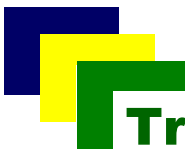
Kingston Community Energy Consumption and Greenhouse Gas Inventory Update (2011)

TriEdge & Associates

November, 2012



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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. The Kingston community also became a member of the Federation of Canadian Municipalities (FCM) Partners in Climate Protection Program (PCP) and joined approximately 200 Canadian Municipalities and over 600 global communities dedicated to the reduction of GHG emissions. 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 2011, TriEdge & Associates in collaboration with PE International developed the *Kingston Community GHG Inventory (2006 to 2009)*. This document presents the Kingston community energy consumption and GHG emission inventory for the years 2000 (baseline) and 2006 to 2011.

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. Changes in methodology from the most recent inventory are identified to allow for consistency. Modifications in methodologies and emission factors were applied to historical data sets to enable the inventories from 2000 and 2006 to 2009 to be restated. This enables consistency and allows for a meaningful comparison from year to year. Data sets were collected for the years 2010 and 2011. Energy consumption and GHG emissions data is provided for 2000 and 2006 to 2011. Energy cost data is presented for 2006 to 2011.

Analyses are provided for 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). Energy cost data is compared from 2006 to 2011. Based on Statistics Canada Census data and estimates of the Kingston student population we estimated that the Kingston community population increased by approximately 10.4% from 2000 to 2011. These population estimates were used to determine per capita estimates for consumption, GHG emissions and cost.

Confounding factors including population, Ontario electricity emission factor changes and weather are reviewed. The Kingston community energy consumption and GHG emissions are compared to benchmark communities London and Guelph.

2011: 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 community energy sectors are residential, ICI (industrial, commercial and institutional), transportation and waste. Table 1 provides the contribution of each of the emission sources to consumption, GHG emissions and cost for 2011. Table 2 provides the contribution from each of the sectors to consumption, GHG emissions and cost.

Table 1: 2011: Energy Consumption, Emission and Cost Details by Emission Source

Emission Source	Consumption			GHG Emissions			Cost		
	Million GJ	% of Total Sources	GJ/Capita	tonnes	% of Total Sources	GHG Emissions per Capita (tonnes)	Million $	% of Total Sources	$/Capita
Electricity	5.0	18.2%	35.5	209,997	14.0%	1.5	$191.4	32.0%	$1,350
Natural Gas	14.8	53.6%	104.4	742,848	49.6%	5.2	$148.8	24.8%	$1,049
Fuel Oil	0.5	2.0%	3.8	39,237	2.6%	0.3	$14.8	2.5%	$105
Diesel	0.9	3.4%	6.7	66,697	4.5%	0.5	$32.0	5.3%	$225
Gasoline	5.6	20.4%	39.8	384,385	25.6%	2.7	$192.6	32.1%	$1,358
Propane	0.7	2.4%	4.7	39,871	2.7%	0.3	$19.4	3.2%	$137
Waste	n/a	n/a	n/a	15,732	1.0%	0.1	n/a	n/a	n/a
Total	27.6	100.0%	194.9	1,498,767	100.0%	10.6	$599.0	100.0%	$4,224

Table 2: 2011: Energy Consumption, Emissions and Cost Details by Energy Sector

Sector	Consumption			GHG Emissions			Cost		
	Million GJ	% of Total Sources	GJ/Capita	tonnes	% of Total Sources	GHG Emissions per Capita (tonnes)	Million $	% of Total Sources	$/Capita
Residential	5.6	20.2%	39.3	270,890	18.1%	1.9	$158.4	26.4%	$1,117
ICI	15.5	56.0%	109.2	761,064	50.8%	5.4	$216.1	36.1%	$1,524
Transportation	6.6	23.8%	46.5	451,082	30.1%	3.2	$224.5	37.5%	$1,583
Waste	n/a	n/a	n/a	15,732	1.0%	0.1	n/a	n/a	n/a
Total	27.6	100.0%	194.9	1,498,767	100.0%	10.6	$599.0	100.0%	$4,224

Table 1 and 2 indicate that in 2011 the Kingston community consumed **27.6 Million GJ** (194.9 GJ/Capita), released **1,498,767 tonnes** of GHG emissions (10.6 tonnes of GHG emissions/Capita) and spent **$599 Million** ($4224/Capita) on energy. Natural gas is the dominant emission source accounting for 54% of the total consumption and 50% of the total GHG emissions. While electricity and gasoline only account for 18% and 30% of the

total energy consumption respectively, they both contribute 32% to the total energy cost. ICI is the dominant sector and is responsible for 56% of the total consumption, 51% of the total GHG emissions and 36% of the cost.

Energy Consumption

Figure 1 provides the total Kingston community energy consumption (expressed as Gigajoules - GJ) from all sources (electricity, natural gas, heating fuel, gasoline, diesel and propane) for the base year 2000 and 2006 to 2011. Since 2000, the energy consumption has increased by approximately 22%.

Figure 1: Energy Consumption (Million GJ) from 2000 and 2006 to 2011

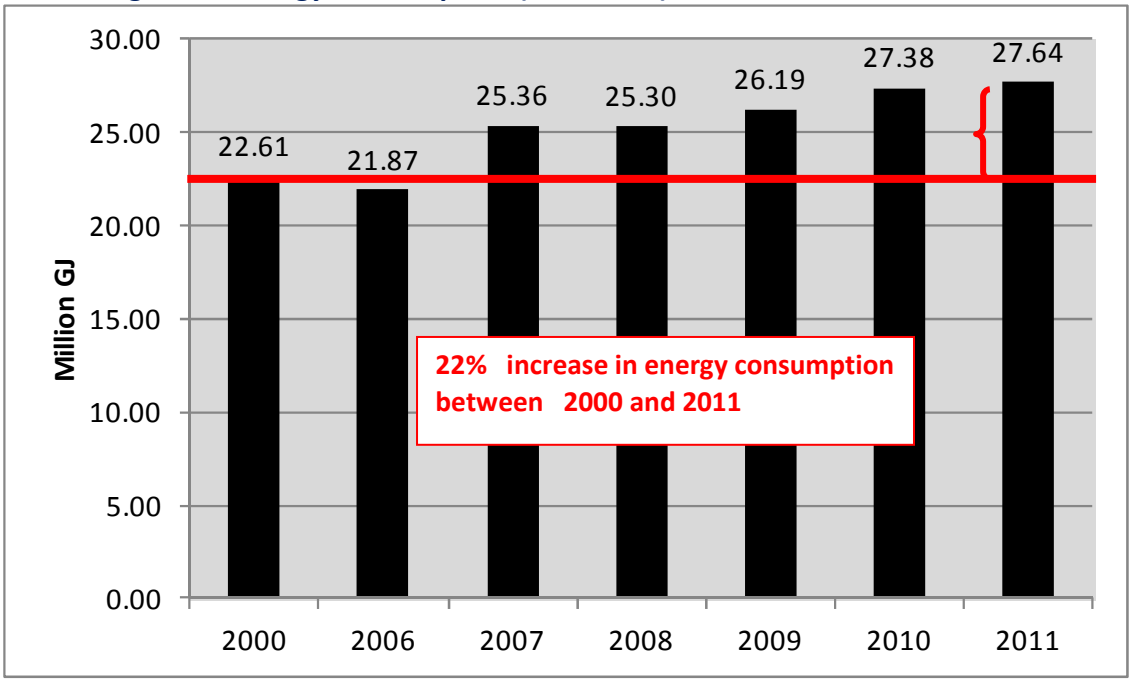


Figure 2 provides the Kingston community energy consumption per capita (GJ/Capita) from all sources for the base year 2000 and 2006 to 2011. The Kingston community experienced an increase in energy consumption per capita of 10.7% from 176 GJ/Capita in 2000 to 195 GJ/Capita in 2011.

Figure 2: Energy Consumption per Capita (GJ/Capita) from 2000, and 2006 to 2011

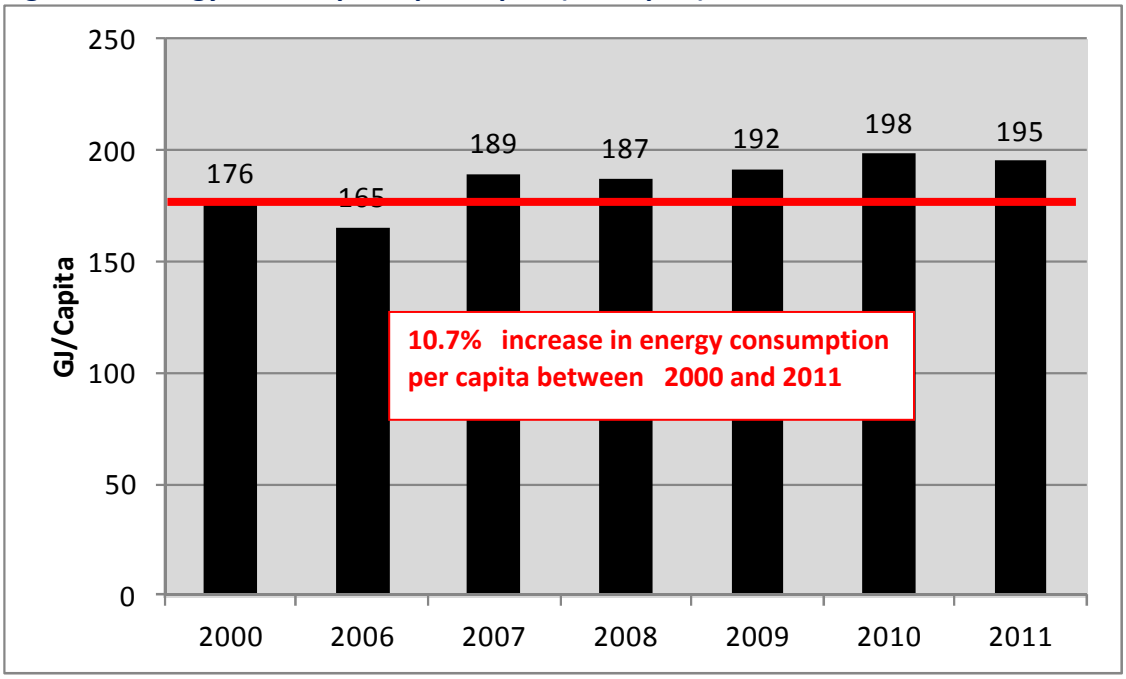
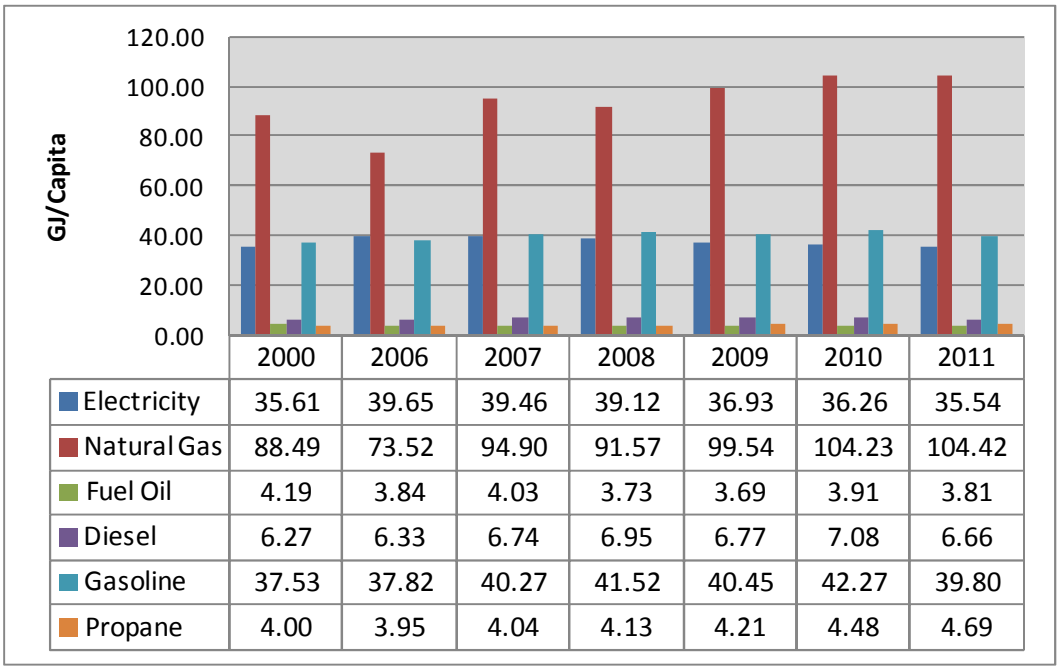


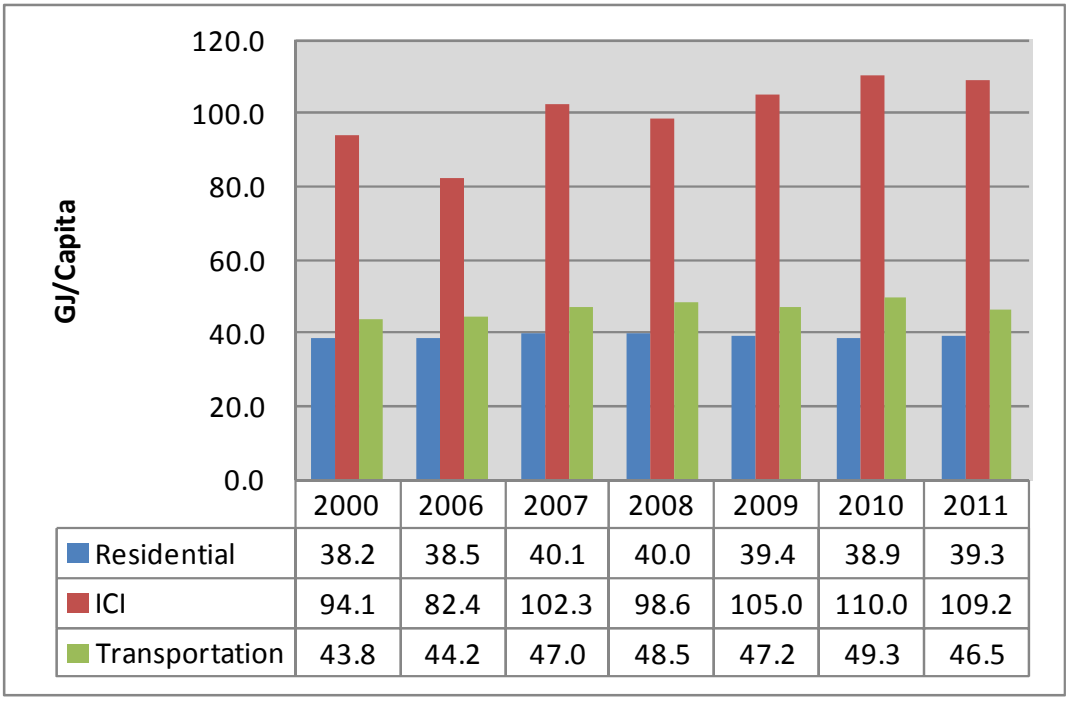
Figure 3 and Figure 4 provide the energy consumption per capita (GJ/Capita) by emission source and sector respectively. Figure 3 illustrates that natural gas is the dominant emission source and that the 10.7% GJ/Capita increase is predominately due to natural gas. Figure 4 illustrates that the ICI sector is the dominant sector predominately responsible for the 10.7% GJ/Capita increase. The residential GJ/Capita has remained relatively stable and the transportation GJ/Capita has increased marginally.

Figure 3: Energy Consumption per Capita by Emission Source (2000 and 2006 to 2011)



	2000	2006	2007	2008	2009	2010	2011
Electricity	35.61	39.65	39.46	39.12	36.93	36.26	35.54
Natural Gas	88.49	73.52	94.90	91.57	99.54	104.23	104.42
Fuel Oil	4.19	3.84	4.03	3.73	3.69	3.91	3.81
Diesel	6.27	6.33	6.74	6.95	6.77	7.08	6.66
Gasoline	37.53	37.82	40.27	41.52	40.45	42.27	39.80
Propane	4.00	3.95	4.04	4.13	4.21	4.48	4.69

Figure 4: Energy Consumption per Capita (GJ/Capita) by Sector



	2000	2006	2007	2008	2009	2010	2011
Residential	38.2	38.5	40.1	40.0	39.4	38.9	39.3
ICI	94.1	82.4	102.3	98.6	105.0	110.0	109.2
Transportation	43.8	44.2	47.0	48.5	47.2	49.3	46.5

Greenhouse Gas Emissions

Figure 5 and Figure 6 illustrate that while the Kingston community GHG emissions increased by 4.1% from 2000 and 2011 the GHG emissions per capita decreased by 5.7%.

Figure 5: Tonnes of GHG Emissions (2000 and 2006 to 2011)

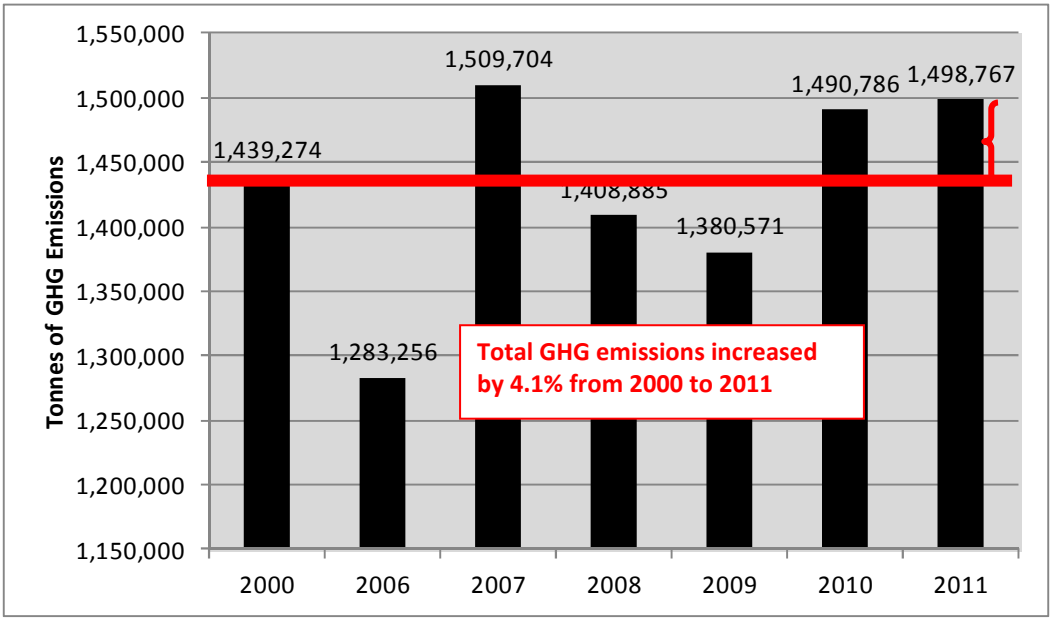


Figure 6: Tonnes of GHG Emissions per Capita (2000 and 2006 to 2011)

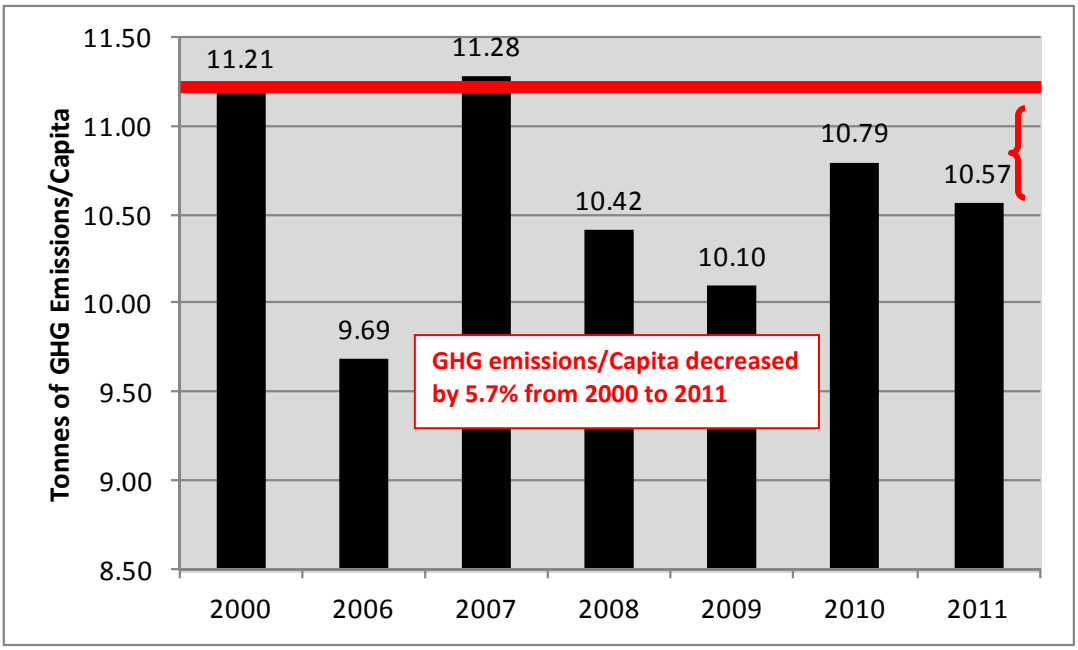
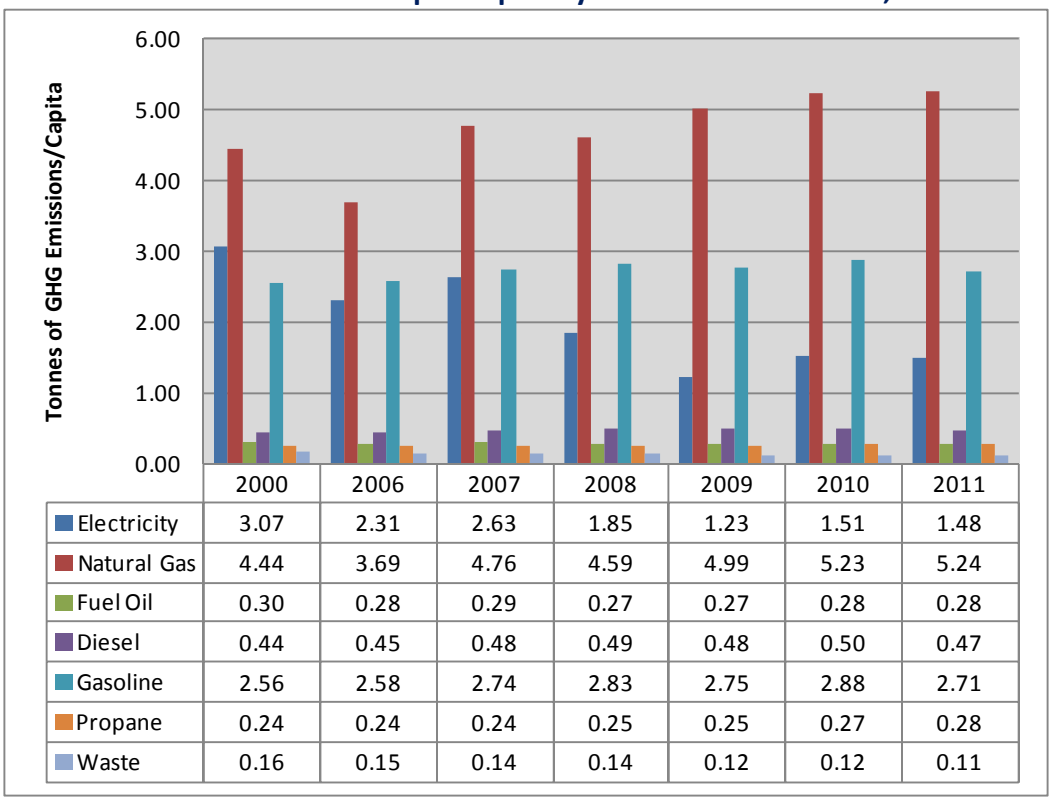


Figure 7 and Figure 8 provide the tonnes of GHG emissions per capita by emission source and sector respectively. Figure 7 illustrates that the electricity GHG emissions per capita have decreased by 52% since 2000 and that the natural gas GHG emissions per capita have increased by 18% since 2000. Since the consumption of electricity per capita remained relatively constant from 2000 to 2011, the decrease in emissions is due to the decrease in the Ontario electricity emission factor of 52% between 2000 and 2011. Since emission factor for natural gas has remained constant over time the increase in the GHG emissions/Capita is consistent with the increase in per capita natural gas consumption of 18%.

