Exhibit A
EITP-12-005

City of Kingston
Community Green House Gas Emission Inventory (2006 to 2009)

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December, 2011

Cover Page Photo Credit: Brock St. in downtown by Wayne Heibert

EXECUTIVE SUMMARY

Background and Methodology

In 2003, the City of Kingston engaged ICLEI Energy Services to complete a greenhouse gas (GHG) inventory for the Community of the City of Kingston for the base year of 2000. At that time City Council endorsed a GHG emission reduction target of 10% for the community by the year 2014 in comparison to the base year of 2000. In 2007, Ted Hsu provided a working paper for the Kingston Environmental Advisory Forum (KEAF) PCP working group titled *Trends in Kingston's Community Greenhouse Gas Emissions (2000-2006).* This document presents the City of Kingston Community GHG inventories for the years 2006 to 2009.

The methodology adopted for this inventory aligns with the FCM/ICLEI guidance document and the inventory is defined by the geopolitical boundary of the Municipality of the City of Kingston. In order to compare the 2006 to 2009 inventories to the base year (2000) inventory, the base year (2000) inventory was restated to ensure consistency in data sources, methodology and emission coefficients

Energy consumption and GHG emissions were compiled for 2000 and 2006 to 2009. Since energy expenditure data was not available for the base year (2000), expenditure data was only compiled for 2006 to 2009. Emission source analysis (electricity, natural gas, heating oil, diesel, propane and waste) and sector analysis (residential, industrial/commercial/institutional, transportation and waste) were conducted. Energy consumption and GHG emission comparisons are made to the base year (2000). Confounding factors (heating and cooling degree days, population growth, changes in the electricity emission coefficient and the economy) that may have an influence on energy consumption and GHG emissions were reviewed. The Kingston community energy consumption and GHG emissions were compared to benchmark communities London, Guelph and Oshawa.

Emission Source and Sector Overview

The Kingston Community GHG emissions are derived from the following sources: electricity, natural gas, fuel oil, diesel, gasoline, propane and waste. The following table provides the average contribution (2006 to 2009) of each of the emission sources to the overall average energy consumption, emissions and cost. On average (2006 to 2009), natural gas is the highest annual emission source for consumption and emissions and electricity is the highest annual emission source for energy expenditure.

Table 1: (2006 to 2009) Average Contribution of Each of the Emission Sources to the Overall Average Energy Consumption, Emission and Expenditure.

Emission Source	Consumption		Emissions		Expenditure	
	Average GJ	Average Percentage	Average CO2e(t)	Average Percentage	Average $Million	Average Percentage
Electricity	5,218,001	21%	261,056	19%	$164	33%
Natural Gas	12,108,220	49%	607,499	44%	$138	28%
Fuel Oil	514,021	2%	37,299	3%	$12	2%
Diesel	901,642	4%	63,637	5%	$23	5%
Gasoline	5,386,229	22%	366,748	27%	$148	30%
Propane	549,533	2%	32,933	2%	$14	3%
Waste	0	0%	13,636	1%	$0	0%
Total	24,677,645	100%	1,382,810	100%	$499	100%

The following table provides the average contribution (2006 to 2009) of each of the sectors to the overall energy consumption, emission and expenditure. The ICI sector is the highest consumer of energy, producer of emissions and has the highest overall energy expenditure.

Table 2: (2006 to 2009) Average Contribution of Each of the Sectors to the Overall Average Energy Consumption, Emission and Expenditure

Sector	Consumption		Emissions		Expenditure	
	Average GJ	Average Percentage	Average CO2e(t)	Average Percentage	Average $Million	Average Percentage
Residential	5,314,491	22%	277,781	20%	$130	26%
ICI	13,075,285	53%	661,007	48%	$198	40%
Transportaton	6,287,870	25%	430,385	31%	$172	34%
Community Waste	0	0%	13,636	1%	$0	0%
Total	24,677,645	100%	1,382,810	100%	$499	100%

Energy Consumption

Figure 1 provides the total Kingston community energy consumption (expressed as Giga Joules) from all sources (electricity, natural gas, heating fuel, gasoline, diesel and propane) for the base year 2000 and 2006 to 2009. The energy consumption (GJ) increased by approximately 16% between 2000 and 2009.

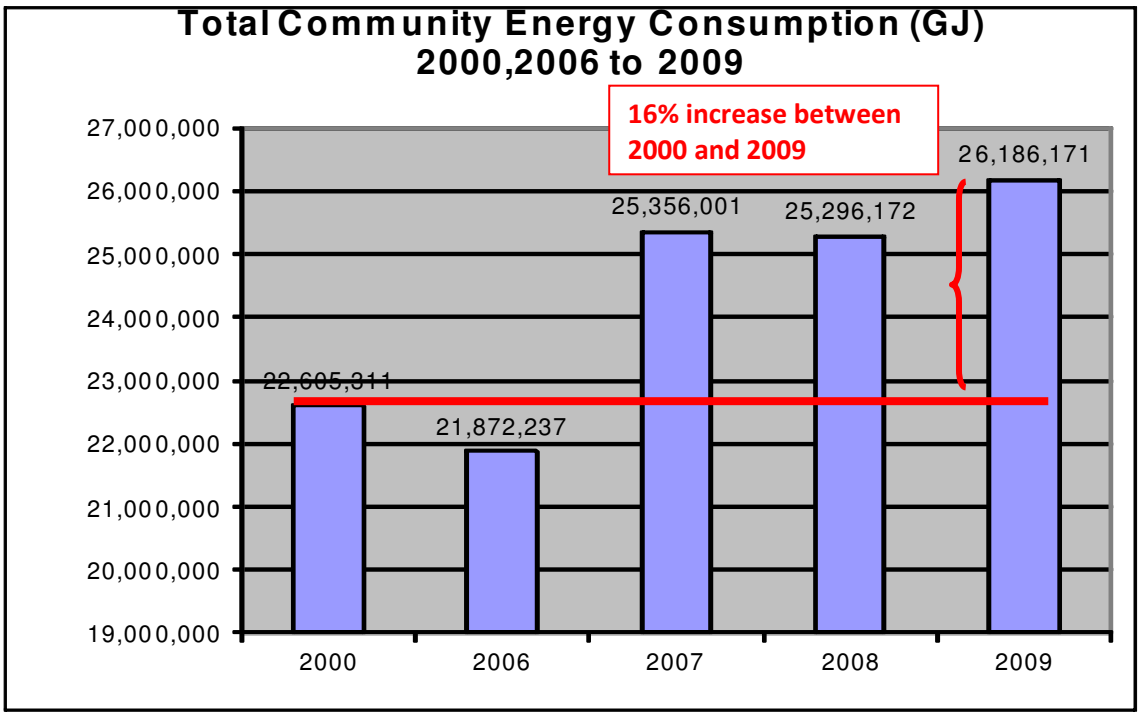


Figure 1: Total Community Energy Consumption (GJ) (2000 and 2006 to 2009)

The following figure provides a summary of the percentage difference in consumption for each of the emission sources between 2000 and 2009. The consumption of all emission sources with the exception of fuel oil increased during this time period.

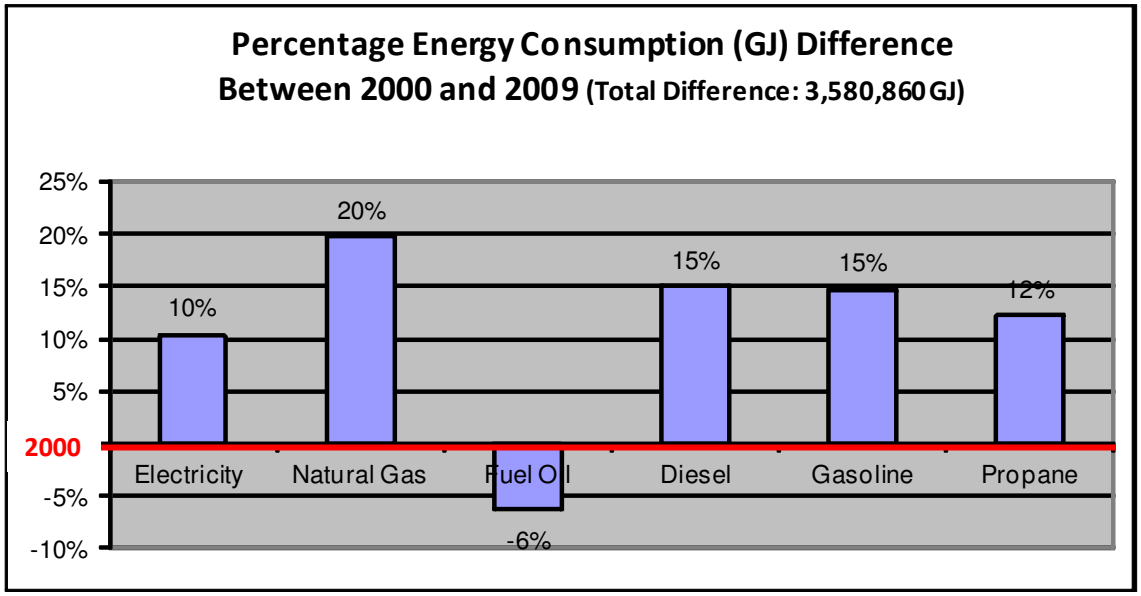


Figure 2: Percentage of Energy Consumption (GJ) Difference between 2000 and 2009 by Energy Source

Greenhouse Gas Emissions

Figure 3provides the total GHG emissions for 2000 and 2006 to 2009. Total GHG emissions increased by approximately 4.8% between 2000 and 2009. The significant dip in GHG emissions evident in 2006 compared to 2000 is in part due to an anomalously warm winter and cool summer and a significant reduction in the Ontario energy grid electricity emission factor. The total Heating Degree Days and Cooling Degree Days (HDD and CDD) was 11% less in 2006 than in 2000. For the years 2007 to 2009, the total number of HDD and CDD ranged between 3% and 4% less than 2000. Between 2000 and 2006, the electricity emission factor decreased by 36%. The electricity emission factor decreased by an additional 3% in 2008. The years 2007, 2008 and 2009 had comparable total green house gas emissions.

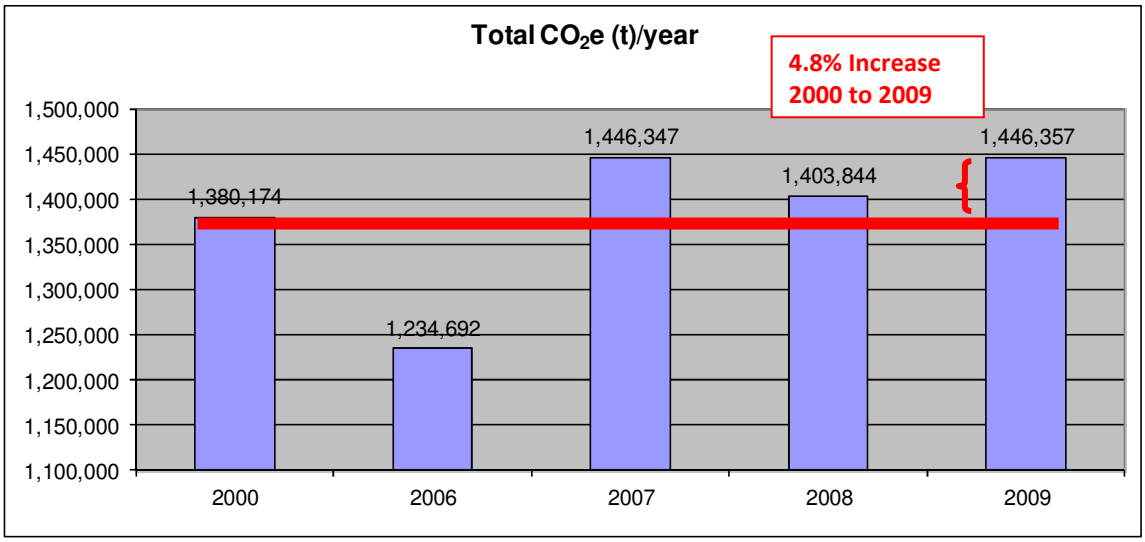


Figure 3: Total Community CO_2e (t)/year (2000 and 2006 to 2009)

Figure 4 indicates that the total Kingston community GHG emissions on a per capita basis reduced by approximately 0.65% between 2000 and 2009. It is estimated that the population grew approximately 5.45% between 2000 and 2009.

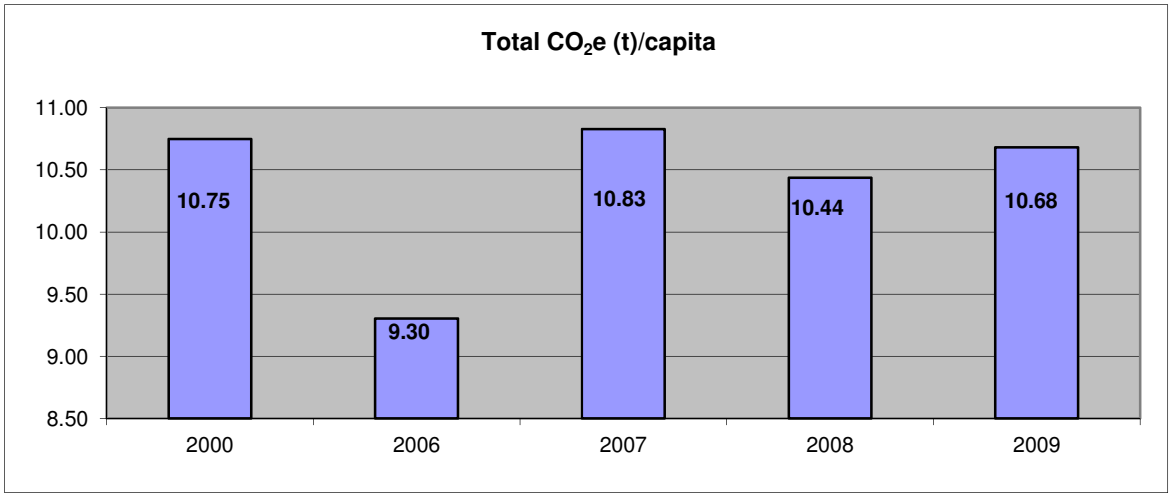


Figure 4: Total CO_2e (t)/capital for 2000 and 2006 to 2009

Figure 5 provides a summary of the percentage change of emissions derived from each of the emission sources between the base year (2000) and 2009. There was a significant decline (33%) in GHG emissions derived from electricity. This is in part due to the 39% reduction in the electricity emission factor resulting from improvements to the Ontario Energy mix.

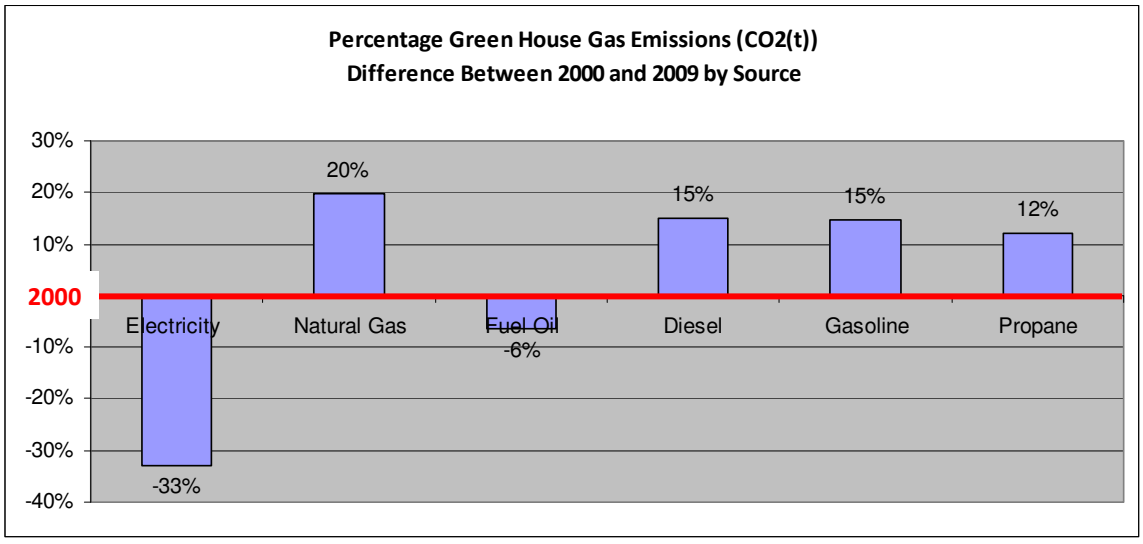


Figure 5: Percentage GHG emissions (CO2e (t)) Difference from 2000 to 2009 by Source

Energy Expenditures

Figure 6 provides the Kingston Community estimated annual energy expenditures from 2006 to 2009 and Figure 7 provides the breakdown of energy expenditures by emission source. The reduction in energy source expenditures between 2008 and 2009 is largely attributed to a reduction in gasoline costs.

