Durham Region Community Greenhouse Gas Emissions Inventory

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Prepared for:

Durham Region Roundtable on Climate Change

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Contents

1.0 Introduction

1.1 Background

In April 2008, the Region of Durham initiated a multi-stakeholder advisory committee called the Durham Region Roundtable on Climate Change ("the Roundtable") to address climate change challenges in the Region both through mitigation and adaptation. In May 2009, Durham Sustain Ability (DSA) was retained to provide a community baseline greenhouse gas (GHG) emissions inventory for the Region in conjunction with the work performed by Durham Region in completing a baseline inventory for municipal operations.

1.2 Climate Change – Local Actions in a Global Context

Greenhouse gas concentrations in the atmosphere (the most common of which include carbon dioxide CO_2, methane CH_4, and nitrous oxide N_2O) have been increasing significantly over the past 150 years contributing to tangible global climate change effects. This is mainly caused by human activity: primarily burning fossil fuels as well as creating landfill waste methane and removing carbon sinks such as deforestation and agricultural practices.

An excellent summary paper outlining the current climate change science, GHG emission reduction targets and current/proposed strategies to meet those targets on the international, national and provincial/state levels along with comments and conclusions was endorsed by Regional Council in September 2009. The document can be found at http://www.durhamclimatechange.ca/report2009-J-37.htm

Climate change is a global issue requiring local action, mainly in the areas of responsible energy consumption and shifting to renewable energy sources. In Canada, FCM and the International Council for Local Environmental Initiatives (ICLEI) have developed a framework for reducing greenhouse gas (GHG) emissions for municipalities called Partners for Climate Protection (PCP). Currently, 188 Canadian municipalities have registered in the PCP program including Durham Region.

The PCP program consists of five milestones:

1. Conduct a baseline GHG emission inventory analysis for municipal operations and the community.
2. Establish GHG reduction targets for municipal operations and the community.
3. Develop a local action plan outlining actions that reduce GHG emissions and energy consumption for municipal operations and the community at large.
4. Establish a program to implement adopted actions that will reduce GHG emissions as outlined in the local action plan.

5. Establish a monitoring and reporting system to verify GHG reduction achievements. Revise the action plan periodically to reflect new ideas and strategies.

Milestone 1 will be deemed complete with the submission of this work (Community Inventory) along with the completed corporate inventory to the PCP program for approval.

1.3 Methodology

Establishing a GHG emissions inventory involves gathering data on fuel, energy and waste from all sectors comprising the community at large. This community data includes the municipal operations data gathered specifically for the corporation by Durham Region. Energy consumption data in the residential, industrial, commercial and institutional (IC&I), and transportation sectors are gathered along with waste generation and disposal information.

Early in the process, the major Durham energy providers of electricity and natural gas were gathered at a summit meeting in which they endorsed the program and participation in the energy data gathering as the start of a longer-term partnership. They were willing to become partners in subsequent stages of the program including participation in working teams addressing milestone 3 local action plan work.

The following energy providers supplied the energy data:

Residential, IC&I sector electricity usage and prices – Hydro One,, Oshawa PUC, Whitby Hydro, and Veridian
Residential, IC&I sector natural gas usage and prices – Enbridge

Transportation sector data was gathered from existing survey information for Durham residents based on annual average daily trips and kilometers driven. Durham Region provided waste generation and disposal data.

Once energy consumption and waste generation data were collected, appropriate emission coefficients can be applied for each source of energy and waste to landfill to calculate the resulting GHG emissions. Annual emissions are expressed in absolute terms and are not corrected for weather or population growth, however emissions are also expressed on a per capita basis for trend analysis.

The equivalent carbon dioxide coefficient (eCO2) for electricity is based on the annual average amount of fossil fuel (coal, natural gas, oil) used at Ontario's electricity power plants. Other sources such as hydropower, nuclear and renewable energy do not directly produce eCO2 emissions. As Ontario's electrical generation mix changes from year to year so does the eCO2 electricity coefficient. This means that the GHG emissions associated with electricity consumption in the Region can vary year to year even if there is no significant change in energy usage, in fact when a municipality reduces its energy consumption, its GHG emissions may even increase if the provincial fossil fuel mix

significantly increases. All municipalities participating in the PCP program use this GHG calculation methodology (PCP Protocol) in Canada and throughout the world.

