in the workplace. At this time, the webpages are not used to their full potential and most staff are not aware of the resources available to them.

Measure	Cost	Savings	Length
Increase webpage awareness	N/A	N/A	Annual, Ongoing



## 10.4 Regulatory and Internal Reporting



Regular reporting is a beneficial method of notifying all key stakeholders of on-going initiatives and successes, as well as providing stakeholders with forums that encourage engagement and knowledge exchange.

Additionally, we participate in local knowledge-sharing forums including the Mayor's Megawatt Challenge, Climatewise, energy municipal groups, and the IESO's Energy Manager Hub.

Figure 27: Markham's Global Reporting Initiative in our Annual Report

We are quick to celebrate the teams responsible for our energy achievements, including recently earned awards such as Canada's Greenest Employer, Energy Manager of the Year, ENERGY STAR, and Living City Energy Efficiency Leadership. Table 16: Regulatory and Internal Reporting is a summary of how and where the City shares its successes.

Regulatory and Internal Reporting	
Reporting Item	Timeline
Embedded Energy Manager's Energy Management Plan	2013, Annually thereafter
Ontario Regulation 507/18: Energy Consumption and GHG Emissions Summary	July 2013, Annually thereafter
Ontario Regulation 507/18: Energy Reporting and Conservation and Demand Management Plan	July 2014, Every 5 Years thereafter
Corporate Energy Team	Quarterly
EEM Quarterly Reports	Quarterly
Facility Operation Staff	Monthly
GRI/Annual Report	Annually

Table 16: Regulatory and Internal Reporting

Measure	Cost	Savings	Length
Create revised corporate energy management plan	N/A	N/A	2018-2019
Internally and externally report annually on energy consumption and GHG emissions	N/A	N/A	Annual, Ongoing

## 11 Financial Considerations

For 2013 and 2014, Gas Tax Funding was the backbone funding source for approved energy capital projects. The City sought alternatives to reduce its dependency on Gas Tax Funding, which would lower its risk of not receiving funding against other competing projects. In 2015, the City developed a revolving Energy Conservation Fund to provide sufficient funding (from renewable energy, grants, utility rebates, Demand Response, and confirmed energy savings from projects) to finance all energy management projects with favourable return-on-investment terms. Since 2016, the City has been using solar revenue as its primary funding source due to lack of available Gas Tax funding.

See Appendix V for description of projects, forecasted costs, and savings. The table below outlines the expected expenditure in order to save the estimated cumulative energy cost savings against the baseline. All of the savings accumulated by each measure will carry over into subsequent years. Without the capital funding and staffing resources recommended throughout the CEMP, the City may have difficulty achieving its objectives and targets.

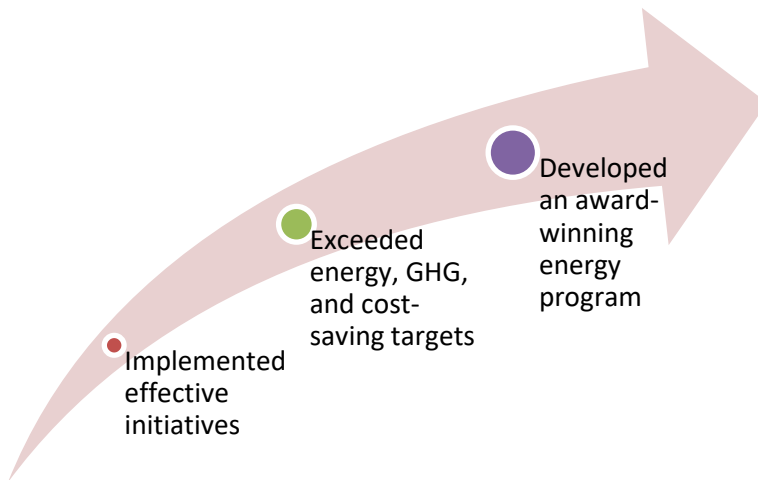
The energy team estimated preliminary cost and savings (table below) based on the prioritization of several projects planned for the duration of the CEMP. The team prioritized projects according to return on investment, lifecycle, low risk/ease of implementation, repeatability, and resolving persistent issues. The capital budgets will follow the City’s procedures of requesting projects through the annual Capital Budget process.

2019 CEMP Annual Projected Financial Performance Summary						
Description	2019	2020	2021	2022	2023	5 Year Total
Estimated Capital Budget (\$)	240,000	260,000	20,000	270,000	280,000	1,300,000
Estimated Cumulative Savings (\$)	120,000	240,000	390,000	510,000	660,000	1,900,000

Table 17: 2019 CEMP Annual Projected Financial Performance Summary



## 12 Conclusion



We are proud of the teams that accomplished so much with so little resources. We have a small but mighty team that efficiently collaborated to roll out cost-effective energy projects and programs, exceeded our energy and cost-saving targets, and celebrated our successes in building an award-winning energy program. We increased energy-efficiency in our existing facilities, designed and constructed (2) new facilities to be LEED certified, and increased our renewable energy solar portfolio.

The recommended 2019 CEMP initiatives were developed based on the best available knowledge at the time of creation. Several of the measures are low cost with potentially large opportunities for reducing energy, greenhouse gas emissions, and utility costs. The CEMP is intended to act as a framework to address the increasing concerns of effectively and efficiently managing energy consumption, cost, and greenhouse gas emissions. With rising fuel prices, aging energy infrastructure, finite fuel resources, and tangible evidence of global warming, energy management is becoming increasingly important for not only municipalities, but the world as a whole.

