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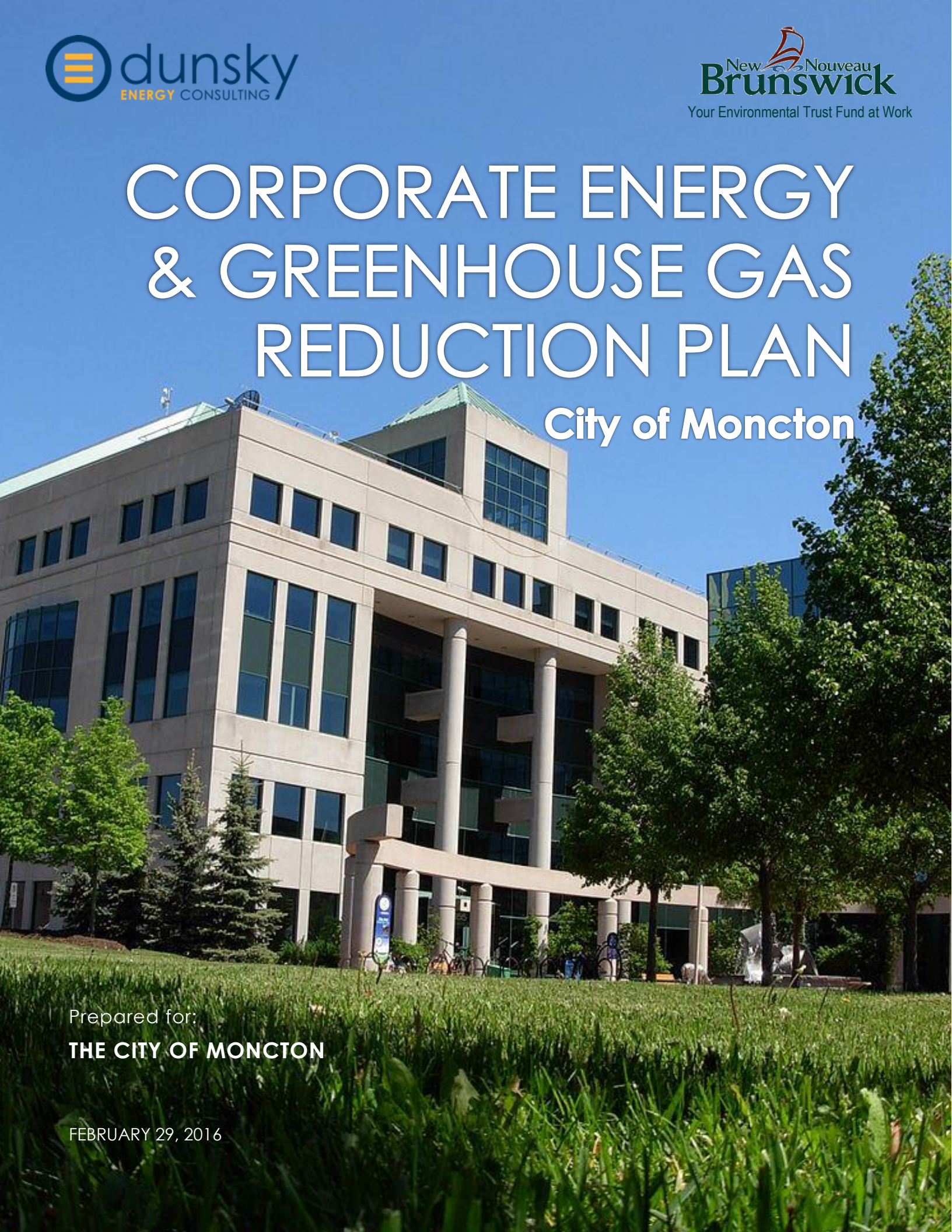
CORPORATE ENERGY & GREENHOUSE GAS REDUCTION PLAN

City of Moncton



Prepared for:

THE CITY OF MONCTON

FEBRUARY 29, 2016

CORPORATE ENERGY AND GREENHOUSE GAS REDUCTION PLAN

CITY OF MONCTON

SUBMITTED TO:

CITY OF MONCTON

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EXECUTIVE SUMMARY

By developing this Corporate Energy and Greenhouse Gas (GHG) Reduction Plan (the Plan), the City of Moncton acknowledges the leading role that it must take to reduce emissions associated with its municipal operations, thus encouraging the broader community to adopt energy conservation and GHG reducing practices.

CURRENT GHG EMISSIONS AND TARGETS

The Plan aims to achieve and exceed the City's Corporate GHG Reduction Target adopted in 2007, calling for a 20% reduction of GHG emissions below 2002 levels by 2017. The 2013 Corporate GHG Emission Inventory indicates that the City's emissions were 14,000 tCO_2e/yr, (almost equivalent to the 2002 baseline) and thus meeting the 2017 target will require the City to achieve a reduction of 2,800 tCO_2e/yr.

PROPOSED ACTIONS

The Plan proposes to achieve the target through the following actions:

1 BUILDING RETROFITS

Building upon its ongoing schedule of facility condition and energy evaluations, it is proposed that the City implement energy efficiency retrofits at many of its most energy intensive facilities. Measures include equipment upgrades, existing building commissioning, operator training and control measures for ice rinks. Emissions are expected to be reduced by 895 tCO_2e/yr by 2020.

2 EFFICIENT NEW BUILDINGS

The City has adopted a Green Building Policy, requiring that all new buildings be constructed following Leadership in Energy and Environmental Design (LEED™) or Green Globes criteria. When designing a new City-planned facility, energy efficiency will be considered a priority. Currently planned facilities are expected to produce an additional 660 tCO_2e/yr, which compares to 1,185 tCO_2e if these buildings were built to a lower standard.

3 RENEWABLE ENERGY IN BUILDINGS

Opportunities for solar photovoltaic (PV) energy generation and biomass heating have been identified in municipal facilities. Rooftop solar PV arrays at City Hall and the Codiac Transpo center, and heating from wood residues at the Operations Centre would reduce GHG emissions by 485 tCO_2e/yr.

4 GREEN FLEET

A combination of vehicle replacement and behavioral measures can help to decrease GHG emissions from the fleet. Developing a right sizing policy, tracking fuel consumption and training drivers on sustainable driving practices, as well as looking for opportunities to integrate electric vehicles into the fleet could yield GHG reductions of 95 tCO_2e/yr.

5 STREETLIGHT AND PARK LIGHTS UPGRADES

Converting all City-owned streetlights and park lights to LED lights would generate GHG reductions of 225 tCO_2e/yr. When accounting for NB Power's recent streetlight conversions, total GHG reductions amount to 1,010 tCO_2e/yr.

THE EFFECT OF NB POWER ELECTRICITY GENERATION

A large share of the City's corporate GHG emissions come from electricity generation and thus how electricity is produced in New Brunswick has a major impact when accounting for GHG emissions. NB Power is currently shifting its electricity toward non-emitting sources (renewable and nuclear energy), which will potentially contribute a further 2,300 tCO_2e/yr of to the City's planned GHG reductions.

IMPACTS

Buildings, municipal vehicles and streetlights together represent 95% of the City's total corporate GHG emissions and therefore are the focus of the Corporate GHG Reduction Plan. As the single greatest source of GHG emissions, municipal buildings have the highest potential to contribute to achieving the City's GHG target.

As shown in Table 1, implementation of the Plan will decrease GHG emissions from municipal operations by 13% by year 2020, compared to the baseline, while the contribution of NB Power's move to lower-emitting electricity generation sources will provide further reductions to help the City meet its target.

A specific timeframe has been assigned to each action, ranging from short term (for implementation before 2017), mid-term (between 2017 and 2020) and long term (for consideration beyond 2020).

The Plan calls for investment of close to $6M spread out over five years which could be supported by potential grants and incentives (such as NB Power's $280,000 incentives for building retrofits), along with innovative financing approaches to municipal energy improvements. The five action areas described in the Plan should generate annual energy bill savings in the order of $580,000 to support the City's investment. A detailed table gathering all the measures and their impact, timeframe and responsible City departments is available in Appendix A.

Table 1: Summary of GHG and financial impacts of the Plan

	GHG emissions/ reductions (tCO_2e/yr)	Total investment required	Annual Cost Savings
Baseline GHG emissions (2002)	**13,960**		
2017 target (-20% below baseline emissions)	-2,800		
Actions			
Building retrofits	-895	$3,300,000	$350,000
Efficient new buildings	660	-	-
Renewable energy in buildings	-485	$1,900,000	$115,000
Green fleet	-95	$3,000	$15,000
Streetlight and park lights upgrades	-1,010	$750,000	$105,000
TOTAL (Reduction from baseline emissions)	**-1,820** (-13%)	**$5,900,000**	**$580,000**
NB Power grid effect	-2,300	-	-
TOTAL with NB Power grid effect (Reduction from baseline emissions)	**-4,120** (-30%)	**$5,900,000**	**$580,000**

NEXT STEPS

The City of Moncton's Corporate GHG Reduction Plan includes five key action areas covering eleven measures that can contribute to meeting the City's GHG reduction targets.

While it may not be feasible to successfully implement all measures included in this Plan by the target date of 2017, it is anticipated that the City should be able to achieve the vast majority of these measures by 2020, if a detailed plan of action is in place by 2017.

After City Council has received the Plan, the next steps will be to designate responsibility for each action area and set a timeframe for implementing the measures.

In most cases the identified measures require some form of upfront investment, but deliver energy cost savings to support the investment, ultimately resulting in a positive net present value for the City over the lifetime of the investments made. A key step in implementing the Plan will be to identify financing sources for each measure.

Finally, as the measures are implemented, the City should put in place tools and systems to monitor its progress toward the 20% reduction target through regular updates of the corporate GHG inventory and tracking other key performance indicators such as energy savings, renewable energy generation and the overall cost/benefits for each investment.

Ultimately, the successful implementation of this plan will lead to robust GHG reductions across the City's operations that can demonstrate opportunities to reduce GHG across the community. Moreover, these measures together should ultimately result in reduced operating costs for City services, thus supporting further GHG reduction actions.

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1. INTRODUCTION: MONCTON'S GHG REDUCTION TARGET

In the fight against global climate change, cities are increasingly taking a lead role to reduce GHG emissions from their own operations and throughout their communities. Besides striving to improve their environmental performance, cities are also motivated by their vulnerability to climate change impacts, such as extreme weather events, which can directly impact municipal infrastructure and services.

With this in mind, the City of Moncton (the City) joined the Federation of Canadian Municipalities' (FCM) Partnership for Climate Protection (PCP) program in 2001. Since then, the City has completed Milestone 1 of the program by establishing the City's corporate and community GHG inventory, and Milestone 2 by setting GHG emission reduction targets, for both municipal operations (corporate level) and the broader community. Developing a Plan to achieve the GHG targets is the natural following step and constitutes Milestone 3 of the PCP program.

This Plan describes strategies and actions to reduce GHG emissions from municipal operations to meet the City's corporate GHG target, and achieve long-term energy cost savings. The City of Moncton's Corporate GHG and Energy Reduction Plan (hereafter referred to as the *Corporate GHG Plan*) offers an opportunity for the City's administration to **lead by example** within the community by identifying achievable and cost-effective GHG reducing initiatives. It is intended to become a communication tool to engage the community.

LINK TO OTHER PLANS AND INITIATIVES

The Corporate GHG Plan has been developed in alignment with the City's current priorities and seeks to leverage existing initiatives and maximize synergies among the proposed actions and other City initiatives.

Recently, the City engaged in a collaborative exercise to develop its Integrated Community Sustainability Plan (ICSP), which states the vision for a Sustainable Moncton and guides the City's efforts towards energy conservation and GHG reduction. The Corporate GHG Plan directly supports Objective A1 of the ICSP related to energy conservation. Suggested actions in the ICSP were analyzed and included in the GHG reducing measures described herein.

The City has already implemented several initiatives that directly fit with the objective of the Corporate GHG Plan. These include the City's Green Building Policy, the Vehicle and Equipment Idling Policy, energy building retrofits, and the creation of the Energy Management Fund, among others. These existing initiatives will be further discussed in Section 3: Achieving the Moncton's GHG Reduction Targets.

THE CITY OF MONCTON'S CORPORATE GHG EMISSIONS AND TARGET

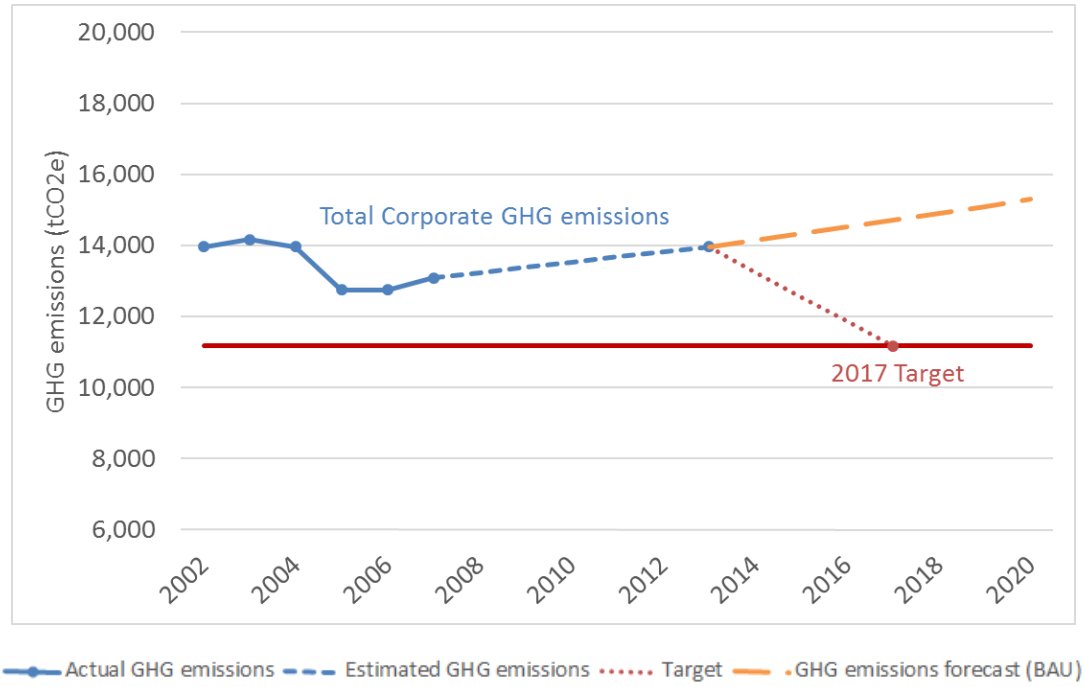
Moncton's Corporate GHG Target: 20% below the 2002 baseline GHG emissions

The City established its first Corporate GHG Inventory in 2002 and has been regularly tracking its GHG emissions (the most recently for 2013). In 2007, the City adopted the target to reduce its corporate emissions by 20% below the 2002 baseline-year emissions, by the year 2017.

