

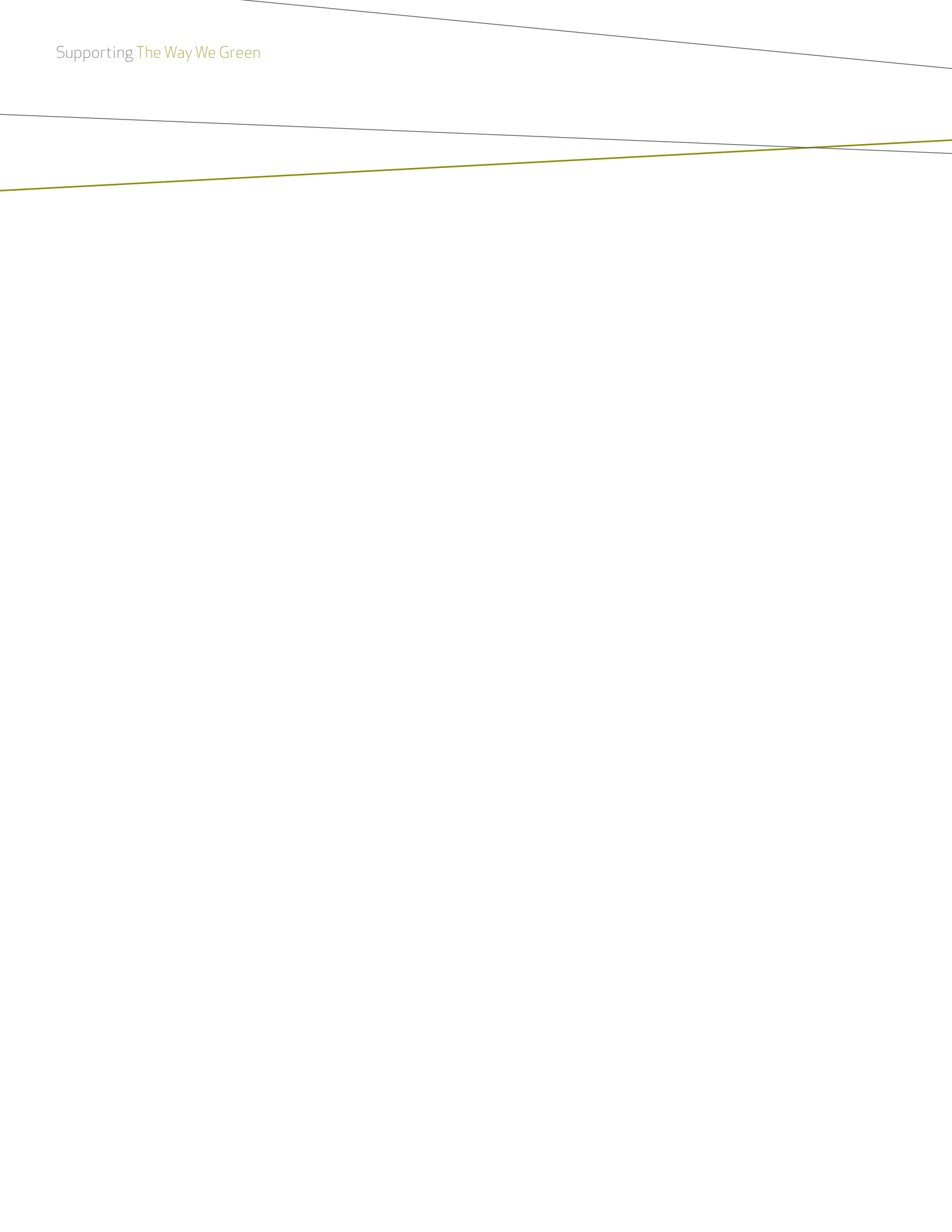


CITY OPERATIONS GREENHOUSE GAS MANAGEMENT PLAN

SUPPORTING **THE WAY WE GREEN**

June 14, 2012





EXECUTIVE SUMMARY

RATIONALE FOR PLAN

Scientific evidence shows that Earth's climate is changing, with the primary cause being the surge in greenhouse gas (GHG) emissions from human activity. Economic analyses also show that strong, early action to mitigate climate change can outweigh costs. In response to this challenge, countries and cities around the world are setting targets and developing plans to reduce their GHG emissions. Most notably, G8 countries have recommended that all developed countries should reduce emissions 80 per cent or more by 2050.

In 2007, Edmonton City Council registered its climate change concern by supporting the Alberta Urban Municipalities Resolution for Support for Municipal Climate Change Initiatives which states: **"A global reduction in emissions of greenhouse gases (GHG) is necessary to slow climate change and reduce the risks to human health, the physical environment, economy and quality of life."**

This City Operations Greenhouse Gas Management Plan is a response to the global threat of climate change. Its mandate comes from a number of City Council directives including: (a) a goal in *The Way We Green* for Edmonton to become "a carbon-neutral city" and (b) Strategic Action 6.10.1 contained in *The Way We Green* that directs the City of Edmonton to establish, implement and maintain "a City Operations Greenhouse Gas Management Plan aimed at significantly reducing greenhouse gas emissions from City operations." This plan "leads by example" — adopting and demonstrating high standards of sustainable living that are encouraged throughout the community.

TARGETS AND ACTIONS

This plan aims to achieve a 50 per cent reduction in GHG emissions from City operations by 2020 (from 2008 levels), an 80 per cent reduction by 2050, and carbon neutrality as the eventual long-term outcome. Attaining the plan's 2020 target will require City Operations to reduce emissions from 330,000 tonnes of carbon a year to 165,000 tonnes a year, i.e., a reduction of 165,000 tonnes a year. The plan proposes this target will be achieved in the following ways:

- **Green Power Purchases: Net reduction of 111,000 tonnes a year**
Annual purchases of green power (from renewable energy sources) will be the largest contributor to the 50% reduction target. Amounts of green power purchased will increase proportionally from 2013 to 2020, contributing to a 111,000 tonne reduction in 2020.¹

1 **Greening of Alberta's Power Grid:** Over the next decade, greenhouse gas emissions from electricity used by the City could be reduced by up to 25 percent due to the potential transition to a less carbon-intensive power generation grid. This achievement would allow the City to reduce its purchase of green power, as the electricity component of the greenhouse gas emissions inventory for City Operations would be reduced.



- **Building Retrofits: Net reduction of 26,000 tonnes a year**

GHG emissions from existing City buildings will decline by 19,000 tonnes a year through energy-efficiency upgrades that are currently planned and by an additional 7,000 tonnes a year through new efforts proposed in this plan.

- **Roadway Lighting: Net reduction of 25,000 tonnes a year**

GHG emissions from the City's 100,000 streetlights will decline by 10,000 tonnes a year by 2020 through light fixture conversions that are currently planned and by an additional 15,000 tonnes a year through accelerated conversion efforts proposed by this plan.

- **Landfill Gas Emissions: Net Reduction of 10,000 tonnes a year**

GHG emissions from the City's three decommissioned landfills will decline naturally by 10,000 tonnes a year by 2020.

- **Composter Facility: Net reduction of 6,000 tonnes a year**

GHG emissions from Waste Management Services' Composter Facility will decline by 4,000 tonnes a year through an energy-efficiency upgrade that was performed in 2011 and another that is recommended in this plan prior to 2020.

- **Municipal Fleet: Net reduction of 4,000 tonnes a year**

GHG emissions from the City's fleet (which does not include Transit vehicles) will decline by 4,000 tonnes a year by 2020 as a result of improvements that are currently anticipated through the Sustainable Fleet Management Plan, including measures such as driver education, vehicle right-sizing, increased use of biofuels, hybrid vehicle purchases, and trailer skirt installation. No new efforts beyond these are proposed in this plan.

- **Urban Forest: Net reduction of 2,000 tonnes a year**

Efforts to double the City's urban forest canopy by 2090 will result in an annual reduction of 2,000 tonnes a year by 2020.

- **New Buildings: Net increase of 19,000 tonnes a year**

GHG emissions will increase by 22,000 tonnes a year as a result of new City-owned buildings that are planned for construction from 2013-2020. However, this amount will be reduced by 3,000 tonnes a year through higher energy efficiency requirements proposed by this plan.

The Plan proposes that a social cost of carbon be factored into the City's investment and procurement decisions, where appropriate and that a cost of \$40 per tonne be used for this purpose. For example, when evaluating competing proposals for leased space, purchase of equipment, or purchase of infrastructure that generates GHG emissions, the City would consider differences that might exist in GHG emissions from one proposal to another. In situations where differences occurred, they would be assigned a cost of \$40 a tonne over the life of the lease or asset. The cost of this externality would be included in the total cost of the proposal to be considered in the final investment decision. A formal procedure guiding this approach would need to be developed in conjunction with Financial Services and the \$40 threshold would need to be periodically reviewed to reflect new information and greater certainty surrounding the social cost of this externality.

All but one of the initiatives in this plan meets this criterion; the exception being the doubling of the urban forest canopy by 2090. While the cost of the urban forest strategy is high from the standpoint of carbon sequestration, an expanded urban forest provides a wide range of other benefits that warrant the investment.

The purpose of Table A is to show the financial cost (or savings) of individual initiatives relative to the GHG emissions they reduce/avoid over their lifecycles. These calculations are shown in the fifth column (i.e., titled Costs or Savings per Tonne). As indicated in the table, over the course of their lifecycles, most of the infrastructure investments generate net savings and reduce emissions. This is the case for building retrofits, roadway lights conversions, compost facility retrofits, and higher energy efficiency standards for new buildings. Moreover, this situation (i.e., financial savings) is true for both *business as usual* initiatives (BAU) and for the new initiatives that are proposed.

At the same time, green power purchases and implementation of the sustainable fleet management plan come at a cost of \$23 and \$19 a tonne respectively. These costs are deemed justified as they are less than the \$40/tonne threshold recommended by this plan.