If followed as a guiding tool, this plan will assist the City of Markham in achieving the goals presented in the plan, as well as satisfy the requirements for Ontario Regulation 507/18: Energy Reporting and Conservation and Demand Management Plans and the Partners for Climate Protection (PCP) Corporate Milestone 4 and 5. A summary of our PCP Milestone progress is summarized in the table below.

PCP Milestone Framework	Corporate Status
<b>Milestone 1: Create a Baseline Emissions Inventory and Forecast</b>	Complete
<b>Milestone 2: Set Emissions Reduction Targets</b>	Complete
<b>Milestone 3: Develop a Local Action Plan</b>	Complete
<b>Milestone 4: Implement the Local Action Plan</b>	Complete with 2019 CEMP
<b>Milestone 5: Monitor Progress and Report Results</b>	Complete with 2019 CEMP

Table 18: PCP Milestone Framework Corporate Status Update

Appendix I) 2014 CEMP Results

2014 Measure	Results	Completed/On-going
Optimize BAS for major facilities	Completed BAS optimization for 7 facilities. Paybacks were less than 1 year. On-going.	Yes
Add additional project meters	We are now able to monitor 15 energy conservation projects in total, 11 of which were added since the 2014 CEMP	Yes
Investigate centralizing sub-metering monitoring and management	Not started	No
Centralize sub-metering monitoring and management at largest facilities	Not started	No
Increase quantity of buildings with PowerStream Interval Metering	Increased building quantity by 3. On-going	Yes
Establish an EMIS	Completed - 426 accounts in systems and all major buildings	Yes
Use EMIS in conjunction with project and sub-meters to track energy performance	Completed. On-going	Yes
BAS training from BAS providers	Completed at 2 sites. On-going	Yes
Support lifecycle upgrades with funding, incentives, and studies	Completed over 200 energy-efficiency projects, 80% through Lifecycle	Yes
Support additional special events to promote energy awareness	Completed	Yes
Study best practice operating procedures for major equipment	Completed with respect to BAS and area specific low-cost/no-cost opportunities. On-going	Yes
Re-commission buildings as necessary	2 buildings were re-commissioned. 15-20% electricity savings and paybacks were less than 1 year.	Yes
Partner with Humber College to perform energy audits in lowest performing facilities	1 energy audit completed. On-going	Yes
Enter building data into Portfolio Manager	2 buildings were submitted to Portfolio Manager to achieve EnergySTAR certification.	No
Form DREAM team	Completed	Yes
Evaluate Procurement Contracts	Completed. Converted TOU to RPP	Yes
Provide facility staff with Powerview training and login information	Completed, distributed annually. On-going	Yes
Provide facility staff with EMIS training	4 training sessions hosted at launch and 1 two years later. On-going	Yes
Integrate into the monthly building manager forum to share best practices	On-going. Attend as required	Yes
Establish competition by facility type	Completed - Community Centre Battle of the Buildings Competition launched in 2015 and has expanded to include Administrative facilities.	Yes
Create energy management plans for reporting	Completed for the Green Energy Act and Alectra Utilities	Yes

2014 Measure	Results	Completed/On-going
Externally report annually on energy consumption and GHG emissions	Completed annual through the Global Reporting Initiative (GRI)	Yes
Internally report on energy consumption and costs	Quarterly reports provided to senior management. Monthly reports provided through Battle of the Buildings competition	Yes
Implement best practice operating procedures for major equipment	On-going. 2 commissioning projects completed and 7 BAS optimization projects. Posters created through Battle of the Buildings with area specific operational savings opportunities	Yes
Establish the ECF	Completed	Yes
Utilize the ECF to fund energy projects	Completed - in use since 2017	Yes
Roll out Project Hand Over Procedure to Facility Staff	Not fully utilized	No
Work with facility staff to retrieve all new building documentation	Most facility staff have access to As-Built drawings folders and reports. Drawings also uploaded to cloud-based drive to provide documentation to external resources	Yes
Expand MDEI to buildings where feasible	Expanded district energy network to Pan Am CC	Yes
Design all new buildings with at minimum LEED Silver	2 new facilities were constructed to minimum LEED Silver: Pan Am and Aaniin Community Centres	Yes
Evaluate including energy targets in staff performance reviews	Not started	No
Evaluate and Apply for HPNC incentives on new construction buildings where feasible	Completed for Pan Am and Aaniin Community Centre	Yes
Increase webpage awareness	Periodically review and update webpage content	Yes
Enroll in Procurement Contracts	Converted small Time of Use accounts to RPP	Yes
Increase DR participation where feasible	Evaluated. Currently no further opportunities	Yes
Evaluate natural gas rather than diesel backup generation in new buildings	2 new backup generators were installed - both natural gas	Yes
Install solar systems where feasible	Added 450kW solar to Pan Am CC. FIT contract was submitted but cancelled. City is investigating feasibility of net-metering. Ongoing	Yes
Lease rooftop to PowerStream where feasible	Added 450kW solar to Pan Am CC. Cornell CC FIT contract was submitted but cancelled by Provincial government	Yes
Expand renewable energy initiatives where feasible	Evaluated during CHP project. Currently no further opportunities	Yes

Appendix II) CEMP Self-Assessment Tool

The City of Markham undertook an energy management self-assessment during plan development in 2014 and again in 2019 to determine its strengths, weaknesses, and opportunity for improvement. Each section was graded on a scale ranging from 0 to 4, with zero representing a generous opportunity for growth and 4 representing next to zero room for growth.