Moncton's Corporate Emissions Trend: Stabilized but not significantly reduced since 2002

Figure 1 presents the GHG emissions trend since 2002 along with the 2017 target and the emissions forecast under a 'business-as-usual' (BAU) scenario.

Figure 1: Corporate emissions' trends



Despite Moncton's significant population growth over this period (in the order of 1% per year) and the resulting increased demand for municipal services, the City's emissions in 2013 are at about the same absolute level as they were in 2013.

As illustrated by Figure 2, City operations emit GHGs from five sources: Buildings, Vehicle Fleet, Streetlights, Water and Sewage, and Waste. Contributing 57% of total emissions, buildings represent the single largest contributor to the City's corporate emissions. The vehicle fleet and streetlights also represent significant contributions, while water, sewage[1] and waste[2] are very small contributors to total emissions.

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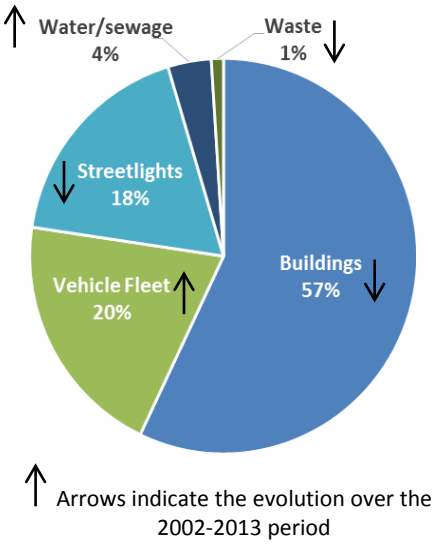
[1] GHG emissions from the water and sewage sector come from the electricity used by pumping and lift stations, and other facilities related to drinking water treatment. The third-party operated TransAqua wastewater treatment facility is excluded from the inventory.

[2] Landfilling waste emits methane, a powerful GHG, due to the decomposition of the organic portion of waste.

Figure 2 also indicates how each sector has evolved over the 2002-2013 period. Buildings' emissions have slightly decreased by 3% as a result of energy retrofits and the decommissioning of two arenas before 2007, of which one was replaced by a privately owned sports plex and 4-ice centre. The emissions from the 4-ice centre were included in the inventory but the sports plex was excluded.

Streetlights have recently undergone major changes as high-pressure sodium lights have progressively been replaced by highly-efficient LED lights, as part of New Brunswick Power's streetlight program. The conversion of traffic lights to LED by the City in 2006 also contributed to the 14% GHG reduction in this sector. Waste related emissions, associated with waste produced at municipal buildings, facilities and parks, have decreased by 9%, a reduction that may be due to natural variation, this is likely as a result of the City's waste reduction efforts such as introducing dedicated organic waste collection in 2006.

Figure 2: Moncton's corporate emissions breakdown by sector



On the other hand, vehicle fleet and water-and-sewage emissions have increased over the same period of time, by 30% and 18% respectively. Both may be explained by the increased demand for services from Moncton's growing community. For instance, between 2002 and 2013, the number of water pumping stations was expanded from two to eight, leading to a corresponding increase in electricity consumption.

Moncton's Challenge: Meeting the GHG reduction target despite the increasing needs for City services

Without any intervention, the City's GHG emissions are projected to grow at a rate similar to what was observed in the last five years (1% per year), which approximately matches Moncton's population growth rate. This illustrates the challenge that lies ahead for the City, which has committed to meeting an absolute GHG emission target, against a backdrop of an increasing population, and the associated increasing demand for City services.

At the time that this plan was developed, the City had completed a number of measures since 2002 that have stabilized its corporate GHG emissions, but have not created sufficient reductions to meet its 2017 target. Moreover, NB Power has decreased the GHG intensity of its electrical generation base, and has reduced streetlight energy consumption, which will play an important role to assist the City in meeting its targets.

Given the short time left before the target date, we do not believe it is advisable or feasible for the City to rush through all the recommended GHG reducing measures by 2017. Instead, the City is well positioned after receiving this plan to establish a detailed implementation and financial plan (ideally by the 2017 deadline) to put in place the majority of the Corporate GHG Plan measures by 2020.

2. APPROACH: DEVELOPING GHG REDUCING MEASURES

The Corporate GHG Reduction Plan was developed by **Dunsky Energy Consulting**, in close collaboration **with the City's Environmental Planning and Management and Facilities departments**. Preliminary findings were presented to selected City administration representatives, as part of a stakeholder consultation session, held on November 24th, 2015 to gather feedback and additional input to the Plan.

To develop the Plan, a five-step approach was taken:

1. **REVIEW AND ANALYZE GHG EMISSIONS DATA**
   Historical emissions data from the City's GHG inventories were analyzed, to identify trends and potential for reduction. A forecast of emissions was developed to assess the level of reduction required to meet the target. Historical energy consumption data were also analyzed for the most-energy intensive facilities to identify savings opportunities.

2. **IDENTIFY POTENTIAL GHG REDUCING MEASURES**
   This step began with a review of the City's existing initiatives that aim to lower the City's emissions. Whenever these existing actions had been implemented after the most recent inventory (2013), their contribution to reducing emissions was evaluated. Initiatives already planned by the City were also included. Then, a list of potential new measures was drawn up for each sector.

3. **SCREEN MEASURES**
   Each new measure identified was screened at high-level using a number of criteria, including: GHG impact, payback, total investment, feasibility and complexity, and co-benefits (including Operation & Maintenance (O&M) benefits, visibility or other public benefit).

4. **PERFORM DETAILED ANALYSIS OF RETAINED MEASURES**
   For measures that passed the high-level screen, a deeper analysis was performed, including an assessment of the measure net present value (NPV) and directions regarding the measure implementation plan and schedule.

5. **PREPARE GHG REDUCTION PLAN**
   Once the list of measures had been finalized, a draft Plan was prepared to summarize the findings and establish an action plan to help the City reach its target. The Plan includes a detailed implementation roadmap with budget, resources and schedule required to move ahead, as well as a monitoring plan to help the City track the progress toward the target. Comments from the City were integrated into the final version of the Plan delivered on March 1st, 2016.

3. ACTIONS: ACHIEVING MONCTON'S CORPORATE GHG TARGET

Buildings, municipal vehicles and streetlights together represent 95% of the City's total corporate GHG emissions and therefore are the focus of the Corporate GHG Reduction Plan. As the single greatest source of GHG emissions, municipal buildings have the highest potential to contribute to achieving the City's GHG target, and as such should represent the area of the greatest investment and the focus of the City's efforts.

The Plan proposes to achieve the target through the following actions:

1 BUILDING RETROFITS

Building upon its ongoing schedule of facility condition and energy evaluations, the City will implement energy efficiency retrofits at many of its most energy intensive facilities. Measures will include equipment upgrades, existing building commissioning, operator training and control measures for ice rinks. Emissions are expected to be reduced by 895 tCO_2e/yr by 2020.

2 EFFICIENT NEW BUILDINGS

The City has adopted a Green Building Policy, requiring that all new buildings be constructed following Leadership in Energy and Environmental Design (LEED™) or Green Globes criteria. When designing a new City-planned facility, energy efficiency will be considered a priority. Currently planned facilities are expected to produce an additional 660 tCO_2e/yr, which compares to 1,185 tCO_2e if these buildings were built to a lower standard.

3 RENEWABLE ENERGY IN BUILDINGS

Opportunities for solar photovoltaic (PV) energy generation and biomass heating have been identified in municipal facilities. Rooftop solar PV arrays at City Hall and the Codiac Transpo center, and heating from wood residues at the Operations Centre would reduce GHG emissions by 485 tCO_2e/yr.

4 GREEN FLEET

A combination of vehicle replacement and behavioral measures will help to decrease GHG emissions from the fleet. Developing a right sizing policy, tracking fuel consumption and training drivers on sustainable driving practices, as well as looking for opportunities to integrate electric vehicles into the fleet could yield GHG reductions of 95 tCO_2e/yr.

5 STREETLIGHT AND PARK LIGHTS UPGRADES

Converting all City-owned streetlights and park lights to LED lights would generate GHG reductions of 225 tCO2e/yr. When accounting for NB Power's recent streetlight conversions, total GHG reductions amount to 1,010 tCO2e/yr.

THE EFFECT OF NB POWER ELECTRICITY GENERATION

As nearly 70% of the City's GHG emissions are associated with electricity consumption (buildings, streetlights and water treatment), and thus the impact of how electricity is produced in New Brunswick is significant. In 2013, 28% of New Brunswick Power's electricity was generated from renewable resources (hydro, wind and biomass) and this share is expected to reach 40% by 2020 to meet the

Renewable Portfolio Standard set by the New Brunswick government. Overall, 75% of electricity in New Brunswick should come from non-emitting sources by 2020 (including nuclear). If achieved, the City's emissions would experience an additional reduction of 2,300 tCO_2e/yr, excluding other measures.

TIMEFRAME

We have categorized measures depending on their implementation schedule as follows:

Short Term Measures: Measures or alterations that have been *completed* or are *planned* (within allocated budgets) to be implemented by 2017.

Medium Term Measures: Measures that will be implemented by 2020.

Longer Term Measures: Additional opportunities for GHG savings that may be pursued beyond 2020, not assessed for specific GHG and cost impacts.

GHG REDUCTION MEASURES

The Plan calls for investment of close to $6M spread out over five years which could be supported by potential grants and incentives (such as NB Power's $280,000 incentives for building retrofits), along with innovative financing approaches to municipal energy improvements. The five action areas described in the Plan should generate annual energy bill savings in the order of $580,000 to support the City's investment. A detailed table gathering all the measures and their impact, timeframe and responsible City departments is available in Appendix A.

Table 2 below shows the anticipated total GHG reductions resulting from the five actions identified above and described in detail in the following section. Implementation of the Plan will decrease GHG emissions from municipal operations by 13%, compared to the baseline, while contribution of NB Power's lower-emitting grid will help exceed the 2017 target of 20% below the 2002 emissions baseline.

Table 2: Summary of GHG and financial impacts of the Plan

	GHG emissions/ reductions (tCO_2e/yr)	Total investment required ($)	Savings ($/yr)
Baseline GHG emissions (2002)	**13,960**		
2017 target (-20% below baseline emissions)	-2,800		
Actions			
Building retrofits	-895	$3,300,000	$350,000
Efficient new buildings	660	-	-
Renewable energy in buildings	-485	$1,900,000	$115,000
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TOTAL Reduction from baseline emissions	**-1,820** -13%	**$5,900,000**	**$580,000**
NB Power grid effect	-2,300	-	-
TOTAL with NB Power grid effect Reduction from baseline emissions	**-4,120** -30%	**$5,900,000**	**$580,000**

(1) BUILDING RETROFITS

CONTEXT

The City's buildings represent the largest single source of GHG emissions, and as a result they likely represent the highest potential for GHG savings and energy cost savings. Overall, 69 individual municipal buildings are listed in the Corporate GHG Inventory (excluding parks and utility pumping stations), ranging from small tool sheds and washrooms to large facilities such as City Hall, and sports arenas. Moreover, some buildings are grouped into campus developments with shared energy infrastructure.

EXISTING MEASURES

- Building benchmarking (86 facilities)
- Energy audits (City Hall and St George Fire Station)
- Integrated Building Study (33 buildings audited)
- Energy Management Fund

MEASURE DESCRIPTIONS

COST-EFFECTIVE ENERGY EFFICIENCY RETROFIT AND COMMISSIONING PACKAGE (Short – Medium Term)

We have defined an energy efficiency retrofit package as a group of bundled measures that together meet a 10-year payback period threshold. This follows the measure bundles selection methods presented in the 2013 Energy Study at City Hall, and allows for the inclusion of longer payback measures that offer high GHG savings and a larger overall per project NPV. We consider the energy efficiency retrofit package to include all three elements described below, recommending that the equipment upgrades be undertaken alongside existing building commissioning and operator training in order to optimize the overall GHG and bill saving impacts.

Based on the 2013 Energy Study reports for City Hall and the St Georges Fire Station, along with a comparison with the apparent savings achieved at City Hall due to measures implemented since 2013, we have estimated that on average Moncton's City facilities would be able to achieve the following cost-effective energy savings through energy efficiency upgrades:

1 **EQUIPMENT UPGRADES (EU)**: Estimated 15% reduction in energy consumption

- Lighting upgrades including LED, High efficiency T8 and T5 fluorescent, improved lighting controls and automation
- Building Automation System (BAS) Upgrades
- HVAC upgrades: efficient boiler replacement (at end of life of existing), heat pump heating and cooling for air-conditioned spaces, variable frequency drive on fans and pumps where there is variable demand, air curtains in garages.

2 **EXISTING BUILDING COMMISSIONING (EBCx):** Estimated 10% reduction in energy consumption at facilities with central HVAC controls through a Building Automation System (BAS).

EBCx is a systematic process for investigating, analyzing, and optimizing the performance of building systems through the identification and implementation of low/no cost energy saving measures. The goal of EBCx is to provide the tools to support the continuous improvement of system performance over time, with a particular focus on optimizing the operations of existing

equipment. EBCx is typically led out by an experienced engineer or commissioning agent, who performs a series of evaluations and measure identifications.

3 **OPERATOR TRAINING AND OCCUPANT ENERGY AWARENESS (OT)**: Results in a 2% savings at facilities with central BAS, and 4% in facilities without central BAS.

The City is in the process of centralizing the maintenance of its facilities under the Facilities group, which includes a small team of dedicated technicians and experts. This group is ideally placed (and is currently engaged) to be trained to optimize the performance of the energy systems across the City's portfolio of buildings.