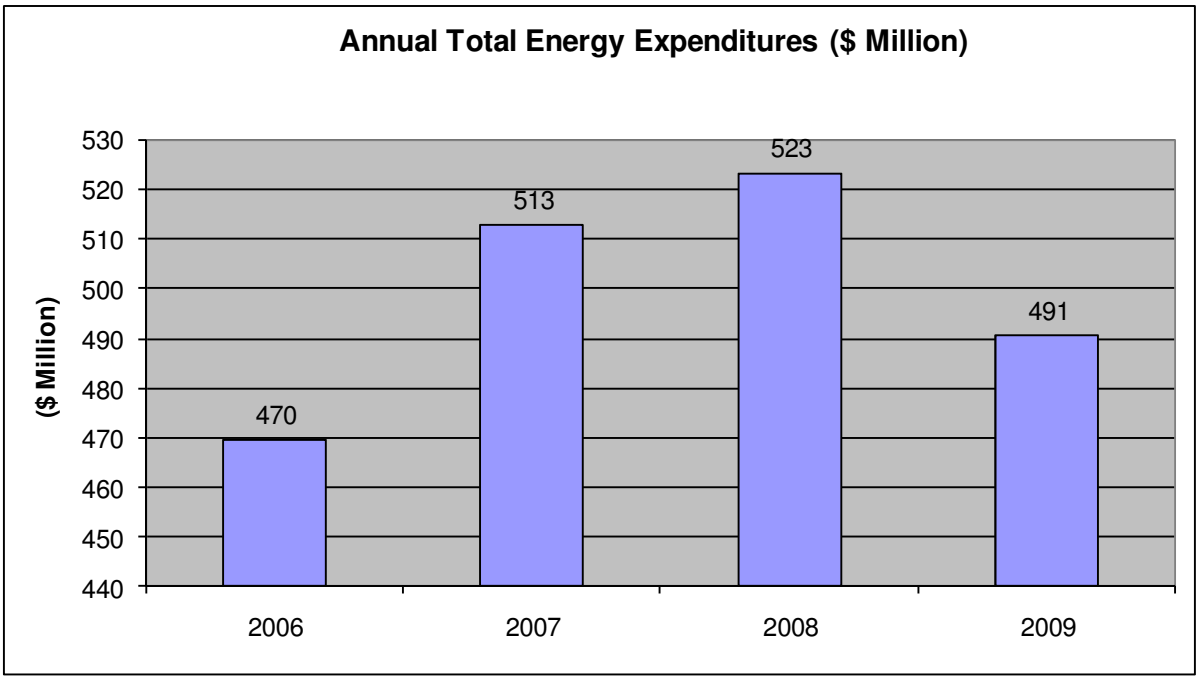
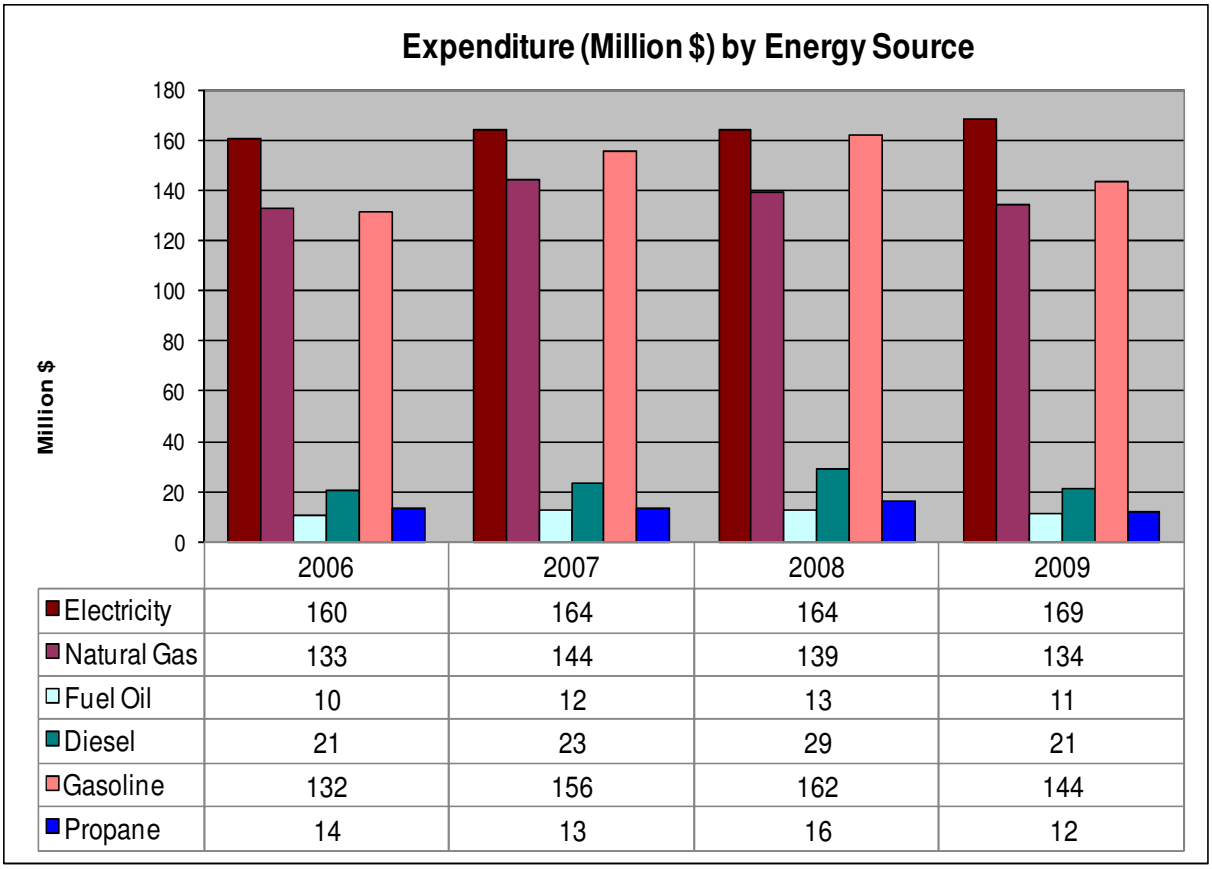


Figure 6: Annual Total Energy Expenditures ($Million) 2006 to 2009



	2006	2007	2008	2009
Electricity	160	164	164	169
Natural Gas	133	144	139	134
Fuel Oil	10	12	13	11
Diesel	21	23	29	21
Gasoline	132	156	162	144
Propane	14	13	16	12

Total	$470	$513	$523	$491

Figure 7: Distribution of Energy Cost by Emission Source (2006 to 2009)

Benchmarking

The Kingston community greenhouse gas emissions per capita were benchmarked against London, Oshawa and Guelph. The year with the most consistent data set was 2007. In 2007, where benchmark comparisons are possible, Kingston (at 10.8 CO_2e (t)/capita) was marginally below the benchmark community average of 10.9 CO_2e (t)/capita.

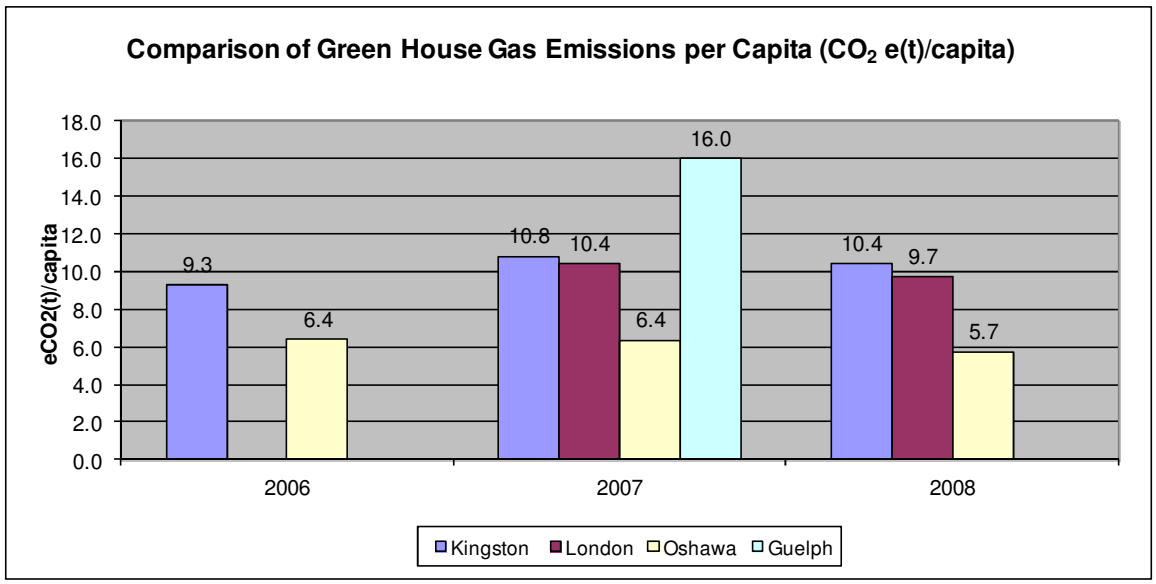


Figure 8: Community Comparison of GHG Emissions per Capita

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1.0 INTRODUCTION

Climate change is one of the defining issues of the 21st century. The legacy of today's organizations and communities will be determined by their leadership and ability to adapt and innovate. Through its membership in the FCM Partners in Climate Protection (PCP) program, the City of Kingston has joined approximately 200 Canadian Municipalities and over 600 global communities dedicated to the reduction of GHG emissions. The PCP program provides a five (5) milestone approach to reducing community GHG emissions:

- Milestone 1: Emission Inventory and Forecast
- Milestone 2: Reduction Target
- Milestone 3: Develop a Local Action Plan
- Milestone 4: Implement the Local Action Plan
- Milestone 5: Measure Progress and Report Results

In 2003, the City of Kingston engaged ICLEI Energy Services to complete a GHG inventory for the Community of the City of Kingston for the base year of 2000. Council endorsed a GHG emission reduction target of 10% for the community by the year 2014 in comparison to the base year of 2000. In 2007, Ted Hsu provided a working paper for the Kingston Environmental Advisory Forum (KEAF) PCP working group titled *Trends in Kingston's Community Greenhouse Gas Emissions (2000-2006).* In 2010, the importance of Climate Change was recognized within the *Sustainable Kingston Plan* Environmental Pillar under Environmental Responsibility Theme EN1: Energy, Air and Climate Change.

This document presents the City of Kingston Community GHG inventories for the years 2006 to 2009. A review of the protocol and boundary applied to this inventory is discussed and the inventory methodology is detailed to allow for consistency to past inventories and subsequent inventories. Energy consumption, GHG emissions and energy cost data is provided for 2006 to 2009. Analyses are provided of the emission sources (electricity, natural gas, heating oil, diesel, propane and waste) and energy sectors (residential, industrial/commercial/institutional (ICI) and transportation). Energy consumption and GHG emission comparisons are made to the base year (2000). Confounding factors that may have an influence on energy consumption and GHG emissions are reviewed. The Kingston community energy consumption and GHG emissions are compared to benchmark communities.

The objectives of the Kingston Community GHG inventory (2006 to 2009) are to:

- Develop credible Corporate and Community GHG Inventories for the years 2006 to 2009;
- Develop a GHG Inventory Tool for both the Corporate and the Community GHG Inventories to enable the City of Kingston to easily update the inventories in the future;
- Provide a discussion and analysis of confounding factors (e.g. weather and regional economic trends) that influence annual energy consumption for the Community GHG inventory; and
- Provide an assessment of per capita energy intensity with benchmarking to at least three other similar single tier municipalities. for the Community GHG inventories

2.0 INVENTORY PROTOCOL, BOUNDARY & SCOPE

2.1 PROTOCOL

To determine the most appropriate boundary and protocol for the City of Kingston Community Inventory (2006 to 2009) the following documents were reviewed:

- Developing Inventories for Greenhouse Gas Emissions and Energy Consumption: A Guidance Document for Partners for Climate Protection in Canada. ICLEI and FCM.
- International Local Government GHG Emissions Analysis Protocol (IEAP) Version 1.0 (October, 2009)
- Local Government Operations Protocol – For the Quantification and Reporting of Greenhouse Gas Emissions Inventories – Version 1.0 (September, 2008). Developed in Partnership by: California Air Resources Board, California Climate Action Registry, ICLEI and The Climate Registry
- ISO/PDTR 14069 – Working Draft 2 – Version 2010-09-28
  Greenhouse Gases – Quantification and Reporting of GHG Emissions for Organizations – Guidance for the Application of ISO 14064-1.

The previous GHG emission inventory reports, *City of Kingston: Corporate Emissions Inventory [ICLEI - Sept. 11, 2003], City of Kingston: Community Emissions Inventory [ICLEI – Sept. 11, 2003] and Trends in Kingston's Community Greenhouse Gas Emissions (2000-2006) [Ted Hsu, Nov. 23, 2007*] were also reviewed.

Having completed a review of relevant protocols, we recommended that the City of Kingston apply the Guidance Document for PCP in Canada (FCM/ICLEI) as the protocol for the Community GHG inventory (2006 to 2009). This recommendation was based on the following:

- This guidance document was developed for PCP member organizations and communities and the City of Kingston has been a PCP member since 2001, and it
- Allows for meaningful GHG emission comparisons between the City of Kingston and other Canadian municipal PCP organizations and communities;

The baseline (2000) inventory (ICLEI, 2003) was based on the FCM/ICLEI guidance document.

The sectors to be reported in Milestone One for the Community are summarized in Table 1.

Table 1: PCP Milestone 1 - Community Sectors
Residential
Commercial
Industrial
Transportation
Waste

The ICLEI (2009) Protocol, ISO draft protocol and the Local Government Operations (2008) protocols include land use and agriculture sources of GHG emissions. The recommended FCM/ICLEI guidance document does not include these sources of GHG emissions. These sources were not considered within the previously completed baseline inventories and they are not addressed within the current 2006 to 2009 GHG Corporate Inventory.

2.2 BOUNDARY CONDITIONS

The City of Kingston Community GHG Inventory (2006 to 2009) adopts a geopolitical boundary for determining what is to be included within the inventory. All GHG emissions associated with activities occurring within the City of Kingston's geopolitical boundary (i.e. the Municipality of the City of Kingston) are to be included.

2.3 SCOPE

Community greenhouse gas emissions were categorized into the following three (3) scopes.

Scope 1: Direct Emissions

Direct emissions are emissions from sources within the City of Kingston's geopolitical boundary.

1. Stationary Combustion: Combustion that produces electricity, steam heat or power using equipment in a fixed location.
2. Mobile Combustion: Combustion of fuels associated with transportation.
3. Process Emissions: Emissions from physical or chemical processing other than fuel combustion.
4. Fugitive Emissions: Emissions that are not physically controlled but result from intentional or unintentional releases.

Scope 2: Indirect Emissions

Scope 2 is a specific category of indirect emissions associated with the consumption of purchased or acquired electricity, steam, heating or cooling. These emissions result from activities that take place within the geopolitical boundary but the source of the emissions (i.e. electricity power plant) may be outside of the geopolitical boundary.

Scope 3: Other Indirect Emissions

Scope 3 includes all other indirect emissions not covered in Scope 2, such as emissions resulting from the extraction and production of purchased materials and fuels.

Table 2 provides a review of the protocol and boundaries of the past inventories and compares them to the current (2006 to 2009) inventory.

Table 2: City of Kingston Community GHG Inventory Review - Past and Present Protocol Boundary/Activity Comparison and Review							
		Protocol/Guidelines			Previous Inventories		
Activity Area	Scope	ICLEI Protocol	FCM -PCP ICLEI Guideline	Draft ISO Protocol	Kingston ICLEI (2003) Yr: 2000	Kingston Hsu (2006) Yr: 2000 to 2006	2006 to 2009 Inventory
Energy							
Stationary	S1: Utility deliverd fuel consumption	√	No		N/A	N/A	Utilities are not genrators. Utilities are distributers. Not relevant to the the Kingston Inventory
	S1: Decentalized fuel consumption	√	√	√ Draft ISO identifies stationary emissions from: residential commercial and industrial No break-down provided	√	√	Included withing inventory - propane natural gas, and heating fuel.
	S2: Utility-consumed fuel for electricity and heat generation	√	√		N/A	N/A	Utilities are not generators. Utilities Utilities are distributers. Not relevant to the Kingston inventory.
	S2: Utility-delivered electricy/heat/ steam cooling consumption	√	No		N/A	N/A	Utilities are not generators. Utilities are distributers. Not relevant to the Kingsotn inventory
	S2: Decentralized electricy/heat/steam consumption	√	√		√	√	Included within inventory. Emissions from electricity.
	S3: Up and Down Stream emissions	√	No		No	No	Not included in Kingston inventory.
Transport	S1: Tailpipe from on-road vehicles	√	√	√	√	√	Included within the Kingston Inventory.
	S1: Tailpipe from rail, sea, airborne and non-road vehicles operating in comm.	√	No Exclusion Protocol provided		No	No	Not considered within Kingson Inventory
	S2: Electricity assoc. with vehicles in community (lightrail)	√	Considered insignificant		N/A	N/A	No lightrail in Kingston. Not relevant to the Kingston inventory.
Fugitive Emissions	S1: Fugitive emissions not already accounted for	√	No	√	No	No	Not inlcuded within the Kingston inventory.
	S3: Up and Down Emissions	√			No	No	Not included within the Kingston Inventory.
Industrial Processes							
	S1: Decentalized process emissions	√	Option to include or not. Record in inventory.	√ No break-down	No	No	Not included within the Kingston Inventory.
	S3: Up and Down Stream emissions	√			No		Not included within the Kingston Inventory.
Agriculture							
	S1: Emissions from livestock and soils.	√	No	√ No break-provided	No	No	Not included within the Kingston Inventory.
	S3: Up and Down stream emissions from fertilizer/pesticide manufacture	√			No	No	Not included within the Kingston Inventory.

Table 2: City of Kingston Community GHG Inventory Review - Past and Present Boundary/Activity Comparison and Review							
		Protocol/Guidelines			Previous Inventories		
Activity Area	**Scope**	**ICLEI Protocol**	**FCM -PCP ICLEI Guideline**	**Draft ISO Protocol**	**Kingston ICLEI (2003) Yr: 2000**	**Kingston Hsu (2006) Yr: 2000 to 2006**	**2006 to 2009 Inventory**
Land Use, Land Change and Forestry							
	S1: Net bigenic carbon flux	√	No	√ No break down	No	No	Not included in the Kingston Inventory.
Waste							
Solid Waste Disposal	S1: Direct Emissions from landfill, compost and incineration facilities within comm.	√	Includes all solid waste regardless of location of landfill. Excludes industrial construction wastes.	√ No break down provided	√	√ Total estimate provided	Included in the Kingston Inventory.
	S3: Landfill, incineration and compost emissions in present year from waste produced in community.	√					Included in the Kingsotn Inventory.
Waste Water Treatment and Discharge	S1: Direct Emissions from wastewater facilities located in community.	√	No Details of emissions captured in corporate.		√ See Note	No	Includes methane and nitrous oxides. Emissions associated with WWTP are detailed within the corporate report.
	S3: Present-yr emissions from wastewater produced to date inside the community. Future emissions from treated water.	√			N/A	N/A	Annual emissions will be captured in S1.

Protocols:
ICLEI Protocol: International Local Government GHG Emissions Analysis Protocol (IEAP) - Version 1.0 (October, 2009)
ICLE/FCM: Partners for Climate Protection - Developing Inventories for GHG Emissions and Energy Consumption - A Guidance Document for Partners in Climate Protection in Canada.
ISO Draft Protocol: ISO/PDTR 14069 - Working Draft 2 - Version 2010-09-08 - Quantificaiton and Reporting of GHG Emissions for Organizations.

3.0 DATA SOURCES AND METHODOLOGY

For the development of both the corporate and community GHG inventory, the following five (5) principles for the accounting and reporting of GHG emissions common to the WRI/WBCSD GHG Protocol, ISO 14064 GHG Accounting Standards and the IEAP were applied:

Relevance: The GHG inventory shall appropriately reflect the GHG emissions of the community within is geopolitical boundary.

Completeness: All GHG emissions sources and activities within the chosen inventory boundary shall be accounted for. Any specific exclusion will be disclosed.

Consistency: Consistent methodologies to allow for meaningful comparisons of emissions over time shall be used. Any changes to the data, inventory boundary, methods, or any relevant factors in the time series, shall be disclosed.

Transparency: All relevant issues shall be addressed in a factual and coherent manner to provide a clear audit trail, should auditing be required. Any relevant assumptions shall be disclosed and include appropriate reference to the accounting calculation methodologies and data sources used, which may include the relevant Protocol and any relevant supplements.

Accuracy: The quantification of GHG emissions should not be systematically over or under the actual emissions. Accuracy should be sufficient to enable intended users to make decisions with reasonable assurance as to the integrity of the reported information.