Below are the major categories the City reviewed:

Energy Management

Category	Description of Goals
Commitment	A written energy policy, agreed by senior management, communicated to all employees, recently written (within 3 years). Written formal energy management plan endorsed by senior management and available to all employees. Subject Matter Experts assigned responsibility to energy management.
People	Energy manager recognized and empowered leader having site manager and senior management support. Senior management actively supports the energy program and promotes energy efficiency in all aspects of site operations. Active cross-functional team guiding site energy program. Staff trained to operate facilities efficiently.
Planning	Upgrade plans established; reflect assessments. Full compliance with organizational energy-efficiency design guidelines and goals. Plan goals roll up to corporate goals. Corporate energy management plan endorsed, with implementation strategy to achieve goals including net-zero energy and community resiliency.
Financing	Internal/external roles defined and funding identified. Capital procedures exist to obtain funding for energy efficiency. Clear payback investment threshold. All capital funding requests assessed for energy impact.
Communication	Regular communications to all employees on initiatives and progress against the strategy and targets. Regular management meetings to review energy use and cost.
Tracking	Revise plan based on results, feedback and business factors. Best practices shared with other sites. Regularly report outcomes. Monitor success of existing projects.

Technical

Category	Description of Goals
Incentives, Rebates, and Revenue	Researches rebates and incentives offered regionally and nationally. Communicates often with utility representatives. Evaluate and pursue revenue stream opportunities.
Equipment Replacement	Projects/contracts include energy analysis. Energy projects evaluated with other investments. Lifecycle costing applied. Energy-efficient procurement policy in place with specific procurement policies used for particular products, e.g. lighting, motors, BAS etc.
Maintenance Procedures	Maintenance budgets include repairs to save energy and support on-going performance of automation systems
Operational Knowledge	Appropriate operational skills and knowledge for staff key to energy management, e.g. operators, maintenance, boiler-house, caretakers, security, etc. Establish and implement best practice operating procedures for major equipment. Staff familiar with energy management processes and procedures.
Documentation	Critical building and equipment documentation available and used for load surveys/recommissioning/efficiency goals.
Resources	Clear job description and assigned adequate resources. Extensive regular reviews by multi-functional team of internal and external professionals. Full assessment every 5 years.

Monitoring and Targeting

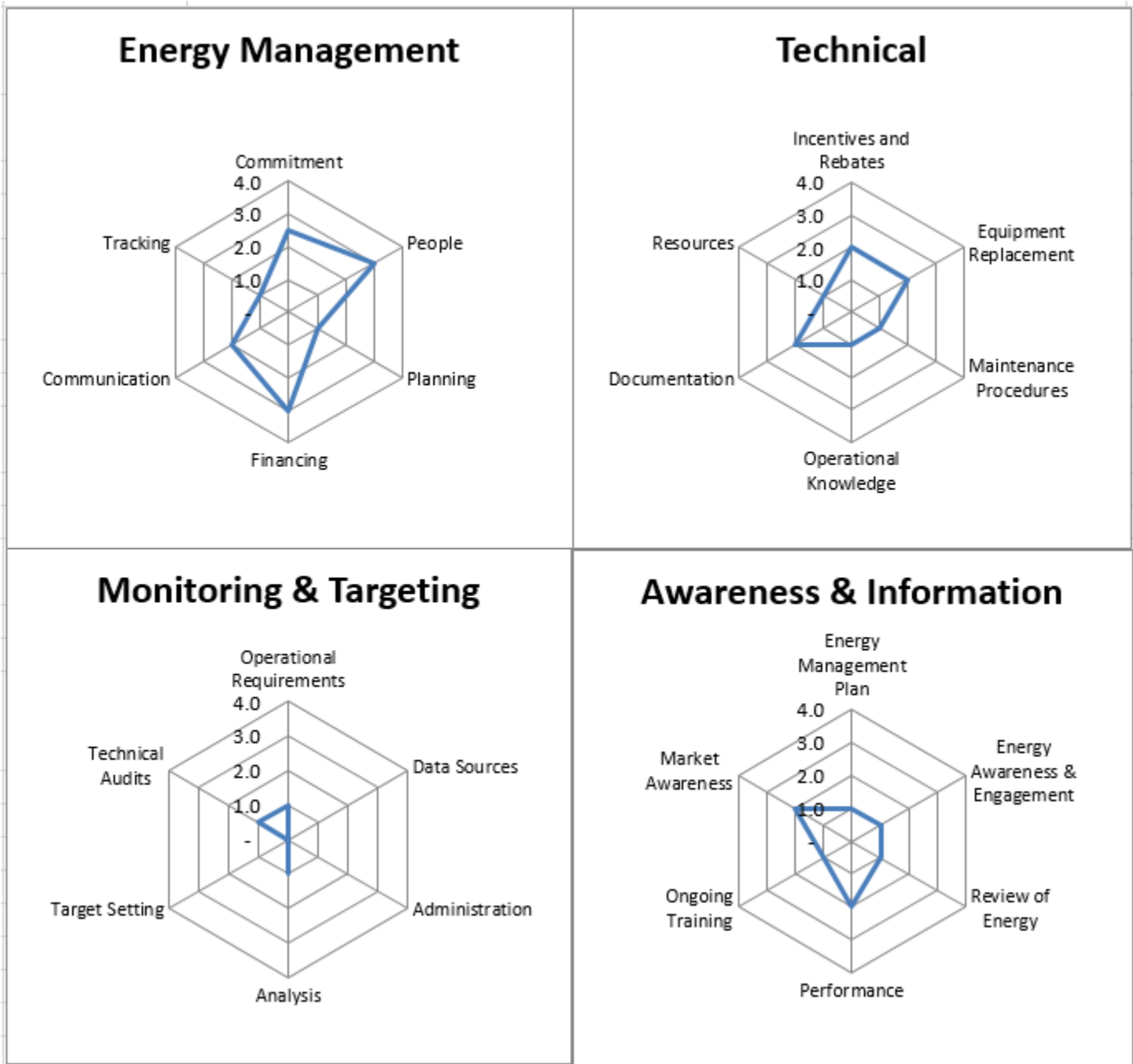
Category	Description of Goals
Operational Requirements	Active reporting systems for energy waste and suggestions (lights on, doors open, steam leaks etc.). Job/Priority sheets for reducing energy waste (e.g. repair compressed air leak). Operating instructions include energy use issues (e.g. shut down procedures).
Data Sources	Regular collection of energy consumption and cost data accessible by all accountable staff, consolidated into central resource. Develop and implement standardized specifications for metering and automation systems.
Administration	Key utilities and users are metered separately. Each entity has total accountability for their energy use and utility budgets. Regularly reviews energy use. Energy bills verified for accuracy. Tracks facility consumption against targets by utility type.
Analysis	Estimate potential for improvement. Key loads metered, tracked, analyzed, and reported. Facility peak demand analyzed. Profiles identifying trends, peaks, valleys, and causes. Comparison of energy data with utility bills. Benchmarks similar facilities and identifies operational improvements.
Target Setting	Set energy performance goals based on analysis. Quantitative and qualitative targets challenging, but achievable. Performance compared with appropriate benchmarks (internal or external) and KPIs. Short and long-term facility and corporate goals.
Technical Audits	Metering, Monitoring and Targeting (MM&T) system actively used to identify savings opportunities. Audits, asset registers, and studies reviewed and/or completed to identify opportunities and ensure facilities are operating efficiently.