To implement this measure, the technician team would be given strategic and targeted training by an experienced energy management expert (engineer) to help them identify further opportunities and solutions to reduce the energy consumption at City facilities through continuous improvement and preventative maintenance.

In buildings with a central BAS, the energy savings would result largely from tuning the systems and set points, resulting in an estimated 2% per year savings. In facilities where there is no central BAS (and thus no EBCx savings) an additional estimated 2% savings can be achieved by coupling the operator training with occupant energy awareness training to help ensure the users of the facility understand how best to save energy on the site through responsible handling of thermostats, and other equipment.

4 **FLOATING HEAD PRESSURE CONTROL (FHPC) – *APPLICABLE TO ICE RINKS ONLY***

Floating head pressure control is an alteration that can be made to arena ice plants resulting in significant energy savings, without needing to change the main ice plant components (compressors, fans, heat exchangers).

Floating head pressure controls allow the head pressure (and associated temperature) to lower when ambient temperature falls. The energy savings from floating head pressure control are derived from operating the compressors at a lower pressure, allowing the condenser to take advantage of the low ambient temperature. While common in industrial and commercial refrigeration, the ice rink community has been slow to adopt floating head pressure controls.

The estimated savings range for FHPC is 12-25% of ice plant electricity use. Based on the consumption at Moncton rinks, we provide a conservative estimate of 75,000 kWh/year of energy savings for each rink at a given facility. There are likely two candidates for FHPC among Moncton's facilities: Superior Propane Centre (four rinks) and the Crossman Community Centre (one rink). FHPC is considered to be a low-cost strategy, and thus the measure price is estimated based on a conservative 5-year payback.

METHODOLOGY

As part of the City's Integrated Building Study, 33 energy-intensive buildings are currently undergoing or underwent an energy audit or a facility condition assessment. Focusing on those selected for an energy audit (17), we performed five tasks to determine the GHG reduction potential of these municipal facilities:

1) Reviewed the energy and GHG data for major facilities included in the 2013 Corporate GHG Inventory report.
2) Reviewed the engineering energy audits performed on City Hall and the St-George Fire Station in 2013 to identify cost-effective energy conservation measures.

3) Analysed facility energy billing data contained within the City's Energy Star Portfolio Manager account for major City facilities to determine important energy use trends and identify further GHG reducing opportunities.
4) Presented the proposed GHG reducing measures with the City's management and operations teams and received feedback on the technical feasibility and economic potential of the proposed measures, and
5) Toured a sample of the City's largest energy consuming facilities to observe the operations.

The estimates presented below are rooted in a detailed analysis of municipal buildings available in Appendix B.

GHG IMPACT

Table 3 lists the facilities that have undergone an energy assessment as part of the Integrated Building Study. Applicable energy efficiency measures and their impact on GHG emissions are presented below.

Table 3: Estimated GHG reductions achieved by energy efficiency retrofits

Municipal facilities (to be evaluated under IBS)	Applied measures[3]	Annual energy savings	GHG reduction (tCO_2e/yr)
Coliseum	Option 1 Option 2[4]	3,115 GJ (E) 7,108 GJ (E, G)	341 887
Agrena	EU + EBCx + OT	1,524 GJ (E, G)	151
655 Main Street - City Hall	EU (lighting)	217 GJ (E)	24
100 Worthington Ave - Operations Centre	EU + EBCx + OT	399 GJ (E)	44
100 Worthington Ave - Central Stores	EU + EBCx + OT	24 GJ (E)	3
100 Worthington Ave - Salt/Sand Shed	EU + EBCx + OT	7 GJ (E)	1
100 Worthington Ave - Green Tarp Storage	EU + EBCx + OT	19 GJ (E)	2
Botsford St Fire Station #3	EU + OT	92 GJ (E)	10
Brandon St Fire Station #4	EU + OT	183 GJ (E, G, O)[5]	42
99 Hildegarde Rd Fire Station #5	EU + OT	76 GJ (E)	8
Moncton Market	EU + EBCx + OT	229 GJ (E, O)	21
Assomption Blvd Storage [Fire Station]	EU + OT	14 GJ (E)	1
Crossman Kay Community Centre Arena	EU+EBCx+OT+FHPC	1,923 GJ (E, G)	142
Magnetic Hill - Admin building	EU + EBCx + OT	115 GJ (E)	13
Red Ball Internet Centre	EU+EBCx+OT+FHPC	1,835 GJ (E, N)	81
Codiac Transpo	None proposed	0 GJ	0
09002 - 800 St. George Blvd Fire Station #2	EU + OT	108 GJ (E)	12
TOTAL			**895**[6]

[3] EU: Equipment upgrade; EBCx: Existing Building Commissioning; OT: Operator training and occupant energy awareness

[4] Options 1 and 2 are described in detail in Appendix B. Option 1 consists in keeping the Coliseum as a recreational ice rink, while Option 2 would involve converting the Coliseum to expand the convention center space (Agrena), which would increase Gas consumption at the facility for heating.

[5] Energy savings include a switch from oil to natural gas heating (increased boiler efficiency).

[6] Conservative estimate assuming option 1 is selected for the Coliseum (see details in Appendix B). Selecting option 2 for the Coliseum would yield total GHG reductions of 1,440 tCO_2e/yr.

COSTS AND BENEFITS

Based on completed audit reports, the proposed measures were selected to yield a simple payback of 10 years for each bundle applied to each facility, except for the FHPC measure (5-year payback). This translates into a total upfront investment in the order of $3.3M and annual savings of around $350,000, assuming the Coliseum remains an ice rink. The Net Present Value of these investments is estimated at approximately $700,000[7]. The conversion of the Coliseum into a convention center space would yield significant additional GHG and energy savings[8], but the cost of such a conversion was not estimated as part of this analysis since the main purpose of the conversion would not be energy efficiency.

Potential Incentives

Retrofits to municipal buildings are eligible to receive financial incentives under NB Power Energy Smart Program for Commercial Buildings. NB Power offers $30/GJ saved, which would amount to $280,000 in total for the buildings reviewed (10,000 GJ saved in total). This would decrease the payback period of all building retrofit measures combined to 8.5 years from 9.4 years without the incentives.

[7] Assuming a 15-year useful life and 3.5% discount rate.

[8] It would increase GHG savings by 550 tCO_2e and annual energy costs savings by $180,000.

(2) EFFICIENT NEW BUILDINGS

CONTEXT

To provide the municipal services needed by its growing population, Moncton plans to build several new facilities in the near future. This will have an impact on Moncton's GHG emissions since all new facilities must be included within the GHG inventory. Similarly, buildings that will be decommissioned must also be removed from the inventory.

EXISTING MEASURES

- Green Building Policy
- New Fire Station and Downtown Centre built according to Green Globes 3 (45% more efficient than standard practice)

MEASURE DESCRIPTION

To ensure that new buildings are built as energy efficient as possible, as their design will impact energy consumption over the entire lifecycle of the building, the City recently adopted a Green Building Policy (included as Appendix C). The Policy states that newly constructed buildings shall be designed according to meet LEED or Green Globes criteria, but does not provide specifics as to energy performance target.[9] However, review of the available energy models for new facilities currently being developed reveals an average of 40% better energy performance compared to standard code performance, with the Downtown Centre achieving a 45% saving (modeled) compared to code. Given the success the City has achieved through this policy, it should consider adopting a specific energy performance target within the Green Building Policy.

Three major buildings are planned to be commissioned in the next years: the new fire station (80 Caledonia Road), the Downtown Centre and the new RCMP station. Other smaller facilities will also be constructed and will have to meet the Green Building Policy.

Building to LEED standards includes meeting a number of prerequisites that lend themselves to energy efficient performance. Specifically, LEED construction requires that a thorough commissioning plan be put in place that begins before the building is designed, and continues through to occupancy. It also includes minimum targets for energy performance, and including a rigorous estimate of the energy performance during the design phase.

METHODOLOGY

The impact of the City's Green Building Policy, that requires new buildings to follow LEED or Green Globe standards, was estimated by assessing the energy performance of the new buildings as compared to standard construction following building code requirements.

While the energy consumption for the fire station and the Downtown Centre could be estimated from energy models, the consumption of the RCMP station as well as smaller planned facilities were estimated assuming similar savings levels (in the order of 40% when compared to a reference building).

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[9] The Green Building Policy states that buildings larger than 500m^2 must achieve LEED certification (with Green Globe Level 2 considered an acceptable alternative), while smaller facilities must just apply the LEED principals, but do not require formal certification.

The City also plans to retire a number of buildings, some of them being demolished while others may see their usage change (for example, the Centennial Beach changing room could become a picnic shelter and the former Assomption Boulevard fire station building wouldn't be used by the City anymore).

GHG IMPACT

Overall, as indicated in Table 4, the renewal of the City's building portfolio will result in a net GHG emissions increase of around 660 tCO_2e. However, this represents a reduction of 520 tCO_2e compared to what would have happened, had the City not adopted the Green Building Policy.

Table 4: GHG impact from new and retired buildings

Facility	GHG emissions under GB Policy (tCO_2e/yr)	Estimated GHG emissions without GB Policy (tCO_2e/yr)
Build new efficient buildings	**690**	**1,210**
New Fire Station	51	83
Downtown Centre	473	860
RCMP Station	144	234
Parks and Recreational facilities	21	34
Decommission old buildings	**-30**	**-30**
Total GHG Impact	**+660**	**+1,180**

(3) RENEWABLE ENERGY IN BUILDINGS

CONTEXT

Two renewable energy options were identified through discussion with City representatives and on-site assessments: rooftop solar Photo voltaic (PV) and biomass boilers.

With decreasing costs in recent years, rooftop solar PV has become a viable option to generate zero-emission electricity on-site. Installing solar panels may also serve to showcase the City's leadership in developing local renewable energy capacity, which is why two emblematic buildings (the City Hall and Codiac Transpo) were selected.

Biomass heating represents another promising opportunity for the City that was assessed for the Operations Center. Though more complex to operate than a solar PV arrant, external service provision options exist to provide the equipment, feedstock, and operation.

The opportunities discussed below are those identified during the site visit, but other facilities could consider similar projects.

MEASURE DESCRIPTIONS

1

SOLAR PV: CITY HALL (34kW) AND CODIAC TRANSPO (450 kW Max) (Medium – Long Term)

City Hall and Codiac Transpo each appear to present an opportunity to install solar PV panels.

- City Hall: A 34 kW system installed along the pitched part of the south facing penthouse structure, as well as on the lower portion of flat roof extending along the west side of the building (after the roof membrane has been fixed or replaced).
- Codiac Transpo has a large flat roof that is covered only minimally with equipment (roof top heating and ventilation units) and is almost entirely unshaded. It is a new facility that will not likely require roof repairs for 10-20 years. Moreover, as a modern, energy efficient facility, Codiac Transpo has largely addressed its energy demand issues. Taking these factors together, along with the facility's status of providing a shared service to three municipalities, it may be ideally suited to host a solar PV array. The installed capacity of the solar PV system was estimated at 450 kW based on available rooftop area and the building's energy requirement. This system would provide over 85% of the facilities needs on an annual basis. However, NB Power currently limits net-metering contracts to 100kW systems, with larger systems requiring specific exception.
- As a further option, the Alma St. parking garage was mentioned as an option. However, given that the roof of this structure is used for parking, an additional structure would be needed to carry the PV panels, which would increase the installation costs significantly compared to the City Hall or Codiac Transpo systems. One alternative option could be to construct a small pergola over 2-3 parking spaces on the roof, and connect them to EV charging stations. While this would not likely prove to be cost-effective from an energy bill

saving perspective, it would offer additional value to the City for public education and a lead-by-example action.

2

BIOMASS BOILER: OPERATIONS CENTRE (Medium Term)

Our assessment suggests that replacing or supplementing the oil boiler at the Operations Centre may prove an ideal location to demonstrate the potential of biomass heating to reduce GHG emissions and generate value from the City's wood waste. The following supports the use of a biomass boiler to heat the Operations Centre:

- The Operations Centre is the central depot for the parks maintenance crews which would facilitate the collection of wood waste on the site. It also has more land adjacent to the facility, and partially used in-door garage spaces that could be ideal for wood storage and chipping.
- The Operations Centre represents the single largest consumer of heating oil among City facilities, using more than three times as much fuel oils as any other of the City's buildings. This offers the greatest potential benefit potential benefit and helps justify engaging in a complex heating operation like biomass.
- The Operations Centre is home to many of the City's key technical staff and is a logical fit for the biomass boiler operation team. Biomass boilers are complex systems that require regular operator attention to ensure that the wood chip feed is maintained.
- There is a significant use of propane heat on the site, and it may be possible to replace some of these heating needs by expanding the hydronic heating loop and installing a biomass boiler of a higher capacity than the current oil boiler, thus generating further GHG reductions and energy bill savings.

Prior to installing a biomass boiler at the Operations Centre, we recommend that the City implement the other cost-effective EE upgrades that will be identified in the current round of facility energy audits. This may help to further reduce boiler heating needs on the site, as well as the biomass boiler equipment costs.

METHODOLOGY

The solar PV system capacity and electricity generation potential were assessed using Dunsky's in-house model, based on available rooftop area and limiting factors such as shade. Annual savings were based on average electricity rates paid by the City, while the PV system costs come from Dunsky's review of system costs across North America. Details on the assumptions are provided in Appendix D.

The evaluation of biomass as a potential heating source for the Operations Centre was done at a high-level, based on a documented case study for a similar project in another municipality. Costs and savings were extrapolated from the case study (which showcased a smaller installation than what is required at the Operations Centre). Results should be viewed as indicative only, as equipment and biomass feedstock costs may have changed with time and vary with the location. We recommend that a

feasibility study be conducted in order to estimate precisely what costs such an installation would entail.[10]

Alternatively, a full service third-party contract that includes installation and operation of the biomass boiler under a 20-year contract may provide another cost-effective option. Budget prices quoted from a local supplier indicate that a biomass fed system supplied on a long term build and operate contract could be supplied at a price competitive with current fuel oil prices.

GHG IMPACT

Table 5: GHG impact from renewable energy measures

Facility	Non-renewable energy displaced (GJ/yr)	GHG reduction (tCO_2e/yr)
Solar PV		
City Hall	170 GJ (electricity)	14
Codiac Transpo	2,273 GJ (electricity)	190
Biomass heating system		
Operations Centre	3,826 GJ (oil)	282
Total GHG savings		**485**

COSTS AND BENEFITS

Costs and savings for the two proposed solar PV systems are detailed in Table 6.

