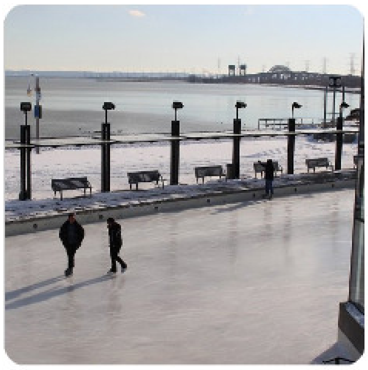
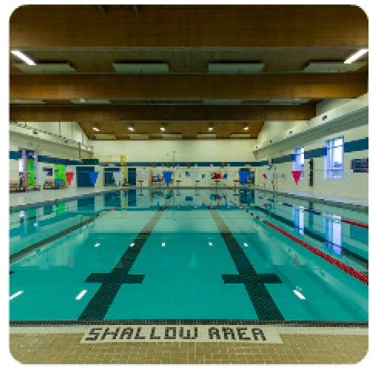
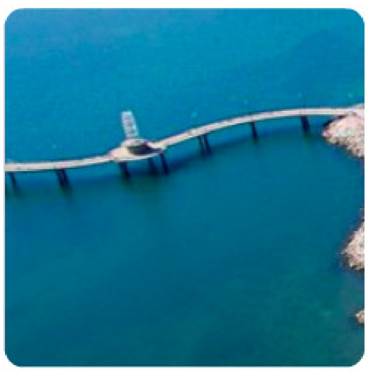
CITY OF Burlington

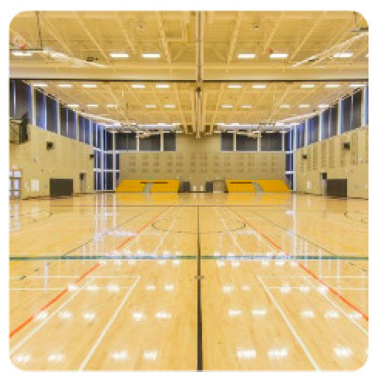
Corporate Energy and Emissions Management Plan: 2019-2024









InDEco Strategic Solutions for a Changing World™ & THE PARAGON GROUP

Corporate Energy and Emissions Management Plan 2019-2024

The City of Burlington

IndEco & The Paragon Group

Contents

Executive summary v
Purpose v
Scope and methods v
Major assumptions vi
Status of data vii
Main findings vii
Conclusions and recommendations x
Background and context 1
About the City of Burlington 1
Progress since the previous plan 4
Corporate energy use and costs progress 6
Preferred state of energy management 8
Present state of energy management 10
Corporate energy and emissions inventory 10
Corporate fleet fuel consumption 15
Water Conservation 17
Energy management initiatives that have been implemented 18
Assets and plans 20
Objectives and targets 21
Objectives 21
Targets 21
Energy use versus energy intensity 23
Key performance indicators 23
Updating and reporting on the plan 24
Plan strategy 25
Data management 25
Training and engagement 26
Staffing 28
Policies and procedures 29
Technologies for facilities 30
Technologies for fleets 36
Priority actions 38
Year 1 actions 38
Years 2-5 actions 38

Years 5-20 actions ... 39
Costs of actions: 2019-2025 ... 44

Getting to net zero – one possible scenario ... 47

Conclusions and recommendations ... 50

References ... 51

Appendix A. Present state ... 55

Existing corporate energy initiatives, policies, and plans ... 55

Appendix B. Global climate change and energy planning initiatives ... 60

C40 Cities Climate Leadership Group ... 60
Global Covenant of Mayors ... 60
The Under2 Coalition ... 61
Net Zero Building-World Green Building Council ... 62
Climate change policy developments in Ontario ... 62

Appendix C. Municipal experience and best practices ... 66

Appendix D. Financial incentives ... 72

Independent Electricity system Operator (IESO) ... 72
Enbridge Gas Distribution ... 72
Federal incentives ... 74
The Atmospheric Fund incentives ... 76

Appendix E. List of acronyms ... 77

Appendix F. Facility energy use 2014-2018 ... 78

Appendix G. Energy density and conversion factors, and greenhouse gas emission factors ... 82

Appendix H. Conservation demand management plan checklist ... 83

Executive summary

PURPOSE

Burlington’s Corporate Energy and Emissions Management Plan (CEEMP) is designed to identify opportunities for reducing energy use and greenhouse gas emissions from City operations; supporting international, federal, provincial and City goals.

Historically, energy use and greenhouse gas (GHG) emissions increased over time as cities grew. We now recognize that increasing energy efficiency is vital to enhancing the social, economic and environmental well-being of all communities. Working to mitigate GHG emissions is an important strategy for reducing the scale of climate change. The CEEMP provides policy direction on energy efficient city operations and reducing GHG emissions. A separate plan, The Community Energy Plan (CEP) (transitioning to the Climate Action Plan), addresses energy use and greenhouse gas emissions in the broader community, considering not just city operations, but also the contribution of residents and businesses.

The CEEMP provides policy direction for energy management and supports Burlington’s desired vision–as set out in the City’s strategic plan–of being healthy and greener through environmental leadership, including by making the city’s operations net carbon neutral by 2040.[1]

The CEEMP updates the Corporate Energy Management Plan that was adopted in 2014 and is designed to meet the requirement of Ontario Regulation 507/18, under the *Electricity Act* that municipalities update corporate energy plans every five years.

SCOPE AND METHODS

This plan addresses corporate energy use and Scope 1 and Scope 2 GHG emissions from buildings, parks, vehicle fleets, street and traffic lights.[2, 3] The plan does not address rental properties, joint ventures, or local boards (e.g. Burlington Public Library, the Burlington Performing Arts Centre).

[1] “Net zero” or carbon neutral means that any carbon emissions released are offset, either by providing an equivalent amount of carbon-free energy to the market, or by buying an equivalent number of offsets. In the case of electricity, ‘net zero’ could be achieved by sending to the grid a quantity of electricity with zero emissions equal to the quantity of electricity taken from the grid.

[2] Scope 1 emissions are the direct emissions associated with fuel use by Burlington. Scope 2 emissions are the emissions associated with generating the electricity used by Burlington. Other emissions not included are: upstream oil and gas emissions, methane associated with the transportation and distribution of natural gas, emissions embedded in products used by the City, and employee commuting emissions, for example.

[3] Because the energy and emissions associated with transit operations are determined primarily by behaviours of citizens, it was decided that transit vehicles would be excluded from the methodology and calculations. Transit use is addressed by the community energy plan. This is consistent with the practice used in the Federation of Canadian Municipalities program, Partners for Climate Protection.

The plan is concerned with energy use and emissions over two timeframes: 2019 to 2024, and 2025-2040. The first is determined by the regulatory requirement, the second by the City's Strategic Plan.

The scope of the work has four components:

- A review of changes in energy use and emissions since the adoption of the previous Corporate Energy Management Plan in 2014, and the factors that contributed to these changes
- Clarification of the 'preferred state' of energy use in the City and the establishment of targets along the path to that preferred state
- Development of actions to be undertaken to move towards the preferred state between 2019 and 2024, and beyond 2024
- Estimating the impact of those actions on energy use and emissions

Methods employed in developing the plan included:

- Analysis of utility data, and fuel consumption by fleets
- Interviews with staff from across City departments on their practices, successes and challenges in managing energy use and suggestions for the plan
- A strategic planning workshop with staff from several departments to identify the preferred state, actions to get there and to assign priorities to those actions based on the ease and importance of the action
- A review of key documents, including the previous Corporate Energy Management Plan; City policies, reports and plans; energy plans of other jurisdictions; and literature on energy saving technologies and opportunities
- Consultation with key technology suppliers
- Modeling stock turnover and the adoption of new technologies in the City

MAJOR ASSUMPTIONS

The modest population growth projected by the City of Burlington is not anticipated to result in a significant increase in the need for municipal facilities.

The required resources will be available to execute this plan. This includes financial and human resources where applicable and the commitment of Council and staff to implement the plan.

STATUS OF DATA

- Historic data for facilities are from utility bills and are deemed to be accurate.
- Fleet data are collected from fuelling facilities. These data have limitations, including how they are distributed across specific vehicles and the duty cycle of those vehicles.
- Projected emission savings and costs are based on the interviews with suppliers, project team experience in other jurisdictions and published literature. Estimates were made about the applicability of data from these sources to Burlington and how these may change over the 21 year time horizon of the plan. These estimates become increasingly speculative the longer the time horizon.
- Costs are based on 'typical' costs and are not based on assessments of specific projects. Those cost estimates will need to be developed as specific projects are identified.

MAIN FINDINGS

Main findings relate to energy and greenhouse gas trends over the last five years, data management, training, staffing, policies and procedures, and technologies.

Energy and greenhouse trends 2014-2018

The City of Burlington used 208 TJ (58 GWh) at a cost of just under $5.5 million on energy in 2018; a significant cost to the City. This energy use resulted in the release of 7,300 t CO_2eq of greenhouse gases, which contribute to climate change.[4]

The City of Burlington uses energy for a number of uses: for heating and cooling of buildings, lighting and equipment in buildings, streetlighting, and to power vehicles. The distribution of energy used for these purposes by energy source from 2014 to 2018, and the associated greenhouse gas emissions, are presented in Figure 1 and Figure 2.

[4] "t CO_2eq" is tonnes of carbon dioxide equivalent. A tonne is one thousand kilograms. Carbon dioxide equivalents is a way of measuring the climate forcing (contribution to climate change) of all greenhouse gases – most significantly carbon dioxide, methane and nitrous oxide – as if they were all carbon dioxide (CO_2). This is done by multiplying the releases by the "Global Warming Potential" (GWP) for each gas. GWPs differ depending on the time period considered. The default assumption is a 100-year forcing. (Environment and Climate Change Canada, 2019)

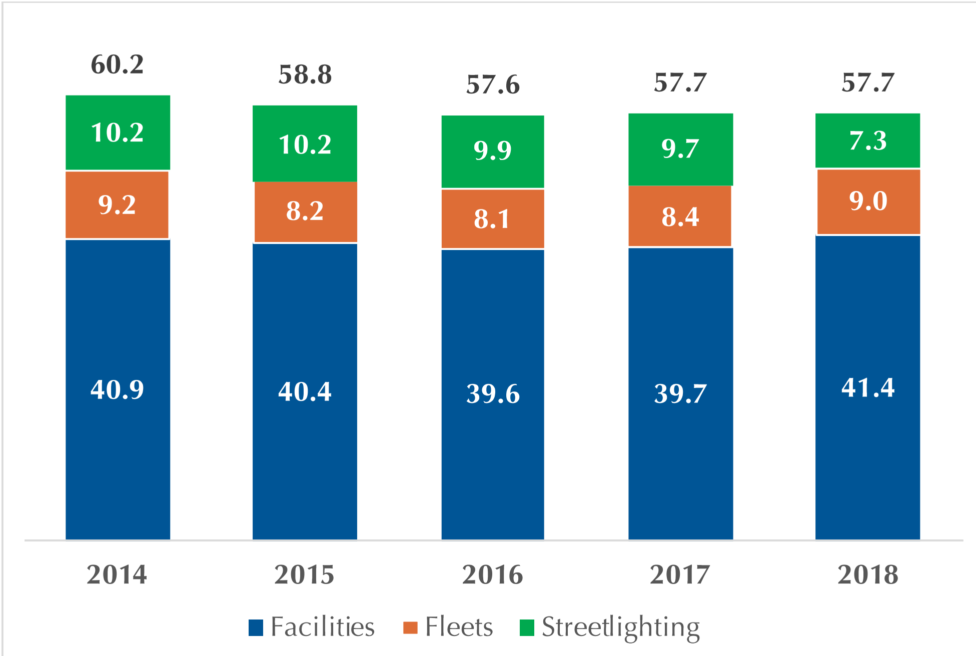


Figure 1 City of Burlington energy use 2014-2018 (eGWh)

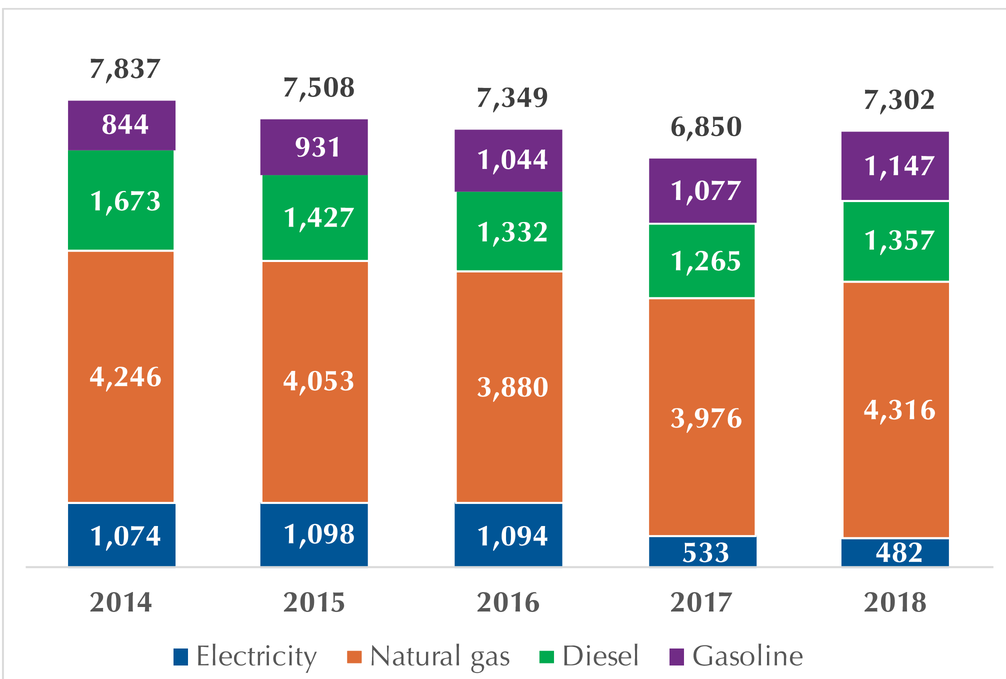


Figure 2 City of Burlington greenhouse gas emissions by energy source in 2014-2018 (t CO_2eq)

Data management

Burlington has undertaken several initiatives to ensure that energy and emissions data are tracked and managed. On the facilities side, the City has adopted AssetManager, a software platform that captures monthly energy data from utilities bills and is able to show trends in usage over time in aggregate, by facility type, or by individual facility. It also can report greenhouse gas emissions and do CUSUM analyses to identify specific changes. Several staff members have been provided with access and training to the tool. In addition, Panoramic Power has been introduced into six buildings and provides more detailed information on facility operations. On the fleet side, fuel purchases are tracked in a database, and telemetrics have been collected from 29 light duty vehicles. However numerous staff reported that they do not have access to energy information in a readily understandable format and the data on fleets is difficult to access and analyze.

Training

Staff are offered training on energy efficient operations and practices. This includes awareness programs and annual training and support for building and operations staff. Staff who will be driving vehicles receive instruction on driving for fuel efficiency at the time of hiring.

Staffing

Burlington has dedicated staff with a commitment to providing high quality service to Burlington residents and businesses. There is one person in the City with specific responsibility for energy use in facilities, as part of his responsibilities. This function is less resourced than in some other Ontario municipalities. Staff identified significant resource constraints limiting their ability to undertaken additional actions. These restraints include both time to plan, manage, monitor and evaluate projects.

Policies and procedures

The City has one of the most aggressive targets of Ontario municipalities around emissions reductions. Some policies and procedures do not fully support this target. Staff mentioned the emphasis on first-cost in decision making over life-cycle costs, the commitment to LEED Silver certification (or equivalent) is dated, and there are not formal policies to encourage fleets to reduce their carbon intensity.

Technologies

Over the last five years, numerous technologies have been installed in facilities to make them more energy efficient, and to reduce their greenhouse gas emissions. These include upgrades to boilers, automated systems, HVAC systems, lighting, vehicle downsizing and purchasing of plug-in hybrid electric vehicles. Energy efficiency projects implemented produced an estimated cost saving of approximately 2.9 million dollars, and carbon reductions of more than 150 t/a. Through consultation with staff, experience in other jurisdictions, and review of literature on opportunities, it is clear that numerous additional opportunities remain to be captured.

CONCLUSIONS AND RECOMMENDATIONS

The review of Burlington policies, and consultation with Burlington staff led to the identification of where Burlington would like to be with respect to energy management – the preferred state of energy management. The preferred state consists of ten elements: the commitment to net carbon zero and the use of renewable energy, information availability, collaboration within the City and with others outside, awareness of actions in other jurisdictions, piloting innovative solutions, decision-making based on multiple criteria including life-cycle costs, measuring and monitoring energy and emissions, information reporting to City Council and senior management, and leveraging expenditures.

Targets have been set to move towards the preferred state for 2020, 2024 and 2040. These are shown on Table 1.[5]

Table 1 City of Burlington energy and emissions targets 2020, 2024 and 2040

Target area	Current baseline	2020 target	2024 target	2040 target
Grid electricity (MWh)	**24,115,335**	**23,500,000** (3% reduction)	**18,200,000** (25% reduction)	**-** (100% reduction
Natural gas (m^3)	**2,272,256**	**2,300,000** (0% reduction)	**1,800,000** (21% reduction)	**-** (100% reduction)
Gasoline (L)	**409,133**	**390,000** (5% reduction)	**320,000** (22% reduction)	**-** (100% reduction)
Diesel (L)	**484,193**	**470,000** (3% reduction)	**440,000** (9% reduction)	- (100% reduction)
Renewables capacity (MW)	**-**	**-**	**4**	**21**
GHG emissions (t CO_2eq)	**7,302**	**7,200** (1% reduction)	**5,800** (21% reduction)	- (100% reduction)

To realize these targets, a set of 65 actions were identified addressing each of the components of the preferred state. The primary actions driving progress towards the target are: electrification of buildings (replacing natural gas) and fleets (replacing gasoline and diesel), and installation of renewable electricity generation to replace grid electricity. Other actions support these initiatives through data management, training, staffing, and policies and procedures.

Estimates of the costs of meeting these targets are shown in Table 2. These estimates are based on the assumptions given in Table 13 on page 46 and are part of the "one possible solution" described on page 48.

[5] Greenhouse gas reductions are somewhat dependent on the characteristics of electricity from the Ontario grid, over which the City has no control. The focus of attention should be on the specific energy targets.

Table 2 Summary of the estimated costs of meeting the targets

Year	Technology costs	Staff costs	Gross costs	Energy cost savings	Net cost
2019	$0	$200,000	$200,000	$0	$200,000
2020	$175,000	$300,000	$475,000	-$110,000	$365,000
2021	$3,651,000	$400,000	$4,051,000	-$389,000	$3,662,000
2022	$3,547,000	$400,000	$3,947,000	-$623,000	$3,324,000
2023	$3,444,000	$400,000	$3,844,000	-$899,000	$2,945,000
2024	$3,340,000	$400,000	$3,740,000	-$1,195,000	$2,545,000

Background and context

ABOUT THE CITY OF BURLINGTON

The City of Burlington is located at the western end of Lake Ontario, The City lies within the delineated built-up area of the Greater Golden Horseshoe in Southern Ontario. Burlington is one of the four area municipalities within the Regional Municipality of Halton (Halton Region). In 2016, the population of Burlington was 183,314 (Statistics Canada, 2019). Burlington has decided to protect the urban/rural boundary, so plans modest population growth. Burlington expects to increase its population and employment base by 2031. The 'official' forecast is that population and employment in 2031 will be 193,000 and 106,000, respectively (Burlington, City of, 2018).

Longer term population estimates are being developed by Halton Region. The rate of growth in population and employment is not anticipated to result in a significant increase in the need for municipal facilities.

Figure 3 The downtown core of the City of Burlington

The City of Burlington has a total area of 185.6 km^2. Burlington plans to concentrate new development in mixed-use intensification areas and accommodate new jobs in employment corridors.

The City's energy needs are supplied by Burlington Hydro for electricity, and Enbridge Gas Distribution for natural gas.[6] Most fleet refueling is done at City-owned fueling facilities.

Burlington has implemented a variety of measures to increase energy efficiency in City operations. Some of these actions include: installation of building automation systems, energy management systems and real-time metering for tracking energy use within facilities.

Reducing energy use in city operations will reduce greenhouse gas (GHG) emissions that contribute to climate change. As stated in the strategic plan,

[6] Prior to the merger of Union Gas and Enbridge, the city was served by Union Gas.

the City has a target for city operations to be net carbon neutral by 2040. The strategic plan also includes a community wide target to is work with the community and all levels of government towards the goal of become a net zero carbon community.[7] The City recognizes the significant impacts of climate change and works with a number of organizations to take action on climate change, including the Federation of Canadian Municipalities' Partners for Climate Protection program, ICLEI – Local Governments for Sustainability, Sustainable Hamilton Burlington, QUEST (Quality Urban Energy Systems of Tomorrow), and the Clean Air Council.

Partners for Climate Protection Program

The City of Burlington is a member of the Partners for Climate Protection (PCP) program. The PCP program is a joint partnership between the Federation of Canadian Municipalities (FCM) and ICLEI-Local Governments for Sustainability. The PCP program was developed to help municipalities reduce greenhouse gas emissions through corporate and community local action plans. As a PCP member, the City of Burlington has enhanced its climate action through milestone achievements.

The PCP framework is comprised of five milestones for reducing GHG emissions. They are highlighted below:

Milestone 1: Create a greenhouse gas emissions inventory and forecast;

Milestone 2: Set an emissions reduction target (community and corporate);

Milestone 3: Develop a local action plan;

Milestone 4: Implement the local action plan or a set of activities; and

Milestone 5: Monitor progress and report results.

Once achieving Milestone 5, the PCP program requires members to submit a report highlighting their progress every two years. The City of Burlington completed its local action plans (milestone 3) in 2013 with the Corporate Energy Management Plan and in 2014 with the Community Energy Plan and achieved the final milestones 4 and 5 in 2017.