The following table provides a summary of the Emission Source, Data Source, Data Confidence and Data Assumptions and Limitations. To understand, the impact of the data confidence on the overall estimate of green house gas emissions the percentage of emissions from each emission source for 2009 is provided.

The data source, quality, limitations and assumptions are provided in Table 3.

Table 3: Summary of Energy Data Sources and Quality					
Energy Source	**Data Source**	**Description**	**Data Quality**	**% of 2009 eCO2 (t)**	**Limitations and Assumptions**
Electricity	**Utilities Kingston**	Provides electricity to the central part of Kingston. Consumption and cost data provided for the residential and ICI sectors for the years 2006 to 2009.	High	16%	Based on current method of customer ID it is not possible subdivide the ICI group into its individual sectors.
	Hydro One	Provides electricity to the non-central part of Kingston (i.e. former townships). Consumption and cost data provided for residential, farm and general subgroups for 2006 to 2009.	High		Based on current method of customer ID, it is not possible to subdivide the ICI group into its individual sectors. The farm and general groups were added to form the ICI sector.
Natural Gas	**Utilities Kingston**	Provides Natural Gas to the central part of Kingston. Consumpiton and cost data provided for the residential and non-residential sectors for the years 2006 to 2009.	High	47%	Based on current method of customer ID it is not possible to break out the commercial and industrial sectors.
	Union Gas	Provides Natural Gas to the non-central part of Kingston. Consumption data provided for the residential, commercial and industrial sectors. Average cost data applied.	High for m3 Med for $		Although, data is provided for the residential, industrial and commercial sectors it is presented within the report as residential and ICI to enable consistency between the Utilities Kingston data and the Union Gas data.
Heating Oil	**Major Supplier**	Provided sales (consumption and cost) data as well as an estimate of their percentage of the total Kingston market share.	Low - Med	3%	Estimate is based on the assumption of the Kingston Market Share distribution.
Gasoline	**Kent Marketing Services**	KMS provided the total retail sale of gasoline (consumption and cost) by year.	High	26%	This data set would not capture scenerios where a facility has gas delivered to a tank on-site. This is estimated to be a marginal contribution.

Table 3 continued: Summary of Data Sources and Quality					
Energy Source	**Data Source**	**Description**	**Data Quality**	**% of 2009 Emissions**	**Limitations and Assumptions**
Diesel	**Kent Marketing Services; Stats. Can Vehicle Survey**	KMS data and data from the Statistics Canada Annual Vehicle Survey was used to estimate the total consumption of diesel in Kingston. Cost data provided by KMS was applied.	Low-Med	5%	The KMS data set does not capture the commerical card lock consumption of data. A ratio for diesel to gas use was determined using the Stats. Canada Vehicle Survey. Using this ratio and the gasoline data from KSM an estimate of the consumption of diesel was made. Cost data from KMS was applied.
Propane	**Major Supplier**	Provided an estimate of the growth of the Propane market in Kingston from 2006 to 2009. Average Ontario Propane rates were applied.	Low-Med	2%	Data is not based on actual sales (consumption and cost) data. Using the estimated growth rate from 2006 the data for 2007 to 2009 was estimated.
Waste	**City of Kingston; WSI**	City of Kingston provided tonnage of waste that was received by the Kingston East Landfill and the WM Transfer Station for 2006 to 2009. WSI provided tonnage received for 2006 to 2009. WSI provided an estimate of organic content.	Low-Med	1%	Based on the data provided an estimate of the tonnage of organic waste was estimated .

Data Quality Legend:

- High: Bottom-up activity level data from established and reliable data collection systems.
- Medium: A mix of bottom-up activity level data from established and reliable or ad hoc data collection systems with some assumptions about activity levels.
- Low: Based mainly on assumptions about activity levels.

3.1 ELECTRICITY

The distribution of Electricity within the Municipality of Kingston is provided by Utilities Kingston and Hydro One. Utilities Kingston services the central part of the City and the remainder of the municipality is serviced by Hydro One.

A. Utilities Kingston Data:

Utilities Kingston provided aggregated consumption and cost data for the years 2006 to 2009 for the following customer classes: GS>50, GS<50, Large Use Electric, Street Lighting and Residential. The current method of customer class identification does not allow for separation of commercial and industrial. Therefore, the non-residential classes were combined to form the ICI sector.

B. Hydro One Data:

Hydro One provided aggregated consumption and cost data for the years 2006 to 2009 for the following customer classes: Farm, General and Residential. Farm and General consumption cost and consumption data was aggregated as the ICI sector.

The National Inventory Report (NIR) – Environment Canada (1990-2008) electricity GHG emission factor for Ontario was applied to the aggregated consumption data from Utilities Kingston and Hydro One to determine the GHG emissions from electricity. The electricity GHG emission factor varies from year to year with changes to the Ontario Generation Mix. The GHG emission factors applied are as follows:

- 2006: 0.180 kg CO_2e/kWh
- 2007: 0.200 kg CO_2e/kWh
- 2008: 0.170 kg CO_2e/kWh
- 2009: 0.170 kg CO_2e/kWh

The 2009 GHG emission factor had not yet been release so the factor for 2008 was applied. In the subsequent inventory, this emission factor should be modified to reflect the report factor in the National Inventory Report.

3.2 NATURAL GAS

The distribution of Natural Gas within the Municipality of Kingston is provided by Utilities Kingston and Union Gas. Utilities Kingston services the central part of the City and the remainder of the municipality is serviced by Union Gas.

A. Utilities Kingston Natural Gas Data:

Utilities Kingston provided consumption and cost data for the years 2006 to 2009 for two customer classes – residential and non-residential. The non-residential class includes all services outside of the residential sector including industrial, commercial, and institutional. The current method used by Utilities Kingston does not allow for the commercial, industrial and institutional sectors to be broken out.

Residential Data:

All cost components are included (commodity, distribution costs, transportation and storage). Commodity prices for those customers that have standard supply differ from those customers that are signed with a retailer. In the case of these customers Utilities Kingston assigned an average total cost of which the commodity cost is a component.

Non-Residential Data:

In general, Utilities Kingston does not identify commercial, industrial and institutional customers. The exception is for a group of industrial/institutional customers that are Direct Purchase with a retailer. It this case Utilities Kingston has the consumption data but not the cost data. Therefore, Utilities Kingston applied an estimate of cost based on their standard supply rate for the year. As in the Residential sector, the costs provided for the non-residential sector includes all cost components (commodity, distribution costs, transportation and storage).

B. Union Gas Natural Gas Data:

Union Gas provided 2007 to 2009 consumption data for the following sectors: residential, commercial and industrial sectors. To enable consistency between natural gas data sets the commercial and industrial sectors were combined as the ICI sector. Since consumption data for 2006 was not provided an estimate was made based on the average ratio of Union Gas consumption to Utilities Kingston consumption for the years 2007 to 2009. Union Gas was unable to provide rate data. Estimates for the cost of natural gas were made based on average annual rates available from the Union Gas website.

Residential Rates: https://www.uniongas.com/residential/rates/summary/index.asp

Commercial Rates: http://www.uniongas.com/business/rates/summary/

Cost data is provided for each of the four quarters (Jan, April, Jul and Oct). This cost estimate includes the cost of Gas Commodity Rate, Gas Price Adjustment, Transportation to Union Gas, Transportation Price Adjustment, Storage, Storage Price Adjustment, Delivery and Delivery Price Adjustment.

Consumption data and number of accounts is provided for commercial and industrial. The number of accounts for industrial is much less than for commercial but the consumption is much higher. Since a total cost for ICI is only available, a ratio of the consumption data was used to assign cost to each of the commercial and industrial sectors to enable some insight into the distribution of consumption and cost across these sectors.

The GHG emission factor for natural gas for Ontario (0.001891 tonnes CO_2e/m^3) from the NIR 1990-2008 (Annex 8) was applied to the aggregated consumption data provide by Utilities Kingston and Union Gas to determine GHG emissions from natural gas combustion.

3.3 HEATING OIL (FUEL OIL)

A major supplier provided their sales data (consumption and cost) as well as an estimate of their market share for 2006 to 2009. This allowed an estimate of the total market share (costs and consumption) for the Kingston community. The GHG emission factor for heating oil (fuel oil) from the NIR (1990-2008) Annex 8 of 0.00283 tonnes CO_2e/litre was applied to the estimate of heating oil consumption for the community to determine the GHG emissions from heating oil combustion.

3.4 PROPANE

A major supplier provided an estimate of market growth from 2006 to 2009. This estimate was applied to determine consumption and Ontario market rates were applied to estimate costs. The GHG emission factor for propane from the NIR 1990-2008 Annex 8 (0.00153 tonnes CO_2e /litre) was applied to the estimate of propane consumption for the community to determine the GHG emissions from propane combustion.

3.5 GASOLINE AND DIESEL (Transportation)

The same approach that was used within the *Trends in Kingston's Community Greenhouse Gas Emisions 2000-2006* (Hsu, 2007) to estimate gasoline and diesel consumption was applied in the 2006 to 2009 inventory. Annual data from 2006 to 2009 on retail sales of gasoline and diesel in the City of Kingston was purchased from Kent Marketing Services. It is estimated that this data set captures the majority of gasoline consumption for the community but is not able to capture the majority of diesel consumption within the commercial sector (cardlock). Therefore, to estimate the diesel consumed by the community the Annual Canadian Vehicle Survey was used to establish a diesel to gasoline ratio. This ratio was then used with the gasoline data from Kent Marketing Services to estimate the community consumption of diesel. The rate data provided by KMS was applied to determine the total amount spent on diesel within the community. Consistent with Hsu(2007) inventory, 85% of the consumption from tractor trailers was subtracted of the total diesel consumption to eliminate the impact of inter-urban highway trips outside of Kingston's geopolitical boundaries.

Table 4: Annual Canadian Gasoline and Diesel Fuel Consumption in Ml						
Year	Total Gasoline	Total Diesel	Diesel/Gas Ratio	Tractor Trailer Diesel	Net Diesel (not including Tractor Trailor Diesel)	Net Diesel/Gas Ratio
2006	31,111	10,075	0.324	6,367	4,663	0.150
2007	31,625	11,069	0.350	7,222	4,930	0.156
2008	30,312	10,674	0.352	6,876	4,829	0.159
2009	31,461	9,898	0.315	6,195	4,632	0.147
http://www.statcan.gc.ca/bsolc/olc-cel/olc-cel?catno=53-223-X&CHRO					Average	0.153

The GHG emission factors from the NRI (1990-2008) Annex 8 of 0.00273 tonnes CO_2e/litre and 0.00236 tonnes CO_2e/litre for diesel and gasoline (mobile combustion) were applied to determine the GHG emissions from gasoline and diesel combustion.

3.6 WASTE

The City of Kingston provided the tonnage of waste that was collected by the City as well as hauled by residents to the Kingston East Landfill and the Waste Management Transfer Station for 2006 to 2009. Waste Services Inc. (WSI) provided the tonnage of waste received for 2006 to 2009. WSI provided the tonnage of waste in each of the residential and ICI streams that was organic. A small portion of the overall organic waste collected by the City goes to the Kingston East Landfill which is a rural landfill without methane flaring. The remaining tonnage of waste generated by the City of Kingston goes to landfills where there is, at a minimum, methane flaring. It is the decomposition of organic waste in an anaerobic environment that produces methane. Methane has a global warming potential (GWP) 25 times that of CO_2. Methane flaring and waste recovery for energy transforms the methane into CO_2. Since in nature organics decompose aerobically and release CO2, this is not considered a man-made emission. Landfills with methane capture, flaring and energy recovery systems are not 100% efficient. Therefore, to be conservative an emission factor was applied to the organic waste component of the City of Kingston waste stream to generate a conservative estimate of GHG emissions from landfills. Emissions associated with the transfer of waste materials within the Kingston geopolitical boundaries are captured in the diesel and gasoline energy sources.

3.7 COMPARISON TO BASELINE DATA SOURCES AND METHODOLOGY

In order to make reasonable comparisons to the baseline year (2000), the data sources and methodology differences and impacts were reviewed and where necessary the 2000 baseline was restated. Table 5 provides a summary of a comparison between the emission factors and data sets used for each of the energy sources. The impact of any differences is provided.

Table 5: Differences in Inventory Data Sources/Methodology			
	Hsu (2007) Inventory 2000-2006	**Current Inventory 2006 to 2009**	**Impact**
Electricity			
Emission Factor	Derived from first principles based on the Ontario Energy mix for 2000-2006. Emission factor (tonnes CO2/kwh) of 0.000313 and 0.000224 for 2000 and 2006 respectively.	Derived from the National Inventory Report (1999-2008). Emission factor (tonnes CO2/kwh) of 0.000280 and 0.000218 for 2000 and 2006 respectively.	Restated the 2000 emissions using the 2000 Ontario electricity emission factor from the NIR (1999-2008). Restated the 2006 emissions using the 2006 Ontario electricity emission factor from the NIR (1999-2008) and actual consumption data from both Hydro One and Utilities Kingston.
Data Set	Consumption data was provided from Utilities Kingston but data was not available from Hydro One. Therefore, a relationship using HDD and CDD was used to estimate the missing data.	Used the 2000 consumption estimate provided by Hsu(2007). Consumption data was provided from both Utilities Kingston and Hydro One for 2006 to 2009.	
Natural Gas			
Emission Factor	Same Emission Factor Applied from National Inventory Reports for Ontario 0.00189 CO2(tonnes/m3)		No difference; No Impact.
Data Set	Consumption data was provided from Utilities Kingston for 2000 to 2006 and consumption data was provided from Union Gas for 2003 to 2006. HDD and CDD data was used to estimate 2000 to 2002 Union Gas consumption data. It was noted that the data set may not include consumption from large users.	Consumption data was provided from Utilities Kingston and Union Gas. A comparison of the consumption data for 2006 from the current data set and the Hsu(2007) data set was different by 40%. Therefore, it was assumed that some large users may not have been included in the Hsu(2007) data set. Based on the data for 2006 to 2009, a ratio of the contribution from Utilities Kingston and from Union Gas was determined (2.68). This relationship was used to restate the 2000 data.	The 2000 natural gas consumption data was restated using a ratio of 2.68 for Union Gas to Utilities Kingston annual consumption
Heating Oil (Fuel Oil)			
Emission Factor	Same Emission Factor Applied from the National Inventory Reports 0.00283 CO2(tonnes/litre)		No difference; No impact
Data Set	Same major supplier contacted for input on market growth.		2000 estimate - unchanged
Gasoline and Diesel			
Emission Factor	Same emission factors applied in both inventories: gasoline -0.00273 CO2(t/litre); diesel - 0.00236 CO2(t/litre)		No difference; No impact
Data Set	Same methodology and data sources were applied in both inventories		2000 estimate - unchanged
Propane			
Emission Factor	Same Emission Factor Applied from the National Inventory Reports		No difference; No impact
Data Set	Same major supplier contacted for input on market growth.		2000 estimate - unchanged
Waste			
Emission Factor Data Set	Not considered in inventory since it is such a small component and most waste goes to landfills with at least flaring.	Estimates were made for organic waste from the community and to be conservative the EF from ICLEI(2003) was applied.	Marginal impact since waste makes up only 1% of total emissions. Therefore, 2000 was not restated.

4.0 EMISSION SOURCE ANALYSIS

4.1 OVERVIEW

Emission sources for the Kingston Community greenhouse gas inventory include:

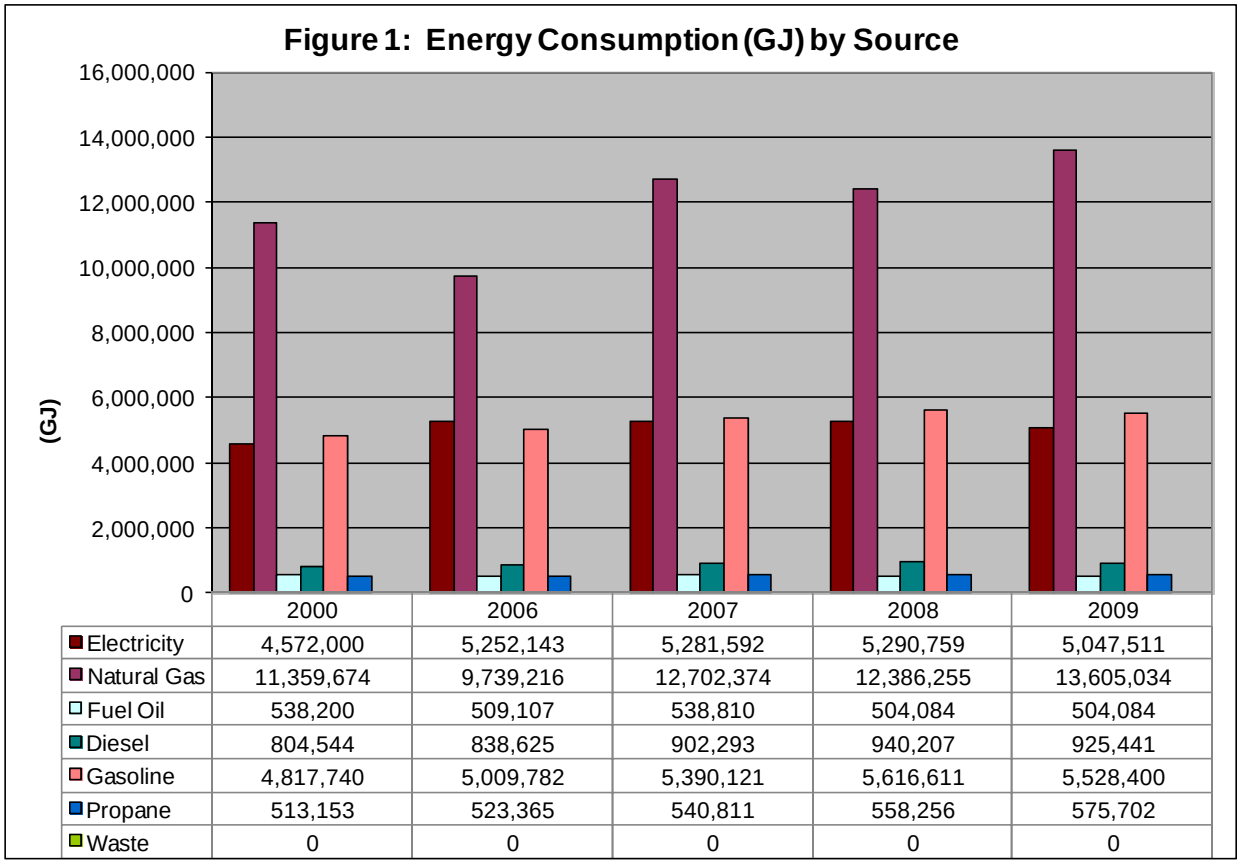
- Electricity,
- Natural gas,
- Fuel oil,
- Diesel,
- Gasoline,
- Propane and
- Waste.