2.0 Community Inventory, Trends and Forecast

2.1 Background

The community baseline year of 2007 was selected to coincide with the corporate inventory year. However, a number of cap-and-trade programs (e.g. Western Climate Initiative which Ontario has joined, US proposed program) use 2005 as the baseline year and Canada currently uses 2006 as a baseline (although this may change in order to harmonize with the US). In order to potentially harmonize with these various programs and to provide trend data, it was decided that inventories would be established for the years 2005, 2006, 2007 and 2008. A business-as-usual (BAU) forecast for the year 2020 will also be provided based on population and household forecasts and the absence of any further efforts to reduce GHG emissions.

The Kyoto protocol uses a baseline year of 1990, however energy data from 19 years ago is not readily available by municipality. Should the Roundtable require a 1990 baseline, one could be estimated by back-casting changes in population, however it is recommended that we await the next round of talks in Copenhagen in December 2009 to ascertain whether 1990 will retain its significance as a continuing baseline beyond Kyoto.

2.2 Community Summary

Durham is a high growth Region and in last four years the population has grown by 6% from 572,855 to 605,735 in 2008. The population is forecasted to grow by 36% to 809,990 by 2020.

Table 1: Summary of Energy Consumption, Energy Cost and eCO2 Emissions

	2005	2006	2007	2008	BAU 2020
Energy Use (GJ)	67,513,687	65,859,290	68,023,961	64,955,161	86,858,165
Per Capita Energy (GJ/capita)	117.9	112.8	114.0	107.2	107.2
Energy Costs ($'000)	$1,345,086	$1,347,304	$1,351,881	$1,402,145	$1,874,951
Per Capita Energy Cost ($/capita)	$2,348	$2,308	$2,266	$2,315	$2,315
eCO2 Emission (t)	3,983,719	3,736,961	3,843,472	3,689,898	4,934,139
Per Capita eCO2 (t/capita)	6.95	6.40	6.44	6.09	6.09

Table 1 summarizes the annual energy consumption, energy cost and eCO2 emissions on an absolute and per capita basis.

From 2005 to 2008, eCO2 emissions on an absolute basis have dropped by over 7% even though population has increased by 6%. Energy consumption has declined by 4%, however total energy costs have risen by 4%.

The business-as-usual forecast for 2020 assumes no further efforts to reduce energy consumption resulting in an estimated rise in GHG emissions of 28% from 3.7 million t to 4.9 million t.

The per capita eCO2 emissions provides additional trend analysis as it removes population as a variable and the per capita energy consumption provides further refinement as it removes the effect of annual changes in the provincial electricity eCO2 emission coefficient. From 2005 to 2008, the per capita eCO2 emissions has declined by 12% from 7.0 t/capita to 6.1 t/capita while the energy per capita has decreased by 9%, which shows that 3% of the improvement in per capita eCO2 emissions is due to the change in the electricity eCO2 coefficient.