The Federation of Canadian Municipalities states that within Canada, half of the GHG emissions are under the direct control or influenced by local governments. Local governments and community initiatives set the foundation for change when they participate in programs such as PCP, the implications of climate change are dealt with collectively. Similarly, another example on a bigger scale that shows how collective engagement can contribute to climate protection is the Global Covenant of Mayors for Climate & Energy, whose members include cities from around the world. Examples of other global climate change initiatives are described in Appendix B.

[7] "Net zero" or carbon neutral means that any carbon emissions released are offset, typically by buying an equivalent number of offsets. In the case of electricity, 'net zero' could be achieved by sending to the grid a quantity of electricity with zero emissions equal to the quantity of electricity taken from the grid.

THE FOUR KEY STEPS OF THE PLANNING PROCESS

Figure 4 shows the major steps in the planning process that were used to develop the City of Burlington's CEEMP.

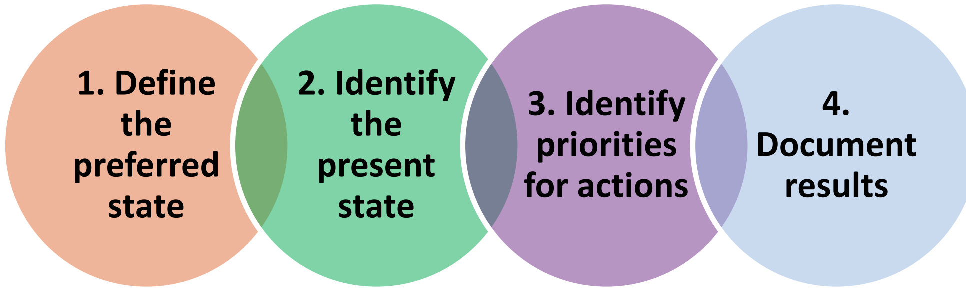


Figure 4 The key steps of the strategic approach for developing the plan

1) The preferred state is a description of where the City of Burlington wants to be with energy use and fuel usage. Defining the preferred state involves identifying goals, objectives, targets, actions, and measures to achieve them. Elements of the preferred state were identified through interviews with key City staff and reviewing the best practices and energy efficiency initiatives in other jurisdictions which can be found on Appendix D.
2) The present state gives an indication of how far away the City's present state of energy management is from where the City wants to be. To identify the present state, we reviewed utility energy data, conducted staff interviews, reviewed building audits, and reviewed Burlington's policies, plans, and past energy efficiency projects. A detailed description of the present state can be found in Appendix A.
3) Identifying a priority of actions was a two-step process. First actions were identified by the project team, and through a strategic planning workshop. Then the actions were rated against a number of criteria, principally the ease of implementation and the importance of the action in getting from the present to the preferred state.
4) Documenting our results include refining a list of actions, priorities, critical paths, costs, monitoring, and verification of actions and plan updating.

Inputs to the planning process included:

- Analysis of the City of Burlington's utility energy use data;
- Review of existing policies, plans, and previous Corporate Energy Management Plan;
- Interviews with City staff: senior management, managers, and facility operating staff;

- A strategic planning workshop with key City staff members;
- Review of energy management best practices in other jurisdictions examples of which are described in Appendix D.

Priority actions include short-term improvements to the City of Burlington’s energy performance. Priority actions can be implemented and completed within the first years of the plan. Medium-term or long-term opportunities focus on deeper retrofits, building efficiency, technological innovations, and fuel switching. Medium-term and long-term actions also include the constant monitoring and reporting on implemented actions.

PROGRESS SINCE THE PREVIOUS PLAN

In 2018, a progress report for corporate energy and greenhouse gas emissions compared energy and water consumption data since 2016. The initiatives that were implemented in 2017 and those still in progress were reported on.

Table 3 provides a summary of some of the initiatives that have been undertaken.

Table 3 Energy initiatives undertaken by Burlington since the last corporate energy management plan (CEMP)

CEMP action	Type of Action	Actions completed, in progress, pending, or abandoned
Energy Management Information Systems (EMIS)	Technical	Specification for new buildings and major retrofit projects are ongoing. Meter specifications were defined. Three real time electricity submetering systems were installed at Tansley Woods Community Centre, Mainway Recreation Centre, and Appleby Ice Centre. Installation and connection of interval meters to EMIS at 3 facilities.
Smart buildings	Technical	Ongoing investigation of power factor [8] correction for large buildings. Ice plant controls were integrated at each of the City's arena. Formal integration specifications for new buildings were developed.
Monitoring and targeting	Operational and technical	Targets for energy use index were developed in the previous Corporate Energy Management Plan. Recommissioning activities in 2017 included the use of real time circuit level metering installations at Mainway Recreation Centre, Tansley Woods Community Centre, and Appleby Ice Centre.
Energy awareness program	Operational	Meetings with users were scheduled to educate on energy and sustainability.
Energy training	Operational	Energy competitions between different facilities and additional building automation system (BAS) training has improved the understanding of energy systems. Building and operations staff received annual training and support. Multiple alarm points were added to notify operations staff on any equipment failure issues.
Measurement and verification	Operational	Updating design criteria for new buildings
Building system documentation	Operational	When buildings were expanded, the building systems were documented.
Maintenance management software tool-HIPPO	Technical	Maintenance management is ongoing for updating the remaining corporate facility data into the HIPPO software.
EnergyStar® PortfolioManager	Technical	AssetPlanner was adopted, providing similar functionality to Portfolio Manager
Building retrofit actions	Technical	Ongoing-the City coordinates on capital retrofit measures annually with the available corporate facility capital improvements funding. A long-term capital plan for energy measures is in progress.

[8] Power factor is the ratio of working power to apparent power. It measures how effectively electrical power is being used. A high-power factor signals efficient utilization of electrical power, while a low power factor indicates poor utilization of electrical power.

CEMP action	Type of Action	Actions completed, in progress, pending, or abandoned
		Lighting at Mainway Arena and Burlington Transit Headquarters was upgraded to LEDs, including lighting controls with occupancy sensors and dimmable drivers. De-ox systems for Zamboni water filling were installed at Mainway Recreation Centre and at Appleby Ice Centre. These are anticipated to lower the natural gas use within the facilities.
Recommissioning	Technical	A recommissioning project was completed at Fire Station 8. This was seen as a pilot for a corporate-wide plan for recommissioning facilities.
New construction	Operational	In 2010, the City of Burlington adopted a policy that all new buildings and major retrofits above a certain size should meet the criteria for Leadership in Energy and Environmental Design (LEED) silver certification.
Renewable energy (RE)	Operational and Technical	Ongoing-the feasibility of RE projects is considered when appropriate. With the City's carbon neutral operations goal, net metered solar projects and other renewables are priorities for new construction projects.
On-site generation and demand response	Technical	Ongoing-monitoring available technology and market conditions for the feasibility of on-site generation projects. Two of the City's arenas are enrolled in IESO's demand response program.
Corporate fleet energy	Operational	Hybrids and plug-in hybrid electric vehicles (PHEVs) were added to the fleet. Fire fleet support (light duty) vehicles have been replaced with more energy efficient vehicles. The City engaged a consulting firm that specializes in zero emission vehicles to explore the practicality of replacing conventional vehicles with PHEVs or battery electric vehicles (BEVs).
Street lighting and traffic signals	Technical	The City partnered with Burlington Hydro to update the City's streetlights to LED fixtures. (Excluding decorative fixtures.)
Corporate energy conservation culture-the city departments	Operational	Facility level reports and dashboards were developed for supervisors and operating staff.

The City of Burlington continues to capture energy opportunities through control and monitoring, staff engagement, and through equipment operation improvements. Anticipated in the near future are upgrades to the HVAC systems for City Hall and Appleby Ice Centre. Additional information about priority actions is discussed below and in Table 11 (p.40).

CORPORATE ENERGY USE AND COSTS PROGRESS

A key component in understanding the progress made since the previous Corporate Energy Management Plan is looking at the overall data on various energy sources and associated cost to the City of Burlington. A comparison of the targets set in 2014 against levels to the end of 2018 is presented in Table 4.

To consider the impacts of the plan, changes in energy use since 2014 when the last plan was adopted were assessed.[9] The City has made progress in implementing energy efficiency measures but fell short of meeting the 2014 targets, with the exception of streetlights. Data in Table 4 show energy use per unit area in city facilities decreased over the 2014 to 2018 period by 1%. Due to a major streetlighting retrofit program, energy use by streetlights dropped by 28%. The energy cost for city facilities increased by 21% since 2014. Corporate fleet fuel consumption displays a 2% decrease.

Table 4 Assessment of progress towards targets in the 2013 plan as of end of 2018

Target type	Target reduction	Progress towards target	Target	Actual	
				2014	2018
Overall energy use in facilities (ekWh/ft²)	15%	1%	31	36.3	36.5
Energy cost for facilities ($/ft²)	20%	-21%	$1.92	$2.40	$2.91
Electricity use for street lighting (MWh)	20%	28%	8,151	10,189	7,307
Water use (m³/ft²)	10%	-38%	0.22	0.24	0.33
Fleet fuel use (eMWh) *	10%	2%	8,239	9,154	8,960

*original target for fleets was in L/100 km. Comparable data are not available.

Table 4 provides an assessment of the City's progress in meeting the targets set in the 2013 Corporate Energy Management Plan. In part, energy use within facilities not meeting the target can be attributed to increased programming in various recreation facilities. Decreases in various buildings due to energy retrofits have been observed.

Energy costs have a significant component that is outside the control of the City. Unit electricity costs in particular have increased significantly, from an average cost of 0.13 $/kWh to 0.17 $/kWh. Natural gas also increased from 0.25 $/m^3 to 0.27 $/m^3, and diesel and gasoline were 0.91 $/L and 1.01 $/L in 2014, decreasing to 0.86 $/L and 1.00 $/L respectively in 2018. While Ontario inflation was about 7.2% from 2014 to 2018, electricity prices rose 25.4% and gas prices 7.7%. Fuel prices declined in absolute terms. All "cobra head" style street lights have been replaced with LED fixtures, this excludes the decorative carriage style fixtures in the downtown areas. Water usage increases can be attributed to the increased numbers of splash pads connected to facilities as well as increased programming as mentioned with the energy increases in facilities.

[9] The earlier plan used data from a 12-month period from approximately 2012. Since it is not feasible to replicate those values and due to some issues with missing data in 2012 and 2013, comparisons are made to energy use in 2014.

Preferred state of energy management

The preferred state is defined as where the City of Burlington wants to be regarding energy management and sets out the long-term direction for energy management within the city corporation.

A major contributing factor for the preferred state is the City's Strategic Plan 2015 – 2040, a 25-year blueprint and guiding document. One of the key strategic directions for the City is to be a healthy and greener city with a goal for city operations, including city facilities and fleet, to be net carbon neutral by 2040. The preferred state was also influenced by interviews with key staff members, reviews of other corporate plans and energy efficiency best practices from other jurisdictions and a strategic planning staff workshop on January 8th, 2019.

The highlighted box below summarizes the consensus on the City of Burlington's preferred state of energy management.

Objectives and targets for making progress towards the preferred state are discussed below.

The City of Burlington's preferred state

1. The City of Burlington produces no net carbon releases from its activities and includes renewable energy, where feasible, in all of its facilities.

2. The City of Burlington manages its energy in a way that reduces the burden on ratepayers, while maintaining a high level of service for residents and businesses, and a healthy work environment.

3. City of Burlington staff members have the training and information they require to effectively and efficiently manage their energy use and emissions within their areas of responsibilities.

4. Burlington collaborates with others both inside and outside the corporation, such as technology firms, to enhance knowledge of how to use and manage operation systems to maximize efficiency and reduce emissions.

5. The City of Burlington keeps aware of initiatives in other municipalities and organizations that are designed to reduce energy use and emissions and assesses the applicability of these initiates to the City. This includes continuing participation in the municipal energy managers community of practice and other appropriate networks.

6. The City is constantly piloting and evaluating innovative ways of increasing energy efficiency, using renewable energy, and reducing GHG emissions.

7. New equipment is chosen with a consideration of its need/necessity, energy use, emissions, and life-cycle cost.

8. The City measures and monitors energy use and greenhouse gas emissions to ensure continual improvement.

9. Council and senior management have knowledge of energy use and emissions from City operations.

10. The City leverages its expenditures on energy efficiency, renewables, and emission reduction opportunities by taking advantage of incentives offered by utilities, IESO and other levels of government.

Present state of energy management

CORPORATE ENERGY AND EMISSIONS INVENTORY

The previous Corporate Energy Management Plan was adopted in 2013. Since then, the City has undertaken a number of energy efficiency initiatives, both technological and operational. In this section, changes in energy use over time as a result of these initiatives are assessed. The data reported in this section draw on utility data for 2014 through 2018. The energy sources graphed in the following sections are electricity, natural gas (thermal energy), gasoline and diesel fuel.

In this section we review:

- Overall trends in energy use in the City of Burlington
- Trends amongst specific building types
- Changes over time in the most energy intensive buildings
- Overall trends in greenhouse gas emissions in the City of Burlington
- Fuel consumption of corporate fleets

Figure 5 shows how electricity and natural gas usage has changed since the last plan.

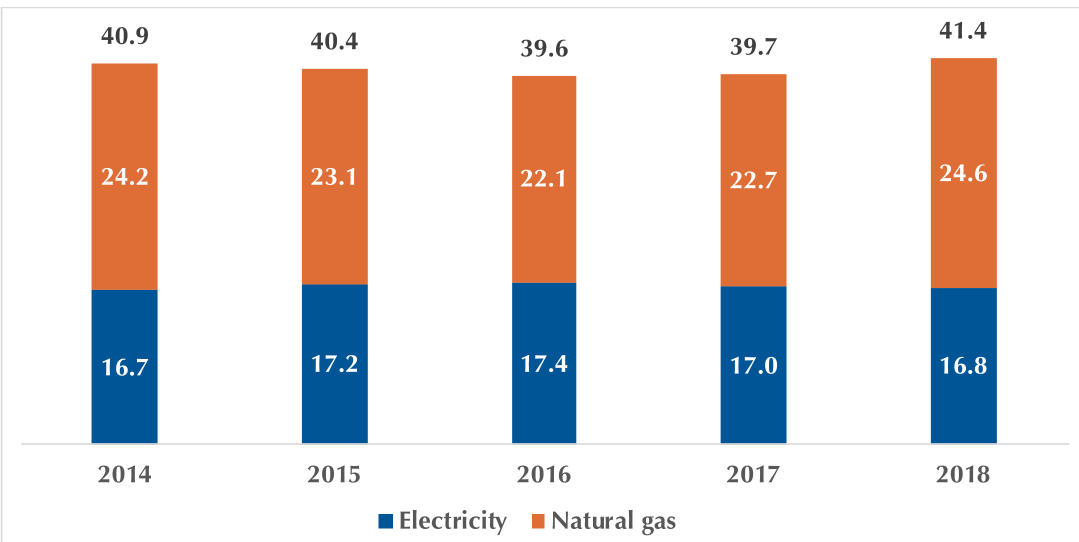


Figure 5 City of Burlington trends on corporate energy use by facilities, including buildings and parks (eGWh) 2014-2018

Although the City of Burlington has implemented both technical and behavioural measures, overall energy use has not changed significantly since 2014. One major efficiency project – retrofitting of streetlights to LEDs – resulted in savings of 2.88 GWh, more than the overall savings in facility energy use of 2.55 GWh.

The City has made good progress on reducing energy use for streetlighting, as illustrated in Figure 6.

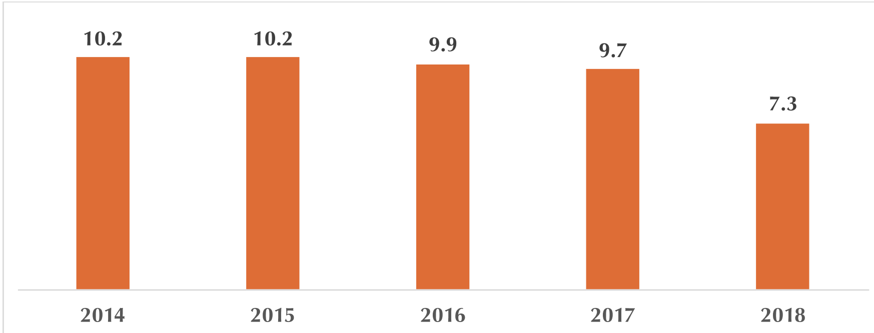


Figure 6 City of Burlington trends on energy use for streetlighting (eGWh) 2014-2018

TRENDS ACROSS SPECIFIC BUILDING TYPES

Large consumers of energy were assessed by individual buildings and facility types. There are no significant trends by facility type, and minimum and maximum use over the five-year period is often small (<10%).

Energy use in administration buildings dropped from 2014 to 2016 but has been increasing since then. In arenas, it has increased slightly each year overall, Energy use in fire stations has fallen slightly since 2016, while use in pools and other buildings has increased since then.

There are a variety of reasons why natural gas and electricity consumption could have increased across facilities. Energy use is affected by the number of hours a building is operating, the number of people using the building, and the months the building is being operated, as well as weather. Seasonal facilities such as arenas are showing an increase in energy use, based on longer operating seasons in warmer weather. For example, ice plants were operated 8% longer in 2018 than they were in 2014. Building energy use may also increase when the floor area of a building is expanded, as happened at Mountainside Recreation Centre.

The ten facilities using the most energy account for 67% of overall consumption in corporate facilities in 2018. The highest consuming facilities are: Appleby Ice Centre (18% of total facility energy use in 2018); Tansley Woods Community Centre (10%); Mainway Recreation Centre (7%), City Hall (5%); Aldershot, Angela Coughlan and Centennial pools (4% each); Burlington Transit Headquarters and Haber Recreation Centre (also 5% each); and the Roads, Parks and Forestry Headquarters (4%).

Energy usage at Mainway Recreation Centre tends to fluctuate based on the amount of ice needed in a particular year, and longer or shorter seasons of operation. This is due to running extensive equipment in order to produce and maintain ice and the varying hours and seasons of operations.

Swimming pools tend to have high energy usage because they use large amounts of energy for heating, ventilation, and dehumidification.

Burlington Transit Headquarters and Angela Coughlan Pool made a significant improvement in reducing both electrical and natural gas consumption over time as a result of major retrofits and upgrades.

ENERGY INTENSIVE BUILDINGS IN THE CITY OF BURLINGTON

Energy intensity is a measure of the energy use per unit, for buildings, this is typically per square foot or per square metre of floor area. By accounting for floor area, it is possible to compare buildings of different sizes. This benchmarking helps to identify high energy using facilities.

Table 5 shows an overview of 2018 corporate facilities and their corresponding gross floor area. The average intensity is graphed on Figure 7.

Table 5 Corporate facilities with the highest energy use in 2018

Facility	Energy use (ekWh)	Gross floor area (ft^2)	Energy use intensity ($ekWh/ft^2$)
Angela Coughlan Pool	1,830,689	15,037	122
Aldershot Pool	1,725,971	16,167	107
Centennial Pool	1,714,320	17,427	98
Tansley Woods Community Centre	4,038,630	59,804	68
Appleby Ice Centre	7,586,482	140,577	54
Burlington Transit Headquarters	2,169,931	40,235	54
Haber Recreation Centre	2,058,623	53,844	38
Mainway Recreation Centre	2,931,615	79,438	37
Operations Centre	1,486,042	50,084	30
City Hall	2,243,315	91,988	24

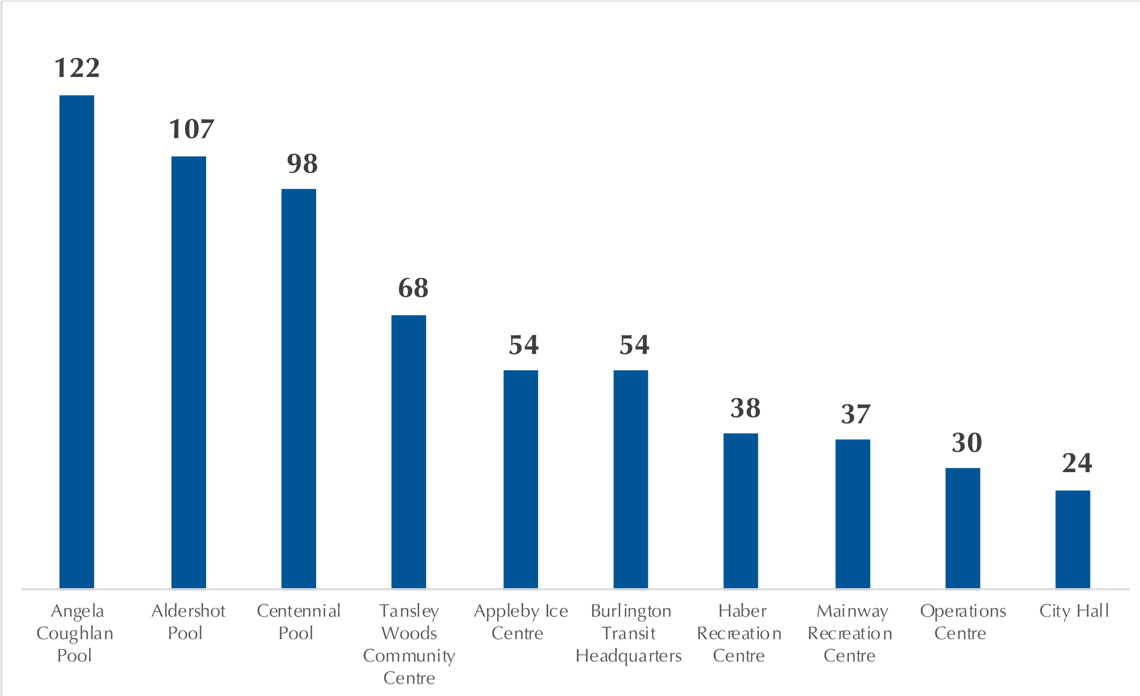


Figure 7 Energy intensity of the facilities with the highest energy use in 2018 (ekWh/ft^2)

Out of the 10 facilities, Angela Coughlan Pool, Aldershot Pool, Centennial Pool, Tansley Woods Community Centre and Appleby Ice Centre use the largest quantity of energy per square foot.

OVERALL TRENDS IN GHG EMISSIONS IN THE CITY OF BURLINGTON

Figure 8 shows the greenhouse gas emissions for the City of Burlington from 2014 to 2018.