The City of Edmonton intends to pursue the purchase of green power within the framework of its current electricity supply agreement with Capital Power (i.e., The Electric Load Purchasing Agreement) which extends to December 31, 2013. The City's goal, over time, will be to direct this funding to renewable energy generation projects that are located in or close to Edmonton. This approach will support local expansion of the renewable energy industry and the retention of economic benefits.

TABLE A

GHG Reduction Initiatives	Status	Long Term (Cost) or Saving ² (\$million)	Emissions Reduction (000 T) ³	(Cost) or Savings per Tonne	Explanation
Building Retrofits	Business as Usual (BAU)	\$19 (NPV saving)	(470)	\$41	BAU involves retrofitting approximately 3% of City owned buildings each year. Historically, this has yielded a 20% energy efficiency improvement and corresponding operational cost savings. Long term savings (shown to the left) represent savings that will be realized (net present value to 2050) on buildings that will be retrofitted from 2013 to 2020.
	New	\$10 (NPV saving)	(235)	\$41	This new initiative proposes a higher energy efficiency performance level for City owned buildings. The calculated savings are for those buildings that will be retrofitted from 2013 to 2020.
	Total	\$29 million (NPV saving)	(705)	\$41	
Roadway Lights Conversion	BAU	\$10 (NPV saving)	(350)	\$28	BAU represents the City's current practice of converting approximately 4,000 of the City's 100,000 streetlight fixtures a year. Long term savings (to the left) represent savings that will be realized (net present value to 2032).
	New	\$34 (NPV saving)	(184)	\$186	This new initiative proposes acceleration of the conversion process to achieve 100% conversion by 2017.
	Total	\$44 million (NPV saving)	(534)	\$82	
Composter Retrofits	BAU	\$9 (NPV saving)	(144)	\$64	BAU involves improving the overall energy performance efficiency of the Waste Management Services compost facility by 20% by 2020. Long term savings (shown to the left) represent savings that will be realized (net present value to 2050).
	New	\$2 (NPV saving)	(63)	\$40	This new initiative involves additional upgrades that will result in 30% energy efficiency improvements.
	Total	\$11 million (NPV saving)	(207)	\$53	
New Buildings (Construction to a higher standard)	BAU	\$22 (NPV saving)	(350)	\$63	BAU involves constructing new City buildings to an energy efficiency level that is 30% better than the Model National Energy Code for Buildings (1997).
	New	\$5 (NPV saving)	(161)	\$28	This new initiative proposes an increase to 50%. Long term savings (to the left) represent savings that will be realized (net present value to 2063) on buildings that will be constructed from 2013 to 2018.
	Total	\$27 million (NPV saving)	(511)	\$52	

GHG Reduction Initiatives	Status	Long Term (Cost) or Saving ² (\$million)	Emissions Reduction (000 T) ³	(Cost) or Savings per Tonne	Explanation
Green Power Purchase	BAU	n/a	n/a	n/a	Currently this strategy is not employed.
	New	Cost depends on how long and extent to which strategy is applied	Reduction depends on how long and extent to which strategy is applied	(\$23)	This new initiative involves purchasing green (renewable) electricity at a premium cost in order to achieve emission reduction targets. Long term costs will be a function of the premium price the City will pay for green power (equivalent to approximately \$23 for every tonne of GHG avoided).
	Total			(\$23)	
Municipal Fleet	BAU	(\$1.1 million) (NPV cost)	(58)	(\$19)	BAU involves implementing the approved Sustainable Fleet Management Plan using continual improvement methodologies and special funding approved by Council in 2009. Long term costs (to the left) represent additional costs that will be incurred from 2013 to 2020, with lifecycle costs calculated to 2025.
	New	na	na	na	No new initiatives are proposed beyond BAU.
	Total	\$1.1 million (NPV cost)	(58)	(\$19)	

² These figures represent long-term net present value costs or savings that were calculated based on assumptions outlined in Section 9 of this report.

³ These figures represent the emissions that will be achieved over the lifecycle of the particular initiative.

SECTION 1 INTRODUCTION

1.1 PURPOSE

The purpose of this plan is to propose a comprehensive strategy for reducing greenhouse gas (GHG) emissions from City Operations, and contributing to Edmonton's long-term goal of carbon-neutrality.

The various initiatives proposed in this plan (and their underlying assumptions) have been reviewed and verified by an external consultant — Navigant Consulting Inc.

1.2 MANDATE FOR DEVELOPING THE PLAN

The City Operations Greenhouse Gas Management Plan was developed in accordance with the following directions from Edmonton City Council:

The City of Edmonton's Strategic Plan — *The Way Ahead*— approved by City Council in 2009, directs the Administration to work toward mitigating climate change by reducing its greenhouse gas emissions.

- In April 2010, City Council established corporate outcome 1.2, directing the Administration to minimize the impact of City operations on air, land, and water systems.
- Under the auspices of the Corporate Leadership Team, the Environmental Policy Leadership Committee directed the Office of Environment to initiate work on a corporate-wide GHG Management Strategy for City Operations⁴.
- In July 2010, City Council established *GHGs from City Operations* as a performance measure for gauging achievement of environmental outcomes.
- On July 20, 2011, Edmonton City Council approved *The Way We Green* plan which included: (a) a goal for Edmonton to become “a carbon-neutral city” and (b) Strategic Action 6.10.1 directing the Administration to establish, implement and maintain “a *City Operations Greenhouse Gas Management Plan aimed at significantly reducing greenhouse gas emissions from City operations*.”
- *The Way We Green* instructs the City of Edmonton to “lead by example” to achieve its sustainability and resilience goals. The plan recognizes that successful implementation of *The Way We Green* will require the City to adopt the high standards of sustainable living it wants to encourage throughout the community.

⁴ At its December 17, 2008 meeting, the Environmental Policy Leadership Committee confirmed that four greenhouse gas emissions reduction scenarios for City Operations should be developed. At its March 20, 2009 and April 9, 2009 meetings, the Committee directed the development of the strategy based on the most aggressive reduction scenario presented.



SECTION 2

RATIONALE FOR CHANGE

2.1 IMPLICATIONS OF CLIMATE CHANGE

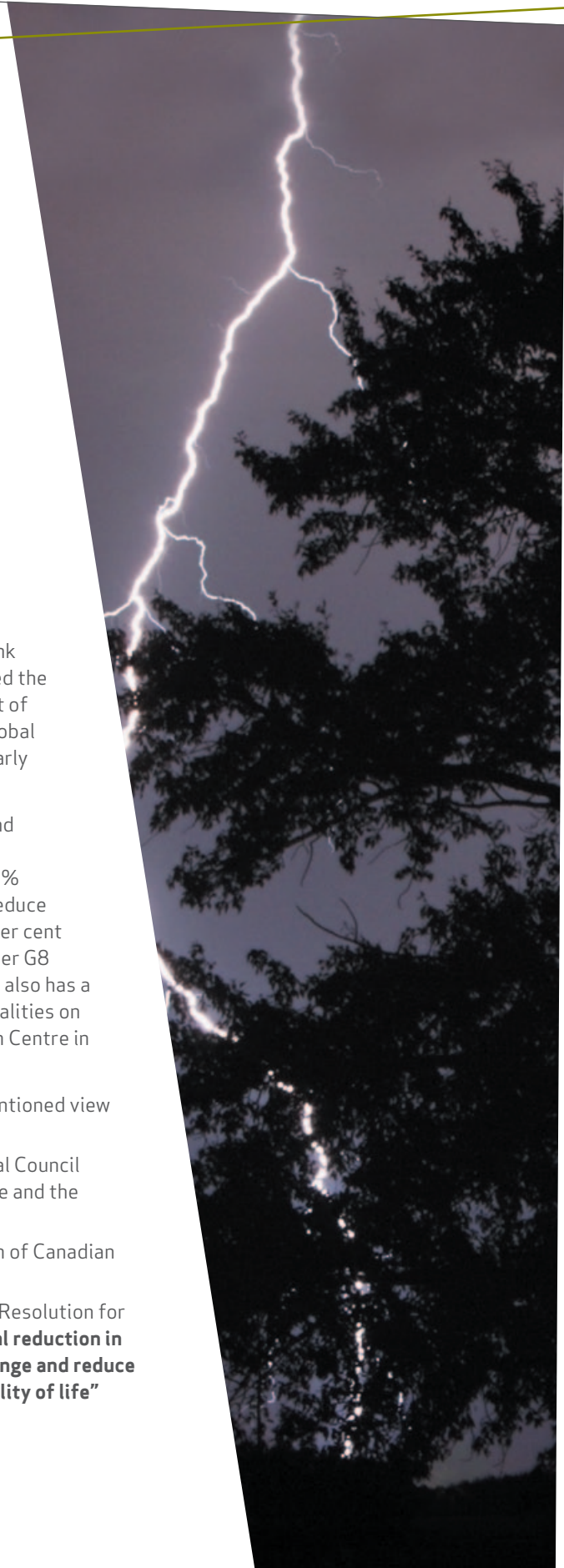
The balance of scientific evidence shows that Earth's climate is changing, with the primary cause being the surge in greenhouse gas (GHG) emissions from human activity. The Intergovernmental Panel on Climate Change (IPCC) is the world's preeminent authority on this subject. In its 2007 Fourth Assessment Report (based on extensive review of the latest peer reviewed science) the IPCC concluded global emissions need to peak around 2015, with 50 per cent to 85 per cent reductions below 2000 levels by 2050, if the world is to avoid tipping points with dangerous disruptions such as severe agricultural collapses, water shortages, droughts, and sea level rise.

The economics of climate change mitigation are also becoming clearer. Commissioned by the British Government and authored by former World Bank Chief Economist Nicholas Stern, the *Economics of Climate Change* estimated the costs of reducing greenhouse gas emissions to a safe level were one percent of global gross domestic product; compared to a loss of up to 20 per cent of global GDP if society does nothing. Stern concluded that "the benefits of strong, early action on climate change outweigh the costs".