Figure A: Absolute eCO2 Emissions by Sector and Per Capita Trend Line

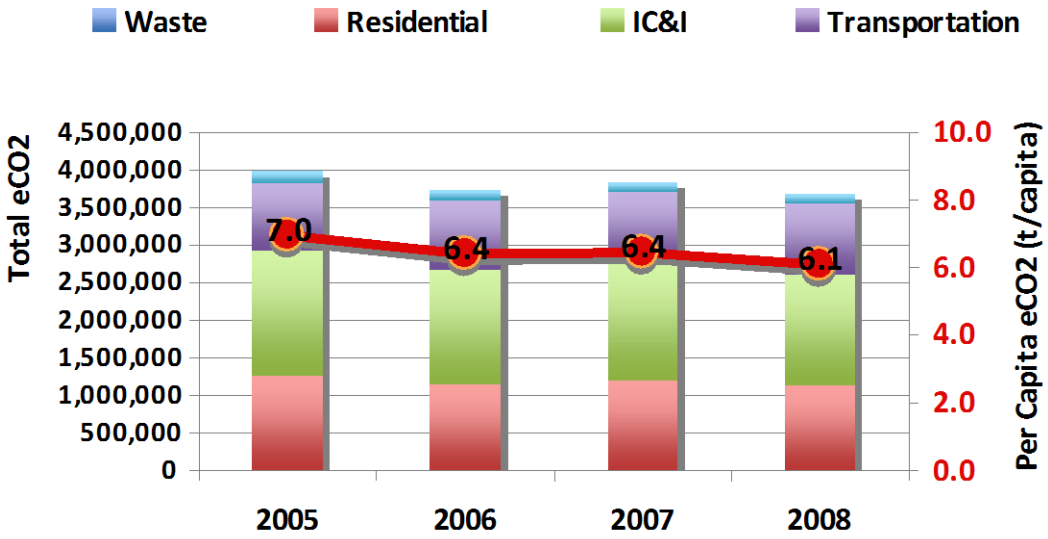


Figure A provides total GHG emissions by sector with the total per capita GHG emissions trend line over the four-year period. Section 2.4 will provide further discussion on each sector.

2.3 Inventory Baseline Year - 2007

In the baseline year of 2007, the community generated 3.74 million t of GHG emissions from energy consumption and waste disposal. On a per capita basis, this equates to 6.4 t per person. Refer to Figures B and C for a breakdown of energy consumption and GHG emissions by sector, respectively. The institutional, commercial and industrial (IC&I) sector is the largest consumer of energy and emitter of GHG emissions followed by the residential sector and vehicle transportation. The community produced 439,082 t of waste of which 36% was diverted from landfill. The landfill waste produced 135,447 t of GHG emissions, corresponding to 3.5% of the total community emissions.

Figure B: 2007 Energy Consumption By Sector

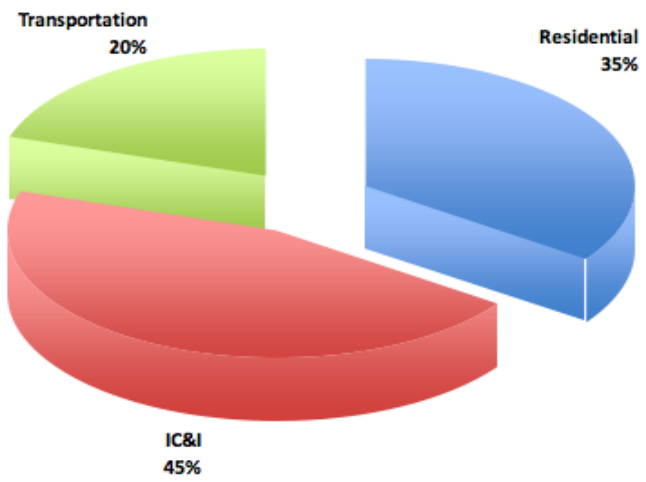
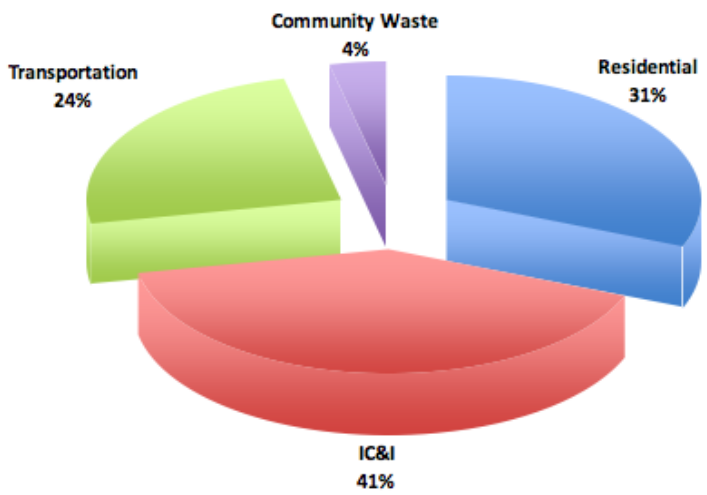


Figure C: 2007 eCO2 Emissions By Sector



Figures D, E, and F provide a breakdown of energy consumption, energy cost, and GHG emissions by source. Natural gas represents the largest source of energy consumption and

eCO2 emissions followed by electricity. Natural gas is almost half of all energy usage, however it represents only about one-quarter of the total energy costs. Electricity cost is much more significant at 40%, which indicates that electricity conservation has a much greater economic driver.