To be able to compare the various types of emission sources the energy consumption (i.e. m3 natural gas, kWh electricity, liters of fuel etc.) has been converted to Giga Joules (GJ). The following table provides a summary of the Average Contribution of each of the emission sources to the overall average consumption, emissions and expenditures from 2006 to 2009. From this table it is evident that natural gas was the emission source with the highest average (2006 to 2009) consumption and emissions, while electricity was the emission source with the highest expenditure. On average Kingston Community annually consumed approximately 24,677,645 GJ of energy, released approximately 1,382,810 CO2e (t) at an expenditure of approximately $499 million.

Table 6: (2006 to 2009) Average Contribution of Each of the Emission Sources to the Overall Energy Consumption, Emissions and Expenditure

Emission Source	Consumption		Emissions		Expenditure	
	Average GJ	Average Percentage	Average CO2e(t)	Average Percentage	Average $Million	Average Percentage
Electricity	5,218,001	21%	261,056	19%	$164	33%
Natural Gas	12,108,220	49%	607,499	44%	$138	28%
Fuel Oil	514,021	2%	37,299	3%	$12	2%
Diesel	901,642	4%	63,637	5%	$23	5%
Gasoline	5,386,229	22%	366,748	27%	$148	30%
Propane	549,533	2%	32,933	2%	$14	3%
Waste	0	0%	13,636	1%	$0	0%
Total	24,677,645	100%	1,382,810	100%	$499	100%

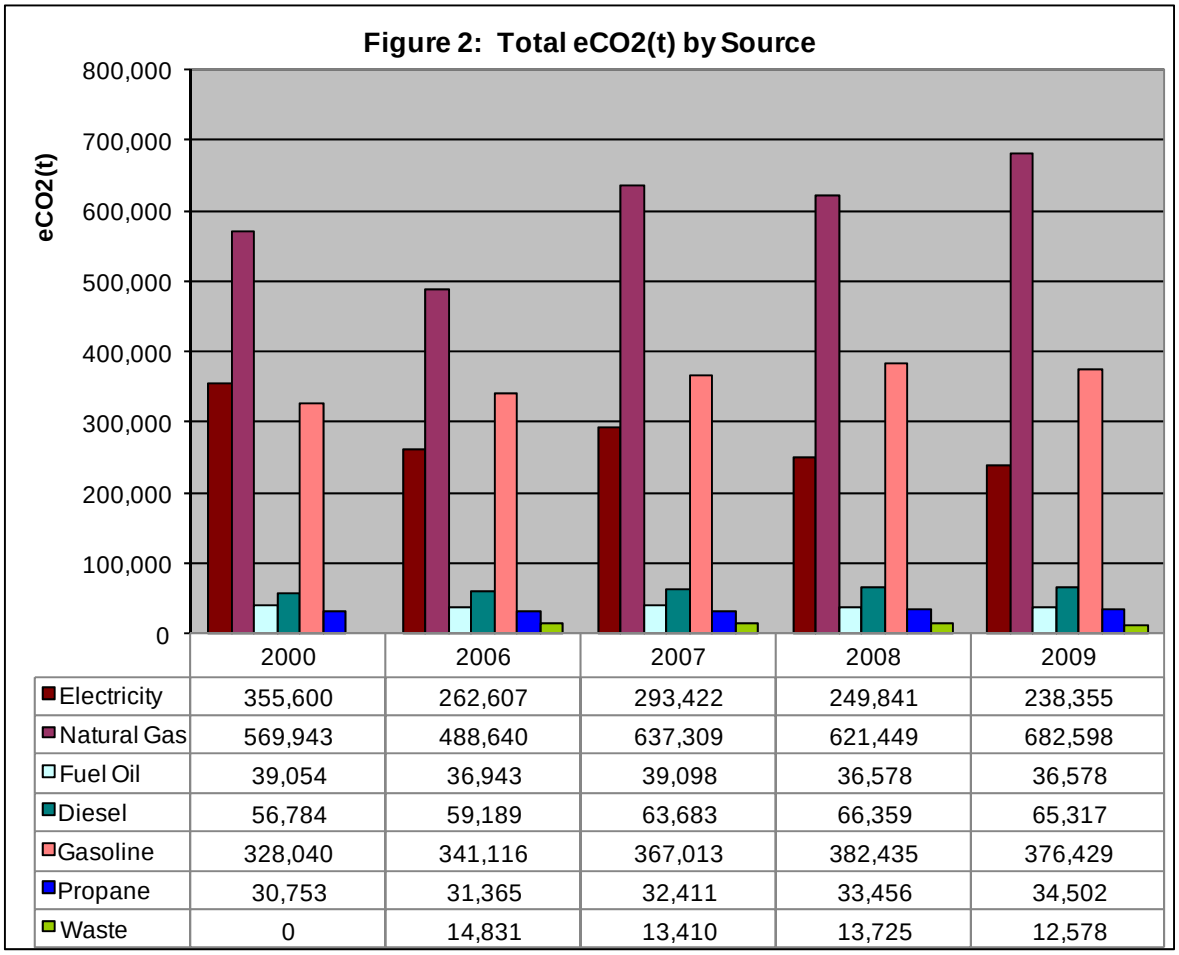
Figures 1 and 2 provide a comparison of the emission sources for the years 2000 and 2006 to 2007 by energy consumption and green house gas emissions. Figure 3 provides a comparison of the emission sources for 2006 to 2009 by energy expenditure. Energy expenditure data was not available for 2000.



	2000	2006	2007	2008	2009
Electricity	4,572,000	5,252,143	5,281,592	5,290,759	5,047,511
Natural Gas	11,359,674	9,739,216	12,702,374	12,386,255	13,605,034
Fuel Oil	538,200	509,107	538,810	504,084	504,084
Diesel	804,544	838,625	902,293	940,207	925,441
Gasoline	4,817,740	5,009,782	5,390,121	5,616,611	5,528,400
Propane	513,153	523,365	540,811	558,256	575,702
Waste	0	0	0	0	0

Total GJ	22,605,311	21,872,237	25,356,001	25,296,172	26,186,171

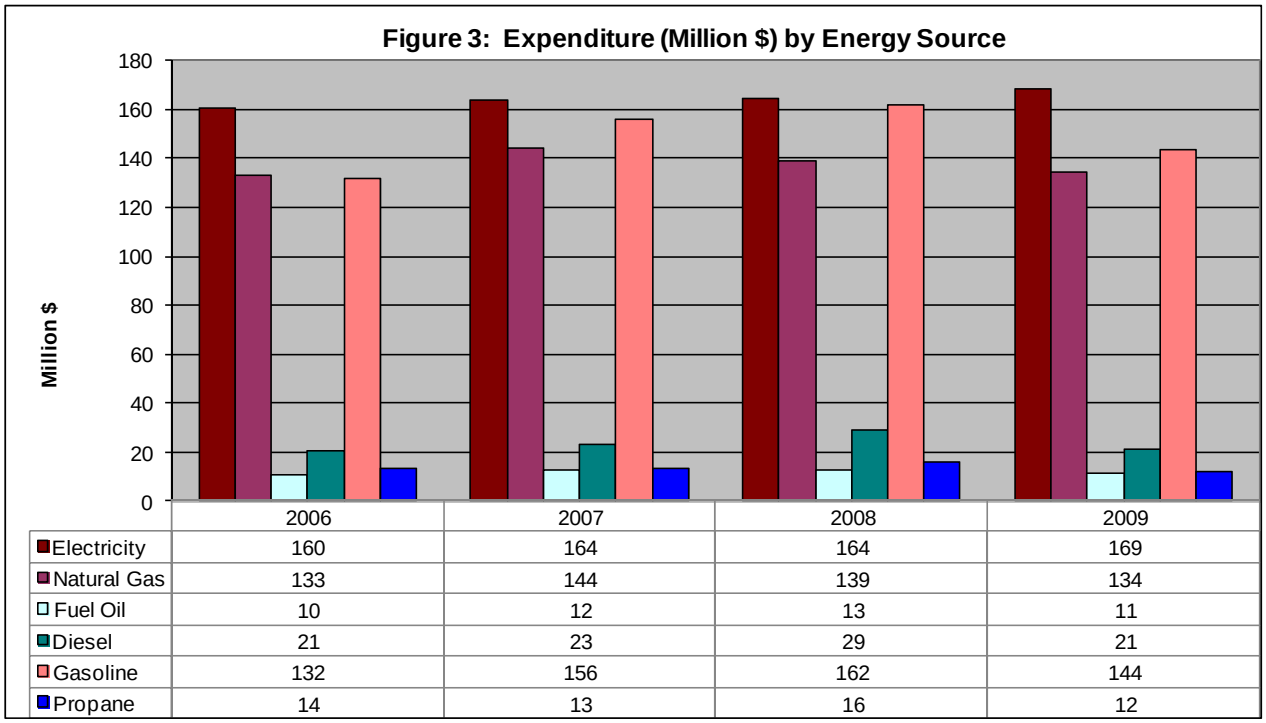
Figure 1: Annual Energy Consumption (GJ) by Emission Source (2000 and 2006 to 2009)



	2000	2006	2007	2008	2009
Electricity	355,600	262,607	293,422	249,841	238,355
Natural Gas	569,943	488,640	637,309	621,449	682,598
Fuel Oil	39,054	36,943	39,098	36,578	36,578
Diesel	56,784	59,189	63,683	66,359	65,317
Gasoline	328,040	341,116	367,013	382,435	376,429
Propane	30,753	31,365	32,411	33,456	34,502
Waste	0	14,831	13,410	13,725	12,578

Total eCO2(t)	1,380,174	1,234,692	1,446,347	1,403,844	1,446,357

Figure 2: Total GHG Emissions by Emission Source (2000 and 2006 to 2009)



	2006	2007	2008	2009
Electricity	160	164	164	169
Natural Gas	133	144	139	134
Fuel Oil	10	12	13	11
Diesel	21	23	29	21
Gasoline	132	156	162	144
Propane	14	13	16	12

Million $	$470.62	$512.83	$523.29	$490.65

Figure 3: Total Expenditure by Emission Source (2000 and 2006 to 2009)

The following sections provide a detailed analysis of each of the emission sources (electricity, natural gas, fuel oil (heating oil), diesel, gasoline, propane and waste).

4.2 ELECTRICITY

The table below summarizes the consumption (kWh and GJ), emission and cost data for electricity for 2000 to 2009. The baseline (2000) inventory did not provide expenditure data.

Table 7: Electricity: Consumption, Emissions and Expenditure Data Comparisons (2000 and 2006 to 2009)

Electricity - Consumption, Emissions, and Expenditure Data Comparison (2000 and 2006 to 2009)								
Year	Consumption			Emissions		Expenditure		
	Million kWh	Million GJ	% of Total Sources	eCO2 (kilotonnes)	% of Total Sources	Million $	% of Total Sources	$/kWh
2000	1,270	4.6	20%	356	26%	n/a	n/a	
2006	1,459	5.3	24%	263	21%	$160	28%	$0.110
2007	1,467	5.3	21%	293	20%	$164	32%	$0.112
2008	1,470	5.3	21%	250	18%	$165	31%	$0.112
2009	1,402	5.0	19%	238	16%	$169	34%	$0.120

Key findings from this data set comparison are as follows:

- Electricity consumption increased by 10% from 2000 to 2009.
- The Electricity proportion of the total community consumption (GJ) remained relatively constant from 2000 to 2009.
- Emissions due to Electricity consumption reduced by 33% from 2000 to 2009.
- The Electricity proportion of total community emissions decreased by 10% from 2000 to 2009.
- The Expenditure of Electricity consumption increased $9 Million (6%) between 2006 and 2009.
- The Cost/kWh increased from approximately $0.11 in 2006 to $0.12 in 2009.

The following table summarizes the Emission Factors for the Ontario Energy Mix provided by Environment Canada National Inventory Report (1999 to 2008). Changes in the Ontario generation mix from 2000 to 2009 account for a 39% reduction in Green House Gas Emissions. This implies that the 33% emission reduction between 2000 and 2009 is largely credited to changes in the Ontario electricity generation Mix.

Table 8: Comparison of Electricity Emission Factors (2000 and 2006 to 2009)

Year	Emission Factor NIR (1990-2008): Ontario eCO2 (t)/kwh	Percentage Decrease in Emission Factors Compared to 2000
2000	0.00028	
2006	0.00018	36%
2007	0.0002	29%
2008	0.00017	39%
2009	0.00017	39%

4.2 NATURAL GAS

The following table summarizes the Natural Gas consumption, cost and GHG emission data for 2000 and 2006 to 2009. The baseline inventory (2000) did not provide expenditure data.

Table 9: Natural Gas: Consumption, Expenditure and Emissions for 2000 and 2006 to 2009

Natural Gas - Consumption, Expenditures and GHG Emissions for 2000 and 2006 to 2009								
Year	Consumption			Emissions		Expenditure		
	Million m3	Million GJ	% of Total Sources	eCO2 (kilotonnes)	% of Total Sources	Million $	% of Total Sources	$/m3
2000	301	11	20%	570	26%	n/a	n/a	n/a
2006	258	10	45%	489	40%	$133	28%	$0.51
2007	337	13	50%	637	44%	$144	28%	$0.43
2008	329	12	49%	621	44%	$139	27%	$0.42
2009	361	14	52%	683	47%	$134	27%	$0.37

Key findings from this data set are as follows:

- Natural Gas consumption increased by 20% between 2000 and 2009.
- The Natural Gas proportion of the total sources consumption increased by 32% between 2000 and 2009.
- Natural Gas emissions increased by 20% between 2000 and 2009. Since the emission factor remains constant during this period, this increase is the same as the consumption increase.
- The Natural Gas proportion of the total sources emissions increased by 21%.
- Natural Gas consumption expenditures increased by 1% between 2006 and 2009.
- The Natural Gas proportion of the total sources costs decreased by 1%.
- The Cost/m3 of natural gas decreased from approximately $\$0.51/m^3$ in 2006 to $\$0.37/m^3$ in 2009.

4.4 HEATING OIL

The following table summarizes the Heating Oil consumption, cost and GHG emission data for 2000 and 2006 to 2009. The baseline inventory (2000) did not provide expenditure data.

Table 10: Heating Oil: Consumption, Expenditures and Emissions for 2000 and 2006 to 2009

Heating Oil - Consumption, Expenditures and GHG Emissions for 2000 and 2006 to 2009								
Year	Consumption			Emissions		Expenditure		
	Million liters	Tera Joule	% of Total Sources	eCO2 (kilotonnes)	% of Total Sources	Million $	% of Total Sources	$/liter
2000	14	538	2%	39	3%		2%	
2006	13	509	2%	37	3%	$10	2%	$0.80
2007	14	539	2%	39	3%	$12	2%	$0.90
2008	13	504	2%	37	3%	$13	2%	$0.99
2009	13	504	2%	37	3%	$11	2%	$0.87

Key finding from this data set are as follows:

- Heating Oil (Fuel Oil) consumption decreased by 6% from 2000 to 2009.
- The Heating Oil proportion of the total sources consumption (GJ) remained constant from 2000 to 2009 at 2%.
- Heating Oil emissions decreased by 6% from 2000 to 2009
- The Heating Oil proportion of total source emissions remained constant from 2000 to 2009 at 3%.
- Heating Oil consumption expenditures increased by 8% from 2006 to 2009.
- The Heating Oil proportion of total source expenditures remained constant from 2006 to 2009 at 2%.
- The Cost/litre increased from $0.80 in 2006 to $0.87 in 2009.

4.4 *GASOLINE*

The following table summarizes the Gasoline consumption, cost and GHG emission data for 2000 and 2006 to 2009. The baseline inventory (2000) did not provide expenditure data.

Table 11: Gasoline: Consumption, Expenditures and Emissions for 2000 and 2006 to 2009

Gasoline (mobile) - Consumption, Expenditures and GHG Emissions for 2000 and 2006 to 2009								
Year	Consumption			Emissions		Expenditure		
	Million liters	Peta Joules	% of Total Sources	eCO2 (kilotonnes)	% of Total Sources	Million $	% of Total Sources	$/liter
2000	139	5	21%	328	28%			
2006	145	5	23%	341	25%	$132	285%	$0.91
2007	156	5	21%	367	27%	$156	30%	$1.00
2008	162	6	22%	382	26%	$162	31%	$1.00
2009	160	6	21%	376	24%	$144	29%	$0.90

Key finding from this data set are as follows:

- Gasoline consumption and emissions increased by 15% from 2000 to 2009.
- The Gasoline proportion of the total sources consumption (GJ) remained constant from 2000 to 2009 at 21%.
- The Gasoline proportion of total source emissions decreased by 4% from 2000 to 2009.
- Gasoline consumption expenditures increased by 9% from 2006 to 2009.
- The Gasoline proportion of total source expenditures remained constant from 2006 to 2009 at 2%.
- While there was fluctuation in the unit price of gasoline between 2006 and 2009, the direct comparison of 2006 unit prices and 2009 is relatively stable.

4.5 DIESEL

The following table summarizes the Diesel consumption, cost and GHG emission data for 2000 and 2006 to 2009. The baseline inventory (2000) did not provide expenditure data.

Table 12: Diesel: Consumption, Expenditures and Emissions for 2000 and 2006 to 2009

Diesel (mobile) - Consumption, Expenditures and GHG Emissions for 2000 and 2006 to 2009								
Year	Consumption			Emissions		Expenditure		
	Million liters	Tera Joules	% of Total Sources	eCO_2 (kilotonnes)	% of Total Sources	Million $	% of Total Sources	$/liter
2000	21	805	4%	57	4%			
2006	22	839	4%	59	5%	$21	4%	$0.95
2007	23	902	4%	64	4%	$23	5%	$0.99
2008	24	940	4%	66	5%	$29	6%	$1.20
2009	24	925	4%	65	5%	$21	4%	$0.88

Key finding from this data set are as follows:

- Diesel consumption and emissions increased by 15% from 2000 to 2009.
- The Diesel proportion of the total sources consumption (GJ) remained constant from 2000 to 2009 at 4%.
- The Diesel proportion of total source emissions decreased by 4% from 2000 to 2009.
- Diesel consumption expenditures remained constant in 2000 and 2009.
- The Diesel proportion of total source expenditures remained constant from 2006 to 2009 at 4%.
- The cost of diesel has varied between 2006 and 2009. In 2006 the cost per liter was approximately $0.95 and in 2009 the cost per liter was approximately $0.88.

4.6 PROPANE

The following table summarizes the Propane consumption, cost and GHG emission data for 2000 and 2006 to 2009. The baseline inventory (2000) did not provide expenditure data.

