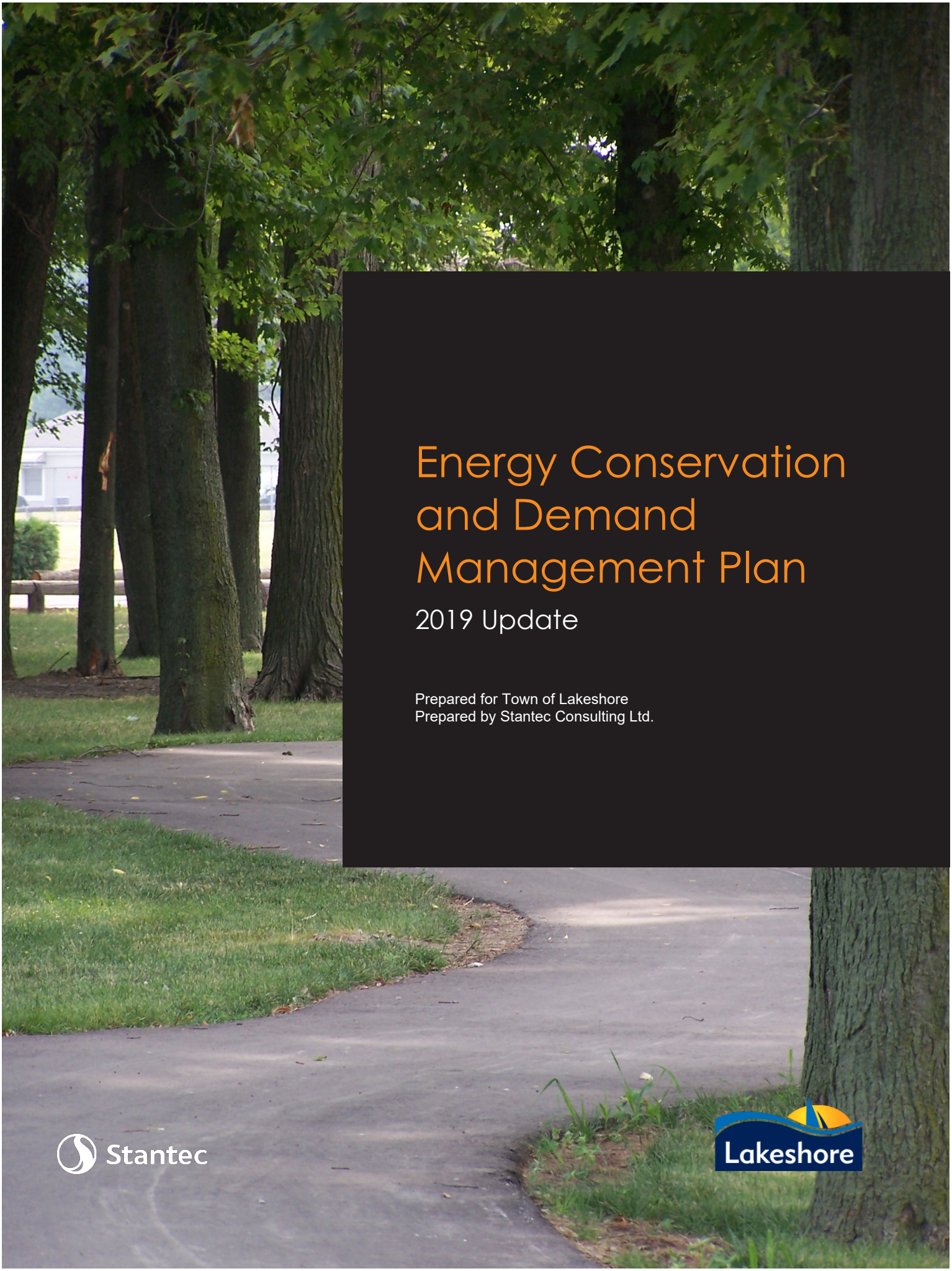

Energy Conservation and Demand Management Plan

2019 Update

Prepared for Town of Lakeshore
Prepared by Stantec Consulting Ltd.

Stantec

Lakeshore

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Abbreviations

Abbreviation	Full Name
AHU	Air Handling Unit
ATC	Atlas Tube Centre
BAS	Building Automation System
BAU	Business as Usual
BCA	Building Condition Assessment
CAFE	Corporate Average Fuel Economy
CO_2e	Carbon Dioxide Equivalent
ECDM	Energy Conservation and Demand Management
ECM	Energy Conservation Measure
EV	Electric Vehicle
FCM	Federation of Canadian Municipalities
GHG	Greenhouse Gas
HDV	Heavy Duty Vehicle
HVAC	Heating, Ventilation and Air Conditioning
kWh	Kilowatt Hour
LCA	Life Cycle Analysis
LDT	Light Duty Truck
LDV	Light Duty Vehicle
LED	Light Emitting Diode
NRCAN	Natural Resources Canada
OCP	Official Community Plan
PV	Photovoltaic
PS	Pumping Station
ORE	Off-Road Equipment
WPCP	Water Pollution Control Plant
WTP	Water Treatment Plant

Executive Summary

The following report presents the Energy Conservation and Demand Management Plan (ECDM Plan) for the corporate operations of the Town of Lakeshore (the Town). The objective of the ECDM Plan is to reduce energy consumption and minimize costs through prudent use and management of energy. The ECDM Plan also meets the requirements of the *Ontario Regulation 507/18 Broader Public Sector: Energy Reporting and Conservation and Demand Management Plans* (O. Reg. 507/18, formerly O. Reg. 397/11).

The ECDM Plan was based on corporate energy and greenhouse gas (GHG) emissions available for the most current year, 2018, and trends since the development of the Town's first ECDM Plan in 2014. In 2018, the Town's corporate energy consumption was 82,835 GJ, or an average of 2.23 GJ per community resident. Since 2011, absolute energy consumption has increased 40% due to the addition of new corporate assets such as the Atlas Tube Centre (ATC) in 2015. In terms of GHG emissions, the Town's 2018 emissions amounted to 2,256 tonnes of carbon dioxide equivalent (tCO_2e), or 61 kilograms CO_2e per person in the community. This is a decline in GHG emissions of almost 7% when compared to 2011 levels largely attributed to the Ontario government greening the electrical grid.

The Town's business as usual (BAU) energy consumption and GHG emissions are forecasted to be approximately 19% and 2.7% higher in 2050 than the 2018 reporting year if no energy conservation and reduction actions are undertaken. However, taking into account the implementation of the initiatives identified in this ECDM Plan, the Town's energy consumption and GHG emissions in 2050 could be as low as 76,000 GJ and 1,500 tCO_2e – a reduction of more than 8% and 30%, respectively, when compared to 2018 levels. In terms of cost avoidance, the reduction in energy and GHG emissions could account for an estimated annual energy savings of over $700,000 between 2020 and 2050.

The identification of initiatives for incorporation into this ECDM Plan was done through a combination of staff engagement, formerly completed location-based site visits, detailed energy assessments of the Atlas Tube Centre and Libro Community Centre, a best-in-class review of other municipalities and input from internal and external subject matter experts.

Adoption of the ECDM Plan does not pre-commit Council or the Town to the initiatives proposed, as summarized in Table E-1. All initiatives will come to Council as either part of annual budget deliberations or as a specific request.

This ECDM Plan was approved by Town of Lakeshore Council on January 14, 2020.

Table E.1 2019 ECDM Plan Initiatives

#	Initiative	Energy Reduction Potential	GHG Reduction Potential	Estimated Cost	Timing	Responsibility	Indicators
Buildings & Facilities							
B1	Develop a Low Carbon Building Policy	Supportive Initiative	Supportive Initiative	• Staff Time	2021	• Facility Services	• Policy and technical standards are completed and approved
B2	Opportunistically Implement Energy Audit Recommendations	19%	8%	• $880,000	Starting in 2020 ongoing as opportunity / funding arises	• Facility Services	Reduction of: • Building Energy Intensity (GJ/m^2) • Building GHG Emissions Intensity (tCO_2e/m^2) • Building Energy Cost Intensity ($/m^2$)
	B2a: Atlas Tube Centre	8%	7%	• $350,000		• Manager of Recreation	
	B2b: Libro Community Centre	1%	1%	• $40,000		• Facility Services	
	B2c: Other Facilities	10%	<1%	• $500,000		• Facility Services	
B3	Plan for Deep Energy Retrofits	40-60%	40-60%	• $3-25/ft^2	2030	• Building Services	• Deep energy retrofit activities are planned for implementation in capital asset management planning systems
B4	Implement a Building Re/Ongoing-Commissioning Program	5-12%	5-12%	• Staff Time	2023	• Manager of Recreation • Manager of Environmental Services • Manager of Public Works	Reduction of: • Building Energy Intensity (GJ/m^2) • Building GHG Emissions Intensity (tCO_2e/m^2) • Building Energy Cost Intensity ($/m^2$)

#	Initiative	Energy Reduction Potential	GHG Reduction Potential	Estimated Cost	Timing	Responsibility	Indicators
B5	Implement an Energy Performance Monitoring Program	Supportive Initiative	Supportive Initiative	• Staff Time	2022 and on-going	• Facility Services	• Monitoring program is in place • All building operators have access to the monitoring system • Building Energy Intensity (GJ/m^2) • Building GHG Emissions Intensity (tCO_2e/m^2) • Building Energy Cost Intensity ($\$/m^2$)
B6	Building Energy Management Training	Supportive Initiative	Supportive Initiative	• Staff Time & Program Cost	2021	• Facility Services	• Training needs identified • Training occurs
B7	Investigate Renewable Energy Sources for Stationary Assets	Supportive Initiative	Supportive Initiative	• Staff Time	Ongoing	• Building Services	• Renewable energy opportunities are identified and assessed • KWh_{ac} produced • % of energy demand from renewable energy

#	Initiative	Energy Reduction Potential	GHG Reduction Potential	Estimated Cost	Timing	Responsibility	Indicators
Fleet & Equipment							
F1	Develop a Low Carbon Fleet Management Policy	Supportive Initiative	Supportive Initiative	• Staff Time	2022	• Public Works	• Policy is completed and approved
F2	Develop an Electric Vehicle and Infrastructure Strategy	5-10%	50-60%	• Assume extra $3,000 per LDV until cost parity is achieved in 2025. LDT premiums will likely range from $8k to $15k for an indeterminable period of time. • Fleet utilization study, including a sample telematics pilot, can range from $75,000 and up. • EV Study: $40,000 - $50,000 • Capacity Assessment: $3,000 - $4,000 per facility	2022 for study	• Facility Services • Public Works	• Unit fuel/km • Total L of fuel types used • # of vehicles with greater fuel efficiency, hybrid, EV etc.
F3	Implement Driver Awareness and Training Programs	<1% per year	<1% per year	• Staff Time	Ongoing	• Public Works • Human Resources	• Number of drivers trained • Unit fuel/km • Total L of fuel types used
F4	Pilot New Technologies	1-25%	1-25%	• Staff Time • Cost for new vehicles	Ongoing	• Public Works	• Number of vehicles with greater fuel efficiency, hybrid, EV etc.

#	Initiative	Energy Reduction Potential	GHG Reduction Potential	Estimated Cost	Timing	Responsibility	Indicators
F5	Expand the Availability of Active and Sustainable Transportation Options for Staff	Up to 5%	Up to 5%	• Staff Time • Program costs will range depending on needs and use	Ongoing	• Human Resources • Public Works	• Number of active transportation programs available to staff • Utilization rate of active transportation programs
F6	Expand New Fleet Supervisor Role to Include Fleet Management	Supportive Initiative	Supportive Initiative	• Staff Time	2020	• Human Resources • Public Works	• Staff member in charge of fleet management
Corporate							
C1	Incorporate Life Cycle Considerations Into Capital Planning and Purchases	Supportive Initiative	Supportive Initiative	• Staff Time	Ongoing	• Engineering & Infrastructure Services • Community & Development Services • Legislative & Legal Services	• Policy is completed and approved
C2	Expand Energy Savings Policy	Supportive Initiative	Supportive Initiative	• Staff Time	2021	• Engineering & Infrastructure Services • Community & Development Services	• Policy is completed and approved

1.0 ECDM PLAN OVERVIEW

1.1 ABOUT THE TOWN OF LAKESHORE

Situated on Lake St. Clair, the Town of Lakeshore (the Town) is located within Essex County and occupies an area of 530 square kilometers. With a population of 36,611 in 2016, the Town is expected to grow 11% by 2030 and, if trends continue, approximately 28% by 2050.

The Town owns and operates over $1.05 billion of assets in the form of buildings, fleet vehicles, and wastewater facilities as well as supporting infrastructure. The operation of these corporate assets collectively contributes to greenhouse gas (GHG) emissions in the Town and provides opportunities for energy conservation and GHG emissions reductions. By developing and implementing an Energy Conservation and Demand Management Plan (ECDM Plan), the Town is demonstrating its commitment to a balanced and sustainable approach to energy usage and management, while maintaining a high level of services for Town residents, businesses, and visitors.

As it relates to strategic actions and meeting the Town's vision of being a progressive town of healthy, integrated communities, the Town's recent Strategic Plan establishes the direction and key priorities of the municipality for the 2019—2022 term that is directly tied to the energy performance of the Town which includes the following thematic goals[1]:

1. The Town of Lakeshore supports and encourages complete community development that balances economic, social, and environmental considerations.

2. The Town of Lakeshore is committed to investing in roads and infrastructure, supported by an asset management plan, to keep people moving and the municipality running.

3. The Town of Lakeshore will respect the ecological integrity of Lake St. Clair and our riparian environments. As temperatures, rain patterns, and water levels continue to fluctuate, Lakeshore will invest in the long-term resiliency of our communities.

4. The Town of Lakeshore is a fiscally responsible corporation that respects the tax dollars of our citizens. The Town supports the development of savings through reserves to reduce long term reliance on debt.

5. The Corporation of the Town of Lakeshore is a dynamic organization and employer of choice that encourages continuous improvement, innovation, and accountability from our employees.

[1] Town of Lakeshore, 2019. *Lakeshore's Strategic Plan 2019-2022*, www.lakeshore.ca/en/municipal-services/resources/Documents/StrategicPlanWeb.pdf, accessed on October, 2019.

This ECDM Plan will support the Town in its goals to invest in infrastructure, to maintain financial prudence, and to invest in continuous improvement and innovation while balancing economic, social and environmental considerations.

1.2 ONTARIO REGULATION 507/18

The *Ontario Regulation 507/18 Broader Public Sector: Energy Reporting and Conservation and Demand Management Plans* (O. Reg. 507/18, formerly O. Reg. 397/11[2]) under the *Electricity Act* currently requires local governments to report on energy and GHG emissions annually from owned and operated buildings and to produce Energy Conservation and Demand Management Plans (ECDM Plans) which are to be updated every five years. Local governments are also required to submit these annual reports to the Ministry of Energy, Northern Development and Mines (the Ministry) as well as publish online and make available to the public the annual reports and the current ECDM Plan.

The Town prepared its first ECDM Plan in 2014, fulfilling the regulatory requirements. To meet the requirements of a five-year update in 2019, this report is considered to be the current version of the ECDM Plan, and has been updated as required by O. Reg. 507/18 to include all the requirements of the original ECDM Plan, as well as:

- A description of current and proposed measures for conserving and otherwise reducing energy consumption and managing its demand for energy.
- A revised forecast of the expected results of the current and proposed measures.
- A report of the actual results achieved.

[2] Government of Ontario. *Ontario Regulation 507/18 Broader Public Sector: Energy Reporting and Conservation and Demand Management Plans*, www.ontario.ca/laws/regulation/180507, accessed on October, 2019.

- 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.

The preparation of the ECDM Plan provided the Town the opportunity to re-evaluate the status of corporate energy consumption and understand how energy use has changed compared to the baseline. A short-term and long-term business-as-usual forecast was also considered, with and without planned energy reduction initiatives, in order to compare to progress and the impacts of the proposed initiatives. The implementation of the ECDM Plan can help ensure that energy conservation and efficiency is a key consideration in the Town's growth and renewal actions. The gradual implementation of progressively sophisticated conservation measures will reduce corporate energy and associated costs for facilities while reducing GHG emissions.

1.3 SCOPE OF THE ECDM PLAN

The Town's ECDM Plan is a corporate-wide plan that focuses exclusively on GHG emissions that are directly controlled by the Town and does not address community GHG emissions or emissions that are outside the geographic boundary of the Town. Although municipal operations form a small subset of overall community GHG emissions, initiatives and assets under local government control may have an indirect impact on community GHG emissions. The assets which the Town has direct control over which are included in this ECDM Plan are summarized in Table 1, and do not include GHG emissions from third-party contractors, construction activities, or business (air and ground) travel. The ECDM Plan covers a horizon from 2020 to 2050.

Table 1. List of Town Assets Included in ECDM Plan

Buildings & Facilities	Fleet & Equipment	Water, Wastewater & Solid Waste Facilities	Streetlights & Traffic Signals
• Administrative buildings • Indoor recreational facilities • Sports arena • Fire stations • Police station • Community centres • Public library • Storage facilities	• Light duty vehicles • Medium duty vehicles • Heavy duty vehicles • Off road vehicles • Other equipment	• Wastewater treatment plants • Wastewater pumping stations • Water pumping stations	• Streetlights • Traffic signals

1.4 METHODS

The ECDM Plan was based on corporate energy data available for the most current year, 2018, and trends since 2011 as well as anticipated growth to 2050. The identification of initiatives for incorporation into the ECDM Plan was done through a combination of staff engagement, formerly completed location-based site visits, detailed energy assessments of the Atlas Tube Centre and Libro Community Centre, a best-in-class review of other municipalities and input from internal and external subject matter experts.

Three workshops with Town staff facilitated sharing of best practices and identification of key plan components, initiatives, and enabling factors. These were completed between May and October 2019. A review of energy conservation and GHG policies, programs, and initiatives from peer cities and municipalities was also conducted and included an assessment of the following cities and municipalities:

- Canada: City of Vancouver, City of North Vancouver, West Vancouver, City of Burlington, City of Toronto, City of Edmonton, City of Calgary, Region of York, City of Waterloo, City of Windsor
- United States: New York City, City of Seattle, City of San Francisco
- Europe: London, United Kingdom
- New Zealand: City of Auckland

Topics which were covered during the reviews included:

- Actions for energy conservation and GHG emissions
- GHG reduction targets and performance against targets
- Financing approaches
- Barriers and challenges
- Recommendations

Town staff reviewed the draft ECDM Plan prior to its finalization.

2.0 2018 CORPORATE ENERGY & GHG EMISSIONS

Cities are centres of communication, commerce, and culture. They are also a significant and growing source of energy consumption and GHG emissions. Cities and regional centres have the opportunity to affect considerable change on GHG emissions levels on a global scale as they are responsible for more than 70% of global energy related GHG emissions [3].

2.1 CURRENT ENERGY & GHG EMISSIONS

In 2018, the Town's corporate energy consumption was 82,835 GJ or an average of 2.23 GJ per community resident. In terms of GHG emissions, this amounted to 2,256 tonnes of carbon dioxide equivalent (tCO_2e), or 61 kilograms CO_2e per person in the community. This energy consumption and associated release of GHG emissions were the direct result of the provision of key services by the Town, which are organized into the following sectors:

- **Buildings & Facilities**: The Town's buildings and facilities consume electricity and natural gas to heat, cool, ventilate, and illuminate administrative, police, and fire buildings, park facilities, and community and recreation centres.
- **Fleet & Equipment**: The Town's fleet vehicles includes light, medium and heavy-duty vehicles for corporate use. The majority of vehicles consume gasoline and diesel.
- **Water & Wastewater Facilities**: To manage and treat water and wastewater, the Town operates and manages water, and wastewater infrastructure which consume energy and release GHG emissions.
- **Streetlights & Traffic Signals**: The Town operates over 2,700 light-emitting diode (LED) lamp streetlights and traffic signals. These assets are powered by electricity.

Table 2 below presents the breakdown of the 2018 energy and GHG emissions by sector.

Table 2. 2018 Corporate Energy and GHG Emissions by Sector

Sector	Energy (GJ)		GHG Emissions (tCO_2e)	
Buildings & Facilities	45,589	55.0%	1,318	58.4%
Fleet & Equipment	8,675	10.5%	604	26.8%
Water & Wastewater Facilities	25,875	31.2%	320	14.2%
Streetlights & Traffic Signals	2,695	3.3%	15	0.7%
Total	**82,835**	**100.0%**	**2,256**	**100.0%**

[3] Environmental Commissioner of Ontario, *Climate Action in Ontario – What's Next (2018)*, https://docs.assets.eco.on.ca/reports/climate-change/2018/Climate-Action-in-Ontario.pdf, accessed August 2019.

Although buildings and waste facilities account for nearly 73% of the Towns energy usage, their GHG emissions are much smaller than expected as more than 95% of Ontario's electricity generation is from low-GHG emitting sources (nuclear, hydro, wind and solar) [4]. This disparity can also be seen in Table 3 which shows that electricity is the highest source of consumed energy at the Town, but a low source of GHG emissions.

Table 3. 2018 Corporate Energy and GHG Emissions by Fuel Type

Fuel Type	Energy (GJ)		GHG Emissions (tCO_2e)	
Electricity	46,847	56.6%	260	11.5%
Natural Gas	27,185	32.8%	1,384	61.4%
Gasoline	3,699	4.5%	249	11.1%
Diesel	4,976	6.0%	354	15.7%
Propane	129	0.2%	8	0.3%
Total	**82,835**	**100.0%**	**2,256**	**100.0%**

A breakdown of GHG emissions is provided in Figure 1 while a breakdown by energy use in each sector is presented in Figure 2.

[4] IESO, *2018 Electricity Data*, www.ieso.ca/en/Corporate-IESO/Media/Year-End-Data, accessed August 2019.

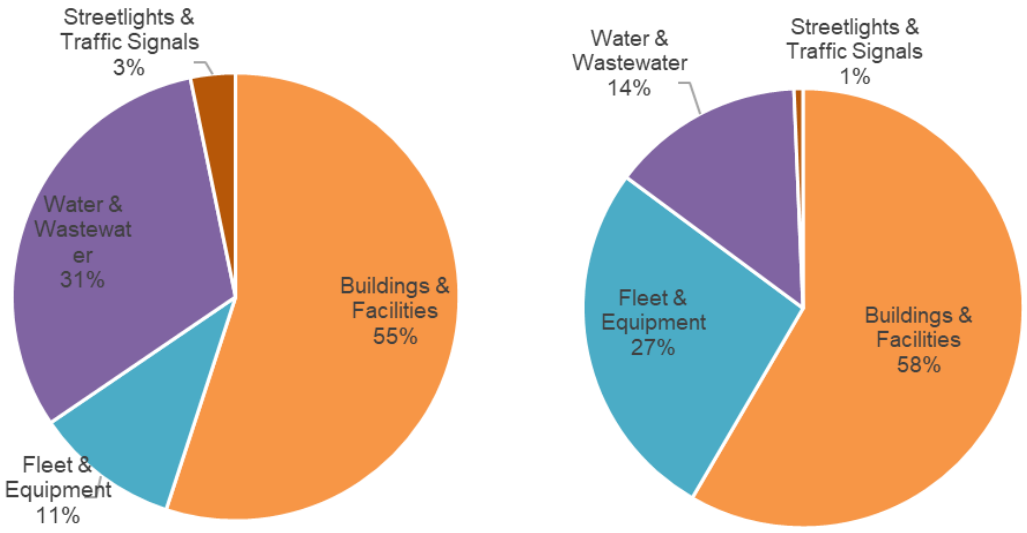

Figure 1. Energy (GJ) (Left) & GHG Emissions (tCO2e) (Right) by Sector

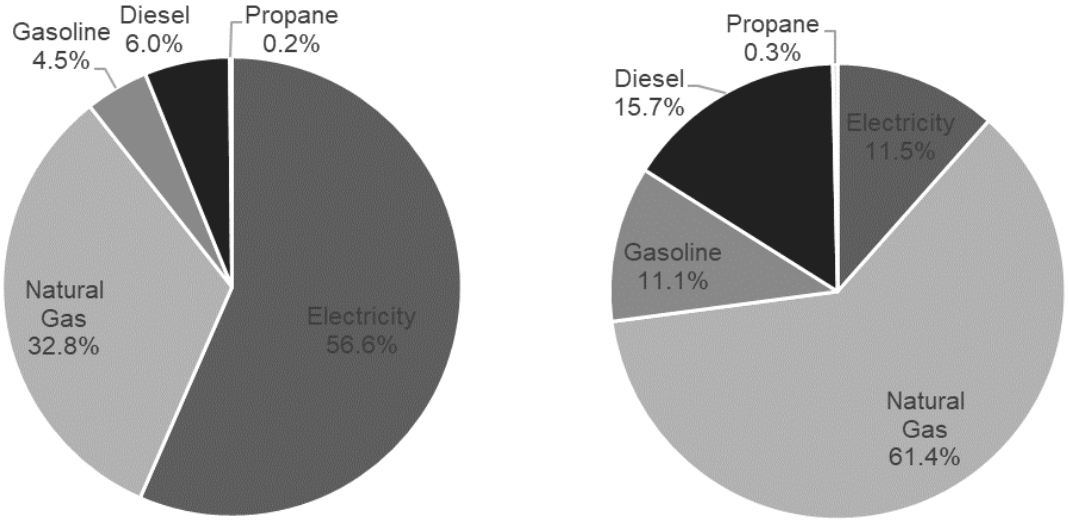

Figure 2. Energy (GJ) (Left) & GHG Emissions (tCO_2e) (Right) by Fuel Type

2.2 HISTORICAL TRENDS

The Town first began tracking energy consumption and GHG emissions in 2011. Since 2011, absolute energy consumption has increased 40% due to the addition of new corporate assets like the ATC in 2015 (Figure 3). In terms of GHG emissions, although the energy consumption has increased, the overall emissions have decreased on an absolute and per capita in the community basis. Figure 4 demonstrates a decline in GHG emissions of almost 7% when compared to 2011 levels largely due to the Ontario government greening the electrical grid.