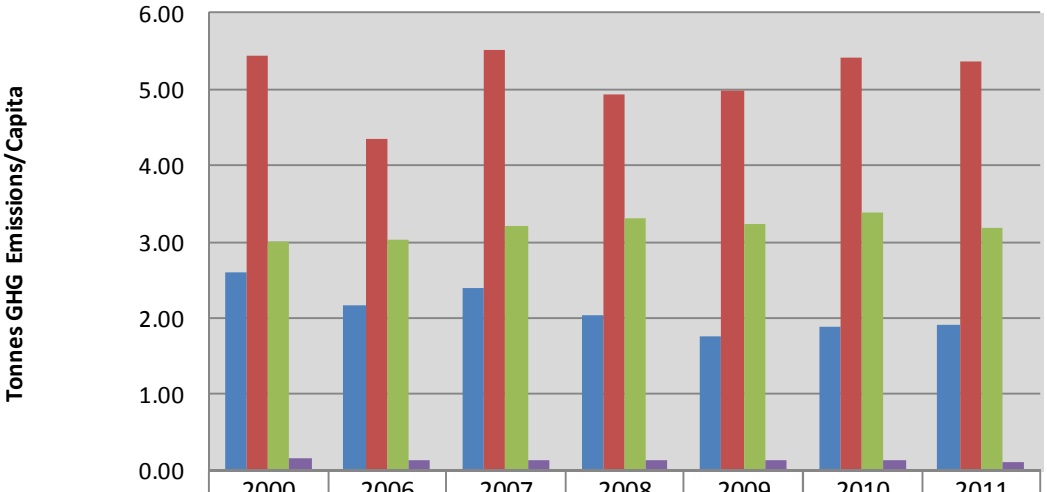
Table 7: Tonnes of GHG Emissions per Capita by Emission Source 2000, 2006 to 2011



	2000	2006	2007	2008	2009	2010	2011
Electricity	3.07	2.31	2.63	1.85	1.23	1.51	1.48
Natural Gas	4.44	3.69	4.76	4.59	4.99	5.23	5.24
Fuel Oil	0.30	0.28	0.29	0.27	0.27	0.28	0.28
Diesel	0.44	0.45	0.48	0.49	0.48	0.50	0.47
Gasoline	2.56	2.58	2.74	2.83	2.75	2.88	2.71
Propane	0.24	0.24	0.24	0.25	0.25	0.27	0.28
Waste	0.16	0.15	0.14	0.14	0.12	0.12	0.11

As illustrated in Figure 8, the ICI sector consistently has the highest GHG emissions/Capita and it has remained relatively consistent over time. The ICI sector is natural gas dominant. The transportation consistently ranks second in the production of GHG emissions/Capita and has remained stable. The residential sector has experienced a decline in the generation of GHG emissions/Capita from 2.6 tonnes of GHG emissions/Capita in 2000 to 1.9 tonnes of GHG emissions/Capita in 2011. The residential sector is electricity dominant and benefits from the reduction in the Ontario electricity emission factor (52% reduction from 2000 to 2011)

Table 8: Tonnes of GHG Emissions per Capita by Sector (2000, 2006 to 2011)



	2000	2006	2007	2008	2009	2010	2011
Residential	2.61	2.17	2.40	2.04	1.77	1.89	1.91
ICI	5.44	4.35	5.52	4.92	4.98	5.40	5.37
Transportation	3.00	3.02	3.22	3.32	3.23	3.38	3.18
Waste	0.16	0.15	0.14	0.14	0.12	0.12	0.11

Energy Expenditures

Figure 9 indicates that the Kingston community has increased its spending on energy by 26.6% from $473 Million in 2006 to $599 Million in 2011. Figure 10 plots the energy cost on a per capita basis and illustrates that since 2006 the energy cost per capita has increased by 18% from $3,571/Capita in 2006 to $4,224 in 2011.

Figure 11 demonstrates that the emission sources with the most significant increases are gasoline and electricity. While the consumption per capita of gasoline only increased by 16%, the cost per capita of gasoline increased by 37%. The consumption of electricity per capita remained relatively constant but the electricity cost per capita increased by 12%. In contrast, the consumption per capita of natural gas increased by 18% but the natural gas cost per capita only increased by 2%. This is reflective of the increased unit costs of gasoline and electricity and the reduced unit cost of natural gas.

Figure 9: Total Energy Cost (2006 to 2011)

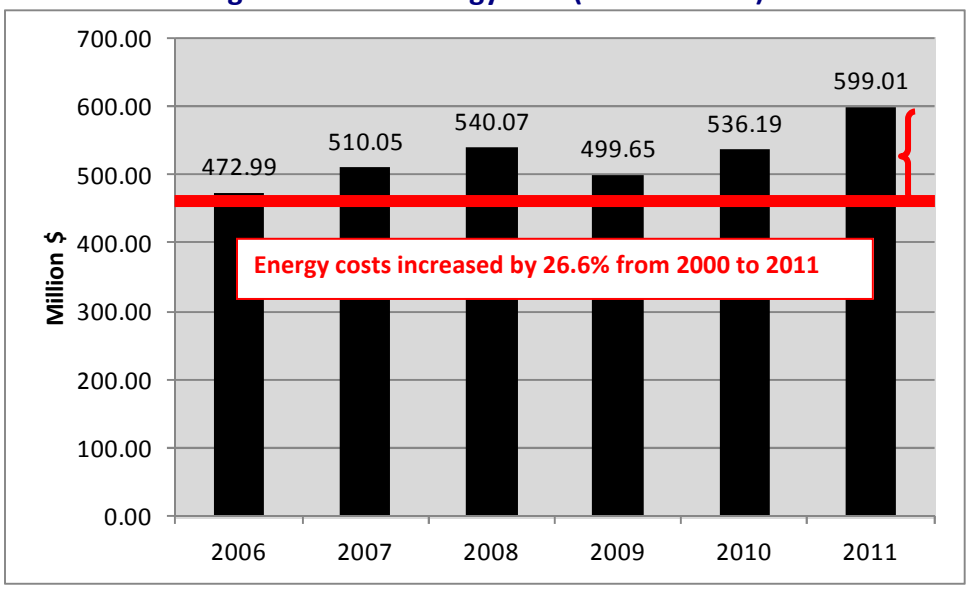


Figure 10: Total Energy Cost/Capita (2006 to 2011)

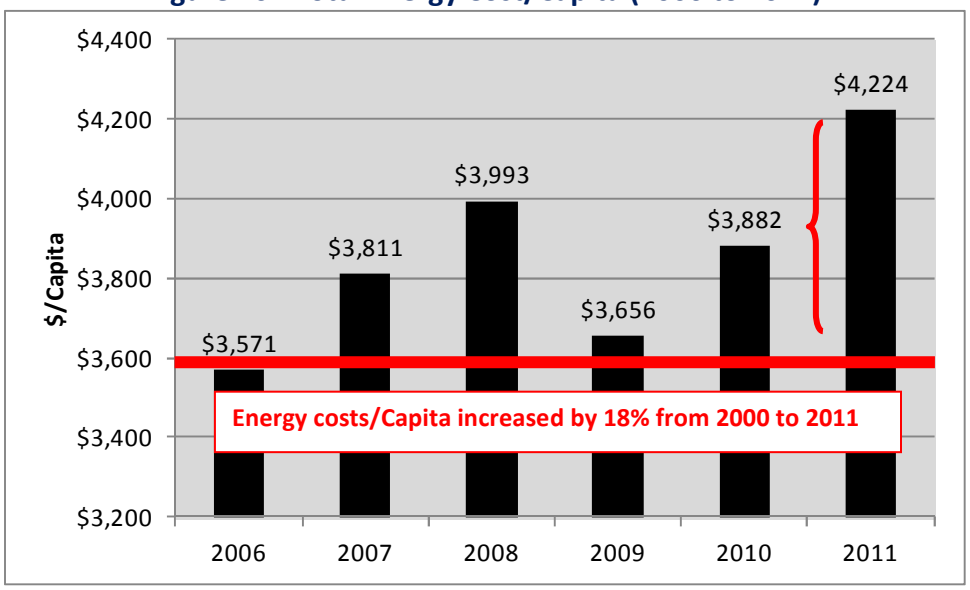
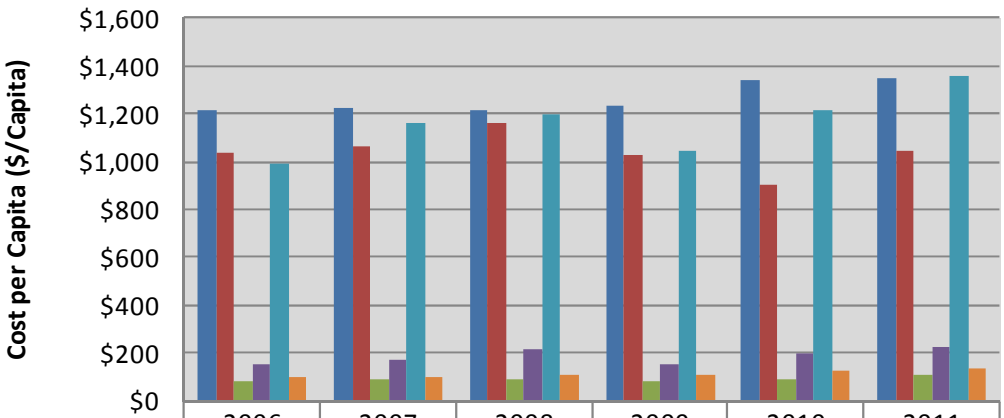
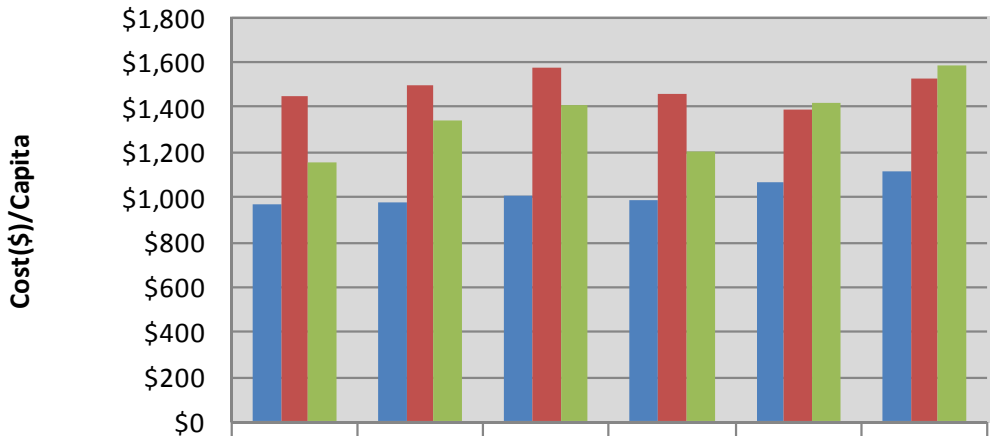


Figure 11: Energy Cost/Capita by Emission Source (2006 to 2011)



	2006	2007	2008	2009	2010	2011
Electricity	$1,211	$1,224	$1,214	$1,233	$1,341	$1,350
Natural Gas	$1,034	$1,059	$1,162	$1,031	$907	$1,049
Fuel Oil	$79	$93	$95	$82	$93	$105
Diesel	$156	$172	$216	$153	$201	$225
Gasoline	$994	$1,164	$1,198	$1,050	$1,217	$1,358
Propane	$97	$98	$108	$105	$123	$137

Figure 12: Energy Cost/Capita by Sector (2006 to 2011)

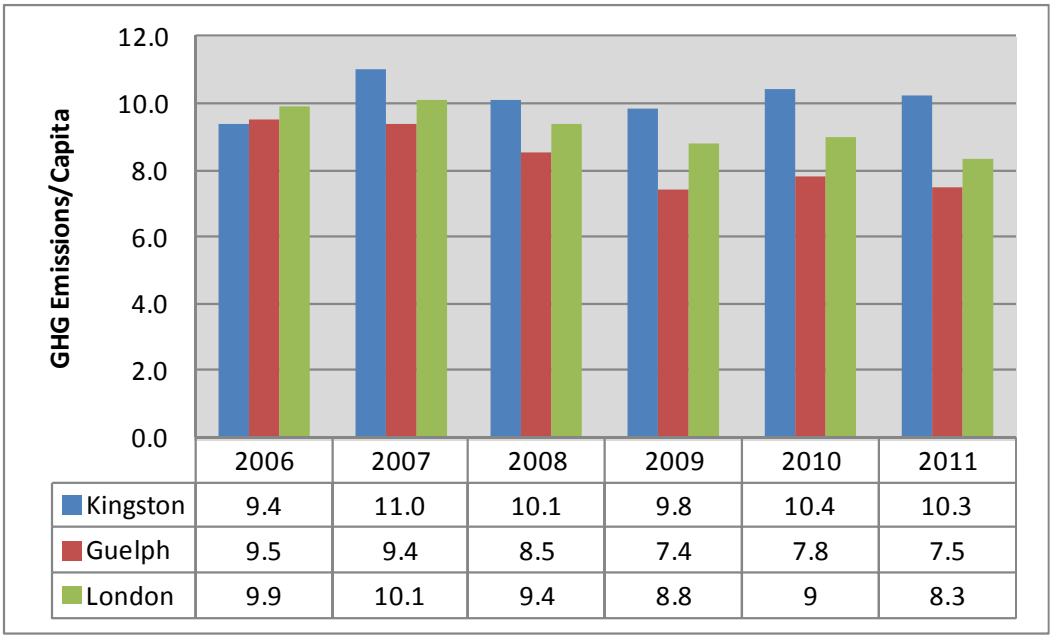


	2006	2007	2008	2009	2010	2011
Residential	$972	$979	$1,006	$990	$1,071	$1,117
ICI	$1,449	$1,495	$1,573	$1,462	$1,394	$1,524
Transportation	$1,150	$1,336	$1,414	$1,203	$1,418	$1,583

Benchmarking

The 2010 and 2011 GHG emissions per capita were benchmarked against London and Guelph. Updated Oshawa data was not available. The Kingston transportation data was reduced slightly to reflect the methodology adopted by Guelph and London. Figure 13 indicates that in 2011 the Kingston community had the highest GHG emissions/Capita in comparison to Guelph and London. A review of the GHG emissions/Capita data for 2010 and 2011 on a sector basis reveals that while Kingston compares well with London and Guelph within the transportation and residential sectors it has significantly higher GHG emissions/Capita associated with the ICI sector.

Figure 13: Kingston, London and Guelph GHG Emissions/Capita (2006 to 2011)



	2006	2007	2008	2009	2010	2011
Kingston	9.4	11.0	10.1	9.8	10.4	10.3
Guelph	9.5	9.4	8.5	7.4	7.8	7.5
London	9.9	10.1	9.4	8.8	9	8.3

Key Influencing Factors

Population growth, changes to the Ontario electricity emission factor and weather changes were examined to determine their impact on the GHG emission inventory.

Population:

Based on Statistics Canada Census data and estimates of the student population we estimated that the Kingston community population increased by 10.4% from 2000 to 2011. The annual population data was used to determine the per capita energy consumption, GHG emissions and cost and allow the data to be normalized for population.

Ontario Electricity Emission Factor:

As a result of improvements to the Ontario energy mix and the phasing out of coal-fired plants, the Ontario electricity GHG emission factor has reduced by approximately 52% from 2000 to 2011. This has had a significant impact on the residential sector which is electricity dominant.

Weather:

Heating Degree Days (HDD) is a measure of the energy needed to heat a building and Cooling Degree Days (CDD) is a measure of the energy needed to cool a building. 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. Since 2000 the number of Cooling Degree Days (CDD) has increased and the number of Heating Degree Days (HDD) has decreased. This implies that the energy required to heat a building has reduced but the energy required to cool a building has increased.

A significant relationship was determined between HDD and residential natural gas consumption per capita. For a reduction of 100 HDD the residential consumption of natural gas per capita (GJ/Capita) will decrease by 0.53 and the residential GHG emissions/Capita will decrease by 0.46.

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1.0 INTRODUCTION

Today, we are bombarded by the impacts of climate change. Winters that forgot to arrive, early springs, prolonged dry seasons, strange and powerful storms are all signs that the predicted pace of climate change was underestimated. While the Kingston community enjoyed unprecedented patio weather in March (2011), there was an underlying sense of concern that nature had lost its rhythm.

The international scientific community has long been in agreement that human activity has increased the concentration of Greenhouse gas (GHG) emissions in the atmosphere. In recent geologic history, there has been a balance in the atmosphere of greenhouse gas emissions that enabled the heat from the sun to be trapped within the lower atmosphere and allow for temperatures to sustain life. Since the industrial revolution the increasing burning of fossil fuels and other anthropogenic sources of GHG emissions has led to an increase in the concentration of GHG emissions to the point where this balance has been impacted and the global temperature is increasing.

We are now experiencing the predictions of the climate change scientists: severe weather events, temperature changes, droughts, agricultural impacts, habitat changes, melting glaciers and ecosystem disturbances. These changes are happening at an accelerated rate compared to predictions.

Municipalities across Canada are challenged by the environmental, social and economic impacts of climate change. In response to this challenge Kingston has joined the Federation of Canadian Municipalities (FCM) Partners in Climate Protection (PCP) program. Through this membership, the Kingston community has as 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

Kingston has completed Milestones 1 and 2.

Previous Kingston Community GHG Inventory Reports

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 Kingston 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. In 2011, TriEdge & Associates in collaboration with PE International developed the *Kingston Community GHG Inventory (2006 to 2009)*.

Outline of the Current Inventory

This document presents the Kingston community energy consumption and GHG emission inventory for the years 2000 (baseline) and 2006 to 2011. A review of the protocol and boundary applied to this inventory is discussed and the inventory methodology is detailed. Changes in methodology from the most recent inventory are identified to allow for consistency. Modifications in methodologies and emission factors were applied to historical data sets to enable the inventories from 2000 and 2009 to be restated. This enables consistency and allows for a meaningful comparison from year to year. Data sets were collected for the years 2010 and 2011. Energy consumption and GHG emissions data is provided for 2000 and 2006 to 2011. Unfortunately, energy cost data was not available for 2000. Energy cost data is presented for 2006 to 2011. Analyses are provided for 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 including population, Ontario electricity emission factor changes and weather are reviewed. The Kingston community energy consumption and GHG emissions are compared to benchmark communities London and Guelph.

Objectives

The objectives of the Kingston Community Energy Consumption and GHG inventory Update (2011) are:

- To assist the Kingston Environmental Advisory Forum (KEAF) in the development of a Kingston community GHG reduction action plan (local action plan – LAP);
- To apply the new emission factors from the most recent Environment Canada National Inventory Report: *(1990 to 2010) GHG Sources and Sinks in Canada.*
- To update the 2006 to 2009 inventory to include 2010 and 2011 data;
- To determine the impact of emission factor changes to GHG emissions;

- To determine the impact of Heating Degree Days (HDD) on natural gas consumption;
- To determine the current status (based on 2011 data) of the Community GHG emissions with respect to the emission reduction target;
- To determine the relationship between energy consumption, GHG emissions and cost over time;
- To determine at a sector level (residential, ICI, transportation and waste) energy consumption, GHG emissions and energy costs;
- To determine at the energy source level (natural gas, electricity, fuel oil (heating oil), propane, diesel and gasoline) the distribution of energy consumption, GHG emissions and energy costs.

2.0 INVENTORY PROTOCOL, BOUNDARY & SCOPE

The GHG inventory protocol, boundary and scope applied in the 2006 to 2009 GHG inventory have been applied to the 2011 GHG inventory update.

Protocol

As in the previous inventory, the current Kingston Community GHG inventory applies the ICLEI protocol for community reporting. The sectors to be reported in Milestone One for the Community include: residential, industrial, commercial, industrial, transportation and waste. With the available Kingston community data, it is not possible to separate the industrial and commercial sectors. Therefore, this sector is reported as a combined sector for industry, commercial and institutions (ICI).

Boundary

As in the case of the previous inventory, the 2011 Kingston Community GHG inventory update adopts a geopolitical boundary to determine what is 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.

Scope

Community GHG emissions are 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 1 provides a summary of the activity areas and scopes and identifies which apply to the Kingston community GHG inventory. The activity areas and scope that apply to the Kingston inventory are highlighted.

Table 1: Summary of Activity Areas, Scope and the Kingston Community Inventory

Summary of Activity Areas, Scope and Application to the Kingston Community GHG Inventory		
Activity Area	**Scope**	**Application to Kingston Community GHG Inventory**
Energy		
Stationary	S1: Utility delivered fuel consumption	Hydro One and Utilities Kingston are distributors not generators. Not relevant to the Kingston inventory.
	S1: Decentralized fuel consumption	Included within the Kingston inventory: propane, natural gas and fuel oil (heating oil).
	S2: Utility-consumed fuel for electricity and heat generation	Hydro One and Utilities Kingston are distributors not generators. Not relevant to the Kingston inventory.
	S2: Utility-delivered electricity/heat/steam cooling consumpiton	Hydro One and Utilities Kingston are distributors not generators. Not relevant to the Kingston inventory.
	S2: Decentralized electricity/heat/steam consumption	Included within the Kingston inventory: emissions from electricity.
	S3: Up and down stream emisions	Not included in the Kingston Community inventory.
Transport	S1: Tailpipe from on-road vehicles	Included within the Kingston Inventory (diesel and gasoline).
	S1: Tailpipe from rail, sea, airborne and non-road vehicles operating in the community.	Not included in the Kingston Community inventory.
	S2: Electricity associated with vehicles in community lightrail.	Not relevant to the Kingston Community Inventory.
Fugitive Emissions	S1: Fugitive emissions not already accounted for.	Not included in the Kingston Community Inventory
	S3: Up and down stream emissions.	
Industrial Processes		
	S1: Decentralized process emissions	Not included in the Kingston Community Inventory.
	S3: Up and down stream emissions	
Agriculture		
	S1: Emissions from livestock and soils	Not included in the Kingston Community Inventory.
	S3: Up and down stream emissions from fertiizer and pesticide manufacture.	