Figure D: 2007 Energy Consumption By Source

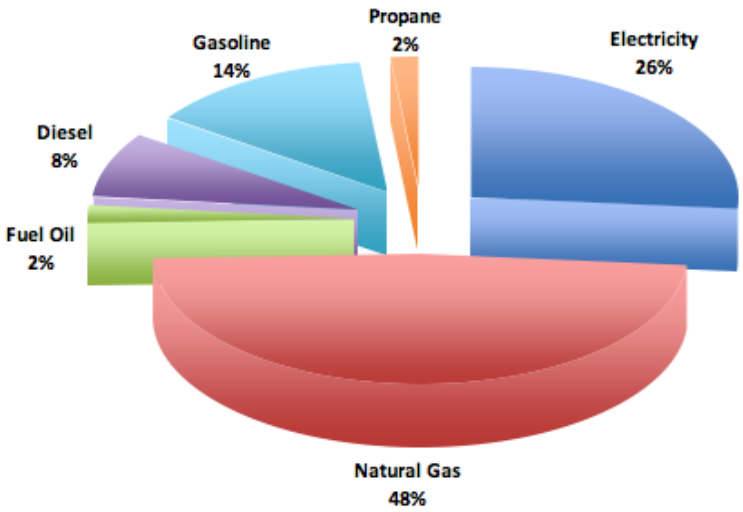


Figure E: 2007 Energy Cost By Source

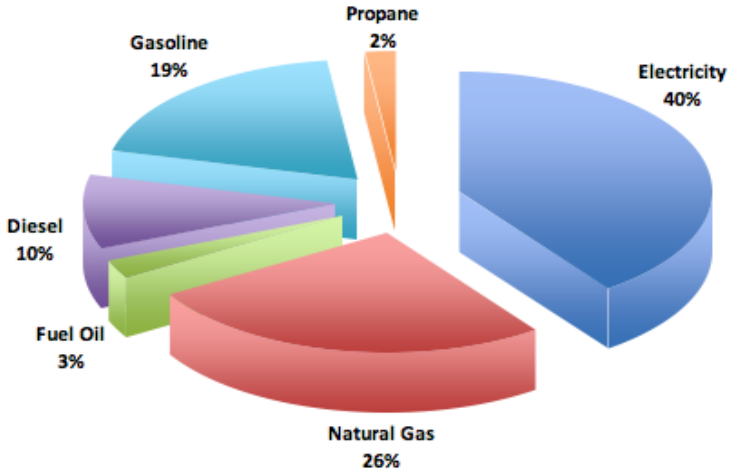
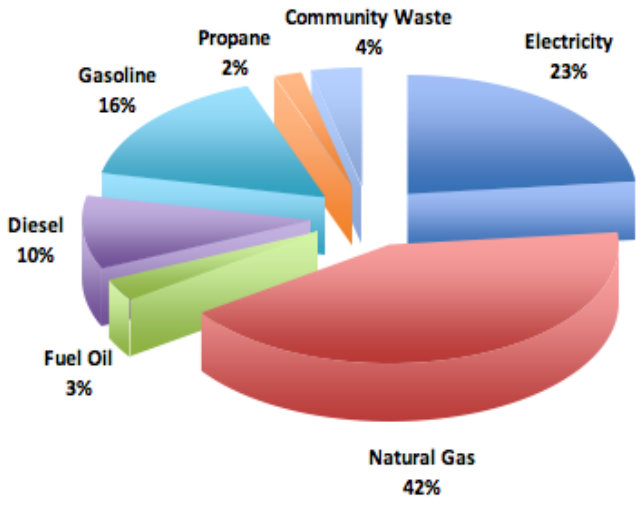


Figure F: 2007 eCO2 Emissions by Source



2.4 Trends and Forecast By Sector

2.4.1 Residential

The residential sector for purposes of this analysis comprises of single-family and semi-detached homes. Condominiums and apartments are generally on single meters and as such are regarded by the electricity local distribution companies (LDC's) as commercial accounts and cannot be readily segregated from other IC&I customers.