Table 6: Estimated costs and savings for City Hall and Codiac Transpo PV systems

Facility	GHG savings (tCO_2e/yr)	PV System Capacity	Estimated Cost	Annual Energy Production	Annual Bill[11] Savings (2016)	System NPV[12]
City Hall	14	34 kW	$90,000	47,400 kWh	$5,500	$53,000
Codiac Transpo	190	450 kW	$1,150,000	632,000 kWh	$68,500	$640,000

[10] For the purposes of this study we have assumed that the biomass boiler would replace 100% of the fuel oil, however, it is likely that the fuel oil boiler would remain in service as a back-up system to cover extreme peaks and biomass boiler service interuptions.

[11] Includes estimated demand savings.

[12] Assuming 30-year useful life and 3.5% discount rate.

Overall the solar PV installations will not likely achieve a 10-year payback threshold (at current prices solar PV in NB would likely achieve a 15-20-year payback). However, both installations offer a positive NPV return, based on a 30 year expected useful life of the panels. Given that solar PV is a reliable and durable technology requiring minimal maintenance, that can last as long as 40 years, it may offer an ideal solution to further reduce the electricity consumption at two of the City's most energy efficient facilities, while setting a high-profile example for the community.

Table 7 presents the cost-benefit analysis for a biomass heating system to meet the heating requirements of the Operations Centre. Alternatively, a third-party supplier offered a preliminary budget price of between $72,000 and $96,000 (depending on the system size and other characteristics) to install and operate (including fuel costs) a biomass boiler on a 20-year contract[13].

Table 7: Estimated costs and savings for the Operations Centre biomass heating system

Facility	Annual Fuel Oil Consumption	Estimated Cost[14]	Annual Bill Savings[15]	Payback	System NPV[16]
Operations Centre	100,000 L	$630,000	$40,000	16 years	$92,000

Potential Incentives

Both solar PV and biomass boiler projects could be eligible to NB Power Energy Smart program for commercial buildings, which offers financial incentives for projects that reduce non-renewable energy use. Based on the capacity of the solar PV systems, the City Hall project could receive a $5,000 incentive, while the larger Codiac Transpo system could benefit from a $70,000 incentive. If the biomass heating system was to displace 100% of the oil use at the Operations Centre, it would be eligible to a $115,000 incentive.

The FCM's Green Municipal Fund (GMF) offers grants and loans for feasibility studies and capital projects that demonstrate innovative and sustainable solutions in municipalities. Grants up to $175,000 are available for feasibility studies, while capital projects can receive a maximum of $5M in loans and $750,000 in grants (up to 80% of eligible costs).

The NB Power Net Metering program offers the City the option to connect a solar PV generation system to NB Power's distribution system. Under the net metering program, the City would only be charged for the net amount of electricity consumed, i.e. the difference between the total electricity consumed and the electricity produced by the solar PV system. As mentioned above, NB Power sets the net-metering limit to 100 kW systems; therefore the City should verify the applicability of the program to larger systems before engaging in any installation.

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[13] This compares favorably to current cost for supply oil to the Operations Center ($90,000 in 2013).

[14] The estimated cost includes the cost of the system, the installation, related professional services (excluding the preliminary feasibility study), and work required to build or adapt the biomass storage room and a heating network between the different buildings.

[15] Biomass prices assume the use of wood pellets at $170/ton, but would be reduced if the City had access to lower-cost biomass such as resinous tree shavings ($50/ton).

[16] Assuming 30-year useful life and 3.5% discount rate.

(4) GREEN FLEET

CONTEXT

Reducing the carbon footprint of the municipal fleet has been a recognized challenge for some time. Initiatives such as the "Vehicle and equipment idling policy" and the City's participation in NB Power's pilot to demonstrate the performances of a plug-in electric vehicle showed Moncton's leadership and commitment to lower the impact of vehicles operations while delivering municipal services. Despite these efforts, Moncton's fleet footprint has increased over the last decade. To reverse this trend toward increasing fleet emissions, both equipment upgrades and behavioral measures can be implemented to decrease fuel consumption.

EXISTING

- Fleet management system
- Electric vehicle pilot
- Vehicle and equipment idling policy
- Right-sizing exercise (retirement of 12 vehicles)
- Pilot use of 50 Automatic Vehicle Location systems

MEASURE DESCRIPTIONS

1

VEHICLE RIGHT SIZING (Short Term)

Vehicle right-sizing seeks to find opportunities to optimize the fleet size and composition, including reducing the number of vehicles and choosing more fuel-efficient vehicles. It is a cost-effective strategy that results in fuel savings while often not entailing incremental costs. The City is currently undertaking a right-sizing exercise to increase efficiency in the municipal fleet. Though not capital-intensive, this measure requires careful planning to establish the functions of each vehicle and find viable replacement options or even recommend elimination from the fleet. Under the current right-sizing exercise, 12 vehicles were removed or are in the process of being removed from the fleet. The City will systematically proceed to this exercise when vehicles need to be replaced or purchased.

2

DRIVER TRAINING AND FUEL CONSUMPTION TRACKING (Short – Medium Term)

Although adopted, the "Vehicle and equipment idling policy" is not widely known nor observed by City fleet operators. The City will seek to increase awareness of the policy and related eco-driving practices among vehicle operators by offering coaching and training to drivers. Training drivers on eco-efficient driving techniques may reduce fuel consumption by up to 10%.

Opportunities for coaching fleet operators on eco-driving practices will be identified using data from "automatic vehicle location" (AVL) systems, which are currently being piloted in the City fleet. The use of AVL systems helps tracking fuel consumption and idling time, and would enable the City to target high fuel consuming vehicles as good candidates for eco-driving coaching sessions and then measure the impact of driver training. The AVL systems are also a powerful tool to increase awareness among the fleet staff, and to help drivers follow their own progress. The City currently has 50 AVL systems and will expand their use to City vehicles if results from the pilot prove the claimed AVL benefits.

Estimated GHG reductions assume that 10% of the fleet operators will be trained and that it will result in a 10% fuel reduction on one tenth of the fleet total consumption.

3

ELECTRIC VEHICLES (Medium – Long Term)

Electric vehicles (EV), either plug-in hybrid vehicles or fully electric vehicles, have the potential to reduce fleet GHG emissions significantly. Due to their limited range and their need for dedicated recharging infrastructure, they may be more suited for certain tasks than others. Typical uses for electric vehicles in municipal operations include parking patrol, traffic control and other works that can be performed by smaller vehicles and do not require long distance travel. The EV pilot conducted with NB Power demonstrated limited autonomy during the winter (25-35 km per charge), therefore limiting the use of the vehicle for municipal services.

As EV prices decrease and battery autonomy improves[17], we expect that EV will take a larger share of Moncton's fleet. As part of the Plan, the City will monitor EVs on the market, identifying when viable electric cars, pick-up trucks or vans become available[18].

METHODOLOGY

A review of the fleet composition was performed to evaluate opportunities for replacement by either cleaner technologies or less-fuel intensive vehicles. Average fuel consumptions and distances travelled annually were taken from municipal-specific data where available or from the literature.

Estimates for behavioral measures were sourced from case studies documenting achievable fuel savings and implementation costs.

GHG IMPACT

Table 8: GHG impact from sustainable fleet measures

Measure	GHG reduction (tCO_2e)
Right-sizing of the fleet	62
Fleet operators training on eco-driving practices and fuel tracking with AVL systems (62 AVL installed and as many drivers trained)	32
TOTAL	**94**

[17] Second generation Chevrolet Volt has increased its maximum autonomy from 60 km to 85 km.

[18] Plug-in hybrid SUV have recently been released (Mitsubishi Outlander), while hybrid minivans (Chrysler Pacifica) are underway.

COSTS AND BENEFITS

Table 9 presents the costs associated with the proposed measures, and compares them with expected fuel savings.

Table 9: Cost-benefit analysis for Green Fleet measures

Measure	Number of units	Estimated Upfront Cost	Annual Maintenance Cost	Annual Fuel Savings	Total annual savings	Payback
Right-sizing	12 vehicles retired	$0	$0	$25,000	$25,000	N/A
Fuel consumption tracking and driver training	12 new AVL systems and training as required	$3,000	$22,000	$13,000	-$9,000	N/A

Removing twelve vehicles from the fleet could yield $25,000 savings annually, without incurring any additional cost. This is a conservative estimate that could increase if the City identifies further right sizing opportunities within the fleet.

Adding more AVL systems to the fleet and training drivers based on the opportunities identified with the AVL systems will require a significant investment. This investment was estimated at $3,000 upfront for the purchase of 12 new AVL systems in the short term and around $22,000 in annual service fees for the 50 AVL already installed and the 12 new ones that will be added. The purchase of this equipment fulfills several purposes and should not only be analyzed from a GHG perspective. The cost for training and coaching fleet operators was not estimated separately as it is likely to be integrated as part of the fleet management processes. However, if the City wants to engage in a formal training course, eco-driving classes are available for a cost in the order of $3,000 per session. If the equivalent of 62 fleet drivers are trained and adopt lasting eco-driving practices, the City will save approximately $13,000 per year. These savings are largely dependent on behavior changes that may not persist beyond a few months. Therefore, it will be important to repeat the training annually or biannually, and to find ways to engage fleet operators all year round.

Potential Incentives

Setting up an eco-driving course might be eligible for a New Brunswick Environmental Trust Fund grant, as it seeks to increase environmental awareness. Opportunities to develop or organize a training course that could be rolled-out to other organizations or local businesses should be investigated to share costs and maximize the benefits of this initiative.

(5) STREETLIGHT AND PARK LIGHTS UPGRADES

CONTEXT

Replacing exterior lights by LED lights is a very effective way to reduce GHG emissions, as LED models reduce electricity consumption by up to 75%. As part of its LED Streetlight Program, NB Power replaced all High-Pressure Sodium streetlights by LED models between 2013 and 2015. The City is now looking for ways to upgrade its own lighting infrastructure, including the one for lighting parks, trails and unmetered facilities.

EXISTING MEASURES

- LED traffic lights replacement
- NB Power LED streetlights replacement

MEASURE DESCRIPTION

1 **NB Power's Street Lighting LED Upgrade Program**

Though owned by NB Power, energy consumed by streetlights located on Moncton's territory contribute to the City's corporate GHG inventory. By 2013, when the most recent inventory was compiled, NB Power had upgraded approximately 25% of Moncton's streetlights to LEDs, and by the end of 2015, the remainder of Power-owned streetlights had been converted. The savings achieved by NB Power's streetlight upgrades completed between 2013 and 2015 have been accounted for in this Plan as an existing measure.

2 **LED EXTERIOR LIGHTING UPGRADES IN PARKS AND CITY PARKING (Short – Medium Term)**

Based on NB Power's results with the street lighting, it is proposed that the City convert its approximately 1,000 exterior lights in parks and parking spaces (interior and exterior) to LEDs.

METHODOLOGY

According to NB Power, LED streetlights reduce electricity use by 50-60%. The City performed a comparison analysis to evaluate the payback period of replacing existing downtown decorative lighting (metal halide and HPS) and the parking garage to LED. Costs and savings for converting the entire City-owned exterior light stock were derived from the comparison analysis.

Considering the payback period between 5 and 8 years, it is recommended that the City proceed to the LED conversion of all its lights in parks and other unmetered facilities over the duration of the Plan. Further opportunities include adding motion and light sensors but associated savings and costs have not been included and should be further investigated on a case-by-case basis.

GHG IMPACTS

Table 10: GHG impact from replacing NB Power and City-owned streetlights and park lights by LED

Facility	Number of lights converted to LED	GHG reduction (tCO_2e)
NB Power streetlights (converted after 2013 inventory)	7,500	790
City-owned lights	1,000	220
TOTAL	8,500	**1,010**

COSTS AND BENEFITS

Table 11 summarizes assumptions that were used to calculate the total investment, savings and net present value for replacing all City-owned HPS lights by LED lights over 5 years.

Table 11: Cost-benefit analysis for the LED conversion of City-owned street and park lights

Measure	Number of units	Estimated Cost[19]	Annual Bill Savings[20]	Annual O&M Savings[21]	Payback	NPV[22]
HPS to LED	1,000	$750,000	$82,000	$23,000	7 years	**$12,000**

[19] Assuming a $750 cost per LED fixture.

[20] Considers a 75% electricity use reduction.

[21] Maintenance costs are estimated at $25/fixture for existing fixtures and at $2/fixture for LED fixtures.

[22] Assuming a 75,000-hour useful life and 3.5% discount rate.

WATER AND WASTE SECTORS

Water treatment and distribution services, wastewater collection and municipal waste disposal together account for just 5% of the City's overall GHG emissions. Emissions from water and wastewater are attributed to the electricity used by pumping stations, lift stations, city well, water tank and potable water treatment plant while emissions from waste come from the methane produced when organic material is landfilled (includes waste generated at municipal buildings and public municipal facilities such as parks and recreational buildings).

GHG reduction opportunities that may lie in these sectors are not believed to hold significant potential toward meeting the City's GHG targets, given their minimal contribution to the overall GHG inventory. For these sectors cost saving we have identified cost saving and demonstration measures, but have not quantified their impacts on the GHG inventory.

Water: One opportunity that may result in energy bill savings would be to install pressure limiting valves at low points in the network where the water pressure significantly exceeds the City's target water pressure. However, identifying these locations, and assessing the impact on pumping energy would require a detailed engineering study that is beyond the scope of this report.

Waste: Actions that further divert waste from landfill, including education activities to increase recycling and organic waste sorting at municipal facilities may offer benefit to the City. Although waste landfilling contributes only 1% to total corporate emissions, its share of Moncton's Community GHG Inventory is much greater, thus solutions implemented at the City's corporate level could demonstrate approaches to reduce the community waste related GHG generation.

4. NEXT STEPS: IMPLEMENTATION AND MONITORING PROGRESS

The City of Moncton's Corporate GHG Reduction Plan includes five key action areas covering eleven measures that can contribute to meeting the City's GHG reduction targets.

While it may not be feasible to successfully implement all measures included in this Plan by the target date of 2017, it is anticipated that the City should be able to achieve the vast majority of these measures by 2020, if a detailed plan of action is in place by 2017.