Table 13: Propane: Consumption, Expenditures and Emissions for 2000 and 2006 to 2009

Propane - Consumption, Expenditures and GHG Emissions for 2000 and 2006 to 2009								
Year	Consumption			Emissions		Expenditure		
	Million Liters	Peta Joule	% of Total Sources	eCO2 (kilotonnes)	% of Total Sources	Million $	% of Total Sources	$/liter
2000	20	513	2%	31	3%			
2006	21	523	2%	31	2%	$14	3%	$0.66
2007	21	541	2%	32	2%	$13	3%	$0.63
2008	22	558	2%	33	2%	$16	3%	$0.73
2009	23	576	2%	35	2%	$12	3%	$0.54

Key finding from this data set are as follows:

- Propane consumption and emissions increased by 12% from 2000 to 2009.
- The Propane proportion of the total sources consumption (GJ) remained constant from 2000 to 2009 at 2%.
- The Propane proportion of total source emissions decreased by 1% from 2000 to 2009.
- Propane consumption expenditures decreased by 10% from 2006 to 2009.
- The Propane proportion of total source expenditures remained constant from 2006 to 2009 at 3%.
- The Cost/liter Propane decreased from $0.66/liter in 2006 to $0.54/liter in 2009.

4.7 WASTE

The following table summarizes the estimated tonnage of organic waste that went to landfill by the Kingston Community. With the exception of the small amount of organic waste that went to the Kingston East landfill, all of the waste was delivered to landfills where there was, at minimum, of methane flaring. The contribution, therefore of the organic waste to greenhouse gas emissions is minimal. It is recognized that landfills are not able to capture 100% of methane gas. A conservative emission factor has been applied to estimate of the impact of organic waste to the Kingston Community GHG inventory. Although the impact of waste on the GHG inventory is marginal, waste reduction has many other economic, social and environmental benefits.

Table 14: Estimated Community Organic Waste (2006 to 2009)

Year	Organic Waste Tonnes	eCO2 Emissions (t)
2006	30,789	14,831
2007	27,839	13,410
2008	28,492	13,725
2009	26,113	12,578

5.0 SECTOR ANALYSIS

5.1 OVERVIEW

Sectors for the Kingston Community greenhouse gas inventory include:

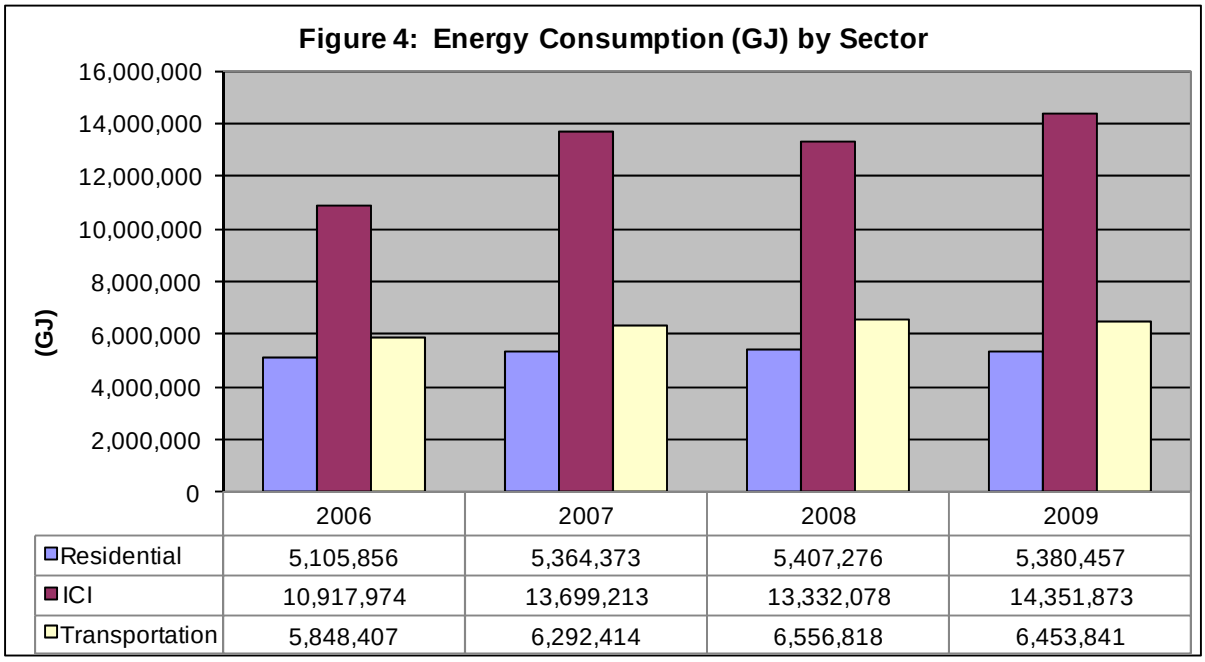
- Residential,
- ICI (Industrial, Commercial and Institutional),
- Transportation, and
- Solid Waste.

While it would be preferable to breakdown the ICI contribution into industrial, commercial and institutional complete data sets were only available for the ICI sector as a whole. To be able to compare the sectors the energy consumption (i.e. m3 natural gas, kWh electricity, liters of fuel etc.) has been converted to Giga Joules (GJ). The following table provides a summary of the Average Contribution of each of the sectors to the overall average consumption, emissions and expenditures from 2006 to 2009. From this table it is evident that the ICI sector had the highest energy consumption, emissions and energy costs. On average Kingston Community annually consumed approximately 24,677,645 GJ of energy, released approximately 1,382,810 CO2e (t) at an expenditure of approximately $499 million.

Table 15: Average Contribution by Sector (2006 to 2009) to Energy Consumption, Emissions and Expenditures.

Sector	Consumption		Emissions		Expenditures	
	Average GJ	Average Percentage	Average CO2e(t)	Average Percentage	Average $Million	Average Percentage
Residential	5,314,491	22%	277,781	20%	$130	26%
ICI	13,075,285	53%	661,007	48%	$198	40%
Transportaton	6,287,870	25%	430,385	31%	$172	34%
Community Waste	0	0%	13,636	1%	$0	0%
Total	24,677,645	100%	1,382,810	100%	$499	100%

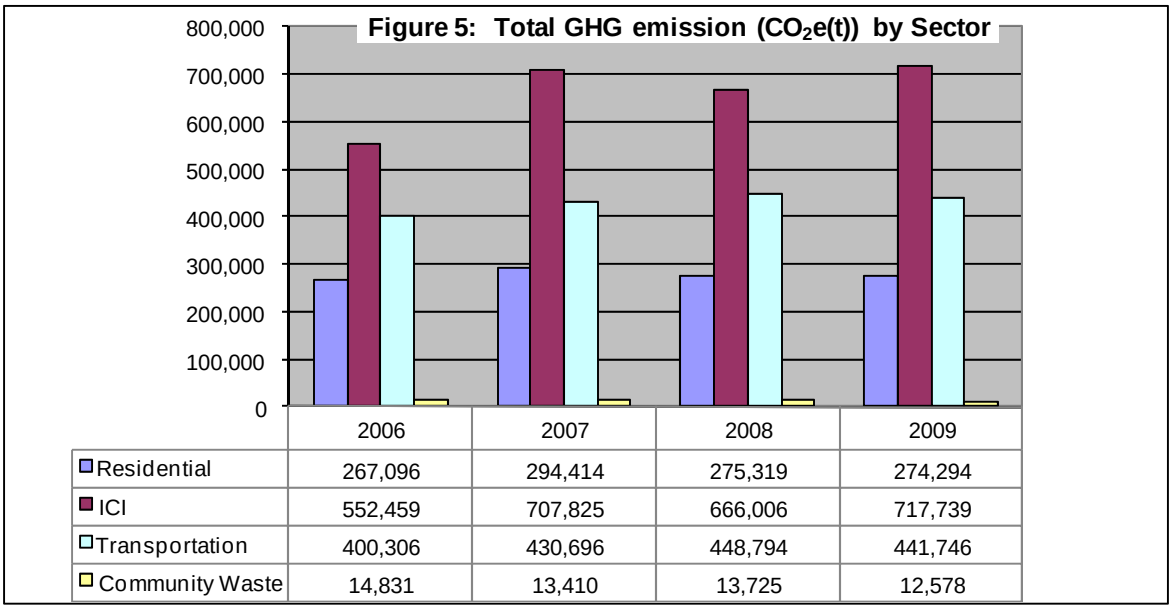
Figures 4 and 5 provide a comparison of the energy consumption (GJ) and eCO2 (t) for 2000 and 2006 to 2009 by sector. Expenditure data was not available for the baseline inventory (2000). Figure 6 provides an energy expenditure data by sector from 2006 to 2009.



	2006	2007	2008	2009
Residential	5,105,856	5,364,373	5,407,276	5,380,457
ICI	10,917,974	13,699,213	13,332,078	14,351,873
Transportation	5,848,407	6,292,414	6,556,818	6,453,841

Total (GJ)	21,872,237	25,356,001	25,296,172	26,186,171

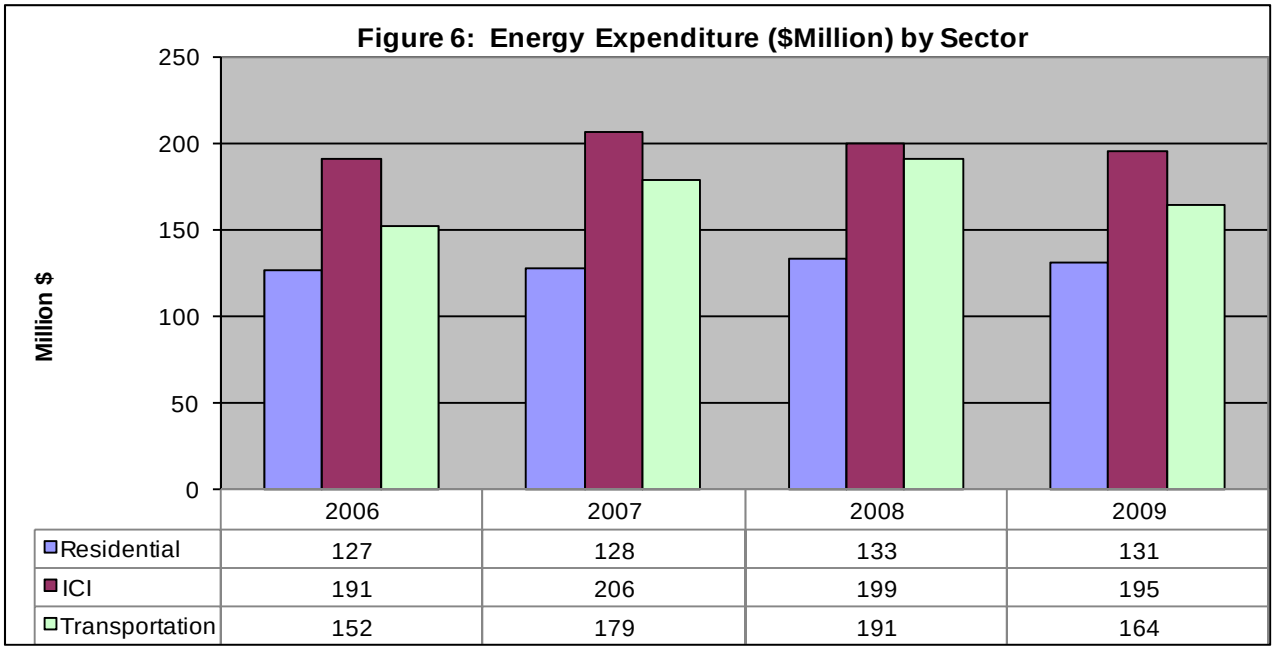
Figure 4: Annual Energy Consumption by Sector (2006 to 2009)



	2006	2007	2008	2009
Residential	267,096	294,414	275,319	274,294
ICI	552,459	707,825	666,006	717,739
Transportation	400,306	430,696	448,794	441,746
Community Waste	14,831	13,410	13,725	12,578

Total $CO_2e(t)$	1,234,692	1,446,347	1,403,844	1,446,357

Figure 5: Annual Total GHG Emissions by Sector (2006 to 2009)



	2006	2007	2008	2009
Residential	127	128	133	131
ICI	191	206	199	195
Transportation	152	179	191	164

Total Expenditure	$470	$513	$523	$490

Figure 6: Annual Energy Expenditure Distribution by Sector (2006 to 2009)

The following sections provide a detailed analysis of each of the sectors (residential, ICI, transportation and waste).

5.2 RESIDENTIAL SECTOR

The baseline data (2000) provided by Hsu (2007) was not sub-divided by sectors. The following table summarizes the residential impact on energy consumption (GJ), greenhouse gas emissions (eCO2 (t)) and cost ($Million) for 2006 to 2009. The percentage of the community energy consumption, greenhouse gas emissions and expenditures remained relatively consistent from 2006 to 2009. The impact from the residential sector was relatively consistent from 2006 to 2009.

Table 16: Residential: Consumption, Cost and Emissions 2006 to 2009

Residential - Consumption, Expenditures and GHG Emissions for 2006 to 2009							
Year	Consumption		Emissions		Expenditures		
	Million GJ	% of Total Sectors	CO_2e (kilotonnes)	% of Total Sectors	Million $	% of Total Sectors	$/$CO_2e$ (t)
2006	5.11	23%	267	22%	126.8	27%	$475
2007	5.36	21%	294	20%	127.9	25%	$435
2008	5.41	21%	275	20%	132.6	25%	$482
2009	5.38	21%	274	19%	131.1	27%	$478

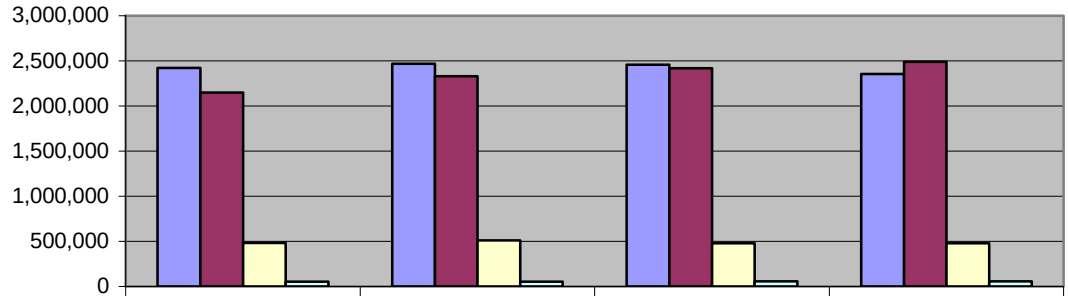
The following table provides a breakdown of the residential percentage distribution of energy consumption (GJ), emissions (CO_2e (t)) and expenditures from 2006 to 2009. It is evident that within the residential sector, electricity and natural gas were the largest contributors to consumption, emissions and expenditures. Electricity is the source with the largest expenditure. It is evident that the range of percentage consumption, emissions and expenditures did not vary significantly from 2006 to 2009.

Table 17: Residential: Distribution of Consumption, Emissions and Expenditures by Source (2006 to 2009)

Residential: Distribution (Range from 2006 to 2009) of Energy Consumption, Emissions and Expenditures by Source			
Source	**Consumption GJ**	**Emissions (CO_2e(t))**	**Expenditures ($Million)**
Electricity	47% to 44%	47% to 41%	65% to 68%
Natural Gas	42% to 46%	40% to 46%	26% to 22%
Fuel Oil	9%	13%	8%
Propane	1%	1%	1%

The following figure provides the (2006 to 2009) residential energy consumption, emission and expenditure summaries for each of the energy sources. The community energy consumption was dominated by natural gas and electricity. The dominant energy source within the community switched from electricity in 2006 to natural gas in 2009.

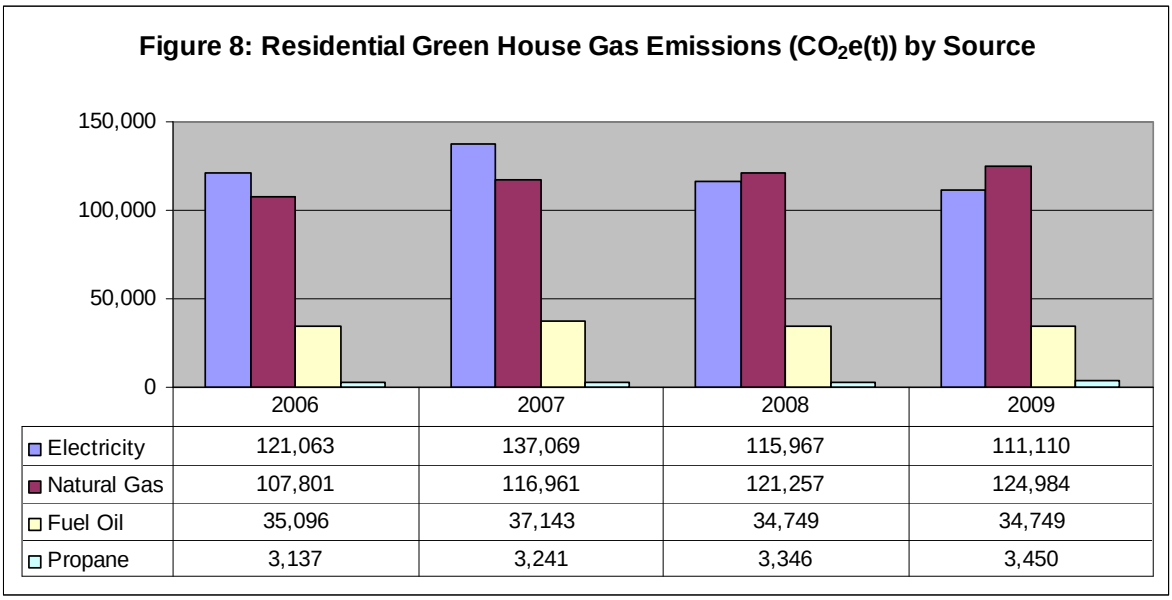
Figure 7: Residential Energy Consumption (GJ) by Source



	2006	2007	2008	2009
Electricity	2,421,256	2,467,237	2,455,767	2,352,911
Natural Gas	2,148,612	2,331,186	2,416,804	2,491,096
Fuel Oil	483,651	511,870	478,880	478,880
Propane	52,337	54,081	55,826	57,570

Total Million GJ	5.11	5.36	5.41	5.38

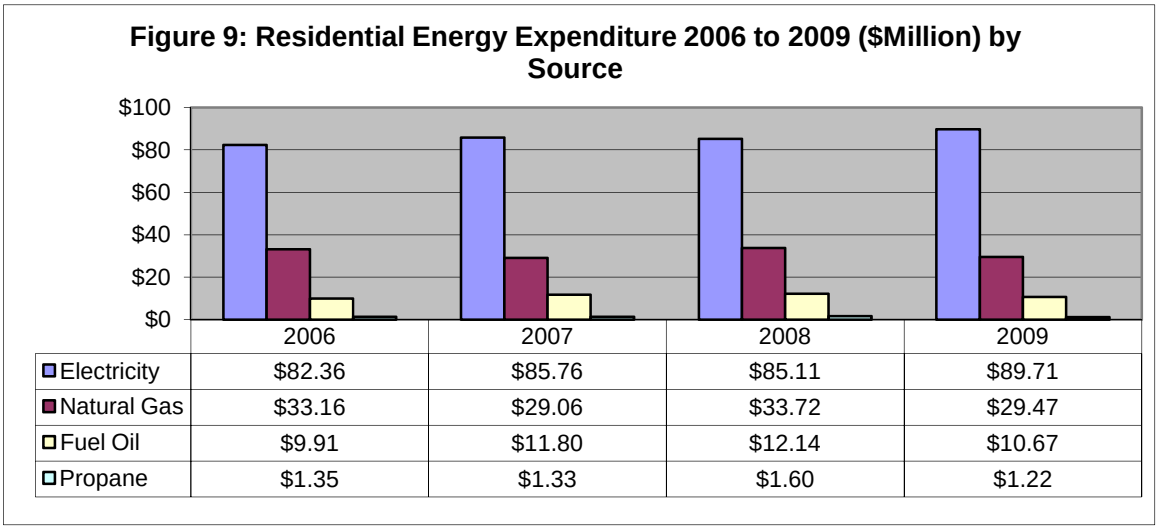
Figure 7: Annual Residential Energy Consumption by Source (2006 to 2009)



	2006	2007	2008	2009
Electricity	121,063	137,069	115,967	111,110
Natural Gas	107,801	116,961	121,257	124,984
Fuel Oil	35,096	37,143	34,749	34,749
Propane	3,137	3,241	3,346	3,450

Total CO_2e (kilotonnes)	267	294	275	274

Figure 8: Annual Residential GHG Emissions by Source (2006 to 2009)



	2006	2007	2008	2009
Electricity	$82.36	$85.76	$85.11	$89.71
Natural Gas	$33.16	$29.06	$33.72	$29.47
Fuel Oil	$9.91	$11.80	$12.14	$10.67
Propane	$1.35	$1.33	$1.60	$1.22

Total $Million	$126.8	$127.9	$132.6	$131.1

Figure 9: Annual Residential Energy Expenditure by Source (2006 to 2009)

5.3 *ICI SECTOR*

The baseline data (2000) provided by Hsu (2007) was not sub-divided by sectors. The following table summarizes the ICI impact on energy consumption (GJ), emissions (CO_2e(kt)) and expenditures ($Millions) for 2006 to 2009.