Table 1 (cont'd): Summary of Activity Areas, Scope and the Kingston Community Inventory

Summary of Activity Areas, Scope and Application to the Kingston Community GHG Inventory		
Activity Area	**Scope**	**Application to Kingston Community GHG Inventory**
Land Use, Land Changes and Forestry		
	S1: Net bigenic carbon flux	Not included in the Kingston Community Inventory.
Waste		
Soilid Waste Disposal	S1: Direct Emissions from landfill, compost and incinceration facilities within the community	Included within the Kingston Community Inventory.
	S3: Landfill, incineration and compost emissions in the present year from waste produced in the community.	Included within the Kingston Community Inventory.
WasteWater Treatment and Discharge	S1: Direct Emissions from wastewater facilities located within the community.	Includes methane and nitrous oxides. Emissions associated with Kingston waste water treatment and discharge are detailed within the Kingston Corporate GHG Inventory report.
	S3: Present year emissions from waste water produced to date inside the community. Future emissions from treated water.	Annual emissions are captured in S1.

3.0 DATA SOURCES AND METHODOLOGY

3.1 Data Sources

As in the previous inventory, the development of the City of Kingston 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.

Table 2 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 2011 is provided.

3.2 Methodology

GHG emissions are reported as equivalent tonnes of Carbon Dioxide (eCO2 (t)). To estimate GHG emissions the quantity of the emission source is multiplied by the emission factor for that emission source. The emission factors are derived from the most recent Environment Canada National Inventory Report (1990 to 2010).

3.2.1 Emission Factors

Emission factors for natural gas, fuel oil (heating oil), diesel (motor) and gasoline (motor) have remained unchanged. For these emission sources the same emission factors have been in place since the baseline inventory in 2000. Electricity is the only emission factor that has changed with time. This emission factor is a function of the Ontario electricity energy mix and as the Province approaches its target of phasing out coal-fired plants the emission factor for electricity is impacted. In addition each time the National Inventory Report (NIR) is updated by Environment Canada the historical emission factors for electricity are modified to reflect improved methodologies in estimating this emission factor. Therefore for each year 2000 and 2006 to 2011, there is a difference electricity emission factor. Since the most recent NIR is for 1990 to 2010, the Ontario electricity emission factor provided for 2010 is applied to 2011. It is likely that in updated NIR the historical electricity emission factors may be restated. This will require that the Kingston community electricity GHG emission estimates to be recalculated. Details relating to the impact of the electricity emission factor on GHG emissions are provided in Section 4.2 and Section 6.

3.2.2 Emission Sources – Consumption and Cost Data

Table 2 provides a summary of the data sources, the data quality and the percentage of 2011 GHG emissions represented by each of the emission sources. This is followed by a detailed account of the data sources and methodology applied for each of the emission sources.

Table 2: Summary of Energy Data Sources and Quality

Summary of Energy Data Sources and Quality			
Emission Source	**Data Source**	**Data Quality**	**% of 2011 GHG Emissions**
Electricity	Utilities Kingston	High	14.0%
	Hydro One	High	
Natural Gas	Utilities Kingston	High	49.6%
	Union Gas	High for consumption Medium for cost	
Heating Oil	Major Supplier	Low	2.6%
Gasoline (Motor)	Kent Marketing Services	Medium to High	25.7%
Diesel (Motor)	Kent Marketing Services; Statistics Canada Data	Low-Medium	4.5%
Propane	Major Supplier	Low	2.7%
Waste	City of Kingston, WSI, WM	Low to Medium	1.0%

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.

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:

As in the 2006 to 2009 Community GHG Inventory, Utilities Kingston provided aggregated consumption and cost data for 2010 and 2011. Cost and consumption data was provided 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:

As in the 2006 to 2009 Community GHG Inventory, Hydro One provided aggregated consumption and cost data for 2010 and 2011. Consumption and cost data was provided for the following customer classes: Farm, General and Residential. Non-residential cost and consumption data was aggregated as the ICI sector.

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 applied the same methodology for providing the cost and consumption of natural gas in the 2010 and 2011 update as they did in the 2006 to 2009 inventory. Utilities Kingston provided the consumption and cost data for 2010 and 2011 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:

Consumption Data

Union Gas applied the same methodology for the collection of consumption data for the 2010 and 2011 update as they did for the 2007 to 2009 inventories. (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 provided the 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.

Cost Data

In the 2006 to 2009 inventory, Union Gas was unable to provide rate data. Estimates for the cost of natural gas were made based on average annual residential and commercial rates from the Union Gas website. During the 2010 and 2011 update, Union Gas provided average rates for both the residential and commercial sectors for the years 2006 to 2011. The Union Gas cost data for the years 2006 to 2009 was restated to allow meaningful year to year comparisons.

Heating Oil (Fuel Oil)

The same methodology to estimate the consumption and cost of heating oil applied in the 2006 to 2009 GHG inventory was applied in the 2010 and 2011 GHG inventory update. A major supplier provided their sales data (consumption and cost) as well as an estimate of their market share for 2010 and 2011. This allowed an estimate of the total market share (costs and consumption) for the Kingston community.

Propane

The same methodology to estimate the consumption and cost of heating oil applied in the 2006 to 2009 GHG inventory was applied in the 2010 and 2011 GHG inventory update. 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.

Gasoline and Diesel (Transportation)

Annual data from 2010 and 2011 for the retail sales (total liters sold and cost) of gasoline and diesel in the City of Kingston was purchased from Kent Marketing Services (KMS). This is consistent with the methodology adopted in past inventories. *Trends in Kingston's Community Greenhouse Gas Emissions 2000-2006* (Hsu, 2007) determined that while the KMS data set likely captures the majority of gasoline consumption for the community it is less likely able to capture the majority of diesel consumption within the commercial sector (card lock). Therefore, during the 2006 to 2009 inventory and consistent with the approach presented in Trends in Kingston's Community Greenhouse Gas Emissions 2000-2006 (Hsu, 2007), diesel consumed by the community was estimated using a diesel (with adjustments for tractor trailer consumption) to gasoline ratio obtained from the Annual Canadian Vehicle Survey.

Statistics Canada eliminated the Annual Canadian Vehicle Survey in 2010. It was therefore not possible to use the exact same methodology as in the past to estimate the community diesel consumption. For the 2011 Inventory Update, the estimate of the community consumption of diesel was derived from the Statistics Canada data set (CANSIM, Table 405-0002) of the volume

in liters of diesel and gasoline sold in Ontario. It was determined that the historical ratio of gasoline to diesel consumption was consistent with the 2010 and 2011 data set. It was assumed that the percentage of diesel usage from tractor trailers in the past (2000, 2006 to 2009) was consistent for 2010 and 2011.

Waste (Organic)

The only component of the waste that is considered within the inventor is the organic waste stream that goes to landfill. 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. Waste Management provided estimates of waste collected at its transfer facility. WSI provided a conservative estimate of the ICI waste received. This data was used to restate historical waste estimates. WSI provided an estimate of 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 CO_2, 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.

4.0 EMISSION SOURCE ANALYSIS

Emission sources for the Kingston Community greenhouse gas inventory include:

- Electricity,
- Natural gas,
- Fuel oil (Heating Oil),
- Diesel (motor),
- Gasoline (motor),
- Propane and
- Waste.

This section provides an overview of the total community energy consumption, GHG emissions and energy cost by emission source and a detailed review of the consumption, GHG emissions and cost associated with each of the emission sources.

4.1 OVERVIEW

This section provides an overview of the total community energy consumption, GHG emissions and energy cost by emission source.

4.1.1 Energy Consumption (GJ) Overview by Emission Source

This section provides an overview of the community energy consumption. 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). A breakdown of the 2011 community energy consumption by sector is presented. The energy consumption as well as the energy consumption per capita by energy source is compared for the years 2000 and 2000 to 2006.

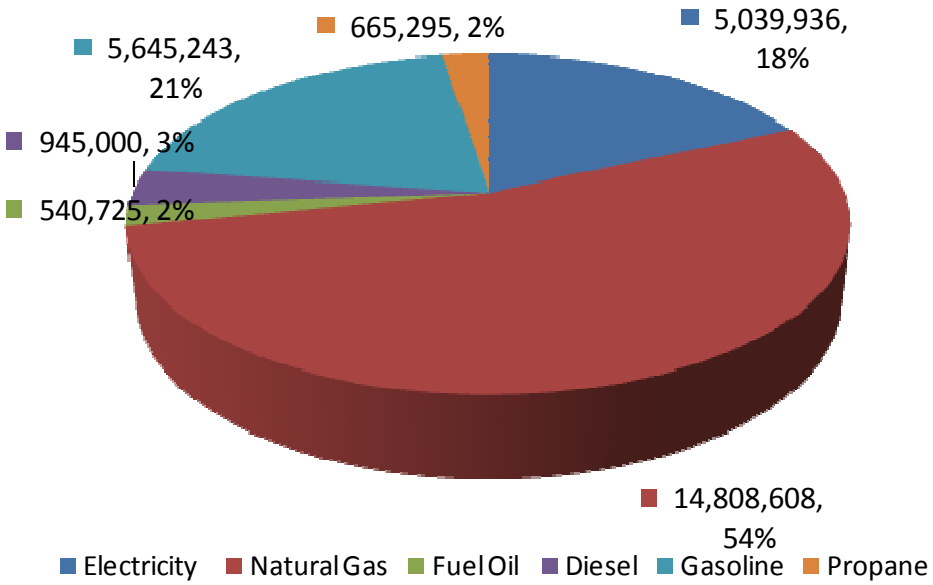
What is a Gigajoule (GJ)?

A Gigajoule is a measure of energy. One gigajoule of electricity energy is equivalent to keeping a 60-watt bulb continuously lit for six months.[1]

[1] http://oee.nrcan.gc.ca/commercial/technical-info/tools/8397

Figure 1 provides the energy consumption (GJ) by source for 2011.

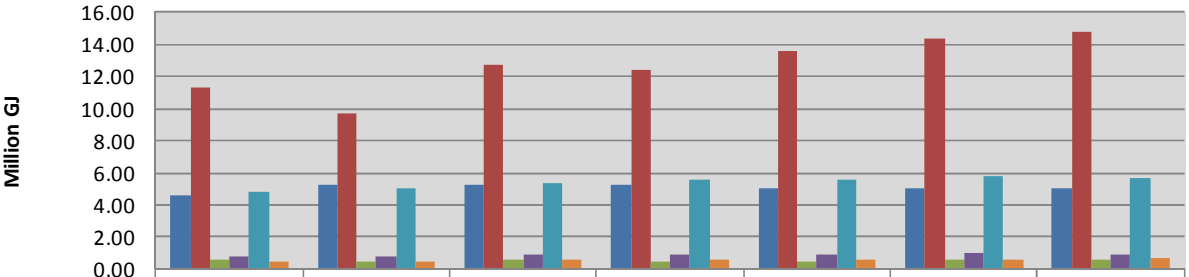
Figure 1: 2011 Community Energy Consumption (GJ) by Source
Total: 27,644,807 GJ



In 2011, a total of 27.6 Million GJ of energy was consumed by the community. Natural Gas is the energy source with the highest level of consumption for the community (54%). Gasoline and electricity account for 21% and 18% respectively of the community energy consumption. Propane, diesel and fuel oil are small contributors together making up 7% of the total community energy consumption.

Figure 2 provides the energy consumption (GJ) by emission source for the years 2000 and 2006 to 2011.

Figure 2: Annual Energy Consumption (Million GJ) by Emission Source (2000, 2006 to 2011)

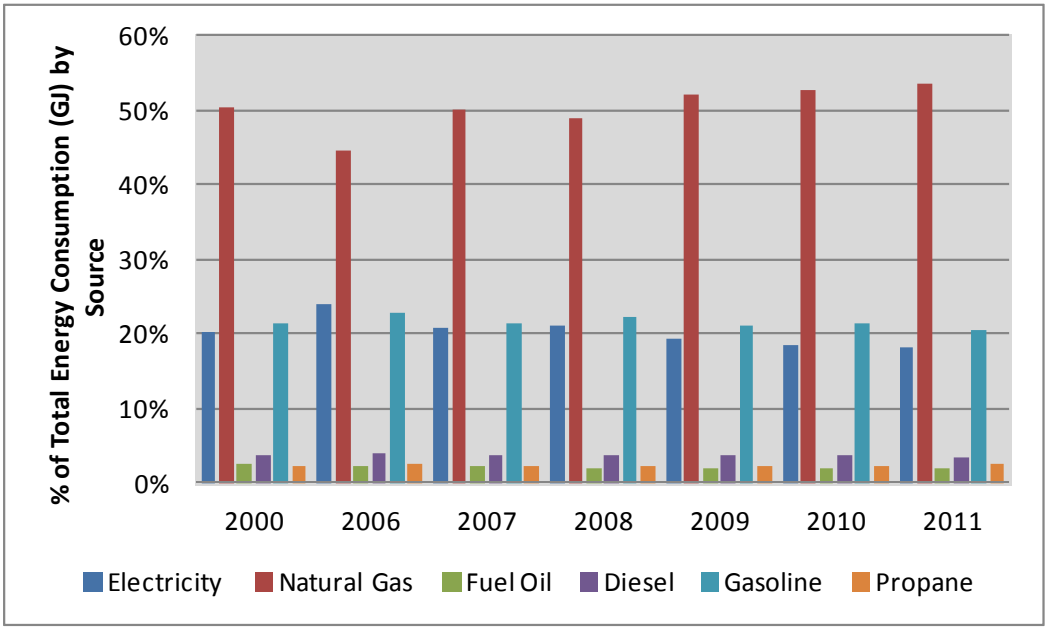


	2000	2006	2007	2008	2009	2010	2011
Electricity	4.57	5.25	5.28	5.29	5.05	5.01	5.04
Natural Gas	11.36	9.74	12.70	12.39	13.61	14.40	14.81
Fuel Oil	0.54	0.51	0.54	0.50	0.50	0.54	0.54
Diesel	0.80	0.84	0.90	0.94	0.93	0.98	0.95
Gasoline	4.82	5.01	5.39	5.62	5.53	5.84	5.65
Propane	0.51	0.52	0.54	0.56	0.58	0.62	0.67

Total (Million GJ)	2000	2006	2007	2008	2009	2010	2011
	22.61	21.87	25.36	25.30	26.19	27.38	27.64
% Difference from 2000	n/a	-3.24%	12.17%	11.90%	15.84%	21.11%	22.29%

Overall, energy consumption (GJ) has increased by approximately 22% between the base year (2000) and 2011. Figure 3 illustrates the difference in the percentage of the total energy Consumption (GJ) by emission source for the years 2000 and 2006 to 2011.

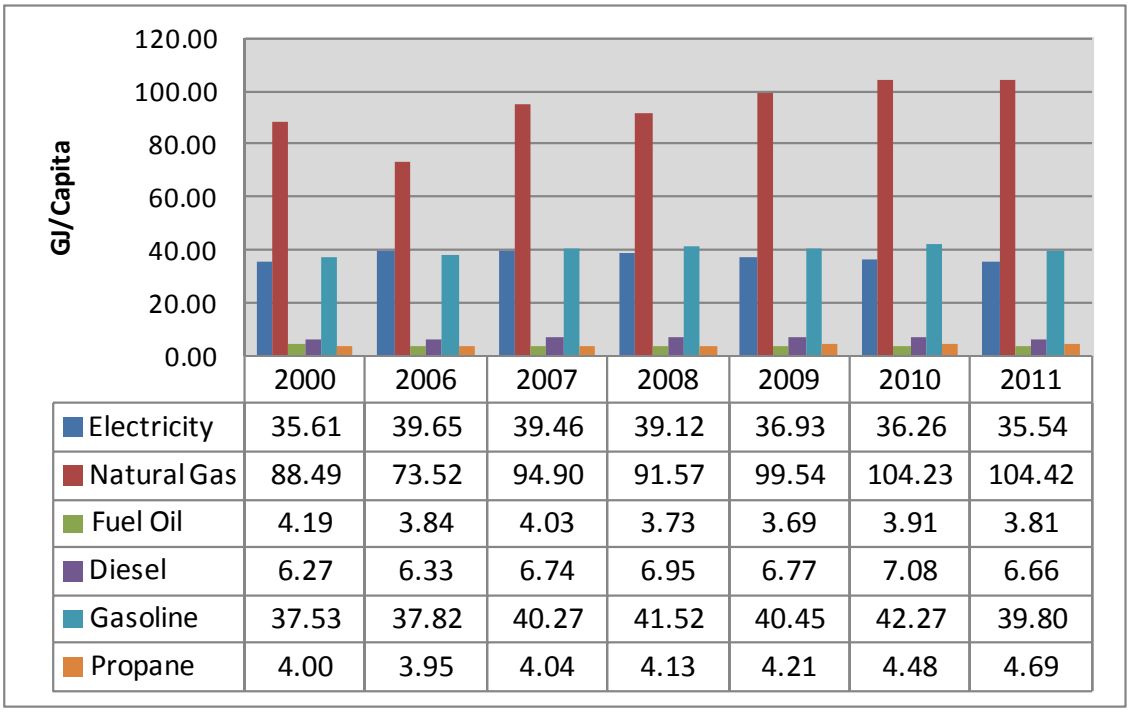
Figure 3: Percentage of Total Energy Consumption (GJ) by Source (2000 and 2006 to 2011)



The data presented in Figure 3, indicates that the percentage breakdown of total energy consumption (GJ) by emission source has remained relatively consistent over the years (2000 and 2006 to 2011). Natural gas is the greatest component of the total energy consumption (GJ) and its percentage of total energy consumption increased by 4% (50% to 54%) from 2000 to 2011. Electricity and gasoline are the second greatest components of consumption with comparable percentages. Electricity experienced a 2% decrease from 20% in 2000 to 18% in 2011. The percentage of gasoline consumption decreased from 21% in 2000 to 20% in 2011. The percentage of total energy consumption for fuel oil, diesel and propane remained relatively constant at 2%, 4% and 2% respectively.

Figure 4 illustrates the community energy consumption per capita (GJ/Capita) by emission source for the years 2000 and 2006 to 2011. Population estimates are based on Statistics Canada Census data and estimates of the student population. Details regarding population estimates are provided in Section 6.

Figure 4: Consumption per Capita (GJ/Capita) by Emission Source (2000 and 2006 to 2011)



	2000	2006	2007	2008	2009	2010	2011
Electricity	35.61	39.65	39.46	39.12	36.93	36.26	35.54
Natural Gas	88.49	73.52	94.90	91.57	99.54	104.23	104.42
Fuel Oil	4.19	3.84	4.03	3.73	3.69	3.91	3.81
Diesel	6.27	6.33	6.74	6.95	6.77	7.08	6.66
Gasoline	37.53	37.82	40.27	41.52	40.45	42.27	39.80
Propane	4.00	3.95	4.04	4.13	4.21	4.48	4.69

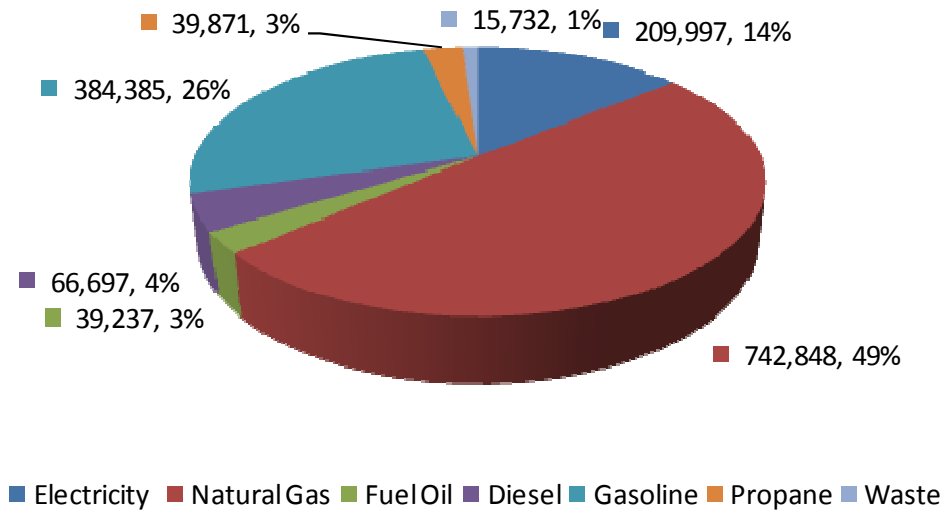
Year	2000	2006	2007	2008	2009	2010	2011
Total GJ/Capita	176	165	189	187	192	198	195
% Difference from 2000	n/a	-6.23%	7.58%	6.21%	8.80%	12.57%	10.70%

Figure 4 indicates that community energy consumption per capita (GJ/Capita) has increased by 10.7% (18.8 GJ/Capita) between 2000 and 2011 and that consumption of natural gas is the largest component of this increase. The relationship between natural gas and weather is discussed in Section 6.

4.1.2 GHG Emissions Overview by Emission Source

This section provides and overview of the community GHG emissions by emission source. Figure 5 provides a summary of the total community GHG emissions generated by emission source for 2011.

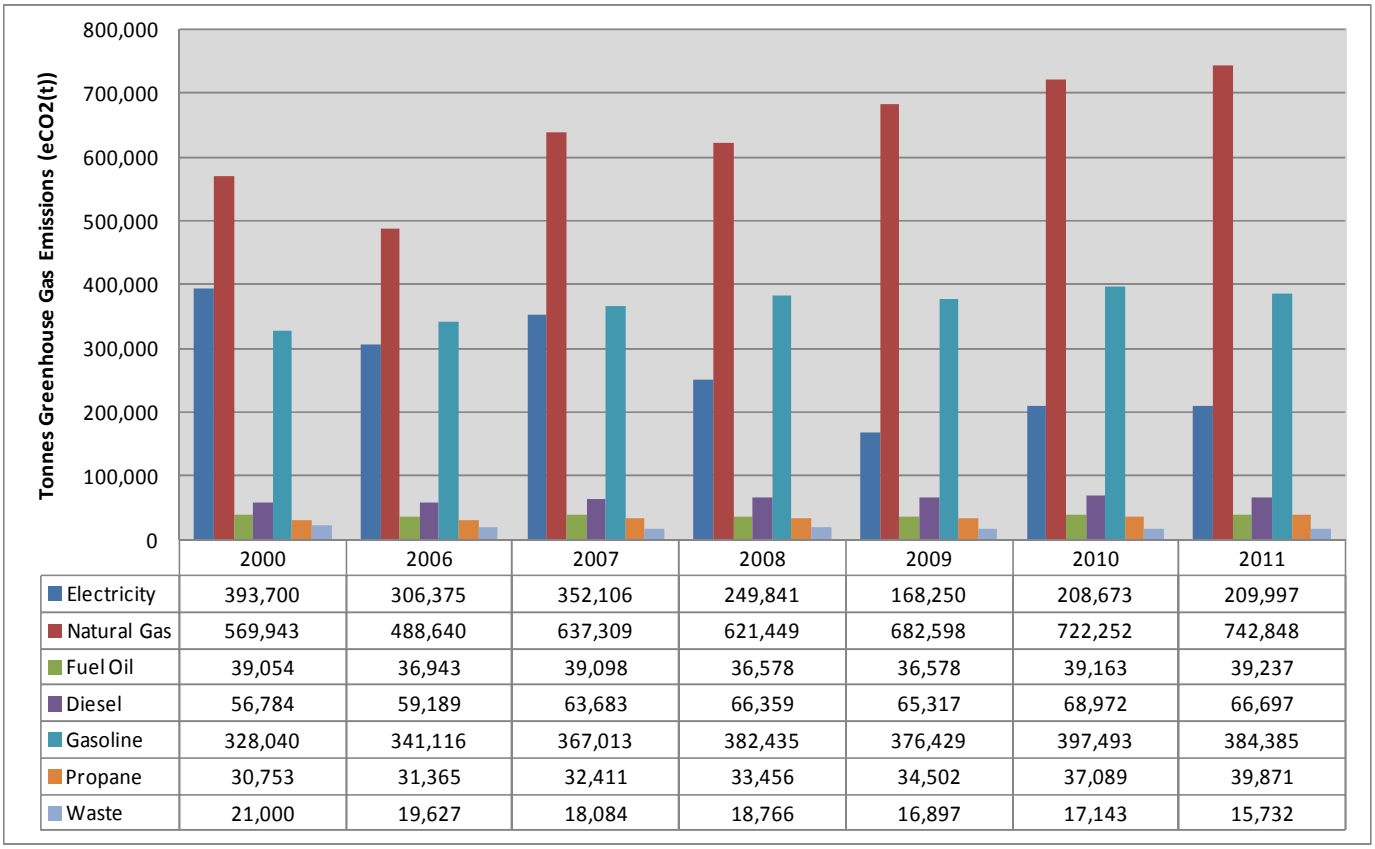
Figure 5: 2011 Community Greenhouse Gas Emissions by Source
Total: 1,498,767 eCO2 (t)



In 2011, the Kingston community released 1,498,767 tonnes of GHG Emissions. Half of the GHG emissions were derived from natural gas; 26% came from gasoline (motor) and 14% came from electricity. Together, propane, diesel, fuel oil and waste contributed 11% of the total emissions.