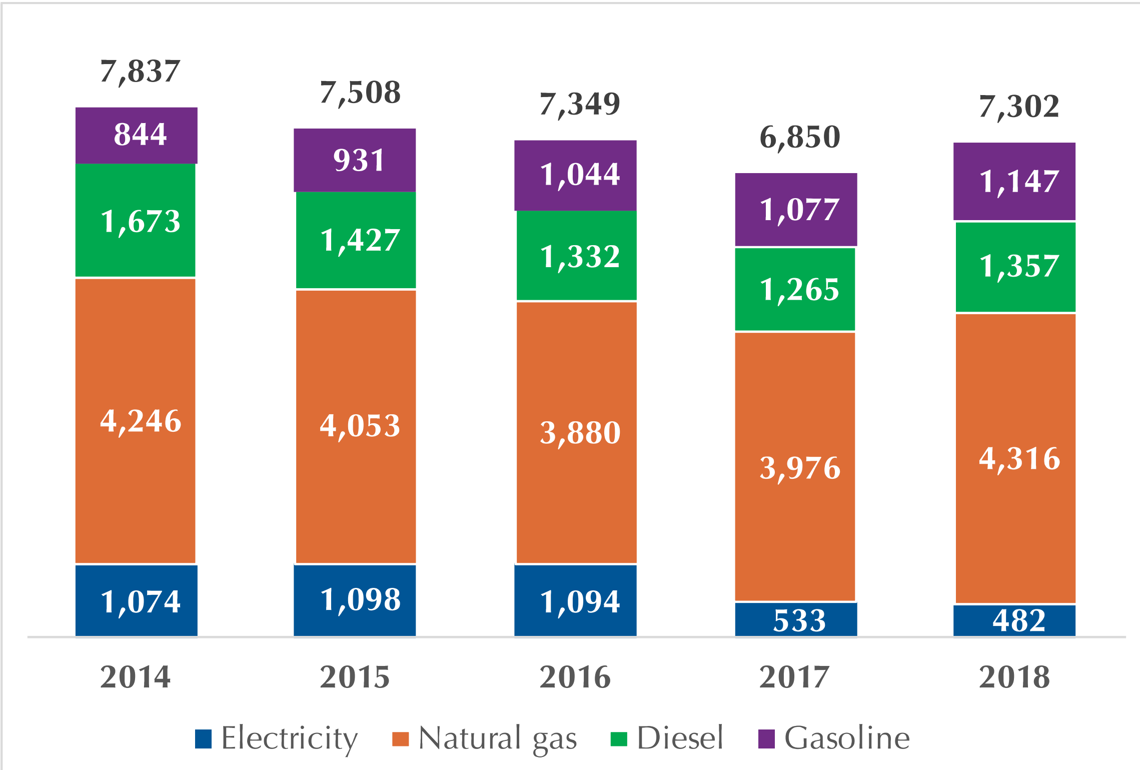


Figure 8 City of Burlington greenhouse gas emissions from 2014-2018 (t CO_2eq)

Overall emissions of greenhouse gases associated with electricity have declined significantly in Ontario since the phase out of coal-fired generation in 2014. The change in GHG emission intensity of Ontario electricity is illustrated in Table 7. Although the GHG intensity of electricity has fallen over recent years, it is expected to increase somewhat in coming years (Independent Electricity System Operator (IESO), 2018a).

Table 6 Average greenhouse gas intensity of Ontario electricity at the point of consumption (g CO_2eq/kWh)

Year	GHG intensity of electricity (g CO_2eq/kWh)
2012	110
2013	80
2014	40
2015	40
2016	40
2017	20

SOURCE: (Environment and Climate Change Canada, 2019)

Administrative buildings, recreational centres and pools, and arenas display the largest carbon footprint across facility types.

A closer look at City Hall reveals that the building has reduced its GHG emissions over time. Central Arena and Tansley Woods Recreation Centre also display reductions in GHG emissions from 2014 to 2018. Central Arena and Tansley Woods Recreation Centre have had recent HVAC and lighting upgrades that can account for the improvements.

CORPORATE FLEET FUEL CONSUMPTION

On average, the City's consumption of gasoline and diesel fuels has decreased modestly over the years. Since 2014, diesel consumption in corporate vehicles has decreased by 30% and consumption of gasoline has increased by the same percentage. Conversely, the fire department uses more diesel-powered vehicles than gasoline vehicles, where consumption of diesel fuel has increased by 18% and gasoline fuel has decreased by 11%.

A green fleet strategy was adopted in 2008, and there are plans to update it in 2020. The city has taken a number of steps to moderate fuel use in vehicles, including:

- Adding five plug-in hybrid electric cars to the fleet, as well as a number of gasoline hybrids
- Requiring new vehicle requests to include anticipated loading and use so that right-sizing can be done
- Incorporating anti-idling technology into some vehicles. For example, aerial trucks have technology to allow signing and use of the bucket without the need to run the truck engine

- Adopting criteria for energy efficiency as part of procurement
- Participating in the Halton Fleet Managers Group
- Programs for regularly maintaining vehicles in good operating order
- Gathering telemetric data on 29 light duty vehicles to identify opportunities for improving efficiency

There are challenges in fully understanding energy use in fleets, and where the opportunities for improving efficiency due to data limitations. Addressing these data issues is a priority in coming years.

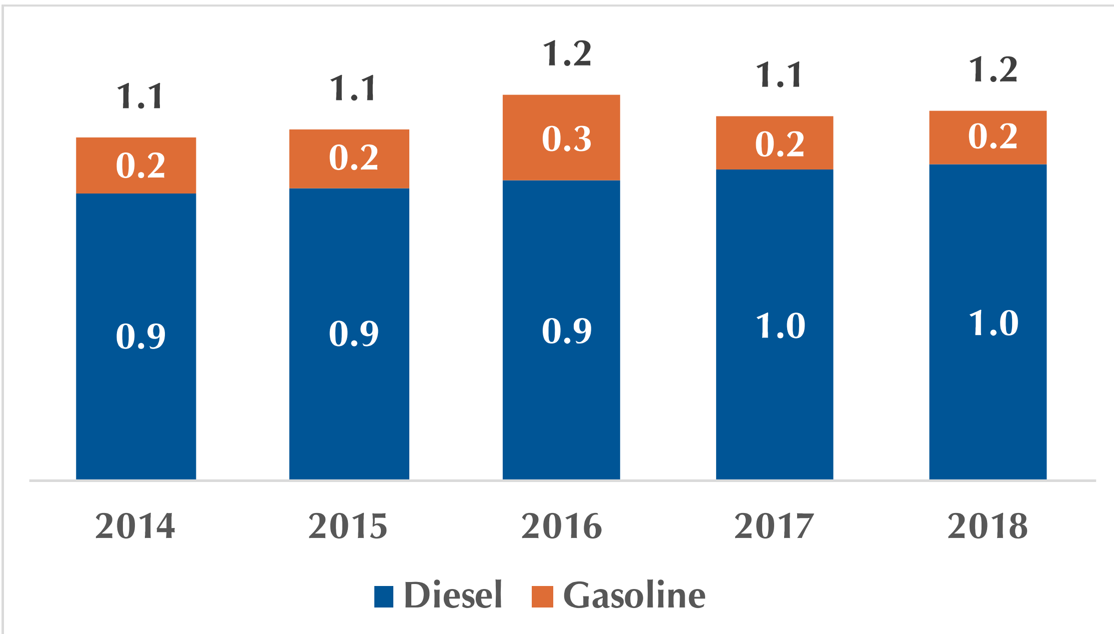


Figure 9 Fire department fleet fuel consumption data in equivalent gigawatt hours (eGWh)

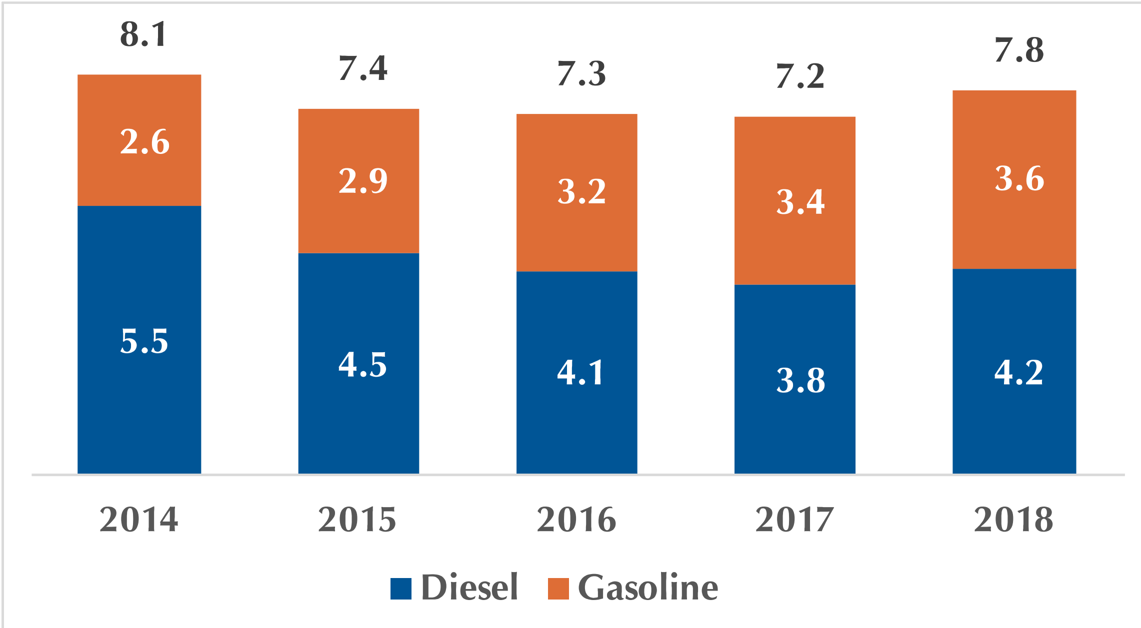


Figure 10 Corporate fleet fuel consumption in equivalent gigawatt hours (eGWh)

WATER CONSERVATION

For many municipalities, water and wastewater treatment and distribution systems are major users of energy. In Burlington's case, these are handled by the Region of Halton but Burlington still wants to avoid excessive charges for water and to use water efficiently, and hence tracks its use within city operations.

Burlington also recognizes that it takes a significant amount of energy to pump, produce and treat water and any efforts to conserve water could transfer to energy savings and therefore carbon reduction by Halton Region. Burlington continues to strive to improve water use in its facilities wherever possible during major renovations, re-builds and regular replacements by installing low flow fixtures. The use of flow-through splash pads greatly increases water use and offsets these efforts overall, the benefits of these types of systems should be re-evaluated including environmental impacts. Water use by city facilities is presented in Figure 11.

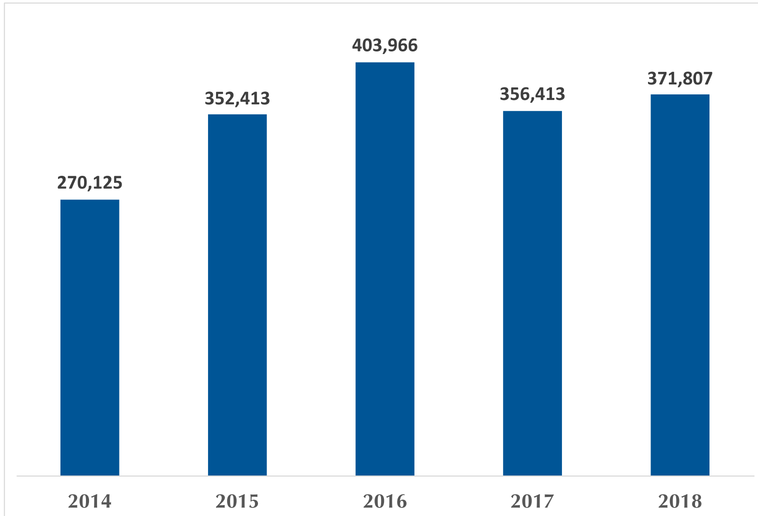


Figure 11 City of Burlington water use in city facilities, 2014-2018 (m^3)

ENERGY MANAGEMENT INITIATIVES THAT HAVE BEEN IMPLEMENTED

The City of Burlington upgraded existing City facilities to make them more energy efficient, for example by adding new boilers to buildings, automated systems, HVAC (heating, ventilation and air conditioning) upgrades, new lighting with instant capability, and underwater lighting. These upgrades have projected annual savings that have made facilities easier to operate.

To consider how these initiatives support the overall goals of energy reductions, they were analyzed as part of the overall energy use of the building, for both the electricity saving projects, and the gas saving projects.

In 2018, it was estimated that the City paid approximately 0.17 \$/kWh for electricity and 0.27 \$/m^3 for natural gas. The energy efficiency projects initiated since the last plan produced an estimated cost saving of \$2.8 million on electricity projects and \$75,000 on natural gas projects. Additionally, in 2018, the associated greenhouse gas reduction is estimated to be 112 t CO_2eq for electricity projects and 139 t for natural gas projects.

Analysis of retrofits undertaken

Burlington implemented a number of energy efficiency measures over the 2014 to 2018 period, which were calculated to result in savings over that period of 3.3 GWh of electricity and 1.3 million m^3 of natural gas. Due to changes in activity levels, the savings representing a small percentage of overall use in some buildings, and other factors, the savings are often not visible in overall energy use in retrofitted buildings. Figure 12 shows changes in electricity use in buildings the year after electricity retrofits were undertaken. The tan line shows the pattern that would be expected in the absence of compounding factors. The blue markers show the actual change in energy use for specific buildings in specific years. Other things being equal, one would expect the blue markers to fall on the tan line. As the figure makes clear, for many of the buildings retrofitted, usage was actually higher in the following year (above the horizontal axis), or higher than expected (above the tan line), while for other buildings the drop was greater than expected for those buildings (below the tan line).

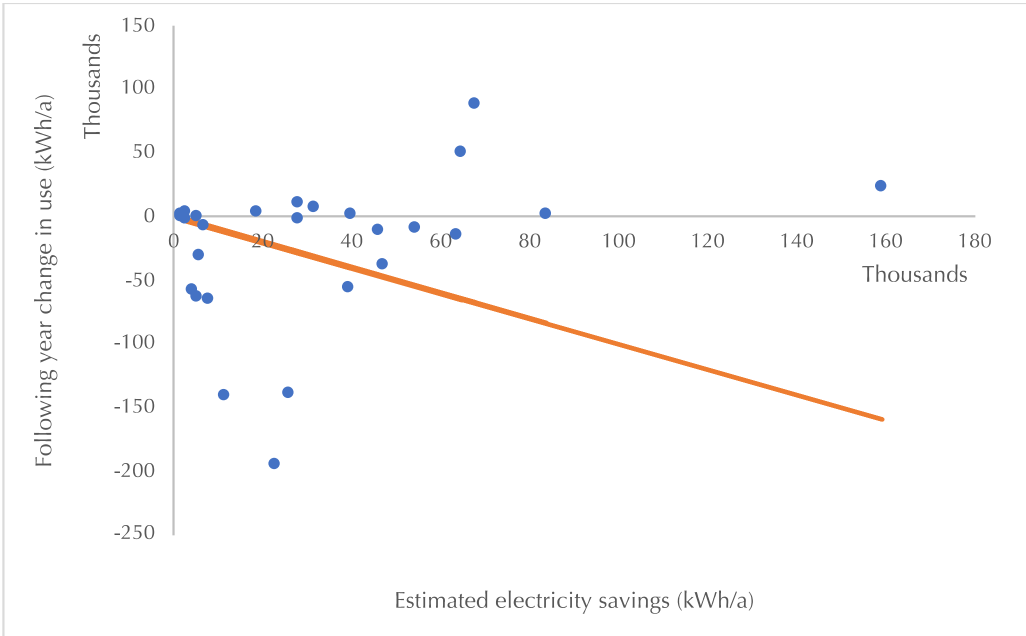


Figure 12 Changes in electricity use in the year following retrofits

A similar story applies to natural gas retrofit projects, as illustrated in Figure 13.

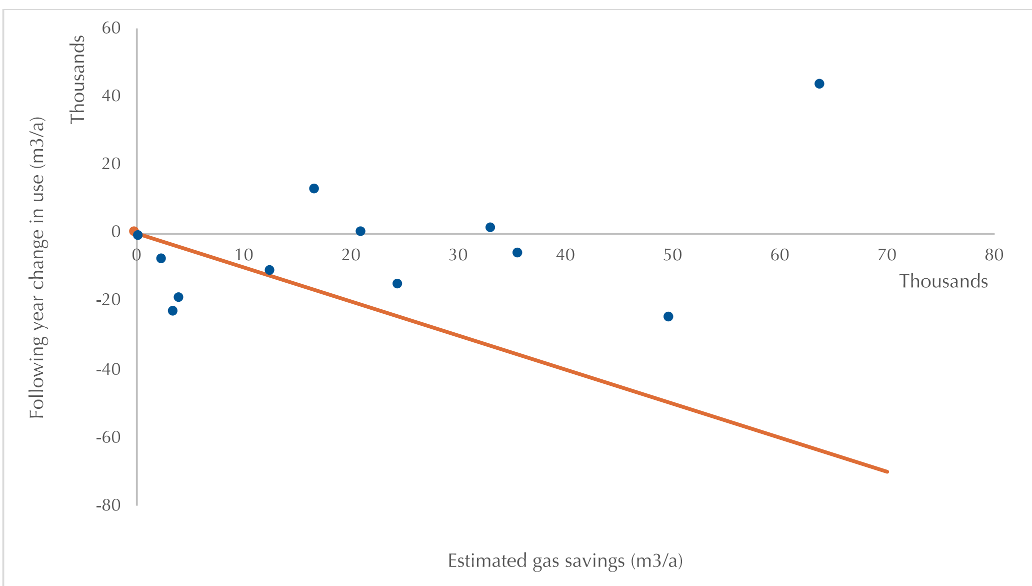


Figure 13 Changes in natural gas use in the year following retrofits

ASSETS AND PLANS

Burlington has plans to renovate many of its assets over the life of this plan. These represent an opportunity to concurrently undertake energy efficiency upgrades. Over the next five years, a number of facilities will be renovated, covering as much as 400,000 ft^2 to 500,000 ft^2 of floor area. An equivalent area could be expected to require significant renovation over the 2025-2040 time frame. The specific buildings to be renovated will be determined by the asset management plan, the needs of the corporation, and the availability of resources to undertake the renovations.

Objectives and targets

OBJECTIVES

A key driver of actions over the long-term will be the strategic plan objective of ensuring that City operations have net zero carbon releases.

Over the next five years, the primary objectives are to achieve the following:

1. To further build a culture of conservation, so that efficient use of energy and limiting greenhouse gas emissions is part of the day-to-day activities of City staff
2. To enhance the corporate structure and processes for managing all energy and greenhouse gas emissions
3. Where equipment is being replaced or refurbished, to do so in a way consistent with the long-term goals, particularly for long life assets
4. To make good progress on the long-term trajectory towards net zero greenhouse gas emissions, not just focusing on quick payback incremental projects

TARGETS

Table 8 shows near and longer-term targets for energy reductions relative to the 2018 baseline, greenhouse gas reductions[10] and increase in City renewable electricity generation over three time scales: near term to 2020, over the 2019-2024 period, and from 2025 to 2040. The grid electricity targets may be met by a combination of energy efficiency measures, (estimated at 2.5% of existing electricity uses per year before accounting for electrification of existing natural gas, gasoline and diesel uses) and renewable energy generation. The 2020 target is all energy efficiency. These targets are reflective of a calendar year.

[10] Greenhouse gas estimates are based on the greenhouse gas intensity of electricity in 2017 of 20 g CO_2eq/kWh. IESO data suggest that GHG intensity will increase somewhat over coming years, but IESO does not provide specific estimates (Independent Electricity System Operator (IESO), 2018a). As an example, if GHG intensity rises gradually to 60 g CO_2eq/kWh in 2024, reductions that year would only be 6%. Given that Burlington does not have control over the carbon content of grid electricity, efforts should focus on the energy targets, and in particular reduction of fossil fuels (natural gas, gasoline and diesel).

Table 7 Energy and greenhouse gas reduction targets

Target area	Current baseline	2020 target	2024 target	2040 target
Grid electricity (MWh)	**24,115,335**	**23,500,000** (3% reduction)	**18,200,000** (25% reduction)	**-** (100% reduction
Natural gas (10^3 m^3)	**2,272,256**	**2,270,000** (0% reduction)	**1,800,000** (21% reduction)	**-** (100% reduction)
Gasoline (L)	**409,133**	**390,000** (5% reduction)	**320,000** (22% reduction)	**-** (100% reduction)
Diesel (L)	**484,193**	**470,000** (3% reduction)	**440,000** (9% reduction)	- (100% reduction)
Renewables capacity (MW)	**-**	**-**	**4**	**21**
GHG emissions (t CO_2eq)	**7.302**	**7,220** (1% reduction)	**5,800** (21% reduction)	**-** (100% reduction)

The intermediate targets are stepping stones to the longer-term target, which requires the elimination of the use of fossil fuels for space heating and vehicles. In addition, although Ontario's grid electricity is much cleaner than it was, there are still greenhouse gas emissions associated with electricity production, particularly during the daytime when there is greater use of gas-fired generation.

In broad terms, the strategy for facilities consists of increasing energy efficiency by 45-50% by 2040, and replacing natural gas used primarily for space and water heating with alternative systems that use a mix of efficiency measures, grid electricity or local renewables based on what is appropriate for the specific building. Grid electricity is replaced (on a net basis) by City-owned renewable generation.[11] Where these substitutions are not practical, it may be possible to purchase renewable natural gas, or green power.[12]

For fleets, the strategy consists of lowering demand and increasing energy efficiency through both operations and purchases. Over the long term, significant changes to transportation technologies are likely, with increased electrification, and possible availability of alternative fuels, such as hydrogen or 'renewable diesel'.[13] In the short term, electrification is

[11] "On a net basis" means that over the course of the calendar year, electricity used from the grid is less than or equal to electricity generated by the City's renewable energy systems.