The residential sector accounted for 31% of total community GHG emissions in 2007. Table 2 shows the residential energy consumption, energy cost and eCO2 emissions on an absolute and per capita basis.

From 2005 to 2008, the population grew by 5.7% while the number of households increased by 7.3%. Despite the increase in population and households, the energy consumption has dropped by 5% and the eCO2 emissions have decreased by 10%. The difference between the two measures can be attributed to the change to the provincial electricity eCO2 coefficient from 2005 to 2006. The eCO2 coefficient for the year 2006 has also been used for the years 2007 and 2008 as it's currently the last published figure.

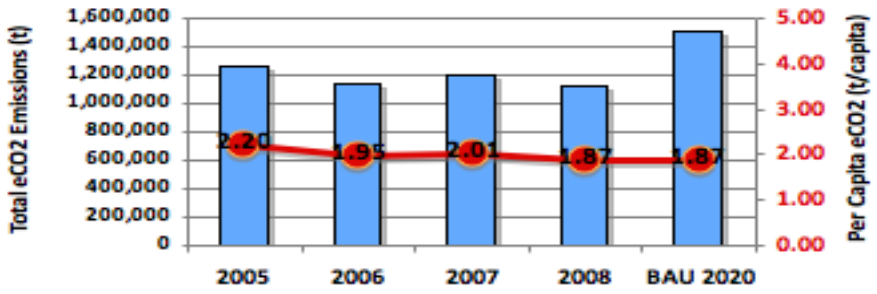
Changes in annual weather will also effect annual energy consumption and eCO2 emissions. Drops in per capita energy consumption from 2005 to 2006 and from 2007 to 2008 may be partially due to relatively warmer winters in 2006 and 2008 versus 2005 and 2007, respectively.

Table 2: Residential Energy Consumption, Energy Cost and eCO2 Emissions

Residential	2005	2006	2007	2008	BAU 2020
Energy Use (GJ)	23,563,906	22,445,437	23,669,431	22,379,934	29,926,490
Per Capita Energy (GJ/capita)	41.1	38.4	39.7	36.9	36.9
Energy Costs ($'000)	$448,109	$440,094	$437,343	$428,711	$573,273
Per Capita Energy Costs ($/capita)	$782	$754	$733	$708	$708
eCO2 Emissions (t)	1,257,474	1,138,437	1,196,784	1,130,366	1,511,528
Per Capita eCO2 (t/capita)	2.20	1.95	2.01	1.87	1.87

Figure F shows the residential eCO2 trends. The bars illustrate the trend on an absolute basis and line provides the trend on a per capita basis. The residential eCO2 emissions are forecasted to rise by 314,744 t or 26% from 2007 to 2020 if no further action is implemented.

Figure F: Residential eCO2 Emission Trends



2.4.2 Institutional, Commercial and Industrial (IC&I)

The IC&I sector comprises of institutions (government, schools, hospitals, churches, museums, and other public buildings), office buildings, retail establishments, and industrial facilities. It also includes apartments and condominiums for this analysis for reasons discussed in residential section 2.4.1.

This sector accounts for the largest portion of total community GHG emissions. In 2007, it generated 41% of emissions. Table 3 shows the IC&I energy consumption, energy cost and eCO2 emissions on an absolute and per capita basis.