As with any growing Town, the increase in population is often the largest driver of energy and GHG emissions growth due to the increased demand for local services and infrastructure systems. However, a more dramatic rise in energy and GHG emissions was mitigated as a result of the implementation of energy efficiency and reduction actions by the Town since 2011.

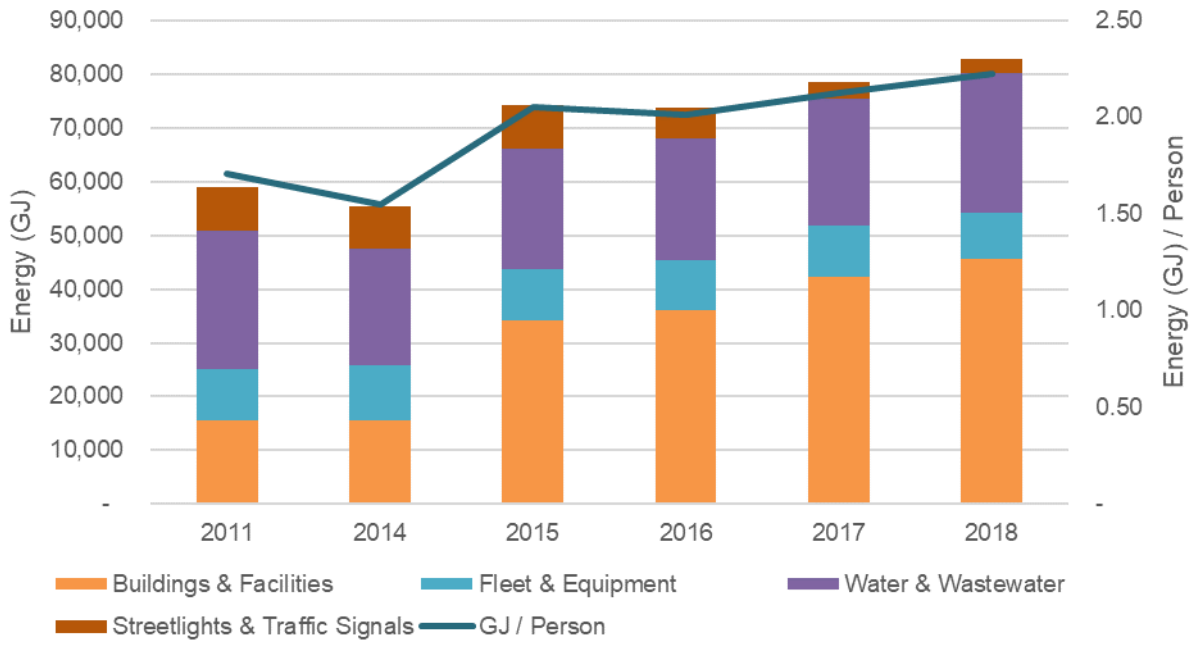

Figure 3. Annual Absolute and Per Capita Energy Consumption

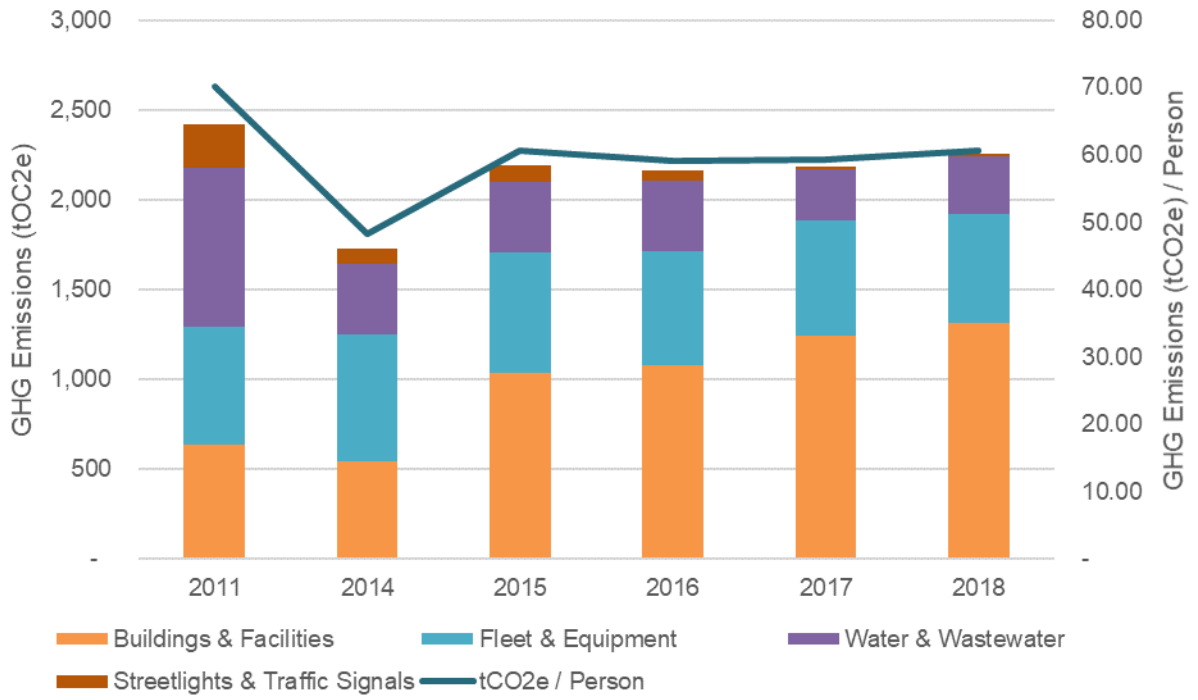

Figure 4. Annual Absolute and Per Capita GHG Emissions

2.3 PAST INITIATIVES

The Town's 2014 ECDM Plan was developed based on input provided by Town staff. The 2014 ECDM Plan identified several initiatives for the Town, most of which have been implemented. Table 4 presents a summary of these program initiatives and their implementation status.

Table 4. Status of 2014 ECDM Plan Initiatives

I.D. #	Opportunity	Description	Status
1	Overall	The Energy Management Committee will seek to maximize the savings available through education, policies, standards, procedures, behavior modifications, and other low-cost solutions before recommending solutions requiring higher capital investment.	In-progress, continuous initiative
2	Renewable Energy	The Town will consider additional renewable energy generation at other municipal facilities where possible.	In progress, continuous initiative

I.D. #	Opportunity	Description	Status
3	Staffing Requirements and Duties	Incorporate energy conservation and efficiency into standard operating procedures and the knowledge requirements for management level positions with a direct responsibility for facility energy consumption.	In progress, continuous initiative
4	Energy Efficiency	Incorporate life cycle cost analysis into the design procedures for all capital projects.	Complete
5	Retrofits	The intention of the ECDM plan is to dovetail energy conservation and demand management as part of Lakeshore's normal course of business for all facility and operational retrofits, including capital renewal and life cycle replacement projects.	In progress, continuous initiative
6	Energy Leadership	Establishment of the Energy Management Committee	Completed
7	Energy Training	Seek to include energy training concepts for relevant staff, where appropriate.	In progress, continuous initiative
8	Procurement Planning	In addition to costs, consideration should be given to available energy services, energy quality and reliability, and supplier performance. The Town of Lakeshore will consider energy efficient criteria when evaluating, comparing, selecting, or purchasing materials and equipment.	In progress, continuous initiative
9	Communication	Consider developing a communication strategy that creates and sustains awareness of energy efficiency.	In progress, continuous initiative
10	Asset Level	Evaluate the potential energy saving opportunities within each facility and will prioritize the efforts to be undertaken based on the expected energy and cost savings, the payback for the individual measure to be employed, and the availability of Town resources to affect the improvement.	In progress, continuous initiative
11	Monitoring	Measurements of effectiveness will be undertaken annually, through the existing requirement for the Town to publish annual updates on the energy consumption and GHG emissions reported for the 2011 baseline year.	Completed annually

2.4 ENERGY & GHG EMISSIONS FORECAST TO 2050

A model of business as usual (BAU) energy and GHG emissions was developed to estimate future energy consumption, associated costs, and GHG emissions through to 2050 to examine the possible magnitude of the reduction opportunities available to the Town (Figure 6). To develop the BAU forecast, the Town's 2018 energy use was grown proportionally to higher service demand levels as a result of an increasing population and planned structural changes, such as the expansion of the Denis St Pierre Water Pollution Control Plant (WPCP) and the construction of a new Town Hall, as well as planned energy and GHG reduction initiatives set by the Provincial and the Federal Governments (e.g. vehicle fuel-economy standards).

The Town's BAU energy consumption and GHG emissions are forecasted to be approximately 19% and 2.7% higher respectively than in 2018 if no energy conservation and reduction actions are undertaken (Figure 5 and Figure 6).

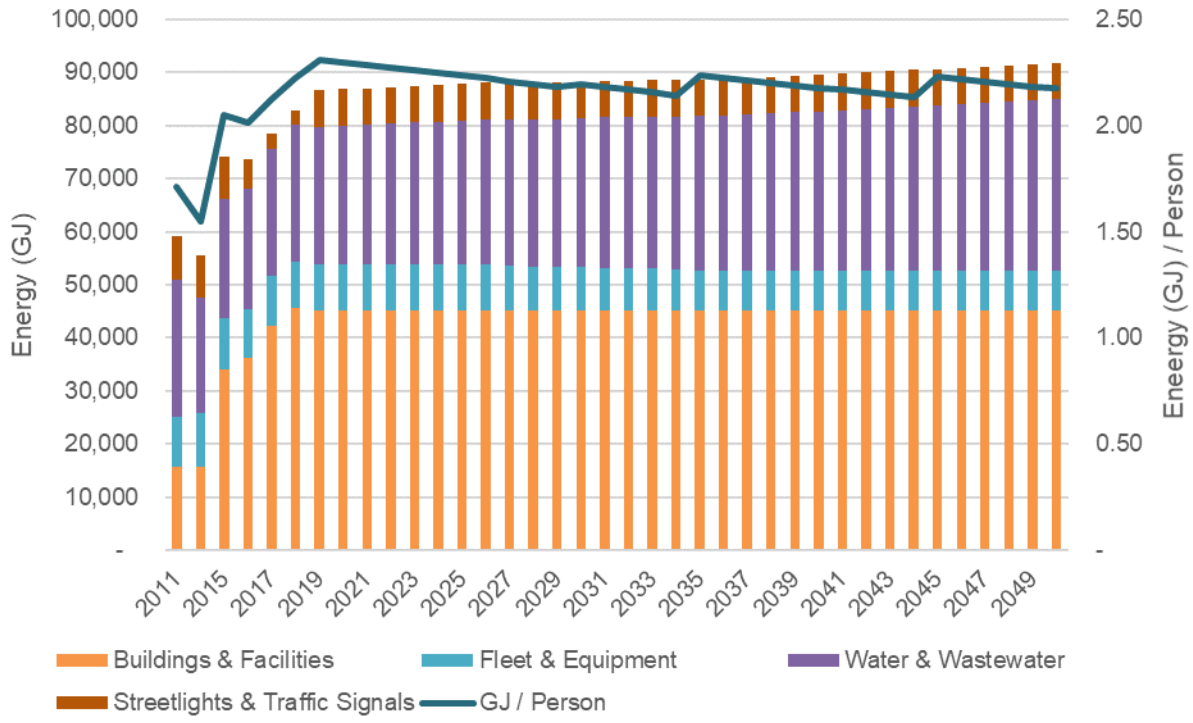

Figure 5. Forecasted Energy Consumption by Fuel Type Under a BAU Scenario

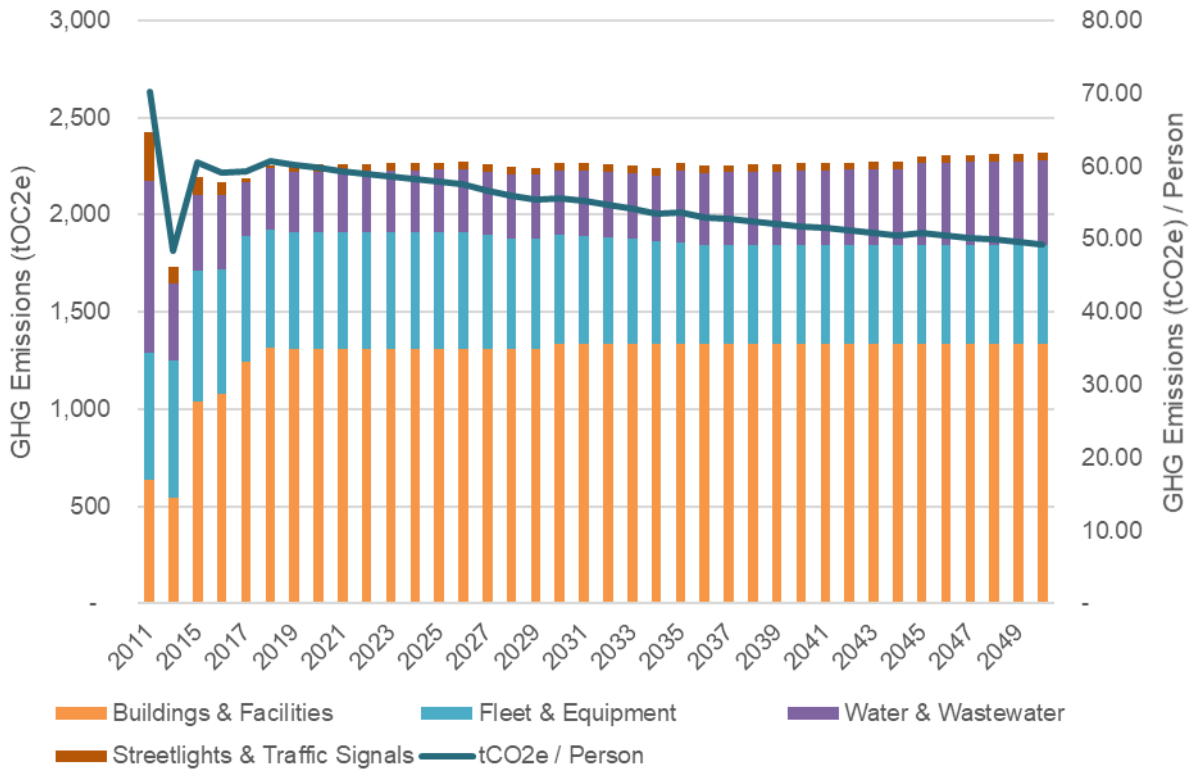

Figure 6. Forecasted GHG Emissions Under a BAU Scenario

The overall objective of the ECDM Plan is to reduce total energy consumption through the prudent and efficient use of energy and resources while continuing to maintain an efficient and effective level of service to residents, businesses, and visitors. On this basis, the ECDM Plan has established the following goals:

- To establish key policies that will support and maintain the reduction of energy and reduce GHG emissions as a result of municipal operations.
- To create a culture of sustainability and conservation within the Corporation.
- To implement renewable energy opportunities where feasible.
- To demonstrate sound operating and maintenance practices that complement the energy efficiencies implemented through the ECDM.
- To make available program and resources for all staff so that they can contribute to energy conservation and a reduction in GHG emissions both at work and at home.

The achievement of these objectives and the implementation of the currently proposed initiatives are estimated to reduce the Town's energy consumption and GHG emissions to 76,000 GJ and 1,500 tCO_2e by 2050 – a reduction of more than 8% and 30%, respectively, when compared to 2018 levels (Figure 7 and Figure 8). In terms of cost avoidance, the reduction in energy and GHG emissions could account for an estimated average annual savings of over $700,000 between 2020 and 2050.

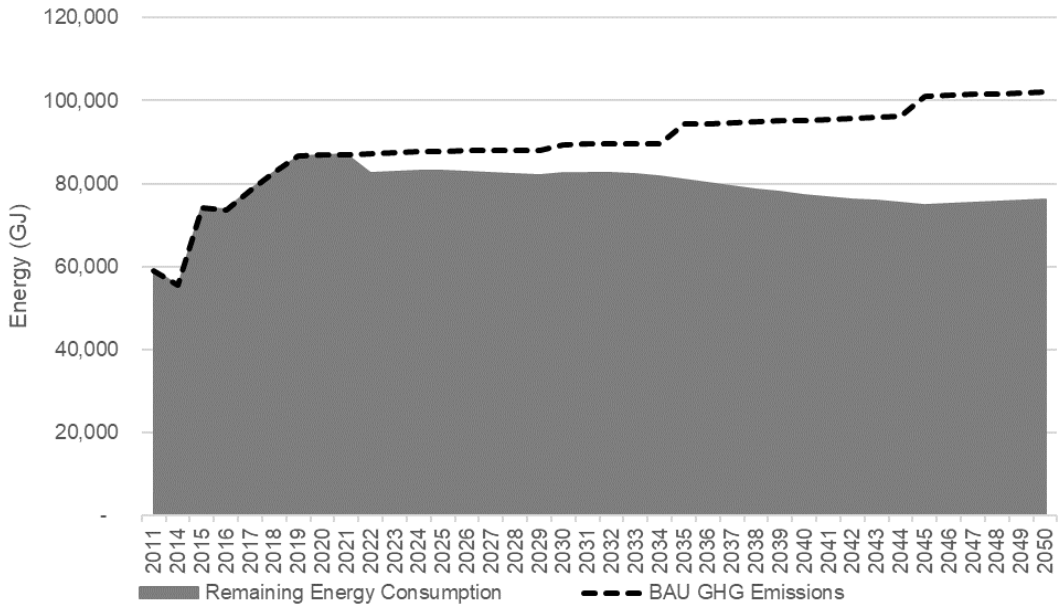

Figure 7. Forecasted ECDM Plan Energy Consumption Compared to BAU Scenario

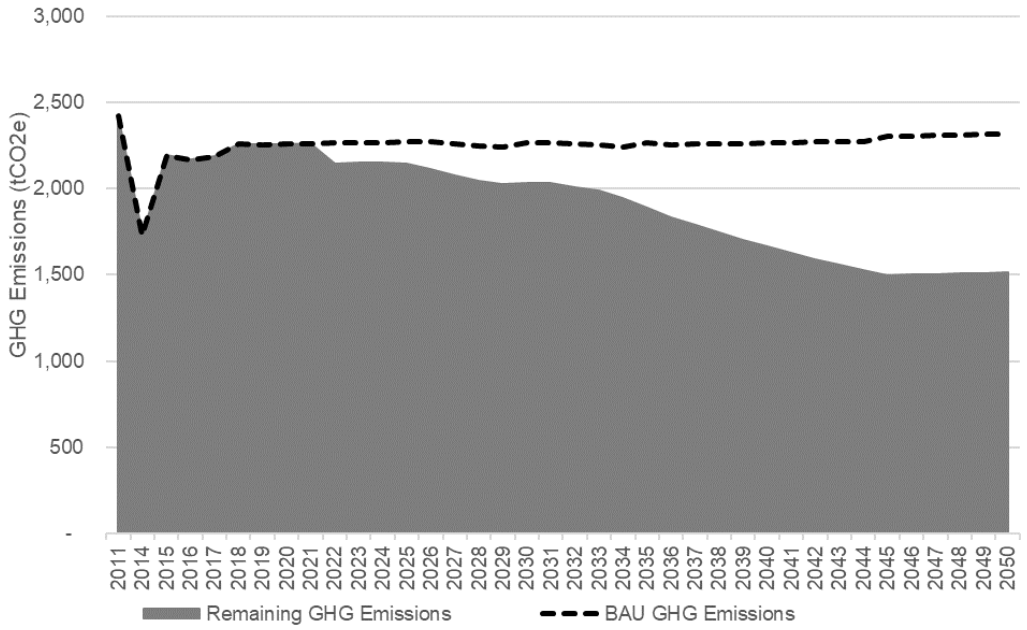

Figure 8. Forecasted ECDM Plan GHG Emissions Compared to BAU Scenario

The proposed list of initiatives in Table 5 represents a combination of staff engagement, detailed energy assessments, best-practice information collected from similar regional and local governments and input from internal and external subject matter experts. The initiatives fall into three categories:

- **Process** - Improvements or alternatives to current process-based operations that are quicker and more straightforward at a low or no additional cost (e.g., energy tracking, green procurement standards)
- **Program** - Improvements that take longer to implement with moderate costs (e.g., retro-commissioning program, building monitoring program, fleet utilization, etc.)
- **Project** - Capital projects to upgrade equipment and facilities and are usually more costly to implement with detailed planning required (e.g., converting natural gas fired boilers to heat pumps, converting fleet to electric, etc.)

Table 5. 2019 ECDM Plan Initiatives

#	Sector	Initiative	Action Type
B1	Buildings & Facilities	Develop a Low Carbon Building Policy	Process
B2	Buildings & Facilities	Opportunistically Implement Energy Audit Recommendations: • B2a: Atlas Tube Centre • B2b: Libro Community Centre • B2c: Other Facilities	Project
B3	Buildings & Facilities	Plan for Deep Energy Retrofits	Project
B4	Buildings & Facilities	Implement a Building Re/Ongoing-Commissioning Program	Program
B5	Buildings & Facilities	Implement an Energy Performance Monitoring Program	Project
B6	Buildings & Facilities	Building Energy Management Training	Project
B7	Buildings & Facilities	Investigate Renewable Energy Sources for Stationary Assets	Project
F1	Fleet & Equipment	Develop a Low Carbon Fleet Management Policy	Process
F2	Fleet & Equipment	Develop an Electric Vehicle and Infrastructure Strategy	Process
F3	Fleet & Equipment	Implement Driver Awareness and Training Programs	Project
F4	Fleet & Equipment	Pilot New Technologies	Project
F5	Fleet & Equipment	Expand the Availability of Active and Sustainable Transportation Options for Staff	Program
F6	Fleet & Equipment	Expand New Fleet Supervisor Role to Include Fleet Management	Project
C1	Corporate	Incorporate Life Cycle Considerations into Capital Planning and Purchases	Process
C2	Corporate	Expand Energy Savings Policy	Process

3.0 BUILDINGS & FACILITIES

In 2018, the Town's buildings and facility portfolio accounted for 55% of its energy use and 58% of its annual GHG emissions. With an average lifecycle of greater than 50 years, many of the Town's current building stock will still be operational in 2050. A summary of energy and GHG emissions by facility type is presented in Table 6 which shows that the top three energy consuming facilities are the Atlas Tube Centre, the Denis St Pierre WPCP, and the Lakeshore Water Treatment Plant (WTP). These are also the largest GHG emission sources accounting for over 81% of building and facility GHG emissions.