[12] Renewable natural gas and green power may be purchased from certain suppliers in Ontario. In the case of green power, customers pay the supplier a contracted amount on top of their normal electricity charges, and the supplier contracts to have an incremental amount of green power (e.g. wind, solar, small scale hydro) equal to the amount being purchased to be supplied to the grid. The customer does not get the actual electrons from the renewable generation. Renewable gas is similar, except the supplier arranges for an equivalent amount of methane from wastewater treatment plants or landfills to be injected into the natural gas distribution system.

[13] Renewable diesel is chemically identical to diesel fuel made from fossil fuels but is made from biomass, rather than from fossil fuels.

commercially available only for light duty vehicles, which account for a small percentage of present-day fuel use.

Additional details of proposed actions are discussed in sections below.

ENERGY USE VERSUS ENERGY INTENSITY

Targets have been set in units of total energy use, rather than energy intensity (for example kilowatt hours per square metre, or litres per 100 kilometres). This reflects Burlington's goal for an absolute reduction in emissions to zero, as well as the fact that Burlington's population is not anticipated to grow significantly over the period to 2040. Energy intensity measures will still be useful in benchmarking Burlington facilities – comparing performance of Burlington arenas and pools, for example, to those of other municipalities.

KEY PERFORMANCE INDICATORS

The targets suggest the key performance indicators below be reported annually based on calendar year consumption:

- Total GHG emissions – tonnes of carbon dioxide equivalent
- Total energy use – gigajoules or kilowatt-hours equivalent
- Total electricity demand – gigajoules and megawatt-hours
- Grid electricity demand – gigajoules and megawatt-hours
- Electricity self-generation – gigajoules and megawatt-hours
- Total fossil fuel demand for buildings – natural units and gigajoules or megawatt-hour equivalents
- Total fossil fuel demand for fleets – natural units and gigajoules or megawatt-hour equivalents
- Other fossil fuel demand – natural units and gigajoules or megawatt-hour equivalents

Secondary performance indicators include

- Energy intensity of buildings – energy use per unit floor area
- Thermal energy intensity of buildings – thermal energy (in particular fossil energy) per unit floor area
- Weather normalized energy use – weather corrected total energy use
- Total vehicle-distance travelled by fuel type
- Average fuel efficiency of the fleet (MJ/km or ekWh/km, and L/100 km for fossil use)

Disaggregated data are desirable wherever possible, e.g. per building, per function, per vehicle etc.

UPDATING AND REPORTING ON THE PLAN

The Corporate Energy and Emissions Management Plan is a living document and should be reviewed at least once a year. As part of the annual review, the persons responsible for the plan should complete the following steps:

- Track the activities that have been implemented, based on a checklist of all of the actions included in the CEEMP
- Track quantitative progress towards targets, using the energy performance indicators (EnPIs) described in this plan
- Note any updates to the CEEMP, based on new audits, organizational changes, lessons from past projects, availability of new technologies or sources of funding
- Identify the priority actions for the coming year, and secure funding and resources for their implementation
- Compile an update report annually describing projects implemented, progress towards targets, updates to the CEEMP, and priority actions for the coming year
- Update the City website content to highlight projects completed, status of CEEMP, and corporate commitments to energy management
- In 2024, report on implementation of the CEEMP as required under *Regulation 507/18*. Include detail on: energy and greenhouse gas emissions to 2023, current and proposed energy efficiency and demand management measures, report on results achieved, and a revised forecast of the expected results of the current and proposed measures.

Plan strategy

The plan strategy consists of six key components:

1. Data management
2. Training and engagement
3. Staffing
4. Policies and procedures
5. Technologies for facilities
6. Technologies for vehicles/fleets

DATA MANAGEMENT

Burlington has adopted a comprehensive system for logging and tracking energy billing associated with facilities: AssetPlanner. Natural gas, electricity and water bills are entered as received, and are available to users to assess energy use and changes over time. Data from 2014 to date are fully up to date and supporting information (e.g. floor area) has been verified.

Some members of the operations staff have been trained on the use of the system, but it is not clear that it is getting used as fully as it might by staff outside of the Capital Works department.

In addition, Burlington has implemented Centrica's Panoramic Power in six of its buildings. This technology provides real-time visibility on energy use. This energy management system is key, particularly in high use buildings. An energy management system involves having a power monitoring "current transformer" [CT] on each main circuit of the building and can offer the user information on how much energy each system is using; showing various lighting systems, cooling, ventilation, and other mechanical systems all separately. It also shows which system is running the longest or at various times of the day. The result is the operator having actionable information on what each of these systems are doing "when no one is looking".

This in turn allows the operator to predict when a system is in need of repair (pumps or motors that draw increased current as their bearings fail), has gone offline entirely (drawing zero current when it should be in operation), or is in need of an adjustment to the control system (a system operating when it is not needed).

The combination of a well-trained and engaged operator with a solid energy management system is a powerful tool for energy conservation, as well as early detection of maintenance issues, reduced operational cost, and increased system uptime. It is estimated that this single change can reduce energy consumption of a building by 10-20% (Lee & Cheng, 2016).

Both the Fire and Corporate Fleet departments maintain information on fuel use by vehicle. Both are using the WinFuel package, which captures vehicle information, fuel consumption and odometer readings at the time of refueling. Staff have difficulty extracting key information that would support the management of fuel use in the City. It is unclear whether this reflects limitations of the database, staff training or the data collection process.

In addition, the AVANTIS system has been adopted to track vehicle maintenance requirements.

TRAINING AND ENGAGEMENT

There are opportunities to increase the awareness and knowledge related to energy at multiple levels of the Corporation: from Council, to the Business Leadership Team (BLT), facility operators, vehicle users and all staff in the Corporation.

City Council and the Burlington Leadership Team

City Council and the Burlington Leadership Team receive annual reports on energy use, including changes over time. Council also adopts the five-year Corporate Energy and Emissions Management Plan. Both Council and the Business Leadership Team have a critical role in creating and enhancing the 'culture of conservation', by reaffirming their support and encouragement of staff taking steps to reduce energy costs, usage and associated greenhouse gas emissions. They need to understand the significance of energy use to the City's budget, how Burlington's commitments and actions compare to those of other municipalities, and how staff are progressing towards meeting the targets set out in the City's Strategic Plan (net carbon neutrality by 2040) and Corporate Energy and Emissions Management Plan. They need to demonstrate that there will be support and recognition of staff efforts to meet the targets that are created.

Departmental managers

Engagement is also required on the part of departmental managers. They need to understand and take responsibility for energy use in their department. In addition, there is an opportunity to establish a committee to play a key role in ensuring that specific targets set for individual facilities and vehicles or vehicle types are consistent with the overall corporate targets. It may also serve as a forum for reviewing monthly or quarterly progress towards targets, and to identify where adjustments to the plan may be required.

Operations staff

At the facility level, staff need to have good information about the systems within their facility, and the understanding to know how to interpret and act on this information. There are multiple mechanisms through which this may be achieved, including:

- **Regular training refreshment** – This is particularly important as staff turns over and operators move to other departments, buildings, and roles to allow for continuous growth in their careers. Supporting the operators with regular efficiency training in each role will improve that person's effectiveness in every role they hold.
- **Lunch & learns** – Inviting the suppliers of various systems into the facility to offer a technical training session on how the system operates and what to watch for is a valuable and (often) free tool to gain insight that may not be available from anywhere else. It is also recommended that operators from similar buildings be invited to the lunches, so that the knowledge can be disseminated to every building of that type.
- **Building Operator Certification** – The BOC program offered by the Canadian Institute for Energy Training is a focused program on improving the energy management of buildings, specifically tailored for building operators. Having each City of Burlington operator work towards this qualification will improve the energy comprehension throughout all operators. Additionally, these courses have the benefit of facilitating dialogue and trading of ideas with operators from other jurisdictions and industries, such that attendees often finish the course with a list of exciting projects to investigate.
- **Operator-led workshops** – It is said that by teaching, we learn twice. Operators that have expertise in a particular area should be encouraged to lead training sessions with other operators. This can be within a broader subject like refrigeration or lighting, or it may focus on a particular system (i.e. a Dectron™ unit at a pool) that the operator has in-depth experience working with. Further, this will facilitate the deeper Q&A that leads to partially inactive systems being repaired and restored to full function.
- **Operator engagement** – After doing a job for years, the routine of the familiar will always set in unless it is disturbed by an outside force; systems operate the way they always have and operators stop looking for ways to improve and do things differently. Unless of course they are engaged with new ideas, systems for doing things better, or success stories shared with and by colleagues. Having an active energy training program will revitalize senior staff to look at building systems with new eyes and have fresh motivation to find ways to operate better than ever before.

The importance of this last factor cannot be understated: A person will fight for their own idea with vigor and creativity, but if that same idea comes from someone else (e.g., an outside consultant or energy auditor), it will often receive a lackluster effort at best. By promoting operator engagement, ideas will be created and tried, with the motivation to make them work.

Drivers and fleet managers

On the fleet side, regular driver training has been demonstrated to reduce fuel consumption by 5-10% (Federation of Canadian Municipalities, 2010), but needs to be repeated regularly to be effective (e.g. every six months). Natural Resources Canada (Natural Resources Canada, 2018) offers a program called *Smart*Driver *in the City* for professional drivers and managers in urban and municipal fleets that addresses a number of topics, including:

- Use of gears and fuel economy
- Idling
- Effective fuel-reducing devices
- Maintenance and fuel efficiency
- Tires and fuel efficiency.

There is no charge for the training.

Training is most effective when it involves feedback on specific activities, is linked to carbon reductions, and provides new ideas (Truck News, 2017) (Scott, Gossling, Hall, & Peeters, 2016).

Other City staff

As users of City facilities and other resources, all staff in the City can help contribute to the City's energy and environmental targets through good energy management actions, including turning off equipment when it is not being used, consolidating trips, and using telecommunications instead of travel.

STAFFING

Meeting energy and greenhouse gas reduction targets – particularly aggressive ones – will require a commitment of resources, including staff resources. In interviews with staff, they indicated that their existing commitments limit their ability to take on additional responsibilities related to energy efficiency.

In the immediate term, one position of energy analyst is required. The Project Manager – Energy should develop analysis of the longer term staffing needs. The energy analyst will report to the Project Manager – Energy, and will be responsible for providing support to the following activities:

Project management related to buildings and renewables

- Energy Retrofit Management: Identification, quoting, coordination, and commissioning, as well as supporting the building operators with the technical aspects of their own retrofit projects;

- Planning future projects, with required budgets to be approved by Council;
- Project management of the geo-thermal installations; and
- Oversight of renewable energy installations;

Training and employee engagement

- Planning, managing, and running the training for the building operators;
- Identifying 3rd party training opportunities;
- Coordinating lunch & learns with appropriate suppliers;
- Promoting the culture of conservation, including fun competitions/challenges that engage all members of city staff.

Analysis of fleets (in coordination with the Fleets Manager)

- Maintain fleet databases and report on performance, including analysis of telemetric and automatic vehicle location (AVL) systems;
- Support the development of energy efficiency projects related to fleets, including: the updated corporate fleet strategy, installation of charging capacity, and the driver training program;
- Provide support to the energy committee for all aspects related to buildings and vehicles;
- Monitor the evolving vehicle options and investigate their applicability to Burlington.

POLICIES AND PROCEDURES

A number of proposed policies and procedures are identified in the table that follows. Some of these merit further comment including:

- Establish sub-targets for each facility or vehicle type with relevant managers and expect staff ensure these targets are met. These persons will need to have plans for meeting their individual targets, and the tools and other resources required to implement the plans.
- Re-establish the cross-departmental energy committee and give the committee the responsibility to ensure that individual sub-targets identified in the point above will meet the overall Corporate targets.
- Ensure that new construction and major retrofits are designed to a very high standard of energy efficiency and low greenhouse gas emissions. With careful design, high performing buildings may actually have *lower* construction costs than medium performing buildings. For example, in an analysis of a base office building,

construction costs for reducing greenhouse gas emissions by 34% were estimated to increase construction costs by 3.1%, but reducing greenhouse gas emissions by 82% increased construction costs relative to the base building by only 2.2% (Provident, Morrison Hershfield, & Integral Group, 2017). Given that new buildings and buildings undergoing major renovations are likely to be in use in 2040, all new buildings will be fossil-free and designed for low electricity demand.

- Apply a climate change lens to decision making as directed by City Council on April 23, 2019 for energy management initiatives to reduce the carbon footprint of facilities and improve resiliency.
- Adopt a shadow price for greenhouse gas emissions. A shadow price adds a surcharge to the price of major projects based on their estimated greenhouse gas emissions. Treasury Board of Canada and other government organizations use this in their decision making. That price is 50 $/t, but will be reviewed by the Treasury Board of Canada Secretariat for future carbon pricing (Treasury Board of Canada Secretariat, 2018).
- Beyond the shadow price, consideration should be given to an internal carbon tax. An internal carbon tax has been set by more than 1,200 companies worldwide (Ahluwalia, 2017) including Microsoft, Walt Disney, and the TD Bank Group. Typically the companies set a carbon price, then charge it back to business units based on their overall contribution to the company's greenhouse gas emissions. Funds are then used to fund energy saving or emissions reducing projects. Microsoft has produced a guide based on its own experience (DiCaptrio, 2013). Companies using this tool report significant financial savings, and innovative solutions. In Burlington's case, such a plan – even at 50 $/t of carbon–the level that the federal government will impose in 2022–would raise approximately a quarter of a million dollars, and would affect decision-making.
- In Ontario, numerous municipalities have established revolving funds for energy efficiency, sometimes funded by FIT revenues, sometimes by direct initial funding. Among the municipalities with revolving funds for sustainable energy policies are Caledon, Pickering, Guelph and York Region (ICF Canada, 2018).

TECHNOLOGIES FOR FACILITIES

To reduce energy use, costs and emissions associated with facilities, it is important to consider each of the components that contribute to these, including:

- Activity levels – can activity levels be reduced without compromising service to citizens or health and productivity of staff? In the case of facilities, that may mean can the floor area required be reduced? Or can the hours of use be reduced (e.g. lights in unoccupied rooms)?

- Energy efficiency or intensity – can the efficiency of technologies be improved? In the case of lighting as an example, what technologies provide more lumens per watt? For space heating, what building technologies reduce energy use per square metre?
- Timing of use – can some energy use be shifted to times of day when resulting emissions (and costs) will be lower? In particular, grid electricity is less carbon intensive and generally cheaper at night than during the day, or during shoulder seasons (spring and fall) than during summer or winter. Can certain activities that require energy be shifted to off-peak periods?
- Greenhouse gas intensity – are there options for substituting energy technologies which result in lower emissions of greenhouse gases per joule of energy required? In practice, can natural gas use be replaced with (grid) electricity, or can grid electricity be replaced with renewable sources.

Examples of each of these are presented in Table 9. Choosing the best mix requires a good understanding of where energy is being used in facilities, which will vary by facility type.

Table 8 Strategies and savings for corporate buildings

Type of action	Description	Potential energy savings	Cost category
Activity levels	Facility planning to reduce space needed	Varies	No cost/low capital cost
	Facility scheduling, re-commissioning and operation	10-20% (Mills, 2011)	No cost/ low capital cost
	Occupant behaviour change programs	5-20% (Mulville, Jones, Huebner, & Powell-Greig, 2017)	No cost / low capital cost
	Lighting and plug load controls	Up to 20% of lighting and plug load energy (Bastian, 2018)	No cost / low capital cost
Energy efficiency	Upgrade lighting LEDs	Up to 75% of lighting energy	Low capital cost
	HVAC equipment upgrades	20-40%	Medium capital cost (2-7 year payback)
	Building automation systems	Up to 10-40% (Aste, Manfren, & Marenzi, 2017)	Medium capital cost
Timing of use	Off-peak load shifting	Demand	No cost / low capital cost
Greenhouse gas intensity	Geothermal heating systems	>90% of GHG emissions	High capital cost (>7 year payback)
	Solar generation	100% of GHG emissions	High capital cost (>7 year payback)

Further examples of some of these opportunities are provided in the examples below.

Example 1: Recommissioning

In simple terms, recommissioning is the act of restoring building systems back to the way they were intended to operate when they were new. In some cases, they have drifted from this state due to age, control systems, wear and tear, or other reasons. In other cases, the system may never have been properly commissioned from the beginning such that it has never operated correctly.

As is obvious from the list of common annual or biannual inspection activities below, many of these are low-or no-cost opportunities that can have a significant impact on both facility operation, as well as energy use. It is recommended that a regular recommissioning process be scheduled at each facility, examining each of the major systems on an annual or bi-annual basis, for example:

- Equipment or lighting that is on when it may not need to be
- Systems that simultaneously heat and cool
- Belts and valves that are not functioning properly
- Thermostats and sensors that are out of calibration
- Air balancing systems that are less than optimal
- Economizers that are not working as designed
- Controls sequences that are functioning incorrectly
- Variable-frequency drives that operate at unnecessarily high speeds or that operate at a constant speed even though the load being served is variable
- Changing occupancy.

Example 2: Lighting retrofit

Lighting retrofits often bring one thought to mind: replacing existing fixtures with LED technology. This is for good reason – LED technology is generally much more energy efficient, directs the light to the task surface/area more effectively, and lasts longer than its predecessors, and therefor requires less maintenance. Indeed, when the existing technology is incandescent, halogen, or many types of fluorescent, a direct LED replacement can save 50-75% of energy costs as well as a substantial portion of the maintenance associated with the lighting system.

In addition to the simple LED fixture retrofit, another key element to reducing lighting energy is through the use of effective controls to minimize the lighting duty cycle to the periods when they are actually needed. These controls ensure lights are turned off when rooms are vacant. The current building code requires many of the controls and occupancy sensors that would typically be recommended to minimize wasted energy but does not apply to existing buildings in the same way.

One example where both of these strategies were incorporated was at an ice pad that was previously lit with high-bay fixtures. The energy intensity of these units was so great that the operators could see deformations in the ice below each fixture toward the end of a long day of use. After an investigation and analysis, it was decided to replace the fixtures with dimmable LED and incorporate an occupancy-based control system to minimize duty cycle.

The LED fixtures themselves reduced energy consumption by 60% over the previous lights. The control system was programmed to only operate at 100% output during the actual rented ice time. Initially, this caused problems because the lights would shut off as soon as the ice time was over, requiring that players and spectators find their way out in the dark, but this was soon remedied with the dimming feature, whereby the occupancy system would maintain the lights at 20% output whenever the area (pad or stands) were occupied. Then once the area was empty, the lights would turn off entirely after a 15-minute delay. The addition of the controls reduced the duty cycle by an additional 30%. The final result was a total energy reduction of 72% from the previous (40% remaining from LED x 70% remaining from controls = 28% of original consumption).

Example 3: Demand response ventilation

Fresh-air ventilation is the silent energy waster. Anytime fresh air is pumped into a space, the 'stale' air must be exhausted via the air-handler, dumping conditioned air outside and losing the energy that went into initially heating or cooling that air. But how much fresh air is needed in a space? If the rate is too low, the air feels stale and clammy; most of us have been in a conference room full of people with this feeling. However, if the rate of fresh air is greater than needed, we don't notice it – and conditioned air is exhausted and wasted needlessly. Most building spaces fall into this latter category.

The good news is that the 'quality' of air can be easily measured, at least from the perspective of whether there is enough fresh air for comfort. The measurement metric is the concentration of CO_2 in the air, which is given off by people in the space. The outside air is typically 350-450 ppm CO_2. Without fresh air in a building space, the occupants will gradually contribute to the CO_2 levels until they rise above 1200 ppm; at the point the air begins to feel stale and uncomfortable.

Installing a CO_2 sensor that is tied to the makeup air system or fresh-air damper can adjust the amount of fresh air in a space to always provide the exact amount required to keep the space feeling pleasant, without wasting any unnecessary conditioned air. Further, it can maximize fresh air into the zone when there are many occupants (i.e., a large meeting) to keep the air from getting stale and uncomfortable. Depending on the current makeup air rates, this can reduce natural gas consumption by 20-40% in a building, as well as reducing the electricity consumption of the ventilation fans by 10-20%.

Thermal monitoring is another strategy for controlling demand response ventilation. This is a more recent technology being used for this purpose, with the claim being that CO_2 control is too slow, and by the time the system responds to the higher levels, the air is already uncomfortable. Thermal monitoring is able to respond more quickly. One such system has been installed in the Burlington Public Library (Feedback Solutions, 2017).

Energy conservation retrofits

The list below includes many of the common retrofits that apply to municipally owned buildings. The energy management team is already familiar with these retrofits, many of which have already been implemented throughout various buildings. These retrofits should continue to be implemented within the broader framework described in this report.

- Recommissioning: Building energy systems tend to drift over time, usually resulting in more energy consumption. 10-20% of a building's energy can be saved through low/no-cost measures adjustments. An energy monitoring system and appropriate training help significantly with this.
- Lighting retrofits: Replacement of LED bulbs in existing fixtures, replacement of fixtures with LED fixtures, or the addition of control systems to minimize duty cycle
- Variable frequency drives: Should be considered for all motors, fans, and pumps – beginning with the largest units and working down to 0.25-1hp motors. Energy is proportional to the cube of the fluid moved, so reducing a flow-rate by 50% will result in an energy reduction of 75-87%.
- Better HVAC controls and thermostats, installation of thermostats on vestibule heaters and electric baseboards
- Heat-recovery ventilators for facilities that require significant exhaust (arenas, pools)
- Regular scheduled sealing or caulking with spray foam to reduce air leakage
- Adding insulation in ceilings, or walls (if they are exposed during other projects)
- Upgrading to more efficient heating & cooling systems during retrofit; opt for systems that include VFD motors, condensing heaters, multi-stage cooling, etc.
- Exterior Insulated Finishing Systems (EIFS); generally only cost effective with older buildings that need to be re-sided for aesthetic reasons
- Triple-glazed windows: generally only cost effective when windows are being replaced for other reasons (e.g. age)
- Floating heat pressure controls for arenas to reduce the duty cycle of compressors
- Infrared ice surface temperature controlled (rather than slab temperature control)
- Controlling pool filtration rate on flow using a VFD rather than on maximum flow or with valve throttling

TECHNOLOGIES FOR FLEETS

Fleets present a particular problem for greenhouse gas reduction because they are almost totally dependent on fossil fuels, and for many types of vehicles, non-fossil alternatives are nascent. The same basic approach as described for facilities applies to fleets:

- Activity levels – can activity levels be reduced without compromising service to citizens or health and productivity of staff? In the case of fleets, can the distances traveled or the hours a vehicle is operating be reduced?
- Energy efficiency or intensity – the efficiency of technologies must be improved. Smaller, more fuel efficient vehicles will be used when possible instead of larger less fuel efficient ones. More fuel efficient models are chosen over less efficient ones.
- Timing of use – energy use should be shifted to times of day when resulting emissions (and costs) are lower. Burlington does this today, and should continue. It will become more important as the fleet is electrified.
- Greenhouse gas intensity – substituting energy technologies which result in the release of fewer greenhouse gases per joule of energy are required. In practice, that may mean electric vehicles, where they are available, gaseous fuels such as compressed natural gas or propane, or liquid fuels derived from biomass, such as biodiesel.