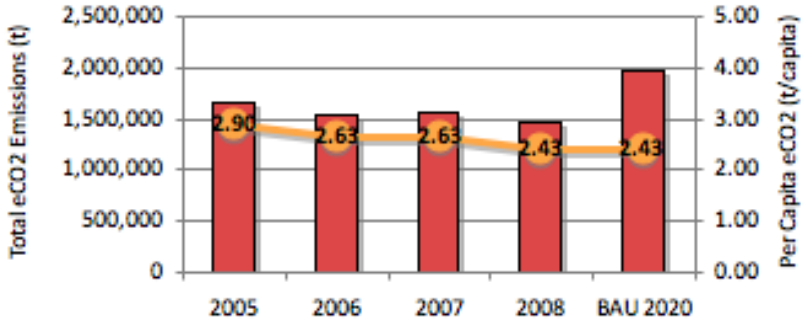
From 2005 to 2008, total energy consumption and eCO2 emissions declined by 7% and 16%, respectively. As in the residential sector, the difference between the two measures can be attributed to the change to the provincial electricity eCO2 coefficient from 2005 to 2006. The actual drop in energy consumption between 2005 and 2006 was 3%. The other major change occurred between 2007 and 2008 in which energy consumption and eCO2 emissions dropped by 7%. This may be partially or fully due to the effects of the recession starting in 2008 when some businesses started to reduce production and occupancy rates for commercial space declined, all of which effects energy consumption.

Table 3: IC&I Energy Consumption, Energy Cost and eCO2 Emissions

IC&I	2005	2006	2007	2008	BAU 2020
Energy Use (GJ)	30,862,479	30,060,132	30,706,653	28,719,770	38,404,131
Per Capita Energy (GJ/capita)	53.9	51.5	51.5	47.4	47.4
Energy Costs ($'000)	$569,559	$555,648	$543,891	$535,269	$715,763
Per Capita Energy Costs ($/capita)	$994	$952	$912	$884	$884
eCO2 Emissions (t)	1,662,351	1,535,814	1,571,383	1,469,005	1,964,356
Per Capita eCO2 (t/capita)	2.90	2.63	2.63	2.43	2.43

Figure G illustrates the IC&I eCO2 trends. The bars show the trend on an absolute basis and the line provides the trend on a per capita basis. It is assumed that this sector will grow relative to anticipated population growth. The IC&I eCO2 emissions are forecasted to rise from 939,859 t in 2007 to 1,275,896 t in 2020, an increase of 392,973 t corresponding to a 25% rise if no further action is implemented.

Figure G: IC&I eCO2 Emission Trends



2.4.3 Transportation

The transportation sector includes travel by all Durham residents in personal vehicles and public transportation vehicles, but not rail, marine or air transportation by residents as per PCP protocol. It also includes commercial vehicles used by Durham businesses and institutions based on provincial proxy data. The total vehicle kilometers traveled is then used to calculate fuel and emission data based on average fuel efficiencies for different classes of vehicles.

In 2007, transportation accounted for the third largest portion of total community GHG emissions generating 24% of emissions. Table 4 shows the transportation consumption, energy cost and eCO2 emissions on an absolute and per capita basis.

From 2005 to 2008, total transportation fuel consumption and eCO2 emissions increased by 6%. On a per capita basis, both energy and eCO2 emissions remained essentially constant showing the direct relationship between total vehicle kilometers traveled and population growth. Total energy costs in the transportation sector ballooned by 34% in four years much of which is attributable to the high fuel prices in the first three quarters of 2008.

Table 4: Transportation Energy Consumption, Energy Cost and eCO2 Emissions

Transportation	2005	2006	2007	2008	BAU 2020
Energy Use (GJ)	13,087,301	13,353,720	13,647,877	13,855,457	18,527,544
Per Capita Energy (GJ/capita)	22.8	22.9	22.9	22.9	22.9
Energy Costs ($'000)	$327,418	$351,562	$370,647	$438,165	$585,915
Per Capita Energy Costs ($/capita)	$572	$602	$621	$723	$723
eCO2 Emissions (t)	901,255	919,601	939,859	954,153	1,275,896
Per Capita eCO2 (t/capita)	1.57	1.58	1.58	1.58	1.58

Figure H shows the transportation eCO2 trends. The bars show the trend on an absolute basis and the line provides the trend on a per capita basis. It is assumed that this sector will grow relative to anticipated population growth as demonstrated by current trend relationships. The transportation eCO2 emissions are forecasted to rise by 392,973 t from 2007 to 2020, corresponding to a 36% rise if no further action is implemented.