Countries around the world are setting aggressive GHG reduction targets and developing corresponding plans. Most notably, leaders of G8 countries have recommended that developed countries reduce their emission of GHG by 80% or more by 2050. Moreover, the Government of Canada has set a target to reduce emissions by 17 per cent below 2005 levels by 2020 and 60 per cent to 70 per cent by 2050. Canada's 2020 target is tied to that of the United States, while other G8 countries are targeting even greater reductions. The Government of Alberta also has a Climate Change Strategy which has led to the direct engagement of municipalities on climate change, and the establishment of a Municipal Climate Change Action Centre in the province.

On a number of occasions, Edmonton City Council has affirmed the aforementioned view of climate change and the need for local action:

- In 1993 Edmonton City Council endorsed the signing of the International Council for Local Environmental Initiative (ICLEI) Declaration on Climate Change and the Urban Environment.
- In 2005 Edmonton City Council endorsed the City joining the Federation of Canadian Municipalities Partners in Climate Protection program.
- In 2007 Edmonton Council supported the Alberta Urban Municipalities Resolution for Support for Municipal Climate Change Initiatives which states: **"A global reduction in emissions of greenhouse gases (GHG) is necessary to slow climate change and reduce the risks to human health, the physical environment, economy and quality of life"**



SECTION 3 PRINCIPLES & APPROACHES USED TO DEVELOP THIS PLAN

3.1 PRINCIPLES AND APPROACHES USED TO DEVELOP THIS PLAN

Principles are basic beliefs or truths that help guide a decision-making process. The following principles, taken from *The Way We Green*, were used to establish this plan:

- Principle:** Communities must aim to not increase the net amount of carbon dioxide and other greenhouse gases in the atmosphere. Community design and planning must be based on low fossil fuel use in both building construction and operation.
- Principle:** A sustainable society does not subject nature to systematically increasing concentrations of substances extracted from the earth's crust.⁵
- Principle:** Use of non-renewable natural resources must decline at a rate that is equal to or greater than the rate of depletion.

This plan also applies the following approaches proposed in *The Way We Green*:

- Acknowledge that there is an environmental cost to emitting carbon dioxide that is not reflected in traditional economic models and pricing systems;
- Make infrastructure investment decisions based on life-cycle analysis; and,
- Where possible, apply demand management as a first measure for avoiding unnecessary GHG emissions.

Central to these principles and approaches is the understanding that expedient action is required to limit the magnitude of climate change.

⁵ This principle is one of four sustainability principles promoted by The Natural Step Canada.



3.2 THE COST OF CARBON

How much should the City of Edmonton be willing to pay to reduce or avoid a tonne of GHG emission? This complex question is being considered by organizations around the world. The key point of agreement is that GHG emissions cause a wide range of damage that is not reflected or compensated for in the price of the fossil fuel consumed. It is argued that these externalities⁶ should, in some way, be factored into the policy and investment decisions made by organizations, including local governments.

This plan proposes that a **social cost of carbon** be factored into the City's investment/procurement decisions. This cost would be expressed in dollars per tonne of CO₂ emitted, and would represent what the City believes to be "the full global cost today of an incremental unit of carbon (or equivalent amount of other greenhouse gases) emitted now, summing the full global cost of the damage it imposes over the whole of its time in the atmosphere. Moreover, it would represent the scale of the externality that needs to be incorporated into decisions on policy and investment options in government."⁷

This dollar amount would be used by the City of Edmonton to evaluate the full cost of the City's investments/procurements that emit significant amounts of GHGs. For example, when leasing office space, the City would consider the energy efficiency of competing buildings, estimate the GHG emissions of those buildings over the period of their potential leases, determine the cost of the emissions (based on the City's approved social cost of carbon), and include this cost as part of the total cost when comparing the cost of different lease options. Similarly, the *social cost of carbon* amount would provide a benchmark for evaluating the cost-effectiveness of higher energy efficiency standards that reduce GHG emissions (compared to business-as-usual options). Initiatives would be considered cost-effective if they were able to reduce GHG emissions at an incremental cost per tonne that was less than the *social cost of carbon*.

The main difficulty in putting this concept into practice is determining an accurate social cost of carbon. Estimates

produced to date by different research bodies are highly uncertain, ranging from \$43/tC with a standard deviation of \$83/tC.⁸ In one report, in another, from less than \$1/tC to over \$1,500/tC.⁹

The UK government is an example of a major government that has put the *social cost of carbon* concept into practice. It currently assigns a social cost of carbon on a scale that started at £25.50/tCO₂ (approximately \$40.00 CDN) in 2007, rising year on year to £59.60/tCO₂ (approximately \$95.00 CDN) in 2050.

The UK government's position on this matter was influenced significantly by the **Stern Review on the Economics of Climate Change**.¹⁰ The Stern Review's main conclusion is that the benefits of strong, early action on climate change far outweigh the costs of not acting. Overall, the Stern Review indicates that each tonne of CO₂ emitted causes damages worth at least \$85.00.

In 2008, the European Union (EU) commissioned a scientific paper¹¹ to understand the efforts required to protect the climate within a 2° C limit. The paper identified how this target might be achieved through global action and concluded that stabilization of atmospheric GHG levels at 550ppm CO₂ would require a price of approximately 40 €/tCO₂ by 2030 (approximately \$55.00 CDN). Stabilization at 450ppm CO₂ would require a higher carbon price of up to 80 €/tCO₂ by 2030 (approximately \$110 CDN).

Canadian research^{12,13} pegs this cost at between \$25 and \$100 per TCO₂e.

⁶ An externality is a cost or benefit conferred upon an agent who was not part to the transaction. The presence of externalities leads to a sub-optimal allocation of resources as the full costs to society are not taken into account in agents' decision-making.

⁷ The Social Cost of Carbon, Department for Environment Food and Rural Affairs, Government of UK, December 2007

⁸ One TC is roughly equivalent to 4 tCO₂.

⁹ http://en.wikipedia.org/wiki/Carbon_tax

¹⁰ A 700-page report released for the British government in October, 2006 by economist Nicholas Stern.

¹¹ The 2 Degree C Target, prepared and adopted by EU Climate Change Expert Group 'EG Science' Final Version, Version 9.1 th July 2008

¹² Federal Paper — (*Turning the Corner*) released in 2007, and

¹³ Rick Hyndman, The Cost of Carbon, Alternatives Journal, Volume 35, Number 1- January 2009 (posted on the Canadian Association of Petroleum Producers website), www.capp.ca

This plan proposes the adoption of a social cost of carbon (to be used for City policy and decision-making purposes) that acknowledges a social cost of carbon of at least \$40.00/tCO₂ that would be reviewed and updated periodically to reflect new information and greater certainty. As a result, the following investments (explained further in this plan) would be considered cost-effective:

- Street lighting upgrades
- Higher energy efficiency standard for retrofit buildings
- Higher energy efficiency standard for the City's Compost Facility
- Higher energy efficiency standard for new building construction
- Purchase of green power



SECTION 4

GHG REDUCTION TARGETS

4.1 GHG REDUCTION TARGETS

The Way Ahead establishes six 10-year goals. One goal, “Preserve and Sustain Edmonton’s Environment” states: “*In partnership with its citizens, businesses and institutions, Edmonton is the nation’s leader in setting and achieving the highest standards of environmental preservation and sustainability both in its own practices, and by encouraging and enabling the practices of its partners.*”

Supporting this goal, City Council approved:

- Several corporate outcomes and measures (July 2010) including outcome 1.2 which states, “The impact of City Operations on air, land, and water systems is minimized.” The accompanying measures that were approved focused on greenhouse gas emissions and energy consumption:
- *The Way We Green* in (July 2011) which included: (a) a goal for Edmonton to become “a carbon-neutral city” and (b) a strategic action (6.10.1) directing the Administration to establish, implement and maintain “a *City Operations Greenhouse Gas Management Plan* aimed at significantly reducing greenhouse gas emissions from City operations.”

4.2 NATION’S LEADER

The goal to be a nation’s leader in reducing GHG emissions from City Operations is a robust challenge. The City of Calgary has set a target to reduce GHG emissions by 20% by 2020 and was able to surpass this target in 2011 with the help of green power purchases. The City of Calgary and the City of Toronto have pledged to reduce GHG emissions by 80% by 2050.

The targets proposed for the City of Edmonton (Section 4.3) are achievable, aggressive and consistent with those of other leading cities.



4.3 PROPOSED GHG EMISSIONS REDUCTION TARGETS FOR CITY OPERATIONS

In keeping with Edmonton City Council's directions, this plan proposes the following GHG reduction targets for City Operations:

Table 1 –GHG Reduction Targets for City Operations

Corporate Target (% reduction from 2008 emissions)	Target Date
50% reduction	2020
80% reduction	2050
Carbon Neutral	long term

(**Note:** The target to reduce GHG emissions by 50 per cent is equivalent to the annual GHG emissions produced by 25,000 light pick-up trucks.¹⁴)

¹⁴ Assumption — vehicle is driven 40,000 km/year, with a fuel consumption rate of 6.7 litres/100 km (USA target for 2020 (<http://www.tc.gc.ca/eng/mediaroom/releases-nat-2008-08-h006e-4909.htm>), an emissions conversion rate of 0.00244333 tCO₂e/l from combustion in a 2005 or newer Tier 1 level emissions standard vehicle.

SECTION 5

ACHIEVING 2020 TARGET

5.1 SOURCES AND AMOUNTS OF GHG EMISSIONS FROM CITY OPERATIONS

In 2008, City Operations emitted 330,000 tonnes of GHGs from five main sources:

- Buildings (172,200 tonnes)
- Streetlights (69,300 tonnes)
- Landfill (48,600 tonnes)
- Municipal fleet (24,300 tonnes)
- Composting operations (18,500 tonnes)

At the same time, Edmonton's urban forest served as a carbon sink, capturing 2,500 tonnes of carbon.