Examples of each of these are presented in Table 10. Choosing the best mix of strategies requires a good understanding of duty cycles of each type and use. The most effective means of attaining this understanding is with telemetrics, which should be standard in all vehicles.

Table 9 Strategies and savings for corporate fleets

Type of action	Description	Potential energy savings	Cost category
Activity levels	Fleet management & logistics for maintenance activities: matching vehicle capacity with load, routing optimization, etc.	15-30% (see e.g. (Lukman, Cerinšek, Virtič, & Horvat, 2018)	No cost/low capital cost
	Reduce idling with addition of anti-idling technologies such as auto-shutoff, auxiliary power, etc.[14]	>30% during idle time of fire trucks for example (Zheng et al., 2018)	Medium to high capital cost
	Enhanced driver training – up to a 35% difference in fuel consumption between the 'best' and 'poorest' driver (Natural Resources Canada, 2018). Drivers require regular refreshing of training	5-10% typically	No cost / low capital cost
Energy efficiency	Right-sizing vehicles	10-50%	No cost / low capital cost
Greenhouse gas intensity	Electric vehicles	Typically 60% >95% of GHG emissions	Medium to high capital cost
	Renewable diesel	100% of GHG emissions	Not generally available at this time

[14] A compendium of anti-idling technologies is available at (Gaines, 2018).

Priority actions

Actions under the plan are presented in Table 11 according to the time they are to be taken: in the first year, years 2-5, or later.

YEAR 1 ACTIONS

The first year actions are very important, as they directly or indirectly impact the City's energy performance. All of these actions are easy enough to be initiated and often completed in Year 1. These actions are grouped by category and are numbered for ease of identification. The numbering is not an indication of importance; however some actions will need to be completed first as they may directly impact other actions.

In the first year of the CEEMP, the City should continue to implement high priority technical actions for retrofitting the City's existing buildings, and upgrading the City's vehicle fleet with more efficient vehicles. In particular, the City should take advantage of existing incentive programs being offered by the Independent Electricity System Operator and Enbridge Gas Distribution, as these end in 2020. Although the province and the Independent Electricity System Operator are seeing increased conservation activities as important to meeting future demand through at least 2035, the specific incentives and programs available today may not be available after 2020.

YEARS 2-5 ACTIONS

In the second phase of the CEEMP (January 2020 – January 2024), the City will implement the high-priority organizational actions presented in Table 11. These actions continue initiatives begun in the first year of the plan, and involve more significant changes to facilities and fleets to realize the targets set out above.

A key initiative will be the conversion of some of the buildings to geothermal heating over this time period.

During this time period, it is also expected that solar capacity will be installed at the rate of one megawatt per year.

On the fleet front, Burlington has already begun to electrify its light duty vehicle fleet, with the addition to the fleet of five plug-in hybrids, and an investigation of opportunities by a consultant specializing in zero emission vehicles. A detailed plan for rolling out electric vehicles will be part of the analysis to be provided from the consultant's study and the updated Fleet Management Strategy. For the purposes of this plan it is assumed that half of the light duty cars will be replaced with EVs by 2024.[15] Already, many analysts argue that EVs are competitive with conventional vehicles, due to their lower operating and maintenance costs, and the vehicles themselves

[15] A more detailed analysis will be done as part of the green fleet strategy.

are expected to reach price parity with conventional vehicles soon (Gordon, 2018). Financial incentives, such as the iZEV incentive introduced by the federal government help address the current capital price difference between EVs and conventional vehicles. The conversion of half the light-duty car fleet does not materially impact on electricity demand in the city, requiring less than 200 MWh or about 1% of total electricity demand in 2024.

YEARS 5-20 ACTIONS

Longer-term actions are more speculative, particularly given that technologies and policies related to energy are undergoing rapid change. Nevertheless it is important to assess how Burlington will achieve its goals for net zero carbon by 2040. In the next section, one scenario for getting there is considered.

Table 10 Actions to be undertaken over year 1, years 2-5 and years 5-20

Preferred state		Action	Year 1	Year 2-5	Year 5-20
The City of Burlington produces no net carbon releases from its activities and includes renewable energy in all of its facilities and fleet.	1	Systematically upgrade lighting to the highest efficiency option to meet a particular need	x	x	
	2	Where appropriate, upgrade ventilation to demand responsive technologies	x	x	x
	3	Deploy cost-effective idle-reducing technologies, possibly including: LED lights, auxiliary batteries, automatic shut-off devices	x	x	x
	4	1 MW solar installed per year.	x	x	x
	5	Develop a plan for upgrading electric vehicle charging facilities to address near and longer-term plans for electrification of transportation	x		
	6	Gradually phase out purchase of gasoline light duty vehicles and begin to investigate phase out of medium duty vehicles.		x	x
	7	When new ice resurfacing machines are purchased, choose electric models		x	x
	8	Consider starting a bike sharing program for staff members to get around facilities.		x	
The City of Burlington manages its energy in a way that reduces the burden on ratepayers, while maintaining a high level of service for residents, businesses, and a healthy work environment.	9	Develop processes to provide departmental managers with information on the energy bills for their departments to sign approval for.	x		
	10	Provide regular information on energy usage and costs to facility and vehicle operators	x		
	11	Continually communicate with Burlington Hydro to ensure proper bill adjustments for streetlights, which are not metered.	x	x	x
	12	Assign budgetary responsibility for energy use to staff members who have the ability to reduce energy use directly.		x	
Burlington staff members have the training and information they require to effectively and efficiently manage their energy use and emissions within their areas of responsibilities.	13	Develop a plan for communicating about the City's energy reduction programs and initiatives to all staff	x		
	14	Conduct an assessment of training needs of city staff as well as building operators	x		

Preferred state		Action	Year 1	Year 2-5	Year 5-20
	15	Develop an ongoing energy training and awareness plan for all levels of staff that includes workshops, lunch and learns, building systems training, utility billing training and city energy policy training.	x	x	x
	16	Send staff with energy management and building operations responsibilities to conferences and trade shows for information sharing	x	x	x
	17	Develop resources to guide facility operators to make better (energy) choices.	x		
	18	Develop guidelines that alert operators on consumption and provides information reports to operators.		x	
	19	Install automated systems for monitoring lighting and temperature with an alert system for out-of-ordinary events.		x	
	20	Work with operators to identify specific steps to achieve facility or vehicle type specific targets		x	
	21	Develop bi-annual training program on efficient driving, awareness of environmental issues, anti-idling policy and practices, and potential cost savings for staff using Corporate vehicles		x	
Burlington collaborates with others both inside and outside the corporation, such as technology firms, to enhance knowledge of how to use and manage operation systems.	22	Establish (re-establish) a cross-departmental energy committee to monitor progress towards targets, and to ensure that targets for individual areas are collectively meeting overall corporate targets	x	x	x
	23	Consider energy and emissions impacts when other corporate plans and policies are being proposed. A mandatory section of report or business case.	x	x	x
	24	Participate in multi-municipality groups e.g. energy managers, fleet managers,	x	x	x
The City of Burlington monitors of initiatives in other municipalities and other organizations that are designed to reduce energy use and emissions and assesses the applicability of these initiates to the City.	25	Sponsor a series of lunch and learns on energy related initiatives with special guests from other jurisdictions, organizations and vendors.		x	x
	26	Identify and adopt industry best practices (e.g. ORFA).	x		
	27	Benchmark Burlington energy use and targets against other similar municipalities		x	

Preferred state		Action	Year 1	Year 2-5	Year 5-20
The City is constantly piloting and evaluating innovative ways of increasing energy efficiency, using renewable energy, and reducing GHG emissions.	28	Establish corporate standards for service provision and energy-saving equipment (e.g. light switches, ranges of acceptable temperatures).		x	
	29	Develop interdepartmental and possibly intermunicipality competitions on reducing energy use.		x	
	30	Monitor changes in technology, costs, performance and availability of alternative lower carbon fuels, including biodiesel, CNG, renewable diesel, and hydrogen for heavy duty vehicles		x	x
	31	Test out all-electric vehicles in applications where they make sense	x	x	x
New equipment is chosen with a consideration of its energy use, emissions, and life-cycle cost.	32	Establish a reserve account to reinvest energy savings, possibly funded by an internal carbon shadow price		x	
	33	Develop a clear and well-publicized process for funding smaller projects from the energy reserve		x	x
	34	Adopt the federal shadow price for carbon for the purposes of decision-making and assessing projects	x	x	x
	35	When purchasing new vehicles and other equipment consider purchasing 'best in class' options, taking into account life cycle costs and carbon intensity as per green procurement policy.	x	x	x
	36	Develop criteria for right sizing new vehicles	x		
The City has reached its preferred state by preparing a series of targets and milestones updated regularly along the way.	37	Require each department to reduce their energy consumption by a certain percentage each year.	x	x	x
	38	Set annual targets for each building and category of vehicle to meet the overall efficiency targets	x	x	x
	39	Consider grading staff on energy use in their yearly review to solidify implementation.		x	
	40	Ensure operators have tools needed to achieve goals	x	x	x
-	41	Re-affirm/update targets as required to reflect progress	x	x	x
-	42	Evaluate the need for additional staff to meet the City's energy goals	x		
-	43	Fleet and facility energy analyst		x	

Preferred state		Action	Year 1	Year 2-5	Year 5-20
Council and senior management have knowledge of energy use and emissions from City operations, and ensure sufficient resources are allocated for plan implementation.	44	Develop energy KPIs to be integrated into the Business Leadership Team dashboards	x	x	x
The City leverages its expenditures on energy efficiency, renewables, and emission reduction opportunities by taking advantage of incentives offered by utilities and other levels of government.	45	Monitor new sources of funding and incentives for energy efficiency or GHG reduction initiatives	x	x	x
	46	Advocate higher levels of government to support greening of fleets	x	x	x
Burlington ensure that it monitors and tracks energy use and GHG emissions to be able to measure progress against targets.	47	Develop annual report cards on the energy and emissions from each building and vehicle group	x	x	
	48	Track and assess progress on interim targets and short-term initiatives	x	x	x
	49	Consider certifying to ISO 50001 Energy Management Systems		x	
	50	Confirm protocols for on-going monitoring and valuation of energy saving initiatives		x	
	51	Install sub-meters on major systems in largest energy using buildings to provide real time information to operations staff.	x	x	
	52	Investigate diurnal and seasonal patterns of energy use to take advantage of load shifting opportunities and reduce use of electricity during peak times when it is expensive and more carbon intensive.		x	
	53	Ensure that data systems for fleets are capturing relevant data on distance travelled, fuel use, fuel and vehicle type, driver, etc. and that staff have knowledge in how to extract and analyze data	x		
	54	Assess results of recent project using telemetrics of a sub-set of vehicles, and determine need and desirability of increasing the number and duration of vehicles with telemetric capability	x		
	55	Survey staff compliance with anti-idling		x	

Preferred state		Action	Year 1	Year 2-5	Year 5-20
	56	Consider participating in E3 Fleet Rating System or equivalent		x	
Burlington has operating policies and procedures that ensure its energy-using equipment is maintained and operated to reduce energy use and emissions.	57	Adopt new building construction standards for corporate facilties that will support the goal of net zero carbon emissions	x		
	58	Develop a standard for major renovations to be near net carbon neutral or net carbon neutral.	x		
	59	Develop a formal commissioning or recommissioning policy for new buildings, major renovations, and additions to buildings		x	
	60	Identify options for reducing duty cycles of equipment while maintaining service performance, for example by use of occupancy sensor to adjust ventilation to occupancy.		x	
	61	Prepare an update of the 2008 Corporate Fleet Strategy addressing changes in needs, technologies and updates or creation of associated city policies, including vehicle maintenance, travelling with loads, duty cycles etc.		x	
	62	Eliminate underutilized or excess vehicles. Excess availability of vehicles tends to lead to increased use.		x	x
	63	Investigate and acquire routing software for snow clearing (and GPS)			x
	64	Accelerate replacement of oldest, least-efficient vehicles		x	x
	65	Substitute communications technology for transportation, such as virtual meetings or work from home policies			x

COSTS OF ACTIONS: 2019-2025

The estimated costs of these actions are shown on Table 12. These costs are based on the assumptions on Table 13, which reflect current costs. They are also assuming that the programs will be rolled out roughly equally over the years. In practice, depending on the size of the buildings geothermal is installed in, for example, the costs may be higher in some years and lower in others.

Table 11 Costs of plan actions 2019-2024

Year	Costs for electricity conservation	Costs for geothermal installations	Costs for renewables installations	Incremental vehicle costs	Staff & other costs	Total costs
2019	$0	$0	$0	$0	$200,000	$200,000
2020	$151,000	$0	$0	$24,000	$300,000	$475,000
2021	$147,000	$980,000	$2,500,000	$24,000	$400,000	$4,051,000
2022	$143,000	$980,000	$2,400,000	$24,000	$400,000	$3,947,000
2023	$140,000	$980,000	$2,300,000	$24,000	$400,000	$3,844,000
2024	$136,000	$980,000	$2,200,000	$24,000	$400,000	$3,740,000

Table 12 Cost assumptions

Cost/saving area		Unit costs	
Cost of conservation		0.25	$/kWh
Costs of geothermal		7200	$/t
		70%	increment
Costs of solar generation		2,500	$/kW in 2021
	falling to	2,000	$/kW in 2025
Incremental EV cost for automobiles		13,000	$/vehicle
EV incentive for automobiles		5,000	$/vehicle
Electricity savings		-0.168	$/kWh
Natural gas savings		-0.266	$/m³
Gasoline savings		-1	$/L

Realistically, the costs of the technologies are likely to decline, and the costs of the energy will almost certainly rise. The analysis has not accounted for changes in non-energy operating costs such as maintenance.

Staff and other costs shown are incremental.

The capital costs need to be seen as an investment which will realize savings over their extended lifetime. Within the period of the plan, the estimated savings are shown on Table 14. These saving estimates are very conservative, assuming no increase in energy prices.

Table 13 Savings from plan actions 2019-2024

Year	Net electricity savings	Natural gas savings	Fuel savings	Total savings
2019	$0	$0	$0	$0
2020	-$101,000	$0	-$9,000	-$110,000
2021	-$345,000	-$27,000	-$17,000	-$389,000
2022	-$504,000	-$94,000	-$25,000	-$623,000
2023	-$747,000	-$119,000	-$33,000	-$899,000
2024	-$1,031,000	-$123,000	-$41,000	-$1,195,000

The net costs of the plan are shown on Table 15. With an expected life of 20 years for the renewable and geothermal systems, and 10 years for the EVs, the net present value of these investments is about $1,000,000 with a 4% discount rate.

Table 14 Net cost of plan actions, 2019-2024

Year	Total costs	Total savings	Net cost
2019	$200,000	$0	$200,000
2020	$475,000	-$110,000	$365,000
2021	$4,051,000	-$389,000	$3,662,000
2022	$3,947,000	-$623,000	$3,324,000
2023	$3,844,000	-$899,000	$2,945,000
2024	$3,740,000	-$1,195,000	$2,545,000

Getting to net zero – one possible scenario

The actions for the longer term are necessarily more general and will be refined over time. Initiatives begun during earlier phases continue, including renovating facilities, conversion away from natural gas, and electrifying the vehicle fleet.

As an indication of the kinds of actions and possible implications, we present a scenario that involves the following key activities:

- Continuing improvement of the efficiency of existing uses of electricity at the rate of 2.5% per year
- Conversion of buildings with gas-fired heating equipment to geothermal
- Conversion of fossil-fuel vehicles to electric vehicles as the technology becomes available, based on the average lifetime of each vehicle type
- Installation of solar generation at the rate of approximately 1 MW per year through 2040 (2 MW in 2030)

Most of the technologies required by this scenario are available today, and are cost-effective on a life-cycle basis. The technology for many of the larger zero emission vehicles is not yet commercially available, but is developing rapidly. In the absence of suitable technology, Burlington will need to purchase offsets, or – if there is a market for it – sell excess solar power to the grid. Although the city does not have enough roof space to accommodate 1MW per year until 2040, we expect to see virtual net metering technology become available in the next five years which would allow the City to install large ground-mounted systems on remote property to offset various facility accounts.

Under this scenario, the demand for energy falls quite dramatically due to the general efficiency improvements, geothermal heating requiring about one-third the energy of natural gas heating, and electric vehicles being much more efficient than conventional vehicles. (These technologies are for illustrative purposes; other options may make sense in the case of particular buildings. For example, smaller buildings may be more suited to passive design with solar; heavy-duty trucks may go to hydrogen fuel.)

The changes in demand over time are shown in Figure 14.

The supply is increasingly met by City-owned solar power, with an installed capacity in 2040 of 21 MW. The supply scenario is shown in Figure 15.

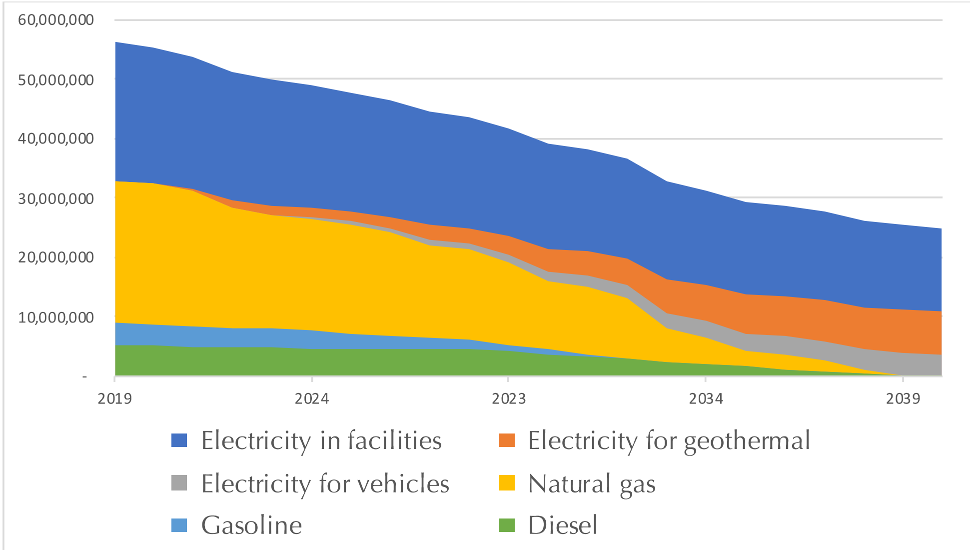


Figure 14 Changes in demand under the net zero scenario (ekWh/a)

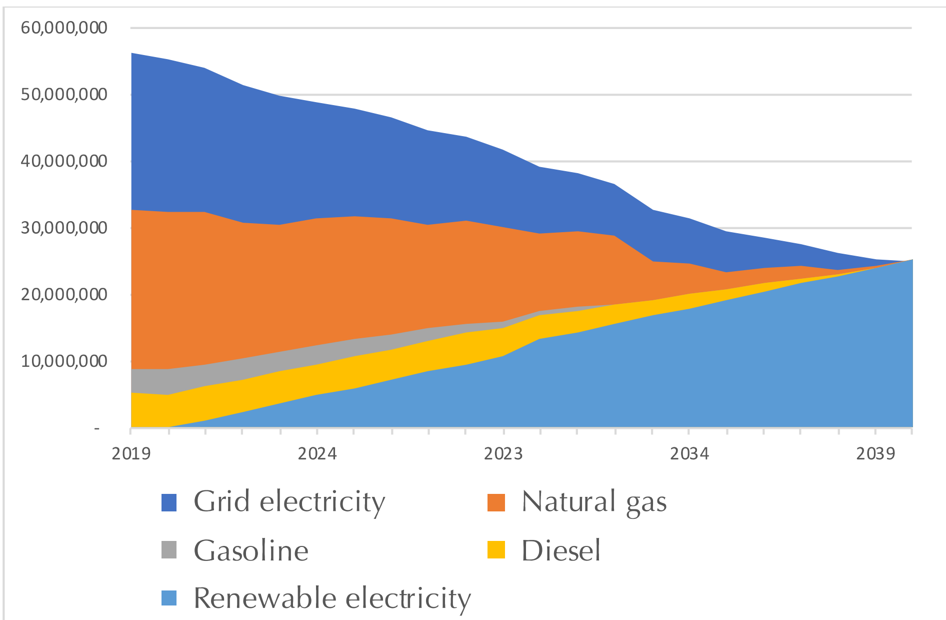


Figure 15 Changes in energy supply under the net zero scenario (ekWh/a)

Over the long term, costs and savings become more speculative, but as an indication, rough net cost estimates to 2040 are presented on Table 16. As discussed above, these savings estimates are very conservative in that they assume no increase in energy costs.