Awareness and Information

Category	Description of Goals
Energy Management Plan	Detailed opportunities with timelines and ROI. Energy plan includes implementation strategy. Clear delineation of roles and responsibilities.
Energy Awareness & Engagement	Planned outreach and communications. Support organizational initiatives. Employees aware of site energy costs. Awareness campaigns held regularly.
Review of Energy	Compare usage & costs vs. goals, plans, KPIs, benchmarking other sites. Review and optimization of equipment operation. Results reported to site and corporate management.
Performance	Staff aware of energy performance. Recognition system in place. Awards for projects pursued by operators. Senior management acknowledges site successes. Meet regulatory and internal reporting requirements. Government and third-party recognition highlighting achievements sought.
Ongoing Training	Broad training/certification in technology and best practices. Regular training on automation systems and energy-efficient use of equipment. Energy included in staff induction training.
Market Awareness	Regular monitoring of trade journals, emerging technologies, internal databases, and other facilities. Best practices shared and implemented.

2014 Assessment

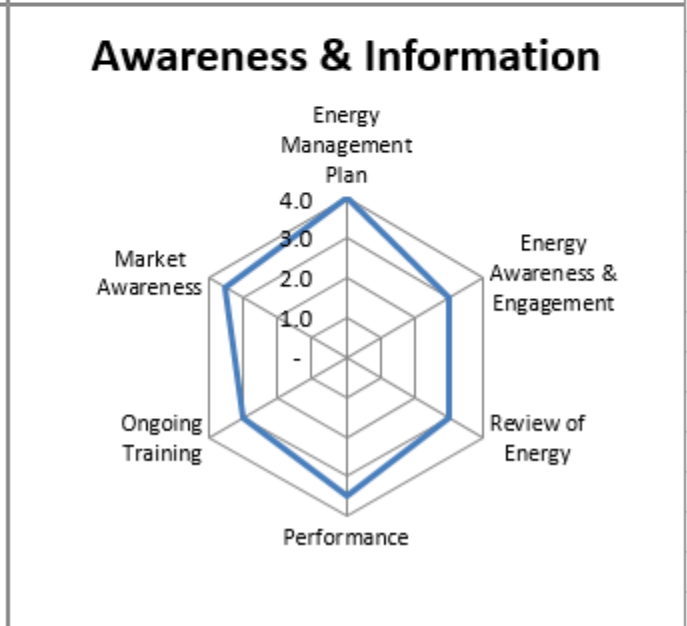
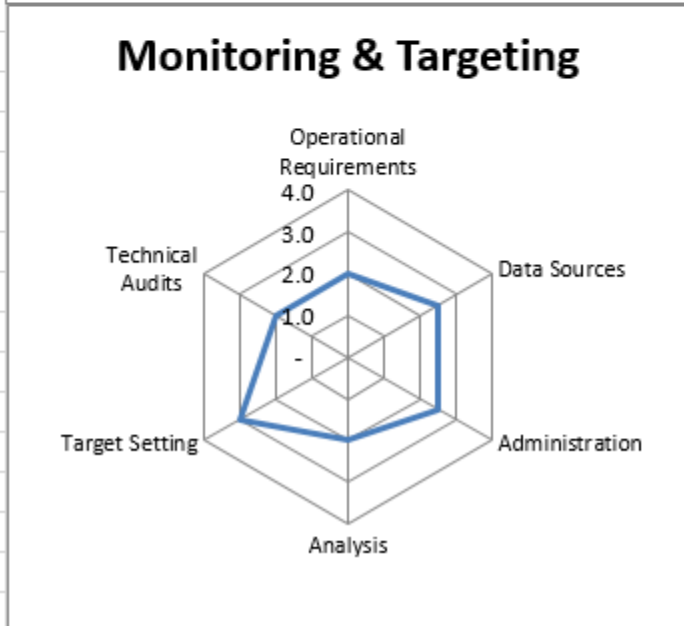
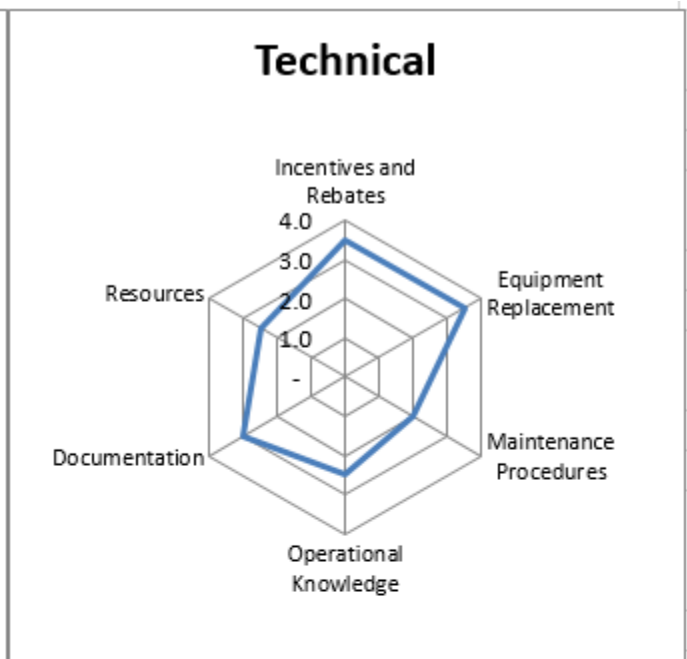
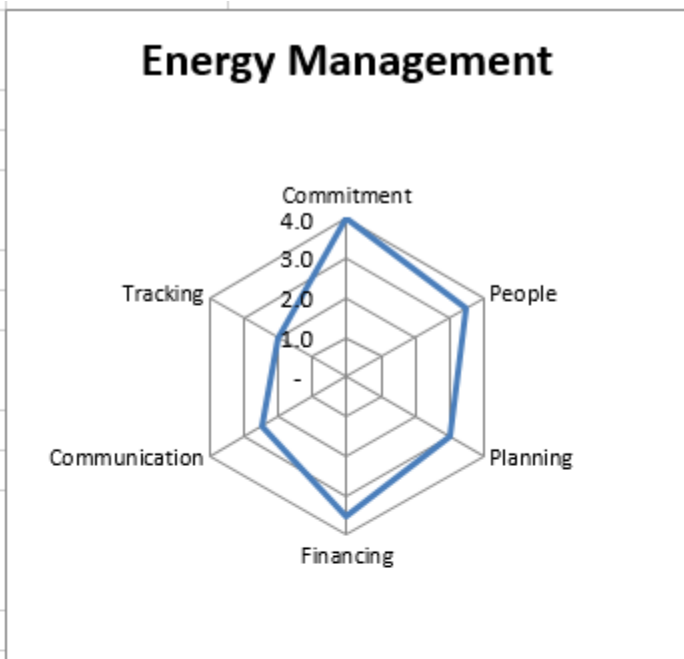