Table 18: ICI: Consumption, Expenditures and Emissions (2006 to 2009)

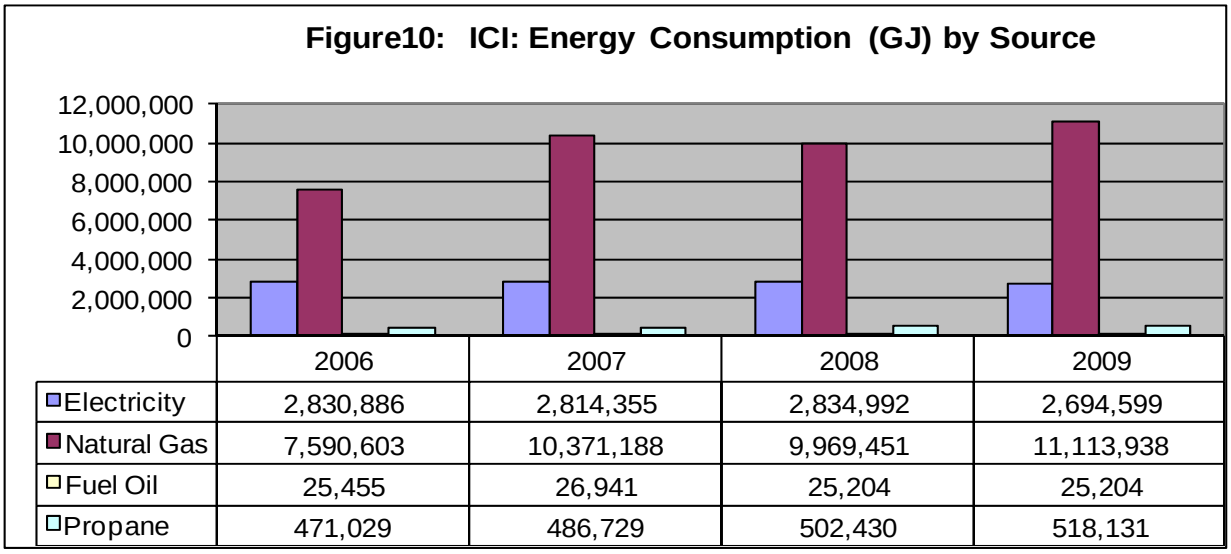
ICI - Consumption, Expenditures and GHG Emissions for 2006 to 2009							
Year	Consumption		Emissions		Expenditures		
	Million GJ	% of Total Sources	CO_2e (kilotonnes)	% of Total Sources	Million $	% of Total Sectors	$/$CO_2e$ (t)
2006	10.92	50%	552	45%	190.6	41%	$345
2007	13.70	54%	708	49%	206.0	40%	$291
2008	13.33	53%	666	47%	199.5	38%	$300
2009	14.35	55%	718	50%	195.1	40%	$272

The following table provides a breakdown of the ICI percentage distribution of energy consumption (GJ), emissions (CO_2e(t)) and expenditures from 2006 to 2009. It is evident that within the ICI sector, electricity and natural gas were the largest contributors to consumption, emissions and expenditures. Natural Gas has the highest consumption, emissions and expenditure. The electricity consumption and emissions decreased over the period and that of natural gas increased.

Table 19: Distribution of Consumption, Emissions and Expenditures by Source (2006 to 2009)

ICI: Percentage Distribution (Range from 2006 to 2009) of Energy Consumption, Emissions and Expenditures by Source			
Source	**Consumption GJ**	**Emissions (CO2(t))**	**Expenditures ($Million)**
Electricity	26% to 18%	26% to 18%	41% to 38%
Natural Gas	70% to 79%	70% to 79%	52% to 59%
Fuel Oil	0.2%	0.3%	0.3%
Propane	4%	5% to 4%	4%

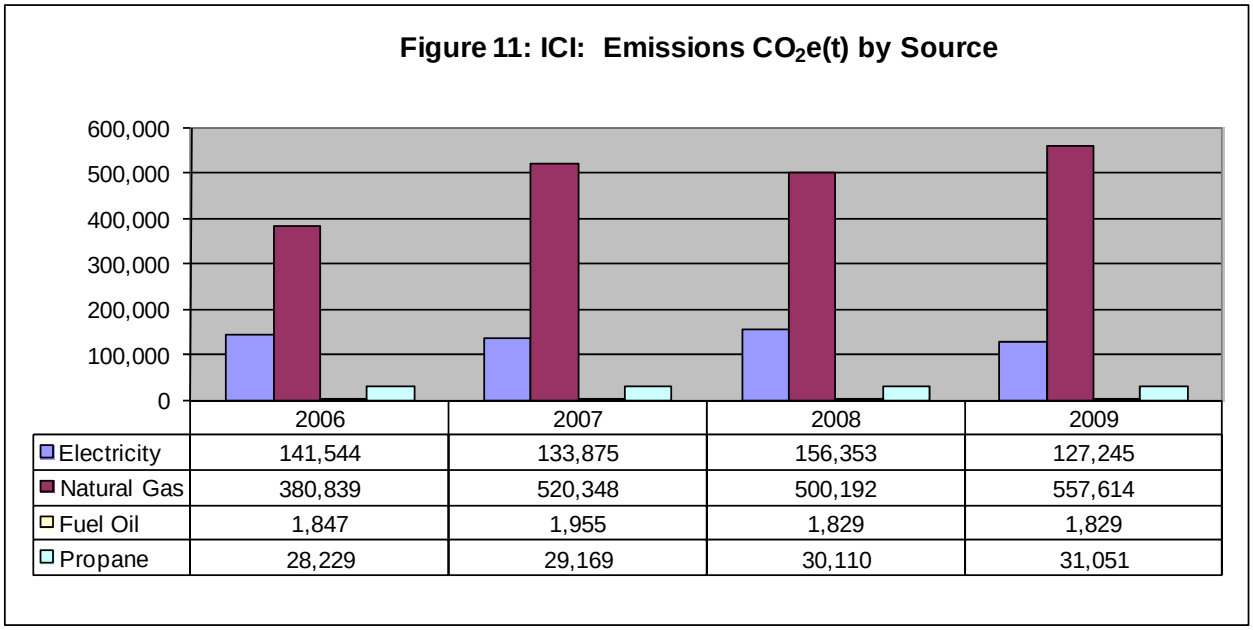
The following figures (figure 10, 11 and 12) provide the (2006 to 2009) ICI energy consumption, emission and expenditure summaries for each of the energy sources.



	2006	2007	2008	2009
Electricity	2,830,886	2,814,355	2,834,992	2,694,599
Natural Gas	7,590,603	10,371,188	9,969,451	11,113,938
Fuel Oil	25,455	26,941	25,204	25,204
Propane	471,029	486,729	502,430	518,131

Total Million GJ	10.92	13.70	13.33	14.35

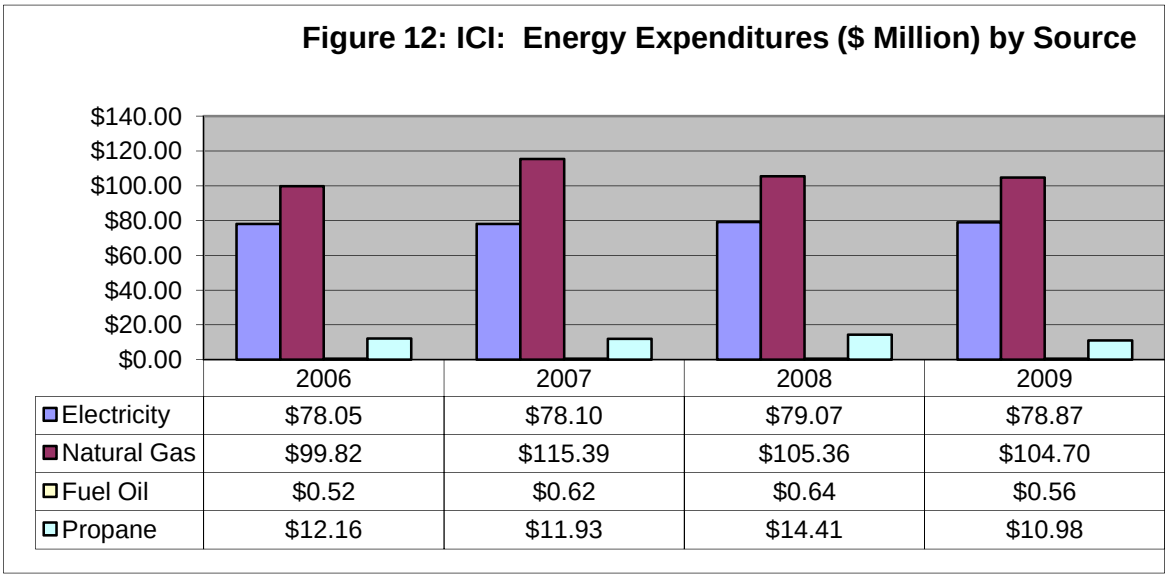
Figure 10: ICI Energy Consumption by Source (2006 to 2009)



	2006	2007	2008	2009
Electricity	141,544	133,875	156,353	127,245
Natural Gas	380,839	520,348	500,192	557,614
Fuel Oil	1,847	1,955	1,829	1,829
Propane	28,229	29,169	30,110	31,051

Total CO_2e (kilotonne)	552	708	666	718

Figure 11: ICI Emissions (CO_2e (t)) by Source (2006 to 2009)



	2006	2007	2008	2009
Electricity	$78.05	$78.10	$79.07	$78.87
Natural Gas	$99.82	$115.39	$105.36	$104.70
Fuel Oil	$0.52	$0.62	$0.64	$0.56
Propane	$12.16	$11.93	$14.41	$10.98

Total Million $	$190.6	$206.0	$199.5	$195.1

Figure 12: Annual Energy Expenditures by Source (2006 to 2009)

5.4 *TRANSPORTATION SECTOR*

As discussed in section 3.0, the current inventory (2006 to 2009) applied the same methodology used in the Hsu (2007) inventory to estimate the energy consumption (GJ) and eCO2 (t) from community transportation. Expenditure data is provided for the current inventory (2006 to 2009). Transportation comprises approximately 4% to 5% of the total sectors (residential, ICI and transportation). The transportation sector is composed of gasoline and diesel. The following table provides a summary of the usage (liters), energy consumption (GJ), emissions (CO_2e (t)) and expenditures for gasoline and diesel from 2006 to 2009.

Table 20: Transportation: Gasoline and Diesel Consumption, Emissions and Expenditures (2006-2009)

Transportation: Gasoline and Diesel Consumption, Emissions and Expenditures								
Year	Gasoline				Diesel			
	(litres)	GJ	CO_2 e(t)	Expenditure	(litres)	GJ	CO_2e (t)	Expenditure
2000	139,000,000	4,817,740	328,040		20,800,000	804,544	56,784	
2006	144,540,730	5,009,782	341,116	$131,624,378	21,681,110	838,625	59,189	$20,662,097
2007	155,514,171	5,390,121	367,013	$155,866,006	23,327,126	902,293	63,683	$22,977,219
2008	162,048,786	5,616,611	382,435	$162,048,786	24,307,318	940,207	66,359	$29,193,089
2009	159,503,757	5,528,400	376,429	$143,502,980	23,925,564	925,441	65,317	$20,958,794

Between 2006 and 2009 the transportation sector:

- represented 27% to 25% of the consumption (GJ) of the total sectors;
- represented 32% to 31% of the emissions (CO_2(t)) of the total sectors, and
- represented 32% to 34% of the energy expenditure of the total sectors.

Table 21: Transportation: Consumption, Emissions and Cost as a Percentage of Total Sectors

Year	Transportation Fuel: Consumption, Emissions, Expenditures and % of Sectors					
	Consumption		Emissions		Expenditures	
	GJ	% of Sectors	CO_2e(t)	% of Sectors	$	% of Sectors
2000	5,622,284	n/a	384,824	n/a	n/a	n/a
2006	5,848,407	27%	400,306	32%	$152,286,476	32%
2007	6,292,414	25%	430,696	30%	$178,843,224	35%
2008	6,556,818	26%	448,794	32%	$191,241,875	37%
2009	6,453,841	25%	441,746	31%	$164,461,774	34%

6.0 COMPARISON OF RESULTS WITH 2000 BASELINE INVENTORY

6.1 CONSUMPTION

The following graph indicates that the total consumption of energy, measured in Giga Joules (GJ), from all energy sources (electricity, natural gas, heating oil, gasoline and diesel and propane) increased by approximately 16% between 2000 and 2009. It is estimated that the population increase between 2000 and 2009 was approximately 5.45%.

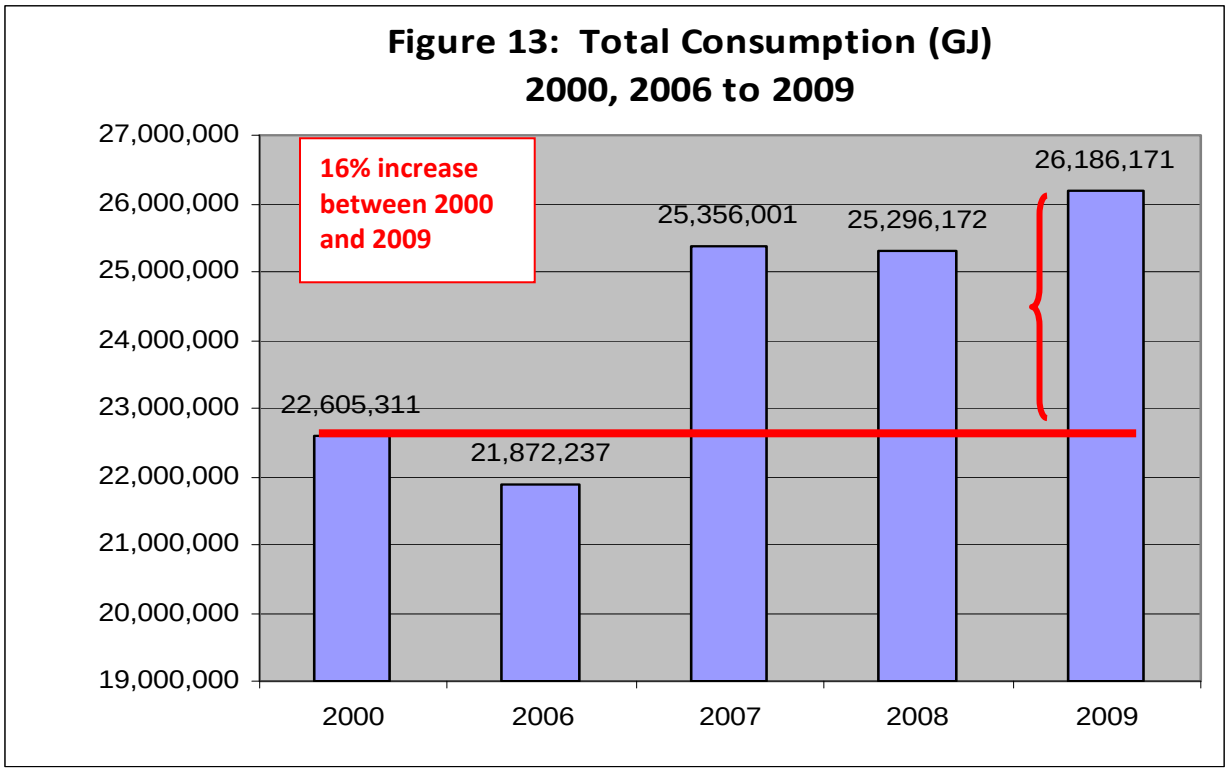


Figure 13: Total Energy Consumption (2000 and 2006 to 2009)

The following table provides the percentage increase in the consumption (GJ) of the various energy sources. Between the year 2000 and 2009 it is estimated that the Kingston community consumed 20% more natural gas, 10% more electricity, 15% more diesel and gasoline and 12% more propane. The heating oil consumption decreased by 6% between the year 2000 and 2009.