After City Council has received the Plan, the next steps will be to designate responsibility for each action area and set a timeframe for implementing the measures.

In most cases the identified measures require some form of upfront investment, but deliver energy cost savings to support the investment, ultimately resulting in a positive net present value for the City over the lifetime of the investments made. A key step in implementing the Plan will be to identify financing sources for each measure.

Finally, as the measures are implemented, the City should put in place tools and systems to monitor its progress toward the 20% reduction target through regular updates of the corporate GHG inventory and tracking other key performance indicators such as energy savings, renewable energy generation and the overall cost/benefits for each investment.

Ultimately, the successful implementation of this plan will lead to robust GHG reductions across the City's operations that can demonstrate opportunities to reduce GHG across the community. Moreover, these measures together should ultimately result in reduced operating costs for City services, thus supporting further GHG reduction actions.

IMPLEMENTING THE PLAN

The Plan's implementation will be coordinated by the City's Environmental Planning and Management department, but will require support from many City departments, including:

- Energy and Facilities Management
- Fleet Management
- Finance and Legal Departments
- Codiac Transpo
- Parks and Leisure Services

Each action will be led by a City department, supported by other departments and the Environmental Planning and Management team (Table 12).

The Plan launch should start with a kick-off meeting gathering all involved parties to present the Plan's actions, major milestones and expected outcomes. Then, specific committees formed within each concerned department would meet and start planning the roll-out of the actions.

Table 12: Roles in the implementation of the Plan

Action	Lead Department	Support Department	Timeframe
1. Building Retrofits	Facilities	• Environmental Planning	Short-Medium
2. Efficient new buildings	Facilities	• Environmental Planning	Short-Medium
3. Renewable energy in buildings			
Solar PV at City Hall	Facilities	• Environmental Planning	Medium-Long
Solar PV at Codiac Transpo	Codiac Transpo	• Facilities • Environmental Planning	Medium-Long
Biomass at Operations Centre	Facilities	• Engineering • Environmental Planning	Medium
4. Green fleet	Engineering	• Environmental Planning	Short-Medium
5. Streetlights and park lights upgrades	Engineering	• Parks & Leisure Services • Environmental Planning	Short

FINANCING THE PLAN'S MEASURES

A high-level estimate of budget costs for each measure has been provided throughout this Plan. Once the lead and supporting departments have been assigned for each measure, a financial plan will be needed to raise the required upfront capital. This can be done as a larger fund to support many measures, or on a measure by measure basis. A number of financing tools and options to support the Plan measures have been identified.

1 **Integration of GHG Measures into Capital Budget Planning:** Many of the measures related to building retrofits can be integrated within capital budget planning and implemented alongside planned facility upgrades and deferred maintenance. A few opportunities include:

- **Procurement Rules:** Incorporating GHG reducing measures into procurement rules is one strategy for accomplishing this, as well as expanding or planning specific purchases of GHG reducing equipment and services.
- **Deferred Maintenance Planning:** Efficiency upgrades can sometimes be incorporated into deferred maintenance planning.[23] Given that the measures in the Plan carry an average payback of 10 years, the City could consider issuing a long term bond (15-20 years) to support the select efficiency upgrades (focusing on longer term persistence measures), and use the additional debt to cover needed deferred maintenance needs.

[23] One example of this is the City of Cleveland's RENEW program that issued bonds to support projects that included deferred maintenance alongside efficiency upgrades. (http://emeraldcities.org/cities/cleveland)

This could expand the City's current deferred maintenance budget and speed capital allocations for GHG reducing measures.

- **Energy Service Company (ESCO):** Finally, the City could consider revisiting the ESCO model to plan and implement energy efficiency projects. While it is rare for ESCOs in Canada to finance projects for municipalities, a cost/benefit sharing agreement could reduce the upfront cost to the City. Moreover, strategies like the Government of Quebec's[24] *NPV-Max* approach can be employed to ensure optimal returns to the City.

2 **Operating Budget Approaches:** Another approach that may be an ideal fit for certain measures is to identify options to finance them through the facility or department operating costs, rather than the capital budget. This can streamline decision-making to the department level, and may in some cases help reduce the additional debt load on the City.

Examples may include:

- Install solar PV systems under a lease or power purchase agreement
- Operating leases for EV or hybrid vehicles
- Third-party owned and operated biomass boilers

The City's recently established **Energy Management Fund** will also play a key role to support GHG and energy reducing measures. The City currently invests $20,000 per year in this fund, which supports internal energy saving initiatives through a revolving fund. While it is ideally suited to support the Plan measures, it is not currently sufficient to finance the full $3.3M of building retrofits identified in the Plan.

Finally, while NB Power does not currently offer on-bill financing (OBF), given the duration of this Plan, the City should be aware of any such offer that may be presented by NB Power in the future.

3 **Incentives and Grants:** Three key sources of incentives and grants have been identified for the measures in the Corporate GHG Plan. While these funds are rarely sufficient to cover project costs in their entirety, they can play a key role in supporting detailed feasibility studies and planning in the early, high-risk stages, as well as reducing the overall cost of the measures to the City. Identified sources of funds include:

- **NB Power's Energy Smart Commercial Buildings Retrofit Program:** provides financial incentives of up to $3,000 towards an evaluation to determine the potential for energy efficiency upgrades in a commercial building and a maximum of $75,000 towards the energy retrofitting project costs.
- **FCM Green Municipal Fund:** supports initiatives that demonstrate an innovative solution or approach to a municipal environmental issue, and that can generate new lessons and models for municipalities of all sizes and types in all regions of Canada. It includes loans and $5 million in grants for capital projects in the energy, transportation, waste and water sectors, as well as grants to support plans, feasibility studies and pilot projects.

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[24] In 2009 the Government of Quebec adopted the "Règlement sur les contrats de travaux de construction des organismes publics" (RLRQ c C-65.1 r5) to govern how public energy efficiency retrofit projects are evaluated and selected. It requires proposals to be based on the maximum net-present value (NPV-Max), which provides a clear indication of the cost-to-benefit ratio of the proposed EE project over the life of the installed measures. The application of this model is intended to ensure the optimal breadth and depth of energy savings in public facilities.

- **The Government of New Brunswick's Environmental Trust Fund:** provides assistance for action-oriented projects with tangible, measurable results, aimed at protecting, preserving and enhancing the Province's natural environment.

MONITORING PROGRESS

Monitoring progress of the Plan is a key step in the GHG reduction planning process to verify if the City is on track to achieve its target. The monitoring plan should also identify which actions have been successfully implemented, and what results have been delivered to date. The suggested monitoring plan includes three activities:

1

ANNUAL REPORTING

The easiest way to actually verify whether the City is on track to meet its GHG target is to update the corporate GHG emissions inventory each year. The systematic update of the GHG inventory should not require as much work as setting up the initial inventory has been completed, and collecting the data needed for regular updates are now part of existing processes for the City's Environmental Planning and Management department. Attention should be paid to ensure new buildings are included in the inventory, removing retired buildings and updating the GHG emission factor from electricity production in New Brunswick, based on the most recent data published by Environment Canada. The City could also release an update each year on the state of corporate emissions and communicate on progress made to date to the City's administration, staff and community.

2

ACTION-SPECIFIC PERFORMANCE INDICATOR TRACKING

For each action, performance indicators should be established and tracked to allow for a more accurate measurement of the changes occurring from the implementation of the GHG reducing measures. Regularly tracking these indicators will also help to assess the success of an action, and allow the City to change course of an action if it doesn't produce expected results. Each department responsible for implementing the actions will also be in charge of monitoring the results, reporting to the Environmental Planning and Management department.

3

FIVE-YEAR REVIEW

After five years, the Plan should be reviewed to assess the results achieved over the Plan's duration. Through this process, emerging opportunities will be assessed, and new targets and actions will be defined to further reduce the City's corporate emissions.

Recommended Corporate GHG Reduction Plan performance indicators are included in Table 13 below.

Table 13: GHG Reduction Plan Performance Indicators

Action	Suggested performance indicators
All GHG Reduction Plan Applies Action Areas	GHG Emissions (CO_2e) (Tons of reductions, total tons, tons/GJ)
1. Building retrofits GHG Reduction Target: 895 tons	Total energy consumption (GJ, kWh, m^3, L)
	Unit energy consumption (GJ/ft^2, kWh/m^2, m^3/m^2, L/m^2)
2. Efficient new buildings GHG Target: 661 ton GHG increase, *(as compared to 1,185 ton increase expected for the new facilities under standard construction practice)*	Total energy consumption (GJ, kWh, m^3, L)
	Unit energy consumption (GJ/ft^2, kWh/m^2, m^3/m^2, L/m^2)
	# of LEED and Green Globes certified buildings
	% reduction in energy use compared to standard practice
3. Renewable energy in buildings GHG Reduction Target: 485 tons	Solar PV electricity production (kWh)
	Biomass consumption (tons)
4. Green fleet GHG Reduction Target: 95 tons	Total fuel consumption (L diesel, L gasoline)
	Unit fuel consumption (L/100km, kWh/km)
	Distance travelled (km)
	Idling time reduction (min)
	# of electric vehicles purchased
5. Streetlight and park lights upgrades GHG Reduction Target: 293 tons	Total energy consumption (kWh)
	# of LED lights installed

APPENDIX A: GHG REDUCTION PLAN SUMMARY TABLE

	GHG Impact (tCO_2e/yr)	Total estimated investment	Annual savings	Payback (yrs)	Net Present Value ($)	Potential NB Power incentive	Implementation timeframe (Short-medium-long term)	Lead department	Support department
Action 1: Buildings retrofits	**-895**	**$3,301,839**	**$351,167**	**9.4**	**$717,583**	**$277,897**			
Coliseum (Option. 1: Keep as ice rink with efficiency improvement)	-341	$1,081,885	$108,188	10.0	$158,615	$75,000	Medium	Facilities	Environmental Planning
Coliseum (Option. 2: Convert to Convention Center)	-887	N/A	$291,200	N/A	N/A	$75,000	Medium	Facilities	Environmental Planning
Coliseum Agrena	-151	$515,813	$51,581	10.0	$75,623	$45,724	Medium	Facilities	Environmental Planning
655 Main Street - City Hall	-24	$93,137	$9,314	10.0	$13,655	$6,506	Medium	Facilities	Environmental Planning
100 Worthington Ave - Operations Centre	-44	$135,786	$13,579	10.0	$19,908	$11,981	Medium	Facilities	Environmental Planning
100 Worthington Ave - Central Stores	-3	$8,693	$869	10.0	$1,275	$719	Medium	Facilities	Environmental Planning
100 Worthington Ave - Salt/Sand Shed	-1	$2,800	$280	10.0	$410	$198	Medium	Facilities	Environmental Planning
100 Worthington Ave - Green Tarp Storage	-2	$7,291	$729	10.0	$1,069	$560	Medium	Facilities	Environmental Planning
Botsford St Fire Station #3	-10	$49,773	$4,977	10.0	$7,297	$2,752	Medium	Facilities	Environmental Planning
Brandon St Fire Station #4	-42	$203,232	$20,323	10.0	$29,796	$5,485	Medium	Facilities	Environmental Planning
99 Hildegarde Rd Fire Station #5	-8	$28,795	$2,880	10.0	$4,222	$2,267	Medium	Facilities	Environmental Planning
Moncton Market	-21	$90,293	$9,029	10.0	$13,238	$6,873	Medium	Facilities	Environmental Planning
Assomption Blvd Storage [Fire Station]	-1	$7,043	$704	10.0	$1,033	$409	Medium	Facilities	Environmental Planning
Crossman Kay Comm Centre Arena	-142	$481,939	$52,724	9.1	$121,069	$57,684	Medium	Facilities	Environmental Planning
Magnetic Hill - Admin building	-13	$41,247	$4,125	10.0	$6,047	$3,454	Medium	Facilities	Environmental Planning
Red Ball Internet Centre	-81	$516,287	$68,082	7.6	$258,781	$55,045	Medium	Facilities	Environmental Planning
280 Pacific Ave - Codiac Transit	0	$0	$0	N/A	N/A	$0	Medium	Facilities	Environmental Planning
800 St. George Blvd Fire Station #2	-12	$37,825	$3,782	10.0	$5,545	$3,241	Medium	Facilities	Environmental Planning

	GHG Impact (tCO_2e/yr)	Total estimated investment	Annual savings	Payback (yrs)	Net Present Value ($)	Potential NB Power incentive	Implementation timeframe (Short-medium-long term)	Lead department	Support department
Action 2: Efficient new buildings	**+661**	**-**	**-**	**-**	**-**				
New Fire Station – 80 Caledonia Rd	+51	-	-	-	-	-	Medium	Facilities	Environmental Planning
Downtown Center	+473	-	-	-	-	-	Medium	Facilities	Environmental Planning
RCMP Station	+144	-	-	-	-	-	Medium	Facilities	Environmental Planning
New Hal Betts Building	+15	-	-	-	-	-	Short	Facilities	Environmental Planning
Beach Replacement	+6	-	-	-	-	-	Medium	Facilities	Environmental Planning
BLDG02042 - Demolition	-2	-	-	-	-	-	Medium	Facilities	Environmental Planning
BLDG02038 - Change of usage	-19	-	-	-	-	-	Medium	Facilities	Environmental Planning
BLDG01006 - Change of usage	-6	-	-	-	-	-	Medium	Facilities	Environmental Planning
Action 3: Renewable energy in buildings	**-485**	**$1,859,330**	**$113,570**	**16.4**	**$1,410,583**	**$188,094**			
Solar PV at City Hall	-14	$87,210	$5,500	15.9	$717,583	$5,114	Medium-Long	Facilities	Environmental Planning
Solar PV at Codiac Transit Centre	-190	$1,140,000	$68,500	16.6	$53,000	$68,185	Medium-Long	Codiac Transpo	Environmental Planning
Biomass heating at Operations Centre	-282	$632,120	$39,570	16.0	$640,000	$114,795	Medium	Facilities	Engineering, Environmental Planning
Action 4: Green fleet	**-94**	**$3,000**	**$15,157**	**0.2**	**-**	**-**			
Right sizing exercise	-62	-	$24,710	-	-	-	Short	Engineering	Environmental Planning
Fuel consumption tracking and driver training	-32	$3,000	-$9,553	-	-	-	Short-Medium	Engineering	Environmental Planning
Action 5: Streetlights and park lights upgrades	**-223**	**$750,000**	**$104,734**	**7.2**	**$11,694**	**-**			
City-owned streetlights replacement	-223	$750,000	$104,734	7.2	$11,694	-	Short-Medium	Engineering	Parks and Leisure Services, Environmental Planning
TOTAL	**-1,036**	**$5,914,169**	**$584,629**	**33.1**	**$2,139,860**	**$465,991**			

APPENDIX B: DETAILED BUILDING ANALYSIS

As part of our analysis of potential GHG reducing measures, a Dunsky Energy Consulting representative toured five City of Moncton Facilities in November 2015. While formal energy audits have been or will be conducted on these facilities under the Integrated Building Study (IBS), the tour by the Dunsky team member aimed to support high-level GHG reduction opportunity identification. It is assumed that the IBS formal energy audits will provide verification of many of the measures described here, along with technical and budgeting details that will facilitate measure implementation.