High-Level Assessment	Commitment	People	Planning	Financing	Communication	Tracking	Average
Energy Management	2.5	3.0	1.0	3.0	2.0	1.0	2.08
High-Level Assessment	Incentives and Rebates	Equipment Replacement	Maintenance Procedures	Operational Knowledge	Documentation	Resources	Average
Technical	2	2	1	1	2	1	1.50
High-Level Assessment	Operational Requirements	Data Sources	Administration	Analysis	Target Setting	Technical Audits	Average
Monitoring and Targeting	1	0	0	1	0	1	0.50
High-Level Assessment	Energy Management Plan	Energy Awareness & Engagement	Review of Energy	Performance	Ongoing Training	Market Awareness	Average
Awareness and Information	1	1	1	2	1	2	1.33





2019 Assessment

High-Level Assessment	Commitment	People	Planning	Financing	Communication	Tracking	Average
Energy Management	4.0	3.5	3.0	3.5	2.5	2.0	3.08
High-Level Assessment	Incentives and Rebates	Equipment Replacement	Maintenance Procedures	Operational Knowledge	Documentation	Resources	Average
Technical	3.5	3.5	2.0	2.5	3.0	2.5	2.83
High-Level Assessment	Operational Requirements	Data Sources	Administration	Analysis	Target Setting	Technical Audits	Average
Monitoring and Targeting	2.0	2.5	2.5	2.0	3.0	2.0	2.33
High-Level Assessment	Energy Management Plan	Energy Awareness & Engagement	Review of Energy	Performance	Ongoing Training	Market Awareness	Average
Awareness and Information	4.0	3.0	3.0	3.5	3.0	3.5	3.33