Table 15 Net cost of plan actions, 2019-2040

Year	Total costs	Total savings	Net cost
2019	$200,000	$0	$200,000
2020	$475,000	-$110,000	$365,000
2021	$4,051,000	-$389,000	$3,662,000
2022	$3,947,000	-$623,000	$3,324,000
2023	$3,844,000	-$899,000	$2,945,000
2024	$3,740,000	-$1,195,000	$2,545,000
2025	$4,000,000	-$1,510,000	$2,490,000
2026	$3,900,000	-$1,810,000	$2,090,000
2027	$3,940,000	-$2,100,000	$1,840,000
2028	$3,920,000	-$2,420,000	$1,500,000
2029	$4,320,000	-$2,740,000	$1,580,000
2030	$6,250,000	-$3,220,000	$3,030,000
2031	$4,230,000	-$3,580,000	$650,000
2032	$4,230,000	-$3,890,000	$340,000
2033	$4,070,000	-$4,110,000	-$40,000
2034	$3,930,000	-$4,390,000	-$460,000
2035	$3,890,000	-$4,650,000	-$760,000
2036	$3,880,000	-$4,950,000	-$1,070,000
2037	$3,870,000	-$5,250,000	-$1,380,000
2038	$3,880,000	-$5,510,000	-$1,630,000
2039	$3,870,000	-$5,800,000	-$1,930,000
2040	$3,470,000	-$6,060,000	-$2,590,000

Conclusions and recommendations

Major technological, behavioural, and operational changes need to occur within facilities and fleets to reduce energy use and help the City move towards its long-term strategic plan goal of making City operations net carbon-neutral.

On the facilities side, a major move away from natural gas is required: primarily achieved by the conversion of heating and cooling in facilities from natural gas to geothermal systems. Concurrently, Burlington will take advantage of opportunities to reduce overall electricity and natural gas use through conservation initiatives, drawing as appropriate on third-party incentives to help support these.

On the fleets side, a move away from gasoline and diesel is required to get to net zero carbon. For light duty cars, the conversion to electric vehicles can begin immediately, however they represent a small portion of the overall fleet. Low carbon technologies for trucks, and medium-and heavy-duty vehicles are emerging, but are not yet commercial.[16] In the near term, the focus should be on data systems to better understand duty cycles and the patterns of vehicle use. These will also facilitate near term actions to reduce fuel use and emissions through driver education, route optimization, anti-idling actions, and other initiatives that will reduce fuel use.

These changes are essential to meeting the strategic objective of net zero carbon and need to be seen as investments.

[16] Ford, Tesla and Rivian are expected to introduce all-electric pick-up trucks in 2021 (Evarts, 2019).

References

Ahluwalia, M. B. (2017). *The business of pricing carbon: How companies are pricing carbon to mitigate risks and prepare for a low-carbon future*. Retrieved from Center for Climate and Energy Solutions website: https://www.c2es.org/site/assets/uploads/2017/09/business-pricing-carbon.pdf

Aste, N., Manfren, M., & Marenzi, G. (2017). Building Automation and Control Systems and performance optimization: A framework for analysis. *Renewable and Sustainable Energy Reviews*, *75*, 313–330. https://doi.org/10.1016/j.rser.2016.10.072

Bastian, H. (2018). *Assessment of plug load management strategies to advance energy savings across Oregon's state buildings portfolio.* Retrieved from American Council for an Energy-Efficient Economy website: https://aceee.org/sites/default/files/plug-load-or.pdf

Burlington, City of. (2018). *Grow Bold: Burlington Official Plan* (No. Adopted on April 26, 2018.). Retrieved from City of Burlington website: https://www.burlington.ca/uploads/21493/Doc_636610358428491805.pdf

Burlington, City of. (2019, April 29). City of Burlinton declares climate emergency.

C40 Cities Climate Leadership Group Inc. (2019). About C40. Retrieved February 5, 2019, from C40 Cities website: https://www.c40.org/about

Canada Green Building Council and The Delphi Group. (2016). New CaGBC market impact report demonstrates green buildings are an engine of economic growth in Canada. Retrieved November 16, 2018, from New CaGBC market impact report demonstrates green buildings are an engine of economic growth in Canada website: https://www.cagbc.org/News/EN/2016/20160210_News_Release.aspx

DiCaptrio, T. (2013). *Carbon fee: Theory & Practice - The what, why and how of Microsoft's efforts to drive culture change* (p. 40). Retrieved from Microsoft Corporation website: https://download.microsoft.com/documents/en-us/csr/environment/microsoft_carbon_fee_guide.pdf

Environment and Climate Change Canada. (2019). *National inventory report 1990-2017: Greenhouse gas sources and sinks in Canada*.

Evarts, E. C. (2019). Ford confirms future all-electric F-Series truck, holds details close. Retrieved from Green Car Reports website: https://www.greencarreports.com/news/1120987_ford-confirms-future-all-electric-f-series-truck-holds-details-close

Federation of Canadian Municipalities. (2010). *Enviro-fleets: Reducing municipal heavy-duty vehicle emissions – A guide to best practices*.

Feedback Solutions. (2017). *Occupancy tracking: your source of savings*. Retrieved from Feedback Solutions website: http://feedbacksolutions.ca/wp-content/uploads/2017/11/FacExecSB_Nov2Webinar_FINAL.pdf

Gaines, L. (2018). Compendium of idling reduction equipment for Class 1-8 vehicles. Retrieved April 25, 2019, from Argonne National Laboratory website: https://www.anl.gov/es/reference/compendium-of-idling-reduction-equipment-for-class-18-vehicles

Global Covenant of Mayors for Climate & Energy. (2019). About us. Retrieved from https://www.gobalcovenantofmayors.org/about/

Gordon, J. (2018). Why fleets can overestimate the total cost of ownership for EVs. Retrieved from Fleetcarma website: https://www.fleetcarma.com/fleets-can-overestimate-total-cost-ownership-evs/

ICF Canada. (2018). *Ontario municipal energy profile*. Retrieved from Independent Electricity System Operator website: http://www.selwyntownship.ca/en/townshiphall/resources/2018/Council-Agenda-August-7-2018/6.-a-5.-Attch-1---Municipal-Energy-Profile-Report.pdf

IndEco Strategic Consulting Inc. (2013). *A guide to preparing conservation and demand management plans*. Toronto: Ontario Ministry of Energy.

Independent Electricity System Operator (IESO). (2018a, September). *2018 Technical Planning Conference*.

Independent Electricity System Operator (IESO). (2018b, November). *Planning to meet the needs of Ontario's electricity system*. Presented at the Southwest Regional Electricity Forum. Retrieved from http://www.ieso.ca/-/media/Files/IESO/Document-Library/regional-planning/Forums/2018/SW-Presentation-Planning-to-Meet-the-Needs-of-Ontarios-Electricity-System.pdf

Lee, D., & Cheng, C.-C. (2016). Energy savings by energy management systems: A review. *Renewable and Sustainable Energy Reviews*, *56*, 760–777. https://doi.org/10.1016/j.rser.2015.11.067

Lukman, R. K., Cerinšek, M., Virtič, P., & Horvat, B. (2018). Improving efficient resource usage and reducing carbon dioxide emissions by optimizing fleet management for winter services. *Journal of Cleaner Production*, *177*, 1–11. https://doi.org/10.1016/j.jclepro.2017.12.142

Mills, E. (2011). Building commissioning: a golden opportunity for reducing energy costs and greenhouse gas emissions in the United States. *Energy Efficiency*, *4*(2), 145–173. https://doi.org/10.1007/s12053-011-9116-8

Ministry of the Environment, Conservation and Parks. (2018). Preserving and Protecting our Environment for Future Generations: A Made-in-Ontario Environment Plan [Ontario Government]. Retrieved from https://prod-environmental-registry.s3.amazonaws.com/2018-11/EnvironmentPlan.pdf

Mulville, M., Jones, K., Huebner, G., & Powell-Greig, J. (2017). Energy-saving occupant behaviours in offices: change strategies. *Building Research & Information*, *45*(8), 861–874. https://doi.org/10.1080/09613218.2016.1212299

Natural Resources Canada. (2018). SmartDriver in the City. Retrieved from Natural Resources Canada website: https://www.nrcan.gc.ca/energy/efficiency/transportation/21048#city

Ontario Ministry of Energy. (2017). *Ontario's long-term energy plan 2017: Delivering fairness and choice* (No. ISBN 978-1-4868-0736-9). Retrieved from Queen's Printer of Ontario website: https://files.ontario.ca/books/ltep2017_0.pdf

Ontario Ministry of Energy, Northern Development and Mines. (2019). *Energy intensity by operation type April 18*. OMENDM.

Provident, Morrison Hershfield, & Integral Group. (2017). *The City of Toronto Zero Emissions Building Framework* (p. 118). Retrieved from City Planning Division, City of Toronto website: https://www.toronto.ca/wp-content/uploads/2017/11/9875-Zero-Emissions-Buildings-Framework-Report.pdf

Ribeiro, D., Bailey, T., Drehobl, A., King, J., Samarripas, S., Shoemaker, M., … Castro-Alvarez, F. (2017). *The 2017 city energy efficiency scorecard* (No. U1705). Retrieved from American Council for an Energy-Efficient Economy website: https://aceee.org/local-policy/city-scorecard

Schleussner, C.-F., Rogelj, J., Schaeffer, M., Lissner, T., Licker, R., Fischer, E. M., … Hare, W. (2016). Science and policy characteristics of the Paris Agreement temperature goal. *Nature Climate Change*, *6*(9), 827–835. https://doi.org/10.1038/nclimate3096

Scott, D., Gossling, S., Hall, C. M., & Peeters, P. (2016). Can tourism be part of the decarbonized global economy? The costs and risks of alternate carbon reduction policy pathways. *Journal of Sustainable Tourism*, *24*(1), 52–72. https://doi.org/10.1080/09669582.2015.1107080

Statistics Canada. (2018). *Report on energy supply and demand in Canada: 2016 preliminary*. Retrieved from https://www150.statcan.gc.ca/n1/en/pub/57-003-x/57-003-x2018002-eng.pdf?st=H-5guRxS

Statistics Canada. (2019, April 3). Census Profile, 2016 Census - Burlington, City, Ontario. Retrieved April 23, 2019, from https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/Page.cfm?Lang=E&Geo1=CSD&Code1=3524002&Geo2=PR&Code2=35&Data=Count&SearchText=Burlington&SearchType=Begins&SearchPR=01&B1=All

The Climate Group. (2018). Under2 Coalition [Organization]. Retrieved November 12, 2018, from The Climate Group website: https://www.theclimategroup.org/project/under2-coalition

Toth, C., Virdi, S., & Simcisko, K. (2014). *Energy conservation & demand management plan: 2014-2019.* Retrieved from Town of Oakville website:

https://www.oakville.ca/assets/general%20-%20environment/CDMPlan2014-2019TRv1.pdf

Treasury Board of Canada Secretariat. (2018, January 11). Greening government strategy. Retrieved April 30, 2019, from Government of Canadatr website: https://www.canada.ca/en/treasury-board-secretariat/services/innovation/greening-government/strategy.html

Truck News. (2017, November 1). Refresher courses needed to maximize value of driver training:PIT. Retrieved from trucknews.com website: https://www.trucknews.com/business-management/refresher-courses-needed-maximize-value-driver-training-pit/1003081721/

World Green Building Council. (2018). What is Net Zero? Retrieved November 15, 2018, from What is Net Zero? website: https://www.worldgbc.org/advancing-net-zero/what-net-zero

Zheng, A., Lehmann, J., Sharp, K., Turcotte, K., Garis, L., & Pike, I. (2018). *Anti-idling technology on fire service vehicles: An evaluation of the benefits*. Retrieved from University of the Fraser Valley website: https://cjr.ufv.ca/wp-content/uploads/2018/11/Anti-Idling-Technology-on-Fire-Service-Vehicles-October-2018-1.pdf

Appendix A. Present state

This section provides an overview of the present state of the City of Burlington's energy use within city facilities and fleets. It draws on a review of current energy initiatives, policies and plans.

EXISTING CORPORATE ENERGY INITIATIVES, POLICIES, AND PLANS

This City of Burlington has adopted multiple corporate plans, strategies, and guidelines that demonstrate the City's commitment to the environment, energy, and sustainability by establishing goals as a community and as a corporation. These include:

- Burlington's Strategic Plan 2015-2040
- The City of Burlington Official Plan, 2018
- Sustainable Building and Design Guidelines, 2018
- Declaration of a Climate Emergency, 2019
- Greening the Corporate Fleets Transition Strategy, 2008
- The Community Energy Plan, 2014

A description of each document and how it aligns with the objectives of the corporate energy management plan is provided in this section.

Burlington's Strategic Plan 2015-2040

The City of Burlington's commitment to *A Healthy and Greener City: Visualizing 2040* is in keeping with the CEEMP through (2) two key actions related to energy management.

1. The City operations are net carbon neutral; and
2. The City will work with stakeholders to implement the CEP commitments.

Both the Strategic Plan and the CEEMP encourage energy-efficient technology and the development of sustainable energy guidelines for new and existing buildings. This 25-year plan has a key strategic objective of encouraging a healthier environment through better environmental outcomes that fight climate change, improving the quality of life, economic competitiveness, and through fostering civic pride. Active transportation such as cycling and walking, are also encouraged.

The plan identifies strategic initiatives to accommodate growth through delivering financially sustainable features, such as energy-efficient buildings and retrofitting buildings to reduce Burlington's energy and environmental footprint. Additionally, the plan discusses demonstrating leadership in its own facilities, through initiatives such as a city's awards program and a design review panel.

The City of Burlington displays environmental leadership by recognizing that climate change is a significant issue and will work with stakeholders and other levels of government towards being a net carbon neutral community, as well as to ensure that the City's operations are net carbon-neutral. The strategic plan states the city will to continue to work with Burlington Hydro Inc. to explore district energy, micro-generation, new storage technologies, and will evaluate metrics for progress based on:

I. Combined conservation and demand management targets resulting in an overall annual reduction of per capita community energy use of 5% or 6.7 GJ/a per person from 2014 to 2031,[17]
II. Sustainable local generation (renewable and district energy): 12.5 MW by 2031, approximately 3.5% of Burlington's peak electrical demand,

and other community related goals to ensure energy reduction by 2031. The plan highlights the City of Burlington's committed behaviour to increasing energy efficient projects though local generation, retrofitting existing buildings, setting goals and monitoring metrics for progress.

The City of Burlington Official Plan, 2018

The Burlington Official Plan (OP) is a document that provides guidance on land use planning decisions and implements regional and provincial requirements. The Plan complies with the Planning Act of Ontario, and outlines the long-term community vision, and provisions that support future infrastructure, sustainable design, reduction of sprawl and mobility hubs. The OP focuses on natural resource management, transportation, economic, and environmental development within the city. The OP provides the City of Burlington with a long-term framework for establishing active and sustainable modes of travel based on complete communities, reducing environmental impacts and energy use.

The 2017 Burlington Official Plan, which is in-force and effect, is an office consolidation based on the 1994 Official Plan and includes the following policies in section 2.6.2 related to the CEMP:

- The environmental effects of City operations shall be reviewed, and alternative approaches will be encouraged that will benefit the environment and the community.
- Best Management Practices for energy conservation and efficiency shall be utilized and regularly reviewed in all facilities built, owned and operated by the City.
- Where feasible, alternative or innovative environmentally friendly energy sources will be utilized for City facilities.

The City adopted a new Official Plan in April 2018. At the time of drafting of this report City Council announced that it would be undertaking a scoped review of the building heights and densities contained within the adopted Official Plan and has approved a workplan that focuses the review on the Downtown and Neighbourhood Centres Designation. Further, the adopted Official Plan remains at the Region of Halton for approval to address all conformity issues.

As a result, the policies in the adopted Official Plan are not in force and effect, however they have been summarized below for information purposes.

Environment and sustainability initiatives connect with the corporate focus of the CEEMP in Chapter 4. Environment and Sustainability. Section 4.1.2 a) states:

[17] Arguably, the corporate target should be at least as high as the community target, if the City is to show leadership to the community. However, a target of 5% per year over the long term is a very aggressive target.

The City will work to improve air quality and energy efficiency, to reduce greenhouse gas and fuel emissions, and to mitigate and adapt to climate change through land use and transportation policies related to:

viii. encouraging energy generation from renewable sources and community energy

ix. solutions such as micro grids, district energy, and energy storage; and encouraging sustainable, energy efficient and low carbon buildings.

Additionally, Section 7. Design Excellence includes policies directly supporting the CEEMP through the encouragement of sustainable site and building design. Section 7.1.1 includes general objectives promoting sustainable site and building design to:

v. reduce waste, energy and water consumption; and

vi. enhance air quality, mitigate greenhouse gas emissions and adapt to climate change.

7.4.1 Policies are on the required land use planning applications for public service facilities and states that sustainable design measures should be integrated:

i. energy efficiency, passive design measures, renewable energy sources and other low carbon building strategies;

iv. additional sustainable transportation measures such as electric vehicle charging stations that exceed the requirements of the Building Code;

viii. maintenance, monitoring and communication of sustainable building features; and

ix. other innovative sustainable design approaches or technologies.

The OP recognizes the important of incorporating low carbon building strategies into other city planning applications and sets to reduce the City's carbon footprint and greenhouse gas emissions through its policies.

Sustainable Building and Design Guidelines, 2018

In keeping with the Infrastructure, Transportation and Utilities and Design sections in the City of Burlington's OP, and in alignment with Burlington's Strategic Plan 2015-2040, and the Community Energy Plan, the Sustainable Building and Development Guidelines (SBDG) highlight Burlington's commitment to consider alternative energy systems and district energy systems and measures to achieve carbon neutrality in buildings. These guidelines address sustainable approaches to site design, transportation, the natural environment, water, energy, emissions, and waste materials.

The SBDG is a tool that assess sustainable features of development applications. The guidelines provide the rationale for sustainable building. The guidelines include both required measures and encouraged ones. Based on the number of implemented guidelines, the plan identifies awards and utility incentives for applicants.

Section 5. Energy and Emissions addresses strategies for reducing the Urban Heat Island including incorporating vegetation on impervious surfaces, light-coloured material/paving to enhance the paving landscape, and the inclusion of cool roofing materials, green roofing or a combination of both in development projects.

Other sustainable initiatives that are encouraged in projects include achieving a 10% or better energy efficiency improvements over ASHRAE 90.1-201, generating a portion of building energy needs using an on-site renewable energy supply, and demonstrating that a project has a net-zero energy footprint. SBDG encourages the use of district heating or cooling in buildings, metering of energy usage for each unit, and third-party commissioning of building systems at the completion of construction.

Declaration of a climate emergency, 2019

On April 23, 2019 Burlington's City Council unanimously passed a motion to declare a climate emergency (Burlington, City of, 2019). The climate emergency declaration provides staff and residents with clarity of purpose regarding Council's view of the importance of climate change, and directs staff to immediately increase the priority of the fight against climate change and to apply a climate lens to the plans and actions of the City of Burlington, including the Council strategic workplan and future budgets.

Greening the Corporate Fleets Transition Strategy, 2008

Greening the Corporate Fleet Transition Strategy (GCFTS) highlights Burlington's commitment to greening corporate fleet vehicles. In 2008, city council endorsed this strategy in support of low emission vehicles, cleaner fuels, and the right-sizing of vehicles. The main goal of the strategy is to improve the efficiency and greenhouse gas emission reduction within the City's corporate fleets. This strategy includes nine sections that highlight issues, city actions, and corresponding targets for each action. These actions include assisting with the correct sizing of light-duty vehicles and choosing hybrid vehicles during the sizing assessment process.

The strategy includes a comparison of emission reduction options and initiatives such as the implementation of smart driver education training. It supports best municipal practices for the use of biodiesel fuel, monitoring vehicles to track fuel consumption, fuel costs, mileage, and maintenance costs to ensure fuel efficiency targets are met. The strategy seeks to improve Burlington's fuel efficiency of city operations and reduce greenhouse gas emissions.

The Community Energy Plan, 2014

The Community Energy Plan (CEP) was endorsed by Burlington City Council in 2014. It is a 20-year plan encouraging lower community energy use. The CEP's vision aligns with Burlington's CEEMP in wanting to achieve a community that is efficient and economically viable. The plan builds support on reducing a reliance on energy use, reducing one's carbon footprint, and improving local energy security through the use of local renewable generation. The main difference between the CEP and CEEMP is that the CEEMP focuses on energy and emissions at the corporate level only. A CEP includes community actions and conservation initiatives to reduce energy use and greenhouse gas emissions.

The CEP consists of 5 overall goals with objectives, and 55 actions. The goals closely aligning with the CEEMP include:

1. Create leading edge community engagement in energy initiatives (conservation, generation and security) in order to enhance the implementation effectiveness and support sustained quality of life in Burlington;
2. Improve the energy efficiency of buildings in Burlington in ways that contribute to Burlington's overall economic competitiveness;

3. Increase sustainable local energy generation in Burlington and enhance supply security in ways that support Burlington's economic competitiveness; and
4. Optimize integrated community energy systems and efficiency opportunities through land use planning; and
5. Increase transportation efficiency.

The CEP forecasted that community energy use could reduce by approximately 27% by 2030, translating into a 26% reduction in greenhouse gas emissions from approximately 6.8 to 5 t/a per capita. The CEP identifies district energy and combined heat and power in the Energy Generation and Security section as key tools to enable Burlington to achieve its goals and targets. The plan established task groups to share progress on actions and are working together to improve energy efficiency and greenhouse gas reduction in the City of Burlington. An update of the plan is in progress.

Appendix B. Global climate change and energy planning initiatives

Burlington's plan takes place within a global context of cities committing to reduce greenhouse gas emissions. This section includes examples of current city initiatives for fighting climate change.

The final section highlights the policy changes within climate change planning in Ontario and what those mean for the City of Burlington.

C40 CITIES CLIMATE LEADERSHIP GROUP

Climate change has had detrimental effects on cities through extreme cases of heat waves, droughts, food security, sea level rises, coastal flooding, and through power supply risk. Research continuously supports a direct relationship between climate hazards and global greenhouse gas emissions. Worldwide collaboration in the form of partnerships, knowledge and data sharing is tackling energy management greenhouse gas mitigation at the global scale.

C40 is a network of the world's megacities committed to addressing climate change. C40 supports cities to collaborate effectively, share knowledge and drive meaningful, measurable and sustainable action on climate change. The C40 Cities Climate Leadership Group is a data-driven organization founded on the idea that cities can achieve more by functioning as a connected network than by working at the individual level alone. The organization was founded in 2005 and to date, C40 Cities have committed to reducing their emissions by a total of more than 4 gigatons of CO2 by 2030. The group includes more than 85 cities from around the world. Canadian cities represented in the group are Montreal, Toronto and Vancouver.