Figure 6 provides a summary of the total GHG emissions generated by emission source for the baseline year (2000) and the years 2006 to 2011.

Figure 6: Total GHG Emissions by Emission Source (2000 and 2006 to 2011)



	2000	2006	2007	2008	2009	2010	2011
Electricity	393,700	306,375	352,106	249,841	168,250	208,673	209,997
Natural Gas	569,943	488,640	637,309	621,449	682,598	722,252	742,848
Fuel Oil	39,054	36,943	39,098	36,578	36,578	39,163	39,237
Diesel	56,784	59,189	63,683	66,359	65,317	68,972	66,697
Gasoline	328,040	341,116	367,013	382,435	376,429	397,493	384,385
Propane	30,753	31,365	32,411	33,456	34,502	37,089	39,871
Waste	21,000	19,627	18,084	18,766	16,897	17,143	15,732

Total tonnes of Greenhouse Gas Emissions (eCO2(t))	2000	2006	2007	2008	2009	2010	2011
	1,439,274	1,283,256	1,509,704	1,408,885	1,380,571	1,490,786	1,498,767
% Difference from 2000	n/a	-10.84%	4.89%	-2.11%	-4.08%	3.58%	4.13%

Total community GHG emissions increased by approximately 4% from 2000 to 2011. The most notable changes in GHG emissions between 2000 and 2011 are: a 30% increase for natural gas, a 46.7% decrease for electricity and a 17% increase for gasoline.

Figure 7 illustrates the percentage of the total GHG emissions represented by each of the emissions sources for the years 2000 and 2006 to 2011. The percentage of annual GHG emissions remained relatively constant for fuel oil, diesel, gasoline, propane and waste. While the annual percentage of GHG emissions associated electricity decreased over time, the annual percentage of GHG emissions associated with natural gas increased over time.

Figure 7: Percentage of Greenhouse Gas Emissions by Source (2000 and 2006 to 2011)

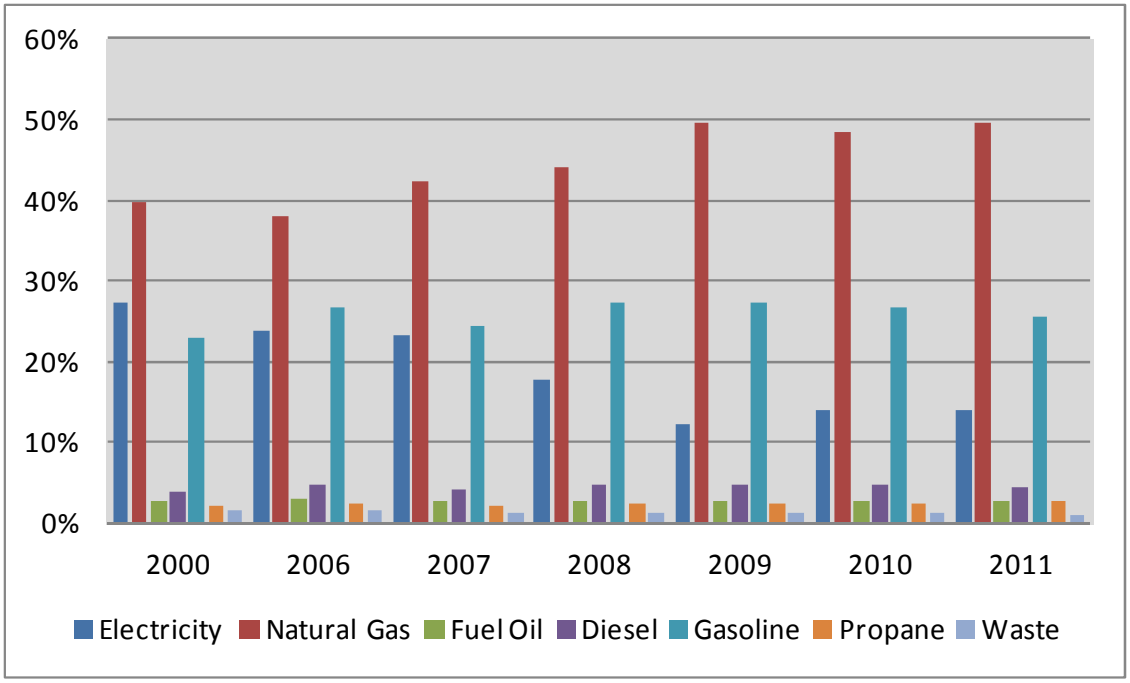
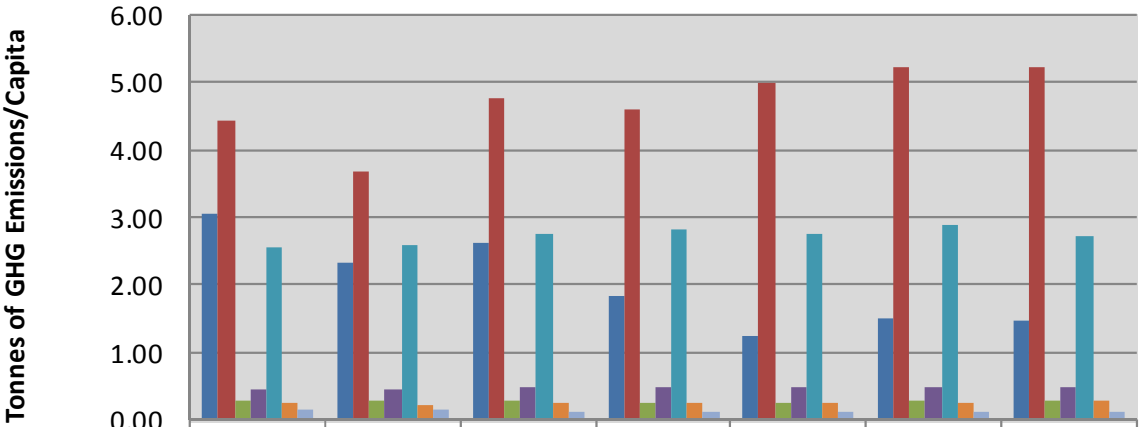


Figure 7 highlights a key change in the production of GHG emissions by energy source overtime. Natural gas, electricity and gasoline are responsible for approximately 90% of the total community GHG emissions. Natural Gas is the greatest contributor to the total GHG emissions and grew from 40% of the total in 2000 to 50% of the total in 2011. In contrast, electricity decreased from 27% of the total in 2000 to 14% of the total in 2011. Gasoline remained relatively consistent growing from 23% of the total in 2000 to 26% of the total in 2011. Diesel, fuel oil, propane and waste remained relatively stable and collectively contributed approximately 10% of the total community GHG emissions.

Figure 8 illustrates the community GHG emissions per capita by emission source for the years 2000 and 2006 to 2011. Population estimates are based on Statistics Canada Census data and estimates of the student population. Details regarding population estimates are provided in Section 6.

Figure 8: GHG Emissions per Capita by Emission Source (2000 and 2006 to 2011)



	2000	2006	2007	2008	2009	2010	2011
Electricity	3.07	2.31	2.63	1.85	1.23	1.51	1.48
Natural Gas	4.44	3.69	4.76	4.59	4.99	5.23	5.24
Fuel Oil	0.30	0.28	0.29	0.27	0.27	0.28	0.28
Diesel	0.44	0.45	0.48	0.49	0.48	0.50	0.47
Gasoline	2.56	2.58	2.74	2.83	2.75	2.88	2.71
Propane	0.24	0.24	0.24	0.25	0.25	0.27	0.28
Waste	0.16	0.15	0.14	0.14	0.12	0.12	0.11

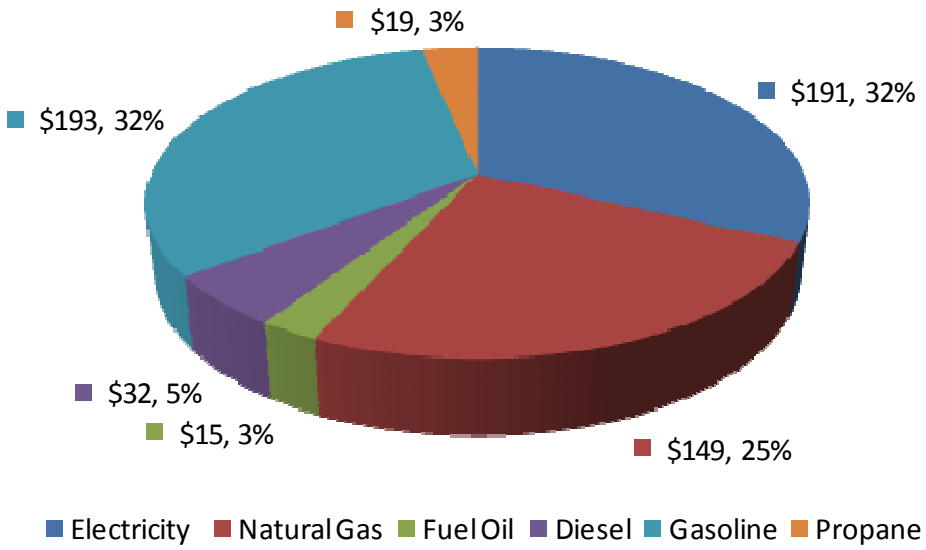
Year	2000	2006	2007	2008	2009	2010	2011
Total tonnes of GHG Emissions per capita (eCO2(t)/Capita)	11.21	9.69	11.28	10.42	10.10	10.79	10.57
% Difference from 2000	n/a	-13.6%	0.6%	-7.1%	-9.9%	-3.7%	-5.7%

Figure 8 indicates that community GHG emissions per capita have decreased by 5.7% from 11.2 tonnes of GHG emissions/Capita in 2000 to 10.6 tonnes of GHG emissions/Capita in 2011. Most notable is the electricity GHG emissions per capita which decreased by 52% since 2000 and the natural gas GHG emissions per capita which increased by 18%. Since the consumption of electricity per capita remained relatively constant from 2000 to 2011, the decrease in emissions is due to the decrease in the Ontario emission factor of 52% between 2000 and 2011. Since emission factor for natural gas has remained constant over time the increase in the GHG emissions/Capita is consistent with the increase in per capita natural gas consumption of 18%.

4.1.3 Energy Cost Overview by Emission Source

This section provides an overview of the community energy cost by emission source. Figure 9 provides a summary of the cost of energy by emission source for the year 2011.

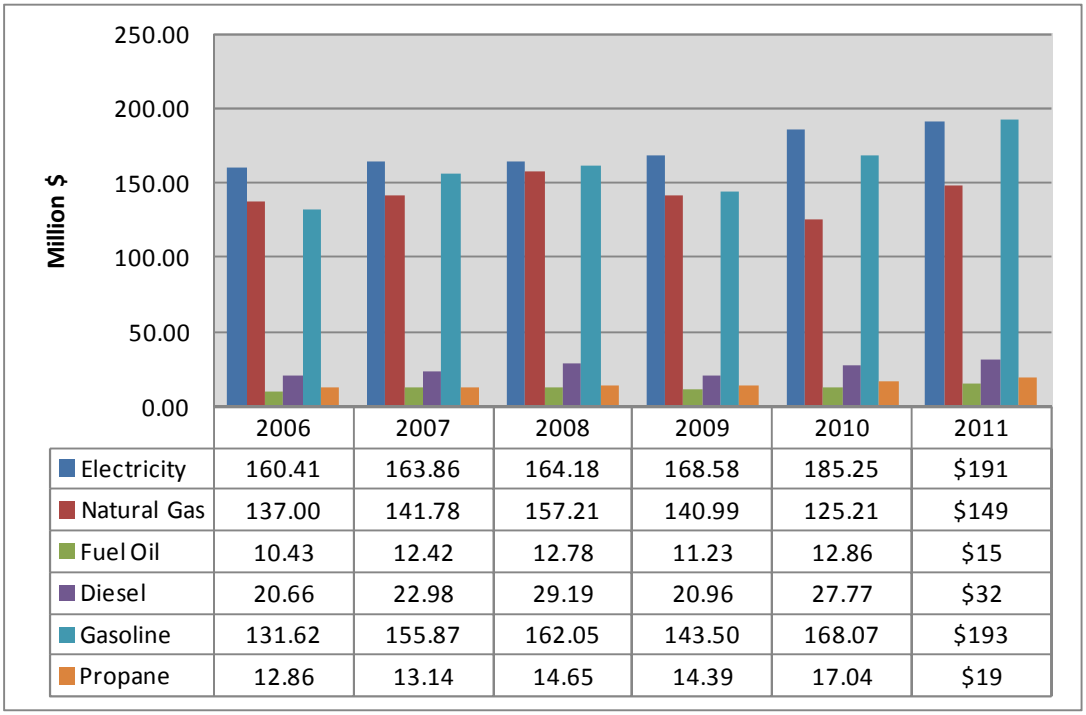
Figure 9: 2011 Community Energy Cost (Million $) by Emission Source
Total Cost: $599 Million



In 2011, the Kingston community spent $599 Million on energy. Each with a contribution of 32%, gasoline and electricity are the emission sources with the largest contribution to the community's energy cost. Natural gas ranked third with a contribution of 25% of the community's energy cost. Propane, diesel and fuel oil collectively make up approximately 11% of the total community's energy cost.

Figure 10 provides a summary of the Cost of Energy by Emission Source for the years 2006 to 2011. Emission source cost data was not available for the baseline year (2000).

Figure 10: Total Expenditure by Emission Source (2006 to 2011)



	2006	2007	2008	2009	2010	2011
Electricity	160.41	163.86	164.18	168.58	185.25	$191
Natural Gas	137.00	141.78	157.21	140.99	125.21	$149
Fuel Oil	10.43	12.42	12.78	11.23	12.86	$15
Diesel	20.66	22.98	29.19	20.96	27.77	$32
Gasoline	131.62	155.87	162.05	143.50	168.07	$193
Propane	12.86	13.14	14.65	14.39	17.04	$19

Energy Cost (Million $)	2006	2007	2008	2009	2010	2011
	$472.99	$510.05	$540.07	$499.65	$536.19	$599.01
% Difference from 2006	n/a	7.8%	14.2%	5.6%	13.4%	26.6%

Overall, the cost of energy has increased by approximately 26.5% from $473 Million in 2006 to $599 Million in 2011. Figure 11 illustrates the difference in the percentage of energy cost by emission source.

Figure 11: Percentage of Cost by Emission Source (2006 to 2011)

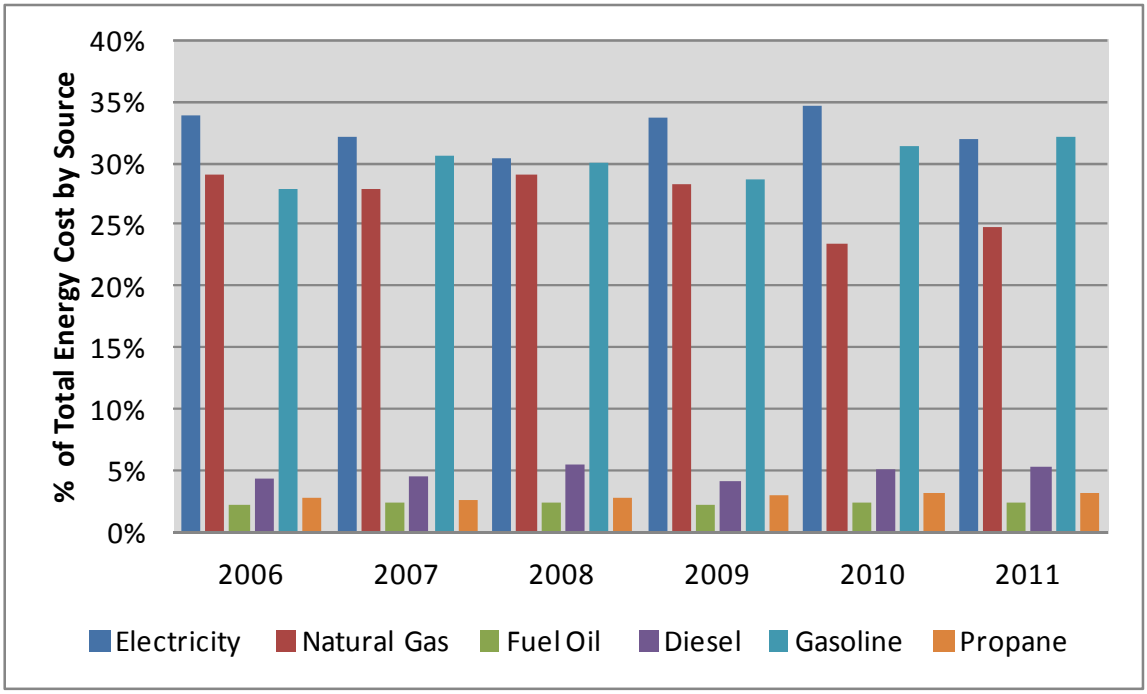
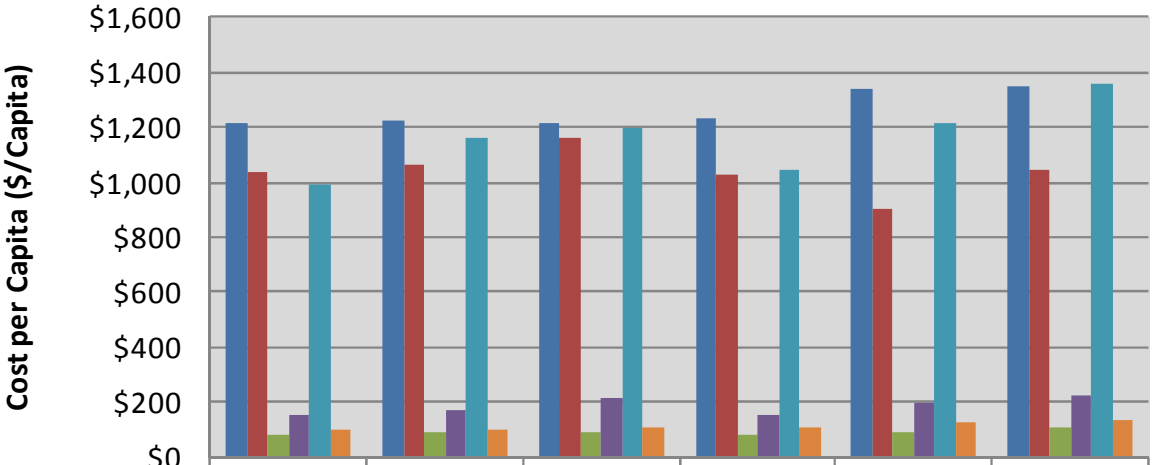


Figure 11 illustrates that the percentage of community energy costs by emission source has remained relatively stable from 2006 to 2011. Electricity consistently accounts for the highest percentage of cost in comparison to all of the emission sources (decreased from 34% to 32% of the total between 2006 and 2011). While the consumption (GJ) and the GHG emissions associated with natural gas have increased over time its contribution to total energy cost has decreased over time (29% in 2006 to 25% in 2011). In contrast, the percentage contribution of gasoline to total energy cost has increased from 28% in 2006 to 32% in 2011. The cost contribution derived from fuel oil, diesel and propane have remained unchanged at 2%, 4% and 3% respectively.

Figure 12 provides the energy cost per capita by emission source for 2006 to 2011.

Figure 12: Energy Cost per Capita by Emission Source (2006 to 2011)



	2006	2007	2008	2009	2010	2011
Electricity	$1,211	$1,224	$1,214	$1,233	$1,341	$1,350
Natural Gas	$1,034	$1,059	$1,162	$1,031	$907	$1,049
Fuel Oil	$79	$93	$95	$82	$93	$105
Diesel	$156	$172	$216	$153	$201	$225
Gasoline	$994	$1,164	$1,198	$1,050	$1,217	$1,358
Propane	$97	$98	$108	$105	$123	$137

Year	2006	2007	2008	2009	2010	2011
Total Energy Cost/Capita	$3,571	$3,811	$3,993	$3,656	$3,882	$4,224
% Difference from 2000	n/a	6.7%	11.8%	2.4%	8.7%	18.3%

The total community energy cost per capita increased by 18% ($653/Capita) from 2006 to 2011 ($3,571/Capita in 2006 to $4,224 in 2011). While the cost of all emission sources increased over this period, the most significant increases were from electricity and gasoline.

4.2 ELECTRICITY

As discussed in Section 3, the electricity emission factor changes from year to year depending on the Ontario energy mix. In addition, each time the Environment Canada National Inventory Report is published the historical electricity emission factor is restated to reflect improved methodologies. Table 3 below provides a summary of the electricity emission factor for 2000 and 2006 to 2011 derived from the NIR (1990 to 2010). The electricity emission factor for 2011 was assumed to be the same as the electricity emission factor published for 2010. During subsequent inventories the 2011 electricity inventory will have to be restated to reflect the updated emission factor.

Table 3: Comparison of Ontario Electricity Emission Factors from 2000 to 2006 to 2011

Year	Emission Factor NIR (1990-2010): Ontario kg CO2/kwh	Difference between 2000 based on NIR (1990 -2010)
2000	0.31	N/A
2006	0.21	-32.26%
2007	0.24	-22.58%
2008	0.17	-45.16%
2009	0.12	-61.29%
2010	0.15	-51.61%
2011*	0.15	-51.61%

Table 4 summarizes the consumption (kWh and GJ), GHG emission and cost data for electricity for 2000 and 2006 to 2011. The baseline (2000) inventory did not provide expenditure data.