TABLE 2 — CITY OPERATIONS' GREENHOUSE GAS INVENTORY

	BUILDINGS EMISSIONS ¹⁵	MUNI FLEET EMISSIONS ¹⁶	LANDFILL EMISSIONS ¹⁷	STREETLIGHTS EMISSIONS ¹⁸	COMPOSTER EMISSIONS ¹⁹	FOREST (SINK)	TOTAL
2008 (TCO ₂ e) ²⁰	172,200	24,300	48,600	69,300	18,500	-2,500	330,000
% total	52%	7%	15%	21%	6%	-1%	100%

15 16 17 18 19 20

5.2 HOW ARE THE GHG EMISSIONS FROM CITY OPERATIONS ESTIMATED?

The City subscribes to the ICLEI Greenhouse Gas Reporting Protocol which defines items eligible for inclusion in the City Operations GHG Inventory.

The ICLEI Greenhouse Gas Reporting Protocol identifies a number of municipal operations that are typically included in a City Operations' GHG Inventory. Although the protocol identifies waste water and water treatment as municipal operations, they are not included in the City of Edmonton's inventory given that responsibility for these operations resides with EPCOR. Should the City wish to influence EPCOR's performance in this area, it would be through its role as shareholder and not through the GHG Management Plan for City Operations.

City-funded boards and authorities have also been excluded from the GHG Inventory for City Operations

as they too are managed outside the City of Edmonton management framework. These entities include: Edmonton Police Services²¹, Shaw Conference Centre, Telus Space Science Centre, Kinsmen Arena, Edmonton Research Centre, Art Gallery of Alberta, Citadel, Snow Valley and Edmonton Public Libraries²². Overall, emissions from these organizations are proportionately small — equivalent to approximately 10 – 15 per cent of the GHG Inventory from City Operations.

5.3 REPORTING GHG EMISSIONS FROM TRANSIT OPERATIONS

Emissions from Edmonton Transit's fleet will be reported as part of the Community GHG Inventory. A separate strategy addressing Transit's GHG targets and related initiatives is currently under development within the Transportation Department. The resulting strategy will be presented to Edmonton City Council in 2012.

¹⁵ **Buildings Emissions:** Includes GHG emissions from owned and leased facilities where the City pays utility costs.

¹⁶ **Municipal (Muni) Fleet Emissions:** Includes emissions from all vehicles operated by City departments that are under the authority of the City Manager, with the exception of vehicles operated by Edmonton Transit (see Section 5.2 for explanation of this practice).

¹⁷ **Landfill Emissions:** Includes emissions from three landfills that are owned by the City of Edmonton: Beverly Landfill (Rundle Park), South Side (Millwoods Golf Course) and Clover Bar Landfill.

¹⁸ **Streetlights Emissions:** Includes greenhouse gas emissions from electricity used to power approximately 100,000 roadway lights throughout Edmonton.

¹⁹ **Composter Emissions:** Includes emissions from the energy used to operate the City's composting facility.

²⁰ TCO₂e means tonnes of carbon dioxide equivalent. This is the metric measurement unit for greenhouse emissions. The global warming impact of all greenhouse gases is measured in terms of equivalency to the impact of carbon dioxide (CO₂). For example, one million tonnes of methane, a far more potent greenhouse gas than carbon dioxide, is measured as 23 million tonnes of CO₂ equivalent.

²¹ The buildings occupied by Edmonton Police Services are included in the City Operations Inventory due to the control exercised over them by the Capital Construction Department and Asset Management & Public Works Department. All other sources of GHG emissions such as fleet are excluded from this inventory.

²² Ibid.



5.4 TARGET ASSESSMENT VOLUMES

The proposed 2020 target (i.e., 50 per cent reduction in GHG emissions from City Operations) requires a reduction of 165,000 tonnes of GHG emissions by 2020. Figure 1 shows how this reduction can be achieved through infrastructure improvements and the purchase of "green power." As indicated in Figure 1, green power purchases are the single largest source of GHG reductions in the strategy over the next 10 years.

FIGURE 1: GHG REDUCTION TRAJECTORY (2011 - 2020)

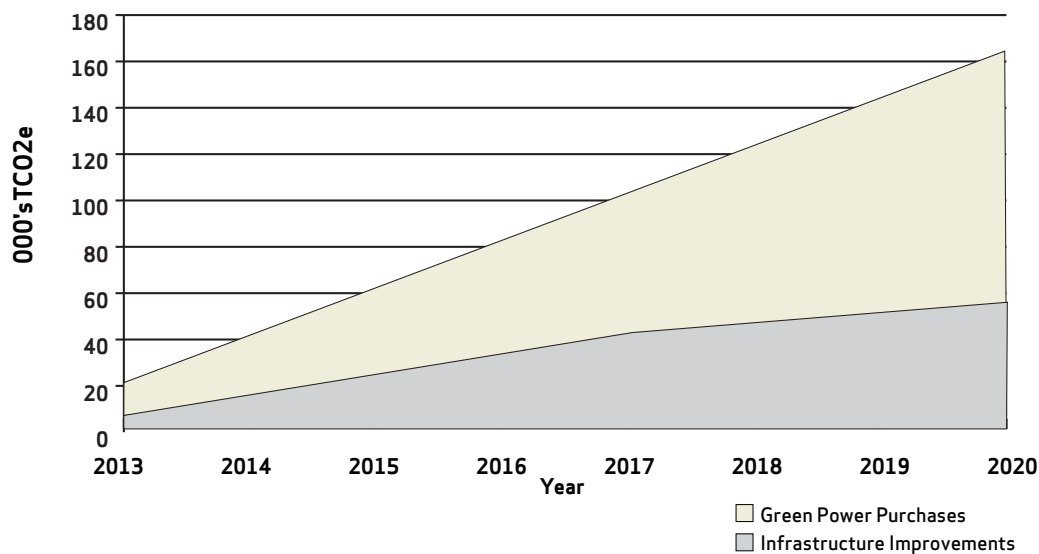


Table 3 shows the total emissions from City Operations that are possible from 2013 to 2020. Some of these reductions will occur without additional investment (e.g., reduced carbon intensity of the Alberta power grid), while others will require increased investment. Sections 5.5 – 5.12 explain how these reductions will be realized.

As shown in Table 3, the majority of the GHG emissions reduction would be achieved through the purchase of green power, more efficient street lights, retrofitting existing buildings, and the reduced emissions from City landfills. Although new buildings and a larger fleet will increase GHG emissions, this increase will be partially offset with the purchase of higher energy efficiency options as proposed in this plan.

TABLE 3 — FORECAST OF ANNUAL GHG EMISSIONS — 50 PER CENT REDUCTION STRATEGY

	2008 Baseline (000 T)	2013 (000 T)	2014 (000 T)	2015 (000 T)	2016 (000 T)	2017 (000 T)	2018 (000 T)	2019 (000 T)	2020 (000 T)
New Buildings (See Section 5.5)	0	18	18	18	18	18	19	19	19
Building Retrofits (See Section 5.6)	172	164	162	159	156	154	151	149	146
Municipal Fleet (See Section 5.11)	24	21	20	20	20	20	20	20	20
Street Lighting (See Section 5.7)	69	63	58	53	49	44	44	44	44
Compost Facility (See Section 5.10)	19	15	15	15	15	13	13	13	13
Landfill Clover Bar (See Section 5.9)	32	29	29	28	28	27	27	26	26
Landfill Rundle Park (See Section 5.9)	5	4	4	4	4	4	4	4	3
Landfill South Side (See Section 5.9)	12	11	11	11	11	10	10	10	10
Urban Forest to double canopy (See section 5.12)	(3)	(3)	(3)	(3)	(4)	(4)	(4)	(4)	(5)
Emissions from Operations	330	323	315	306	297	287	284	280	276
% Reduction from 2008	0	2%	5%	7%	10%	13%	14%	15%	17%
Green Purchases (Section 7.3)	0	(13)	(25)	(37)	(49)	(60)	(77)	(94)	(111)
Net Emissions	330	310	289	269	248	227	207	186	165
% Reduction from 2008	0%	6%	15%	19%	25%	31%	38%	44%	50%
Alberta Grid (See Section 5.8)	0	(13)	(19)	(25)	(30)	(35)	(38)	(40)	(43)
Total Emissions with Grid Effect	330	297	270	243	218	192	168	146	122
% reduction from 2008	0%	10%	18%	26%	34%	42%	49%	56%	63%

For comparison purposes, Table 4 shows the business-as-usual scenario, i.e., the result of continuing current standards and practices, and not making additional improvements as outlined in Table 3.

Under the business-as-usual scenario (Table 4), GHG emissions in 2020 would be 8 per cent lower than in 2008. Increased emissions from new buildings would be offset by: (a) reduced emissions from landfills, and (b) retrofits to City-owned and leased buildings, (c) conversion of high pressure sodium vapour street light fixtures to LED, (d) upgrades to equipment within the compost facility, and (e) expansion of the urban forest.