Deadline 2020 is an analysis for C40 of how cities can deliver on climate change action through the implementation of science-based climate action plans by 2020. To limit the global temperature rise to 1.5°C, climate change plans will guide cities, help them reduce their greenhouse gas emissions, and aid with the transition of being emissions neutral by 2050. The plan aims to make cities more resilient, while simultaneously generating social, environmental, and economic benefits for all citizens. The analysis demonstrates that substantial reduction of greenhouse gases in cities is required to achieve the Paris targets, and it acknowledges that achieving these reductions will be a difficult challenge for most cities, and notes that it is important for all cities to begin reducing per capita emissions as soon as possible (C40 Cities Climate Leadership Group Inc., 2019, p. 40)

GLOBAL COVENANT OF MAYORS

The Global Covenant of Mayors for Climate and Energy is the largest global coalition for city climate leadership (Global Covenant of Mayors for Climate & Energy, 2019). As nations join to work toward the Paris Climate Agreement, cities' involvement and cooperation is urgent. Climate change has had detrimental effects on cities through extreme cases of heat waves, droughts, food security, sea level rises, coastal flooding, and through power supply risk. Research continuously supports a direct relationship between climate hazards and global greenhouse gas emissions. Worldwide collaboration in the form of partnerships, knowledge and data sharing is tackling energy management greenhouse gas mitigation at the global scale.

The GCoM partners share a long-term vision of cooperation to combat climate change on a large scale. Cities contain more than half of the world's population and account for more than 70% of all emissions. The coalition believes that, with the help of its partners across the world, it could collectively reduce 17 billion tons of CO_2e by 2030. All levels of government have a role to play in achieving a net-zero-emission world by 2050, and the GCoM coalition includes participation and commitment from any level and any size of government. The Climate Group found that in recent years, many states and regions have adopted more ambitious targets than their national governments, a movement that is supported by GCoM.

The mission of the Global Covenant of Mayors is to serve cities and local governments by organizing and mobilizing climate and energy efforts in their communities, by working with the local governments and other partners. As of March 2019, over 9,200 cities from more than 130 countries had already committed to taking action with them. The cities register, implement, and monitor their strategic action plans, such as their *Corporate Energy and Emissions Management Plan,* and make information on their efforts and successes publicly available. The three initiatives of the coalition address the need for research, innovation, technical assistance and city-level intelligence to help cities combat climate change. These initiatives are "Innovate4Cities", "Data4Cities", and "Invest4Cities".

THE UNDER2 COALITION

The Under2 Coalition is a group of subnational governments established in 2015 also illustrating that better results are achieved through good teamwork, is the Under2 Coalition. The Coalition consists of more than 220 governments across the globe committed to keeping global temperature from rising 2°C. Canadian members include Quebec, Ontario, British Columbia, the Northwest Territories, and the City of Vancouver. The Climate Group is the Secretariat to the organization and works alongside governments on climate change action. Under2 Coalition's work is achieved through three key avenues: transparency, policy action, and through the development of 2050 pathways.

The Under2 Coalition (2018) believes that climate action can be achieved through transparency, by supplying governments with the tools and expertise to assess their emissions, track progress, and ensure that policies deliver against targets. Sharing, promoting, and developing new climate policies also can ensure full decarbonization. The Coalition provides direction on what technical support and resources governments will need to establish long-term greenhouse gas reduction goals. The new technologies, infrastructure, and investments, related risks and trade-offs, required to achieve this is known as 2050 pathway analysis.

The group hosts workshops for government experts and research partners on policy challenges and solutions around community renewables, energy efficiency in buildings, and engaging with energy-intensive industries. Other initiatives the Coalition has undertaken are a series of webinars to raise awareness, and present opportunities on renewable energy, LED lighting, climate solutions in the healthcare sector, and information on how to strengthen greenhouse gas accounting capacity at the sub-national level.

In 2018, 120 states and regions from 32 countries disclosed their climate action and targets. The response to climate commitment is expected to grow, (The Climate Group, 2018) states that by 2020, 90% of states and regions in the Under2 Coalition will be disclosing their climate targets and actions annually. Globally recognized leaders of climate action are empowering economies to shift towards a 'net-zero' future and in turn, paving the way for other jurisdictions to do so as well.

NET ZERO BUILDING-WORLD GREEN BUILDING COUNCIL

The World Green Building Council (2018) defines net zero buildings as structures that are energy efficient, supply energy needs from renewable sources both off and/or on site. Green buildings are known to have environmental, economic and social benefits. Green buildings are designed to utilize less water and energy, and some buildings are able to generate their own energy. By combining practices of net zero building with green infrastructures such as green roofs, green walls, and rainwater harvesting within buildings, cities improve air quality, provide habitats for flora and fauna, and enhance human health through a better quality of living.

Data support a strong linkage between green buildings and economic benefits. In fact, a report by the Canada Green Building Council and The Delphi Group (2016) stated that Canada's green building industry generated $23.45 billion in GDP and represented nearly 300,000 full-time jobs in 2014. At a much lower level, the building level, assets value is significantly higher than in older, traditional buildings that have not undergone major or minor retrofits improving energy efficiency.

In addition, net zero buildings can help Canada advance Paris Agreement levels of global emission reductions. Organizations such as the Global Network of Green Building Councils is committed to achieving the following by 2050:

I. Limit global temperature rises to 2º Celsius
II. Reduce the building and construction sector's CO_2 emissions by 84 Gt
III. Ensure all buildings are net zero emissions.

(World Green Building Council, 2018).

The City of Burlington can lead in environmental stewardship by following in the footsteps of climate change organizations and adopt stringent standards for its buildings. The city can implement energy efficiency performance requirements within all buildings. Sustainable development can be achieved by incorporating energy management within all levels of building design, construction, and operations. Net zero building will help reduce the negative impacts of development at the global scale and lower the City of Burlington's carbon footprint.

CLIMATE CHANGE POLICY DEVELOPMENTS IN ONTARIO

The electricity system in Ontario has experienced significant changes through the falling demand for electricity and an increase in generating capacity. In general, there is less pressure to reduce electricity use than there was in 2012-2014. Despite this, governments at all levels are making a conscious effort to track and reduce greenhouse gas emissions.

In 2016, Canada ratified the Paris Agreement (PA) joining the international effort to reduce global warming to less than 2°C Celsius above pre-industrial levels and to attempt to limit warming to 1.5 °C (Schleussner et al., 2016). The Paris Agreement limits and holds warming to well below 2°C to avoid dangerous levels of climate change. To achieve this, Canada committed to reducing greenhouse gas emission in 2030 by 30% relative to 2005 emission levels.

Under the previous Ontario government, the 2017 Ontario Long-Term Energy Plan: Delivering Fairness and Choice delivered a 20-year roadmap for the energy sector in Ontario (Ontario Ministry of Energy, 2017). The plan identified a number of objectives for making energy more affordable and for managing electricity system costs over the long term. The plan introduced new regulatory protections. Key initiatives within the plan included:

- Ensuring affordable and accessible energy
- Ensuring a flexible energy system
- Innovating to meet the future
- Improving value and performance for customers
- Strengthening a commitment to energy conservation and energy efficiency
- Responding to the challenge of climate change
- Supporting First Nation and Métis capacity and leadership
- Supporting regional solutions and infrastructure

Since the plan was prepared, the government has changed, and a new energy plan has not been released.

The outlook of electricity planning

Electricity requirements are affected by a variety of factors that range from energy form, technology, equipment purchasing decisions, behaviour, demographics, population, the economy, energy process, transportation policy, and conservation (Independent Electricity System Operator (IESO), 2018a). The key drivers of electricity demand include major economic drivers, electricity and natural gas prices, and conservation initiatives. Carbon and energy costs are expected to rise, as we continue to see above normal temperatures across Canada. The effects of climate change will put stress on Ontario's electricity system.

The Independent Electricity System Operator (IESO) predicts an increase in overall demand as electrification of the economy increases. It is expected that Ontario will continue on the path of keeping greenhouse gas emissions in the electricity sector low, though they are expected to increase during refurbishing of aging nuclear plants when other sources of supply will be drawn upon (Independent Electricity System Operator (IESO), 2018a).

Electricity conservation savings grew from 2006 to 2017. Conservation savings reached approximately 16 TWh in 2017, where 10 TWh savings were achieved through conservation programs, driven by education and financial incentives. In addition, 6 TWh savings were achieved by minimum efficiency regulations: building codes and equipment standards (Independent Electricity System Operator (IESO), 2018a). The current long-term conservation forecast of 32 TWh by 2035 reports that half of the forecasted savings are from codes and standards and the other half are from conservation programs. Figure 16 shows that as codes and standards continue to grow, historical program savings reach the end of their life cycle.

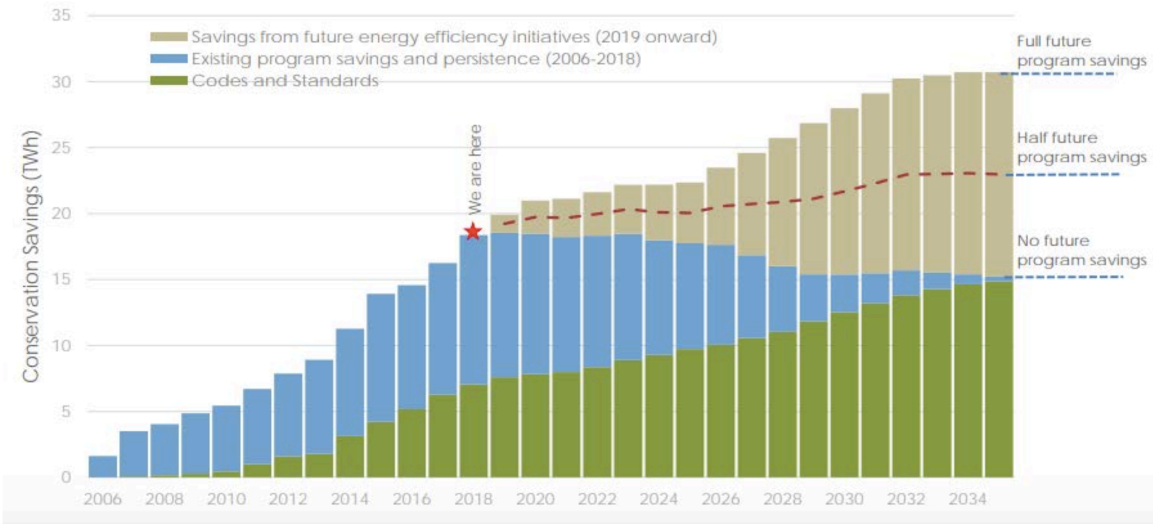


Figure 16 Forecast of Ontario electricity conservation to 2035 (Independent Electricity System Operator (IESO), 2018a)

Future conservation programs represent about 15 TWh energy savings and 2,400 MW of peak demand savings by 2035 (Independent Electricity System Operator (IESO), 2018a). Additionally, the IESO estimates savings from codes and standards to be approximately 15 TWh by 2035.

The IESO forecasts a need for new capacity of approximately 1,400 MW in 2023. The need increases to 3,700 MW in 2025 before plateauing to about 2,000 MW over the long-term. This assumes that capacity from existing resources continues to be available post contract, helping to defer and reduces the need for additional capacity (Independent Electricity System Operator (IESO), 2018b). The IESO suggests that this will be met through the continuation of acquiring capacity from demand response.

The Pan-Canadian Framework on Clean Growth and Climate Change

The 2016 Pan-Canadian Framework was designed to meet Canada's commitments under the Paris Agreement: to meet emission reduction targets and build a strong and resilient economy. A key element of the Framework is the use of market instruments to induce reductions. The Framework gives provinces the options of setting up their own carbon pricing regime, otherwise the federal government will introduce one in provinces. With the cancellation of the cap and trade program under the new government elected in 2018, Ontario became one of the provinces subject to the federal program. Most (80%) revenues collected by the federal government are being distributed to taxpayers directly. The remaining 20% is going into funds that other organizations – including municipalities – will be able to draw upon.

Preserving and protecting our environment for future generations: A made-in-Ontario environment plan

In 2018, Ontario released an environmental plan that proposes a range of initiatives to protect air, land and water, prevent and reduce litter and waste, and reduce greenhouse gas emissions and climate change (Ministry of the Environment, Conservation and Parks, 2018).

The plan does not specifically include any incentives or requirements that affect municipalities directly.

Appendix C. Municipal experience and best practices

This section reviews energy plans of neighbouring and leading jurisdictions. Jurisdictions were chosen based on proximity to Burlington and that are recognized energy plan leaders. It reviews city energy initiatives for: The Town of Oakville, the City of Guelph, the City of Vancouver, and the City of Portland, Oregon.

These jurisdictions set targets and robust metrics that exceed provincial or state requirements and align with planetary boundaries. The ACEEE publishes a report on *City Energy Efficiency Scorecard* (Ribeiro et al., 2017). This report discusses local policies and actions advancing energy efficiency. Within the report, the energy efficient scoreboard compares and ranks cities across five policy areas:

- Local government operations
- *Community-wide initiatives*
- *Building policies*
- *Energy and water utilities*
- *Transportation policies*

The city energy efficiency scorecard measures the progress of city policies and programs that save energy, benefiting the environment and economic growth. The report offers recommendations and strategies on how cities can improve on energy efficiency. The following strategies are recommended by ACEEE:

1. Adopt policies and plans to save energy in public sector buildings and fleets;
2. Include opportunities for improving energy plans, revisit timelines, set energy-saving targets, and allow the public access to energy information;
3. Ability to track, manage, and communicate energy performance;
4. Adopt stringent building codes, require energy audits, and implement energy performance requirements for building types;
5. Form partnerships with energy and water utilities to expand access to energy efficiency programs; and
6. Promote location-efficient development and improve access to decrease transportation energy usage.

Notable features of the plans reviewed are summarized in Table 9. There are municipalities that do not differentiate or fully separate between corporate and community responsibilities. Examples include the City of Vancouver and the City of Portland, Oregon. However, the overlapping of actions has allowed for effective implementation and action on energy management. After reviewing available resources within North American municipalities and cities, having a Sustainability Coordinator role that reports directly to the Chief Administrative Officer has been effective for recognizing the importance of building relationships among departments and bringing awareness to corporate energy management. Within Ontario, The City of Markham, The City of Barrie, and The City of Pickering has included this role within their city department. Most Notably, The City of Burlington joins the list of leaders when it grew to include a Sustainability Coordinator role within the Capital Works department.

Table 16 Energy conservation and best practices in the Town of Oakville, the City of Guelph, the City of Vancouver, and the City of Portland, Oregon.

Targets	Initiatives to reach goals and targets	Documents
Town of Oakville, Ontario, Canada		
o Achieve a 15% reduction of 2012 baseline energy use by 2019. o Under the corporate greenhouse gas emission reduction target update (2015-2050) the town set a corporate GHG emission reduction target of 80% below 2014 levels by 2050. o A corporate greenhouse gas per capita emission reduction of 20% below 2014 levels by 2030 & sub targets: I. 30% per capita reduction in building emissions from 2014 levels by 2030 II. 10% per capita reduction in fleet emissions from 2014 levels by 2030 III. 40% per capita reduction in streetlight emissions from 2014 levels by 2030	o Started a Drive Smart campaign for all staff, and energy efficiency driver-training program. o Installed solar PV on four town facilities: Town Hall, Glen Abbey Community Centre, River Oaks Community Centre and Sixteen Mile Sports Complex. o Installed a high-efficiency vertical geothermal bore field system in the LEED certified Oakville Transit building. o Through the Ontario Power Authority's Feed-In Tariff program, a unique project of 500-kW capacity rooftop solar array was created at Oakville-Trafalgar Memorial Hospital. The power generated will provide $6.35 million in revenue to the hospital over a 20-year period and achieved gold certification after earning 39 credits in the green building system. o Converted existing streetlights to LED bulbs, and made improvements to buildings, meeting the LEED silver certification or exceeding it. o Over the past few years, Town of Oakville Sixteen Mile sports complex and office spaces have achieved LEED Gold certifications. o Town staff and departments are required to follow the Sustainable Green Fleet Procedure on fleet greening to assist the Town's GHG emission reduction goals, reduce the use of non-renewable resources and improve fuel efficiency.	Energy Conservation and Demand Management (2014-2019) (Toth, Virdi, & Simcisko, 2014). Sustainable Green Fleet Procedure (Town of Oakville, 2019).

City of Guelph, Ontario, Canada		
o City corporate operations will be powered by 100% renewable energy by 2050.	o Added 10 hybrid gas-electric cars to City fleet (half of the City's fleet of cars). o From 2013-2016, the City completed 8 facility retrofits. o In 2015, The City ran a pilot to transition to LED street lights. After its success, in 2017 Council approved switching 13,119 street lights to LEDS. o The City has added a biogas-fueled cogeneration plant at the City's wastewater treatment plant. o Guelph Transit uses biodiesel in its fuel supply, and rainwater harvesting in bus washing operations. o Based on progress review, energy use and emissions are expected to remain the same in 2050 as they are today in Guelph.	Corporate Energy Business Plan (2013, City of Guelph).

The City of Vancouver, BC, Canada		
o Under the Renewable City Strategy (2015-2050) the City plans to derive 100% of the energy from renewable sources before 2050. o Reduce greenhouse gas emissions by at least 80% below 2007 levels before 2050. o Buildings constructed from 2020 and onwards are to be carbon neutral in operations (To date there has been a decrease of 5% from the baseline value). o By 2030, 55% of energy use in Vancouver is derived from renewable sources.	o Vancouver became the first city in Canada with a strategy that shifts to 100% renewable energy. o The City has implemented a comprehensive corporate waste reduction and diversion program for all City facilities o Achieved a 70% waste diversion in public-facing City facilities, and 90% waste diversion in all other City-owned facilities. o The City has implemented a program to significantly reduce greenhouse gas emissions as well as fossil fuel use in City-run buildings and vehicles and achieve carbon-neutral operations. o Upgrades to City facility lighting, building automation systems, and heating systems have resulted in significant energy savings and a reduction in GHG emissions. o The City had a 25% decrease in water use in City operations since 2006. o The City has fitted 107 idle-stop devices to its fleet vehicles to limit emissions form idling, and since 2008 has cut fleet emission by 10% and overall corporate emissions by 25%. o The City has a sustainable commuting program that offers incentives to City employees to engage in active transportation when travelling to and from work. The program is funded through a parking charge. o The City promotes efficient driving practices through driver training and staff education, "idle-free" signs, idle cut-offs to three minutes, a complete "no air conditioning" policy. o The corporate solid waste diversion program has a scope that includes zero waste meetings, zero waste and reduced consumption procurement, and waste minimization for all operations, programs and projects.	The Greenest City: 2020 Action Plan (2015, City of Vancouver). Renewable City Action Plan (2017, City of Vancouver). Renewable City Strategy (2015, City of Vancouver). Zero Waste 2040 (2018, City of Vancouver).
The City of Portland, Oregon, United States		

o Under the 2030 Environmental Performance Objectives, the City aims to reduce carbon emissions form City operations by 53% below previous levels. o Set a 2030 target to annually generate or purchase 100% of all electricity for City operations from renewable resources. o Set a 2030 target of reducing fleet vehicle carbon emissions 10% below previous levels. o Set a 2030 goal of recovering 90% of waste from City operations, with a secondary goal of reducing total waste from City operations 25% below previous levels. o Set a target to reduce the total energy use of all buildings built before 2010 by 25%. o Set a target to supply 50% of all energy used in buildings from renewable resources, with 10% produced within Multnomah County from on-site renewable sources. o Set a target to reduce energy use in City and county government buildings by 2% annually (exceeded this goal by achieving a 2.7% reduction per year). o Set a target to reduce the lifecycle carbon emissions of fuels by 20% o Set a 2030 target to ensure that 80% of City-managed natural areas are in "healthy" or good condition.	o The City of Portland has been working on the City Energy Challenge to cut energy use and save money in City operations. To date, completed energy efficiency improvements saved $5.5 million dollars each year. Cumulative savings have reached $42 million. o Since 2009, the City has installed 17 renewable energy systems which include biogas, solar electric, hydro, wind, solar hot water, and solar pool heating totaling 2,484 kW installed capacity. o In 2015, City Council adopted Resolution 37153 that added fossil fuel companies to the City's Corporate Securities do-not-buy list, committing the City to hold no financial stake in the 200 largest fossil fuel firms. o The City of Portland reduced city fleet emissions to 23% below previous levels, exceeding the 2030 Environmental Performance Objective. This decrease can be attributed to: an increase in use of low carbon fuels and new sources of biofuel. o City policy sets an ethanol and biodiesel use standards for all corporate vehicles. o The City used high blends (from 20 to 99 %) of regionally produced biodiesel in their diesel-powered vehicles and equipment since 2007. o The City's feet contain flex fuel vehicles that can run on gasoline blends containing 85% ethanol. o Exemplary transportation policies include mode share, vehicle-miles-traveled reduction goals, as well as several efforts to increase local efficiency.	2015 Sustainable City Governance Principles and 2030 Environmental Performance Objectives (2015, City of Portland). Portland Climate Action Plan (2015, City of Portland). Climate Action Through Equity (2016, City of Portland). Green Building Policy (2009, City of Portland). Sustainable Procurement Policy (2018, City of Portland). Idle Reduction Policy (2009, City of Portland). Biofuels Requirements for Petroleum-Based Fuels Sold in Portland and City-Owned Vehicles (2006, City of Portland).

The cities and towns identified in Table 17 are leaders in energy management because their plans go above and beyond the ability to identify potential improvements, building performance and alternative forms of energy. To achieve desired targets most towns and cities have developed strategies with specific actions that are ranked based on priority. The City of Guelph for example, has integrated these actions into its annual savings. Constant monitoring and benchmarking have led to effective energy conservation and cost savings. Having defined tasks and follow-through have allowed for effective progress on energy use and greenhouse gas emissions.

In addition, having energy management responsibilities distributed within departments facilitates successful plan implementation. The Town of Oakville, with a population only slightly higher than Burlington for example, has two people that would fall under the corporate banner for energy management, and an additional staff member that manages the Community Energy Plan.

Some municipalities have drawn on their local LDCs Energy Manager program to cover a part of the salary of a staff person. (This program has been ended.)