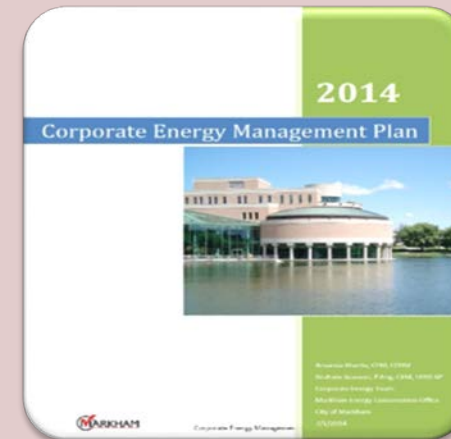


Appendix III) Summary of the City's Energy & Environmental Management Policies

City of Markham Energy & Environmental Management Policies		
Policy/Program	Purpose	Benefits to the City
Greenprint	<ul style="list-style-type: none"> <li>- Long term sustainability plan</li> <li>- Integrates all initiatives, plans, programs, policies, and decision making frameworks towards a common goal</li> <li>- Aims to maximize quality of life for entire municipality</li> </ul>	<ul style="list-style-type: none"> <li>- Reduces redundancy amongst other initiatives, plans, and programs</li> <li>- Streamlines policies and decision-making framework</li> <li>- Maximizes value for entire municipality</li> </ul>
Corporate Energy Management Plan	<ul style="list-style-type: none"> <li>- Comply with O.Reg 507/18 to create a corporate energy management plan</li> <li>- Report on energy consumption and GHG emissions</li> <li>- Outline goals and plan to reduce energy consumption and mitigate demand for energy</li> </ul>	<ul style="list-style-type: none"> <li>- Allows the City of Markham to accurately track energy consumption and identify areas where energy conservation measures will be most effective</li> </ul>
Markham's Official Plan	<ul style="list-style-type: none"> <li>- Plan describing multi-level municipal council's policies and land usage</li> <li>- Plan outlines council actions on air quality, climate change, noise &amp; vibration, brownfield &amp; site remediation, conservation areas, water management, and much more</li> </ul>	<ul style="list-style-type: none"> <li>- Identifies natural environments and strategies for protection</li> <li>- Cooperatively works with the Region and other partners to align policies and address key concerns</li> </ul>
LEED Certification	<ul style="list-style-type: none"> <li>- Build buildings to a higher level than the Ontario Building Code.</li> <li>- Improve construction practices to a higher standard than conventional building practices.</li> <li>- Build efficient buildings and reduce energy use in buildings.</li> <li>- Provide a better and healthier working environment for staff and visitors.</li> <li>- Achieve Silver level or higher, as directed by Council</li> </ul>	<ul style="list-style-type: none"> <li>- Save money on energy usage in buildings through efficiency and conservation.</li> <li>- Increase water savings throughout buildings.</li> <li>- Reduction of waste and materials through construction and over the life time of the building.</li> </ul>
Corporate Green Procurement	<ul style="list-style-type: none"> <li>- Integrate environmental performance considerations into the procurement process</li> </ul>	<ul style="list-style-type: none"> <li>- Reduce the environmental impacts of procurement while simultaneously realizing a slight decrease in life-cycle costs</li> </ul>
Meatless Mondays	<ul style="list-style-type: none"> <li>- Educate public on resource and energy intensity associated with meat production</li> </ul>	<ul style="list-style-type: none"> <li>- Reduce embodied energy &amp; negative environmental impacts associated with meat consumption</li> <li>- Increase food security</li> </ul>
Zero Waste	<ul style="list-style-type: none"> <li>- Markham Zero waste program vision is to achieve an 80% diversion of waste by 2014.</li> <li>- Ten new initiatives to reach 80% diversion of waste.</li> <li>- Maximize Recycling and composting city-wide.</li> <li>- Provide recycling collection to Homes, Multi-residential, Apartment/townhouse units, Schools, Business Improvement Areas.</li> </ul>	<ul style="list-style-type: none"> <li>- Maximizes the reduction of waste in the city from the point of purchase. Reduces poor packaging design and inefficiency.</li> <li>- 5 Community Recycling Depots provide enhanced recycling of special materials.</li> <li>- Community Recycling Depots accept materials to be recycled that cannot be taken from the curb.</li> </ul>
Fleet Vehicles	<ul style="list-style-type: none"> <li>- Purchase vehicles with higher fuel economy and promote more economical driving through education</li> <li>- Purchase or modify cars to use cheaper fuel</li> </ul>	<ul style="list-style-type: none"> <li>- Lower operating costs of municipal fleet vehicles</li> </ul>
Markham Environmental Sustainability Fund	<ul style="list-style-type: none"> <li>- Municipal program that funds innovative and leading environmental initiatives that contributes to the sustainability and health of the natural environment.</li> <li>- Provides financial resources for projects in Markham that promote environmental responsibility and protection of natural resources.</li> </ul>	<ul style="list-style-type: none"> <li>- Improves energy efficiency through initiatives/ pilot projects.</li> <li>- Implementation and promotion of green roofs, water management, clean air, wildlife habitat restoration, and rainwater harvesting.</li> <li>- As a result from these initiatives it will help reduce the implication of climate change and reach goals of Kyoto.</li> </ul>