TABLE 4 — FORECAST OF ANNUAL GHG EMISSIONS — BUSINESS-AS-USUAL SCENARIO

Note: Minor rounding discrepancies exist in this table	2008 Baseline (000T)	2013 (000T)	2014 (000T)	2015 (000T)	2016 (000T)	2017 (000T)	2018 (000T)	2019 (000T)	2020 (000T)
New Buildings (See Section 5.5)	0	20	21	21	21	21	22	22	22
Building Retrofits (See Section 5.6)	172	165	163	162	160	158	156	155	153
Municipal Fleet (See Section 5.11) ²⁴	24	21	20	20	20	20	20	20	20
Street Lighting (See Section 5.7)	69	67	66	64	63	62	61	60	59
Compost Facility (See Section 5.10)	19	15	15	15	15	15	15	15	15
Landfill Clover Bar (See Section 5.9)	32	29	29	28	28	27	27	26	26
Landfill Rundle Park (See Section 5.9)	5	4	4	4	4	4	4	4	3
Landfill South Side (See Section 5.9)	12	11	11	11	11	10	10	10	10
Urban Forest to maintain existing canopy (See Section 5.12)	-3	-3	-3	-3	-3	-3	-3	-3	-3
Total Emissions	330	330	327	323	319	316	312	309	305
% reduction from 2008	0%	0%	1%	2%	3%	4%	6%	7%	8%
Alberta Grid (See Section 5.8)	0	(14)	(20)	(27)	(33)	(40)	(44)	(45)	(49)
Total Emissions with Grid Effect	330	316	307	296	286	276	269	263	256
% reduction from 2008	0%	4%	7%	10%	13%	16%	19%	20%	23%

²⁴ No allowance for growth is incorporated in the Booz/Allen/Hamilton study used to derive the data for the model used to derive the future GHG emissions for the Fleet. ("Final Report — Towards Sustainability: Strategies for the City of Edmonton Fleet Operations, McLean, VA — Booz/Allen/Hamilton — January, 2009 (Fleet Services Strategic Fleet Management Plan) Version April , 2009)

5.5 NEW BUILDING CONSTRUCTION CONTRIBUTION

New City-owned buildings that are slated for construction from 2011 to 2020 will produce an additional 22,000 TCO₂e a year if constructed to the City's current building standard of energy performance efficiency (i.e., a minimum of 30 per cent better than the Model National Energy Code for Buildings (1997)). This plan requires a higher standard, 50 per cent better than the Model National Energy Code for Buildings (1997), beginning in 2013. This will result in an additional 19,000 TCO₂e/yr by 2020, compared to the 22,000 TCO₂e that would have resulted from the lower standard.

5.6 EXISTING BUILDINGS — RETROFITS

On average, retrofits to City buildings yield an energy efficiency improvement of approximately 20 per cent. From 2013 onward, this plan calls for energy performance improvement retrofits to achieve a minimum 30 per cent energy efficiency improvement. By applying this standard to 30 per cent of the existing building inventory through to 2020, emissions are expected to be reduced by an additional 7,000 TCO₂e/yr by 2020 as compared to the business-as-usual model.

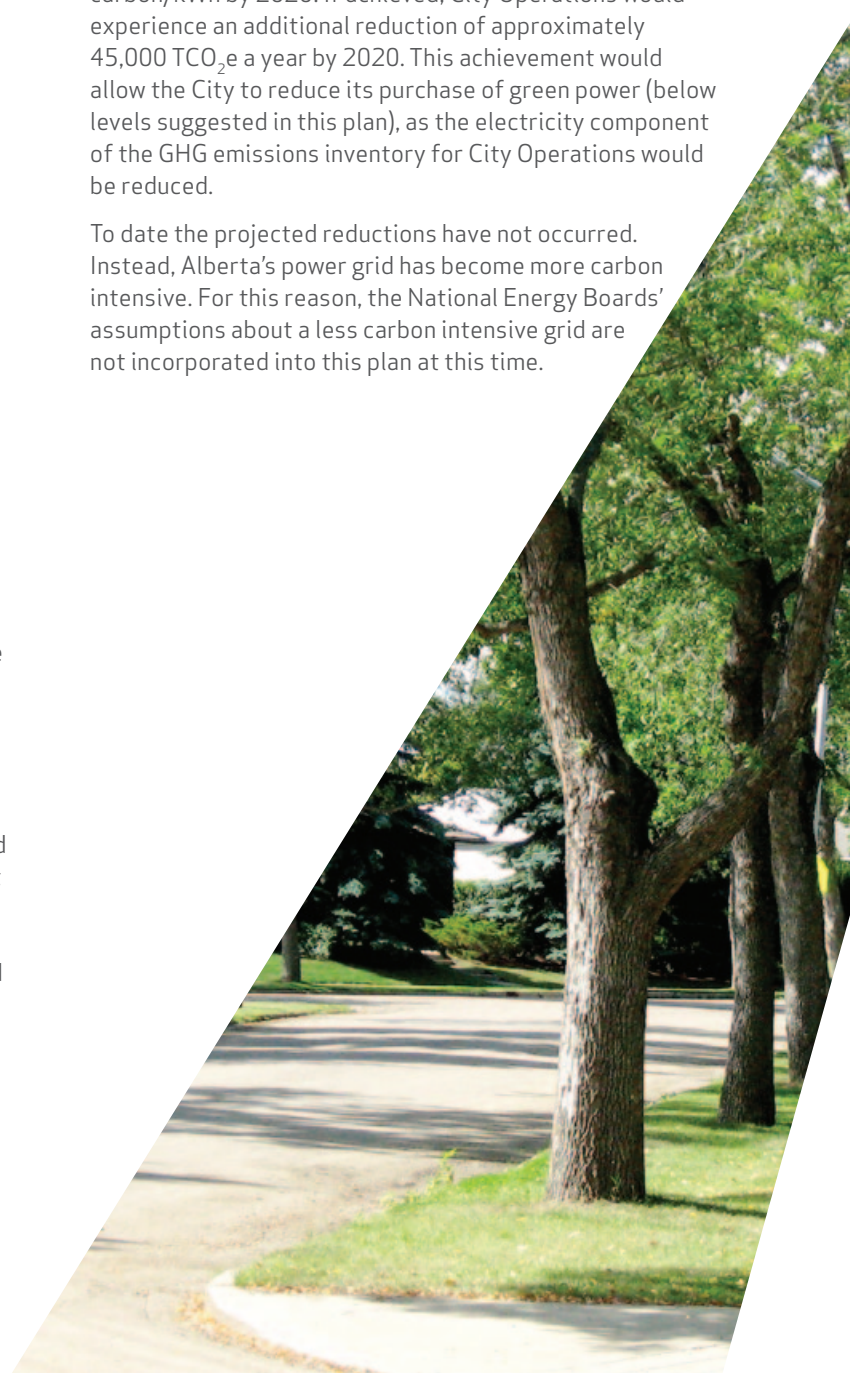
5.7 INFLUENCES FROM STREET LIGHTING UPGRADES

Conversion of City street light fixtures (from high pressure sodium vapour to LED) is currently under way with plans to convert 43,000 of the City's 100,000 streetlights by year-end 2020. This conversion will reduce greenhouse gas emissions by approximately 3.0 per cent. *The Plan* recommends an additional 4.5 percent reduction by pursuing full conversion of all 100,000 fixtures by year-end 2017. This investment will provide the City with significant financial savings over the lifecycle of these assets but will require additional up-front investment. (Note: The full business case for accelerated conversion will be presented to the Transportation and Infrastructure Committee in the summer of 2012).

5.8 THE EFFECT OF THE ALBERTA POWER GRID

In 2008, 198,000 TCO₂e were emitted from electricity used in City Operations. Over the next decade, this total could be reduced by approximately 25 per cent due to the potential transition to a less carbon-intensive power generation grid. According to the 2010 National Energy Board forecast, emissions from electricity generation in Alberta's power grid (grid factor) could fall from 880 to 650 grams carbon/kWh by 2020. If achieved, City Operations would experience an additional reduction of approximately 45,000 TCO₂e a year by 2020. This achievement would allow the City to reduce its purchase of green power (below levels suggested in this plan), as the electricity component of the GHG emissions inventory for City Operations would be reduced.

To date the projected reductions have not occurred. Instead, Alberta's power grid has become more carbon intensive. For this reason, the National Energy Boards' assumptions about a less carbon intensive grid are not incorporated into this plan at this time.





5.9 LANDFILL GAS DEGRADATION

In 2008, approximately 32,000 TCO₂e were emitted from the Clover Bar Landfill, 4,500 TCO₂e from the Beverly Landfill (Rundle Park), and 12,300 TCO₂e from the South Side Landfill (Millwoods Golf Course). These totals include flaring of landfill gas at the Beverly Landfill and landfill gas capture at the Clover Bar Landfill. No capture or flaring amenities exist at the South Side Landfill. Over time, emissions from all three sites will reduce naturally as landfilled materials degrade. This plan takes into account this decrease in GHG emissions from the landfill through to 2020.

5.10 WASTE MANAGEMENT COMPOSTING FACILITY

The Edmonton Composting Facility uses energy to operate kilns and lighting fixtures. The potential exists to make these components 30 per cent more energy-efficient than today. This would reduce emissions by approximately an additional 1,900 TCO₂e per year, as compared to a 20 per cent upgrade.

5.11 MUNICIPAL FLEET

In April 2010, the Sustainable Fleet Long-term Action Plan was developed by Fleet Services. The Long-term Action Plan put forward a number of recommendations for reducing greenhouse gas emissions from vehicles used in City Operations. Many of these recommendations are being implemented, including allocating \$4.4 million for the purchase of hybrid vehicles over several years, upgrading waste management vehicles, continued implementation of the Fuel Sense program combined with idle control initiatives, right sizing of the light duty fleet, and introduction of the federally mandated renewable fuel content in both diesel and gasoline fuels.

Within existing budget parameters the Action Plan is able to achieve an annual reduction in GHG emissions of roughly 4,000 TCO₂e by 2020.