Table 6. 2018 Energy and GHG Emissions by Building / Facility

Building / Facility	Energy (GJ)	Percent of Total Building Energy	GHG Emissions (tCO_2e)	Percent of Total Building GHG Emissions
Atlas Tube Centre	37,993	53.2%	1,073	65.5%
Comber Community Centre	416	0.6%	17	1.0%
Comber Library	129	0.2%	6	0.3%
Denis St Pierre WPCP	14,074	19.7%	78	4.8%
Dog Pound	167	0.2%	8	0.5%
Fire Station #1	219	0.3%	9	0.5%
Fire Station #2	284	0.4%	10	0.6%
Fire Station #3	279	0.4%	9	0.6%
Fire Station #4	521	0.7%	22	1.3%
Fire Station #5	405	0.6%	16	1.0%
Lakeshore Arena	166	0.2%	1	0.1%
Lakeshore Marina	545	0.8%	3	0.2%
Lakeshore Town Hall	1,576	2.2%	38	2.3%
Lakeshore WTP	7,529	10.5%	183	11.2%
Libro Community Centre	498	0.7%	17	1.0%
Maidstone PW Garage	579	0.8%	24	1.5%
North Woodslee WPCP	227	0.3%	1	0.1%
OPP Station	674	0.9%	20	1.2%
Parks Garage	68	0.1%	0	0.0%
Puce Community Hall	103	0.1%	4	0.2%
Rochester PW Garage	777	1.1%	33	2.0%
South Woodslee WPCP	585	0.8%	3	0.2%

Building / Facility	Energy (GJ)	Percent of Total Building Energy	GHG Emissions (tCO_2e)	Percent of Total Building GHG Emissions
Stoney Point WTP	1,658	2.3%	32	1.9%
Water Distribution	187	0.3%	7	0.4%
Comber Pumping Station (PS)	503	0.7%	3	0.2%
Patillo Road WPCP	57	0.1%	0	0.0%
Lakeshore Low-Lift PS	608	0.9%	7	0.4%
Stoney Point Low-Lift PS	358	0.5%	11	0.7%
Haycroft PS	277	0.4%	2	0.1%
Total	**71,460**	**100.0%**	**1,637**	**100.0%**

Green building certifications are an important first step toward reducing energy consumption and GHG emissions in buildings. In order to achieve more intensive energy reductions, existing buildings and facilities may require deep energy retrofits that radically overhaul the building envelope to reduce energy needs. Maintenance and ongoing-commissioning programs - a process of ongoing monitoring, adjustment, and retrofitting with new technologies like building automation systems upgrades, and energy sub-metering will be key to maintaining energy and GHG reductions. Building condition assessments (BCA) and behavioral change programs are also important initiatives that will complement retrofit and building monitoring programs. One of the most cost-effective GHG emissions avoidance measures is to improve existing building utilization rates therefore minimizing the number of new buildings requiring construction in the future.

The following is a list of the proposed building and facility initiatives:

- B1: Develop a Low Carbon Building Policy
- B2: Opportunistically Implement Energy Audit Recommendations
- B3: Plan for Deep Energy Retrofits
- B4: Implement a Building Re/Ongoing Commissioning Program
- B5: Implement Building Management Performance Monitoring Program
- B6: Building Energy Management Training
- B7: Investigate Renewable Energy Sources for Stationary Assets

With the proposed building and facility initiatives it is estimated that the Town can reduce energy and GHG emissions by up to 11% and 28%, respectively by 2050 (Table 7).

Table 7. Estimated Energy and GHG Emission Reductions From Buildings & Facilities

Year Ended	2020	2025	2030	2040	2050
Estimated Energy Reduction (GJ) Compared to 2018 Reporting Year	-1%	-5%	-4%	-9%	-11%
Estimated GHG Emissions Reduction (tCO_2e) Compared to 2018 Reporting Year	-1%	-8%	-6%	-20%	-28%

The following sections describe the proposed buildings and facilities ECDM initiatives.

B1: Develop a Low Carbon Building Policy

As described in its Official Community Plan (OCP), the Town aims to promote green building styles, designs and construction techniques which conserve energy and include high-efficiency heating/cooling and lighting systems, fixtures and appliances[5]. To better define and conceptualize this OCP goal, it is recommended that the Town consider developing a Low Carbon Building Policy for Town-owned buildings.

The objective of the Policy would be to provide guidance on green building practices to Town staff, consultants, contractors, suppliers, and any others involved in the planning and execution of construction projects at Town-owned buildings and facilities. The policy would emphasize the importance of energy efficiency while requiring that users take into consideration the types of energy used and the source of the

[5] Town of Lakeshore, 2010. *Official Plan*, www.lakeshore.ca/en/business-and-development/official-plan.aspx, accessed on October, 2019.

energy (e.g., renewables). It is recommended that the Policy apply to Town-owned buildings that meet any of the following criteria:

- New buildings with a gross floor area greater than 5,400 ft^2
- Major additions to existing buildings, where the size of the addition is greater than 5,400 ft^2
- Major renovations, retrofits, and rehabilitation of existing buildings, where the construction budget is greater than $100,000

When drafting the Low Carbon Building Policy document, it is recommended that Town staff take into consideration the Canada Green Building Council Zero Carbon Building Standard (Appendix A).

B2: Opportunistically Implement Energy Audit Recommendations

In the 2014 ECDM Plan, several building energy conservation opportunities were identified at the Denis St. Pierre Water Pollution Control Plant, the Town Hall, the Stoney Point Water Treatment Plant, the Maidstone Public Works Garage, and the John George Water Treatment Facility. During the development of the ECDM Plan, detailed energy audits were completed at the Atlas Tube Centre, the Libro Community Centre and the Public Library. The scope of the energy audits included reviewing building thermal performance, load distribution, existing equipment and controls schedules, occupancy patterns, lighting, and efficiency systems to identify energy and emission reduction opportunities. The recommendations ranged from lighting system upgrades, Building Automation Systems (BAS) upgrades, the use of insulation and weather-stripping to installing variable speed motors, and the installation of heat recovery systems.

The implementation of the energy audit recommendations is estimated to result in both energy cost savings with reasonable payback periods. It is recommended the Town prioritize the efforts to be undertaken based on the expected energy and cost savings, the payback for the individual measure to be employed, and the availability of Town resources to affect the improvement. Priority should be given to the ATC as it has the highest reduction potential. The recommended energy conservation measures (ECM) from the recently completed detailed energy audits for the ATC and Libro Community Centre are presented in the tables below.

Table 8. Atlas Tube Centre ECMs

Measure	Probable Cost ($)	Total Cost Savings ($)	Simple Payback (Years)
Demand Control Ventilation (x5 Air Handling Units (AHUs)	32,000	6,268	5.1
Heat Recovery Condensate Drain	17,000	1,498	11.3
Energy Recovery Ventilation (x4 AHUs)	62,000	3,271	19.0
Optimum Start/Stop (x7 AHUs)	114,000	14,122	8.1

Measure	Probable Cost ($)	Total Cost Savings ($)	Simple Payback (Years)
Variable Frequency Drive (x4 AHUs)	38,000	7,375	5.2
Interior LED Retrofit	53,000	8,897	6.0
Pool LED Retrofit	10,000	624	16.0
Arena LED Retrofit	87,000	18,970	4.6
Liquid Pool Cover	3,700	12,213	0.3
Arena Low-e Ceiling	195,000	69,012	2.8
Low-flow Water Closets and Urinals	50,000	4,862	10.3

In addition, significant natural gas savings, upwards of 30%, could possibly be achieved at the ATC through the installation of a GeoExchange system if a study showed it to be feasible. During the energy audit, it was noted that in the summer months with AHUs in cooling mode, the cooling tower reportedly exceeds its maximum potential capacity. A potential solution to address the cooling load issue is to implement a GeoExchange field in the area between the phase I and the phase II buildings (which is mid-way for the two systems) to reject the excess heat while saving energy and avoid replacing the existing AHUs due to their remaining useful life. A more detailed analysis is required to determine the feasibility of this opportunity which could cost between $60,000 to $70,000.

Table 9. Recommended ECMs: Libro Community Centre and the Public Library

Measure	Probable Cost ($)	Total Cost Savings ($)	Simple Payback (Years)
Demand Control Ventilation-Community Centre	32,000	354	>20
Programmable Thermostat-Community Centre	3,200	3,402	0.9
Occupancy Sensors and Programmable Thermostat -Community Centre	7,000	1,729	4.0
Variable Volume Temperature (VVT)-Community Centre	26,000	1,263	>20
Window Film-Community Centre	900	40	>20
Demand Control Ventilation-Library	7,900	(672)	>20
Programmable Thermostat -Library	1,600	2,470	0.6
Occupancy Sensors and Programmable thermostat -Library	4,000	1,547	2.6
VVT Control -Library	5,200	433	12.0
Window Film -Library	900	6	>20

Measure	Probable Cost ($)	Total Cost Savings ($)	Simple Payback (Years)
Low-flow Water Closets and Urinals-Community Centre	7,500	132	>20

The recommended ECMs for the other facilities identified in the 2014 ECDM Plan are presented in Appendix C.

In order to carry out these initiatives, it is recommended that the Town continue to seek out funding opportunities and incentives, such as the saveONenergy incentive program, the Federation of Canadian Municipalities (FCM) Green Municipal Fund, and the Federal Community Infrastructure Improvement Fund to improve the business case for high GHG reduction actions that have a longer or lower financial return on investment.

As grants and funding programs typically have detailed requirements or are only available for a short duration of time, the Town may need to consider the use of a combination of other financing vehicles, like expanding the Town's energy reserve fund, using green debt financing (e.g., green bonds), or utilizing energy performance contracts.

B3: Plan for Deep Energy Retrofits

Deep energy retrofits simultaneously retrofit or replace equipment and building envelope infrastructure (e.g. roof, walls, windows) to achieve large energy and GHG emission reductions and tend to be informed by building condition assessments and commissioning activities. Deep energy retrofits typically involve:

- Significantly reconfiguring the interior
- Replacing the roof
- Adding or rearranging windows for increased daylight
- Replacing the HVAC (heating, ventilation and air conditioning) systems with renewable technologies like ground-source heat pumps

Natural Resources Canada (NRCAN) estimates that deep energy retrofits can achieve upwards of a 60% reduction in energy consumption which directly translates to a similar reduction in GHG emissions.[6]
A decrease in energy demand means smaller mechanical systems and options for cleaner fuel sources. Electrically driven heat-pumps generate significantly fewer GHG emissions than a natural gas boiler or furnace.

[6] Natural Resources Canada, 2018. *Retrofitting*, www.nrcan.gc.ca/energy/efficiency/buildings/20707, accessed on Sept 4, 2018.

Deep retrofits require a significant capital investment and long-term planning. At present, the Town has not accommodated for this initiative in its five to ten-year budgets, and thus the retrofits would not likely occur until 2030 or later making this a long-term initiative. As a prerequisite to deep energy retrofits, in the short-term, it is recommended that the Town use Building Conditions Assessments (BCA) and energy audits to develop energy and water performance baselines. This would enable the Town to forecast and plan for additional capital costs and provide Council with a clear business case as to why the upgrades are occurring and the rationale for not seeking a 'like-for-like' replacement long before the capital is required.

B4: Implement a Building Re/Ongoing-Commissioning Program

Commissioning verifies that a building has been constructed to its proper specifications. The best time to commission a building is during design and construction, with special attention being paid to the building envelope. Post-construction, continuous commissioning of a building's entire system over a specified period of time (typically every 1-2 years) is recommended to maintain continuous peak performance over its useful life. Ongoing-commissioning and re-commissioning are important because they reduce operating costs, reduce the risk of failures, and inform retrofit opportunities and deep energy retrofit plans long before they are due. Various pre- and post-implementation commissioning case studies have shown efficiency improvements on the order of 5% to 30% because of improved operations and maintenance. The studies also show that the resulting simple payback periods are typically less than 2 years[7]. Typical commissioning activities include:

- Adjusting reset and set-back temperatures and temperature settings
- Staging / sequencing of boilers, chillers, and air handling units
- Adjusting and repairing dampers and economizers
- Modifying control strategies for standard hours of operation
- Eliminating simultaneous heating and cooling
- Air and water distribution balancing and adjustments
- Verifying controls and control sequencing, including enabling and re-enabling automatic controls for set points, weekends, and holidays

It is recommended that this initiative be added to the Town's existing Strategic Facilities Plan immediately as the re-commissioning of buildings would occur on a five-year cycle or when the function of a building or facility changes.

[7] Office of Energy Efficiency and Renewable Energy, 2010. *Operations & Maintenance Best Practices: A Guide to Achieving Operational Efficiency,* https://www.energy.gov/sites/prod/files/2013/10/f3/omguide_complete.pdf August 3, 2018.

B5: Implement Building Management Performance Monitoring Program

Low-energy intensive buildings do not always operate as they were designed resulting in poor energy performance. Annual energy performance reporting, whether through Energy Star Portfolio Manager or a third-party energy management system, can close the gap between predicted and actual energy use and provide support to an ongoing building commissioning program (Initiative B5). Providing building operators with energy management dashboards will enable them to benchmark their energy performance against prior year data and buildings in the portfolio that are of similar typology to identify underperformers and the need for improvements. Over time, energy performance monitoring can also result in the identification of opportunistic business changes like adjusting how facilities are programmed and managed (e.g., shifting the ice season from the fall to the winter, establishing temperature and environment policies for staff and patrons, closing facilities, etc.).

It is recommended that the Town utilize a no-cost energy monitoring and benchmarking program like the LAS system, or Energy Star Portfolio Manager to track and assess energy and water consumption. Although there are no associated costs with the use of the LAS system or Energy Star Portfolio Manager, the Town will need staff resources to orientate, upload building and facility data, and track and report on performance over time.

B6: Building Energy Management Training

Building managers and supervisors are responsible for day-to-day maintenance and operation of buildings and facilities with complex heating, mechanical and electrical systems and requirements. Proper understanding and training in the systems is key to achieving and maintaining energy savings and GHG reductions. Training building managers and supervisors on energy management practices and concepts builds competencies that they can use to operate their facilities and carry out operations more effectively and efficiently. It is recommended that the Town seek a building training program that:

- Examines best-practices, approaches, case studies and the role of technology
- Examines in detail the investigation process
- Identifies how to assess and implement measures
- Provides details on the requirements for ongoing maintenance, monitoring and reporting
- Incorporates hands-on activities that allows for onsite assessment of equipment and systems
- Provides case studies and approaches to dealing with staff and tenants

Additional information on a best practice approach for training can be found in ASHRAE Guideline 0, The Commissioning Process, and Guideline 1.3P, Building Operation and Maintenance Training for the HVAC&R Commissioning Process.

B7: Investigate Renewable Energy Sources for Stationary Assets

There exits an opportunity to implement renewable energy systems – such as solar photovoltaic (PV), wind, solar water/air heating, passive heating and cooling technologies, ground source heat pumps, and biomass on some of the Town's stationary assets like buildings. Renewable generation lowers the stresses on the distribution grid, carries significant environmental benefits, and further positions the municipality as a leader in sustainability. Opportunities for renewable generation can also result in additional long-term revenue streams to the Town. It is recommended that the Town explore such opportunities as they arise (e.g., new buildings or major retrofits).

Summary of Proposed Initiatives

A summary of the proposed initiatives for the Town's buildings and facilities is presented in the following table:

Table 10. Summary of Buildings & Facilities Initiatives

#	Initiative	Energy Reduction Potential	GHG Reduction Potential	Estimated Cost	Timing	Responsibility	Indicators
B1	Develop a Low Carbon Building Policy	Supportive Initiative	Supportive Initiative	• Staff Time	2021	• Facility Services	• Policy and technical standards are completed and approved
B2	Opportunistically Implement Energy Audit Recommendations	19%	8%	• $880,000	Starting in 2020 Ongoing as opportunity / funding arises	• Facility Services	Reduction of: • Building Energy Intensity (GJ/m^2) • Building GHG Emissions Intensity (tCO_2e/m^2) • Building Energy Cost Intensity ($/m^2$)
	B2a: Atlas Tube Centre	8%	7%	• $350,000		• Manager of Recreation	
	B2b: Libro Community Centre	1%	1%	• $40,000		• Facility Services	
	B2c: Other Facilities	10%	<1%	• $500,000		• Facility Services	
B3	Plan for Deep Energy Retrofits	40-60%	40-60%	• $3-25/$ft^2$	2030	• Building Services	• Deep energy retrofit activities are planned for implementation in capital asset management planning systems

#	Initiative	Energy Reduction Potential	GHG Reduction Potential	Estimated Cost	Timing	Responsibility	Indicators
B4	Implement a Building Re/Ongoing-Commissioning Program	5-12%	5-12%	• Staff Time	2023	• Manager of Recreation • Manager of Environmental Services • Manager of Public Works	Reduction of: • Building Energy Intensity (GJ/m^2) • Building GHG Emissions Intensity (tCO_2e/m^2) • Building Energy Cost Intensity ($/$m^2$)
B5	Implement an Energy Performance Monitoring Program	Supportive Initiative	Supportive Initiative	• Staff Time	2022 and on-going	• Facility Services	• Monitoring program is in place • All building operators have access to the monitoring system • Building Energy Intensity (GJ/m^2) • Building GHG Emissions Intensity (tCO_2e/m^2) • Building Energy Cost Intensity ($/$m^2$)
B6	Building Energy Management Training	Supportive Initiative	Supportive Initiative	• Staff Time & Program Cost	2021	• Facility Services	• Training needs identified • Training occurs

#	Initiative	Energy Reduction Potential	GHG Reduction Potential	Estimated Cost	Timing	Responsibility	Indicators
B7	Investigate Renewable Energy Sources for Stationary Assets	Supportive Initiative	Supportive Initiative	• Staff Time	Ongoing	• Building Services	• Renewable energy opportunities are identified and assessed • KWh_{ac} produced • % of energy demand from renewable energy

4.0 FLEET & EQUIPMENT

The Town owns and operates a variety of vehicles to perform daily operations. These include road insured vehicles such as light duty trucks and off-road equipment like back-hoes which utilize either gasoline or diesel fuel. Corporate fuel usage is influenced by the size of the vehicle fleet, the vehicle operators and the efficiency of the individual vehicles. In 2018, fleet and equipment accounted for 27% of the Town's GHG emissions. Heavy duty vehicles accounted for half of the fleet's GHG emissions with light duty vehicles following close behind accounting for 37% of fleet GHG emissions (Table 11).

Table 11. Fleet GHG Emissions by Classification

Classification	GHG Emissions (tCO_2e)	Percent of Total Fleet GHG Emissions
Light Duty Vehicle (LDV)	14.8	2.4%
Light Duty Truck (LDT)	211.0	35.0%
Heavy Duty Vehicle (HDV)	309.2	51.2%
Off-Road Equipment (ORE)	68.7	11.4%
Total	**603.7**	**100.0%**

Fleet and equipment business as usual GHG emissions are expected to decline post 2030 as a result of the expected changes to the Corporate Average Fuel Economy (CAFE) Standards and tailpipe GHG emissions standards for light duty and heavy duty vehicles starting in 2027. Currently there is a limited number of low- or no-emission heavy duty vehicles and equipment options available for purchase, many of which do not meet occupational health and safety requirements. Therefore, there are very limited options in reducing GHG emissions from heavy duty vehicles. Over time as the market conditions in this area improve, it is recommended that the Town consider pilot testing of hybrid or fully electric heavy equipment and off-road vehicles prior to purchasing.

Based on the proposed actions, it is estimated that the Town's fleet can reduce its energy and GHG emissions by up to 45% and 44%, respectively, by 2050 as a result of fleet optimization, reduction and the conversion of light duty vehicles and trucks to electric (Table 12). The conversion of heavy-duty fleet to electric or through the use of biofuels would be able to reduce GHG emissions further.

Table 12. Estimated Energy and GHG Emission Reductions From Fleet & Equipment

Year Ended	2020	2025	2030	2040	2050
Estimated Energy Reduction (GJ) Compared to 2018 Reporting Year	0%	-1%	-26%	-44%	-44%
Estimated GHG Emissions Reduction (tCO_2e) Compared to 2018 Reporting Year	0%	-1%	-27%	-45%	-45%

Fleet and equipment GHG emissions are the direct result of a wide and varied range of services delivered to the community. As no single measure can eliminate fleet and equipment GHG emissions, a suite of strategies is required which include:

- F1: Develop a Low Carbon Fleet Management Policy
- F2: Develop an Electric Vehicle and Infrastructure Strategy
- F3: Implement Driver Awareness and Training Programs
- F4: Pilot New Technologies
- F5: Expand the Availability of Active and Sustainable Transportation Options for Staff
- F6: Expand New Fleet Supervisor Role to Include Fleet Management

F1: Develop a Low Carbon Fleet Management Policy

The purpose of a Low Carbon Fleet Management Policy is to reduce the environmental impact of the Town's vehicle and equipment fleet by reducing associated fuel consumption and GHG emissions, while maintaining or improving the level of service offered to the community. As it relates to energy and GHG emissions management, the Low Carbon Fleet Management Policy would include guidance on:

- **Procurement Standardization**: Procurement standardization aims to minimize fleet and equipment diversity as much as possible which can lead to economic savings, lower maintenance costs, increased operational efficiency and safety, improved vendor relations, and support the migration to renewable fuels. It is recommended that standardization be focused on purchasing fuel vehicles and equipment appropriate for Town operations, while accounting for lifecycle costs, and heavily weighting items that are renewably powered or electric. This will require the development of a low-carbon vehicle standard to create a hierarchy of most-preferred to least preferred technologies based on GHG emissions for a range of operational activities.

- **Life Cycle Costing**: Life cycle costing identifies when vehicle and equipment assets should be replaced to minimize the total cost of ownership to the Town. Lifecyle analysis also provides optimal timing for replacement, based on anticipated use, and can be used to assign actual asset costs, based on actual use, to end users. It is recommended that the vehicle and equipment life cycle replacement and cost assignment program feed into the Town's asset management and financial systems.
- **Vehicle Right Sizing**: Vehicle right sizing assigns vehicles based on identified need rather than driver preference. It is recommended that the policy afford appropriate Town staff with the ability to allocate vehicles for staff based on the functional needs required with the objective of rationalizing fleet assets, reducing fuel consumption and GHG emissions, and increasing fleet efficiencies.

Using life cycle costing while assessing vehicle operational demands and GHG emissions, the Town will be able to purchase vehicles that provide the same level as operational service and achieve the highest possible GHG emissions reduction. It is estimated that a low carbon fleet management policy and supporting actions such as vehicle rightsizing can achieve upwards of 10-17% in GHG reductions from fleet.

It is recommended that the Town develop the Low Carbon Fleet Management Policy as it will guide the implementation of the remaining fleet and equipment initiatives. An example of a similar policy is included in Appendix C.

F2: Develop an Electric Vehicle and Infrastructure Strategy

According to Bloomberg New Energy Finance, by 2040, nearly 55% of vehicle sales will be electric, and are projected to achieve cost parity to their equivalent gasoline powered vehicle by the early 2020s[8] (Figure 9). It is anticipated that by 2025 light duty vehicle (LDV) Electric Vehicles (EV) will reach cost parity with their gasoline and diesel counterparts.

[8] Bloomberg New Energy Finance, 2018, *Electric Vehicle Outlook 2018,* https://about.bnef.com/electric-vehicle-outlook/, accessed on Sept 4, 2018.

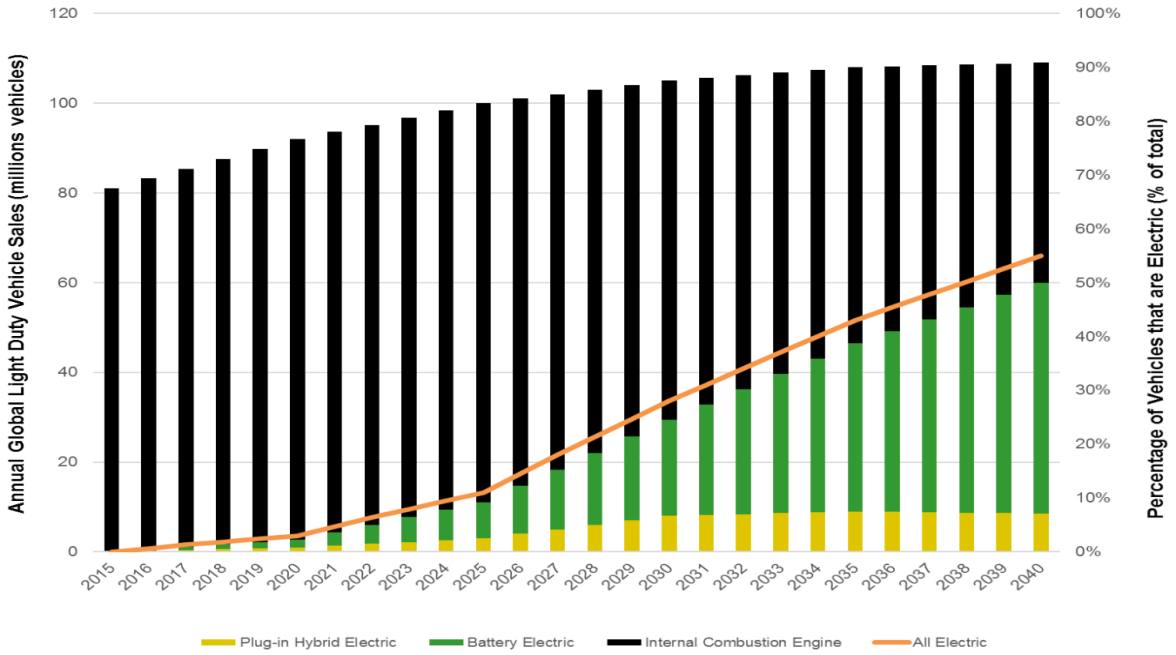

Figure 9. Forecasted Electric Vehicle Global Sales[9]

The variety and types of electric vehicles available for sale are also expected to expand significantly from the current offering of light-duty vehicles to pick-up trucks and SUVs over the next five years. As the battery life, charge time, cost-parity of electric vehicles have improved significantly, it is now feasible for the Town to opportunistically reduce energy and GHG emissions from its light duty vehicle fleet by replacing these with electric vehicles. This will not only support corporate needs but will encourage the public to make their own investments in electric vehicle technology as well.