CITY HALL

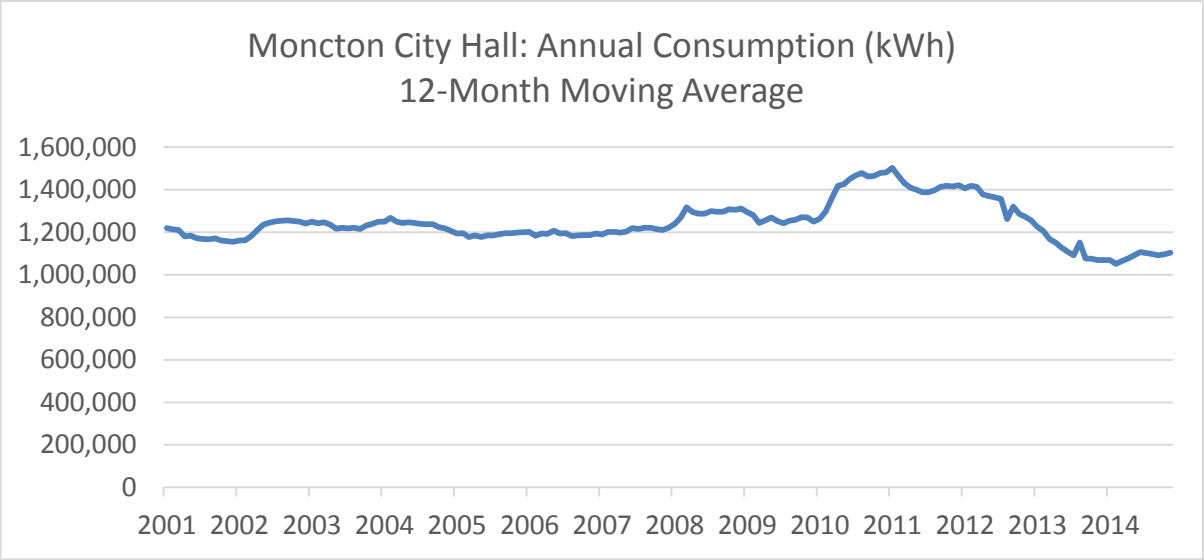
Moncton's City Hall was the subject of an Energy Study conducted by MCW Maricor in 2013. That study identified the following five cost-effective energy and water saving measures that together were estimated to deliver a total energy savings of 220,951 kWh/year (16% of the 2012-13 baseline consumption):

Table 14: City Hall Energy Study ECMs

2013 Energy study ECMs	Net Savings	Status 2015	Remaining Potential
Lighting Upgrades	255 GJ	Partially complete	60% remaining potential estimated
Server Room Heat Recover	128 GJ	Complete	None identified
Cooling tower replacement	13 GJ	Cooling tower resurfaced to extend life for 5-10 years	100% upon future
Update Building Automation System	410	Complete	Minimal further potential (0%)
Domestic Water Retrofits	0	Partially complete	May yield some minor service hot water related energy savings

The tour of City Hall revealed that the majority of the ECMs had been carried out. It is therefore likely that completing the proposed lighting upgrades represent the largest potential opportunity for further energy savings.

Figure 3: Moncton City Hall Electrical Annual Consumption



A review of City Hall energy billing data over the past fifteen years reveals near steady annual consumption, that rise in and after the year 2010. The steep jump in consumption in 2010 may indicate an operational issue with the building at that time, which represents an opportunity for energy savings through Existing Building Commissioning (EBCx).

From 2013, when the Energy Study was performed until the most recent 12-month period (2014-15) energy consumption has dropped and the 12 month moving average has again stabilized, presumably due to the implementation of the ECMs.

2012-13 average Consumption	2014-15 Average consumption	Estimated Apparent Reduction	Estimated Remaining Reduction Potential
1,370,175 kWh/yr	1,086,720 kWh/yr	283,455 kWh/yr (22%)	68,508 kWh/yr (5%) for lighting upgrades

The apparent energy savings (22%) exceed the estimated energy savings from the 2013 Energy Study (16%), even before the lighting measures are fully implemented. We attribute this to two likely factors:

1) The City's Facilities department implemented various building controls optimization improvements alongside the BAS upgrade, which we believe constitute an EBCx process.
2) The building operators undertook a range of operational and behavioral improvements which likely resulted in further improvements.
3) The Energy Study may have applied conservative energy saving values for the equipment replacement ECMs.

From the City Hall Energy Study, facility tour and energy billing analysis we draw the following assumptions pertaining to the potential energy savings through equipment replacement, EBCx and operator training at City facilities (see Table 15 below). These values are applied to estimate the energy and impact of building upgrades throughout this report, and are assumed to apply to all fuels equally and in proportion to their use in any given facility, except where stated otherwise.

Table 15: Assumed Attribution of ECM Energy Savings at City Hall

ECM	City Hall Results 2013-2015
Savings from equipment replacement ECMs	16% savings identified in City Hall Energy Study 10% attributed to implemented measures (including BAS)
Savings from EBCx	Not identified in City Hall Energy Study 10% assumed to be attributable to EBCx
Savings from Building Operator Training (BOT)	Not identified in City Hall Energy Study 2% assumed to be attributable to BOT
Total achievable potential energy savings	**22% apparent energy savings since 2013** **5% remaining potential from Energy Study (lighting upgrades**)

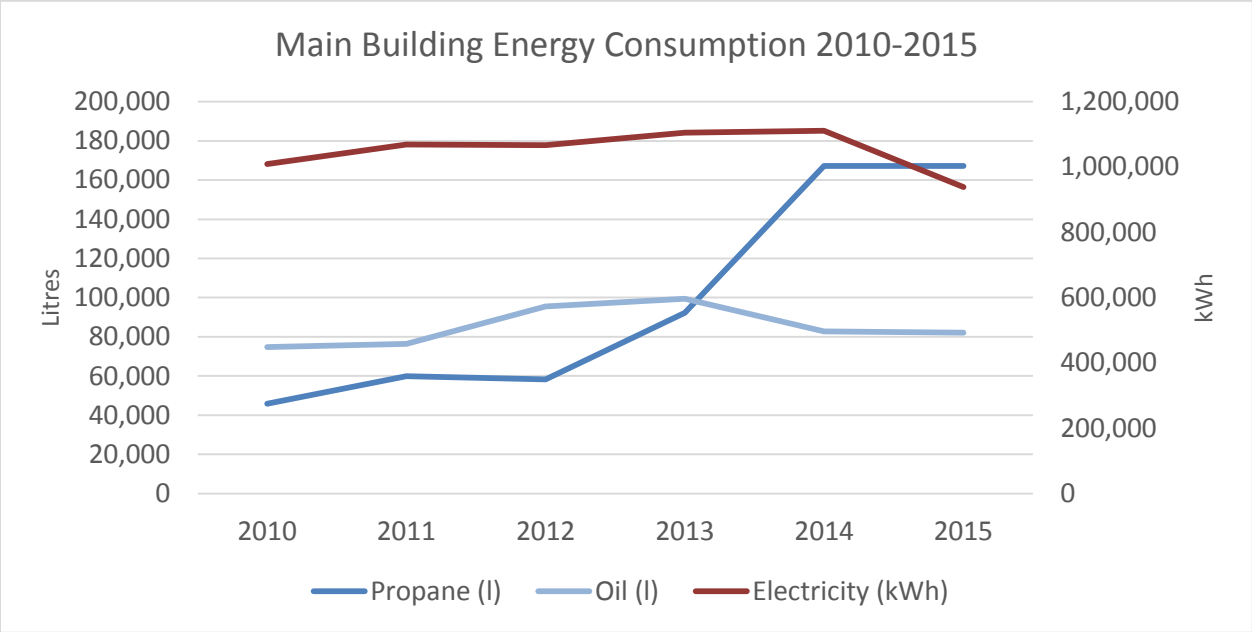
OPERATIONS CENTRE

The City's Operations Centre is a large campus facility that houses the municipal fleet and a range of other utilities and City services. The facility includes four main buildings, each with its own electrical meter:

- Operations Centre
- Central Stores
- Salt/Sand Shed
- Green Tarp Storage

The main operations facility also includes an oil boiler that provides heating to the main building and Central Stores building, as well as a propane tank that fuels combustion heating in various spaces throughout the facility.

Figure 4: Operations Centre Energy Consumption Trends



A review of the energy billing data for the main building reveals two important trends.

1) There has been a significant drop (10%) in electricity consumption between the 2010-2013 period (baseline) and the twelve trailing months up to October 2015. Based on conversations with the City's technical personnel, we believe that this is likely attributable to operational and building operator adjustments.
2) Propane use in the facility has increased significantly from 2013 to 2015 (+100%), which is likely far beyond the increase expected to result from weather variations alone. These high consumption levels are not captured in the 2013 GHG Inventory, and thus if measures are not implemented to reduce the propane consumption back to 2012 levels, the facility may contribute a net increase to the City's GHG emissions.

A tour of the facility revealed a number of ECMs that are likely to be achievable within a 10-year payback bundle, including:

- Replacing magnetic ballasted T8 and T12 Fluorescent lights with LED and/or T5 lamps
- Replacing high-bay HOS and MH lamps with LED and/or high-bay T5 lamps
- Improved lighting controls and switching to allow for partial lighting in spaces not continually used
- Improved heating controls and ventilation in large work spaces
- Replacement of wall unit AC units with mini-split AC or heat pump units that can transfer heat to the building exterior
- Improved space allocation in the storage garage and other high-bay works paces to reduce heating and lighting of spaces with minimal requirements
- Installing air curtains in the main garage workspace to reduce air loss

It is beyond the scope of this report to estimate the specific energy saving contributions of each of these ECMs, however, considering results from published studies and the wide range of high potential ECMs include above, it is our assessment that these opportunities represent sufficient evidence of the potential of achieving the assumed system wide energy savings of 27% through equipment upgrades, EBCx and BOT measures (from the 2013 baseline[25]) for electrical savings at the Operations Centre.

For propane heating, we assume that measures can be implemented to return on-site consumption to the 2012-13 baseline consumption levels, thus no GHG impact is achieved over

FUEL SWITCHING: NATURAL GAS BOILERS

The 2013 St. George Fire Station Energy Study indicates that replacing an oil boiler at the end of its useful life to a high-efficiency natural gas condensing boiler would result in a 3 ton GHG saving with a 7-year simple payback on investment.

However, since 2013 oil prices have dropped significantly, and our analysis of replacing a 75% efficient oil boiler with a 85% efficient natural gas boiler results in an 4% increase in operating costs (not including equipment replacement costs).

Considering the minimal GHG benefit of switch between these two fossil fuels, we have not included natural gas boiler replacements for oil boilers in this plan. However, it has been indicated that the City plans to replace all oil boilers with Gas boilers at the end of their current life. Price fluctuations between oil and gas may make this measure more or less cost-effective with time, moreover sites with existing oil boilers may also be good candidates for replacement with biomass boilers.

[25] Including the apparent 10% reduction in electricity consumption at the site since 2013.

the 2013 inventory.

Our analysis indicates that converting the oil boiler to natural gas would not be a cost effective measure based on current oil and natural gas prices (as was also communicated by City staff during the building tour). No attempt is made to estimate potential oil savings; however it is proposed that the Operations center would be a good candidate for a biomass boiler in the renewable energy measures.

COLISEUM / AGRENA COMPLEX

The Coliseum currently houses Moncton's 150,000 sq-ft convention center (Agrena) and a 160,000 sq-ft arena (seating 6,800). The arena was constructed in 1973 and the Agrena was added in the subsequent decades.

A new arena is being constructed and will open in 2018. The City is currently considering plans for the future of the Coliseum. The two options that were noted during the facility tour are:

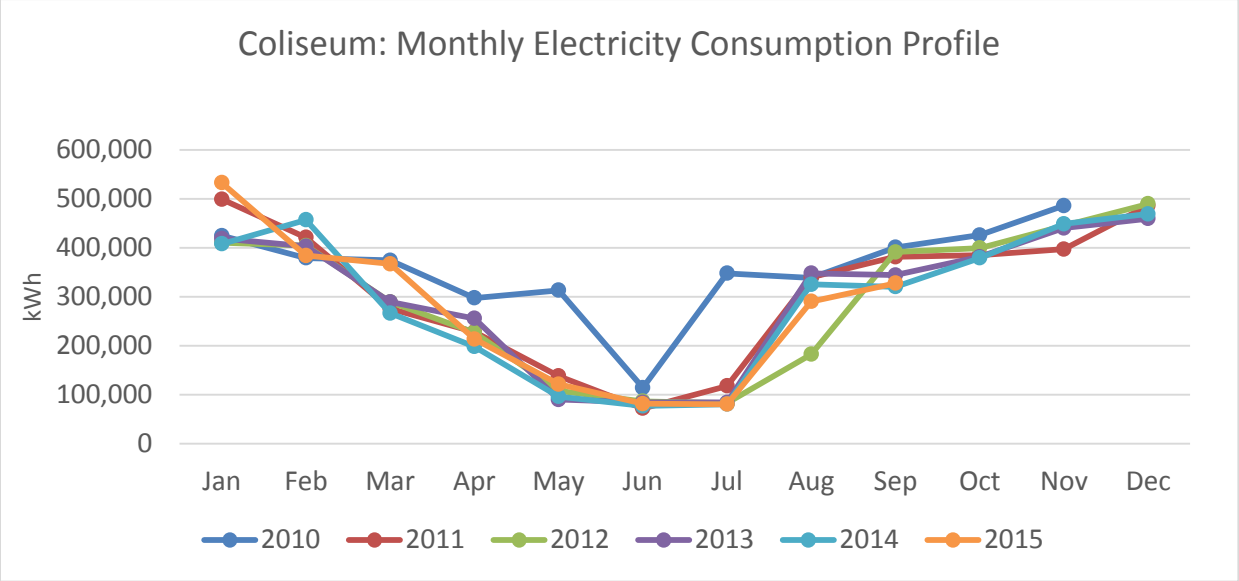
- **Option 1: Keep the Coliseum as a recreational ice rink**

Under this option it is assumed that the City would perform cost-effective lighting/HVAC upgrades, and improve the efficiency of the ice making and maintenance operations. Lighting upgrades would include replacing high-bay HPOS and MH lights with LED bulbs. It is assumed that a 20% reduction in overall electricity would be achievable through these improvements.