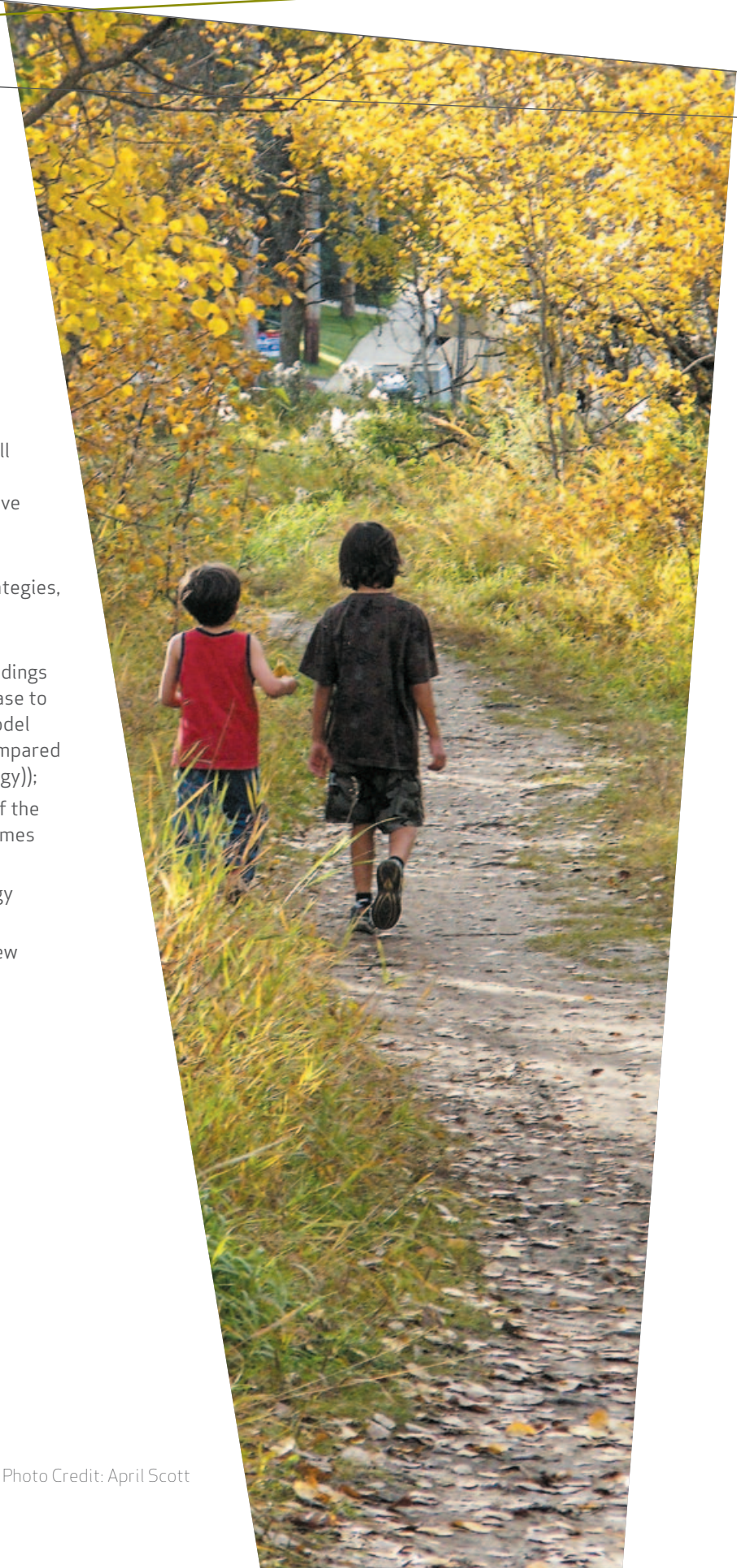
5.12 URBAN FOREST CANOPY

By 2090 the doubling of the urban forest canopy (298,000 park and boulevard trees) would result in the cumulative reduction of 210,000 TCO₂e with an annual reduction of 2,750 TCO₂e being achieved by 2020.

SECTION 6 ACHIEVING THE 2050 TARGET

Although this plan focuses on achieving the 2020 target, over the next decade the City will need to set the stage for achieving the 2050 target. This will involve ensuring this plan continues to develop and evolve through continuous improvement and iterative adjustments and improvements such as, but not limited to:

- Applying aggressive demand management strategies, embracing technology and promoting lifestyle changes;
- Ratcheting up the energy efficiency in new buildings (i.e., determining when it makes sense to increase to 60 per cent and 70 per cent better than the Model National Energy Code for Buildings (1997) (compared to the 50 per cent recommended by this strategy));
- Focusing on hybridization and electrification of the fleet (battery or other) as the technology becomes available (early adopter);
- Looking at the possibility of demolishing energy inefficient buildings;
- Continuing to participate in pilot projects of new technology;
- Increasing the use of renewable energy;
- Applying demand management measures, and,
- Increasing Edmonton's tree canopy.



SECTION 7 CARBON MARKET & GREEN POWER CONSIDERATIONS

7.1 MUNICIPAL PARTICIPATION IN THE CARBON MARKET (SELLING CARBON OFFSETS)

Emissions trading (also known as cap-and-trade), is a market-based approach used to control pollution by providing economic incentives for achieving reductions in the emissions of pollutants. This system of emissions control involves an exchange of permits recorded in a legislated emissions recording system. One party earns credits by implementing emissions reduction measures, and with the credits earns the right to sell them to others in the trading system who are legislated to reduce their emissions. In effect, the buyer is paying a charge for polluting, while the seller is being rewarded for having reduced emissions, but the emissions have overall been reduced in the “system.” Thus, in theory, those who can reduce emissions most cheaply will do so, achieving the pollution reduction at the lowest cost to society.²⁵

In Alberta, the provincially established cap-and-trade system for large emitters prices CO₂ emissions at \$15/tonne. This price is expected to prevail until such time as there is a more widespread national or North American cap-and-trade system in place.

Currently, the City sells credits that were created as a result of the City's composting efforts. By diverting waste from landfill (through composting operations) the City avoids the production of more potent greenhouse gases such as methane. The carbon credits from this effort are certified for trading.

²⁵ Globally in 2008, there were 17 recognized standards for carbon offsets sold in the voluntary market. These included the Clean Development Mechanism (CDM), The Gold Standard, the Voluntary Carbon Standard, the Climate Action Reserve Protocols, the Green-e Climate Protocol for Renewable Energy, and the Climate, Community and Biodiversity Project Design Standards, among others. Of these, the CDM is the most widely used standard in the compliance market, and The Gold Standard and the Voluntary Standard are currently the most popular standards in the voluntary market. The options provided are considered to have higher level of legitimacy.



7.2 GREEN POWER PURCHASE AND THE PURCHASE OF CARBON OFFSETS

In order for the City to achieve a 50 per cent reduction in GHG emissions by 2020, it will be necessary to purchase either green power or carbon offsets. Although significant reductions can be achieved through higher energy efficiency standards involving building retrofits, new building construction, street lights, fleet and facility operations, these improvements will only reduce GHG emissions by approximately 17 per cent by 2020. This plan recommends the purchase of green power to achieve the remaining 33 per cent reduction that is targeted.

Given the option of purchasing either offsets or green power, this plan proposes the purchase green power. In addition to reducing the carbon intensity of the Alberta power grid, this option supports the development of Alberta's renewable energy industry and contributes to Edmonton's energy resilience. Although the purchase of carbon offsets could be used to reduce the City Operations GHG inventory at a lower cost, the quality of many of these credits is often uncertain and the use of these instruments is discouraged by some environmental organizations.

Although green power is this plan's GHG reduction option of choice, any green power purchased to mitigate greenhouse gas emissions from City Operations must comply with reporting protocols that require the power producer to officially retire the emissions credit related to the energy produced on its books upon the sale of energy to the purchaser. This eliminates the potential for "emissions credit leakage" in the emissions accounting "system" whereby a producer sells power but not the credits, and both the producer and the purchaser claim credit for the reduction, generating a double counting "error" in the emissions reductions in the "system".

7.3 GREEN POWER PURCHASE SCHEDULE

This plan is designed to continually improve the City's GHG emission performance in each year leading to the 2020 target. As such, annual shortfalls in the annual emissions trajectory toward the 2020 goal will be addressed through the purchase of green power. It is estimated that this will cost approximately \$12 million (Net Present Value) from 2013 to 2020.

The City of Edmonton intends to pursue the purchase of green power within the framework of its current electricity supply agreement with Capital Power (ie., The Electric Load Purchasing Agreement) which extends to December 31, 2013. The City's goal, over time, will be to direct this funding to renewable energy generation projects that are located in or close to Edmonton. This approach will support local expansion of the renewable energy industry and the retention of economic benefits.

SECTION 8 FINANCIAL IMPLICATIONS OF THIS PLAN

8.1 SHORT-TERM FINANCIAL IMPLICATIONS OF ACHIEVING 2020 TARGETS

Table 5 shows a cash flow format of the currently unbudgeted costs that are expected from 2013 to 2020 to achieve a 50 per cent reduction in GHG emissions (i.e., costs that are over-and-above the costs that would be incurred in a business-as-usual strategy).

Generally, initiatives that reduce GHG emissions beyond the business-as-usual expectations will require a greater initial capital outlay than the business-as-usual options. However, these higher capital cost projects are followed by a stream of operating costs (over their life) that are often much lower than the business-as-usual option. Table 5 looks only at the short to medium term financial implications of implementing the higher standard based initiatives, to 2020.



TABLE 5 — SHORT TERM FINANCIAL IMPLICATIONS OF THIS PLAN

	Totals (\$'000's)	2013 (\$'000's)	2014 (\$'000's)	2015 (\$'000's)	2016 (\$'000's)	2017 (\$'000's)	2018 (\$'000's)	2019 (\$'000's)	2020 (\$'000's)
New Buildings - Capital - Operating	\$5,570 (\$2,088)	\$4,360 (\$216)	\$249 (\$241)	\$104 (\$249)	\$107 (\$257)	\$111 (\$265)	\$638 (\$274)	\$0 (\$286)	\$0 (\$300)
Building Retrofits - Capital - Operating	\$10,433 (\$4,113)	\$1,173 (\$102)	\$1,208 (\$205)	\$1,245 (\$316)	\$1,282 (\$434)	\$1,320 (\$559)	\$1,360 (\$691)	\$1,401 (\$830)	\$1,443 (\$977)
Street Lighting - Capital - Operating	\$31,728 (\$24,132) ²⁶	\$7,848 (\$726)	\$8,252 (\$1,513)	\$8,678 (\$2,366)	\$9,125 (\$3,289)	\$8,702 (\$4,244)	(\$3,446) (\$4,132)	(\$3,623) (\$4,004)	(\$3,809) (\$3,857)
Compost Facility - Capital - Operating	\$1,880 (\$840)	— —	— —	— —	— —	\$1,880 (\$201)	— (\$207)	— (\$213)	— (\$220)
Cost of Green Power Purchases	\$12,617	\$301	\$612	\$930	\$1,266	\$1,577	\$2,095	\$2,634	\$3,203
Subtotal Capital	\$49,610	\$13,381	\$9,710	\$10,027	\$10,514	\$12,013	(\$1,447)	(\$2,222)	(\$2,366)
Subtotal Operating	(\$18,556)	(\$744)	(\$1,346)	(\$2,001)	(\$2,714)	(\$3,692)	(\$3,208)	(\$2,700)	(\$2,150)
Total	\$31,054	\$12,637	\$8,363	\$8,025	\$7,800	\$8,321	(\$4,655)	(\$4,922)	(\$4,517)

Overall, Table 5 forecasts an increased expenditure of approximately \$31 million (from 2013 to 2020) in order to achieve a 50 per cent reduction in the greenhouse gas emissions from City Operations.