To move forward with this initiative, in the short-term, the Town will need to identify a process that incorporates vehicle right-sizing requirements to identify which vehicles can be replaced with EVs, and complete an EV facility survey to assess if the current electrical systems can handle charging stations (i.e., transformer and main disconnect), and to assess if there is spare electrical capacity to install the disconnects/switchgear for the charging stations. These studies, if done on multiple facilities, can cost approximately $4,000 for each facility assessed. Once this pre-work is completed in the medium term, the EV strategy can be developed.

At a minimum, the EV strategy should:

- Establish an EV target for light duty vehicles (e.g., require a minimum of 50% of annual light-duty vehicle purchases be EV by 2030, etc.).

[9] Bloomberg New Energy Finance, 2018. *Electric Vehicle Outlook 2018*, https://about.bnef.com/electric-vehicle-outlook/, accessed on Sept 4, 2018.

- Identify a process that incorporates vehicle right-sizing requirements to identify which vehicles can be replaced with EVs.
- Establish a process to budget for EV infrastructure capital costs as part of annual EV replacements.
- Include a system to monitor billing and electricity use for the EV fleet to allow for tracking, allocating, and reporting of costs and benefits.
- Identify possible charger installations that serve the non-fleet to allow for daytime public charging and nighttime fleet charging, when feasible.
- Identify priority locations and opportunities to develop integrated multimodal mobility hubs that include EV infrastructure on Town-owned property.
- Identify suitable locations for cost-effective low-power and high-power charging to allow for a range of vehicle types and charges.
- Identify priority areas for the co-location of EV infrastructure that supports both light-duty and heavy-duty vehicles.
- Identify opportunities to upgrade charging infrastructure at Town properties to allow for submetering of charging activity, improve remote management capabilities, and increase charging options.
- Include policies that require all new or renovated Town-owned buildings to provide EV charging infrastructure, or at a minimum, have the infrastructure in place (EV ready).
- Include a phased approach to addressed increased charging access (e.g., encourage other types of EVs, encourage at-home charging when feasible, etc.).
- Include a workplace charging program to expand charging access for employees at Town facilities.

The completion of an EV strategy can either involve staff time or be completed by a third party which can cost between $25,000 and $60,000.

F3: Implement Driver Awareness and Training Programs

As a result of the stakeholder workshops, it is recommended that the Town either develop or partner with the County to develop a formal Efficient Driver Training program that would teach employees on fuel efficient driving practices including: optimal driving behaviors, anti-idling, hypermiling (a driving practice utilizing efficient stopping and acceleration), ridesharing, and vanpooling. This is a best management practice which can result in a reduction of 1-5% of fleet energy consumption and associated GHG emissions.

F4: Pilot New Technologies

It is recommended that the Town investigate pilot projects utilizing electric vehicle and other heavy truck hybrid technologies as they become available which result in cost effective and reduced fuel consumption and GHG emissions. For instance, during the procurement of the Town's ice resurfacing machines, the Town could explore the procurement of alternate low-carbon technology vehicles.

F5: Expand the Availability of Active and Sustainable Transportation Options for Staff

Active transportation and other sustainable transportation options, like EV car share, e-bikes, virtual meetings, and alternative work arrangements, can play a key role in reducing the Town's GHG emissions.

The Town can expand the availability of active transportation programs and facilities for Town staff by providing employee transit programs, access to electric bikes (E-Bikes), access to car share vehicles etc., and dis-incentivizing staff parking. The Town can also support ride sharing or similar staff commuting to work by creating a Town car sharing program to more efficiently allocate internal resources and demonstrate the value of this to Town staff. An initiative like this could encourage fleet sharing between departments to provide more efficient and effective access to cars for employees, while reducing the amount of resources spent on fleet management.

F6: Expand New Fleet Supervisor Role to Include Fleet Management

The initiatives identified for fuel and GHG reduction in the Town's fleet will be led by a Fleet Supervisor, to be considered as part of the Town's organizational structure review for position allocation. This will require the modification of the supervisor job description to include fleet management duties which will focus on implementing the fleet initiatives, as well as the following responsibilities:

- Identifying opportunities to reduce costs and maximize profits (e.g., fleet reduction)
- Utilizing telematics to monitor drivers and track vehicles
- Analyzing data to develop strategies for greater fuel efficiency and increase business operational efficiency
- Meeting and collaborating with other local governments to share best practices, seek funding opportunities, etc.

Summary of Proposed Initiatives

A summary of the proposed initiatives for the Town's fleet is presented in the following table:

Table 13. Summary of Fleet & Equipment Initiatives

#	Initiative	Energy Reduction Potential	GHG Reduction Potential	Estimated Cost	Timing	Responsibility	Indicators
F1	Develop a Low Carbon Fleet Management Policy	Supportive Initiative	Supportive Initiative	• Staff Time	2022	• Public Works	• Policy is completed and approved
F2	Develop an Electric Vehicle and Infrastructure Strategy	5-10%	50-60%	• Assume extra $3,000 per LDV until cost parity is achieved in 2025. LDT premiums will likely range from $8k to $15k for an indeterminable period of time. • Fleet utilization study, including a sample telematics pilot, can range from $75,000 and up. • EV Study: $40,000 - $50,000 • Capacity Assessment: $3,000 - $4,000 per facility	2022 for study	• Facility Services • Public Works	• Unit fuel/km • Total L of fuel types used • # of vehicles with greater fuel efficiency, hybrid, EV etc.

#	Initiative	Energy Reduction Potential	GHG Reduction Potential	Estimated Cost	Timing	Responsibility	Indicators
F3	Implement Driver Awareness and Training Programs	<1% per year	<1% per year	• Staff Time	Ongoing	• Public Works • Human Resources	• Number of drivers trained • Unit fuel/km • Total L of fuel types used
F4	Pilot New Technologies	1-25%	1-25%	• Staff Time • Cost for New Vehicle	Ongoing	• Public Works	• Number of vehicles with greater fuel efficiency, hybrid, EV etc.
F5	Expand the Availability of Active and Sustainable Transportation Options for Staff	Up to 5%	Up to 5%	• Staff Time • Program costs will range depending on needs and use	Ongoing	• Human Resources • Public Works	• Number of active transportation programs available to staff • Utilization rate of active transportation programs
F6	Expand New Fleet Supervisor Role to Include Fleet Management	Supportive Initiative	Supportive Initiative	• Staff Time	2020	• Human Resources • Public Works	• Staff member in charge of fleet management

5.0 CORPORATE

It is estimated that the Town can achieve upwards of an 8% energy reduction by 2050 as a result of current and proposed actions identified in this ECDM Plan. Achieving this performance will require the Town to implement conservation first actions like those already identified in this ECDM Plan, but also a change in how the Town internalizes and prioritizes energy consumption, energy savings, and GHG emissions. The following initiatives set these important foundations:

- C1: Incorporate Life Cycle Considerations into Capital Planning and Purchases
- C2: Expand Energy Savings Policy

C1: Incorporate Life Cycle Considerations into Capital Planning and Purchases

Like most local governments, the Town is often juggling and prioritizing competing financial priorities, which can result in a procurement culture where the lowest bid is often seen as the most viable and best value for taxpayers. The result, however, is a system that defaults to 'like-for-like' replacements, penalizes higher cost energy and GHG emission reduction technologies and best-practices, and does not account for the GHG footprint of the products or services being provided. For example, NRCAN estimates that 20% of Canada's GHG emissions are embodied in the construction sector – which are not accounted for in most municipal GHG accounting systems.[10]

[10] Natural Resources Canada, 2019. *Energy and Greenhouse Gas Emissions*, www.nrcan.gc.ca/energy-and-greenhouse-gas-emissions-ghgs/20063, Accessed October 2019.

Life Cycle Analysis (LCA) has been incorporated into the Town's recent capital asset management plan. To shift the current Town culture and narrative, it is recommended that the Town continue to integrate LCA processes into budget and capital planning, strategic planning, purchasing policies, preventative maintenance plans, and environmental management plans. It is also recommended life cycle energy and GHG emissions reduction measures be incorporated as part of the rationale for budget requests, that these measures feed into the annual budgeting process, and that projects be examined in consideration to the total life cycle of the asset. Success means that these measures are incorporated into the initial stages operational and capital project planning, and that options for energy efficiency and conservation are considered, evaluated and quantified in terms of life cycle, which includes cost, maintenance and energy and GHG reductions. In addition to costs, consideration should be given to available energy services, energy quality and reliability, and supplier performance. The Town should consider energy efficient criteria when evaluating, comparing, selecting, or purchasing materials and equipment.

C2: Expand Energy Savings Policy

It is recommended that the Town expand its energy savings policy that has been applied to streetlights to all aspects of the organization. The policy recognizes and make available any operational budgets saved, as a result of energy conservation and demand initiatives, to the sole use and discretion of the Town department that implemented the initiatives.

Summary of Proposed Initiatives

A summary of the proposed corporate initiatives is presented in the following table:

Table 14. Corporate Initiatives

#	Initiative	Energy Reduction Potential	GHG Reduction Potential	Estimated Cost	Timing	Responsibility	Indicators
C1	Incorporate Life Cycle Considerations into Capital Planning and Purchases	Supportive Initiative	Supportive Initiative	• Staff Time	Ongoing	• Engineering & Infrastructure Services • Community & Development Services • Legislative & Legal Services	• Policy is completed and approved
C2	Expand Energy Savings Policy	Supportive Initiative	Supportive Initiative	• Staff Time	2021	• Engineering & Infrastructure Services • Community & Development Services	• Policy is completed and approved

6.0 ECDM PLAN IMPLEMENTATION

6.1 GOVERNANCE AND COLLABORATION

The Town's Energy Management Committee will hold the responsibility of leading the implementation of the ECDM Plan. This responsibility includes:

- Ensuring the Town meets all energy related regulatory requirements
- Serving as a primary point of contact for all energy related matters
- Generating and distributing reports to Council and Staff
- Monitoring and verification of energy performance
- Completing grant and incentive application
- Promotion of energy education and awareness
- Acting as a resource in the planning, development and implementing of energy efficiency projects

The Committee will evaluate the potential energy saving opportunities for each specific policy, project or program initiatives and will prioritize each based on the expected energy and cost savings, the payback, and the availability of Town resources to implement. Individual departments will be responsible for the project management for the implementation of the specific policy and program initiatives, with support from the Committee. Projects will be implemented on a case-by-case basis and brought forth for Council's consideration and approval as necessary.

6.2 MONITORING EXISTING & EVALUATING NEW INITIATIVES

The ECDM Plan contains a list of recommended initiatives to be completed over the next five years and beyond. Implementing the initiatives requires dedicated resources and systems in place to ensure that the policies, programs, and projects recommended are implemented and tracked so that the Town reduces energy consumption and GHG emissions. The intention of the ECDM Plan is to dovetail energy conservation, energy demand management, and GHG emissions as part of the Town normal course of business for asset retrofits, renewals and life cycle replacement projects. Success in this endeavor requires incorporating conservation and demand management options at the initial design stages. In so doing, this ensures that options for improving energy efficiency are considered, evaluated, and quantified in terms of life cycle costing analysis, including cost, maintenance, GHG reductions and other co-benefits that may accrue to the Town. When evaluating future initiatives, a Town checklist should include the following:

- Project base case
- Energy efficient options
- Project costs (base case vs. energy efficient case)
- Project savings (in terms of energy, maintenance, avoided GHG emissions)

- Maintenance savings
- Financial benefits
- Environmental benefits
- Co-benefits
- Incentives/funding available
- Overall benefits
- Life cycle analysis recommendations

This ECDM Plan will be in place for a period of five years at which point an update to the plan will be required. For the next plan, the existing initiatives will be evaluated in consultation with the various Town departments as part of the departmental strategic operations planning process. This will be an opportunity to review and prioritize potential strategies based on resources and emerging technological opportunities.

6.2.1 Funding

Wherever possible, the Town should take advantage of funds to speed up the implementation of project initiatives. For example, the Town could submit an application to Infrastructure Canada for federal funding under the Community, Culture and Recreation Fund to support the energy projects at the identified community centres under the basis that the retrofits would reduce GHG emissions, but also support using the community centres as 'cooling centres' during heatwaves.

As these programs are subject to political changes, the Town should proactively plan and incorporate capital and operating costs of the proposed initiatives into future budgets. This will enable the Town to take advantage of external funding opportunities when they are available, but not have to rely on these external sources to move forward on initiatives.

6.3 REPORTING & COMMUNICATION

6.3.1 Monitoring & Reporting

An ongoing feedback loop, known as the Deming Cycle, facilitates continuous improvement, and can be used to facilitate the continuous improvement of the ECDM Plan to ensure that it remains as a living document. The four components of the Deming Cycle, shown below in Figure 10, are "plan, do, check and act." A run through the plan-do-check-act cycle should occur on an annual basis and coincide with the Town's annual budget cycle for planning each year's capital and operating budgets.

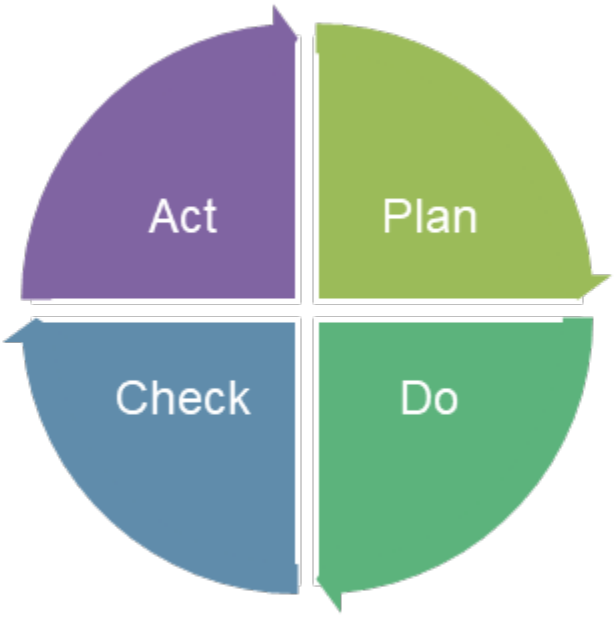

Figure 10. The Deming Cycle (Plan-Do-Check-Act)

A monitoring framework provides the Town with a task list of items to track that will help re-assess the effectiveness of ECDM Plan initiatives, GHG emissions, and other activities contained within the ECDM Plan over time (the "check" components of the cycle). Monitoring includes two components. The first is the monitoring of the ECDM Plan initiatives - what is being done, who is doing it, is the activity funded, etc. The second component is the compilation of the energy and GHG emissions inventory to monitor the success of the ECDM Plan initiatives. Tracking, measuring, and sharing progress towards the initiatives identified in the ECDM Plan is essential to maintaining momentum for change. The success of the ECDM Plan will be measured by the results achieved relative to prior reporting years.

On an annual basis, the Committee will prepare an Energy and GHG Emissions Report, which at a minimum, will include:

- Current energy and GHG emissions profile in aggregate and broken down by asset
- Change in energy and GHG emissions from the prior year and the baseline
- Follow-up actions from the prior year's report
- A description of the work that has been completed
- Extent to which GHG emission reduction have been met
- Identification of any issues or challenges faced in advancing each initiative
- An indication of progress toward achieving each initiative, using the following scale:
  - Not Started – The initiative has not been implemented.

  - On Track – The initiative has been implemented. For various initiatives, progress will be measured through quantitative and qualitative primary indicators (Table 15) and secondary indicators (as identified in the initiatives tables).
  - Outstanding – An issue, barrier and/or challenge is prohibiting the initiative from being implemented
  - Delayed – The initiative has been delayed or placed on hold
  - Completed – The initiative has been completed
- List of new initiatives to address issues, barriers and challenges
- Timing and assigned responsibilities of the initiatives

Table 15. ECDM Plan Key Performance Indicators

Key Performance Indicator (KPI)	Measurement
Building Energy Intensity	Energy use per unit area
Building Emissions Intensity	Greenhouse gas emissions per unit area
Building Energy Cost Intensity	$ per unit area
Renewable Energy Generated	KWh_{ac} produced % of energy demand from renewable energy
Fleet Fuel Efficiency	Fuel quantity per kilometer
Fleet Total Fuel Used	Fuel quantity
Fleet Number of Vehicles in Different Classes	Number of vehicles with greater fuel efficiency, hybrid, electric vehicle etc.
Policy Recommendation	Completion of recommended policy

The implementation of the ECDM Plan (the “Plan and Do” components of the cycle) will require the formulation of an annual work plan to define what actions are undertaken annually. To aid in successful implementation, the annual work plan should tie into departmental business plans and budgets to ensure responsibilities and resources are allocated accordingly. Progress will be reported to the stakeholders as noted in the following section.

6.4 COMMUNICATION STRATEGY

The overall goal of the communication strategy is to outline tools and techniques to assist the Town with ongoing internal communication about the ECDM Plan, including implementation and progress. The communication strategy is focused on internal communication for Town staff and council. The key objectives of the strategy are:

- To communicate the presence and importance of the ECDM Plan

- To share progress and the resulting impacts of the ECDM Plan initiatives
- To motivate multiple audiences about what they can do to reduce the Town's energy use and GHG emissions
- To communicate coming changes in business practices to support the ongoing implementation of the ECDM Plan

It is recommended that the GHG emissions quantification and reporting follow best practice reporting protocols like the World Resources Institute GHG Protocol, or the ICLEI GHG Protocol.

6.4.1 Communications Tactics

The communications strategy includes a series of strategic tactics (Table 16).

Table 16. Suggested Communication Tactics for the Energy Management Committee

Tactic	Description/Rationale
Host Bi-Annual ECDM Plan Meetings	The intent of these meetings is to: • Share best practices between departments • Provide status/progress updates on energy conservation and GHG emission reduction strategies across all departments • Prioritize work • Share funding opportunities • Collaborate on shared initiatives that flow into annual work plans and budgets • Once a year the team will review the ECDM Plan and progress towards its goals
Develop an annual corporate Energy and GHG Emissions Progress Report	The Environmental Services Division will gather information from all departments, and report annually on energy and GHG emissions. Ensure the development of a one-page, graphic summary document which can be used to communicate results with a wide range of audiences including internal staff and Council.
Increase awareness of the ECDM Plan and implement general energy skills training for all staff	Develop (or adopt) training workshops and/or other tools that would be suitable for all Town staff. The workshops could cover: • The presence of the ECDM Plan • The role of all staff members in contributing to energy conservation and GHG emission reductions • Easy tips and reminders for every day corporate energy conservation and GHG emission reductions
Work to integrate key messaging into existing communications	Work alongside other municipal departments involved with corporate communications to share tips and reminders about energy conservation and GHG emission reductions with all staff.

Tactic	Description/Rationale
Create (and publicize) a "Bright Lights" program	Create a staff-based program to celebrate success. Suggest working with the Human Resources to develop a staff recognition program. This could include: • Seeking nominations for staff that have made a difference with energy efficiency • Developing short vignettes • Circulating stories and photos
Ensure open lines of communication	Ensure that staff across the corporation have knowledge of, and access to an ECDM Plan information-sharing portal. This portal might be used to: • Share innovative ideas • Identify areas of concern • Provide feedback or solutions

6.4.2 Communications Recommendations

The following table includes supporting details for each of the tactics:

Table 17. Timing of Suggested Communication Tactics

Tactic	Audiences	Level of Effort	Timing
Host quarterly ECDM Plan Meetings	Senior leaders, representing key departments		Quarterly, Ongoing
Develop an annual corporate Energy and GHG Emissions Progress Report	Council All staff		Annually
Increase awareness of the ECDM Plan and implement general energy skills training for all staff	All staff		End of Year Two
Work to integrate key messaging into existing communications	All staff		End of Year One

TOWN OF LAKESHORE

ECDM Plan Implementation

Tactic	Audiences	Level of Effort				Timing
Create (and publicize) a “Bright Lights” program	All staff					End of Year One
Ensure open lines of communication	All staff					End of Year One

Appendix A CANADA GREEN BUILDING COUNCIL ZERO CARBON BUILDING STANDARD

ZERO CARBON BUILDING STANDARD

Canada Green Building Council®

May 2017

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EXECUTIVE SUMMARY

Over the past several decades, Canada has often been at the forefront of advocacy and action in response to environmental concerns. A prominent example is the Montreal Protocol, which was drafted during an international summit in the city in September 1987 and marked a significant step forward in dealing with the effects of ozone depletion. Indeed, former United Nations Secretary-General Kofi Annan regarded the agreement as "a model for international cooperation."[1]

A year later, Canada served a key role as host of the world's first major conference to examine the broader subject of climate change. Several hundred leading scientists gathered in Toronto in June 1988. The conference, "Our Changing Atmosphere: Implications for Global Security," was regarded as a landmark event.[2]

Fast-forward through the years and it becomes even clearer that Canadians have embraced our role as a galvanizing force for action. Today, Canada is recognized for being the first country to successfully negotiate carbon-trading mechanisms as part of the 2015 COP21 Climate Conference agreements in Paris, ensuring that broad market participation across nations can be achieved.[3] Within our own borders, the 2016 Pan-Canadian Framework on Clean Growth and Climate Change represents more than just our country's commitments to reducing its greenhouse gas emissions: it formalizes a path forward to secure our climate future.

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[1] "International Day for the Preservation of the Ozone Layer," United Nations, http://www.un.org/en/events/ozoneday/background.shtml.

[2] Elizabeth May, "When Canada Led the Way: A Short History of Climate Change," *Policy Options*, October 1, 2006, http://policyoptions.irpp.org/magazines/climate-change/when-canada-led-the-way-a-short-history-of-climate-change/.

[3] Bruce Cheadle, "Canadian Negotiators Pushing Emissions Trading Mechanisms at Climate Conference," *National Observer*, November 14, 2016, http://www.nationalobserver.com/2016/11/14/news/canadian-negotiators-pushing-emissions-trading-mechanisms-climate-conference.

The Canadian green building sector has been active – for decades in finding ways to limit harmful impacts from the built environment. While many of these efforts have been voluntary, an increasing number of governments across the country have recognized the potential of the building sector to fight climate change and have set more specific targets. To meet the COP21 goal of keeping global average temperature increases well below 2ºC, green building organizations around the world are supporting the objective of eliminating greenhouse gas (GHG) emissions associated with the operation of new buildings by 2030, and eliminating the GHG emissions from *all* buildings by 2050.

To meet those targets, bold new approaches are required to drive innovation. For its part, the Canada Green Building Council (CaGBC) has created a new zero carbon standard for assessing the carbon performance of commercial, institutional, and multi-family buildings in Canada. The CaGBC Zero Carbon Building Standard is a unique, made-in-Canada solution to achieving our climate change commitments, providing a path for both new and existing buildings to reach zero carbon.

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

ZERO CARBON REPRESENTS THE NEXT FRONTIER FOR THE BUILDING SECTOR

Canada has one of the most advanced green building sectors in the world and is well positioned to meet the challenge of reducing and eventually eliminating GHG emissions from building operations. Over the last decade green building certification programs have raised the bar for energy-efficiency, renewable energy and sustainability practices and, as a result, have changed the way buildings are designed, constructed, maintained, and operated.

Leadership in Energy and Environmental Design™ (LEED®) certification has demonstrated the market's interest in, and capability to adopt, leading sustainability practices, and has established the business case for such approaches. LEED projects certified in Canada before 2015 are projected to support 700,000 jobs and economic benefits exceeding $62 billion over their life spans.[4] Not only are these buildings better for the environment, but owners also benefit from higher lease rates, report greater tenant satisfaction scores, and spend approximately 28 percent less on energy compared with their non-certified counterparts.[5]

Building on these advancements, the next evolution is underway to meet the needs of a low-carbon economy. Green buildings can and should provide a gateway to innovation, representing an opportunity to apply new approaches, technologies and products that will lead to low carbon performance.

The CaGBC's Zero Carbon Building Standard provides a means to that end by making carbon reductions the key indicator for building performance and encouraging owners to drive down real emissions from buildings. Taking a carbon-centric approach is crucial because the most important factor in the emissions footprint of a building is often not energy performance, but rather the carbon intensity of the local electrical grid and the fossil fuels used. Recognizing the differences in electrical grids and fuels sources is critical to accurately assessing impacts and guiding investments.