Table 4: Electricity: Consumption, Emissions and Expenditure (2000 and 2006 to 2011)

Electricity - Consumption, Emissions, and Cost Data Comparison (2000 and 2006 to 2011)										
Year	Consumption				Emissions			Cost		
	Million kwh	Million GJ	% of Total Sources	GJ per Capita	eCO2 (kilotonnes)	% of Total Sources	GHG Emissions per Capita	Cost (Million $)	% of Total Sources	$/GJ
2000	1,270	4.57	20%	35.6	394	27%	3.07	n/a	n/a	n/a
2006	1,459	5.25	24%	39.7	306	24%	2.31	160.4	34%	$30.5
2007	1,467	5.28	21%	39.5	352	23%	2.63	163.9	32%	$31.0
2008	1,470	5.29	21%	39.1	250	18%	1.85	164.2	30%	$31.0
2009	1,402	5.05	19%	36.9	168	12%	1.23	168.6	34%	$33.4
2010	1,391	5.01	18%	36.3	209	14%	1.51	185.3	35%	$37.0
2011	1,400	5.04	18%	35.5	210	14%	1.48	191.4	32%	$38.0

Key findings from this data set comparison are as follows:

- The annual electricity consumption increased by 10.3% (130 Million kwh) from 2000 to 2011.
- The annual electricity proportion of the total community consumption (GJ) remained relatively constant from 2000 to 2011 (20% in 2000 and 18% in 2011).
- The annual electricity consumption per capita (GJ/Capita) remained relatively constant from 2000 to 2011 (35.6 GJ/Capita in 2000 and 35.5 GJ/Capita in 2011).
- The annual GHG emissions due to electricity decreased 183,703 tonnes (46.7%) between 2000 and 2011.
- The electricity emission factor (based on the Ontario energy mix) decreased by 52% between 2000 and 2011.
- The annual GHG emission per capita due to electricity decreased by 52% (3.07 in 2000 to 1.48 in 2000). Since the consumption per capita remained relatively constant, the GHG emission per capita reduction is the same as the reduction for the electricity emission factor (52%).
- The annual cost of electricity increased by 19.3% between 2006 and 2011 ($160 Million in 2006 and $191 Million in 2011).
- The cost per GJ of electricity increased by 24% between 2006 and 2011 ($31.5/GJ in 2006 to $38.0/GJ in 2011).

4.3 NATURAL GAS

The GHG emission factor for natural gas for Ontario from the Environment Canada NIR (1990 to 2010) Annex 8 was applied to calculate the GHG emissions for natural gas. This emission factor has not changed since the baseline year (2000). This emission factor of 0.001891 tonnes CO_2e/m^3 was applied to the aggregated consumption data provided by Utilities Kingston and Union Gas to determine GHG emissions from natural gas combustion.

Table 5 summarizes the Natural Gas consumption, cost and GHG emission data for 2000 and 2006 to 2011. The baseline inventory (2000) did not provide expenditure data.

Table 5: Natural Gas: Consumption, Expenditure and Emissions for 2000 and 2006 to 2011

Total: Natural Gas - Consumption, Cost and GHG Emissions 2000 and 2006 to 2011											
Year	Consumption				GHG Emissions			Expenditure			
	Million m3	Million GJ	% of Total Sources	GJ/Capita	eCO2 (kilotonnes)	% of Total Sources	eCO2 (t) per Capita	Million $	$/m3	$/GJ	% of Total Sources
2000	301	11.4	50%	88	570	40%	4.4	n/a	n/a	n/a	n/a
2006	258	9.7	45%	74	489	38%	3.7	$137	$0.53	$14.1	29%
2007	337	12.7	50%	95	637	42%	4.8	$142	$0.42	$11.2	28%
2008	329	12.4	49%	92	621	44%	4.6	$157	$0.48	$12.7	29%
2009	361	13.6	52%	100	683	49%	5.0	$141	$0.39	$10.4	23%
2010	382	14.4	53%	104	722	48%	5.2	$125	$0.33	$8.7	25%
2011	393	14.8	54%	104	743	50%	5.2	$149	$0.38	$10.0	25%

Key findings from this data set are as follows:

- Natural Gas consumption and the associated GHG emissions increased by 30% between 2000 and 2011.
- The natural gas percentage of total sources for consumption increased from 50% to 54% from 2000 to 2011.
- The consumption per capita and GHG emissions per capita increased by 18% between 2006 and 2011.
- The annual total cost of natural gas increased by 8.5% between 2006 and 2011 from $137 Million to $149 Million.
- The average cost per unit of natural gas has decreased by 29% between 2006 and 2011.
- The natural gas percentage of total emission source costs has decreased by 4% between 2006 and 2011 from 29% to 25%.

4.4 HEATING OIL

The GHG emission factor for heating oil (fuel oil) in the Environment Canada NIR (1990 to 2010) Annex 8 (0.00283 tonnes CO_2e/litre) has remained constant since the baseline (2000) inventory. This emission factor was applied to the estimate of heating oil consumption for the community to determine the GHG emissions from heating oil combustion.

Table 6 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 6: Heating Oil: Consumption, Expenditures and Emissions for 2000 and 2006 to 2011

Heating Oil - Consumption, Cost and GHG Emissions for 2000 and 2006 to 2011										
Year	Consumption				Emissions			Cost		
	Million liters	GJ (x 1000)	GJ/Capita	% of Total Sources	eCO2 (kilotonnes)	eCO2(t) per Capita	% of Total Sources	Million $	% of Total Sources	$/GJ
2000	13.8	538	4.19	2%	39	0.30	3%	n/a	n/a	n/a
2006	13.1	509	3.84	2%	37	0.28	3%	$10	2%	$20.5
2007	13.8	539	4.03	2%	39	0.29	3%	$12	2%	$23.1
2008	12.9	504	3.73	2%	37	0.27	3%	$13	2%	$25.4
2009	12.9	504	3.69	2%	37	0.27	3%	$11	2%	$22.3
2010	13.8	540	3.91	2%	39	0.28	3%	$13	2%	$23.8
2011	13.9	541	3.81	2%	39	0.28	3%	$15	2%	$27.4

Key finding from this data set are as follows:

- The total consumption and the GHG emissions of heating oil have remained relatively steady between 2000 and 2011.
- Between 2000 and 2011, the consumption per capita (GJ/Capita) has decreased by 9%.
- Over time, heating oil has remained at 2% of the total energy source consumption.
- The heating oil GHG emissions per capita have remained relatively constant and the percentage of total GHG emissions has remained constant at 3%.
- The total cost of heating oil has increased by 42% between 2006 and 2011.
- The cost per GJ of heating oil has increased by 34% between 2006 and 2011.

4.5 GASOLINE

The GHG emission factor for gasoline provided in the Environment Canada NIR (1990 to 2010) Annex 8 (0.00236 tonnes CO_2e/litre) was applied to the gasoline consumption data to determine GHG emissions. Table 7 summarizes the Gasoline consumption, cost and GHG emission data for 2000 and 2006 to 2011. The baseline inventory (2000) did not provide expenditure data.

Table 7: Gasoline: Consumption, Expenditures and Emissions for 2000 and 2006 to 2011

Gasoline (mobile) - Consumption, Cost and GHG Emissions for 2000 and 2006 to 2011										
Year	Consumption				Emissions			Cost		
	Million liters	Million GJ	% of Total Sources	GJ/Capita	eCO2 (kilotonnes)	% of Total Sources	eCO2 (t) per Capita	Million $	% of Total Sources	$/GJ
2000	139	4.82	23%	37.5	328	23%	2.6	n/a	n/a	n/a
2006	145	5.01	27%	37.8	341	27%	2.6	$131.6	28%	$26.3
2007	156	5.39	24%	40.3	367	24%	2.7	$155.9	31%	$28.9
2008	162	5.62	27%	41.5	382	27%	2.8	$162.0	30%	$28.9
2009	160	5.53	27%	40.4	376	27%	2.8	$143.5	29%	$26.0
2010	168	5.84	27%	42.3	397	27%	2.9	$168.1	31%	$28.8
2011	163	5.65	26%	39.8	384	26%	2.7	$192.6	32%	$34.1

Key finding from this data set are as follows:

- Gasoline consumption and emissions increased by 17% from 2000 to 2011.
- The gasoline proportion of the total sources consumption (GJ) and GHG emissions produced remained constant from 2000 to 2011 (with a low of 23% in 2000 and a high of 27% in years 2006, 2008, 2009 and 2010). The gasoline percentage of the total sources is the same for consumption and GHG emissions since the emission factor for gasoline has remained unchanged.
- The GJ/Capita for gasoline increased by approximately 6% from 2000 to 2011 (38 GJ/Capita in 2000 and 40 GJ/Capita in 2011 with a peak of 42 GJ/Capita in 2008).
- The GHG emissions from gasoline increased by 17% from 2000 to 2011 but the GHG emissions/Capita has remained relatively constant during this same period.
- The total annual cost of gasoline has increased by 46% from 2000 to 2011 (increasing from $132 Million in 2006 to $193 Million in 2011).
- The portion of gasoline of the total annual source costs has increased from 28% in 2006 to 32% in 2011.
- The cost per GJ has increased by 30% (from $26/GJ in 2006 to $34/GJ) in 2011.

4.6 DIESEL

The GHG emission factor for diesel provided in the Environment Canada NIR (1990 to 2010) Annex 8 (0.00236 tonnes CO_2e/litre) was applied to the estimated consumption of diesel to determine the GHG emissions.

Table 8 summarizes the Diesel consumption, cost and GHG emission data for 2000 and 2006 to 2011. The baseline inventory (2000) did not provide expenditure data.

Table 8: Diesel: Consumption, Expenditures and Emissions for 2000 and 2006 to 2009

Diesel (mobile) - Consumption, Cost and GHG Emissions for 2000 and 2006 to 2011										
Year	Consumption				Emissions			Cost		
	Million liters	GJ	% of Total Sources	GJ/Capita	eCO2 (t)	% of Total Sources	eCO2 (t) per Capita	Million $	% of Total Sources	$/GJ
2000	21	804,544	3.6%	6.3	56,784	3.9%	0.4	n/a	n/a	n/a
2006	22	838,625	3.8%	6.3	59,189	4.6%	0.4	$21	4.4%	$4.1
2007	23	902,293	3.6%	6.7	63,683	4.2%	0.5	$23	4.5%	$4.3
2008	24	940,207	3.7%	7.0	66,359	4.7%	0.5	$29	5.4%	$5.2
2009	24	925,441	3.5%	6.8	65,317	4.7%	0.5	$21	4.2%	$3.8
2010	25	977,227	3.6%	7.1	68,972	4.6%	0.5	$28	5.2%	$4.8
2011	24	945,000	3.4%	6.7	66,697	4.5%	0.5	$32	5.3%	$5.7

Key finding from this data set are as follows:

- Diesel consumption and GHG emissions increased by 18% from 2000 to 2011.
- The Diesel proportion of the total sources consumption (GJ) and the total sources of GHG emissions remained relatively constant from 2000 to 2011 (ranging from3.6% to 4.5%).
- The GJ/Capita and the GHG Emissions/Capita from diesel did not change significantly between 2000 and 2011.
- Total annual diesel expenditures increased by 55% ($21 Million in 2000 and $32 Million in 2011) between 2006 and 2011, but the diesel proportion of the total sources expenditure remained relatively constant (4 to 5%).
- The diesel cost per GJ increased by 37% from $4.1/GJ in 2006 to $5.7/GJ in 2011.

4.7 PROPANE

The GHG emission factor for propane in the Environment Canada NIR (1990 to 2010) 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 heating oil combustion. This emission factor has remained unchanged since the baseline year (2000) inventory.

Table 9 summarizes the Propane consumption, cost and GHG emission data for 2000 and 2006 to 2011. The baseline inventory (2000) did not provide expenditure data.

Table 9: Propane: Consumption, Expenditures and Emissions for 2000 and 2006 to 2011

Propane - Consumption, Cost and GHG Emissions for 2000 and 2006 to 2011										
Year	Consumption				Emissions			Cost		
	Million liters	GJ (x1000)	% of Total Sources	GJ per Capita	eCO2 (kilotonnes)	% of Total Sources	eCO2 (t) per Capita	Million $	% of Total Sources	$/GJ
2000	20	513	2.3%	4.0	31	2.1%	0.24	n/a	n/a	n/a
2006	21	523	2.4%	4.0	31	2.4%	0.24	$13	3%	$24.6
2007	21	541	2.1%	4.0	32	2.1%	0.24	$13	3%	$24.3
2008	22	558	2.2%	4.1	33	2.4%	0.25	$15	3%	$26.2
2009	23	576	2.2%	4.2	35	2.5%	0.25	$14	3%	$25.0
2010	24	619	2.3%	4.5	37	2.5%	0.27	$17	3%	$27.5
2011	26	665	2.4%	4.7	40	2.7%	0.28	$19	3%	$29.2

Key finding from this data set are as follows:

- Propane consumption and emissions increased by 30% from 2000 to 2011.
- The Propane proportion of the total sources consumption (GJ) and total GHG emissions remained relatively constant 2000 to 2011 and represented a small proportion of the overall (approximately 2% to 3%).
- The consumption per capita (GJ/Capita) and the GHG emissions per capita has increased by 17% from 2000 to 2011.
- The total annual cost of propane increased by 51% from 2006 to 2011 (from $13 million in 2006 to $19 Million in 2011).
- The Propane proportion of total source expenditures remained constant from 2006 to 2011 at 3%.
- The cost per GJ of propane increased by 19% from 2006 to 2011 (from $25/GJ in 2006 to $29/GJ in 2011.

4.8 WASTE (Organic)

The following table summarizes the estimated tonnage of organic waste generated by the Kingston community that went to landfill. It is important to note, that this data is for organic waste only and does not quantify the total tonnage of waste that went to landfill. 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 GHG 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 minimal, waste reduction has many other economic, social and environmental benefits. The reduction of waste and its diversion from landfill is an important component of a sustainable community.

Table 10: Estimated Community Organic Waste (2006 to 2009)

Year	Tonnes of Organic Material to Landfill	e CO2(t)	% of Total Source
2006	40,746	19,627	1.5%
2007	37,541	18,084	1.2%
2008	38,957	18,766	1.3%
2009	35,079	16,897	1.2%
2010	35,588	17,143	1.1%
2011	32,659	15,732	1.0%

The key findings of this data include the following:

- The tonnes of organic material that goes to landfill and the GHG emissions generated from this organic material has decreased by 20% from 2006 to 2011.
- GHG emissions from organic material going to landfill is a minor component of the total community GHG emissions and has decreased from 1.5% to 1% of the total community GHG emissions.

5.0 SECTOR ANALYSIS

Sectors for the Kingston Community GHG inventory include:

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

This section provides an overview of the total community energy consumption, GHG emissions and energy cost by sector. A detailed review of the consumption, GHG emissions and costs associated with each of the sectors is provided.

5.1 OVERVIEW

This section provides an overview of the total community energy consumption, GHG emissions and energy cost by sector.

5.1.1 Sector Energy Consumption (GJ) Overview by Sector

This section provides an overview of the community energy consumption by sector. While it would be preferable to breakdown the ICI contribution into its industrial, commercial and institutional components, 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 Gigajoules (GJ). Figure 13 provides the energy consumption (GJ) by sector for 2011.

Figure 13: 2011 Community Energy Consumption (GJ) by Sector
Total: 27,644,807 GJ

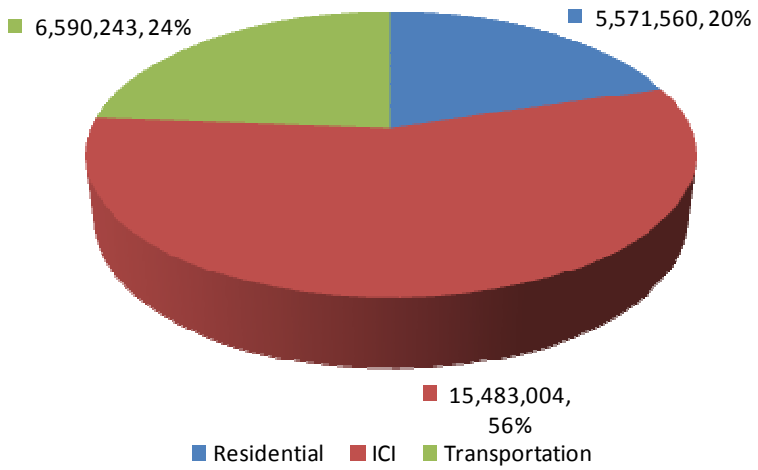
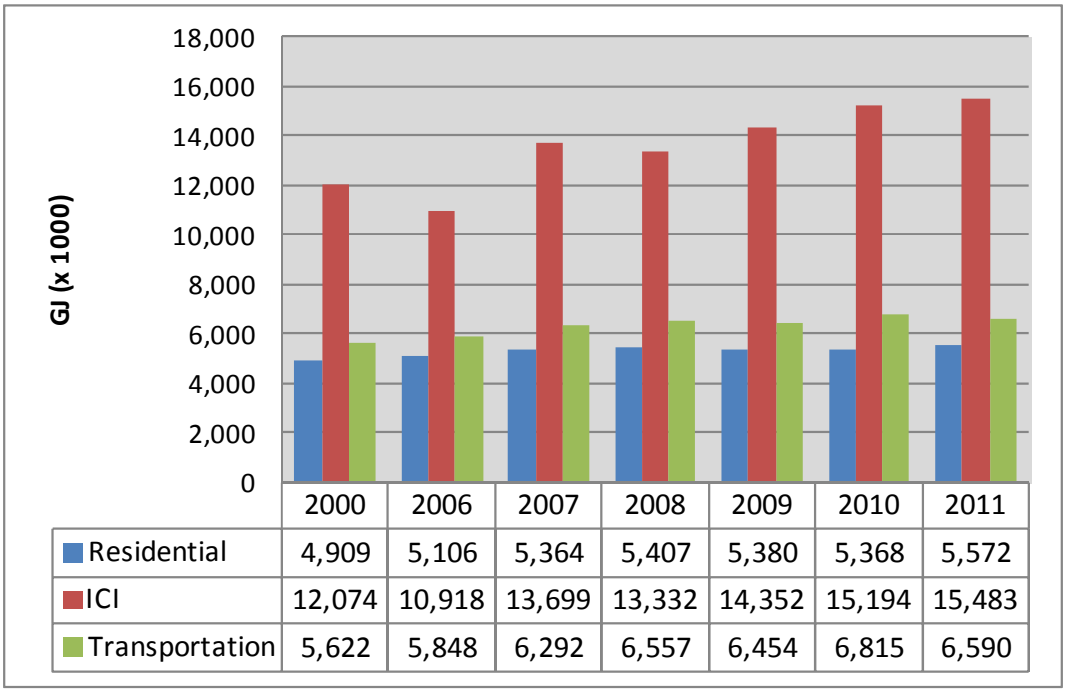


Figure 13 indicates that in 2011 the ICI sector (56%) is the largest energy consumer within the community, followed by the transportation sector (24%) and the residential sector (20%).

Figure 14 provides a comparison of the energy consumption (GJ) for 2000 and 2011 by sector.

Figure 14: Annual Energy Consumption (GJ x 1000) by Sector (2000 and 2006 to 2009)

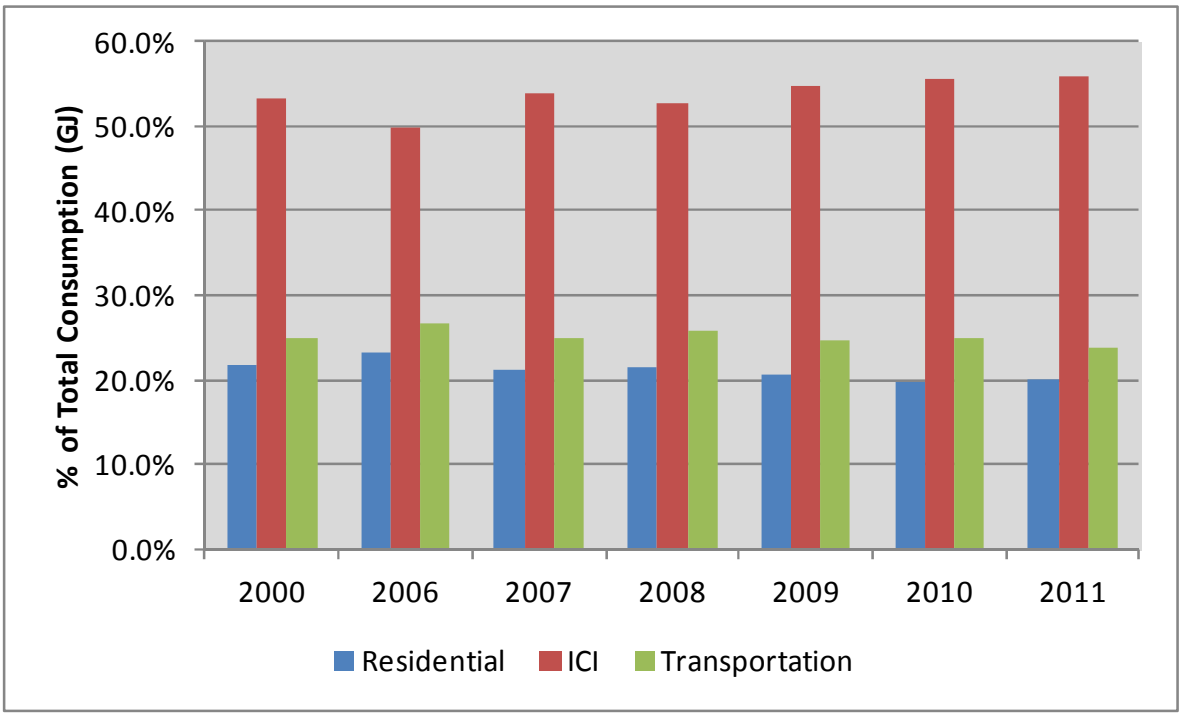


	2000	2006	2007	2008	2009	2010	2011
Residential	4,909	5,106	5,364	5,407	5,380	5,368	5,572
ICI	12,074	10,918	13,699	13,332	14,352	15,194	15,483
Transportation	5,622	5,848	6,292	6,557	6,454	6,815	6,590

Year	2000	2006	2007	2008	2009	2010	2011
Total GJ (x 1000)	22,605	21,872	25,356	25,296	26,186	27,377	27,645
% Difference from 2000	n/a	-3.2%	12.2%	11.9%	15.8%	21.1%	22.3%

Overall, energy consumption (GJ) has increased by approximately 22% between 2000 and 2011. While there was growth in consumption in all three sectors, the most significant energy consumption growth was in the ICI sector. The ICI sector was responsible for 68% of the consumption growth (3,409,321 GJ). The residential sector was responsible for 13% of the growth and transportation contributed 19% of the growth. Figure 15 illustrates the difference in the percentage of the total energy consumption (GJ) by sector for the years 2000 and 2006 to 2011.