Conservative assumptions were used to estimate the costs in Table 5. As a result, the net financial cost of “greener” buildings might actually turn out to be less than amounts shown due to lower maintenance costs, higher resale or lease benefits, technology advancements that might occur more rapidly than expected and reduced capital costs, and/or higher than expected future energy costs that will result in even greater savings.

²⁶ This estimate assumes that reduced electricity use through accelerated conversion of streetlights (from high pressure sodium vapour to LED) would result in proportionate electricity cost savings. This electricity pricing assumption has yet to be confirmed with EPCOR/Capital Power but will be pursued as part of replacement energy contract negotiations which will come into effect in 2014. This matter will be further analyzed and reported to City Council before proceeding with the implementation of this strategy.

8.2 LONG-TERM FINANCIAL IMPLICATIONS OF ACHIEVING 2020 TARGETS

This plan recognizes a limit to what the City of Edmonton should pay to reduce or avoid a tonne of GHG emissions and proposes that the cost of initiatives should not exceed \$40/tonne (with cost per tonne calculated on a net present value basis over the lifecycle of the investment). All but one of initiatives in this plan meets this criterion; the exception being the doubling of the urban forest canopy by 2090. While the cost of urban forest strategy is high from the standpoint of carbon sequestration, an expanded urban forest provides a wide range of other benefits that warrant the investment.

The purpose of Table A is to show the financial cost (or savings) of individual initiatives relative to the GHG emissions they reduce/avoid over their lifecycles. These calculations are shown in the fifth column (i.e., titled Costs

or Savings per Tonne). As indicated in the table, over the course of their lifecycles, most of the infrastructure investments generate net savings and reduce emissions. This is the case for building retrofits, roadway lights conversions, compost facility retrofits, and higher energy efficiency standards for new buildings. Moreover, this situation (i.e., financial savings) is true for both business as usual initiatives (BAU) and for the new initiatives that are proposed.

At the same time, green power purchase and implementation of the sustainable fleet management plan come at a cost of \$23 and \$19 a tonne respectively. These costs are deemed justified as they are less than the \$40/tonne threshold recommended by this plan.

TABLE 6 — LONG-TERM FINANCIAL IMPLICATIONS OF STRATEGY

GHG Reduction Initiatives	Status	Long Term (Cost) or Saving ²⁷ (\$million)	Emissions Reduction (000 T) ²⁸	(Cost) or Savings per Tonne	Explanation
Building Retrofits	Business as Usual (BAU)	\$19 (NPV saving)	(470)	\$41	BAU involves retrofitting approximately 3% of City owned buildings each year. Historically, this has yielded a 20% energy efficiency improvement and corresponding operational cost savings. Long term savings (shown to the left) represent savings that will be realized (net present value to 2050) on buildings that will be retrofitted from 2013 to 2020.
	New	\$10 (NPV saving)	(235)	\$41	This new initiative proposes a higher energy efficiency performance level for City owned buildings. The calculated savings are for those buildings that will be retrofitted from 2013 to 2020.
	Total	\$29 million (NPV saving)	(705)	\$41	
Roadway Lights Conversion	BAU	\$10 (NPV saving)	(350)	\$28	BAU represents the City's current practice of converting approximately 4,000 of the City's 100,000 streetlight fixtures a year. Long term savings (to the left) represent savings that will be realized (net present value to 2032).
	New	\$34 (NPV saving)	(184)	\$186	This new initiative proposes acceleration of the conversion process to achieve 100% conversion by 2017.
	Total	\$44 million (NPV saving)	(534)	\$82	

GHG Reduction Initiatives	Status	Long Term (Cost) or Saving ²⁷ (\$million)	Emissions Reduction (000 T) ²⁸	(Cost) or Savings per Tonne	Explanation
Composter Retrofits	BAU	\$9 (NPV saving)	(144)	\$64	BAU involves improving the overall energy performance efficiency of the Waste Management Services compost facility by 20% by 2020. Long term savings (shown to the left) represent savings that will be realized (net present value to 2050).
	New	\$2 (NPV saving)	(63)	\$40	This new initiative involves additional upgrades that will result in 30% energy efficiency improvements.
	Total	\$11 million (NPV saving)	(207)	\$53	
New Buildings (Construction to a higher standard)	BAU	\$22 (NPV saving)	(350)	\$63	BAU involves constructing new City buildings to an energy efficiency level that is 30% better than the Model National Energy Code for Buildings (1997).
	New	\$5 (NPV saving)	(161)	\$28	This new initiative proposes an increase to 50%. Long term savings (to the left) represent savings that will be realized (net present value to 2063) on buildings that will be constructed from 2013 to 2018.
	Total	\$27 million (NPV saving)	(511)	\$52	
Green Power Purchase	BAU	n/a	n/a	n/a	Currently this strategy is not employed.
	New	Cost depends on how long and extent to which strategy is applied	Reduction depends on how long and extent to which strategy is applied	(\$23)	This new initiative involves purchasing green (renewable) electricity at a premium cost in order to achieve emission reduction targets. Long term costs will be a function of the premium price the City will pay for green power (equivalent to approximately \$23 for every tonne of GHG avoided).
	Total			(\$23)	
Municipal Fleet	BAU	(\$1.1 million) (NPV cost)	(58)	(\$19)	BAU involves implementing the approved Sustainable Fleet Management Plan using continual improvement methodologies and special funding approved by Council in 2009. Long term costs (to the left) represent additional costs that will be incurred from 2013 to 2020, with lifecycle costs calculated to 2025.
	New	na	na	na	No new initiatives are proposed beyond BAU.
	Total	\$1.1 million (NPV cost)	(58)	(\$19)	

²⁷ These figures represent long-term net present value costs or savings that were calculated based on assumptions outlined in Section 9 of this report.

²⁸ These figures represent the emissions that will be achieved over the lifecycle of the particular initiative.

The City Operations' Greenhouse Gas Management Strategy will take the approach that City dollars should be used in the most cost-effective way to reduce greenhouse gas emissions. This will mean giving priority to initiatives that deliver emission reductions at the lowest possible cost per TCO₂e.

SECTION 9

MODEL ASSUMPTIONS

In developing this plan, a number of models were used to evaluate the costs and benefits (both financial and GHG reductions) related to:

- Installing street lighting systems with a higher energy efficiency rating;
- Retrofitting existing building stock;
- Retrofitting the composter facility;
- New building construction;
- Green Energy Purchases;
- Improving the energy efficiency of the municipal fleet; and,
- Doubling the urban forest canopy in Edmonton (boulevard trees).

The following are the key assumptions used in each of the models:

9.1 ASSUMPTIONS — STREET LIGHTING

- Discount rate — 5 per cent (From Finance)
- Inflation rate — 3 per cent (From Maintenance and Capital)
- Inflation — 5 per cent (Electricity)
- Forecast of replacement schedule — 100 per cent of existing roadway street lighting will be replaced by a higher energy-efficient system using 40 per cent less energy by 2020 (estimated)
- Growth rate of 0.73 per cent over five years derived (historic five year trend)
- Base cost of electricity — \$0.10/kWh (estimated)
- Renewable energy cost — \$0.02 premium over regular electricity (estimated)
- Escalation of fuel costs above the rate of inflation — not considered
- Cost of old luminaire = \$300
- Cost of new luminaire = \$580
- Maintenance of old lamp = \$27



- Maintenance of new lamp = \$5
- Signals energy consumption = 4.27 per cent of total Street lights energy consumption (from energy consumption records)
- Number of streetlights in Edmonton = 100,000 (Traffic Operations)
- Estimated Life of high efficiency bulb = 20 years (from EPCOR study)
- Estimated life of standard bulb = 5 years (Traffic Operations)

9.2 ASSUMPTIONS — RETROFITTING EXISTING BUILDING STOCK

- Discount rate — 5 per cent (From Finance)
- Inflation rate — 3 per cent (From Finance)
- Electricity Grid factor = 0.00088 TCO₂e/kWh consumed (Environment Canada)
- Natural gas emission factor = 0.050973788 TCO₂e/Gj combusted (Environment Canada)
- Potential total area of building inventory to be retrofit = 777,000 square metres
- Forecast of retrofit schedule — 30 per cent of existing building stock will be retrofit according to this new standard by 2020
- Base cost of natural gas — \$6/Gj (estimated)
- Base cost of electricity — \$0.085/kWh (estimated)
- Renewable energy cost — \$0.02 premium over regular electricity (estimated)
- Escalation of fuel costs above the rate of inflation — not considered
- Maintenance cost reduction attributable to “green” improvements — not considered
- Worker Productivity improvement financial factor for being a “greener” building — not considered
- Edmonton’s existing building retrofit inventory history was used to develop a representative energy retrofit improvement track record to use in the retrofit model. The following factors were derived from this record:
- Retrofit cost = \$74/square meter
- Average retrofit energy efficiency improvement to facility derived from historic retrofit project list of estimates = 20 per cent