The Zero Carbon Building Standard re-enforces the importance of energy efficiency while also driving careful choices about the types of energy used and encouraging more renewable energy generation both on the building site and offsite.

New construction projects present the best opportunities to achieve zero carbon performance and create a low carbon building stock for future generations. New buildings can be designed for optimal efficiency and resiliency. They can readily integrate renewable energy generation and select technologies that avoid the onsite combustion of fossil fuels.

At the same time, over 80 percent of existing buildings will still be in operation in 2030 and 50 percent in 2050, and therefore existing buildings need to be addressed in order to meet GHG reduction targets for the building sector. To help these buildings overcome the considerable physical and financial limitations in implementing deep retrofits, as much flexibility as possible should be provided in meeting a zero carbon objective.

To acknowledge these differences, the CaGBC's Zero Carbon Building (ZCB) Standard is designed to allow owners of both new construction projects and existing buildings to apply for certification, with unique requirements for each.

New construction projects earn **Zero Carbon Building – Design** certification by modeling a zero carbon balance, highly efficient envelope and ventilation systems, and onsite renewable energy systems. Project teams are required to evaluate energy use holistically, including impacts on peak electricity, and determine the GHG emissions associated with structural and envelope materials. Once occupied, buildings must demonstrate a zero carbon balance over the course of twelve months of operation before they earn **Zero Carbon Building – Design + Performance** designation. Existing buildings can only pursue **Zero Carbon Building – Performance** certification, which does not require a minimum of onsite renewable energy or a minimum level of thermal energy demand performance.

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[4] *Market Impacts Report*, Canada Green Building Council, 2016.

[5] Avis Devine and Nils Kok, "Green Certification and Building Performance: Implications for Tangibles and Intangibles," *Journal of Portfolio Management* – Special Real Estate Issue, 2015, http://www.iinews.com/site/pdfs/JPM_RE_2015_Kok.pdf.

Requirements of the Standard

	ZCB-Design (new construction)	ZCB-Performance (existing buildings)
Demonstrate Zero Carbon Balance	✓	✓
Provide Zero Carbon Transition Plan*	✓	Every 5 years
Install Minimum 5% Onsite Renewable Energy	✓	No requirement
Achieve Thermal Energy Demand Intensity Target	✓	No requirement
Report Energy Use Intensity	✓	✓
Report Peak Demand	✓	✓
Report Embodied Carbon	✓	✓

*Where fuels other than zero emissions biofuels are used onsite

ZERO CARBON BALANCE

Central to the standard's requirements is the achievement of a zero carbon balance, measured annually, in all building operations. To achieve that balance, GHG emissions associated with building operations must be offset using low-carbon renewable energy, either produced onsite or procured from offsite through a contractual arrangement.

The standard applies the GHG inventory methodology used by ENERGY STAR® Portfolio Manager®, the most commonly used energy-performance tracking and benchmarking platform in Canada. Portfolio Manager is used by over 13,000 buildings across the country and serves as the basis for evaluating energy efficiency under the LEED for Existing Buildings: Operations & Maintenance (EB:O&M) rating system. It is also increasingly being adopted for tracking and reporting energy use under benchmarking and disclosure regulations.

The Portfolio Manager methodology is based on the Greenhouse Gas Protocol Corporate Accounting and Reporting Standard developed by the World Resources Institute and World Business Council for Sustainable Development. Portfolio Manager uses average regional emissions intensities for both natural gas and grid electricity to most accurately reflect the actual emissions intensity of a building's operational energy use.

ZERO CARBON TRANSITION PLAN

Significant financial and technological barriers to all-electric buildings may exist in some climate zones and building markets. For this reason, the Zero Carbon Building Standard allows the onsite combustion of fossil fuels and biologically derived fuels. All applicants who rely on onsite combustion of fuels other than zero emissions biofuels must provide a transition plan to demonstrate how the building will decarbonize in the future, showing that they have considered appropriate building design or retrofit measures. Buildings pursuing ZCB-Performance certification are required to update their transition plans every five years.

ONSITE RENEWABLE ENERGY

While the zero carbon balance can be achieved using either onsite or offsite sources of renewable energy, ZCB-Design certification requires that at least five percent of the building's total energy consumption be met using renewable energy that is generated onsite. Generating onsite renewable energy helps to improve building resilience in the face of power outages, reduces overall demand from the electrical grid, minimizes environmental impacts from power generation facilities, and helps prepare for a distributed energy future. To recognize the challenges and limitations faced by existing buildings, this requirement does not apply to ZCB-Performance certification.

THERMAL ENERGY DEMAND INTENSITY

Thermal energy demand intensity (TEDI) refers to the annual heat loss from a building's envelope and ventilation, after accounting for all passive heat gains and losses. Specific TEDI targets for ZCB-Design certification have been set, as per the table on the next page.

The inclusion of a specific TEDI target results in greater occupant comfort and ensures that building designers focus on minimizing a building's demand for energy prior to producing or procuring renewable energy. The target also helps to ensure long-term energy performance, as building

envelopes have long life spans and yield very reliable efficiency gains. Furthermore, they are typically challenging to retrofit.

Finally, improved thermal performance is correlated with improved resilience in the face of power outages, as building interiors are better able to maintain comfortable temperatures when the power supply is disrupted.

TEDI targets for ZCB-Design certification

Climate Zone	TEDI target (kWh/m2/year)
4	30
5	32
6	34
7	36
8	40

Given the challenges and cost implications of major envelope retrofits, applicants for ZCB-Performance certification are not required to meet specific TEDI targets. However, they are encouraged to consider measures to reduce thermal energy demand intensity as opportunities arise.

ENERGY USE INTENSITY

Energy use intensity (EUI) refers to a building's total operational energy use, including all heating, cooling, ventilation, lighting, plug, and process loads. The Zero Carbon Building Standard requires applicants to report their EUI to provide transparency and enable the industry to learn from each zero carbon building. Reporting EUI also enables the building operators to gauge the effectiveness of energy conservation measures and demonstrate progress over time. To provide flexibility to design teams, and in recognition of the further reductions in EUI that codes and incentive/recognition programs can be expected to drive over time, no EUI targets for new construction have been established. Similarly, EUI targets have not been set for operational performance to recognize the wide range in performance of existing buildings and encourage the greatest number of buildings to achieve zero carbon.

PEAK DEMAND

Several Canadian grids are experiencing significant stresses as populations grow and extreme weather events challenge the reliability of utility service delivery. Increased demand can also push up the marginal emissions intensity of electricity use in lower-carbon grids, as sources of backup power often rely on natural gas. To address these concerns, applicants for zero carbon certification will be required to report their annual peak demand. As with EUI, the rationale for this component of the standard is to encourage projects to track and reduce their peak demand over time, helping to reduce stress on the grid and the need for additional generation capacity.

EMBODIED CARBON

Although operational carbon emissions represent the key focus of the Zero Carbon Building Standard, there is a growing awareness of the importance of addressing the embodied carbon and other GHG emissions associated with building materials. Emissions associated with the manufacturing, transport, and installation of building components currently represent a relatively low proportion of an average building's total carbon footprint, but these emissions grow in importance as operational emissions are reduced. Applicants will be required to report the embodied emissions of the building's structural and envelope materials using life-cycle assessment (LCA) software. The embodied carbon requirement has been limited to reporting, to encourage the building industry to grow capacity for conducting LCA - a practice that is still relatively new in Canada.

LOOKING AHEAD

The standard is the product of a broad stakeholder consultation process, driven by a desire to craft a program that is both attractive to the building industry and rigorous in the outcomes it produces. In order to help inform the standard's evolution, the CaGBC launched the **Zero Carbon Building Pilot Program** in January 2017.[6] It offers a two-year immersion opportunity for developers and designers attempting to achieve zero carbon in new or existing buildings. The program is designed to support participants,

[6] Zero-Carbon Buildings Pilot Program, Canada Green Building Council, http://bit.ly/2qsaJsd.

recognize excellence and leadership, and inform the development of tools, resources and education to accelerate market transformation. The pilots themselves will assist CaGBC in refining the standard to ensure it can be adopted widely by the marketplace.

While there is no doubt that Canada's building sector has been dramatically transformed over the last two decades, the time has come to be more ambitious. The CaGBC's Zero Carbon Building Standard will drive meaningful change by defining new levels of performance and bringing focus to carbon emissions reduction. By recognizing the enormous potential that built environments offer, the Standard will help the building industry do its part in shaping Canada's climate future.

***Box 1** Working Group members*

ZCB Working Group members	CaGBC Energy and Engineering Technical Advisory Group members
Natural Resources Canada	Jason Manikel (chair) – Energy Profiles
National Research Council	Lindsay Austrom – Stantec Consulting Ltd.
Public Service and Procurement Canada – Real Property Branch	Eric Van Benscoten – Van-Fort Inc.
Royal Architectural Institute of Canada	Christian Cianfrone – Morrison Hershfield
Real Property Association of Canada	Kevin Henry – HDR Architecture Associates Inc.
Toronto and Region Conservation Authority	Curt Hepting – Enersys Analytics Ltd.
Toronto Atmospheric Fund	Steve Kemp – RDH Building Science Inc.
Pembina Institute	Wendy MacDonald – Advicas Group Consultants Inc.
Province of BC Building Safety Policy Branch	Craig McIntyre – Provident Energy Management Inc.
ON Ministry of Municipal Affairs & Housing	Andrew Morrison – Caneta Research Inc.
City of Toronto	Jean-Francois Pelletier – Vellum
City of Vancouver	Martin Roy – Martin Roy et Associés Groupe Conseil Inc.
University of British Columbia	Gordon Shymko – G.F. Shymko & Associates Inc.
	Anrej Simjanov – Mission Green Buildings
LEED Canada Steering Committee members	**Renewable Energy Working Group members**
Jennifer Sanguinetti (chair) – University of British Columbia	Chris Caners – Solar Share
Cindy Choy - Ministry of Infrastructure and	Ron Seftel – Bullfrog Power
Transportation, Government of Manitoba	Victoria Gagnon – IESO
Marsha Gentile – Ledcor	Patrick Bateman – CanSIA
Arsheel Hirji - City of Calgary Engineering & Energy Services	Nancy Rondeaux – Nova Scotia Department of Energy
Edwin Lim – ECOlibrium	Donovan Woollard – RADIUS Ventures
Josée Lupien – Vertima	Gerard MacDonald – Reshape Strategies
Jamie MacKay – Morrison Hershfield	Kevin Wallace, BC Hydro
Jason Manikel – Energy Profiles	Joan Haysom – Leidos Canada
Grant Peters – Fluent Group	Maryse Lambert, Hydro Quebec
Keith Robertson – Solterre Design	Jeff Toye & Michael Shaw – Manitoba Hydro
Lyle Scott – Footprint	
Doug Webber – WSP Canada Inc.	

THE KEY COMPONENTS OF THE ZERO CARBON BUILDING STANDARD

The Canada Green Building Council's **Zero Carbon Building Standard** represents a unique, made-in-Canada solution that can help us achieve our climate change commitments.

1 ZERO CARBON BALANCE

No net greenhouse gas (GHG) emissions are associated with building operations. GHG emissions are offset by generating clean, renewable energy onsite or offsite.

2 EFFICIENCY

New construction projects consider peak energy while maximizing energy efficiency with a focus on the building envelope and ventilation strategies that drive down thermal energy demand.

3 RENEWABLE ENERGY

Onsite renewable energy is incorporated into new construction projects to provide added resiliency, minimize offsite environmental impacts, and prepare buildings for a distributed energy future.

4 LOW-CARBON MATERIALS

An assessment of the carbon associated with structural and envelope materials—from manufacturing to end of life—informs design decisions.

TO LEARN MORE, VISIT WWW.CAGBC.ORG.

Canada Green Building Council
Every Building Greener

INTRODUCTION

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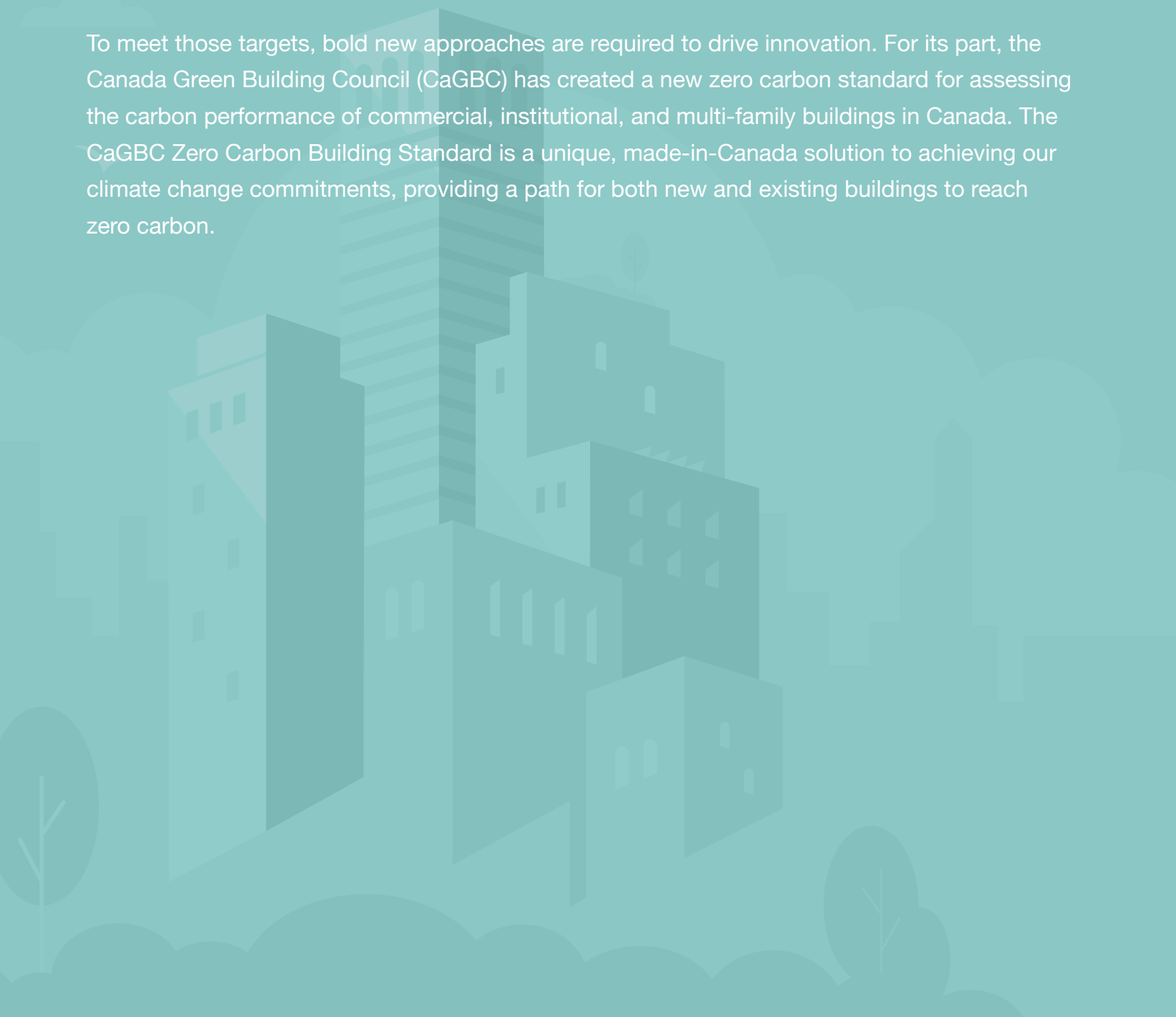
[8] Elizabeth May, "When Canada Led the Way: A Short History of Climate Change," *Policy Options*, October 1, 2006, http://policyoptions.irpp.org/magazines/climate-change/when-canada-led-the-way-a-short-history-of-climate-change/.

[9] Bruce Cheadle, "Canadian Negotiators Pushing Emissions Trading Mechanisms at Climate Conference," *National Observer*, November 14, 2016, http://www.nationalobserver.com/2016/11/14/news/canadian-negotiators-pushing-emissions-trading-mechanisms-climate-conference.

The Canadian green building sector has been active for decades in finding ways to limit harmful impacts from the built environment. While many of these efforts have been voluntary, an increasing number of governments across the country have recognized the potential of the building sector to fight climate change and have set more specific targets. To meet the COP21 goal of keeping global average temperature increases well below 2ºC, green building organizations around the world are supporting the objective of eliminating greenhouse gas (GHG) emissions associated with the operation of new buildings by 2030, and eliminating the GHG emissions from all buildings by 2050.

To meet those targets, bold new approaches are required to drive innovation. For its part, the Canada Green Building Council (CaGBC) has created a new zero carbon standard for assessing the carbon performance of commercial, institutional, and multi-family buildings in Canada. The CaGBC Zero Carbon Building Standard is a unique, made-in-Canada solution to achieving our climate change commitments, providing a path for both new and existing buildings to reach zero carbon.



ZERO CARBON REPRESENTS THE NEXT FRONTIER FOR THE BUILDING SECTOR

Canada has one of the most advanced green building sectors in the world and is well positioned to meet the challenge of reducing and eventually eliminating GHG emissions from building operations. Over the last decade green building certification programs have raised the bar for energy-efficiency, renewable energy and sustainability practices and, as a result, have changed the way buildings are designed, constructed, maintained, and operated.

Leadership in Energy and Environmental Design™ (LEED®) certification has demonstrated the market's interest in, and capability to adopt, leading sustainability practices, and has established the business case for such approaches. LEED projects certified in Canada before 2015 are projected to support 700,000 jobs and economic benefits exceeding $62 billion over their life spans.[10] Not only are these buildings better for the environment, but owners also benefit from higher lease rates, report greater tenant satisfaction scores, and spend approximately 28 percent less on energy compared with their non-certified counterparts.[11]

Building on these advancements, the next evolution is underway to meet the needs of a low-carbon economy. Green buildings can and should provide a gateway to innovation, representing an opportunity to apply new approaches, technologies and products that will lead to low carbon performance.

The CaGBC's Zero Carbon Building Standard provides a means to that end by making carbon reductions the key indicator for building performance and encouraging owners to drive down real emissions from buildings. Taking a carbon-centric approach is crucial because the most important factor in the emissions footprint of a building is often not energy performance, but rather the carbon intensity of the local electrical grid and the fossil fuels used. Recognizing the differences in electrical grids and fuel sources is critical to accurately assessing impacts and guiding investments. The Zero Carbon Building Standard re-enforces the importance of energy efficiency while also driving careful choices about the types of energy used and encouraging more renewable energy generation both on the building site and offsite.

New construction projects present the best opportunities to achieve zero carbon performance and create a low carbon building stock for future generations. New buildings can be designed for optimal efficiency and resiliency. They can readily integrate renewable energy generation and select technologies that avoid the onsite combustion of fossil fuels.

At the same time, over 80 percent of existing buildings will still be in operation in 2030 and 50 percent in 2050, and therefore existing buildings need to be addressed in order to meet GHG reduction targets for the building sector. To help these buildings overcome the considerable physical and financial limitations in implementing deep retrofits, as much flexibility as possible should be provided in meeting a zero carbon objective.

To acknowledge these differences, the CaGBC's Zero Carbon Building (ZCB) Standard is designed to allow owners of both new construction projects and existing buildings to apply for certification, with unique requirements for each.

NEW CONSTRUCTION AND EXISTING BUILDINGS

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

Projects that achieve the requirements for new construction earn **ZCB-Design** certification. Certification is based on final building design and requires a modelled zero carbon balance; highly efficient envelope and ventilation systems to meet a defined threshold for thermal energy demand intensity; and onsite renewable energy systems capable of providing a minimum of 5% of building energy consumption.

[10] *Market Impacts Report*, Canada Green Building Council, 2016.

[11] Avis Devine and Nils Kok, "Green Certification and Building Performance: Implications for Tangibles and Intangibles," *Journal of Portfolio Management* – Special Real Estate Issue, 2015, http://www.iinews.com/site/pdfs/JPM_RE_2015_Kok.pdf.

At its heart, the program is about demonstrating a zero carbon balance in building operations year after year. Buildings that achieve a zero carbon balance and meet the other requirements for existing buildings earn **ZCB-Performance** certification. ZCB-Performance certification is awarded based on a twelve month period of operations, and performance must be verified annually. Recognizing the inherent challenges to retrofitting existing buildings, ZCB-Performance does not require a minimum of onsite renewable energy or a minimum level of thermal energy demand performance.

Buildings that receive ZCB-Design certification are expected to pursue ZCB-Performance certification annually following occupancy. A building that has achieved ZCB-Design certification can apply for ZCB-Performance certification any time after one year of building performance data has been collected. Achieving dual-certification earns buildings the unique designation of **ZCB–Design + Performance**.

Under both ZCB-Performance and ZCB-Design, applicants must evaluate energy use holistically, including impacts on peak electricity, and determine the GHG emissions associated with structural and envelope materials (i.e. embodied carbon). The program's alignment with ENERGY STAR® Portfolio Manager® ensures streamlined documentation of energy performance and GHG emissions.

The requirements of the Zero Carbon Building Standard are summarized below and detailed in subsequent sections.

***Table 1** Requirements of the Standard*

	ZCB-Design (new construction)	ZCB-Performance (existing buildings)
Demonstrate Zero Carbon Balance	✓	✓
Provide Zero Carbon Transition Plan*	✓	Every 5 years
Install Minimum 5% Onsite Renewable Energy	✓	No requirement
Achieve Thermal Energy Demand Intensity Target	✓	No requirement
Report Energy Use Intensity	✓	✓
Report Peak Demand	✓	✓
Report Embodied Carbon	✓	✓

*Where fuels other than zero emissions biofuels are used onsite

ELIGIBILITY AND CERTIFICATION

The ZCB-Design program applies to new commercial, institutional, and multi-family residential buildings other than those covered by Part 9 of the National Building Code, and major renovations to existing buildings. Major renovations to existing buildings include any HVAC, envelope, and/or interior renovations that require a new certificate of occupancy and/or prevent normal building operations from occurring while they are in progress. Proposed changes of use to the building in question are also considered major renovations.

The ZCB-Performance program applies to commercial, institutional, and multi-family residential buildings other than those covered by Part 9 of the National Building Code, provided they have been in operation for three or more years at the time of submittal or were previously certified under ZCB-Design.

Applicants will be awarded certification once all requisite documentation has been received and a review by the CaGBC has confirmed the requirements of the Zero Carbon Building program have been met.

SCOPE

The Zero Carbon Building Standard applies to the entirety of a building site and includes all energy use and generation. A site may include one or more buildings, either as independent or interconnected structures. Consistent with ENERGY STAR® Portfolio Manager®, parking areas may be excluded if all associated energy use and generation is sub-metered.

LOOKING AHEAD

The standard is the product of a broad stakeholder consultation process, driven by a desire to craft a program that is both attractive to the building industry and rigorous in the outcomes it produces. In order to help inform the standard's evolution, the CaGBC launched the Zero Carbon Building Pilot Program in January 2017.[12] It offers a two-year immersion opportunity for developers and designers attempting to achieve zero carbon in new or existing buildings. The program is designed to support participants, recognize excellence and leadership, and inform the development of tools, resources and education to accelerate market transformation. The pilots themselves will assist CaGBC in refining the standard to ensure it can be adopted widely by the marketplace.

While there is no doubt that Canada's building sector has been dramatically transformed over the last two decades, the time has come to be more ambitious. The CaGBC's Zero Carbon Building Standard will drive meaningful change by defining new levels of performance and bringing focus to carbon emissions reduction. By recognizing the enormous potential that built environments offer, the Standard will help the building industry do its part in shaping Canada's climate future.

[12] Zero-Carbon Buildings Pilot Program, Canada Green Building Council, http://bit.ly/2qsaJsd.

PROGRAM REQUIREMENTS

1. ZERO CARBON BALANCE
2. ZERO CARBON TRANSITION PLAN
3. ONSITE RENEWABLE ENERGY GENERATION
4. THERMAL ENERGY DEMAND INTENSITY
5. ENERGY USE INTENSITY
6. PEAK DEMAND
7. EMBODIED CARBON
8. COMPLIANCE AND DOCUMENTATION SUMMARY

1. ZERO CARBON BALANCE

Applicants to the Zero Carbon Building (ZCB) program must demonstrate a zero carbon balance in building operations – that is, projects must annually generate or procure enough zero-emissions, *renewable energy* to offset 100% of the GHG emissions associated with the building's total annual site energy consumption. Existing buildings are evaluated using actual performance, while new construction and major renovation projects are evaluated based on final design.

1.1. ENERGY STAR® PORTFOLIO MANAGER®

The ZCB program leverages ENERGY STAR Portfolio Manager's methodology for calculating GHG emissions in order to support consistency across the building sector and facilitate the calculation of ZCB program requirements. All GHG emission calculations for compliance to the ZCB program follow the Portfolio Manager methodology unless otherwise stated below. For clarification on any component of the Portfolio Manager approach to GHG emissions calculations, please refer to the Technical References on *GHG Emissions*[13] and *Green Power*[14].