- **Option 2: Convert the Coliseum to expand the convention center space**

Under this option the Coliseum space would be transformed to be a large convention space. The lighting and HVAC would be upgraded along with the lighting and HVAC in the Agrena spaces. This would include adding natural gas heating for the former coliseum space, and a complex-wide application of high-bay LED and T5 lighting, as well as HVAC EBCx and equipment improvements. The resulting electrical consumption for lighting, fans and pumps would be reduced by 30%, and the resulting EUI for lighting fans and pumps would be applied throughout the entire facility (Agrena and former Coliseum space).

Figure 5: Coliseum Electricity Consumption Trends (not including Agrena)



Based on the Coliseum's annual energy use profile (2010-2015) and ice maintenance schedule (ice removed for June, July and August), we estimate the following energy use breakdown for the facility.

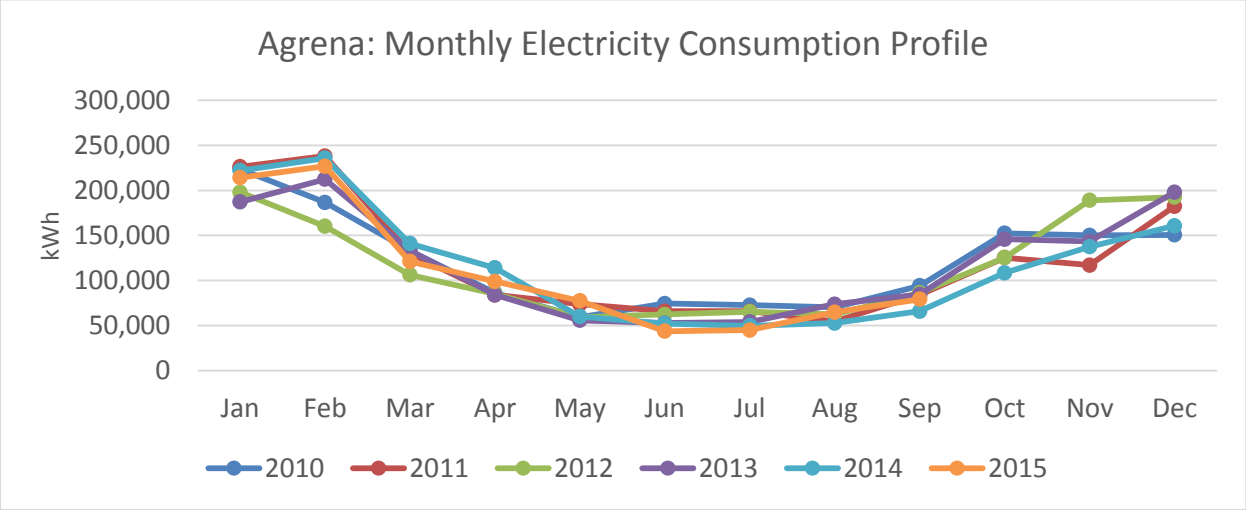
Table 16: Coliseum energy use breakdown (not including Agrena)

Coliseum	Current	Option 1	Option 2
Lighting, fans and pumps	1,450,000 kWh/yr	1,015,000 kWh/yr	737,000 kWh/yr
Ice maintenance and heating	2,300,000 kWh/yr	1,840,000 kWh/yr	458,000 kWh/yr
Total (Electricity)	3,750,000 kWh/yr	2,855,000 kWh/yr	1,195,000 kWh/yr
Natural Gas (Heating)	0 GJ/yr	0 GJ/yr	1,770 GJ/yr
GHG emissions	1,430 tCO_2e/yr	1,089 tCO_2e/yr	543 tCO_2e/yr

- **Impact of Potential Agrena Upgrades**

The Agrena comprises a 150,000 sq-ft facility that host Moncton's major conventions and tradeshows, and includes three meeting halls and a collection of food services. Heating is provided by a combination of natural gas combustion heaters, and electric heating.

Figure 6: Agrena Electricity Consumption Trends

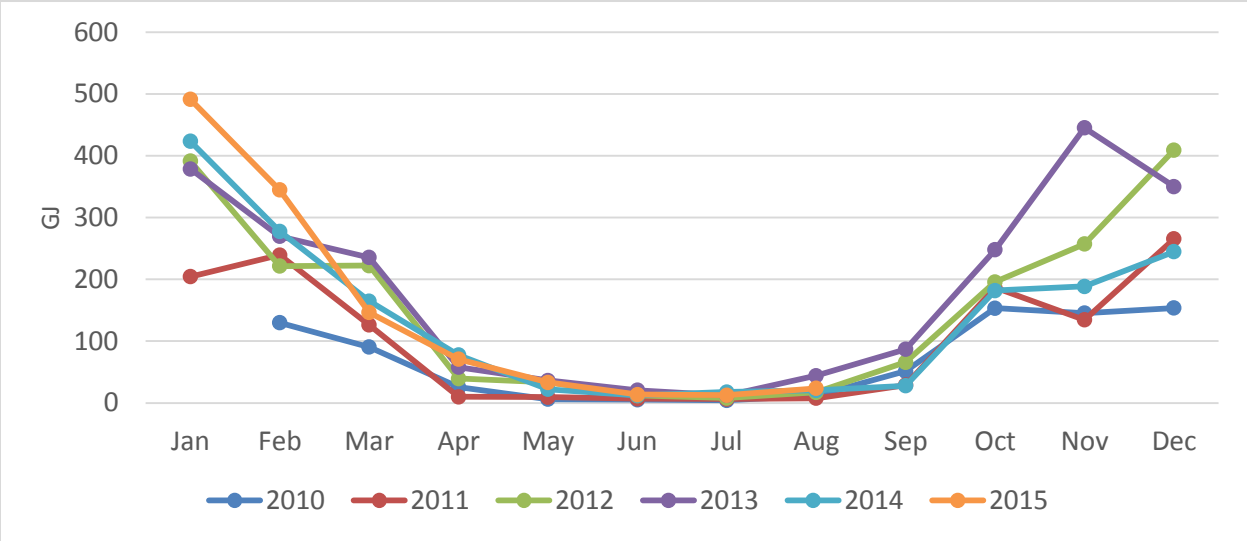


Based on the electricity consumption during the summer months (May-September) a baseload estimate attributable to lighting, fans, pumps and basic operations (kitchens and trade show equipment) was established. It is assumed that baseload increases by 50% over the busy convention season spanning October to April.

A lighting upgrade and HVAC controls tuning was estimated to result in a 30% reduction in the baseload annual consumption (i.e. excluding heating energy).[26]

[26] The Agrena and Coliseum are being evaluated as part of the IBS and it is possible that other cost-effective EE upgrades may be identified as part of that audit.

Figure 7: Agrena Monthly Natural Gas Consumption Profile



Inspection of the Agrena gas monthly usage reveals an annual peak during the November to March period, corresponding with Moncton's primary heating season, with little usage during the summer months (likely limited to the kitchen needs), as is expected for a facility that uses gas heating.

A comparison of the 12 month moving average annual electrical and natural gas usage reveals a steady increase in gas usage from 2010 to 2014, during which annual consumption more than doubled from 1,100 GJ to over 2,200 GJ per year. Over the same period annual electricity use fluctuated, but remained largely within the 1,400,000 to 1,500,000 range, with no clear increasing or decreasing trend.

Assuming that electrical consumption is a reasonable surrogate for the overall facility use for events and trade shows, these results suggest that an EBCx and controls upgrade to the gas boilers and electrical heating would deliver significant savings. Thus, as a conservative estimate, we assume a 10% EBCx and 2% Operator training savings applied to the electrical and gas heating.

Figure 8: Agrena Annual Electricity and Natural Gas Consumption, Twelve-Month Moving Average

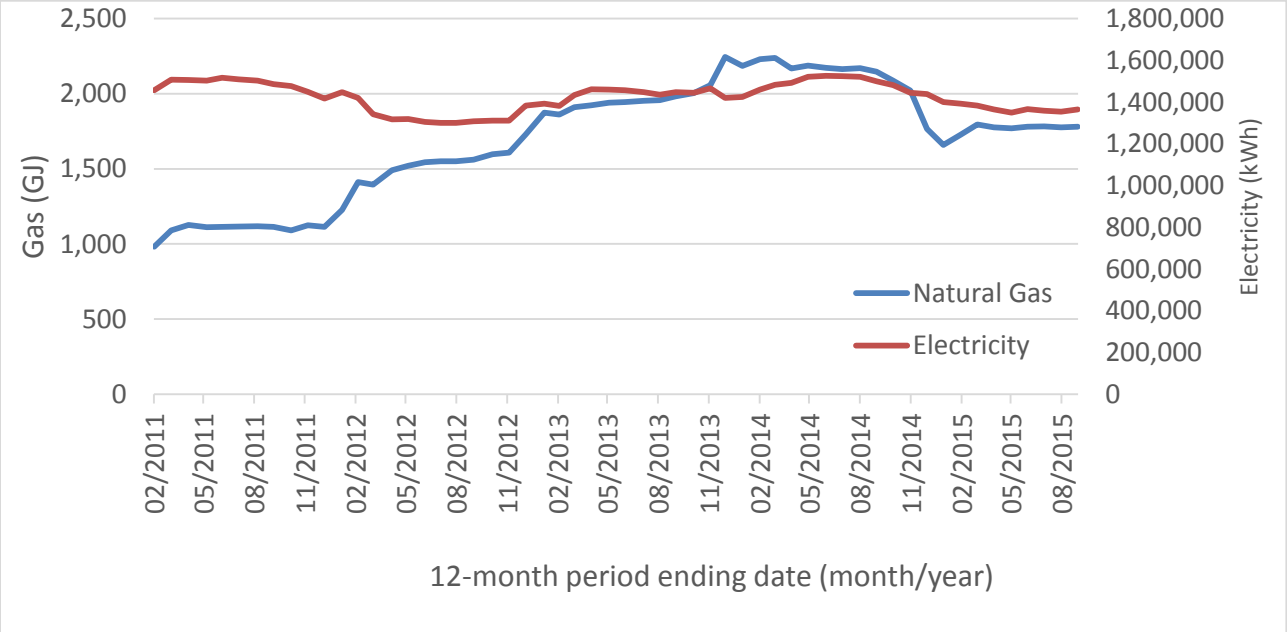


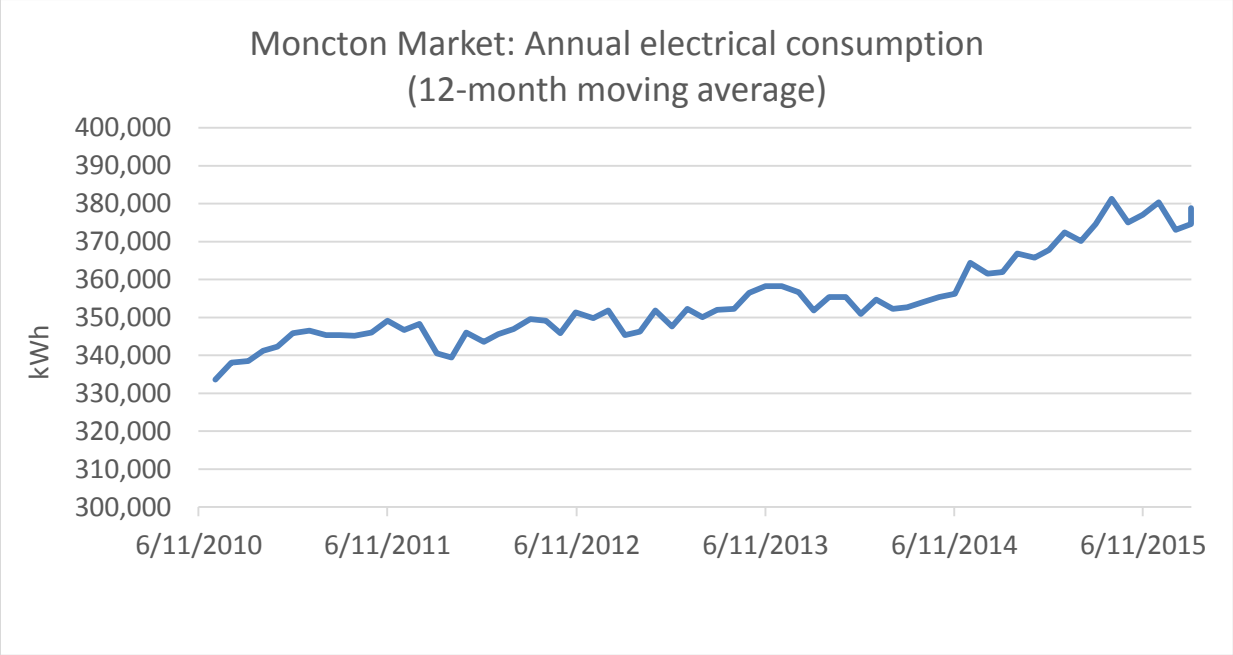
Table 17: Estimated impact of lighting upgrades on the Agrena's electricity consumption

Agrena	Current	After Lighting Upgrade and EBCx
Lighting, fans and pumps	993,000 kWh/yr	695,000 kWh/yr
Heating	432,000 kWh/yr	432,000 kWh/yr
Total (Electricity)	1,424,000 kWh/yr	1,127,000 kWh/yr
Natural Gas (Heating)	1,667 GJ/yr	1,667 GJ/yr
GHG Total	670 tCO_2e/yr	519 tCO_2e/yr

MONCTON MARKET

Despite being used for a small portion of most weeks, the Moncton Market building is one of the City's largest energy consuming facilities, contributing 192 tons per year to the City's Corporate GHG emissions. The trend in annual electricity consumption shows a 10% increase since 2013, which may indicate potential operations savings opportunities related to lighting, refrigeration and controls.