City of Markham Energy & Environmental Management Policies		
Policy/Program	Purpose	Benefits to the City
Markham Organic Home Garden Program	<ul style="list-style-type: none"> <li>- Encourages residents to grow organic food at home and donate the surplus produce to their local food bank.</li> <li>- Award participants with certifications from workshops provided by the city.</li> <li>- Provides tips and newsletters to members containing recipes to help gardening skills.</li> </ul>	<ul style="list-style-type: none"> <li>- Provide access to safe, affordable, and healthy food.</li> <li>- Opportunity to borrow gardening tools and access to seed library.</li> <li>- Community can help with demand of organic grown food.</li> </ul>
Adopt-A-Park	<ul style="list-style-type: none"> <li>- Works with volunteers in community to be active in their local green</li> <li>- Allows community members to become involved in keeping spaces clean and green in the neighbourhood.</li> </ul>	<ul style="list-style-type: none"> <li>- Keeps parks clean from litter by volunteers actively participating in cleanups.</li> <li>- Reduces any vandalism reported in the park to provide a safe environment for families and children.</li> </ul>
Markham Grows Seeds Library	<ul style="list-style-type: none"> <li>- Allows members to borrow seeds at no charge.</li> <li>- Members replenish seeds in the library by returning seeds from the new plants they grow.</li> </ul>	<ul style="list-style-type: none"> <li>- Support urban agriculture throughout the city.</li> <li>- Allows for people in the city to grow their own healthy affordable food.</li> </ul>
Trees for Tomorrow	<ul style="list-style-type: none"> <li>- 4 year strategy to increase overall tree cover in Markham</li> <li>- Reintroduce nature into to urban environment</li> <li>- GHG reduction strategy</li> </ul>	<ul style="list-style-type: none"> <li>- Quality of life improvement</li> <li>- Proactive stance on GHG emissions</li> <li>- Greater erosion control</li> <li>- Mitigates heat island effect</li> <li>- Planning for future generations</li> </ul>
District Heating and Cooling	<ul style="list-style-type: none"> <li>- System implemented as part of urban planning initiative to increase sustainable infrastructure</li> <li>- District Energy plants utilize high-efficiency gas boilers, chillers, thermal storage and waste heat recovery</li> <li>- Electricity generated and added to grid, waste heat used for heating and cooling</li> </ul>	<ul style="list-style-type: none"> <li>- Addresses the City's goal of having a sustainable, reliable energy framework</li> <li>- Reduces GHG emissions</li> <li>- Enhances quality of life for citizens</li> </ul>
Stormwater Management	<ul style="list-style-type: none"> <li>- City-wide system of controlling effects of stormwater</li> <li>- 4 categories: flood control; erosion control; watercourse management; maintenance of stormwater management facilities</li> <li>- Promote systems that mimic the natural water cycle</li> </ul>	<ul style="list-style-type: none"> <li>- Protect and enhance water resources</li> <li>- Maintain continued health of streams, lakes, fisheries and natural heritage systems</li> <li>- Manage risks of flood damage in natural and urban drainage systems</li> </ul>
Milk Bags	<ul style="list-style-type: none"> <li>- Using plastic milk bags for creating reusable plastic sleeping and surgical mats</li> <li>- Landfill diversion strategy</li> <li>- Disaster relief and humanitarian aid strategy</li> <li>- Heighten awareness around waste</li> </ul>	<ul style="list-style-type: none"> <li>- Reduces waste: Over 2,000,000 plastic milk bags diverted from landfill since 2011</li> <li>- Community building via local support groups</li> </ul>
Smart Commute	<ul style="list-style-type: none"> <li>- Transportation management program that offers local businesses and residents practical solutions for commuting to and from work</li> <li>- Supports various commute choices such as: carpooling, transit, cycling, telework and flexible work arrangements</li> </ul>	<ul style="list-style-type: none"> <li>- Decreases urban traffic congestion</li> <li>- Improve air quality</li> <li>- Enhance health and well-being of community</li> <li>- Increase worker productivity</li> </ul>

Appendix IV) Our Successes through an Award-Winning Energy Program



**Canada's Greenest Employer**

**2018**

**Organization:** Mediacorp Canada

**Location:** Citywide

**Significance:** One of 100 Canadian employers that has created an environment in which staff from all areas and levels of the organization are encouraged to develop new opportunities to improve our sustainability and to get involved in minimizing the environmental impact of the City's operations.

**ENERGY STAR**

**Organization:** Natural Resources Canada (NRCan)

**2018**

**Location:** Markham Civic Centre

**Significance:** First municipality in Canada to receive award. Demonstrates energy-efficient leadership and environmental stewardship. Performed better than at least 75 per cent of similar buildings nationwide, and released 35 per cent fewer greenhouse gas emissions.

**ENERGY STAR**

**Organization:** Natural Resources Canada (NRCan)

**2018**

**Location:** Clatworthy Arena

**Significance:** First municipality in Canada to receive award. Demonstrates energy-efficient leadership and environmental stewardship. Performed better than at least 75 per cent of similar buildings nationwide, and released 35 per cent fewer greenhouse gas emissions.

**Living City Energy Efficiency Leadership Award**

**Organization:** Toronto and Region Conservation Authority (TRCA)

**2018**

**Location:** Markham Civic Centre (Silver), Milliken Mills CC (Gold), Markham Village Arena (Gold)

**Significance:** Recognizes leadership in achieving energy targets. The Gold Award represents municipal buildings that meet their target. The Silver Award represents municipal buildings that get to within 5% of their target.

**Energy Manager of the Year - Most Innovative Project**

**Organization:** Independent Electricity System Operator (IESO)

**2018**

**Location:** Citywide/Milliken Mills CC

**Significance:** Demonstrates energy manager/energy program success and leadership. Award earned for the redesign & standardization of the Building Automation Systems for our building fleet.

**Partners for Climate Protection Milestones 1-3**

**Organization:** Federation of Canadian Municipalities (FCM)

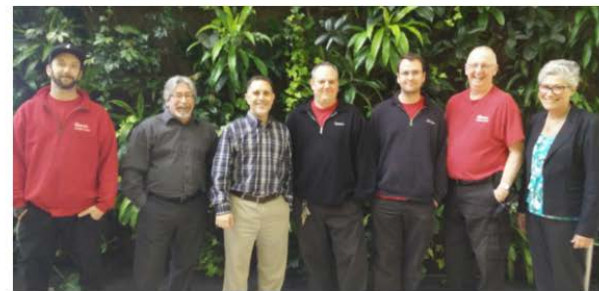
**2015**

**Location:** Citywide

**Significance:** Network of Canadian municipal governments that have committed to reducing greenhouse gases (GHG) and to acting on climate change through a five-milestone process.