Applicants to the ZCB program are required to use Portfolio Manager to track their GHG emissions. However, separate calculations may be required where:

1. *Renewable Energy Certificates (RECs)* are purchased to achieve the zero carbon balance (see Section 1.6);
2. Any energy generated using onsite zero emission *renewable energy* systems is exported to the grid (see Section 1.7); and
3. An applicant chooses to apply custom emissions factors for any district energy, electricity from an *islanded grid*, or onsite biogas or biomass systems used in building operations (see sections 1.4 and 1.5).

As noted in the Technical Reference on GHG Emissions[15], Portfolio Manager does not account for energy consumed for onsite vehicle use, industrial or manufacturing processes, or fugitive refrigerant emissions that result from a building's use of refrigeration or air conditioning equipment.

1.2. CALCULATING THE ZERO CARBON BALANCE

A zero carbon balance is demonstrated by achieving a net emissions balance of zero or less, where net emissions are defined as follows:

Net Emissions =

(*Direct Emissions* + *Indirect Emissions* + Biomass Emissions) – (Avoided Emissions from Offsite Green Power + Avoided Emissions from Exported Green Power)

This calculation has been adapted from Portfolio Manager's standard method of calculating the emissions balance, which does not recognize avoided emissions from exported *green power* (electricity generated from renewable resources, such as solar or wind resources). *Renewable energy* generated and used onsite (typically *green power*) does not contribute to avoided emissions in the calculation of Net Emissions under Portfolio Manager or the ZCB program, as these avoided emissions are already captured through the reduced reliance on energy sources that have associated emissions, such as grid electricity.

The individual components of the equation and their relevance to the zero carbon balance are outlined in the sections below, with a summary provided in Section 1.9.

1.3. DIRECT EMISSIONS

'*Direct Emissions*' refers to emissions associated with onsite combustion, with the exception of biomass combustion (see Section 1.5). Portfolio Manager applies transparent emissions factors to calculate annual building emissions associated with onsite combustion. Provincial GHG factors are used for natural gas, while national factors are used for other fossil fuels (e.g. propane, fuel oil, and diesel). Specific emissions factors are summarized in Figures 1 and 2 of Portfolio

[13] ENERGY STAR® Portfolio Manager Technical Reference: Greenhouse Gas Emissions. August 2016. https://portfoliomanager.energystar.gov/pdf/reference/Emissions.pdf.

[14] ENERGY STAR® Portfolio Manager, Technical Reference: Green Power, 2013, https://portfoliomanager.energystar.gov/pdf/reference/Green%20Power.pdf.

[15] ENERGY STAR® Portfolio Manager Technical Reference: Greenhouse Gas Emissions. August 2016. https://portfoliomanager.energystar.gov/pdf/reference/Emissions.pdf.

Manager's 2016 Technical Reference on GHG Emissions[16]. Portfolio Manager sources all Canadian GHG emissions factors from Canada's annual National Inventory Report.

1.3.1. BIOGAS

The ZCB program recognizes the emissions benefits of certain forms of renewable natural gas (biogas). Eligible biogas resources (i.e. those that are considered 'zero emissions' biofuels) that can be used onsite include gaseous products produced by the anaerobic decomposition of organic wastes from one of the following sources:

a) Sewage treatment plants;

b) Manure and other farm and food/feed-based anaerobic digestion processing facilities; and

c) Landfill gas.

Portfolio Manager currently uses provincial GHG factors for all natural gas combustion and does not recognize the carbon emissions benefits of biogas. Applicants must therefore perform calculations outside of Portfolio Manager in order to determine the required adjustment to the emissions reported by Portfolio Manager in association with biogas.

1.4. INDIRECT EMISSIONS

'*Indirect Emissions*' refers to those emissions associated with purchased energy, such as electricity or thermal energy.

1.4.1. GRID OR DISTRICT ELECTRICITY

Provincial emissions factors are used to represent the average emissions of all grid-connected electricity generators in a given province (whether baseload, intermediate, or peaking). Provincial emissions factors for 2016 are summarized in Figure 6 of Portfolio Manager's 2016 Technical Reference on GHG Emissions[17].

The ZCB program recognizes that in some instances electricity may be sourced from a district energy system or an *islanded grid* (a small grid not connected to the provincial grid). The emission factors for these specific sources may be used where they are available and can be verified by a registered professional. As Portfolio Manager does not permit changes to default emissions factors, applicants must perform calculations outside of Portfolio Manager in order to determine the required adjustment to the emissions reported by Portfolio Manager in association with the district energy system or *islanded grid*.

1.4.2. DISTRICT HEATING AND COOLING

Portfolio Manager provides national GHG emissions factors for district steam, district hot water, and three types of district chilled water systems (Figure 3 of Portfolio Manager's 2016 Technical Reference on GHG Emissions). Applicants are required to identify and enter the fuel being used and, if using district chilled water, the system used to power the building.

The ZCB program recognizes that the emissions factors in Portfolio Manager may not accurately reflect those of the district heating or cooling source for a given building. The emission factors for these specific sources may be used where they are available and can be verified by a registered professional. As Portfolio Manager does not permit changes to default emissions factors, applicants must perform calculations outside of Portfolio Manager in order to determine the required adjustment to the emissions reported by Portfolio Manager in association with the district heating or cooling system.

1.5. BIOMASS EMISSIONS

Portfolio Manager applies a single emissions factor for wood to all biomass (see Figure 7 of Portfolio Manager's 2016 Technical Reference on GHG Emissions[18]).

However, the ZCB program recognizes the emissions benefits of certain forms of renewable biomass. As such, applicants who use an onsite form of biomass may submit more specific emissions factors where they can be verified by a registered professional. As Portfolio Manager does not permit changes to default emissions factors, applicants must perform calculations outside of Portfolio Manager in order to determine the required adjustment to the emissions reported by Portfolio Manager in association with biomass.

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[16] ENERGY STAR® Portfolio Manager Technical Reference: Greenhouse Gas Emissions. August 2016. https://portfoliomanager.energystar.gov/pdf/reference/Emissions.pdf.

[17] ***Ibid.***

[18] ***Ibid.***

1.5.1. ELIGIBILITY OF BIOMASS RESOURCES AS ZERO EMISSIONS BIOFUELS

Biomass resources used onsite that are *eligible* to be treated as *zero emissions biofuels*[19] include:

a) Solid biomass removed from fields and forests which are managed by following sound environmental management practices. Solid biomass can either be whole plants, parts of plants, or harvesting and industrial by-product residues arising from the harvesting and processing of agricultural crops or forestry products that would otherwise be land filled or incinerated;
b) Dedicated energy crops with a rotation of less than 10 years; and
c) Liquid fuels derived from biomass as defined in items (a) and (b) above, including among other things ethanol, biodiesel, and methanol.

Biomass resources that are *ineligible* to be treated as *zero emissions biofuels* include:

a) Municipal solid waste;
b) Forest biomass waste other than mill residue; and
c) To prevent toxic emissions, those manufacturing process by-products that have been treated in the manners listed below:
    i. Wood coated with paint, plastics or formica;
    ii. Wood treated with preservatives containing halogens, chlorine or halide compounds like chromated copper arsenate or arsenic;
    iii. Wood that has been treated with adhesives; and
    iv. Railroad ties.

If the treated biomass types (per 'c' above) comprise 1% or less by weight of the total biomass used and the remainder is from eligible sources of biomass, all biomass may be considered eligible to be treated as a *zero emissions biofuel*.

1.6. AVOIDED EMISSIONS FROM OFFSITE GREEN POWER

'Avoided Emissions from Offsite Green Power' refers to the emissions that are avoided as a result of generating *green power* offsite. Avoided emissions from offsite *green power* can be used to offset any emissions associated with Direct, Indirect or Biomass Emissions.

1.6.1. ELIGIBILITY OF OFFSITE GREEN POWER

To qualify under the ZCB program, offsite *green power* must be generated from:

- Solar energy;
- Wind;
- Water (including low-impact hydro, wave, tidal, and in-stream sources);
- Qualifying biogas (see Section 1.3.1);
- Qualifying biomass (see Section 1.5), or;
- Geothermal energy

Electricity products that drive additional offsite green power generation include both *Renewable Energy Certificates* (*RECs*) and *bundled green power products* (*green power* purchased together with associated *RECs*). The EcoLogo CCD-003 Renewable Low-Impact Electricity Products standard establishes requirements for both. Note that the term "renewable low-impact electricity", as used in the EcoLogo standard, may be considered to be the equivalent of "*green power*", as used here and within Portfolio Manager.

Per the EcoLogo requirements, the electricity associated with all *green power* products (both *bundled green power products* and *RECs*) must be generated within the calendar year in which they are sold, the first three months of the following calendar year, or the last six months of the prior year.

Under the ZCB program, all *RECs* must be certified by EcoLogo and generated from *green power* facilities located in Canada.

Bundled green power products must either be certified under the EcoLogo standard, or meet a set of specific requirements (see Section 1.6.2). If the energy generator providing *green power* does not also provide the associated *RECs*, applicants must purchase *RECs* for 100% of the *green power* that is procured. Under the ZCB program, all *bundled green power products* must be generated in Canada, and per the EcoLogo standard, from a generation facility located

[19] 'Zero emissions' is meant to characterize certain biofuels from a net-carbon emissions perspective; it is understood that other combustion products are released during combustion.

in the *provincial power pool* in which the building is located or a neighbouring *provincial power pool*. Applicants are encouraged to purchase *green power* generated as locally as possible, i.e. within the local municipality, region, or province.

1.6.2. REQUIREMENTS FOR NON-ECOLOGO CERTIFIED BUNDLED GREEN POWER PRODUCTS

Where EcoLogo certification cannot be obtained, applicants to the ZCB program must demonstrate that the *bundled green power products* that have been procured meet the following criteria:

- Demonstrate that all bundled electricity is generated within the *provincial power pool* in which the building is located (note that EcoLogo certified products may also come from neighbouring *provincial power pools*). All bundled electricity must be generated in Canada;
- Conform to all local land use polices and building codes. The project must achieve planning permission and all applicable local permits as defined by the Authority Having Jurisdiction;
- Meet the requirements of the acceptable sources of offsite *green power* as defined in Section 1.6.1;
- For combustion-based systems, meet all of the requirements surrounding biofuels as outlined in Section 1.3.1 (biogas) and 1.5 (biomass);
- For combustion-based systems, meet all local and regional air quality by-laws and requirements and receive all necessary air quality permits from the Authority Having Jurisdiction;
- For all water-powered systems, demonstrate that the facility's installation and operations have achieved all regulatory licenses, requirements, and all other authorizations pertaining to fisheries, without regard to waivers or variances or authorized. These include authorizations issued by the relevant provincial authorities, and under Section 35(2) of the Fisheries Act, by the Minister of Fisheries and Oceans or regulations made by the Governor in Council under the Fisheries Act;
- For all water-powered systems, demonstrate that the facility's installation and operations do not achieve authorization with terms that allow for the harmful operation and or disruption or destruction of fish habitat, as verified by a registered professional Biologist;
- For wind-powered systems, demonstrate that the impacts from the facility are not located in known migratory routes for avian or bat species, and that the impacts on avian and bat species from the facility have been minimized as verified by a registered professional Biologist.

1.6.3. CALCULATING AVOIDED EMISSIONS FROM OFFSITE GREEN POWER

Avoided emissions from the procurement of offsite *green power* are calculated using the marginal or "non-baseload" emissions factor for the province in which the power is generated, regardless of the location of the applicant's building. Marginal grid emission factors (not average emission factors) are used in calculating avoided emissions to reflect the fact that when building loads decrease, non-baseload, or "peak load", power output is typically reduced first.[20] Portfolio Manager obtains marginal emissions factors for each province from Natural Resources Canada. These factors are summarized in Figure 9 of Portfolio Manager's 2016 Technical Reference on GHG Emissions[21].

An electricity meter in Portfolio Manager must be used to record all purchases of *bundled green power products*. Portfolio Manager does not allow the entry of *RECs* in an amount greater than the amount of grid electricity purchased, however; as a result *RECs* cannot be used to offset emissions associated with onsite combustion. To address this, ZCB program participants must track *RECs* and the associated avoided emissions outside of Portfolio Manager.

[20] ENERGY STAR® Portfolio Manager Technical Reference: Greenhouse Gas Emissions. August 2016. https://portfoliomanager.energystar.gov/pdf/reference/Emissions.pdf.

[21] *Ibid.*

1.6.4. ATTRIBUTING RECS TO MULTIPLE PROGRAMS

RECs may be used, or "retired", to meet any applicable regulatory programs in addition to the ZCB program. For example, where a building is located in a municipality or province that requires buildings to offset their operational energy consumption with the purchase of either *bundled green power products* or *RECs*, these purchases can also be used to meet the requirements of the ZCB program.

1.7. AVOIDED EMISSIONS FROM EXPORTED GREEN POWER

The ZCB program recognizes avoided emissions from onsite solar PV or wind energy exported to the grid in the calculation of the zero carbon balance, provided that the associated *RECs* are retained. The avoided emissions are to be calculated using marginal provincial CO_2e factors. As Portfolio Manager does not recognize these avoided emissions, applicants must perform calculations outside of Portfolio Manager in order to determine the required adjustment to the emissions reported by Portfolio Manager in association with exported *green power*.

1.8 REQUIRED DOCUMENTATION

Applicants must provide the following documentation to demonstrate achievement of a zero carbon balance.

1.8.1. ENERGY STAR® PORTFOLIO MANAGER®

Applicants must use Portfolio Manager to track the project's energy consumption and associated GHG emissions. Modeled data should be used in Portfolio Manager for the purposes of ZCB-Design certification. The following must be provided to demonstrate the zero carbon balance has been achieved:

- A download of the annual data for each meter (grid purchased electricity, natural gas, *green power* generated onsite (used onsite and/or exported), *bundled green power products*, *RECs*, etc.), and;
- Emissions data: Total GHG Emissions (the sum of *Direct Emissions* and *Indirect Emissions*), Biomass Emissions, Net Emissions, and Avoided Emissions from Offsite *Green Power*.

Applicants must also share access to the property in Portfolio Manager, by providing Read Only Access to the Canada Green Building Council (account is called "CaGBC ZCB Program").

1.8.2. ALTERNATIVE GHG EMISSIONS FACTORS

While Portfolio Manager assigns a national emissions factor for district energy systems, the ZCB program recognizes that more accurate emissions factors may be obtainable. Where an applicant wishes to use a more specific emissions factor for district energy used in the building, the specific emissions factor calculated by the district energy provider will be accepted. This also applies to any electricity that is procured from an *islanded grid*.

Similarly, applicants using biogas or biomass as an onsite source of energy may submit separate GHG emission calculations that utilize a more accurate emissions factor, where one can be issued by a third party (i.e. not the building owner/manager).

In all cases, a registered professional must sign-off on any custom GHG emissions factor. Applicants must submit all calculations to the CaGBC for review.

1.8.3 ONSITE RENEWABLE ENERGY

Applicants to the ZCB–Design program must report on the quantity of usable energy predicted to be produced by *renewable energy* systems annually (calculated as the output energy from the system less any transmission and conversion losses, such as standby heat loss or losses when converting electricity from DC to AC), and the quantities predicted to be used onsite and exported.

Applicants to the ZCB–Performance program must report on the quantity of *renewable energy* that was generated onsite, and the amounts that were used onsite and exported, during the year for which certification is being sought.

These values may be provided in the form of a downloaded report from Portfolio Manager.

The Portfolio Manager meter used to record any energy generated by *onsite renewable energy* systems other than solar PV or wind (such as solar thermal), which have their own meters, should be classified as electric onsite solar to ensure that all *onsite renewable energy* is reported.

Applicants must provide calculations for the avoided emissions from *onsite renewable energy* that is exported, using the marginal provincial CO_2e factors.

1.8.4. OFFSITE GREEN POWER

The emissions that must be offset with *green power products* (*bundled green power products* and/or *RECs*) to achieve a zero carbon balance can be calculated as follows:

Required avoided emissions from purchases of *green power products* =

***Direct Emissions* + *Indirect Emissions* + Biomass Emissions – Avoided Emissions from Exported Green Power**

Applicants to the ZCB-Design program must provide the following information:

- A narrative indicating the commitment to fulfil the zero carbon balance requirement using purchases of offsite *green power products*, including the intended supplier;
- Estimates of the total quantity of offsite *green power products* that will be required to achieve the zero carbon balance;
- Estimates of the anticipated annual costs associated with the purchase of any required offsite *green power products*, and;
- Sources for all costs used in the calculation of annual cost estimates

Applicants to the ZCB-Performance program must submit proof of purchase (executed contracts) for all offsite *green power products*, as well as the following details for each source of offsite *green power*:

- Type of facility
- Project owner
- Ownership structure
- Year of generation
- Location of generation
- Fuel mix (if from more than one source)
- Estimates of total annual energy generation
- Proof of EcoLogo certification, if applicable (mandatory for *RECs*)
- The quantity of *bundled green power products* and *RECs* purchased
- The type of purchase agreement
- The length of the purchase agreement (in years)
- A copy of the purchase agreement.

1.8.5. NON-ECOLOGO CERTIFIED BUNDLED GREEN POWER PRODUCTS

Where EcoLogo certification cannot be obtained, applicants to the ZCB program must demonstrate that the *bundled green power products* that have been procured meet the criteria established in Section 1.6.2. In addition to the documentation requirements under 1.8.4, applicants must also provide the following documentation:

- A report from the generation facility that notes the methodology and calculations that were used to ensure that the design and operation of the facility will be sufficient to meet the contractual commitment made to the applicant. It will also note and detail the resources used to generate the energy and outline any limiting factors that may impact the ability of the facility to deliver energy. In such cases where resources are prone to fluctuations, a range will be provided to represent the best and worst-case scenarios, noting the methodology used to develop these scenarios (e.g. if the wind blows as anticipated; if the wind blows at the lowest annual recorded levels, etc.)
- Proof of the generation facility's commitment to retire the *environmental attributes* (i.e. *RECs*) that have been procured by the applicant (e.g. proof that *RECs* have been registered with a third party tracking system).

1.8.6. ANNUAL ADJUSTMENTS OF OFFSITE GREEN POWER PROCUREMENT

Applicants to the ZCB-Performance program must submit a copy of all purchase agreements for offsite *green power* products on an annual basis. Applicants wishing to demonstrate that a surplus of *renewable energy* was purchased in the preceding year must submit documentation to indicate the nature and extent of the surplus and how this affects the current year's emissions balance.

1.9. SUMMARY - ACHIEVING THE ZERO CARBON BALANCE

***Table 2** Summary – Achieving the Zero Carbon Balance*

Energy Source	Portfolio Manager Meter	GHG Calculation Method	Emissions Balance
***Direct Emissions** (onsite combustion)*			
Fuel Oil, Propane, Diesel, Kerosene	Fuel Oil, Propane, Diesel, or Kerosene Meter	Total site energy is multiplied by national CO_2e factor	Added to Direct Emissions
Natural Gas / Biogas	Natural Gas Meter	Total site energy is multiplied by provincial CO_2e factors[1]	Added to Direct Emissions
Indirect Emissions			
Grid or District Electricity	Electric Meter	Total site energy is multiplied by average provincial CO_2e factors[1]	Added to Indirect Emissions
District Heating/ Cooling	District Steam, Hot Water, or Chilled Water Meter	Total site energy is multiplied by national CO_2e factors[1]	Added to Indirect Emissions
***Biomass Emissions** (onsite combustion)*			
Biomass	Wood Meter	Total site energy is multiplied by national CO_2e factor for wood[1]	Added to Biomass Emissions
Avoided Emissions			
Offsite Green Power – Bundled Electricity	Electric Meter, specified as Green Power	Calculated using marginal provincial CO_2e factors, based on the location of power generation	Added to Avoided Emissions - Offsite Green Power
Offsite Green Power - RECs	Tracked outside Portfolio Manager[2]	Calculated using marginal provincial CO_2e factors, based on the location of power generation	Added to Avoided Emissions - Offsite Green Power
Onsite Green Power – Solar PV or Wind (used onsite, ownership of RECs retained)	Electric Onsite Solar or Wind Meter	Calculated using average provincial CO_2e factors	Indirect emissions reduction as a result of decreased consumption of grid electricity[3]
Onsite Green Power – Solar PV or Wind (exported, ownership of RECs retained	Electric Onsite Solar or Wind Meter	Calculated using marginal provincial CO_2e factors[4]	Added to Avoided Emissions - Exported Green Power[4]
Onsite Renewable Energy – Other than onsite green power (such as solar thermal)	Electric Onsite Solar Meter[5]	Calculated using average provincial CO_2e factors	Indirect emissions reduction as a result of decreased consumption of grid electricity[3]

[1] The ZCB program allows participants to submit individually-sourced emissions factors for biogas, biomass, district heating/cooling systems, and islanded or district electricity systems, where the emissions factors are available and can be verified by a registered professional. Biogas and biomass may qualify as zero emissions. As Portfolio Manager does not permit changes to default emissions factors, applicants must submit separate calculations.

[2] Portfolio Manager enables tracking of RECs however they must be tied to an electricity meter. For the purposes of the ZCB program RECs must be tracked outside Portfolio Manager so as to enable participants to use RECs to offset emissions from onsite combustion.

[3] Portfolio Manager reports the benefit from reduced reliance on grid electricity in the Onsite Avoided Emissions metric; this metric does not contribute to lowering Net Emissions under Portfolio Manager or the ZCB program, as it is only a quantification of the benefit gained from consuming less grid electricity.

[4] The ZCB program recognizes avoided emissions from exported electricity generated from solar PV or wind. As Portfolio Manager does not recognize these avoided emissions, applicants must submit separate calculations.

[5] The ZCB program recognizes avoided emissions from other zero-emissions onsite renewable energy systems. As Portfolio Manager cannot assess emissions if any meter is classified as "Other", the meter for a renewable energy system other than solar PV or wind should be classified as electric onsite solar.

2. ZERO CARBON TRANSITION PLAN

Applicants to the ZCB program who rely on onsite combustion of fuels other than *zero emissions biofuels* must prepare a Zero Carbon Transition Plan. The transition plan must indicate how the impact of onsite combustion will be mitigated over the lifetime of the building, including the way emissions derived from onsite combustion will be reduced or eliminated using specific design or energy efficiency measures.

2.1 REQUIRED DOCUMENTATION

The Zero Carbon Transition Plan must include the following information:

- A narrative describing why combustion of fuels, other than *zero emissions biofuels*, is necessary (e.g. cite financial and/or technical limitations to design/retrofit);
- A narrative of how building loads have been reduced using heat recovery strategies and/or passive design strategies;
- A narrative describing the mechanical HVAC strategy and how components of the system may be adapted to accommodate non-combustion based technologies, including:
    - Operating temperatures of the distribution system and its ability to accommodate renewable or electrical sourced heating;
    - Space allocation for renewable or electrical-sourced heating technologies;
    - Any barriers to be overcome or preconditions that must be in place for a conversion to a non-combustion based heating source to occur;
- Drawings that show provisions for future upgrades (e.g. space for electricity-based systems, roof space, etc.); and
- A financial comparison of the designed or current system and a non-combustion based alternative, including a 20-year net present value calculation, which includes current and projected fuel cost escalation and a 3% discount rate.

Applicants to the ZCB–Performance program that rely on onsite combustion of fuels other than *zero emissions biofuels* are required to submit a Zero Carbon Transition Plan as part of their initial certification (unless ZCB-Design certification was achieved within the last 5 years). Transition Plans must be updated every five years.

3. ONSITE RENEWABLE ENERGY GENERATION

Applicants to the ZCB-Design program must install *onsite renewable energy* systems to generate a minimum of 5% of the building's total annual energy consumption. Generating *onsite renewable energy* helps to improve building resilience in the face of power outages, reduces overall demand from the electrical grid, minimizes environmental impacts from power generation facilities, and helps prepare for a distributed energy future.

A separate meter in Portfolio Manager must be created to track each *onsite renewable energy* generation system. Note that a Portfolio Manager onsite solar meter should be used to track energy from a solar thermal system[22]. Applicants should refer to the Portfolio Manager Technical Reference on Green Power[23] for details on entering information about onsite *green power* such as solar PV or wind. All *environmental attributes* (in the form of *RECs*) associated with the onsite generation and/or export of *onsite renewable energy* must be retained by the applicant (cannot be sold) to be counted toward the fulfillment of the 5% minimum requirement and the achievement of the zero carbon balance.

Applicants to the ZCB-Performance program are not required to meet the minimum 5% *onsite renewable energy* generation requirement, but are encouraged to consider retro-fitting *onsite renewable energy* generation.