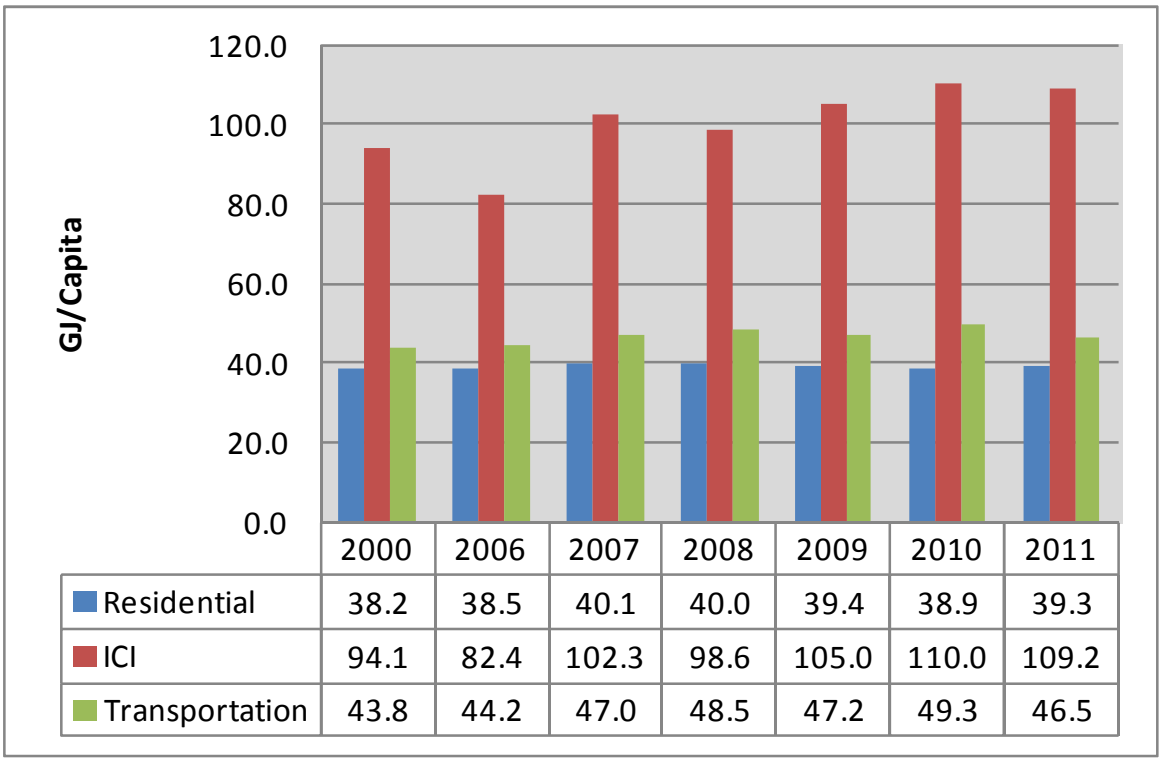
Figure 15: Percentage of Total Energy Consumption (GJ) by Sector (2000 and 2006 to 2011)



The relative percentage of the total energy consumption represented by each of the three sectors has remained relatively stable from 2000 to 2011. It is evident that the ICI sector is consistently the dominant sector for the percentage of total energy consumption growing from 53% in 2000 to 56% in 2011. The percentage represented by the residential sector decreased marginally from 21.7% in 2000 to 20.2% in 2011. Transportation also experienced a slight total percentage reduction from 25% in 2000 to 24% in 2011.

Figure 16 illustrates the community energy consumption per capita by sector for 2006 to 2011. Population estimates are based on Statistics Canada Census data and estimates of the student population. Details regarding population estimates are provided in Section 6.

Figure 16: Consumption per Capita (GJ/Capita) by Sector (2000 and 2006 to 2011)



	2000	2006	2007	2008	2009	2010	2011
Residential	38.2	38.5	40.1	40.0	39.4	38.9	39.3
ICI	94.1	82.4	102.3	98.6	105.0	110.0	109.2
Transportation	43.8	44.2	47.0	48.5	47.2	49.3	46.5

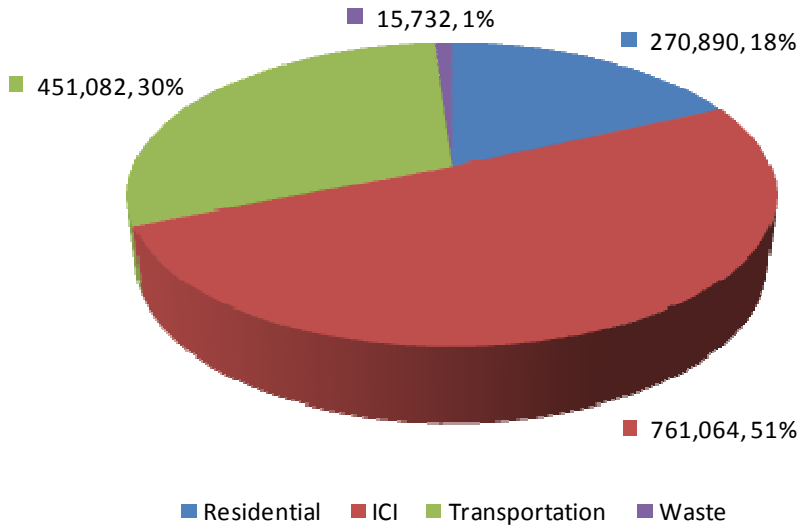
Year	2000	2006	2007	2008	2009	2010	2011
Total GJ/Capita	176	165	189	187	192	198	195
% Difference from 2000	n/a	-6.2%	7.6%	6.2%	8.8%	12.6%	10.7%

The GJ/Capita increased by 10.7% (18.8 GJ/Capita) from 2000 to 2011. While the GJ/Capita increased for each of the three sectors the greatest growth was in the ICI sector. The ICI sector was responsible for 80% of the growth (15.1 GJ/Capita) and the transportation sector accounted for 14% (2.7 GJ/Capita). The residential sector only contributed to 6% of the growth (1.0 GJ/Capita).

5.1.2 Sector GHG Emission Overview

This section provides an overview of the community GHG emissions by sector. Figure 17 provides the GHG Emissions by sector for 2011.

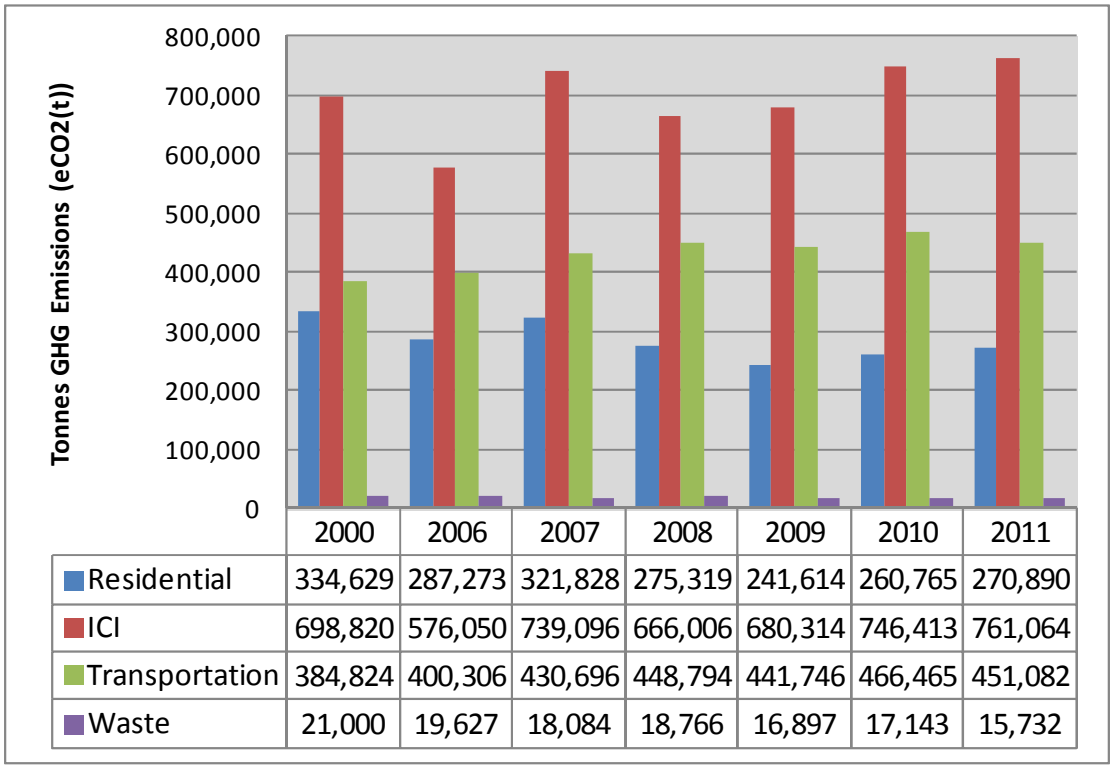
Figure 17: 2011 GHG Emissions by Sector
Total: 1,498,767 eCO2(t)



In 2011, the Kingston community generated 1,498,767 tonnes of GHG emissions. Figure 17 indicates that as with consumption, the ICI sector has the greatest proportion (51%) of the GHG emissions for 2011. The transportation sector ranks second with a contribution of 30% and is followed by the residential sector which represented 18% of the total emissions.

Figure 18 provides a comparison of the distribution of GHG emissions for 2000 and 2006 to 2011 by sector.

Figure 18: Total GHG Emissions by Sector (2000 and 2006 to 2011)



	2000	2006	2007	2008	2009	2010	2011
Residential	334,629	287,273	321,828	275,319	241,614	260,765	270,890
ICI	698,820	576,050	739,096	666,006	680,314	746,413	761,064
Transportation	384,824	400,306	430,696	448,794	441,746	466,465	451,082
Waste	21,000	19,627	18,084	18,766	16,897	17,143	15,732

Total tonnes of Greenhouse Gas Emissions (eCO2(t))	2000	2006	2007	2008	2009	2010	2011
	1,439,274	1,283,256	1,509,704	1,408,885	1,380,571	1,490,786	1,498,767
% Difference from 2000	n/a	-10.84%	4.89%	-2.11%	-4.08%	3.58%	4.13%

The Kingston community GHG emissions increased by approximately 4% between 2000 and 2011. During this period, the residential GHG emissions decreased by 63,740 tonnes (19%) while the ICI and the transportation sector GHG emissions increased by 62,243(9%) and 66,258 (17%) respectively. Figure 19 illustrates the percentage of the total community GHG emissions represented by each of the sectors for the years 2000 and 2006 to 2011.

Figure 19: Percentage of Total Community GHG Emissions by Sector (2000 and 2006 to 2011)

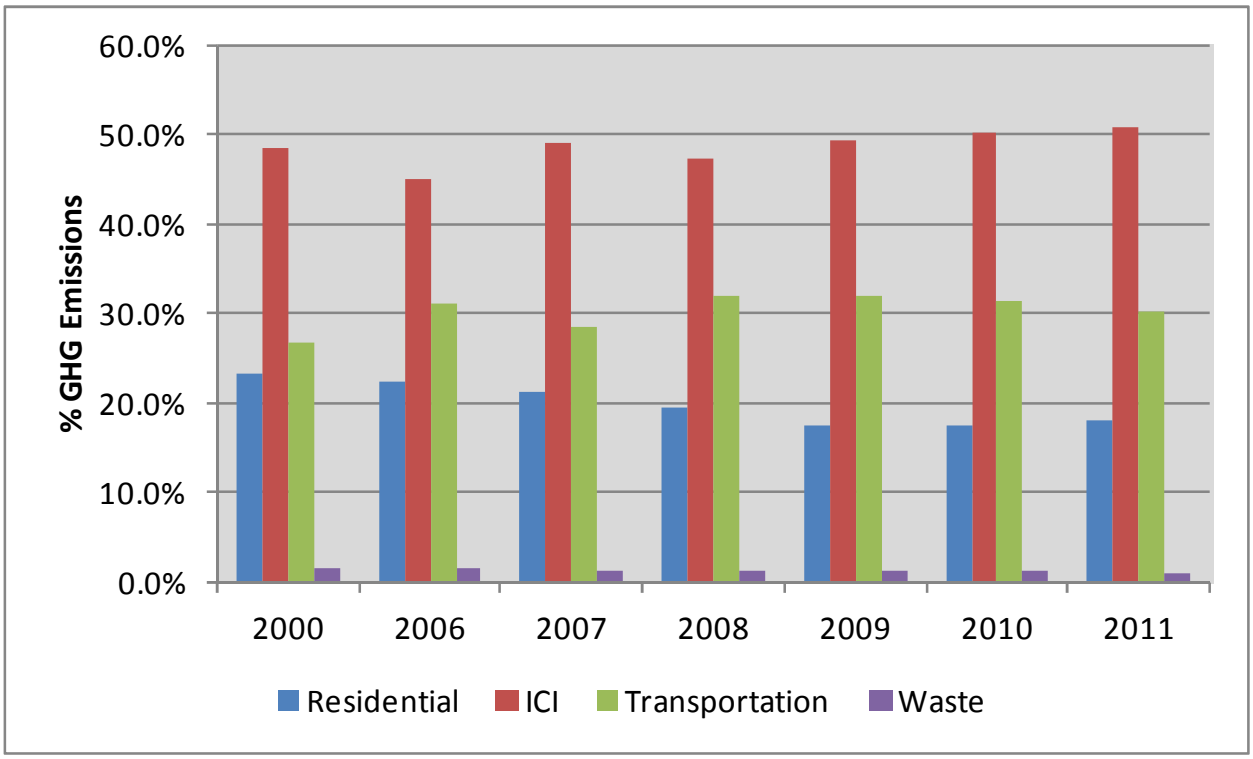
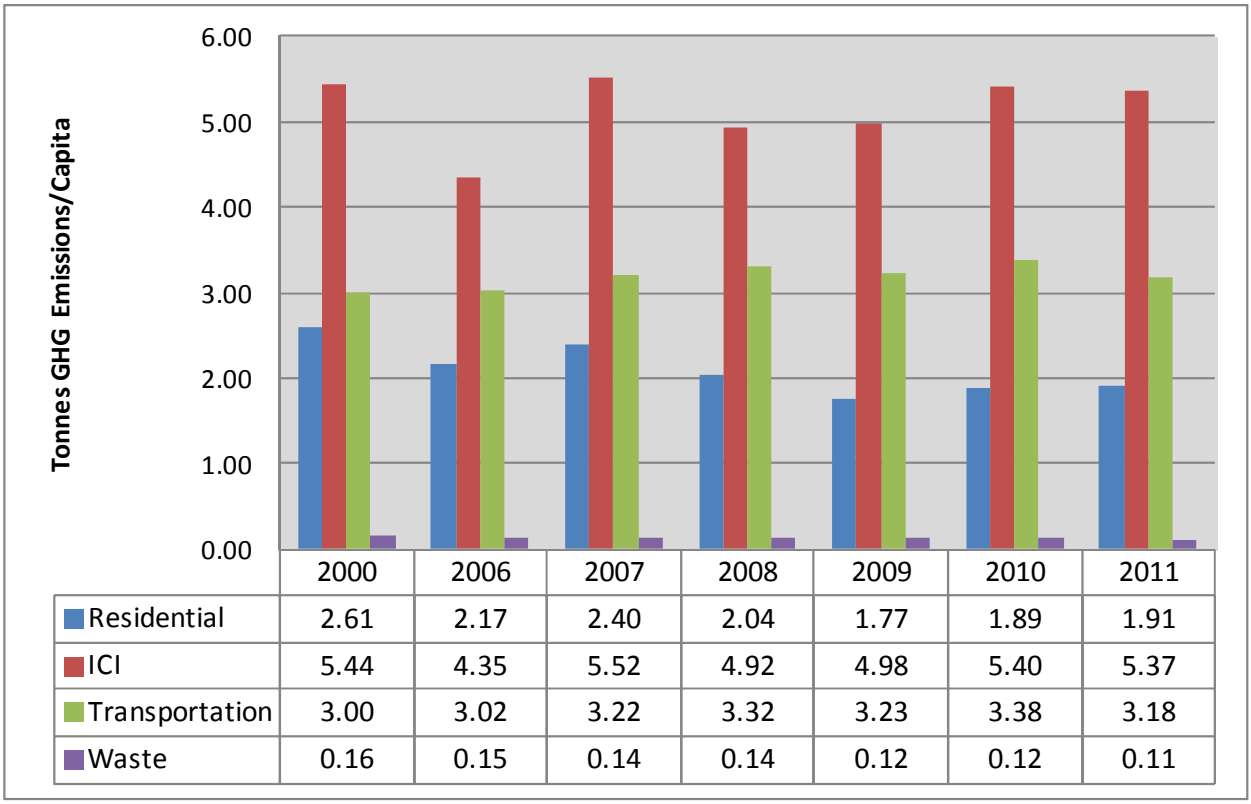


Figure 19 indicates that the percentage of emissions by sector has not changed significantly from 2000 to 2011. The ICI sector is consistently the greatest contributor to the total GHG emissions. The percentage represented by the ICI sector grew from 49% in 2000 to 51% in 2011. The second greatest contributor to the total GHG emissions is the transportation sector growing from 27% in 2000 to 30% in 2011. The residential sector has experience a relatively consistent decreased in the percentage of total GHG emissions (23% in 2000 and 18% in 2011). The waste sector represents a minor and decreasing component of the community GHG emissions.

Figure 20 illustrates the tonnes of GHG emissions/Capita by sector for 2006 to 2011. Population estimates are based on Statistics Canada Census data and estimates of the student population. Details regarding population estimates are provided in Section 6.

Figure 20: Tonnes GHG Emissions/Capita by Sector (2000 and 2006 to 2011)



	2000	2006	2007	2008	2009	2010	2011
Residential	2.61	2.17	2.40	2.04	1.77	1.89	1.91
ICI	5.44	4.35	5.52	4.92	4.98	5.40	5.37
Transportation	3.00	3.02	3.22	3.32	3.23	3.38	3.18
Waste	0.16	0.15	0.14	0.14	0.12	0.12	0.11

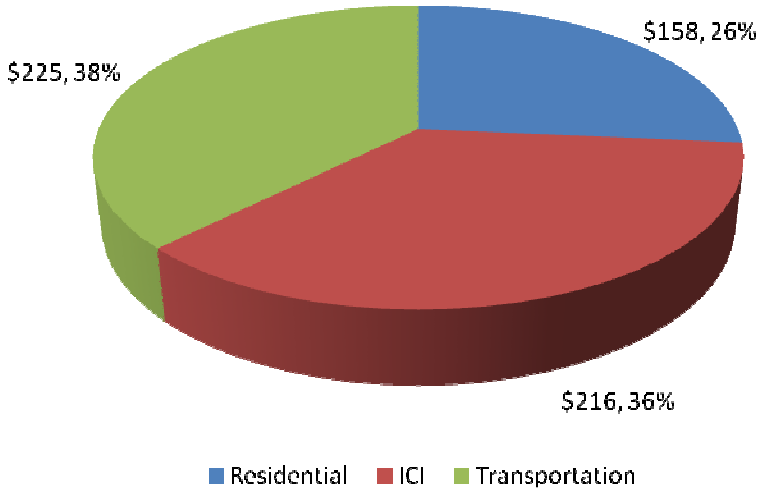
Year	2000	2006	2007	2008	2009	2010	2011
Tonnes GHG Emissions/Capita	11.21	9.69	11.28	10.42	10.10	10.79	10.57
% Difference from 2000	n/a	-13.6%	0.6%	-7.1%	-9.9%	-3.7%	-5.7%

The tonnes of GHG emissions/Capita generated by the Kingston community decreased by 5.7 % from 2000 to 2011. The ICI sector consistently has the highest GHG emissions/Capita. While there were fluctuations throughout the years the GHG emissions/Capita for 2000 and 2011 are consistent at 5.4 tonnes of GHG emissions/Capita. The transportation consistently ranks second in the production of GHG emissions/Capita increasing from 3.0 tonnes of GHG emissions/Capita in 2000 to 3.2 tonnes of GHG emissions/Capita in 2011. The residential sector has experienced a decline in the generation of GHG emissions/Capita from 2.6 tonnes of GHG emissions/Capita in 2000 to 1.9 tonnes of GHG emissions/Capita in 2011.

5.1.3 Energy Cost Overview by Sector

This section provides an overview of the community energy cost by sector. Figure 21 illustrates the cost of energy by sector for 2011.

Figure 21: 2011 Energy Cost ($Million) by Sector
Total: $599 Million



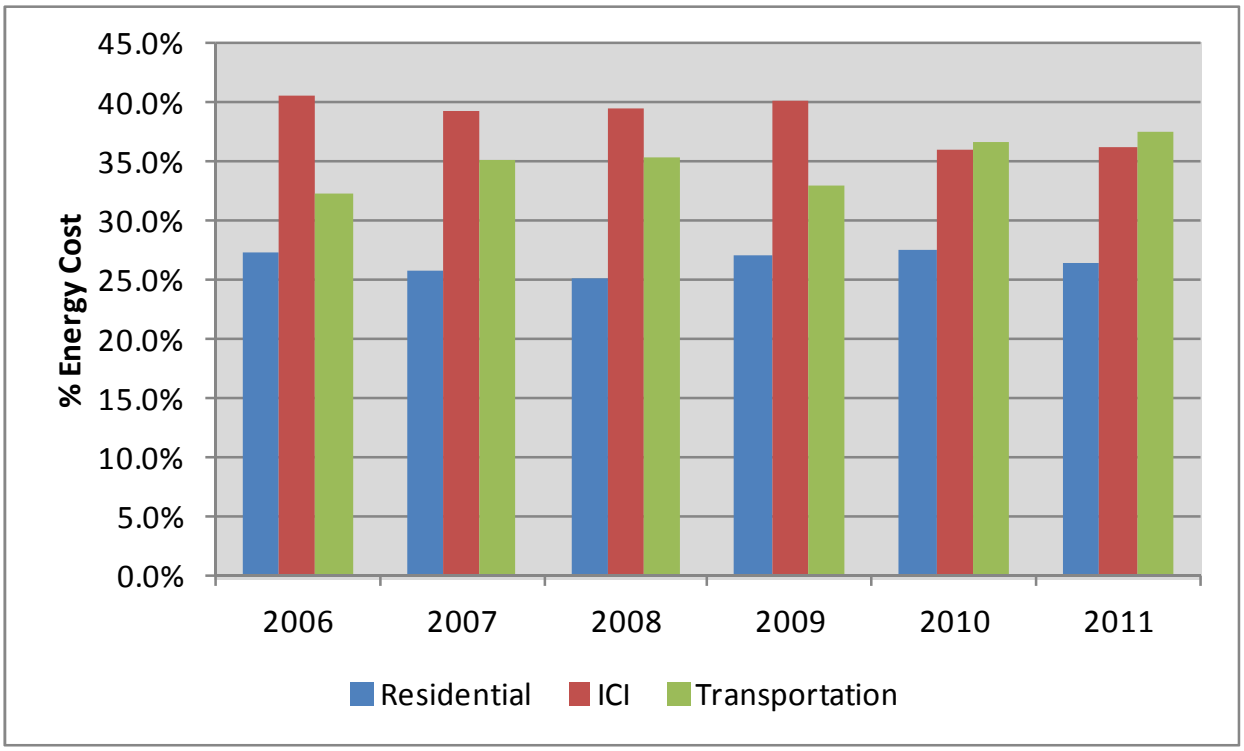
In 2011, the Kingston community spent $599 Million on energy. Figure 21 illustrates that in 2011, the cost of energy for ICI sector and the transportation sector were comparable ($225 Million for the transportation sector and $216 Million for the ICI sector). The residential sector had the lowest energy cost of the three sectors ($158 Million). Energy cost data was not available for 2000. Figure 22 provides a comparison of the distribution of energy costs 2006 to 2011 by sector.