- An improvement in retrofit energy efficiency upgrades to 30 per cent is assumed in the model
- The cost of this higher level of energy efficiency performance from the retrofit as compared to the 20 per cent level, is assumed to be 150 per cent. What cost \$100 to do a 20 per cent improvement will cost \$150 to achieve a 30 per cent energy efficiency retrofit improvement building upgrade
- Life cycle assessment duration of 40 years

9.3 ASSUMPTIONS — RETROFITTING WASTE MANAGEMENT COMPOSTER FACILITY

- Discount rate — 5 per cent (From Finance)
- Inflation rate — 3 per cent (From Finance)
- Electricity Grid factor = 0.00088 TCO₂e/kWh consumed (Environment Canada)
- Natural gas emission factor = 0.050973788 TCO₂e/Gj combusted (Environment Canada)
- Potential total area of building inventory to be retrofit = 44,000 square metres
- Forecast of retrofit schedule — a 30 per cent in energy performance improvement of the entire facility is expected to be completed by 2020.
- Base cost of natural gas — \$6/Gj (estimated)
- Base cost of electricity — \$0.085/kWh (estimated)
- Renewable energy cost — \$0.02 premium over regular electricity (estimated)
- Annual energy consumption = 35,393 GJ, 19,005,462 Wh for 2008 (actual)
- Escalation of fuel costs above the rate of inflation — not considered
- Maintenance cost reduction attributable to “green” improvements — not considered
- Worker Productivity improvement financial factor for being a “greener” building — not considered
- Edmonton’s existing building retrofit inventory history was used to develop a representative energy retrofit improvement track record to use in the retrofit model. The following factors were derived from this record:
- Retrofit cost = \$74/square meter

- Average retrofit energy efficiency improvement to facility derived from historic retrofit project list of estimates = 20 per cent
- An improvement in retrofit energy efficiency upgrades to 30 per cent is assumed in the model
- The cost of this higher level of energy efficiency performance from the retrofit as compared to the 20 per cent level is assumed to be 150 per cent. What cost \$100 to do a 20 per cent improvement will cost \$150 to achieve a 30 per cent energy efficiency retrofit improvement building upgrade
- Life cycle assessment duration of 40 years

9.4 ASSUMPTIONS — NEW BUILDING CONSTRUCTION

- Discount rate — 5 per cent (From Finance)
- Inflation rate — 3 per cent (From Finance)
- Electricity Grid factor = 0.00088 TCO₂e/kWh consumed (Environment Canada)
- Natural gas emission factor = 0.050973788 TCO₂e/Gj combusted (Environment Canada)
- Forecast of new construction — provided by Capital Construction
- Growth rate — as defined in the Capital Construction Schedule — actual forecast was used, no growth was assumed
- Cost of buildings — as defined in the Capital Construction Schedule
- Base cost of natural gas — \$6/Gj (estimated)
- Base cost of electricity — \$0.085/kWh (estimated)
- Renewable energy cost — \$0.02 premium over regular electricity (estimated)
- Escalation of fuel costs above the rate of inflation — not considered
- Maintenance cost reduction attributable to Green construction — not considered
- Worker Productivity improvement financial factor for green buildings — not considered
- Edmonton's existing inventory of buildings was used to develop the energy consumption baseline for various building types. The model then was used to forecast what the energy consumption might be if new buildings of a similar building type were built to improved energy performance levels. The energy types and related data are in Table A1.
- Life cycle assessment duration of 50 years

TABLE A1 — BASE ENERGY CONSUMPTION RATE ESTIMATES FOR EXISTING BUILDING INVENTORY

Building Type	(Mj+Mje)/m ²	% MJ/MJe Total	\$/m ² of Asset Value
Ambulance	1,647	70.67%	\$5,965
Police	824	43.51%	\$4,609
Transit bldg	1,000	0.00%	\$4,007
Recreation bldg	3,792	76.63%	\$3,999
Warehouse	2,448	81.57%	\$4,483
Library	1,123	45.94%	\$10,068
Information	4,162	89.00%	\$8,488
Multi Purpose	3,792	76.63%	\$3,999
Office	2,596	65.35%	\$3,178

9.5 ASSUMPTIONS — GREEN ENERGY

- Discount rate — 5 per cent (From Finance)
- Inflation rate — 3 per cent (From Finance)
- Electricity Grid factor = 0.00088 TCO₂e/kWh consumed (Environment Canada)
- Consume 1136 kWh to generate 1 TCO₂e (calculated)
- Premium = \$0.02/kWh (estimate)
- Cost for Green energy = \$22.73/TCO₂e abated (calculated)
- Must be purchased each year to maintain GHG emissions reduction credit
- Fuel Sense Program = 1,887 TCO₂e/year reduction
- Right Sizing = 55 TCO₂e/year reduction
- Biodiesel use effect on fleet emissions = 425 TCO₂e/year reduction
- Ethanol use effect on fleet emissions = 832 TCO₂e/year reduction
- Skirting initiative = 3TCO₂e/trailer per year
- Hybrid purchase schedule and other initiatives — estimated avoided emissions/year for 2011 through to 2020 supplied by Fleet Services
- Life cycle assessment duration of seven years

9.6 ASSUMPTIONS — MUNICIPAL FLEET

- Discount rate — 5 per cent (from finance)
- Inflation rate — 3 per cent (from finance)
- Diesel cost = \$1/litre (estimate)
- Gasoline Cost = \$1/litre (estimate)
- Premium for five per cent ethanol fuel = \$0.00/L (estimate)
- Premium for two per cent bio diesel = \$0.00/L (estimate)
- Escalation cost for fuel above inflation rate — not considered
- Car:
 - km/year = 30,000
 - Fleet - litres/100 km = 9
 - Hybrid litres/100 km = 4.6
 - Hybrid premium per vehicle = \$10,400
 - TCO₂/vehicle reduction = 3.0
- Light Duty Truck
 - km/year = 23,725
 - Fleet litres/100 km = 18.4
 - Hybrid litres/100 km = 11.8
 - Hybrid premium per vehicle = \$9,940
 - TCO₂/vehicle reduction = 3.6
- Heavy Duty Truck
 - km/year = 22,778
 - Fleet litres/100 km = 71.5
 - Hybrid litres/100 km = 53.6
 - Hybrid premium per vehicle = \$67,000
 - Hybrid TCO₂/vehicle reduction = 11

9.7 ASSUMPTIONS — URBAN FOREST

- Discount rate — 5 per cent (from Finance)
- Inflation rate — 3 per cent (from Finance)
- Cost per tree planted and maintained for two years — \$800 (from Parks data)
- Boulevard Trees in Edmonton = 298,000 (from Parks Data)
- Carbon Sequestration rate for Edmonton tree = 0.00917 TCO₂e/Tree/year (Trees Canada Formula)
- Schedule to double boulevard tree canopy by 2020
- Value for CO₂ sink reduction potential — not considered
- Value for CO sink reduction potential — not considered
- Value for NO₂ sink reduction potential — not considered
- Value for O₃ sink reduction potential — not considered
- Value for PM₁₀ sink reduction potential — not considered
- Value for SO₂ sink reduction potential — not considered
- Value for water runoff mitigation — not considered
- Value for building cooling — electricity use mitigation — not considered
- Value for building heating — natural gas use mitigation — not considered
- Value for aesthetic value — not considered
- Value for natural connections value — not considered
- Value for landscape value — not considered
- Life cycle assessment duration of 80 years

SECTION 10

GLOSSARY

City Operations:	Operations over which the City of Edmonton's City Manager has direct managerial control (<i>but excludes Edmonton Transit as per requirements of the ICLEI Protocol</i>).
Greenhouse gas (GHG)	Includes gaseous emissions of carbon dioxide (CO ₂), nitrous oxide (N ₂ O) and methane (CH ₄).
GHG Inventory	The annual amount of GHG emissions from City Operations summarized by source of emission.
GHG Inventory Model for City Operations	An excel spreadsheet based model that is used by the Office of Environment to convert energy inputs defined for the various branches within City Operations into GHG emissions volumes. The model is located "G:\Office of Environment\Policy Leadership\Greenhouse Gas\GHGAnnualReports\Update 1990-20xx\City Operations\MasterRecords"
ICLEI Protocol:	A protocol developed by the Local Governments for Sustainability Organization (ICLEI) to harmonize GHG reporting measures for municipalities.
Municipal Fleet	Includes all vehicles within City operations other than those serving the needs of Edmonton Transit, Police and EPCOR.
Parks Net Present Value Model	A model used by Office of Environment to forecast the greenhouse gas emissions and related cost for the future expansion of the urban forest in Edmonton. This model can be found in "G:\Office of Environment\Policy Leadership\Greenhouse Gas\GHGManStrategyCityOps\StrategyScenarios\Forecasts\Parks\NPVParksTrees.xls"
Green Purchase	These are used to reduce the GHG emissions inventory. Renewable energy with lower ghg emissions per kWh of consumption compared to coal fired generated electricity, an0064 offset credits are examples of green purchases.
Offset/credit	A carbon offset is a reduction in emissions of greenhouse gasses made in order to compensate for, or to offset an emission made elsewhere. The offset is purchased, the credit is sold.
TCO_{2e}	Tonne of carbon dioxide equivalent. The global warming potential of carbon dioxide in the atmosphere is valued at "one", that for methane is "21," meaning that a molecule of methane is 21 times more effective at heating the atmosphere than is a carbon dioxide molecule or in other words, one tonne of methane released into the atmosphere would be the equivalent of releasing 21 tonnes of CO ₂ . The volume of greenhouse gas emissions from a release of gasses with different global warming factors can therefore be calculated using these global warming factors to generate a result quoting the equivalent release in tonnes of CO ₂ added to the atmosphere, in essence "normalizing" to the carbon dioxide value. Hence the "equivalent" moniker.
Business-as-Usual	Continuing to operate without consideration for implementing changes to achieve a specific goal.
Carbon Sink	A carbon sink is anything that absorbs more carbon than it releases. Typically, vegetation such as trees could qualify as a carbon sink.