3.1. REQUIRED DOCUMENTATION

Applicants to the ZCB-Design program are required to submit calculations for the predicted amount of usable energy produced onsite annually, demonstrating that at least 5% of the predicted total annual energy consumption will be met through *onsite renewable energy* generation. Include the type of *renewable energy* system(s) and output files from the whole building energy simulation used to calculate the predicted total annual energy consumption. Note that the usable energy produced by the *renewable energy* system is the output energy from the system less any transmission and conversion losses, such as standby heat loss or losses when converting electricity from DC to AC).

[22] As Portfolio Manager cannot assess emissions if any meter is classified as "Other", the meter for a renewable energy system other than solar PV or wind should be classified as electric onsite solar.

[23] ENERGY STAR Portfolio Manager, Technical Reference: Green Power, 2013, https://portfoliomanager.energystar.gov/pdf/reference/Green%20Power.pdf.

4. THERMAL ENERGY DEMAND INTENSITY

Thermal Energy Demand Intensity, or *TEDI*, refers to the annual heat loss from a building's envelope and ventilation, after accounting for all passive heat gains and losses. When measured with modelling software, this is the amount of heating energy delivered to the project that is outputted from any and all types of space heating equipment, per unit of *gross floor area*.

The inclusion of a specific *TEDI* target results in greater occupant comfort and ensures that building designers focus on minimizing a building's demand for energy prior to producing or procuring *renewable energy*. The target also helps to ensure long-term energy performance, as building envelopes have long life spans and yield very reliable efficiency gains. Furthermore, they are typically challenging to retrofit. Finally, improved thermal performance is correlated with improved resilience in the face of power outages, as building interiors are better able to maintain comfortable temperatures when the power supply is disrupted.

Applicants seeking ZCB-Design certification are required to achieve a minimum level of performance in *thermal energy demand intensity* according to the climate zones in which their building is located. *TEDI* targets for each climate zone are outlined in Table 3. *TEDI* is to be calculated according to the Zero Carbon Building Energy Modeling Guidelines[24] and must be reported in kWh/m^2/year.

Table 3 *TEDI targets for ZCB-Design*

Climate Zone	TEDI target (kWh/m2/year)
4	30
5	32
6	34
7	36
8	40

The 30/kWh/m^2/year target for Climate Zone 4 aligns with some of the more stringent tiers of forthcoming zero emissions building frameworks in leading Canadian jurisdictions.[25]

4.1 REQUIRED DOCUMENTATION

ZCB-Design applicants must provide the modelled *TEDI* performance of the building, as well as a narrative of how *TEDI* has been reduced through the use of passive design measures.

Applicants seeking ZCB-Performance certification are not required to calculate or report *TEDI* performance.

[24] Available at http://www.cagbc.org/zerocarbon.

[25] For example, a TEDI target of 30 kWh/m^2/year approximately reflects a Tier 3 level of building performance under the City of Toronto's Zero Emissions Building Framework, as well as the proposed BC Step Code's Step 3.

5. ENERGY USE INTENSITY

Energy Use Intensity (EUI) refers to the sum of all site (not source) energy consumed on site (e.g., electricity, natural gas, district heat), including all process energy, divided by the building *gross floor area*. Applicants must report the total site EUI of the building in kWh/m^2/year. This will enable industry to learn from each zero carbon building. Reporting EUI also enables the building operators to gauge the effectiveness of energy conservation measures and demonstrate progress over time. To provide flexibility to design teams, and in recognition of the further reductions in EUI that codes and incentive/recognition programs can be expected to drive over time, no EUI targets for new construction have been established. Similarly, EUI targets have not been set for operational performance to recognize the wide range in performance of existing buildings and encourage the greatest number of buildings to achieve zero carbon.

5.1. REQUIRED DOCUMENTATION

ZCB-Design applicants must provide the modelled site EUI of the building, calculated based on the total predicted annual energy consumption from the whole building energy simulation divided by the *gross floor area*.

ZCB-Performance applicants must provide the metered site EUI reported in Portfolio Manager.

6. PEAK DEMAND

Several Canadian electrical grids are experiencing significant stresses as populations grow and extreme weather events challenge the reliability of utility service delivery. Increased demand can also push up the marginal emissions intensity of electricity use in lower-carbon grids, as sources of backup power often rely on natural gas. To address these concerns, applicants for certification under the Zero Carbon Building Standard are required to report their annual *peak demand* (or peak power) – the highest electrical load requirement in a year. Reporting will encourage projects to track and reduce their *peak demand* over time, helping to reduce stress on the grid and the need for additional generation capacity.

Peak demand must represent the highest electrical load requirement on the grid in a year, reflecting any peak-shaving impacts from demand management strategies including onsite power generation or energy storage. *Peak demand* must be measured and reported in kilowatts (kW).

6.1. REQUIRED DOCUMENTATION

ZCB-Design applicants must provide the modelled *peak demand* of the building, as well as the date and time of day when peak is modelled to occur.

ZCB-Performance applicants must provide the metered *peak demand* and, if available, the date and time of day when *peak demand* occurred.

7. EMBODIED CARBON

Although operational carbon emissions represent the key focus of the Zero Carbon Building Standard, there is a growing awareness of the importance of addressing the embodied carbon and other GHG emissions associated with building materials. Emissions associated with the manufacturing, transport, and installation of building components currently represent a relatively low proportion of an average building's total carbon footprint, but these emissions grow in importance as operational emissions are reduced.

Applicants must conduct a cradle-to-grave life cycle assessment (LCA) of the project. The embodied carbon requirement has been limited to reporting, to encourage the building industry to grow capacity for conducting LCA - a practice that is still relatively new in Canada.

The LCA must include all envelope and structural elements (including parking structure), including footings and foundations, and complete structural wall assemblies (from cladding to interior finishes, including basement), structural floors and ceilings (not including finishes), roof assemblies, and stairs construction, but exclude excavation and other site development, partitions, building services (electrical, mechanical, fire detection, alarm systems, elevators, etc.), and parking lots.

The LCA must assume a building service life of 60 years. If the service life of a product used in initial construction is greater than the building's assumed service life, the impacts associated with the product may not be discounted to reflect its remaining service life.

The LCA must include the following life cycle phases: resource extraction, product manufacturing and transportation, building construction, product maintenance and replacement, and building demolition/deconstruction/ disposal. Do not include the operating energy used by the building.

Embodied carbon must be reported as the LCA impact measure "global warming potential" (GWP), in kilograms of carbon dioxide equivalent (CO_2e), following the US EPA's Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI).

The LCA can be conducted in any manner that is consistent with international best practices, using regionally-appropriate data and impact assessment methods. The LCA is easiest to accomplish using a software tool specifically intended for building design teams, with the necessary background data and complex LCA methods already integrated within the tool. Building-specific simplified tools that do not require advanced LCA knowledge and that are regionally-appropriate include:

- The Athena Impact Estimator for Buildings. This is a free desktop software tool suitable for any stage of design, and can operate on an imported bill of materials or will estimate material quantities based on user inputs about the building.
- Tally. This a Revit® plugin – it operates on the bill of materials in a BIM model. There is an annual subscription fee to access the software.

7.1. REQUIRED DOCUMENTATION

ZCB-Design applicants must provide an embodied carbon report.

ZCB-Performance applicants must provide an embodied carbon report for initial certification (if ZCB-Design certification was not previously awarded) and whenever there are significant changes to the structural or envelope materials.

Embodied carbon reports must identify:

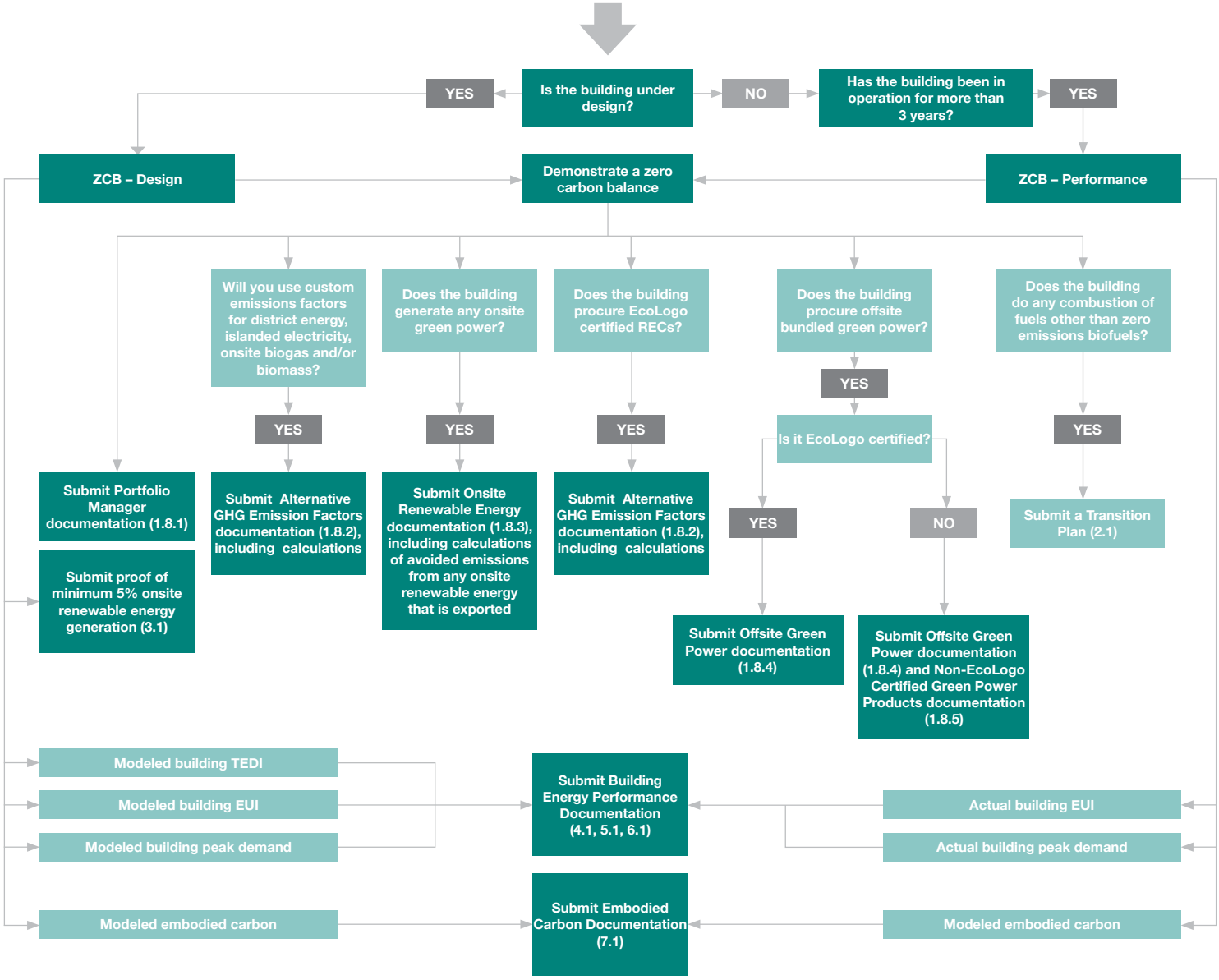
- The LCA software selected
- The elements of the building that are included in the calculation
- Total GWP (in kg CO_2e) of the building

Applicants may also submit a brief commentary on any challenges in meeting this requirement and any measures taken to reduce embodied carbon (*optional*).

If applicants are seeking the LCA credit in the LEED v4 BD+C: Building Life-Cycle Impact Reduction credit, *Option 4. Whole-Building Life-Cycle Assessment*, they may submit the relevant LEED documentation in lieu of the above requirements.

8. COMPLIANCE AND DOCUMENTATION SUMMARY

Figure 1 *Compliance and Documentation Summary Flow Chart*



DEFINITIONS

Building site: The building(s) and all associated area where energy is used or generated. A site may include one or more buildings, either as independent structures or interconnected.

Bundled green power product: See *bundled renewable low-impact electricity product.*

Bundled renewable low-impact electricity product: As defined in the EcoLogo standard, a product that includes both renewable low-impact electricity and the associated *RECs*.

Direct Emissions: Emissions from fuel that is directly burned at the building site, for example natural gas that may be combusted to heat the building.

Embodied carbon: The emissions associated with the production, transportation, assembly, use and eventual decommissioning of materials used in a building's construction. Embodied carbon is measured in kilograms of carbon equivalent.

Energy Use Intensity (EUI): The sum of all *site energy* (not *source energy*) consumed on site (e.g., electricity, natural gas, district heat), including all process loads, divided by the building *gross floor area*. EUI must be reported in kWh/m^2/year.

Environmental attributes: The representation of the environmental costs and benefits associated with a fixed amount of energy generation.

Generation facility: A power station designed and built to generate electricity.

Green power: Electricity generated from renewable resources, such as solar, wind, geothermal, low-impact biomass, and low-impact hydro resources. Green power is a subset of *renewable energy* that does not include *renewable energy* systems that do not produce electricity, such as solar thermal systems. "Green power" is synonymous with "renewable low-impact electricity", a term used within the CCD-003 Renewable Low-Impact Electricity Products standard from EcoLogo.

Green power product: A *bundled green power product* or *REC*.

Greenhouse Gas Intensity (GHGI): The total greenhouse gas emissions associated with energy use on the *building site*. GHGI is reported in gCO_2 e/m^2year.

Gross Floor Area (GFA): The total property floor area, measured between the outside surface of the exterior walls of the building(s). This includes all areas inside the building(s) including supporting areas. GFA is reported in square meters.

Indirect Emissions: Emissions associated with energy purchased from a utility, for example emissions associated with the generation of electricity or district steam.

Islanded grid: A small grid not connected to the provincial grid.

Peak demand: The building's highest electricity load requirement in a year. *Peak demand* is measured and reported in kW.

Provincial power pool: Any power pool of which a province is part including the power pool defined by the local North American Electric Reliability Corporation (NERC) region or, for provinces and territories that are not part of a NERC region (i.e. Newfoundland and Labrador, Yukon, Nunavut, and the Northwest Territories), the provincial/ territorial electricity system. The NERC regions define the following groupings of Canadian provinces:

1. British Columbia and Alberta
2. Saskatchewan and Manitoba
3. Ontario, Quebec, New Brunswick, Nova Scotia, and Prince Edward Island

Onsite Renewable Energy: Energy generated on site from renewable sources, such as solar or wind. Where a site is not able to export energy off the site (i.e. where the building is not connected to the electricity grid), only that energy that can be consumed (or stored and then consumed) onsite is considered *onsite renewable energy*.

Renewable energy: A source of energy that is replenished through natural process or using sustainable management policies such that it is not depleted at current levels of consumption. Air-source and ground-source (geothermal) heat pump systems do not constitute *renewable energy*.

Renewable Energy Certificate (REC): An authorized electronic or paper representation of the environmental attributes associated with the generation of 1 MWh of *renewable energy*.

Site Energy: The amount of energy used on the *building site*.

Source Energy: The amount of raw fuel that is required to operate the building, incorporating all transmission, delivery, and production losses (such as in the generation and transmission of electricity).

Thermal Energy Demand Intensity (TEDI): The annual heat loss from the building envelope and ventilation. When calculated with modelling software, this is the amount of heating energy delivered to the project that is outputted from any and all types of space heating equipment, per unit of *gross floor area*. *TEDI* must be reported in kWh/m^2/year.

Zero Carbon Building: A highly energy efficient building that produces onsite, or procures, carbon-free *renewable energy* in an amount sufficient to offset the annual carbon emissions associated with building operations.

Zero Emissions Biofuel: Biogas or biomass fuels considered to be net-carbon neutral as the amount of carbon released by combustion approximately equates to the carbon that would have been released by natural decomposition processes.

Canada Green Building Council
Every Building Greener

Conseil du bâtiment durable du Canada
Verdir tous les bâtiments

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Appendix B SUMMARY OF ENERGY AUDIT FINDINGS

The following tables present the recommended Energy Conservation Measures (ECMs) by Facility. Any measures identified as future considerations are both time and capital-intensive upgrades that should be considered during future major renovations as these are deep energy retrofits.

Table B-1. Atlas Tube Centre ECMs

Measure	Probable Cost ($)	Total Cost Savings ($)	Simple Payback (Years)
Demand Control Ventilation (x5 AHUs)	32,000	6,268	5.1
Heat Recovery Condensate Drain	17,000	1,498	11.3
Energy Recovery Ventilation (x4 AHUs)	62,000	3,271	19.0
Optimum Start/Stop (x7 AHUs)	114,000	14,122	8.1
Variable Frequency Drive (x4 AHUs)	38,000	7,375	5.2
Interior LED Retrofit	53,000	8,897	6.0
Pool LED Retrofit	10,000	624	16.0
Arena LED Retrofit	87,000	18,970	4.6
Liquid Pool Cover	3,700	12,213	0.3
Arena Low-e Ceiling	195,000	69,012	2.8
Low-flow Water Closets and Urinals	50,000	4,862	10.3

Table B-2. Recommended ECMs: Libro Community Centre and the Public Library

Measure	Probable Cost ($)	Total Cost Savings ($)	Simple Payback (Years)
Demand Control Ventilation-Community Centre	32,000	354	>20
Programmable Thermostat-Community Centre	3,200	3,402	0.9
Occupancy Sensors and Programmable Thermostat -Community Centre	7,000	1,729	4.0
Variable Volume Temperature (VVT)-Community Centre	26,000	1,263	>20
Window Film-Community Centre	900	40	>20
Demand Control Ventilation-Library	7,900	(672)	>20
Programmable Thermostat -Library	1,600	2,470	0.6

Measure	Probable Cost ($)	Total Cost Savings ($)	Simple Payback (Years)
Occupancy Sensors and Programmable thermostat -Library	4,000	1,547	2.6
VVT Control -Library	5,200	433	12.0
Window Film -Library	900	6	>20
Low-flow Water Closets and Urinals-Community Centre	7,500	132	>20

Table B-3. Recommended ECMs: Denis St. Pierre Water Pollution Control Plant

Measure	Probable Cost ($)	Total Cost Savings ($)	Simple Payback (Years)
Replace shop heaters with a high efficiency condensing rooftop unit	TBD	TBD	TBD
Evaluate size requirements, required run time and control of exhaust fans. Consider retrofit to VSD	$34,500	$3,263	10
Install building automation to control lighting, unit heaters, exhaust fans and rooftop units	$60,800	TBD	TBD
Install low flow urinal	$1,900	-	N/A
Utilize occupancy sensors, replace T12 and metal halide lighting with T-5	$13,100	$ 705	19
Replace exterior lights with LED	$15,600	$4,603	3
Install VSD for lift pumps in Maidstone Pump Room	$24,200	$10,708	2
Install VSD for lift pumps in Upper Pump Room	$24,200	$10,708	2
Install VSD for blowers in Blower Building	$40,500	$42,850	1
Install VSD for mixers	$11,300	$2,895	4
Install VSD for sludge pumps	$11,200	$3,355	3
Install VSD for blowers in Centrifuge Building	$36,300	$25,363	1

Table B-4. Recommended ECMs: John George Water Treatment Facility

Measure	Probable Cost ($)	Total Cost Savings ($)	Simple Payback (Years)
Install low flow urinal	$1,900	N/A	N/A
Utilize occupancy sensors and replace interior metal halide lighting with T-5	$18,100	$3,882	4
Replace exterior lights with LED	$4,200	$1,324	2
Install VSD for high lift pumps	$92,500	$42,664	2
Install VSD for coagulant mixer	$3,400	$1,268	2
Install VSD for frazzle ice blowers	$6,700	$1,173	5

Table B-5. Recommended ECMs: Maidstone Public Works Garage

Measure	Probable Cost ($)	Total Cost Savings ($)	Simple Payback (Years)
Replace exterior lights with LED	$2,800	$394	6

Table B-6. Recommended ECMs: Stoney Point Water Treatment Plant

Measure	Probable Cost ($)	Total Cost Savings ($)	Simple Payback (Years)
Evaluate size requirements, required run time and control of exhaust fans. Consider retrofit to VSD	$2,650	$301	8
Install low flow urinal	$1,900	N/A	N/A
Replace exterior lights with LED	$6,000	$1,475	2
Install VSD for high lift pumps	$32,603	$10,488	2
Install VSD for intermediate pumps	$8,466	$1,481	5
Install VSD for low lift pumps	$6,693	$2,601	2

Table B-7. Recommended ECMs: Lakeshore Town Hall

Measure	Probable Cost ($)	Total Cost Savings ($)	Simple Payback (Years)
Evaluate size requirements, required run time and control of exhaust fans. Consider retrofit to VSD	$2,650	$472	5
Install low flow urinal	$1,900	N/A	N/A
Replace exterior lights with LED	$8,000	$1,815	4
Outside air free cooling for Server room. Use heat generated for the rest of the building	$2,760	$1,095	2

Appendix C SAMPLE GREEN FLEET STRATEGY

GREEN FLEET ACTION PLAN

TAKING THE LEAD TOWARDS CLEANER AIR IN RICHMOND

CITY OF RICHMOND:
REDUCING CORPORATE GREENHOUSE GAS EMISSIONS
AND ADVANCING SUSTAINABLE FLEET MANAGEMENT

www.richmond.ca/greenfleet

Richmond

GREEN FLEET ACTION PLAN

RICHMOND'S FLEET GOES GREEN

REDUCING RICHMOND'S CORPORATE GREENHOUSE GAS EMISSIONS THROUGH FLEET VEHICLE MANAGEMENT

Richmond relies on its fleet of vehicles to maintain roads, provide bylaw enforcement, manage water and sewer services, keep parks beautiful and clean and provide many other services in the community. These vehicles are essential; however, the City recognizes that fleet operations generate greenhouse gas (GHG) emissions and to manage the impact of these emissions, the City has been implementing sustainable fleet management initiatives for more than 10 years. Through Richmond's Green Fleet Action Plan, the City has targeted the fleet to expand on this ongoing shift towards "green" operations, which includes applying strategies to purchase vehicles that have lower emissions and explore options to cut fuel consumption.

When Richmond developed the Green Fleet Action Plan as a key opportunity to reduce GHG emissions by making changes to its fleet vehicle program, a few key goals were identified:

1. Reduce GHG emissions
2. Improve fuel efficiency & reduce fuel costs
3. Continue to provide enhanced City services & maintain service excellence

The City is applying multiple solutions to achieve these targets as part of achieving the City's Corporate Energy and GHG Reduction program, and to provide for more sustainable fleet operations. This report includes an overview of actions completed and those underway, and is a summary of the *Richmond Green Fleet Action Plan* technical report. For a copy of the full report, visit www.richmond.ca/greenfleet.

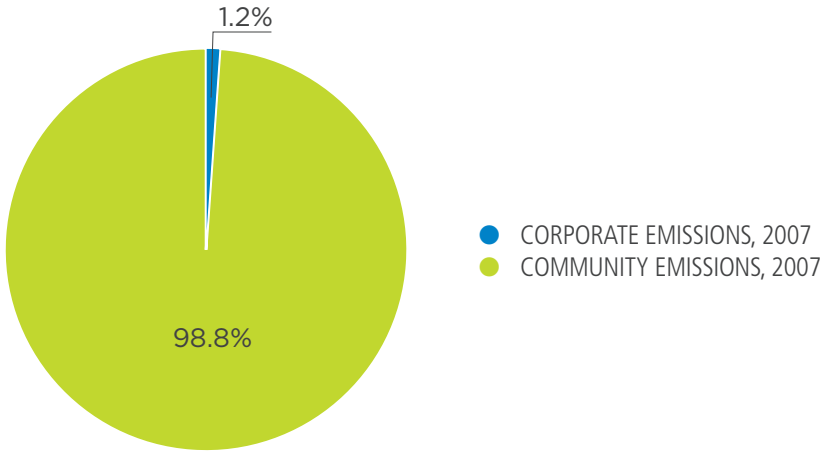
GREENHOUSE GAS REDUCTION TARGET

20% BY 2020

The City has a long history of progressive actions designed to reduce emissions and demonstrate sustainable approaches to fleet management. To track this progress, Richmond first measured the energy use and GHG emissions from its fleet to establish a benchmark. From this, a target to reduce the fleet's GHG emissions by 20% by 2020 was set by Council on October 28, 2013. The Green Fleet Action Plan review also included assessing actions that had already been implemented to reduce GHG emissions along with identifying new opportunities to achieve goals. With changes already underway, Richmond is already seeing improvements in terms of reduced GHG emissions along with some operational cost savings.

Leadership through Fleet Management

Richmond's corporate GHG emissions are just over 1% of the broader community emissions, yet the City's fleet generates about 1/3 of the City's total corporate emissions. With the Green Fleet Action Plan, Richmond is demonstrating leadership in its community and the region by implementing actions that result in measurable improvements that reduce GHG emissions and fuel consumption.