Figure 9: Moncton Market Electricity Consumption Trends



The facility will be subject to a detailed energy audit as part of the first phase of the IBS. One of the key challenges with this site will be to identify measures that can yield cost-effective savings, given the 2-3 days per week schedule of use. With this in mind, the facility tour for this study identified the following opportunities for consideration as part of a cost-effective bundle of GHG reduction measures:

- Replacing high-bay HPS and MH lighting with high-bay T5 or LED lighting
- Replacing magnetic ballasted T8 lighting with electronic ballasted high efficiency T8
- Improving lighting and heating controls and zoning, to allow for partially lighting of access areas only during the week days when the facility is minimally in use.

The site contains over 50 refrigerators and freezers used to preserve market supplies over the week. These are generally older and less efficient models but are owned by the market stall operators. As simple energy saving measure, the City could replace in-fridge display lights with LED bulbs. Also the City could offer an incentive to the stall operators, or make it a requirement, to purchase replacement energy-star rated refrigeration equipment, or alternatively use a temporary sub-meter (e.g. Kill-a-watt) to measure the old equipment's true energy consumption, and then raise the electricity charges to the stall operators accordingly.

Given the rise in energy use on the site since 2013, and the challenges of finding cost-effective savings measures at a site in temporary use, we do not anticipate more than a 10% electricity saving below the 2013 baseline being achieved through cost-effective measures.

Oil Fired Steam Boiler

An oil-fired boiler and propane combustion heaters are used at the site, which together contribute 28% of the building's associated GHG emissions. The oil boiler was observed to be cycling regularly on the day that we toured the facility; regardless of the weather being relatively mild and most of the space being vacant (it was not a market, cleaning or preparation day). This indicates that the steam heating system may be experiencing avoidable energy losses due to steam trap function and poor distribution piping insulation.

Steam heating is not ideal for spaces that are used intermittently because they are not easily shut off for short periods during the heating season. To replace the boiler (which is only five years old) to a hydronic system would not likely be cost effective due to the associated need to replace some or all of the heating coils and distribution piping.

The recommended ECM therefore would be to implement a preventative maintenance schedule that would

- Properly tune steam traps on a regular basis (at least once per heating season)
- Correct any missing or damaged insulation in the main distribution lines
- Implement a nighttime and off-day steam pressure rollback to 8-10 psi (compared to the current set point which is likely to be 15psi) – this would help to prevent further steam losses

This ECM would be expected to result in a 25% oil savings annually, with a five-year payback.

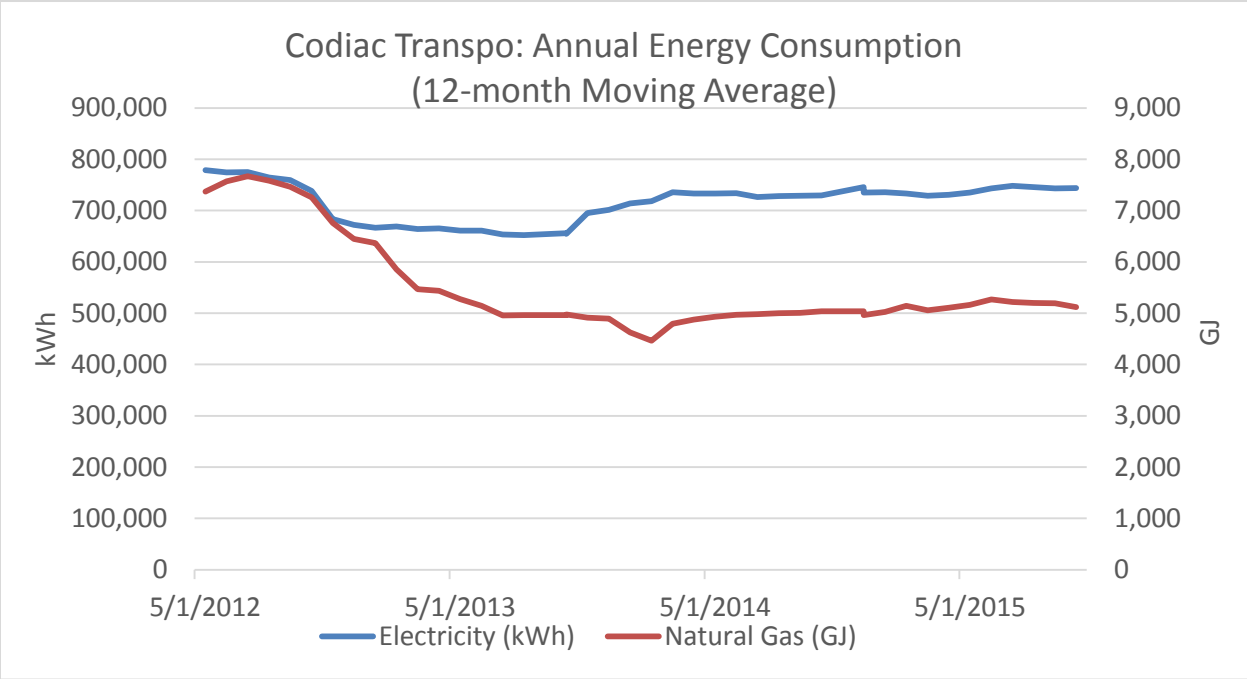
CODIAC TRANSPO

Codiac Transpo is the main depot for the shared public transit system that serves Moncton, Dieppe and Riverview. It is a new facility that opened in 2011, and the operators have been observing the building's performance and making set point adjustments to ensure efficient use of energy on the site.

A tour of the site revealed that there are few if any cost-effective energy saving measures possible at the site. The addition of VFDs to the main heating fluid circulation pumps is the single potential measure that was identified; however, an engineering review would be needed to verify the potential impact of this measure. Moreover the annual consumption trend reveals that there has been little change in consumption at the site since 2013. Given these considerations, we do not include any cost-effective energy saving measures for this facility.

Codiac Transpo may however be a good candidate for hosting a 100 kW net-metered solar PV array, given its significant energy consumption, large unobstructed flat roof, and its status as a shared facility among the three municipalities.

Figure 10: Codiac Transpo Electricity Consumption Trends



APPENDIX C: CITY OF MONCTON'S GREEN BUILDING POLICY

Preamble

Many aspects of our everyday life affect the environment, from our mode of transportation to waste management and energy conservation. In response to this awareness, the City of Moncton has been adopting many environmentally conscious practices within its facilities.

The City of Moncton wants to take active steps to reduce its environmental footprint by ensuring the planning, design, construction and operation of municipal buildings is carried out in a sustainable manner. Occupants, operators and the environment will all benefit from the implementations of sustainable building practices.

Buildings consume a large amount of resources and generate significant volumes of waste. Currently the National Building Code (NBC) does not have minimum standards for green building design, construction or renovations. The industry looks to voluntary green building design guidelines and third-party certification systems such as Leadership in Energy and Environmental Design (LEED) and Green Globes Design to provide a holistic and environmentally responsible approach to building design and operation. Through the adoption of high-performance green building practices, both the economic and environmental performance of the facility can be optimized. Measurable life cycle cost savings will be achieved by ensuring efficient management of energy, water resources, materials and land.

1312.01 Policy Statement

The City of Moncton will establish itself as a greener city by committing to incorporating sustainable green building practices into the design, construction and operations of all new municipal buildings and major renovations.

1312.02 Objectives

The main objectives of this policy are to:

a. Ensure all new municipal buildings incorporate green sustainable building practices into the design, construction, management and operations of the facility.
b. Achieve life cycle cost savings by reducing operating costs through the efficient use of materials, equipment, energy, water and other resources;
c. Show leadership regarding green building construction.

1312.03 Definitions

LEED™

LEED™ (Leadership in Energy and Environmental Design) is a non-governmental, independent green building rating system and certification program. Building projects have to demonstrate their commitment to sustainability by meeting specific performance standards and achieving specific pre-requisites and credits in six key areas: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, Indoor Environmental Quality and Innovation and Design Process. There are four performance levels ranging from Certified, Silver, Gold and Platinum with each level requiring the incorporation of a greater amount of sustainable elements and achieving a greater amount of credits.

LEED™ Rating The LEED™ rating criteria are presented in the form of Prerequisites and Credits.

Green Globes Green Globes is a web based program for green building guidance and certification that includes an on-site assessment by a third party. It was developed by the Green Building Initiative (GBI) in 2005. The assessment covers the following areas: project management, site, energy, water, materials & resources, emissions and indoor environment. There are four performance levels ranging from Green Globes 1-4, with each level requiring a greater percentage of achieved points in the assessed areas.

Green Globes Rating Criteria The Green Globes Design uses a point system; each point is allocated to the areas and sub-areas of the assessment.

Municipal Building Structure that has a permanent foundation, roof and walls, for the purpose of human occupancy or use, owned by the City of Moncton.

Certification The process of an independent third-party verifying the compliance of design and construction of the facility.

Green Building Describing buildings whose performance qualities are more environmentally friendly than "traditional" buildings in regards to construction and operational practices and also performs in a manner to reduce their environmental footprint.

Building Footprint Area The surface area occupied by a building, measured as the product of outermost length and width dimensions of the building.

1312.04 Policy

The City of Moncton will design, construct, manage and operate its municipal buildings in a sustainable manner as follows:

a. Newly constructed buildings with a footprint area smaller or equal to 500 m^2: Building shall be designed in a sustainable manner, following LEED™ rating criteria as a template, when applicable and including basic energy modeling analysis (i.e. RETScreen) to guide building configuration and selection of building operating systems. The process shall be documented.
b. Newly constructed occupied buildings with a footprint area greater than 500 m^2: Design and construct buildings to meet or exceed the Certified Performance Level of the LEED™ rating system, including full registration and certification under the CaGBC.
c. Existing buildings of all sizes: Apply sustainable design principles for retrofits and major renovations projects.

1312.05 Equivalencies & Exceptions

Green Globes Design is considered an acceptable equal to LEED. In buildings greater than 500 m^2 the facility must meet or exceed the 2 Globes Performance level of the Green Globes rating system, including full registration and certification.

Heritage buildings shall be exempt from the requirements of this policy. However, best efforts should be made to incorporate green building principles when possible, without compromising the integrity of the heritage structure. By-law #Z-1102 relates specifically to Heritage Preservation in the City of Moncton.

1312.06 Procedures

a. The Director of Municipal Facilities, working in conjunction with Engineering and Environmental Services and project stakeholders, shall be responsible for ensuring that buildings comply with the "Municipal Green Building Policy".
b. Nothing in this policy prevents a smaller structure from being subjected to a higher level of compliance than the minimum indicated.
c. Project budgets and schedules must be assessed and include applicable incremental cost relating to sustainable building requirements as they pertain to the project (ie: registration/certification and capital cost).
d. Additional capital support required to achieve the assigned targets will be presented in a life cycle cost/benefit analysis format, appropriate to the complexity and scale of the project.

APPENDIX D: MEASURE IMPACT ASSESSMENT ASSUMPTIONS

Parameters	Value	Source
General assumptions		
Discount rate	3.5%	Assumption based on average municipal interest rate
Grid electricity emission factor (2005)	394 gCO2e/kWh	Environment Canada
Grid electricity emission factor (2013)	300 gCO2e/kWh	Environment Canada
Building retrofits		
Fuel oil price	$0.98/L	NB Energy and Utilities Board
Electricity rate	$0.1058/kWh	NB Power
Natural gas price	$0.38/m3	Natural gas NB
Energy savings from equipment upgrades	15%	Estimate from audits and site visit
Energy savings from existing building commissioning	10%	Estimate from audits and site visit
Energy savings from operator training and occupant energy awareness	2%-4%	Estimate from audits and site visit
Energy savings from floating head pressure control at arenas	75,000 kWh/yr	Estimate based on site visit and literature review
Efficient new buildings		
Average efficiency gain with Green Building Policy	40%	Estimate based on energy models for Downtown center and new fire station
Renewable energy in buildings		
Available building rooftop area for solar PV	50%	Estimate
Solar PV system energy output	varies	Retscreen calculated data, based on NB insolation data
Solar PV system cost	$2.55/W	Estimate
Solar PV system cost decrease	6%/yr	Estimate
Solar PV rooftop system effective useful life	30 yrs	Estimate
Oil boiler efficiency	75%	Estimate
Fuel oil price	$0.98/L	NB Energy and Utilities Board
Biomass cost	$170/tonne (wood pellets)	Municipalité de Mont-Carmel (Québec) - Chaufferie à la biomasse, document de transfert de connaissance
Biomass boiler cost per kWh for build-own-operate model with ACFOR	$0.09-0.12/kWh	ACFOR
Biomass boiler effective useful life	30 yrs	Estimate
NB Power incentive (Energy Smart Program for Commercial buildings)	$30/GJ	NB Power
Green fleet		
Average distance travelled per year (car)	15,000 km	City of Moncton (Engineering)
Average fuel consumption per year (car)	12L/100km	Consumption of a mini-van (Natural Resources Canada)
Diesel cost	$1.14/L	NB Energy and Utilities Board
Gasoline cost	$1.02/L	NB Energy and Utilities Board
Fuel savings from driver training	10%	Literature review (e.g. Edmonton Fuel Sense program)

Streetlights and park lights upgrades		
Energy savings from HPS to LED conversion	75%	City of Moncton (Parks and Leisure Services)
LED streetlight unit cost	$750	City of Moncton (Parks and Leisure Services)
Unit maintenance cost for HPS light	$25/yr	City of Moncton (Parks and Leisure Services)
Unit maintenance cost for LED light	$2/yr	City of Moncton (Parks and Leisure Services)
Wattage of LED lights	36-44 W	City of Moncton (Parks and Leisure Services)
Wattage of HPS lights	139 W	City of Moncton (Parks and Leisure Services)
Wattage of metal halide lights	180 W	City of Moncton (Parks and Leisure Services)
Hours of operation	20 hrs	City of Moncton (Parks and Leisure Services)
LED streetlights effective useful life	75,000 hrs	Estimate based on review of Design Light Consortium list

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