Summary of key success factors:

- A supportive council
- Distributed energy responsibility among staff
- Full implementation of energy monitoring and tracking system
- Adopting a robust methodology for establishing realistic energy reduction targets

Appendix D. Financial incentives

This section describes the financial incentives that are available to the City of Burlington. These incentives include:

- utility incentives for electricity savings offered by the Independent Electricity System Operator (IESO)
- utility incentives for natural gas savings offered by Enbridge Gas Distribution (formerly Union Gas)
- those offered at the federal level
- incentives offered by The Atmospheric Fund

The City of Burlington can take advantage of these incentives to implement some of the suggested technical measures. Forming partnerships with energy utilities allows for the expansion and access to energy efficiency programs within the City.

On the electricity side, the Independent Electricity System Operators (IESO) has taken over the SaveOnEnergy programs previously available through Burlington Hydro. The City of Burlington can take advantage of programs such as the Retrofit Program, which provides incentives for reductions in peak electricity demand or electricity consumption.

For natural gas, all applicable technical measures fall under the Equipment Incentive Program and the Custom Engineering Incentive Program offered by Enbridge.

INDEPENDENT ELECTRICITY SYSTEM OPERATOR (IESO)

Full details are available at: **https://saveonenergy.ca**.

Retrofit Program

The Retrofit program provides incentives for electricity savings from lighting retrofits, lighting controls, HVAC redesigns, chiller replacements, variable speed drives, or improvements on thermal performance of a building envelope. There are two types of project applications: Prescriptive Track and Custom Track.

Process & Systems Program

This program provides incentives for innovative changes, equipment retrofits, financial assistance for engineering studies, technical expertise from energy managers.

Energy Performance Program

This incentive is ideal for improving the energy performance of an entire building.

ENBRIDGE GAS DISTRIBUTION

Full details are available at:

https://www.uniongas.com/business/save-money-and-energy/equipment-incentive-program

The Equipment Incentive Program

This program can help reduce costs, increase energy efficiency, and improve the return on investment for equipment related to space heating.

Measure	Incentive	Requirements
Air curtains	Up to $4,000 per door	Natural gas heating, replacements not eligible
Condensing boilers	Up to $500 per unit in new construction Up to $6000 in existing buildings	Space or water heating, thermal efficiency >90%
Condensing make-up air units	Up to 0.40 $/CFM per unit (for unit with variable frequency drive) VFD bonus of $2500 for units over 5,000 CFM	Between 1500 and 14,999 CFM At least 90% thermal efficiency
Condensing unit heaters	$750 per unit	At least 90% thermal efficiency
Condensing furnaces	$200 per unit	AFUE ≥ 95% Non-residential Not part of a system with rooftop units or make-up air units
Demand control ventilation systems	$500 per roof top unit or make-up air unit with a CO_2 sensor	Natural gas space heating, single zone systems
Destratification fans	$1,000 per unit	Where there are ≥25’ ceilings with ceiling mounted natural gas forced air heating systems High-velocity low-speed fans of ≥20 foot diameter
Energy & heat recovery ventilators (ERV)	Up to $1.75 for new ERVs, or $1.15 for replacement ERV or new ERV required by code	Heat recovery effectiveness of at least 65% No demand control ventilation
Infrared heaters	Up to $400 per unit	Incentive varies with heating capacity

Custom Engineering Incentive Program

The custom engineering incentive program that helps fund studies and pilots to identify energy-saving opportunities.

Engineering Energy Efficiency Feasibility Study

This financial incentive is for studies that analyze existing buildings to determine how to optimize energy.

New & Retrofitted Equipment and Process Optimization

This incentive will help fund projects that range from implementing boilers, high efficiency process equipment, building and process controls and building envelope technologies.

The Runsmart Building Optimization

The program offers incentives for retrofits that are low cost and/or no cost energy savings measures and activities that improve a building's natural gas use such as by reducing excessive exhaust quantities.

FEDERAL INCENTIVES

Full details are available at:

https://fcm.ca/en/programs

https://www.nrcan.gc.ca/cleangrowth/20254

The Federal Government of Canada offers funding, grants and incentive programs to encourage energy innovation, a clean economy, and to promote climate change action. The Federation of Canadian Municipalities (FCM) offers programs and tools to help municipalities build stronger communities. FCM supports a variety of opportunities such as plans, studies, pilot projects, capital projects, asset management grants, and partner grants. Additionally, through Natural Resource Canada's (NRCan) Innovation and Clean Growth Programs, there are incentives for projects that support key energy innovative areas. Below is a description of each.

The Green Municipal Fund-Energy

Full details are available at:

https://fcm.ca/en/funding/gmf/pilot-project-retrofit-municipal-facilities

https://fcm.ca/en/funding/gmf/study-energy-recovery-district-energy

This program funds studies, pilot and capital projects for different environmental sectors. Both grants and loans are available for municipal projects. Recipients can receive additional grant of up to 15 percent of their loan amount. The Green Municipal Fund can fund pilot projects of retrofits that improve energy efficient by at least 30% in municipal facilities or provide the funding for capital projects where renewable thermal energy is used in new or existing facilities, to help the city reduce its greenhouse gas emissions.

The Green Municipal Fund-Reduce fossil fuel use in fleets

Full details are available at:

https://fcm.ca/en/funding/gmf/capital-project-reduce-fossil-fuel-use-fleets

This program is available for capital projects that avoid or reduce the use of fossil fuels in municipally owned vehicles and private vehicles delivering municipal services. Regular loans and grants can fund up to 80% of eligible costs. High-ranking projects loans and grants include a low-interest loan of up to $10 million and a grant worth up to 15% of the loan. This program is available for projects that reduce greenhouse gas emissions by 20% compared to an existing baseline measurement. Funding from this program can help municipalities fully transition to alternative fuel consumption.

iZEV incentives (Transport Canada)

Full details are available at:

https://www.tc.gc.ca/en/services/road/innovative-technologies/zero-emission-vehicles.html

Transport Canada's iZEV program offers incentives for Canadians to choose zero-emission vehicles. The government will provide $300 million over the next three years to Transport Canada for the administration of a new program. Transport Canada offers incentives of up to $5,000 for electric battery or hydrogen fuel cell vehicles with a manufacturer's suggested retail price of less than $55,000. This funding can aid municipalities in greening their corporate fleets.

Electric Vehicle Infrastructure Demonstrations

Full details are available at:

https://www.nrcan.gc.ca/energy/funding/icg/18386

The Electric Vehicle Infrastructure Demonstrations are available for projects that need to investigate and understand the impacts and potential hurdles in the deployment of the next generation of charging infrastructure for electric vehicles.

The Low Carbon Economy Fund

Full details are available at:

https://www.canada.ca/en/environment-climate-change/services/climate-change/low-carbon-economy-fund.html

The Low Carbon Economy Fund supports the Pan-Canadian Framework on Clean Growth and Climate Change by leveraging investments in energy efficiency projects. The fund is designed to support projects that will generate clean growth, reduce greenhouse gas emissions, and align with Canada's Paris Agreement commitments. The fund is made up of two components:

1. Low Carbon Economy Leadership Fund
2. The Low Carbon Economy Challenge

The Low Carbon Economy Leadership Fund provides up to $1.4 billion dollars to provinces and territories that have adopted the Pan-Canadian Framework. This funding is available for projects that will help reduce greenhouse gas emissions. Based on population, both provinces and territories are eligible to receive $30 million plus for projects.

Similarly, the Carbon Economy Challenge can fund up to $500 million dollars for projects across Canada that adopt the Pan-Canadian Framework, reduce greenhouse gas emissions, and generate clean growth.

THE ATMOSPHERIC FUND INCENTIVES

High-Performance Buildings

Full details available at: **http://taf.ca/grants/high-performance-buildings/**

TAF furthers its goal of lowering regional emissions by offering grants. Among other criteria, the High-Performance Building program funds projects that increase the energy efficiency of existing buildings by:

- demonstrating innovative approaches to improving the energy efficiency of new construction;
- striving for near net-zero energy consumption;
- advancing policy and financing approaches to facilitate and scale energy-efficiency retrofits; and
- piloting demonstrations of promising energy efficiency and zero-emissions building technologies and management approaches.

Clean Transportation

Full details available at: **http://taf.ca/grants/clean-transportation/**

The Clean Transportation program supports high-impact solutions to electrification, shared mobility, and public transit investment. The grant is for applicants who go above and beyond and offer solutions that provide co-benefits such as improved affordability and increasing the local job market are seen as more desirable.

Appendix E. List of acronyms

ASHRAE – American Society of Heating, Refrigerating and Air Conditioning Engineers

BAS – Building automation system

BLT – Burlington Leadership Team

CDM – Conservation and Demand Management

CEEMP – Corporate Energy & Emissions Management Plan

CO_2eq – a quantity of a greenhouse gas or collection of greenhouse gases expressed as a carbon dioxide (CO_2) equivalent

ekWh – equivalent kilowatt-hour, a measure of energy. Electrical energy is typically measured in kilowatt-hours (kWh), but other forms of energy are not. ekWh is sometimes used to indicate that some or all of the energy quantity being reported is not electrical.

EnPI – Energy performance indicator

EUI – Energy use intensity, for buildings it is typically measured in energy use per unit of floor area

EV – Electric vehicle

GHG – Greenhouse gas, compounds that contribute to climate change

GJ – gigajoule, a billion joules. A measure of energy.

GWh – gigawatt-hour, a million kilowatt-hours. A measure of energy

HVAC – Heating, ventilation and air conditioning

IESO – Independent Electricity System Operator

KPI – Key performance indicator

LEED – Leadership in Energy and Environmental Design, a widely used green building rating system.

LED – Light emitting diode

NPV – Net present value

PHEV – Plug-in hybrid electric vehicle

RPF – Roads, Parks and Forestry

Appendix F. Facility energy use 2014-2018

The following table shows facility energy use both electricity and natural gas from 2014-2018 in kilowatt-hour equivalents (ekWh). The spark lines on the far right give an indication of trends in individual buildings over the 5 years. Facilities are sorted from the largest to the smallest energy users.

Table 17 Energy use from 2014-2018 based on electricity and natural gas utility data (ekWh)[18]

Facilities	2014	2015	2016	2017	2018
Appleby Ice Centre	8,006,347	8,337,657	8,047,959	7,699,598	7,586,482
Streetlights	9,637,727	9,639,306	9,315,347	9,067,149	6,693,583
Tansley Woods Community Centre	4,610,453	3,717,221	3,491,746	3,466,912	4,038,630
Mainway Recreation Centre	2,491,463	2,363,330	3,112,620	2,884,868	2,931,615
City Hall	2,374,089	2,303,158	2,175,617	2,212,512	2,243,315
Burlington Transit Headquarter	2,492,149	2,276,681	2,323,602	2,348,193	2,169,931
Haber Recreation Centre	1,646,331	1,798,137	1,732,956	1,747,540	2,058,623
Angela Coughlan Pool	2,112,644	1,952,623	1,677,823	1,773,201	1,830,689
Aldershot Pool	1,497,163	1,587,976	1,545,771	1,685,947	1,725,971
Centennial Pool	1,122,049	1,667,934	1,794,202	1,776,690	1,714,320
Roads & Parks Maintenance Headquarter	1,506,435	1,258,759	1,117,355	1,186,092	1,486,042
Nelson Recreation Centre	1,277,058	910,450	817,484	1,217,411	1,433,594
Central Arena	1,907,068	1,539,550	1,275,284	1,317,973	1,395,382
Mountainside Arena	284,416	1,102,882	1,196,124	1,359,375	1,377,266
Burlington Seniors' Centre	1,039,465	952,502	931,850	839,989	885,199
Fire Station 1 Headquarters	830,109	793,143	1,050,984	841,809	883,223
Aldershot Arena	582,368	865,081	714,375	861,164	821,916
Skyway Arena	597,390	532,132	557,865	510,096	515,879
Traffic Lights	448,357	463,579	489,753	501,882	511,224
Mountainside Pool	303,413	432,549	420,665	351,852	483,035
Animal Shelter	458,908	413,870	406,046	428,511	480,820
Brant Hills Community Centre	440,246	417,592	392,038	365,345	383,745
Sherwood Forest Community Centre	382,885	351,290	304,600	344,438	362,916
Fire Station 4	427,916	412,443	338,426	367,555	346,046
Fire Station 7	339,081	272,070	270,190	267,186	269,238
Tyandaga Golf Course - Pro shop/Restaurant	314,484	316,537	295,282	278,021	267,439
Fire Station 8	265,459	297,813	261,485	244,883	250,539
Music Centre	273,233	246,828	264,352	275,033	239,336
Nelson Park BMFA/RPF Building	113,535	169,120	160,031	175,913	237,590
Fire Station 6	331,008	267,043	251,220	235,399	219,492
Parking Garage	278,319	256,512	159,930	182,901	198,789
Fire Station 2	251,224	214,075	200,740	188,607	198,027
Fire Station 3	188,402	193,147	177,556	175,041	172,063
Student Theatre Centre	112,160	106,219	121,760	125,630	128,631

18 All data were obtained from the City of Burlington's AssetPlanner software.

Facilities	2014	2015	2016	2017	2018
Fire Station 5	165,141	146,393	168,305	149,220	121,860
Rotary Youth Centre	126,480	113,790	102,801	107,640	109,493
Drama Centre	125,040	120,916	98,010	84,936	103,840
Norton Community Park	79,825	74,923	74,345	78,171	78,960
Elgin Park Maintenance Building	26,078	62,413	64,277	79,634	70,320
Paletta Lakefront Park-Gatehouse	68,991	63,591	51,155	56,787	63,336
Tyandaga Golf Course-Maintenance Bldg	47,225	65,718	67,461	60,434	63,154
Student Theatre Storage Building	109,827	90,611	86,489	90,548	60,725
Greenwood Park Barn	46,456	42,265	30,698	39,810	55,918
City View Park	24,955	49,801	49,705	53,088	55,447
Millcroft Park Maintenance Building	56,989	55,556	50,075	57,723	55,181
Greenwood Cemetery Office and Maintenance Building	47,376	39,674	38,137	40,110	54,185
Ireland Park Concession	53,719	58,485	58,915	47,767	51,748
Ireland Park Maintenance Building	55,838	51,265	53,357	49,976	50,322
Burlington Transit Bus Terminal	56,124	50,078	47,099	50,174	48,455
Millcroft Park	55,541	51,782	49,897	40,221	47,999
Traffic Supervisors Office	37,925	35,447	34,691	40,013	47,128
Brant Street Pier	44,359	56,451	56,133	50,258	44,829
Central Park Maintenance Building	50,356	46,536	39,369	43,412	43,191
Spencer Smith Park East 1	53,279	51,657	43,617	39,681	42,021
Beachway Pavilion Snack Shack	43,223	46,817	53,222	44,993	41,067
Street Lights?	46,713	45,727	46,201	47,176	40,502
Beachway Park & Pumphouse	37,104	29,992	38,903	35,983	39,187
Orchard Park	37,714	31,756	35,174	37,928	38,262
Pumphouse 1	43,223	36,120	35,696	43,334	38,042
Ella Foote Hall	47,773	44,889	41,562	41,000	32,713
Central Park Parking Lots	29,104	29,763	30,758	27,506	28,955
Tansley Woods Park Maintenance & Washrooms Building	24,705	15,694	23,807	22,390	26,775
Lowville Park Pavilion	30,003	28,426	25,776	28,306	26,147
Sherwood Forest Park Maintenance & Washrooms Buildin	9,337	23,819	18,090	25,162	26,104
72 Misc Billing	25,800	25,800	25,800	25,800	25,800
Brant Street Lighting	18,275	17,739	18,711	20,013	25,549
Nelson Park West Baseball Diamond	28,184	28,848	25,543	26,760	25,269
Orchard Park Maintenance Building	26,995	22,079	24,522	20,178	23,852
Hidden Valley Park Maintenance Building	27,153	25,546	27,154	24,752	23,202

Facilities	2014	2015	2016	2017	2018
Roads, Parks and Forestry Northeast Compound	**58,217**	**48,752**	**49,879**	**47,298**	**22,786**
City View Park Maintenance Building		14,951	21,129	19,339	19,888
Nelson Park Washroom Building	**16,364**	**27**	**21**	**1,323**	**18,760**
Maria Street and Brant Street Lighting	20,045	20,592	20,408	20,387	18,241
Lakeshore Rd Streetlights	**17,795**	**19,085**	**19,017**	**18,544**	**17,590**
Lowville Park Old School Building	16,935	16,893	13,863	21,474	16,263
Nelson Park Braves Building	**52,063**	**59,244**	**67,517**	**29,100**	**15,294**
Doug Wright Park	10,659	12,579	12,957	13,759	14,642
Roads, Parks and Forestry West Storage	**25,430**	**28,925**	**27,790**	**25,089**	**13,612**
Nelson Park East Baseball Diamond	11,483	10,196	9,724	12,546	13,555
Sherwood Forest Park West	**12,373**	**10,969**	**11,449**	**10,630**	**12,817**
Hidden Valley Park Washroom Building	6,822	15,023	18,619	15,678	12,339
Nelson Park Baseball Building	**16,902**	**17,475**	**14,225**	**13,036**	**12,330**
LaSalle Outdoor Pool	8,916	10,574	10,872	10,045	10,544
Central Park Washroom Building	**12,407**	**11,261**	**8,640**	**11,145**	**10,512**
Maple Park 2	5,484	7,673	9,859	5,153	8,771
Ireland Park	**11,273**	**9,162**	**4,202**	**9,695**	**6,518**
Palmer Park	5,801	9,326	11,513	10,000	5,440
Greenwood Park	**4,299**	**4,340**	**5,175**	**6,056**	**5,135**
Roads, Parks and Forestry East Storage	7,171	8,876	2,927	3,967	5,039
Spencer Smith Park North	**4,290**	**3,601**	**3,706**	**5,289**	**4,732**
Sioux Lookout	2,188	2,224	2,270	2,064	2,139
6 Misc Billing	**2,489**	**1,746**	**3,233**	**2,489**	**1,746**
Lowville Park Baseball Diamond	1,780	1,604	1,270	611	1,096
Kerns Park	**1,127**	**1,274**	**1,206**	**1,025**	**938**
Roads, Parks and Forestry Salt Domes	10,924	20,214	9,995	10,208	897
Maplehurst Park	**484**	**485**	**488**	**489**	**436**
Roly Bird Park	123	124	122	121	113
Bolus Community Parkette					**51**
Bridgeview Park	153	319	1	-	8
Emerson Park	**4**	**44**	**6**	**4**	**3**
Berton Park	2	2	-	0	1
Newport Park	-	**1**	-	-	-
Grand Total	**51,094,185**	**50,577,138**	**49,490,572**	**49,362,167**	**48,542,364**

Appendix G. Energy density and conversion factors, and greenhouse gas emission factors

This section includes constants used in the analysis throughout the plan.

Energy density of fuels

Energy source	To convert	to	multiply by	Reference
Natural gas	m^3	ekWh	10.84	
Natural gas	m^3	MJ	39.03	A
Diesel	L	ekWh	10.65	
Diesel	L	MJ	38.35	B
Gasoline	L	ekWh	9.29	
Gasoline	L	MJ	33.45	B
Any energy source	kWh	MJ	3.6	
Any energy source	MJ	ekWh	0.27777778	

Global Warming Potential

GHG	CO_2	CH_4	N_2O	Reference
GWP	1	25	298	C

Note: 100-year GWPs

Emissions of Ontario fuels

Fuel	CO_2	CH_4	N_2O	CO_2eq	Reference
Natural gas	1,888	0.037	0.035	1,899	D
Diesel	2,681	0.133	0.4	2,804	D
Motor gasoline	2,307	0.1	0.02	2,315	D

Note: Natural gas is marketable gas in Ontario
CO_2eq is the sum-product of the emission factor of each contaminant and the global warming potential

GHG intensity of Ontario electricity

Year	Intensity	Units	Reference
2012	110	g CO2eq/kWh	E
2013	80	g CO2eq/kWh	E
2014	40	g CO2eq/kWh	E
2015	40	g CO2eq/kWh	E
2016	40	g CO2eq/kWh	E
2017	20	g CO2eq/kWh	E

SOURCES:
A (Statistics Canada, 2018), p.130
B (Environment and Climate Change Canada, 2019), Part 2, p.204
C (Environment and Climate Change Canada, 2019), Part 1, p.18
D (Environment and Climate Change Canada, 2019), Part 2, pp.220-222
E (Environment and Climate Change Canada, 2019), Part 3, p.65

Appendix H. Conservation demand management plan checklist

The checklist below can be used to ensure that all of the required elements have been included in the CDM plan.

- ☐ The Energy use and Greenhouse Gas Emissions Template that is required to be submitted and published on or before July 1 of that year. For the first plan this will be the 2019 template
- ☐ A description of current and proposed measures for conserving and otherwise reducing energy use and managing demand for energy
- ☐ A revised forecast of the expected results of the current and proposed measures
- ☐ A report of the actual results achieved
- ☐ A description of any proposed changes to be made to assist the public agency in reaching any targets it has established or forecasts it has made
- ☐ Cost and saving estimates for its proposed measures
- ☐ The estimated length of time the public agency's energy conservation and demand management measures will be in place
- ☐ A description of any renewable energy generation facility operated by the public agency and the amount of energy produced on an annual basis by the facility
- ☐ A description of:
    - ☐ The ground source energy harnessed, if any, by ground source heat pump technology operated by the public agency
    - ☐ The solar energy harnessed, if any, by thermal air technology or thermal water technology operated by the public agency

- The proposed plan, if any, to operate heat pump technology, thermal air technology or thermal water technology in the future

- Confirmation that the energy conservation and demand management plan has been approved by the public agency's senior management

- The CDM plan has been made publicly available by:

  - Publishing it on the public agency's website (if there is one)
  - Publishing it on the public agency's intranet site (if there is one)
  - Making it available to the public in printed form at the head office

SOURCE: (IndEco Strategic Consulting Inc., 2013)

providing environmental and energy consulting
to private, public and non-governmental organizations

IndEco Strategic Consulting Inc

180 John Street, Toronto ON M5V 1X5

1 888 INDECO1 416 204 0359 ***info@indeco.com*** ***www.indeco.com***