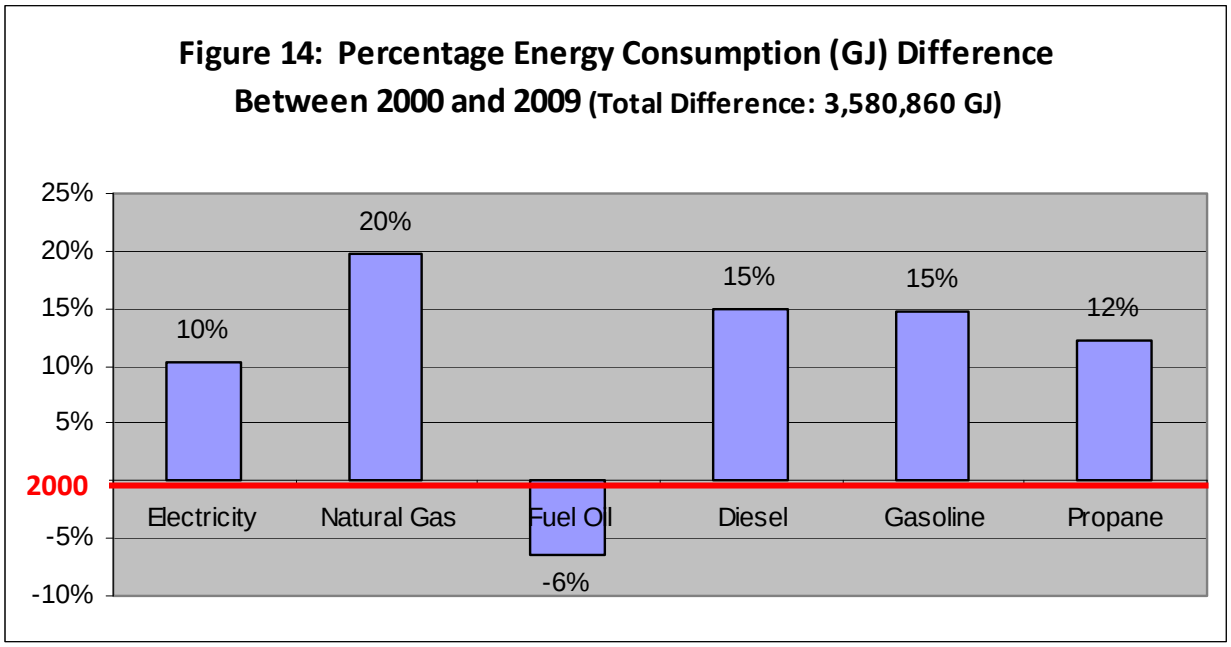


Figure 14: Percentage Difference in Energy Consumption between 2000 and 2009

Between 2000 and 2009 the energy consumption per person (GJ/capita) has increased by approximately 9.7% from 176 GJ/capita to 193 GJ/capita.

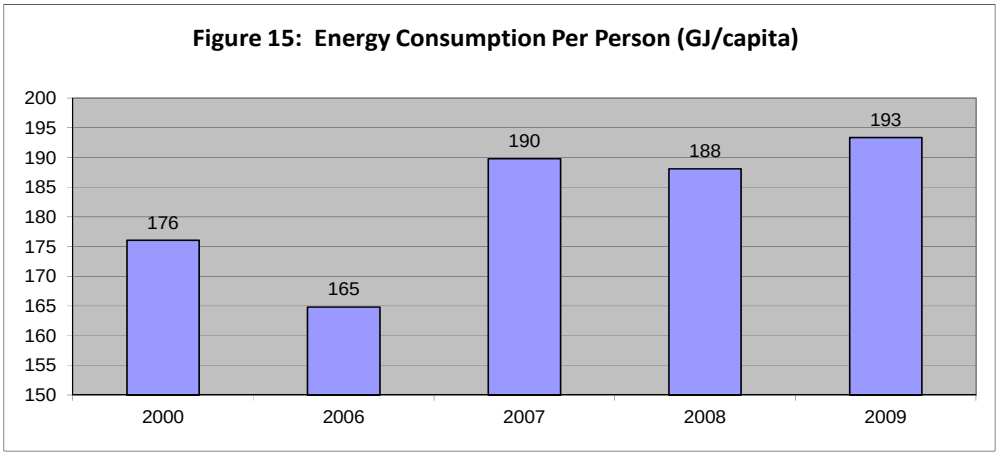


Figure 15: Annual Energy Consumption per Capita (2000 and 2006 to 2009)

6.2 GREENHOUSE GAS EMISSIONS

As indicated in the following figure, the total green house gas emissions increased by 4.8% from 2000 to 2009 (1,390,174 eCO_2 (t)/yr to 1,446,357 CO_2 e (t)/yr).

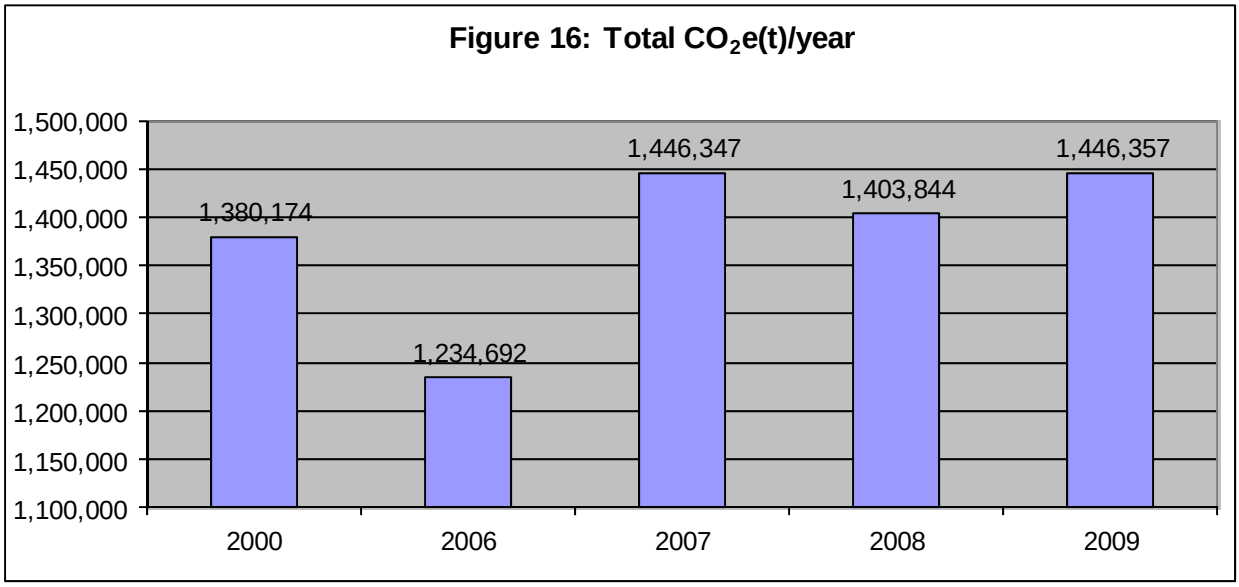


Figure 16: Annual Total GHG Emissions (2000 and 2006 to 2009)

The following figure illustrates the Percentage Greenhouse Gas emission (CO_2e (t)) difference by source from 2000 to 2009. While emissions due to natural gas, diesel and gasoline and propane increased, emissions due to electricity and fuel oil decreased by 33% and 6% respectively, between 2000 and 2009. During this time, the electricity emission coefficient decreased by 39%, due to modifications in the Ontario grid energy mix.

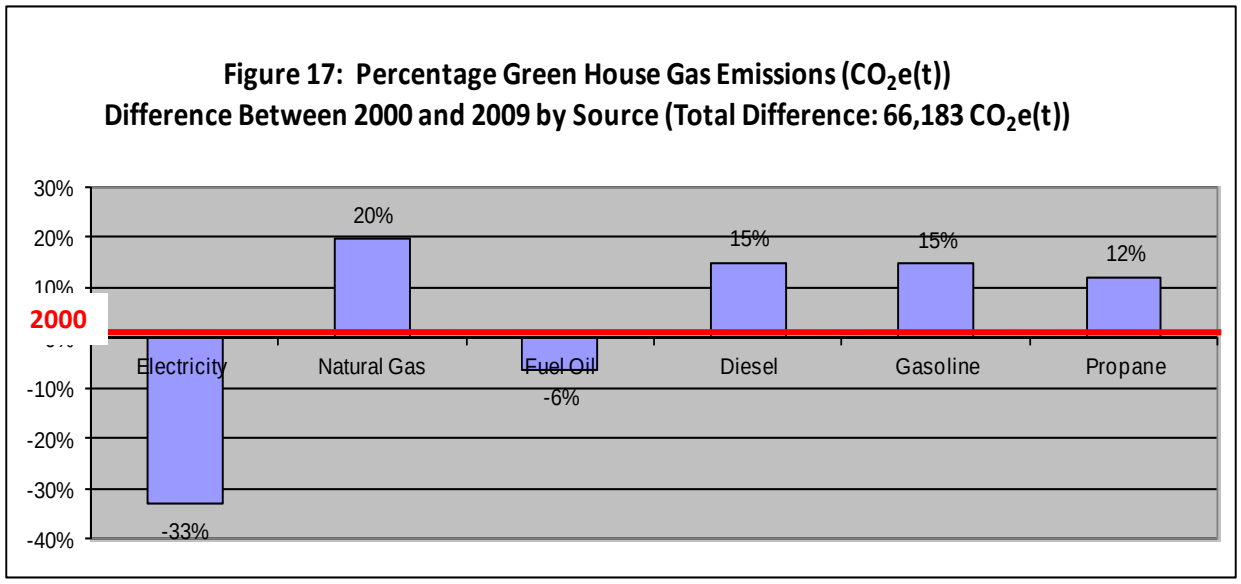


Figure 17: Percentage GHG Emission Difference between 2000 and 2009

Figure 18 illustrates the greenhouse gas emissions emitted per capita from 2000 and 2006 to 2009. The greenhouse gas emissions per capita decreased by 0.65% between 2000 and 2009. It is estimated that between 2000 and 2009 the population increased by approximately 5.5%. Details of the methodology to estimate population is provided in Section 7.3.

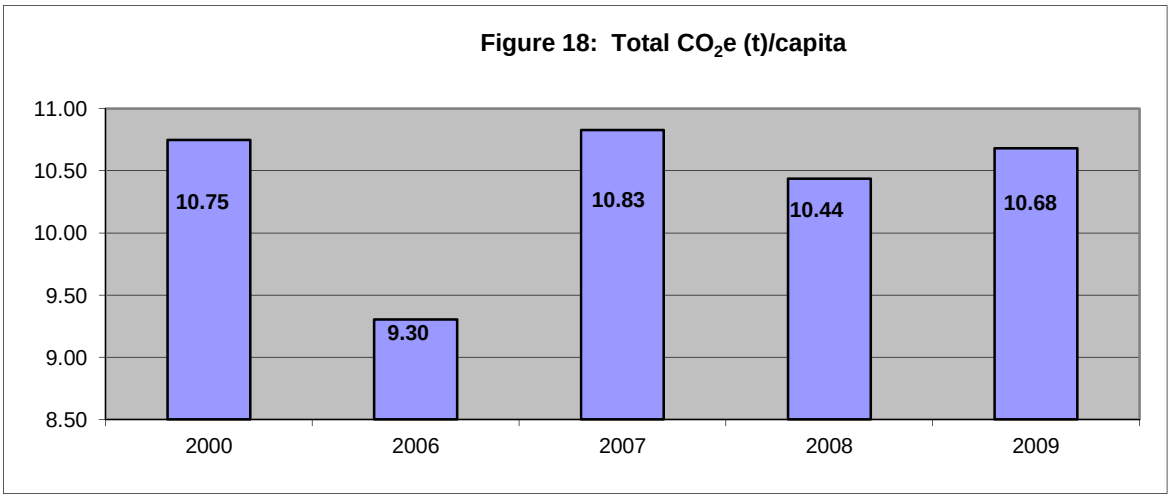


Figure 18: Total Annual GHG Emissions per Capita (2000 and 2006 to 2009)

7.0 CONFOUNDING FACTORS

There are several factors which influence the energy consumption and the resulting greenhouse gas emissions for the Kingston community on an annual basis and over time. The following factors are reviewed and their influence discussed:

- Heating Degree Days and Cooling Degree Days Changes
- Electricity Emission Coefficient Changes
- Population Changes
- Economic Fluctuations

7.1 HEATING DEGREE DAYS AND COOLING DEGREE DAYS

Provided below is a table and a graphs illustrating the total Heating Degree Days (HDD) and Cooling Degree Days (CDD) from 2000 to 2009. HDD is a measure of the need for heating and CDD is a measure of the need for cooling. The number of degrees that a day's average temperature is below 18 degrees Celsius is the number of heating degree days for that day and the number of degrees that a day's average temperature is above 18 degrees Celsius is the number of cooling degree days. Based on this data, 2006 was a year with an exceptionally warm winter and cool summer. The 2006 combined number of HDD and CDD was 11% lower than that for 2000. This 2006 weather anomaly impacted natural gas consumption and emissions associated with heating and cooling (14% reduction in natural gas consumption and emissions between 2000 and 2006).

The years 2007, 2008 and 2009 had a similar number of total HDD and CDD with a percentage change from 2000 of -4%, -4% and -3% respectively.

Table 22: Heating and Cooling Degree Days (2000 t 2009)

Heating and Cooling Degree Days - Hartington IHD, Jan2000 to December 2009						
Year	Total HDD	Ranking	Total CDD	Ranking	Sum	% Change from 2000
2000	4,371.70	2	132.30	10	4,504.00	
2001	3,919.90	9	286.10	3	4,206.00	-7%
2002	3,971.40	8	354.90	2	4,326.30	-4%
2003	4,441.50	1	250.50	6	4,692.00	4%
2004	4,353.20	3	151.40	9	4,504.60	0%
2005	4,244.80	4	384.00	1	4,628.80	3%
2006	3,742.10	10	251.60	5	3,993.70	-11%
2007	4,062.40	7	281.30	4	4,343.70	-4%
2008	4,112.60	6	205.30	7	4,317.90	-4%
2009	4,192.10	5	158.80	8	4,350.90	-3%

Source: Kingston Hydro Load Forecast, March 12, 2010

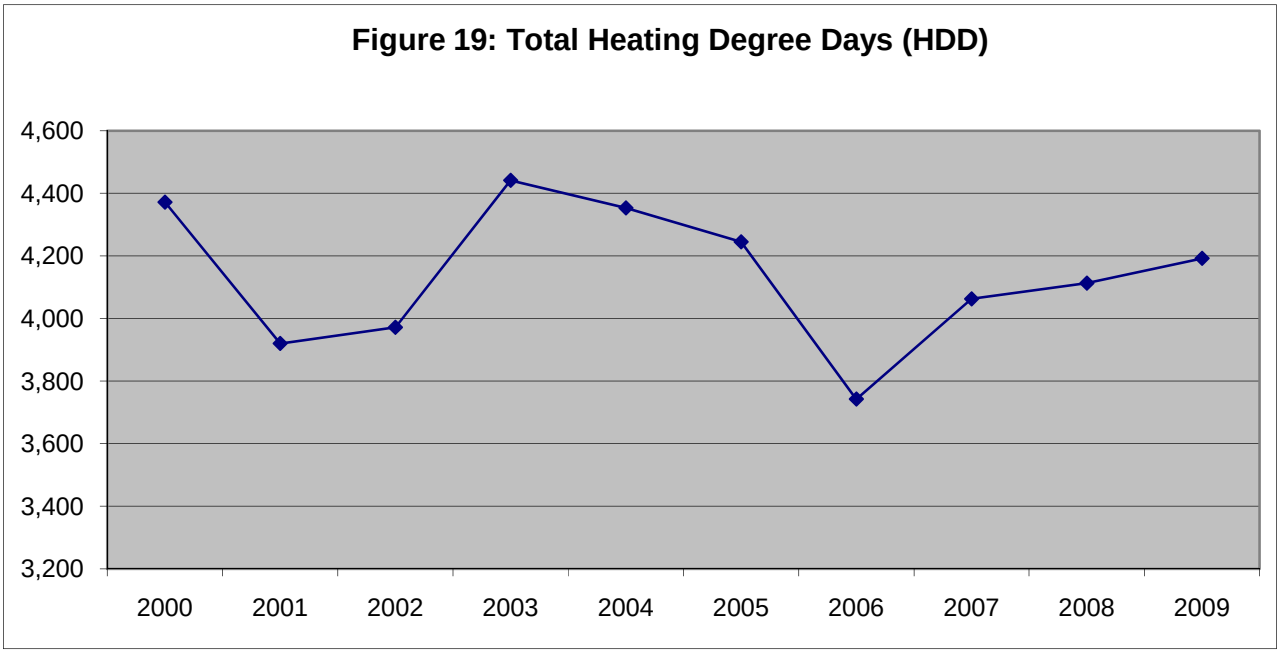


Figure 19: Total Heating Degree Days (HDD) 2000 to 2009

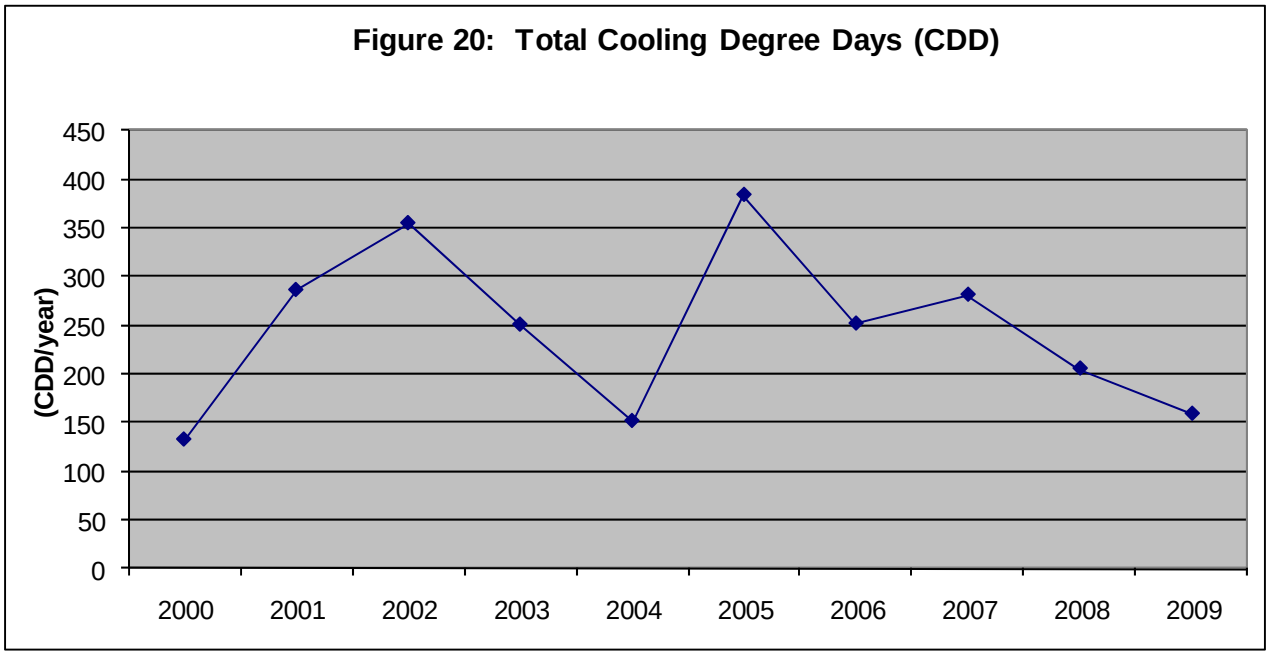


Figure 20: Total Cooling Degree Days (CDD) 2000 to 2009

7.2 ELECTRICITY EMISSION COEFFICIENT CHANGES

The table below summarizes the changes in the Ontario Electricity GHG emission factors due to modifications in the Ontario energy grid mix. From 2000 to 2009, there was a 39% reduction in the emission factor coefficient for electricity. Therefore, while the electricity consumption (GJ) increased by approximately 10% between 2000 and 2009, the GHG emissions due to electricity decreased by 33%.