18%
Light-duty cars

20%
Equipment

37%
Light-duty trucks

23%
Medium and heavy-duty trucks

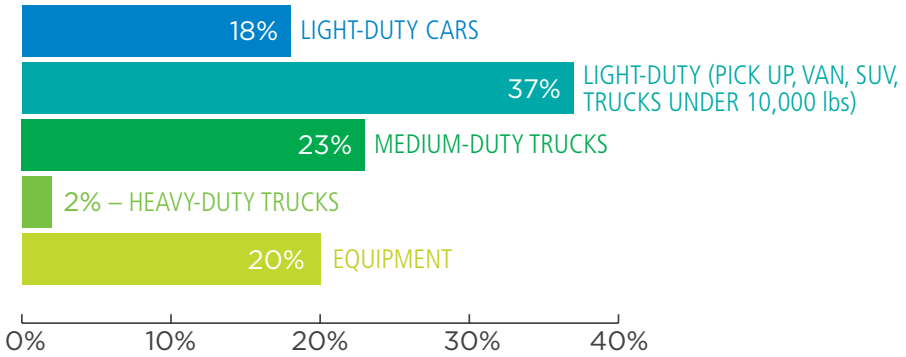
WHAT VEHICLES MAKE UP RICHMOND'S FLEET?

Richmond fleet buys and maintains a wide range of vehicles and equipment, from mowers and snowplows to vans for youth programs and trucks for Parks crews. Many vehicles do more than move people. For example, trucks may have emergency lighting for public safety. Crewcab trucks for operations also act as mobile offices and workshops for crews.

Richmond's Fleet at a Glance

Almost 18% of fleet is made up of light-duty cars and about 37% is light-duty trucks, vans and SUVs. Another 23% of fleet is medium and heavy-duty trucks like big crewcabs, dump trucks and crane trucks. The rest of Fleet's assets are equipment (20%). The Fleet represents 32.7% of the City's total emissions, second only to buildings, offering a tremendous opportunity to achieve the City's targets through green fleet solutions.

PERCENTAGE OF FLEET ASSETS BY MODE (2010)



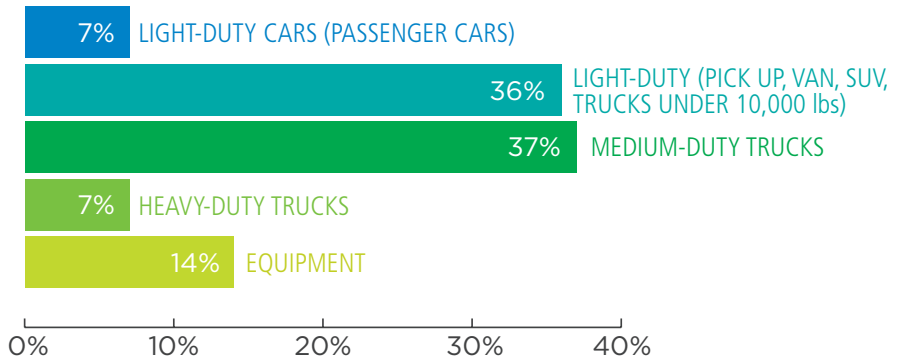
When it comes to a fleet, not all vehicles are alike, and as a result they have different requirements that affect fuel consumption and emissions. For example, cars and light-duty trucks use gasoline, larger fleet vehicles like an excavator use diesel fuel and some specialized equipment like forklifts use propane or electric power. Driver behaviour can also influence fuel use and GHG emissions due to speed, vehicle loads and vehicle maintenance. Richmond's Green Fleet Action Plan includes an inventory of its fleet, fuel consumption and GHG emissions with data from 1995, 2007 and 2010 to help track progress towards its goals.

Where do the Fleet's Green House Gas Emissions Come From?

Passenger cars are responsible for only 7% of Fleet emissions, in part because **by 2010, over 50% of Richmond's passenger cars were already green fleet vehicles (hybrids or Smart Cars)**.

Most of Richmond's fleet are trucks, which have a higher share of emissions, due in part to diesel fuel, fewer green fleet vehicle options in the market, and service requirements that often include idling.

PERCENTAGE OF TOTAL GHG EMISSIONS BY MODE (2010)



"Before we could design a strategy, we first had to get a clear picture of what we had in our fleet. We looked at the City's existing vehicles, including their purpose, fuel use and emissions, and how other factors like driving techniques could affect our targets. Next we were able to create a baseline for fuel costs and GHG emissions for the fleet, and with all of this information, we had a great start to developing models and identifying opportunities for changes that would help us achieve our goals."

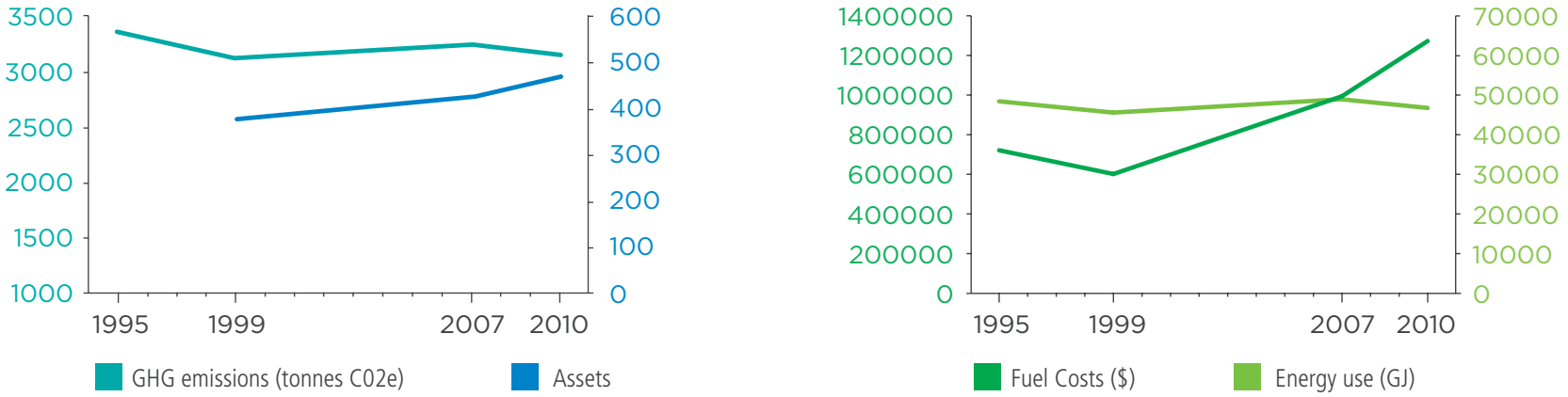
– MALCOLM BRODIE, MAYOR, CITY OF RICHMOND

TRACKING GHG EMISSIONS FOR THE FLEET

Richmond is already making progress on reducing greenhouse gas emissions: 2010 GHG emissions from Fleet were 6% below 1995 emissions and 3% below 2007 levels. It's challenging to reduce fuel consumption and emissions when you're growing, but Richmond is still making progress.

Richmond's population continues to increase, and with this growth there is a corresponding need to expand the fleet to manage the new roads and sewers, respond to a growing number of bylaw calls and meet other service needs. In response, the number of vehicles and equipment in Richmond's fleet increased by 24% between 1999 and 2007. As well, fuel costs have more than doubled in that same time period. Even with the increased number of fleet vehicles and dramatically higher fuel costs, Richmond has made progress in keeping its energy use from rising and reducing fuel costs.

As an example, while fuel costs increased by 28% from 2007 to 2010, thanks to measures such as use of hybrids and Smart Cars, the reduction of litres of fuel used in 2010 over 2007 saved the City $64,650 in fuel costs (based on an average cost price/litre of $1.02 for 2010). In 2010, Richmond's fleet emitted 3,151 tonnes of GHG emissions. In the same year, the fleet used 1,249,957 litres of gasoline and diesel, at a cost of $1.27 million.



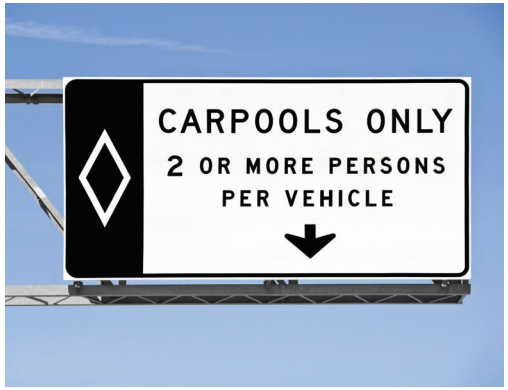
Richmond's fleet has grown while greenhouse gas emissions have shown a slight downward trend; fuel costs have risen steeply while energy use has gone down slightly.

RICHMOND TAKES ACTION

LEADERSHIP FROM WITHIN – EMPLOYEE CARPOOL PROGRAM

Richmond looked at its internal operations and identified staff vehicle usage as a great opportunity to reduce fuel consumption and community GHG emissions through carpooling.

Initiated in 1997, Richmond's employee carpool program has almost 80 participants and more than 70 staff on the waitlist. The program uses 17 vehicles that are based at either City Hall or the Works Yard and travel to Langley, Surrey, White Rock, Delta, Vancouver, and the Tri-Cities. Although the staff carpool does not directly reduce corporate GHG emissions, it does reduce community emissions, demonstrates leadership in transportation, and has been a model for other communities.



80
Carpool Program Participants

70
Staff on the waitlist

PROGRAMS TO REDUCE FUEL CONSUMPTION

Richmond has successfully implemented a number of programs to reduce fuel requirements. Here's a summary of the results.

Reducing Demand	Outcomes
1 Adopted anti-idling programs for fleet since 2004.	Richmond's fleet has had an idle-free program as of September, 2004. Community anti-idling bylaw provides opportunity for education and awareness, introduced July 2012.
2 Implemented driver training for new drivers.	Driver behaviour, including idling, accounts for 5 to 33% of fuel use – smart drivers can help reduce fuel use.
3 Reduced trip length through operational planning.	Bylaw, litter and tree routes have been optimized. Solar compactors at SkyTrain stations reduce number of trips for collection.
4 Initiated pilot IT program to connect Richmond buildings with fibre optic cable for remote meetings to reduce staff driving for meetings.	Fire Halls and City Hall fifth floor connected and using system for remote meetings.
5 Developed a pilot bicycle share program.	The program had low uptake and was discontinued.
6 Implemented Sustainable Commute: the highly successful staff carpool program.	Almost 80 staff participate, with a 70-person wait list. Reduces community GHGs, enhances staff satisfaction and demonstrates leadership. Results in increased wear and tear on City vehicles and the need for accelerated vehicle replacement of carpool units.

"Taking the City's driver training was a great learning experience for work and home because I can use the same driving techniques to improve safety and reduce fuel consumption and emissions when I'm driving my own vehicle as well as when I'm on the job,"

– ROB WILLIAMS, TRUCK DRIVER 3

SAVED 43 TONNES OF GHGs

BETWEEN 2007 - 2010 THANKS TO GREEN FLEET CARS

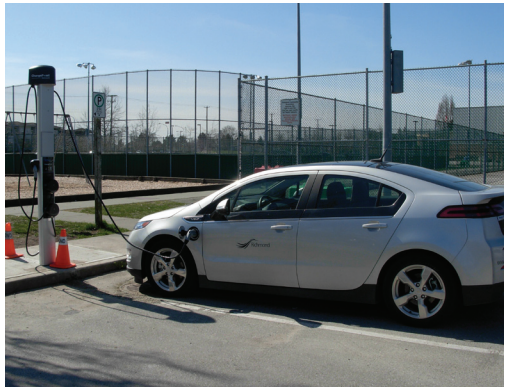
Maintenance & Management Practices	Outcomes
7 Installed an automated fuel management and dispensing system.	Ensures fuel use is monitored and tracked and provides for fuel security.
8 Implented an on-going preventive maintenance program.	Ensures vehicle safety and efficient vehicle performance for worker safety and best vehicle performance.
9 Improved asset management systems.	Financial sustainability of fleet; improved asset management including maintenance schedules and active data use for fuel savings.

Efficient Resource Use	Outcomes
10 Purchased hybrids and Smart Cars.	31 hybrids and 10 Smart Cars as of 2010. Saved 43 tonnes of GHGs between 2007 and 2010 thanks to Green Fleet cars.
11 Re-fit trucks with LED lights and auxiliary batteries to reduce idling.	One-third of fleet vehicles have been converted to LED lighting. As of 2012, all new trucks have LED emergency lighting and dedicated auxiliary batteries where possible.
12 Installed solar panels on Parks trailers to run safety/signal lights.	Two message board trailers have been converted to use solar panels for their safety/signal lighting.
13 Replaced lower tier diesel equipment.	Four units replaced.

"The first time I drove one of the new electric vehicles, I was expecting it to feel different than a regular car. It wasn't. With a few changes to how the car is started, it drives like any other vehicle, and you feel good about the zero emissions as you travel – something to brag about to your colleagues and friends,"

– MARTIN YOUNIS, SENIOR PROJECT MANAGER

Alternative Fuels	Outcomes
14 Adopted a biodiesel 5 blend in diesel fuel prior to 2008.	104 tonnes of Richmond's fleet emissions in 2010 were from renewable resources: biodiesel and ethanol.
15 Switched to low-carbon B.C. grid electricity as a fuel:	
A. Richmond's ice resurfacers	Acquired five electric ice resurfacers in 2012.
B. Electric vehicle passenger cars	Purchased four electric cars in 2012.
C. Electric vehicle charging stations	Installed 11 electric vehicle charging stations in 2013.



9

Electric fleet vehicles procured in 2012

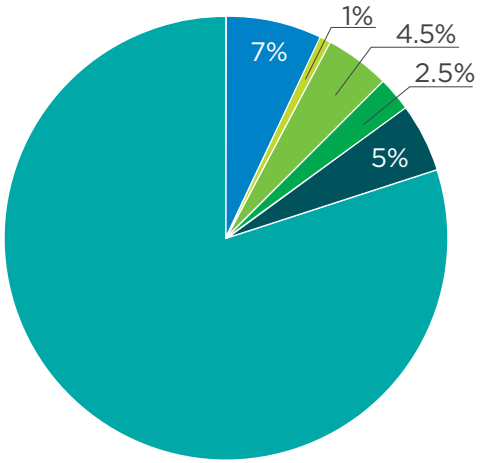
11

Electric vehicle charging stations installed in 2013

REALISTIC TARGETS FOR FUTURE REDUCTIONS

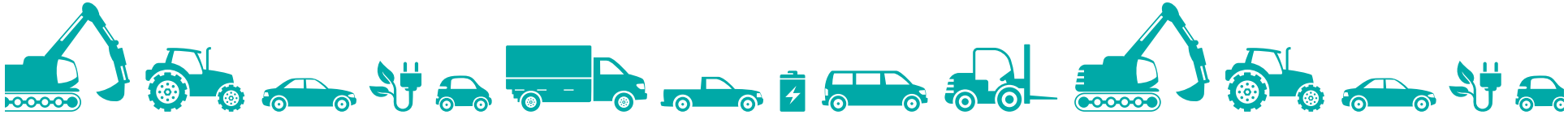
While setting high targets for GHG emission reduction sounds like a good idea in theory, it's not realistic or achievable in the context of a growing City. Richmond, like many communities in the region, will continue to grow in the coming years and the fleet will need to expand to provide services. More vehicles means more emissions and more fuel consumption. But with Green Fleet initiatives, the rate of those increases can be reduced.

Without continued Green Fleet actions, emissions from Richmond's fleet are projected to rise 3% by 2020. Instead, Richmond is aiming to reduce its emissions by 20% from 2010 to 2020. This is based on an annual reduction of 2% per year starting in 2010. This pragmatic approach takes into account growth requirements, costs for purchasing new best-in-class vehicles for trucks and other equipment, as well as purchase of additional electric and hybrid vehicles.



PRAGMATIC 2020 FLEET TARGET: 20%

- REDUCE GROWTH AND DOWNSIZE
- RIGHT-SIZE EXISTING AND NEW ASSETS
- BEST-IN-CLASS REPLACEMENT
- EV AND HYBRID PROCUREMENT
- MAINTENANCE/ANTI-IDLE/SMARTER DRIVING
- REMAINING GHGS



TACTICS TO ACHIEVE 20% REDUCTION TARGET

Richmond has looked at its progress in recent years and is focused on the tactics that have proven successful in reducing GHG emissions. Key actions include: ensuring the right fleet vehicle is assigned to the right tasks. This is sometimes called "down-sizing and right-sizing vehicles" and ensures that a vehicle that uses more fuel and has more emissions is not used when a smaller, more energy-efficient vehicle can do the same job.

The City will also continue to buy best-in-class vehicles, with a focus on light-duty trucks that come with improved emission and fuel consumption ratings. The City also plans to continue to buy and make best use of electric vehicles and hybrids. Purchasing and using the right vehicles for each service is important, but so is looking at how to reduce demand for vehicle use overall, and this requires cooperation from all City departments.

1. Down-sizing & right-sizing vehicles
2. Buy best-in-class vehicles with improved emission & fuel consumption ratings
3. Make best use of electric & hybrid vehicles
4. Reduce demand for vehicle use overall

The following is an overview of tactics identified for reducing GHG emissions and fuel consumption, including priority status and anticipated outcomes.

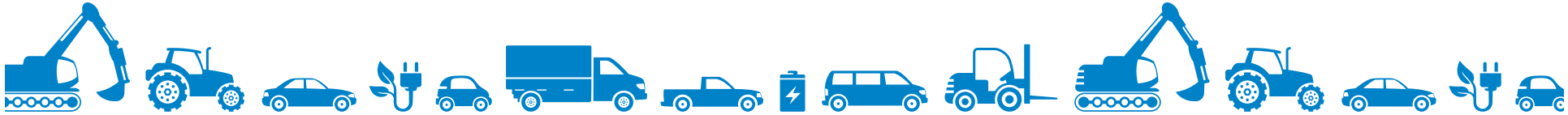
	Actions that support slowing growth of Fleet	Status	Impact Assessments
1	Reduce new growth in assets.	Priority	Eliminating new growth in assets could provide up to 16% reductions in fleet emissions, 2010 to 2020. Potential to reduce overall number of assets in some areas such as passenger cars. Targeted overall GHG reduction of 7%, supported by other actions to reduce demand.
2	Consolidate and eliminate trips through information technology and route optimization. Report all route optimization programs in order to share learning.	Priority	Reduces vehicle kilometres traveled (VKT).
3	Increase employee public transit use for off-site meetings, or pay for taxis or use personal staff vehicle (with mileage reimbursement) when a passenger car with low VKT has been downsized out of fleet.	Priority	Supportive action for downsizing low use passenger vehicles.
4	Extend the Works Yard anti-idling program to City Hall.	Priority	Supports Richmond's community-wide anti-idling initiative, demonstrating leadership.
5	Expand driver training to include anti-idling and smarter driver reminders.	Consider	Up to a 10% reduction in emissions from driving when combined with anti-idling and maintenance.
6	Develop a corporate car share program, e.g. with Modo.	Consider	Reduces the need for passenger cars in fleet, enabling downsizing and freeing resources for other service provisions.
7	Expand Sustainable Commute: offer staff transit passes as an employee benefit.	Consider	Demonstrates leadership, reduces community GHG emissions, and enhances employee satisfaction.

Maintenance and Management Monitoring and Reporting	Status	Impact Assessments
8 Right-size vehicles for best use on an annual basis.	Priority	Fuel cost savings are maximized when higher capital green fleet vehicles are assigned to users with the highest VKT. Passenger car fuel savings of up to 18% may be possible, with a targeted overall GHG reduction of 1%.
9 Systematize preventive vehicle maintenance with the new Faster Asset management software.	Priority	Regularly scheduled vehicle maintenance saves fuel, ensures worker safety and prolongs vehicle life. Use of the Faster Asset software will ensure reduced vehicle downtime and ensure continued service excellence. Targeted GHG reduction of 5%, including anti-idling and smarter driving.
Monitor and report on: 10 VKT annually 11 Sustainable Green Fleet Actions 12 Joining the E3 Fleet Program	Priority	Supports right-sizing and downsizing of existing assets. Mandatory requirement for E3 Fleet review and rating.
13 Provide a monthly fuel use report to all departments using fleet vehicles.	Consider	Supports departments in managing their use of fleet assets.
14 Integrate GHG measurement tools with asset management software.	In process	Assures monitoring and reporting on Fleet emissions performance.
15 Make fuel costs transparent to departments in their leasing rates.	Consider	Provides an incentive for departments to reduce fuel use.
16 Provide additional human resources to Fleet during current critical renewal period.	Consider	Ensure implementation of sustainable actions during current renewal cycle.

REPLACE OLDER LOW-USAGE CARS WITH BEST-IN CLASS COMPACT VEHICLES

Efficient Resource Use	Status	Impact Assessments
17 Continue best-in-class fuel-efficient vehicle procurement, with a focus on light-duty trucks. Replace older, low-usage passenger cars with best-in-class compact vehicles.	Priority	Targeted overall GHG reduction of 4.5%.
18 Reduce idling through better vehicle technology: continue the replacement of truck, van and SUV emergency lights with LEDs and auxiliary batteries; use solar panels where possible to run safety lights.	Priority	Supports anti-idling program. By 2020, 100% of vehicles that idle to run emergency lights should be outfitted with LED lights and auxiliary batteries. Older trucks that cannot convert to auxiliary batteries will be retired.
19 Add GPS units to vehicles to aid in route optimization, best use of vehicles and data collection.	Priority	GPS units support improved fleet management and demand side management ensuring fuel and GHG reductions from other actions.

Alternative Fuels	Status	Impact Assessments
20 Purchase electric vehicles for high use cars. Procure hybrid light-duty trucks when possible.	Priority	Fully electric vehicles have zero tailpipe emissions. Up to 5% additional modeled reductions in fleet emissions with high rates of electric vehicle and hybrid adoption in light-duty vehicles including trucks. Targeted overall GHG reduction of 2.5%.
21 Monitor emerging technologies in plug-in hybrid trucks, and adopt plug-in hybrid purchasing policies for light duty trucks as soon as the technology is market-ready.	Consider	Aim to have 10% of light-duty truck procurements plug-in hybrid or electric vehicles by 2017.
22 Pursue procurement of diesel-electric hybrids for medium and heavy-duty trucks and buses as the technology matures and becomes market-ready.	Consider	No cost to monitor and assess.
23 Monitor and assess emerging technologies, particularly compressed natural gas vehicles. Depending on trends, pursue a feasibility study for establishing an alternative vehicles program that would shift medium and heavy-duty vehicles to compressed natural gas.	Consider	GHG reductions from natural gas vehicles may be as high as 25%, but depend on vehicle type and driving cycle. Full life cycle emissions are also impacted by upstream production and distribution emissions.
24 Monitor the advances in biodiesel fuels and consider switching to a higher biodiesel blend when full lifecycle emissions reductions are assured.	Consider	The GHG benefit of biodiesel is in the full lifecycle of the fuel, with estimated savings of 18% for biodiesel20.



MEASURING PERFORMANCE

Richmond will monitor its fuel use and emissions on an annual basis, and report out on Green Fleet actions like the numbers of hybrid vehicle purchases. Trends in emissions will be tracked on a three-year to five-year basis to allow for updated or new actions to be adopted. Fleet may also provide fuel use data to departments to support their efforts to reduce fuel use, greenhouse gas pollution and costs. Richmond will obtain E3 rating from Fraser River Basin Council, which monitors and measures fleet efficiency.

Taking the Lead Towards Cleaner Air in Richmond

The City of Richmond recognizes that efficient fleet operations are essential to delivering City services and that there are opportunities to improve the sustainability of these operations. The City is proud of its fleet operation track record to date – including reducing GHG emissions by 43 tonnes between 2007 and 2010 thanks to Green Fleet cars – but remains focused on continuous improvement by applying progressive, practical measures to reduce GHG emissions and lower fuel consumption. With the Green Fleet Action Plan, Richmond has set a target to reduce its GHG emissions by 20% by 2020, and it has a clearly-defined strategy and framework to achieve this target by implementing measures based on research, best practices and past successes.

Through its broad range of existing and planned programs, Richmond continues to demonstrate its leadership and commitment to its reduction targets. By reducing demand overall through programs like car pools and prviding driver training, and applying maintenance programs to support safety and efficiency, Richmond is improving efficiencies within its operations. As well, by applying efficient use of resources such as purchasing vehicles with considerably greater fuel efficiency and exploring options for alternate fuel vehicles, Richmond is shifting its fleet operations towards a more sustainable model with reduced emissions.

Together, these actions will help the City achieve its targets in a responsible manner while taking into account the continued growth in the community and continued need to expand its fleet to meet service demand.

Fleet & Environmental Programs

For a copy of this summary report or the full Richmond Green Fleet Action Plan online, please visit www.richmond.ca/greenfleet.

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Richmond