Figure 22: Total Energy Cost ($ Millions) 2006 to 2011)

Energy Cost (Million $)	2006	2007	2008	2009	2010	2011
	$472.99	$510.05	$540.07	$499.65	$536.19	$599.01
% Difference from 2006	n/a	7.8%	14.2%	5.6%	13.4%	26.6%

Overall, the cost of energy to the Kingston community has increased by approximately 26.6% between 2006 and 2011. Figure 23 illustrates the difference in the percentage of energy cost by sector.

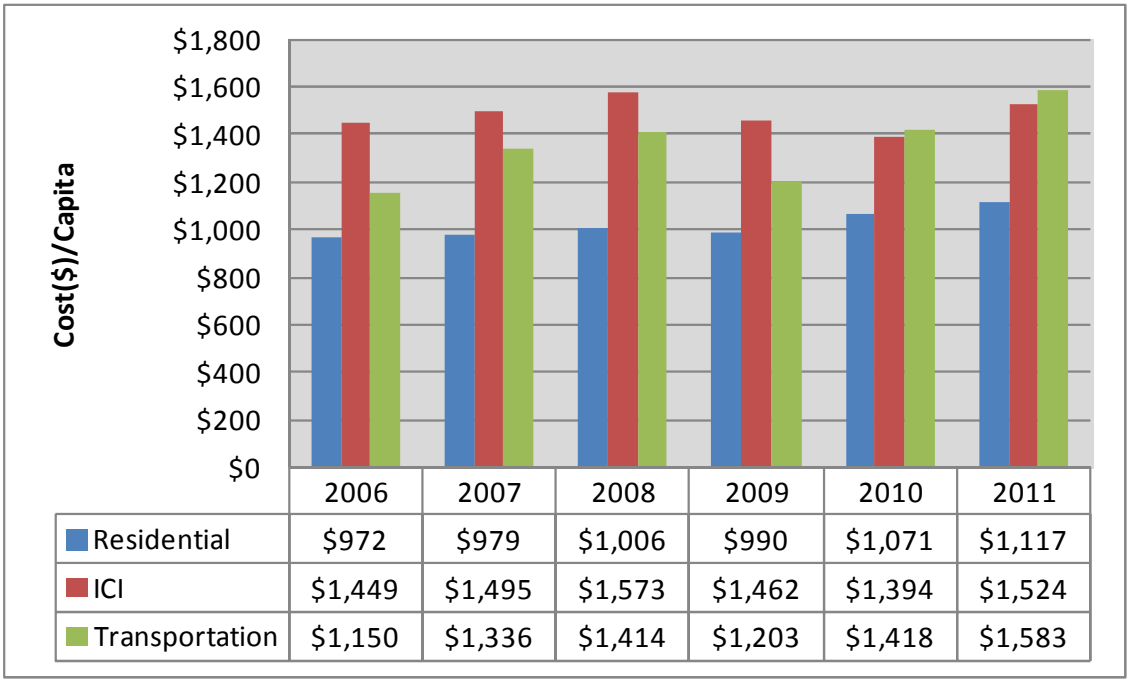
Figure 23: Percentage of Energy Cost by Sector



This data indicates that over time the percentage of energy cost by emission source has experience a variation of approximately 5% across all sectors. As with consumption and GHG emissions, the ICI sector consistently represents the greatest proportion of the community's energy cost. The percentage of the total energy costs represented by the ICI sector decreased from 41% to 36% between 2000 and 2011. During this same time the transportation sector, increased it contribution to the total energy cost from 32% in 2000 to 38% in 2011. While there were slight variations over the years, in 2000 and 2011 the residential sector was responsible for approximately 26% of the total energy costs.

Figure 24 illustrates the energy cost per capita ($/Capita) by sector for 2006 to 2011. Population estimates are based on Statistics Canada Census data and estimates of the student population. Details regarding population estimates are provided in Section 6.

Figure 24: Energy Cost per Capita ($/Capita) by Sector



	2006	2007	2008	2009	2010	2011
Residential	$972	$979	$1,006	$990	$1,071	$1,117
ICI	$1,449	$1,495	$1,573	$1,462	$1,394	$1,524
Transportation	$1,150	$1,336	$1,414	$1,203	$1,418	$1,583

Year	2006	2007	2008	2009	2010	2011
Total Energy Cost/Capita	$3,571	$3,811	$3,993	$3,656	$3,882	$4,224
% Difference from 2006	n/a	6.7%	11.8%	2.4%	8.7%	18.3%

From 2006 to 2011 the cost of energy per capita increased by 18% ($653/Capita) from $3,571 in 2000 to $4,224 in 2011. Between 2006 and 2011, there was an energy cost per capita gain across all sectors. The most significant increase in the energy cost per capita is in the transportation sector which is responsible for a $434/Capita increase from 2006 to 2011 (67% of the total increase). The residential sector experienced the second greatest energy cost per capita gain with a $144/Capita increase from 2006 to 2011 (22% of the total increase). The ICI sector experienced the lowest energy cost per capita increase with a gain of $75/Capita from 2006 to 2011 (11% of the total increase).

5.2 RESIDENTIAL SECTOR

5.2.1 Residential Sector Overview

The following table summarizes the residential impact on energy consumption (GJ), GHG emissions and cost for 2000 to 2011.

Table 11: Residential: Consumption, Cost and Emissions 2006 to 2011

Residential: Consumption, Cost and GHG Emissions for 2000 and 2006 to 2011										
Year	Consumption			Emissions			Cost			
	Million GJ	% of Total Sectors	GJ/Capita	eCO2 (kilotonnes)	% of Total Sectors	Emissions per Capita	Million $	% of Total Sectors	$/GJ	$/Capita
2000	4.91	21.7%	38.2	335	23%	2.6	n/a	n/a	n/a	n/a
2006	5.11	23.3%	38.5	287	22%	2.2	128.8	27.2%	$25	$972
2007	5.36	21.2%	40.1	322	21%	2.4	131.1	25.7%	$24	$979
2008	5.41	21.4%	40.0	275	20%	2.0	136.1	25.2%	$25	$1,006
2009	5.38	20.5%	39.4	242	18%	1.8	135.3	27.1%	$25	$990
2010	5.37	19.6%	38.9	261	17%	1.9	147.9	27.6%	$28	$1,071
2011	5.57	20.2%	39.3	271	18%	1.9	158.4	26.4%	$28	$1,117
Difference between 2000 and 2011							Difference between 2006 and 2011			
Value	0.66	-1.6%	1.04	-63.74	-5.2%	-0.70	$29.6	-0.79%	$3.2	$144.4
%	13.5%	-7.2%	2.7%	-19.0%	-22.3%	-26.7%	23.0%	-2.9%	12.7%	14.8%

While the residential energy consumption (GJ) increased by 13.5% from 2000 to 2011, its percentage contribution to the total community energy consumption decreased from 22% in 2000 to 20% in 2011. **During this period the consumption per capita (GJ/capita) remained relatively constant (38 GJ/capita in 2000 and 39 GJ/capita in 2011).**

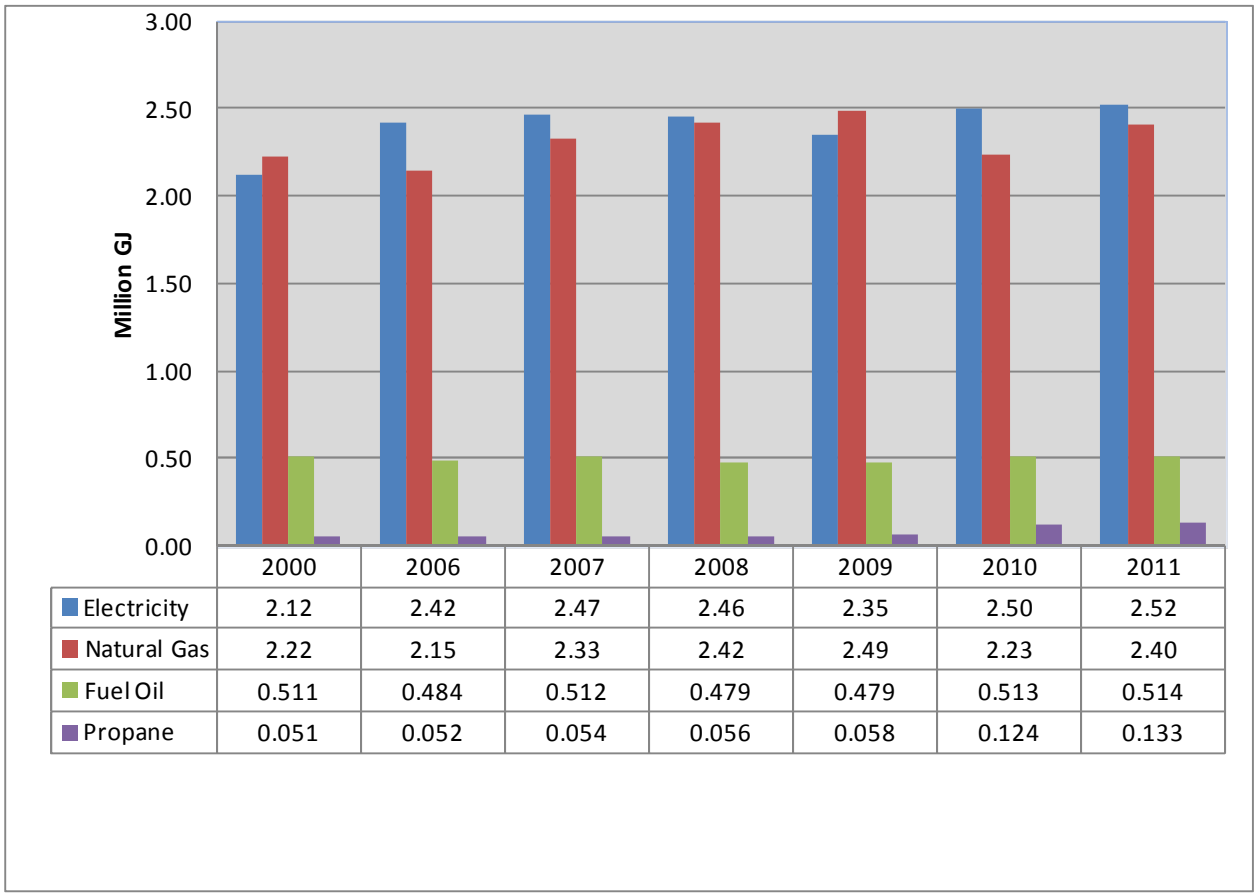
While the GHG emissions from the residential sector decreased by 19% from 2000 to 2011, the percentage contribution to the total GHG emissions only decreased by 5% (from 23% to 18%). **During this period the GHG emissions per capita decreased by 27% from 2000 to 2011 (2.6 in 2000 and 1.9 in 2011).**

The cost of residential energy increased by 23% from 2006 to 2011 ($129 Million in 2006; $158 Million in 2011). In spite of this increased, the residential proportion of the total community energy cost remained relatively constant (with 27% in 2006 and 26% in 2011). The cost per GJ decreased by 13% from 2006 to 2011 ($25/GJ in 2006 and $28/GJ in 2011). **Between 2006 and 2011, the residential energy cost per capita increased by 15% from $972/Capita to $1,117/Capita.**

5.2.2 Residential Energy Consumption by Emission Source

Figure 25 provides a summary of the residential energy consumption (GJ) from 2000 and 2006 to 2011.

Figure 25: Residential: Annual Energy Consumption (Million GJ) by Energy Source



	2000	2006	2007	2008	2009	2010	2011
Electricity	2.12	2.42	2.47	2.46	2.35	2.50	2.52
Natural Gas	2.22	2.15	2.33	2.42	2.49	2.23	2.40
Fuel Oil	0.511	0.484	0.512	0.479	0.479	0.513	0.514
Propane	0.051	0.052	0.054	0.056	0.058	0.124	0.133

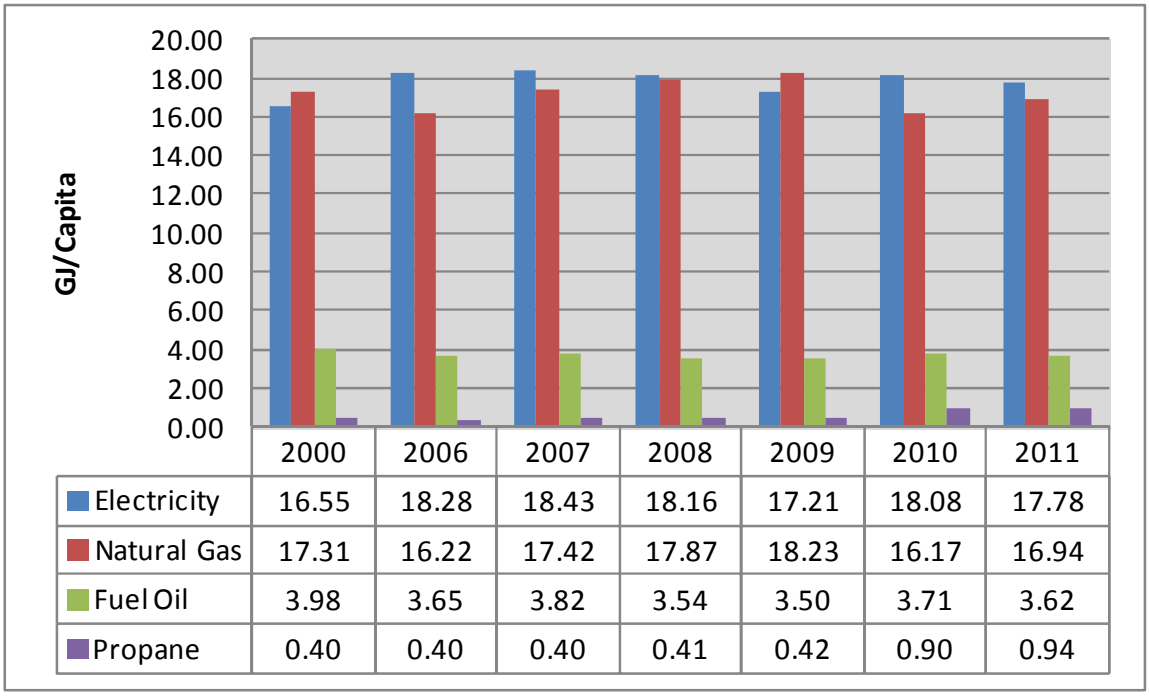
Year	2000	2006	2007	2008	2009	2010	2011
Total (Million GJ)	4.91	5.11	5.36	5.41	5.38	5.37	5.57
% Difference from 2000	n/a	4.0%	9.3%	10.1%	9.6%	9.3%	13.5%

The residential sector ranks third in its contribution to the total community energy consumption. In 2011, the residential sector represented approximately 20% of the total community energy consumption.

The energy consumption associated with the residential sector has increased by 13.5% from 2000 to 2011. The two largest energy sources within the residential sector are natural gas and electricity. In 2000, natural gas was the dominant contributor to energy consumption with electricity trailing slightly behind. In 2011, this relationship between electricity and natural gas had inverted, with electricity being the dominant contributor to energy consumption and natural gas trailing closely behind.

Figure 26 provides a summary of energy consumption within the residential sector (by emission source) on a per capita basis. Between 2000 and 2011 the Kingston population increased by approximately 10.4%. Population estimates are based on Statistics Canada Census data and estimates for student population. The methodology for population estimates is provided in Section 6.

Figure 26: Residential: Energy Consumption per Capita (GJ/Capita) by Emission Source



	2000	2006	2007	2008	2009	2010	2011
Electricity	16.55	18.28	18.43	18.16	17.21	18.08	17.78
Natural Gas	17.31	16.22	17.42	17.87	18.23	16.17	16.94
Fuel Oil	3.98	3.65	3.82	3.54	3.50	3.71	3.62
Propane	0.40	0.40	0.40	0.41	0.42	0.90	0.94

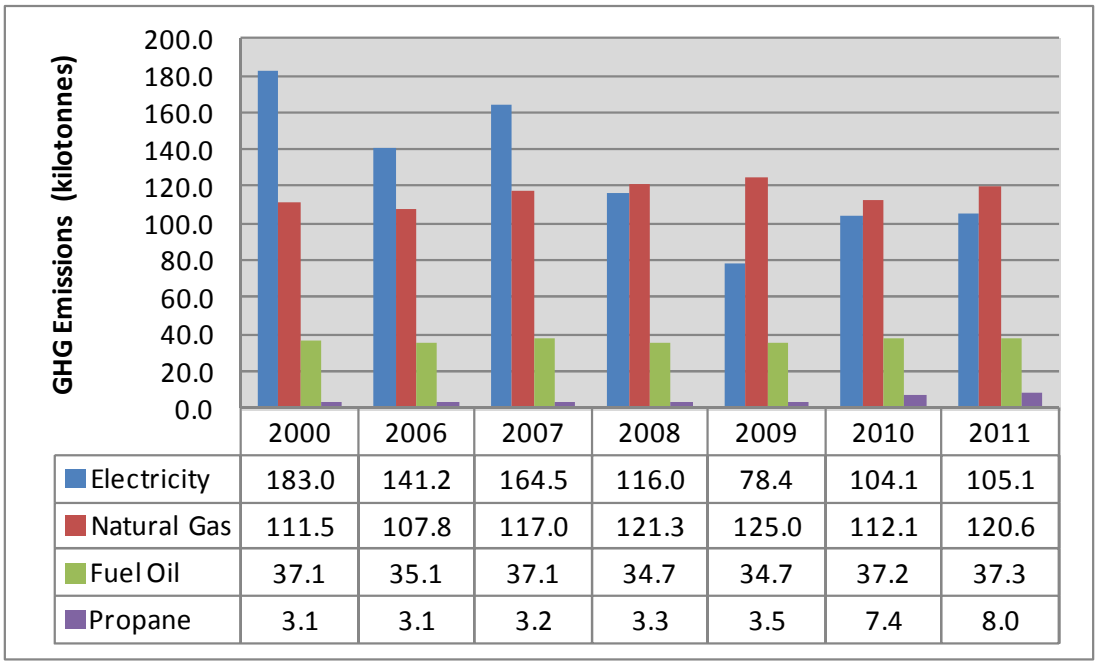
Year	2000	2006	2007	2008	2009	2010	2011
Total (GJ/Capita)	38.2	38.5	40.1	40.0	39.4	38.9	39.3
% Difference from 2000 to 2011	n/a	0.8%	4.8%	4.5%	2.9%	1.6%	2.7%

Figure 26 indicates that the residential per capita consumption of energy overtime (2000 to 2011) has been relatively stable. Between 2000 and 2011, the per capita residential consumption of energy (GJ/capita) increased by 1 GJ (2.7%). The electricity and propane energy sources increased by 1.23 GJ/capita and 0.54 GJ/capita respectively and the natural gas and fuel oil energy sources both decreased by 0.36GJ/capita.

5.2.3 Residential GHG Emissions by Emission Source

Figure 27 illustrates the residential GHG emissions (kilotonnes) by emission source for 2000 and 2006 to 2011.

Figure 27: Residential: GHG Emissions (kilotonnes) by Source (2000 and 2006 to 2011)

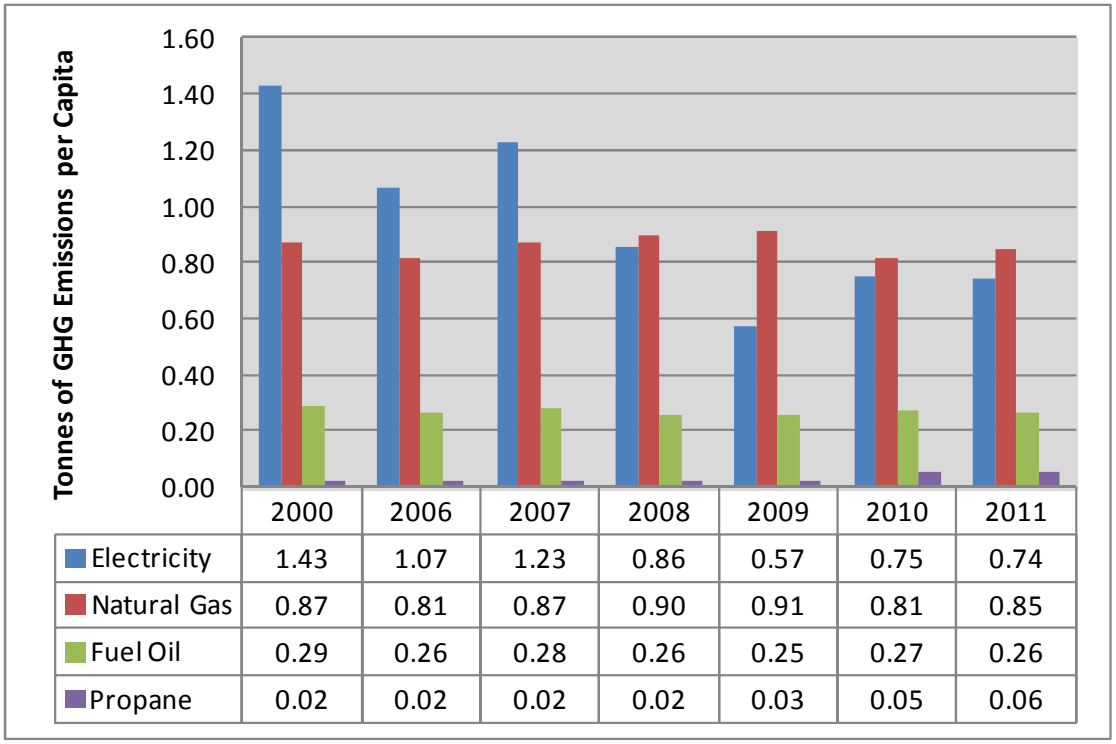


	2000	2006	2007	2008	2009	2010	2011
Electricity	183.0	141.2	164.5	116.0	78.4	104.1	105.1
Natural Gas	111.5	107.8	117.0	121.3	125.0	112.1	120.6
Fuel Oil	37.1	35.1	37.1	34.7	34.7	37.2	37.3
Propane	3.1	3.1	3.2	3.3	3.5	7.4	8.0

Year	2000	2006	2007	2008	2009	2010	2011
Total GHG Emission (kilotonnes)	334.6	287.3	321.8	275.3	241.6	260.8	270.9
% Difference from 2000 to 2011	n/a	-14.2%	-3.8%	-17.7%	-27.8%	-22.1%	-19.0%

While the residential energy consumption has increased by 13.5%, the tonnes of GHG Emissions has reduced by 19%. This GHG emission reduction is largely due to the decrease in the Ontario electricity emission factor (since electricity is a dominant emission source for the residential sector). Figure 28 provides a summary of residential GHG emissions/capita by emission source for 2000 and 2006 to 2011.

Figure 28: Residential: GHG Emissions per Capita by Source (2000 and 2006 to 2011)



	2000	2006	2007	2008	2009	2010	2011
Electricity	1.43	1.07	1.23	0.86	0.57	0.75	0.74
Natural Gas	0.87	0.81	0.87	0.90	0.91	0.81	0.85
Fuel Oil	0.29	0.26	0.28	0.26	0.25	0.27	0.26
Propane	0.02	0.02	0.02	0.02	0.03	0.05	0.06

Year	2000	2006	2007	2008	2009	2010	2011
Total GHG Emissions/Capita	2.61	2.17	2.40	2.04	1.77	1.89	1.91
% Difference from 2000	n/a	-16.8%	-7.8%	-21.9%	-32.2%	-27.6%	-26.7%

Between 2000 and 2011, the Kingston residential sector has realized a GHG emission/Capita reduction of 26.7%. During this same period, the energy consumption per capita (GJ/Capita) increased by 2.7%. This reduction in per Capita GHG emissions is largely due to the improvement of the Ontario energy mix and the resulting reduction in the Ontario electricity emission factor.