Table 23: Comparison of Electricity Emission Factors (2000 and 2006 to 2009)

Year	Emission Factor NIR (1990-2008): Ontario eCO2 (t)/kwh	Percentage Decrease in Emission Factors Compared to 2000
2000	0.00028	
2006	0.00018	36%
2007	0.0002	29%
2008	0.00017	39%
2009	0.00017	39%

7.3 POPULATION

To determine the population to apply to the Kingston Community GHG inventory, three data sets have been used: Census data, TeraTrends Demographic Study (2008) and the Kingston Planning Department's estimate of the 2011 Kingston Community student population.

Census population data is available for 2001 and 2006. Estimates had to be made to determine the population for 2000, 2007, 2008 and 2009. In 2008, the City of Kingston retained TeraTrends to conduct a population study for the City of Kingston. This study generated three growth scenarios (low, medium and high). These growth scenarios are provided below:

Table 24: Kingston Community Estimate Growth Rate 2006 to 2026

Kingston Community Estimated Growth Rate from 2006 to 2026 TeraTrends Demographic Study (2008)			
Rate	**Low**	**Medium**	**High**
2026 Population	122,000	133,100	144,900
Annual Growth from 2006 to 2026	0.20%	0.68%	1.18%

Based on the difference between the 2001 and 2006 Census data populations, the low growth rate is believed to underestimate the Kingston population. It is therefore expected that the growth rate will be closer to the medium scenario. An annual growth rate of approximately 0.68% has therefore been applied to estimate the population for the years 2007, 2008 and 2009. For consistency, this growth rate has also been used to determine the 2000 population estimate.

This estimate, however, did not include the significant Kingston student population whose energy consumption is included within this inventory. The Kingston Planning Department provided an estimate of the 2011 Kingston Student population that is serviced by Kingston:

- St. Lawrence College: 3,200 students
- RMC: 1,260 students
- Queen's: 14,000 students

  Total: 18,460 students

Based on these student estimates it was determined that in 2011 approximately 13.2% of the Kingston population was comprised of students. This percentage was then used to back calculate the student population for 2000 to 2009.

Table 25 provides a summary of the estimated population of the Kingston Community for 2000 and 2006 to 2009.

Table 25: Estimated Population (2000 and 2006 to 2009)

Year	Kingston Census	Population Based on Medium Growth Scenerio (TeraTrends Demograhic Study, 2008)	Est. Student Pop. Serviced by Kingston	Est. Total Kingston Population	Difference from 2000
2000		113,421	14,988	128,409	
2001	114,195		15,090	129,285	0.7%
2006	117,206		15,488	132,694	3.3%
2007		118,001	15,593	133,594	4.0%
2008		118,801	15,699	134,500	4.7%
2009		119,606	15,806	135,412	5.5%
2010		120,417	15,913	136,330	6.2%
2011		121,234	18,460	139,694	8.8%

These population estimates were used to determine the per capita estimates for consumption (GJ) and GHG emissions. Based on these assumptions it is estimate that the population has increased by 5.5% from 2000 to 2009.

7.3 ECONOMIC IMPACTS

To review the community economic impacts that may have impacted energy consumption the following two data sets were reviewed:

- Fluctuations in the Kingston Community Estimate of Full Time Employees (FTE)
- Fluctuations in the Kingston Community distribution of labour force

Fluctuation in the Kingston Community Estimate of Full Time Employees (FTE):

The following figure shows the number of Kingston community FTE from 2006 to 2009. This data indicates the percentage change in FTE compared to 2006. Between 2006 and 2009 the overall number of FTE increased by 2%.

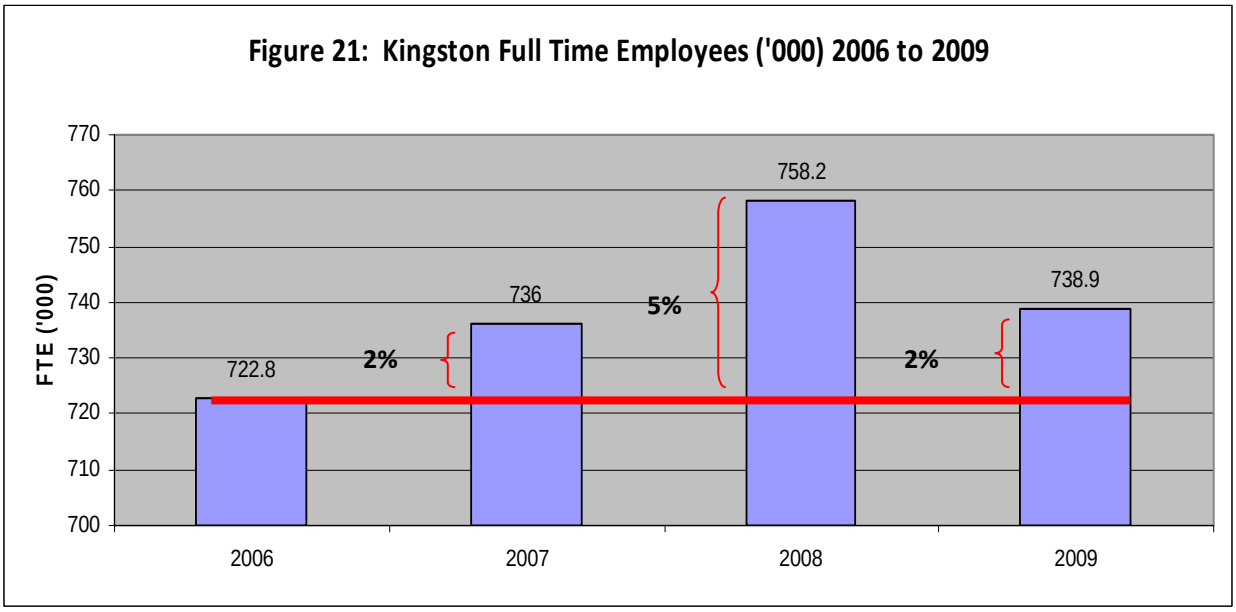


Figure 21: Kingston Full Time Employees 2006 to 2009

Fluctuation in the Kingston Community Distribution of Labour Force:

The following table illustrates the distribution of the Kingston labour force for 2001 and 2006 provided from Statistics Canada Census data. This chart reveals that the distribution of the Kingston labour force was relatively consistent between 2001 and 2006 and that primary industry and processing, manufacturing and utilities make up a relatively small percentage of the overall labour force. A review of the 2011 Census data, once available, will determine if this trend continued from 2006 to 2009.

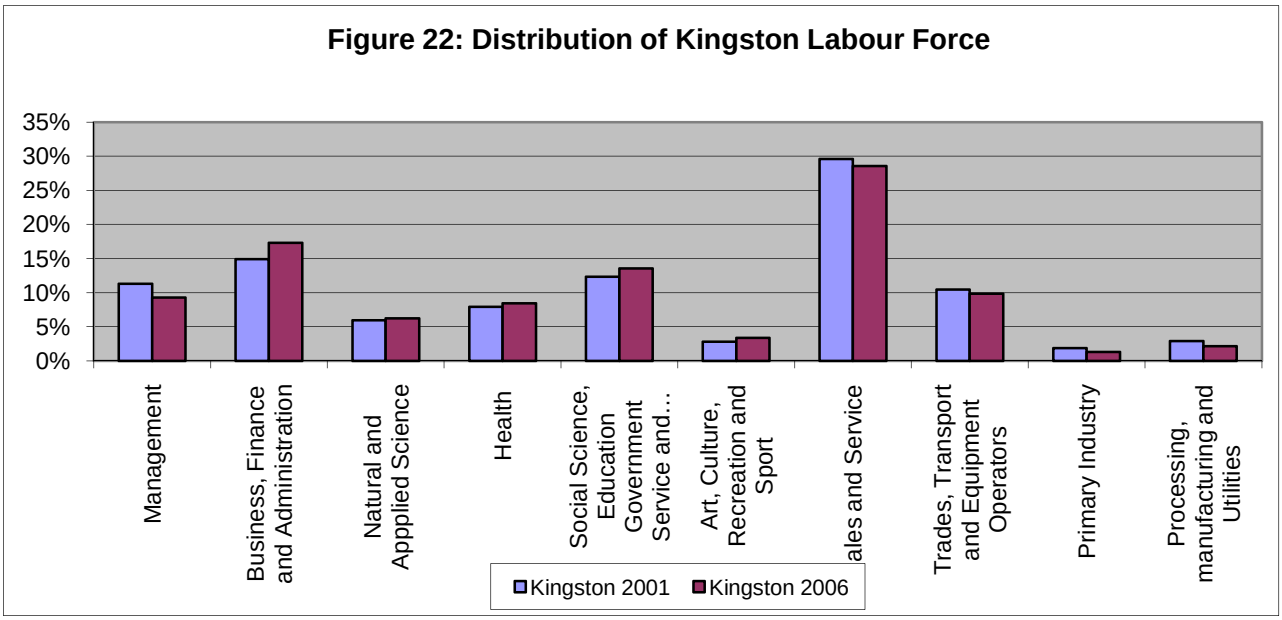


Figure 22: Distribution of the Kingston Labour Force (2001 and 2006 Census Data)

Based on the assumption that the distribution of the labour force did not vary significantly from the distribution evident in 2001 and 2006, it is estimated that the fluctuations in the Kingston economy had a minor contribution to changes in energy consumption and greenhouse gas emissions.

8.0 BENCHMARKING TO OTHER SINGLE TIER MUNICIPALITIES

8.1 SELECTION OF BENCHMARK MUNICIPALITIES

Green House Gas emission comparison data is not readily available. The *Municipal Performance Measurement Program* (MPMP) which reports a common set of indicators for municipalities does not include greenhouse gas emissions or energy consumption.

The selection of municipalities to benchmark the Kingston community GHG emissions against was based on the following: comparable population, single tier municipality, comparable economic sector distribution, availability of data and located within Ontario (same electricity grid energy mix). On this basis, London, Oshawa and Guelph were selected as benchmark communities.

The following documents were reviewed for benchmarking purposes:

London*: 2008 Energy Use Inventory for London & Green House Gas Impacts:* Environmental & Engineering Services Department, City of London (July, 2009).

Guelph: *City of Guelph Community Energy Plan*: Garforth International (April 3rd, 2007).

Oshawa: *Federation of Canadian Municipalities' Partners for Climate Protection Program Public Report:* Commissioner, Development Services Department, City of Oshawa (August 30th, 2010).

8.2 ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSION COMPARISON

The data reviewed to compare the community energy consumption and greenhouse gas emissions of London, Guelph and Oshawa to Kingston did not provide a consistent data set for the years 2006 to 2009. As indicated in the following charts (Comparison of Community Energy Consumption per capita and Community Comparison of Green House Gas Emissions per capita), data not available for all benchmark communities for all years. The year with the most consistent data set was 2007. In 2007 compared to benchmark communities, Kingston and Guelph were the communities with the highest energy consumption on a per person basis. Kingston was above the benchmark community average of 156 GJ/capita. In 2007, where benchmark comparisons are possible, Kingston (at 10.8 CO_2e (t)/capita) was marginally below the benchmark community average of 10.9 CO_2e (t)/capita.

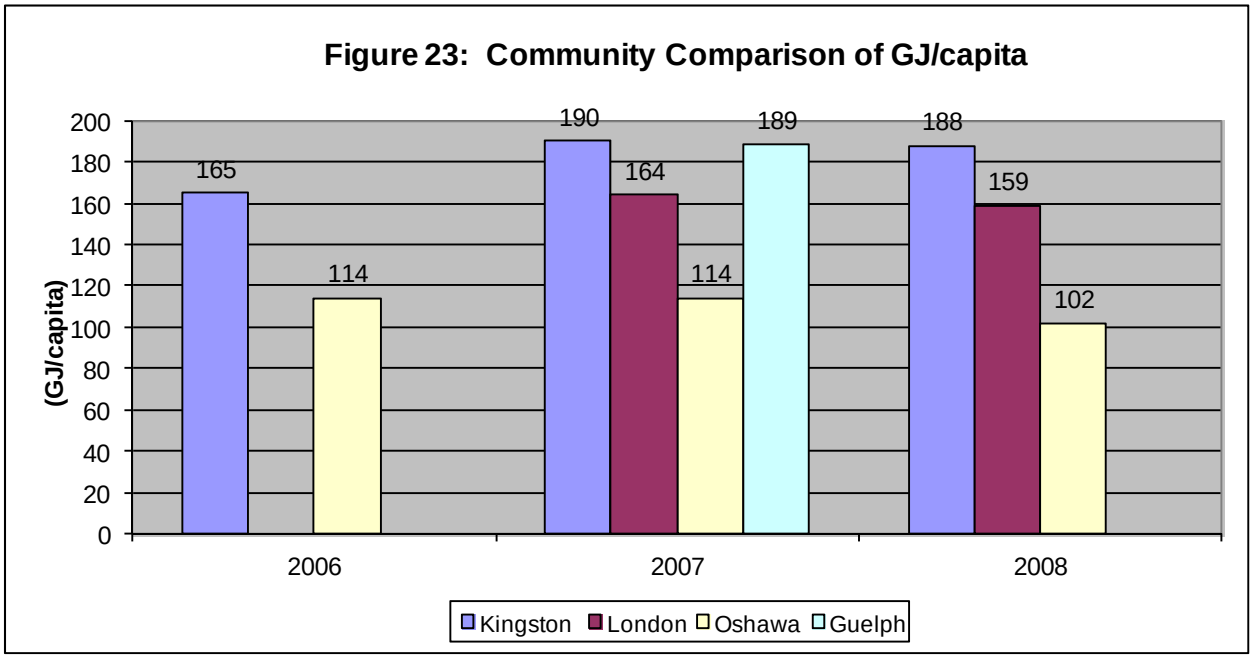


Figure 23: Community Comparison Energy Consumption per Capita

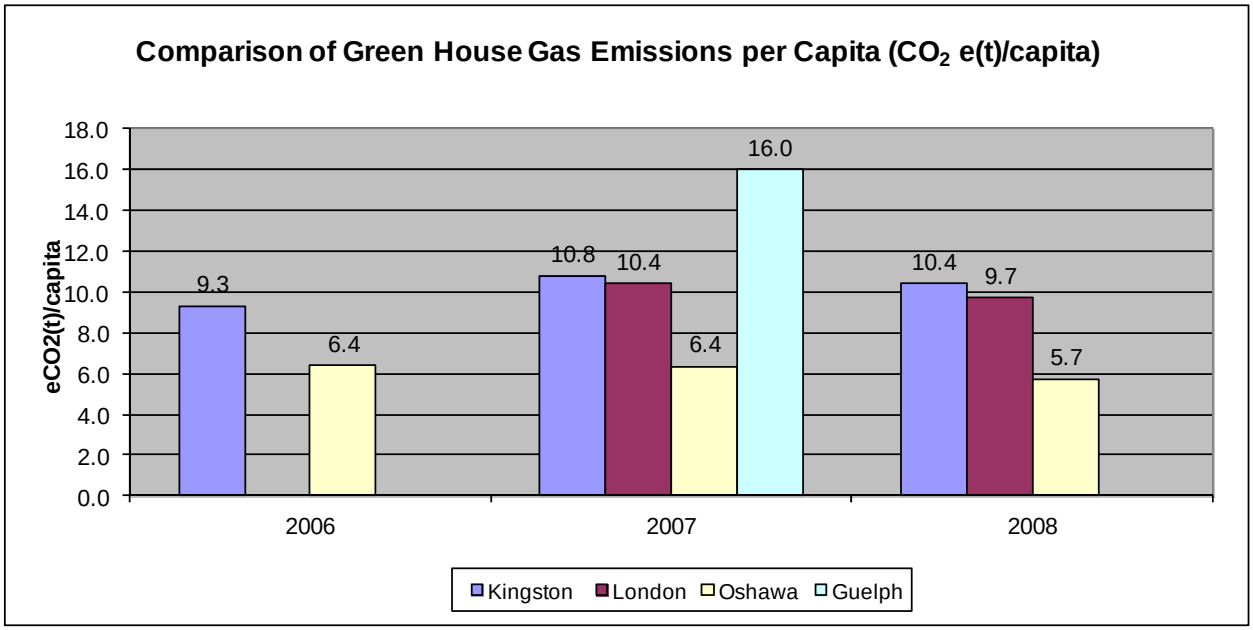


Figure 24: Community GHG Emissions per Capita Comparison

9.0 RECOMMENDATIONS FOR SUBSEQUENT COMMUNITY GHG INVENTORIES and NEXT STEPS

Based on the results and the overall exercise in developing this GHG Inventory for 2006 to 2009, the following recommendations are provided to help the Kingston Community to advance on its objective to reduce its total GHG emissions; as well as to assist the Kingston Community to improve the quality and management of its energy and cost data for future inventories:

- The Kingston Community should measure its greenhouse gas emissions on a more frequent bases (i.e. on an annual basis) to more closely manage and reduce its overall emissions against the 2000 baseline, in order to more regularly assess progress against its set targets. The year 2006 had anomalously warm winter and cool summer. In conjunction with improvements to the Ontario energy grid mix 2006 indicated a reduction in emissions from 2000. This reduction was not sustained in subsequent years. By measuring the Kingston Community emissions on a more frequent basis along with the impact of weather and other relevant confounding factors the status of the Kingston Community's greenhouse gas emissions relevant to the 2000 target could be better understood.

- The Kingston Community should not consider the minimal contribution (1%) of greenhouse gas emissions fro the waste sector to the overall Kingston Community inventory to be the main/only indicator to inform continued efforts to reduce and manage community waste. Greenhouse gas emissions from waste are a single impact category and several other environmental/sustainability impact categories should also be considered as part of the Kingston Community's waste management strategy.

- The Kingston Community should develop a Local Acton Plan with a strong emphasis on the implementation component of the plan. As of December 1st, 20011, the FCM will accept funding applications for plans. As in the past, the FCM will provide up to 50% of eligible costs (up to a maximum of $350,000). Through this funding opportunity, the Kingston community could offset the cost of developing a Local Action Plan.

- Given the current level of greenhouse gas emission in relation to the base year (2000), the Kingston Community may want to revisit its reduction target.

- In order to enable the ICI sector to be broken down into its industrial, commercial and residential components the electricity and natural gas suppliers could be contacted in advance of the inventory request to discuss potential options and timing to provide this level of customer breakdown.

- The Kinston Community should develop a management plan for its greenhouse gas inventory. This plan would be a living document that would consolidate the knowledge and information on procedures, calculations and assumptions utilized in developing its inventories. This would enable a consistent approach among inventories.