Battle of the Buildings Winners





Appendix V) CEMP Summary of Measures

#	Measure	Cost	Savings	Length
1	Obtain FCM's PCP Milestones 4 & 5 awards	N/A	N/A	2019-2020
2	Earn industry-esteemed awards	N/A	N/A	Ongoing
3	Study and Model Fleet Vehicle Net-Zero Carbon Emissions	\$100,000	TBD	2019-2020
4	Improve system efficiencies and expand MDE to buildings, where feasible	Cost neutral	5% to 15% energy per building	Ongoing
5	Investigate and implement district energy carbon reduction strategies, where feasible	TBD	TBD	Ongoing
6	Develop Corporate NZEE 2050 study scope with short to medium to long-term reduction strategies including recommendations and solutions	N/A	N/A	2020
7	Launch Corporate NZEE 2050 study and identify resources (ie. Staff, funding) required to implement the NZEE 2050 plan	\$100,000	TBD	2021-2023
8	Evaluate feasibility of adding facility Level 2 energy audits and/or re-commissioning studies to Capital Lifecycle Plan, and  Perform energy audits prior to major facility upgrades, as necessary	\$0.15 to \$0.24 per ft <sup>2</sup>	5% to 20% per building, often included with BAS, Lifecycle, and re-commissioning projects	2023-2024  Ongoing
9	Re-commission buildings, as applicable	\$0.15 to \$0.30 per ft <sup>2</sup>	5% to 20% per facility, included in BAS savings	Ongoing
10	Enroll eligible facilities in Enbridge's Run it Right program	N/A	3-5% gas savings per facility	Ongoing
11	Apply for utility incentives on eligible projects	N/A	\$100,000/year average revenue	Ongoing
12	Recruit staffing resource to effectively utilize and manage metering tools to identify energy and cost savings	N/A	5-10% per facility	2019 - Recruit Ongoing
13	Develop M&V plans, and utilize/add metering tools for project M&V to secure incentive funding	\$1,000 per project	Included in utility incentive revenue	Ongoing
14	Study and develop city-wide metering program and standardized specifications	N/A	N/A	2019-2020
15	Standardize and centralize metering monitoring and management at largest facilities, if feasible	N/A	N/A	2021-2024
16	Upgrade whole-building Alectra electricity meters to hourly interval meters, and obtain remote access capability	\$500 per building	Included in metering analysis savings	Ongoing
17	Upgrade whole-building Enbridge Gas gas meters to hourly interval meters, and obtain remote access capability	\$1,000 per building	Included in metering analysis savings	Ongoing
18	Complete utility bill audits; identify and implement cost savings	\$5,200 per year UMS software	N/A 1-5% cost savings	2019-2020 Annual
19	BAS and HVAC training	\$1,000 to \$4,000 per session	Included in engagement savings	Annual, Ongoing
20	Utility Management System and metering training	N/A	Included in engagement savings	Annual, Ongoing
21	Study best practice operating procedures for major equipment, and Update Battle of the Buildings engagement tools	\$5,000	N/A  N/A	2020  2021
22	Re-launch competition with new baseline, improved measures and tools	\$10,000 per year	1-5% per year	Annual, 2021-2024
23	Increase Demand Response participation, where feasible	\$5,000 per building	\$60/kW enrolled	Ongoing
24	Investigate demand management opportunities	TBD	TBD	2022
25	Support lifecycle upgrades with funding, incentives, and studies	\$100,000 to \$150,000 per year	5% to 20% on new equipment	Ongoing
26	BAS Preventative Maintenance Contracts	Included in maintenance budgets	5% cost savings	Ongoing
27	Implement BAS Standards and optimize BAS at major facilities	Included in Lifecycle (LC) and LC support costs	5-25% per facility	Ongoing
28	Install CHP at Angus Glen Community Centre Review CHP performance against study baseline	\$2.4M N/A	Net savings \$270k/yr N/A	2019 2019-2020
29	Evaluate CHP business cases, and install where feasible	\$40,000/facility study TBD	N/A TBD	2021 Ongoing



#	Measure	Cost	Savings	Length
30	Design all new buildings with at minimum LEED™ Silver	Varies by building	Varies by building	Ongoing
	Study and model Net-Zero business cases for proposed new construction projects	\$40,000/study	TBD	Ongoing
31	Investigate converting the remaining HPS decorative streetlights to LED	TBD	TBD	Ongoing
32	Evaluate solar PV system business cases, and install where feasible	\$1,100/site - study TBD	0 TBD	2019-2020 Ongoing
33	Evaluate business cases and install solar thermal systems, where feasible	\$10,000 study	TBD	2019-2020 Ongoing
34	Evaluate business cases and add renewable energy, where feasible	Varies depending on energy source	Varies depending on energy source	Ongoing
35	Evaluate business cases and install heat recovery, where feasible	TBD	TBD	Ongoing
36	Support additional special events to promote energy awareness	Varies	N/A	Annual, Ongoing
37	Share project successes, awards, and best practices	N/A	N/A	Annual, Ongoing
38	Increase webpage awareness	N/A	N/A	Annual, Ongoing
39	Create revised corporate energy management plan	N/A	N/A	2018-2019
40	Internally and externally report annually on energy consumption and GHG emissions	N/A	N/A	Annual, Ongoing