Figure H: Transportation eCO2 Emission Trends

2.4.4 Waste

The community waste sector includes all waste collected by Durham Region from residents, institutions and businesses. It also includes waste collected by private companies from institutions and businesses except industrial waste and construction and demolition waste as very little of the organic portion of this waste ends up in municipal landfills and industrial landfill conditions do not foster decay. As little data is available on private collection, provincial proxy data was used to add to Durham Region records. GHG emissions in the waste sector are attributed to the anaerobic decomposition of organic waste sent to landfill. As most landfills have methane recovery, the credit for converting methane to CO2 and producing energy from it (50% of landfill gas is methane and methane has a global warming equivalent measure of 21 times that of CO2), is offset by the GHG emissions associated with transporting the waste to remote landfills, which is currently the case for Durham waste. Therefore, the net effect is the CO2 emissions from methane combustion.

In 2007, waste accounted for 3.5% of total community GHG emissions. Table 5 shows the waste tonnage to landfill and eCO2 emissions on an absolute and per capita basis.

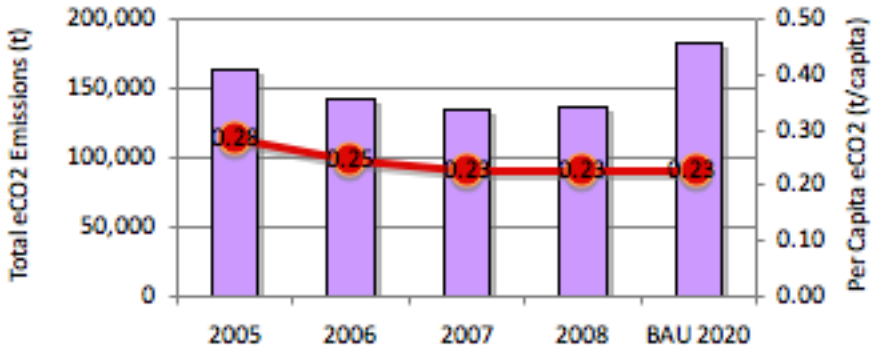
From 2005 to 2007, total waste to landfill and eCO2 emissions were reduced by 17% through successful diversion programs. However, it now appears to have flat-lined in 2008 on a per capita basis and has risen slightly on an absolute basis. The improvements in this sector are generally permanent systemic changes based on improvements in diversion rates. The question remains whether diversion rates can go to the next level in both the residential and institutional/commercial sectors.

Table 5: Waste to Landfill and eCO2 Emissions

Waste	2005	2006	2007	2008	BAU 2020
Waste to Landfill (t)	337,635	297,091	281,185	283,109	378,574
Per Capita Landfill Waste (t/capita)	0.59	0.51	0.47	0.47	0.47
eCO2 Emissions (t)	162,639	143,109	135,447	136,374	182,359
Per Capita eCO2 (t/capita)	0.28	0.25	0.23	0.23	0.23

Figure I shows the waste sector eCO2 trends. The bars show the trend on an absolute basis and line provides the trend on a per capita basis. It is assumed that waste will grow relative to anticipated population growth. The waste eCO2 emissions are forecasted to rise by 46,912 t from 2007 to 2020, corresponding to a 35% rise if no further action is implemented.

Figure I: Waste eCO2 Emission Trends



3.0 Recommendations

This report recommends that Durham Region and the Durham Region Roundtable on Climate Change should:

i) Proceed with PCP milestone 2 work in which GHG emissions targets are established for the community. The minimum target as recommended by PCP is a 6% absolute reduction over 10 years.

ii) As part of milestone 2, revisit criteria in determining the baseline year. It is recommended that 2005 be considered based on harmonization criteria with other programs and the results of this study.

iii) As part of milestone 2, review the concept of having more than one target with different timelines. Based on the science, 2015 is estimated to be a critical peak year and 2020 is a key target year for many programs.

iv) Establish a stakeholder and community engagement framework, scope of work, timeline and budget along with possible funding options for completing milestone 3 in which a comprehensive action plan is developed to achieve the reduction targets.

v) Engage all eight Durham municipalities as key partners in the above process (this work has already begun by DSA).