5.2.4 Residential Energy Cost by Emission Source

Figure 29 provides the residential energy cost by emission source for 2006 to 2011. Energy cost data was not available for the baseline year (2000).

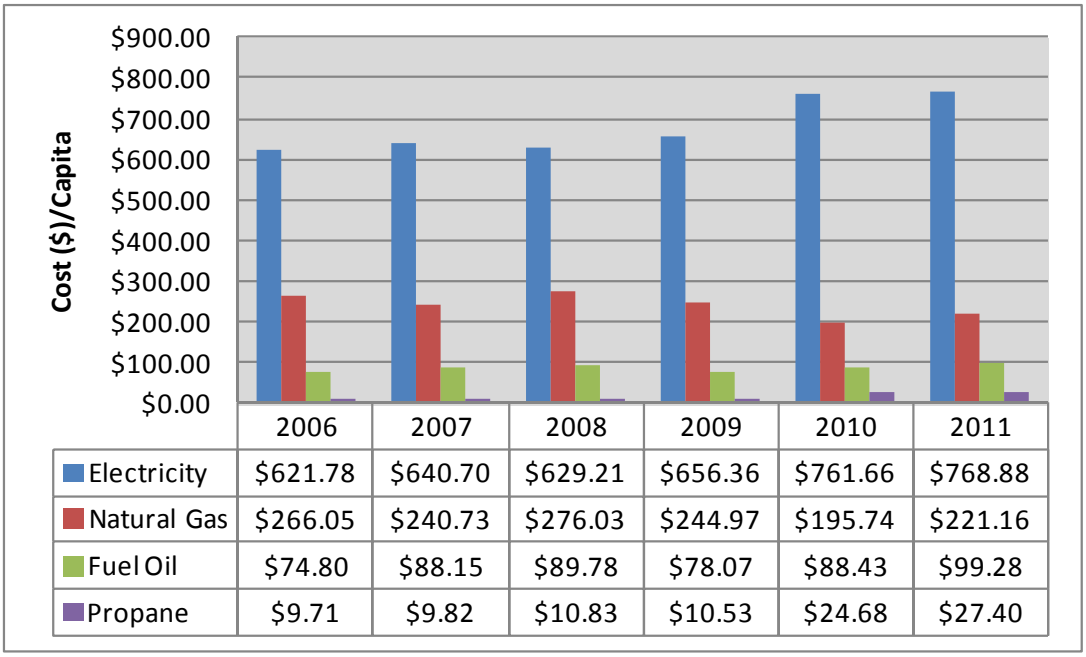
Figure 29: Residential: Energy Cost by Source (2006 to 2011)

	2006	2007	2008	2009	2010	2011
Electricity	$82.36	$85.76	$85.11	$89.71	$105.20	$109.04
Natural Gas	$35.24	$32.22	$37.34	$33.48	$27.04	$31.37
Fuel Oil	$9.91	$11.80	$12.14	$10.67	$12.21	$14.08
Propane	$1.29	$1.31	$1.47	$1.44	$3.41	$3.89

Year	2006	2007	2008	2009	2010	2011
Total Million $	$128.8	$131.1	$136.1	$135.3	$147.9	$158.4
% Difference between 2006 and 2011	n/a	1.8%	5.6%	5.1%	14.8%	23.0%

The residential cost of energy has increased by 23% 9 ($29.6 Million) from 2006 to 2011. Electricity is responsible for 90% ($26.7 Million) of this cost increase.

Figure 30: Residential: Energy Cost per Capita by Source (2006 to 2011)



	2006	2007	2008	2009	2010	2011
Electricity	$621.78	$640.70	$629.21	$656.36	$761.66	$768.88
Natural Gas	$266.05	$240.73	$276.03	$244.97	$195.74	$221.16
Fuel Oil	$74.80	$88.15	$89.78	$78.07	$88.43	$99.28
Propane	$9.71	$9.82	$10.83	$10.53	$24.68	$27.40

Year	2006	2007	2008	2009	2010	2011
Cost/Capita	$972	$979	$1,006	$990	$1,071	$1,117
% Difference from 2006	n/a	0.7%	3.4%	1.8%	10.1%	14.8%

The residential per capita energy cost increased by 14.8% from 2006 to 2011. Electricity is by far the greatest contributor to the residential energy cost/capita followed in order by natural gas, fuel oil and propane. Between 2006 and 2011 the energy cost per capita increased by $147/Capita for electricity, decreased by $45/Capita for natural gas and decreased by $24.5/Capita for fuel oil.

5.3 *ICI SECTOR*

5.3.1 ICI Sector Overview

Table 12 summarizes the ICI impact on energy consumption (GJ), GHG emissions and cost for 2000 and 2006 to 2011.

Table 12: ICI: Consumption, Cost and Emissions 2006 to 2011

ICI - Consumption, Cost and GHG Emissions for 2006 to 2009										
Year	Consumption			Emissions			Cost			
	Million GJ	% of Total Sectors	GJ per Capita	eCO2 (kilotonnes)	% of Total Sectors	GHG Emissions per Capita	Million $	% of Total Sectors	$/GJ	$/Capita
2000	12.07	53.4%	94.1	699	48.6%	5.44	n/a	n/a	n/a	n/a
2006	10.92	49.9%	82.4	576	44.9%	4.35	$191.9	41%	$17.6	$1,449
2007	13.70	54.0%	102.3	739	49.0%	5.52	$200.1	39%	$14.6	$1,495
2008	13.33	52.7%	98.6	666	47.3%	4.92	$212.8	39%	$16.0	$1,573
2009	14.35	54.8%	105.0	680	49.3%	4.98	$199.9	40%	$13.9	$1,462
2010	15.19	55.5%	110.0	746	50.1%	5.40	$192.5	36%	$12.7	$1,394
2011	15.48	56.0%	109.2	761	50.8%	5.37	$216.1	36%	$14.0	$1,524
Difference between 2000 and 2011							Difference between 2006 and 2011			
Value	3.41	2.6%	15.12	62.24	2.2%	-0.08	24.19	0.0	-3.62	74.95
%	28.2%	4.9%	16.1%	8.9%	4.6%	-1.4%	12.6%	-11.1%	-20.6%	5.2%

While the ICI energy consumption (GJ) increased by 28% from 2000 to 2011, its percentage contribution to the total community energy consumption increased from 53% in 2000 to 56% in 2011. **During this period the ICI consumption per capita (GJ/capita) increased by 16% (94 GJ/capita in 2000 and 109 GJ/capita in 2011).**

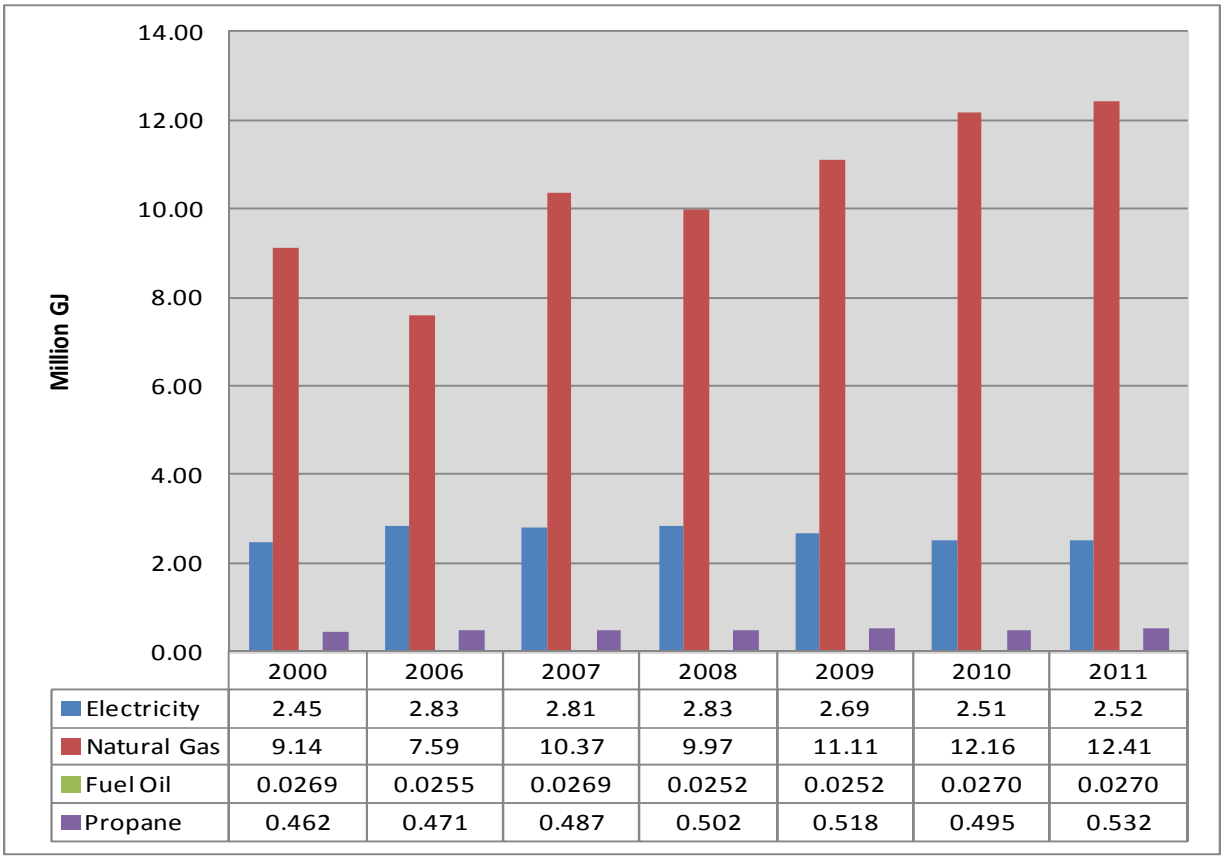
While the GHG emissions from the ICI sector increased by 9% from 2000 to 2011, the percentage contribution of the ICI sector to the total GHG emissions increased from 49% to 51%. **During this period the ICI GHG emissions per capita decreased by 1.4% from 2000 to 2011 (5.44 tonnes GHG emissions/Capita in 2000 to 5.37 tonnes GHG emissions/Capita in 2011).**

The cost of ICI energy increased by 13% from 2006 to 2011 ($192 Million in 2006; $216 Million in 2011). In spite of this increased the ICI proportion of the total community energy cost decreased from 41% in 2006 to 36% in 201). The ICI cost per GJ decreased by 21% ($17.6/GJ in 2006 and $14.0/GJ in 2011). **Between 2006 and 2011, the ICI energy cost per capita increased by 5% from $1,449/Capita to $1,524/Capita.**

5.3.2 ICI Energy Consumption by Emission Source

Figure 31 illustrates the ICI energy consumption (Million GJ) from 2000 to 2011.

Figure 31: ICI: Energy Consumption (Million GJ) by Emission Source

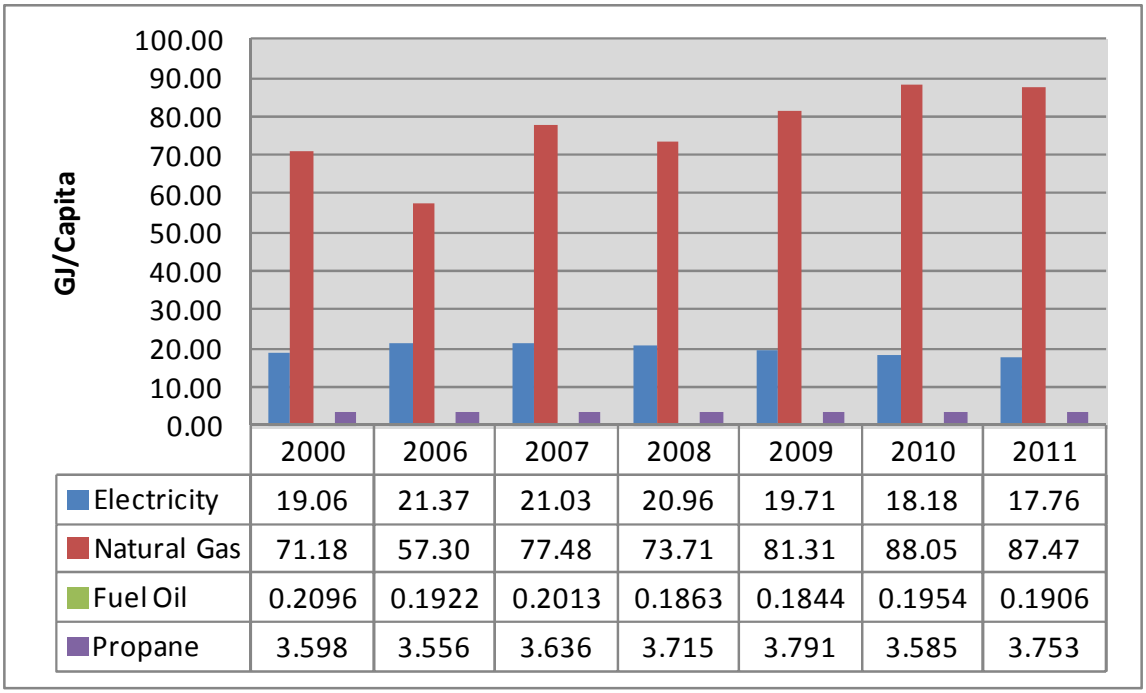


	2000	2006	2007	2008	2009	2010	2011
Electricity	2.45	2.83	2.81	2.83	2.69	2.51	2.52
Natural Gas	9.14	7.59	10.37	9.97	11.11	12.16	12.41
Fuel Oil	0.0269	0.0255	0.0269	0.0252	0.0252	0.0270	0.0270
Propane	0.462	0.471	0.487	0.502	0.518	0.495	0.532

Year	2000	2006	2007	2008	2009	2010	2011
Total Million GJ	12.1	10.9	13.7	13.3	14.4	15.2	15.5
% Change between 2011 and 2000	n/a	-9.6%	13.5%	10.4%	18.9%	25.8%	28.2%

During this time, the energy consumption for the ICI sector has grown by approximately 28%. Natural gas is the dominant energy source within the ICI sector and is responsible for the growth in energy consumption. The consumption of natural gas increased by 36% during this period while the consumption of electricity only increased by 3%. Figure 32 provides ICI energy consumption per capita by emission source for 2000 and 2006 to 2011.

Figure 32: ICI: Energy Consumption per Capita (GJ/Capita) 2000 and 2006 to 2011



	2000	2006	2007	2008	2009	2010	2011
Electricity	19.06	21.37	21.03	20.96	19.71	18.18	17.76
Natural Gas	71.18	57.30	77.48	73.71	81.31	88.05	87.47
Fuel Oil	0.2096	0.1922	0.2013	0.1863	0.1844	0.1954	0.1906
Propane	3.598	3.556	3.636	3.715	3.791	3.585	3.753

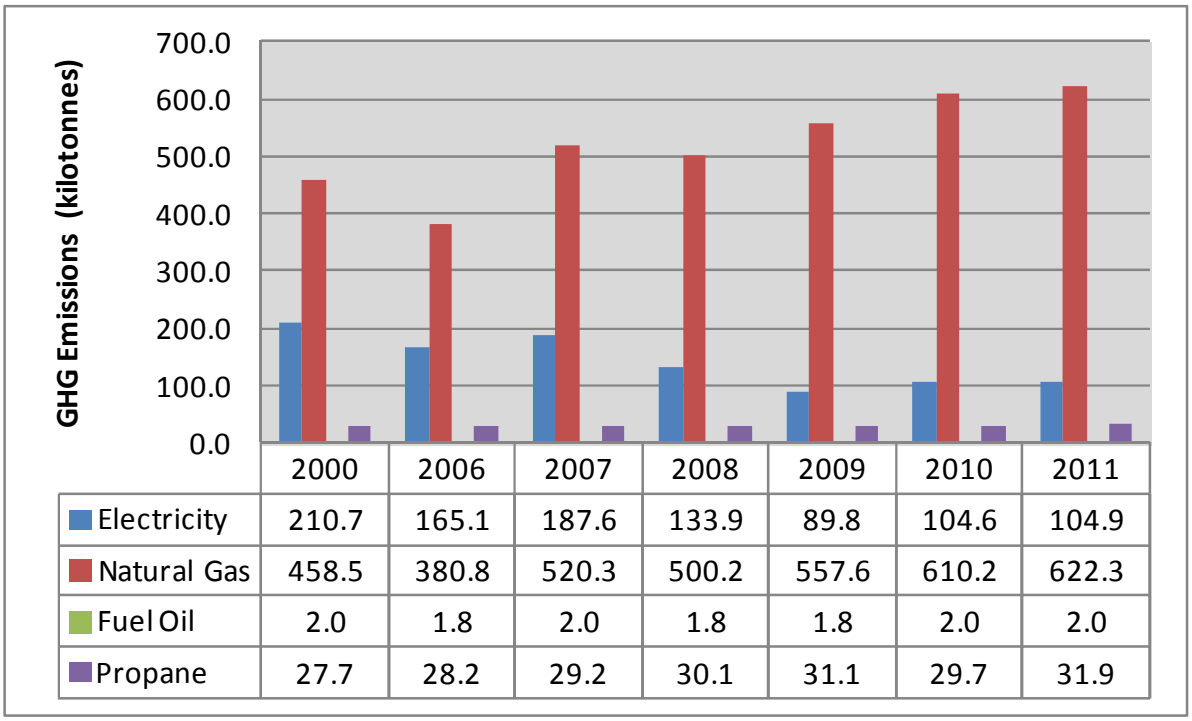
Year	2000	2006	2007	2008	2009	2010	2011
Total (GJ/Capita)	94.1	82.4	102	99	105	110	109
% Change between 2011 and 2000	n/a	-12.4%	8.8%	4.8%	11.6%	17.0%	16.1%

On a per capita basis, the ICI energy sector has experienced an energy consumption per capita increase of 16% from 94 GJ/Capita in 2000 to 109 GJ/Capita in 2011. This increase is due to an increase of 16 GJ/Capita from natural gas within this sector. ICI consumption of electricity has realized a decline of 1 GJ/Capita.

5.3.3 ICI: GHG Emissions by Emission Source

Figures 33 and 34 provide the GHG emissions by emission source and GHG emissions per capita by emission source for 2000 and 2006 to 2011.

Figure 33: ICI: GHG Emissions (kilotonnes) by Emission Source (2000 and 2006 to 2011)

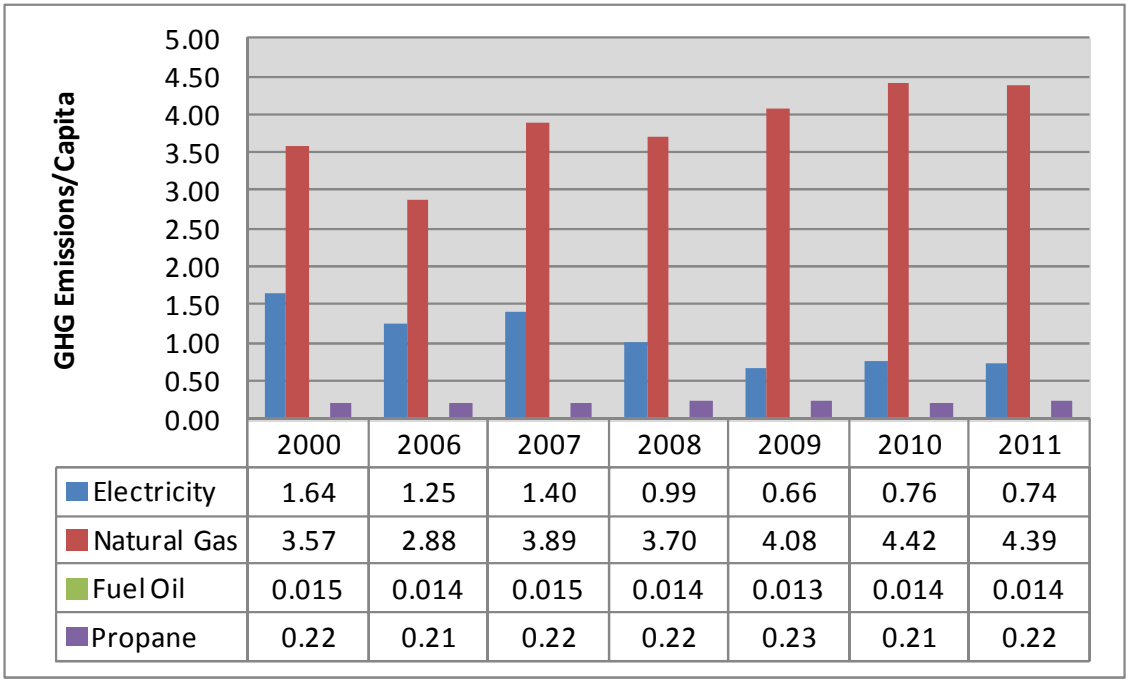


	2000	2006	2007	2008	2009	2010	2011
Electricity	210.7	165.1	187.6	133.9	89.8	104.6	104.9
Natural Gas	458.5	380.8	520.3	500.2	557.6	610.2	622.3
Fuel Oil	2.0	1.8	2.0	1.8	1.8	2.0	2.0
Propane	27.7	28.2	29.2	30.1	31.1	29.7	31.9

Year	2000	2006	2007	2008	2009	2010	2011
Total Emmisions (kilotonnes)	698.8	576.0	739.1	666.0	680.3	746.4	761.1
% Change between 2011 and 2000	n/a	-17.6%	5.8%	-4.7%	-2.6%	6.8%	8.9%

The ICI GHG emissions increased by 8.9% from 2000 to 2011. During this period the GHG emissions from electricity declined by 50% and the GHG emissions from natural gas increased by 26%. The drastic decrease in the GHG emissions attributed to electricity is due to the improvement in the Ontario energy mix and the resulting decrease in the Ontario electricity emission factor.

Figure 34: ICI: GHG Emissions per Capita by Source (2000 and 2006 to 2009)



	2000	2006	2007	2008	2009	2010	2011
Electricity	1.64	1.25	1.40	0.99	0.66	0.76	0.74
Natural Gas	3.57	2.88	3.89	3.70	4.08	4.42	4.39
Fuel Oil	0.015	0.014	0.015	0.014	0.013	0.014	0.014
Propane	0.22	0.21	0.22	0.22	0.23	0.21	0.22

Year	2000	2006	2007	2008	2009	2010	2011
ICI: GHG Emissions/Capita	5.44	4.35	5.52	4.92	4.98	5.40	5.37
% Change between 2011 and 2000	n/a	-20.1%	1.4%	-9.5%	-8.6%	-0.7%	-1.4%

On a per capita basis, the ICI GHG emissions have decreased by 1.4%. The marked decrease in the GHG emissions per capita from electricity due to the decrease in the electricity emission factor is almost completely offset by the increase in natural gas consumption and the accompanying GHG emissions.

5.3.4 ICI: Energy Cost by Emission Source

Figure 35 and Figure 36 provide the ICI energy cost by emission source and the ICI energy cost per capita by emission source for 2006 to 2011.

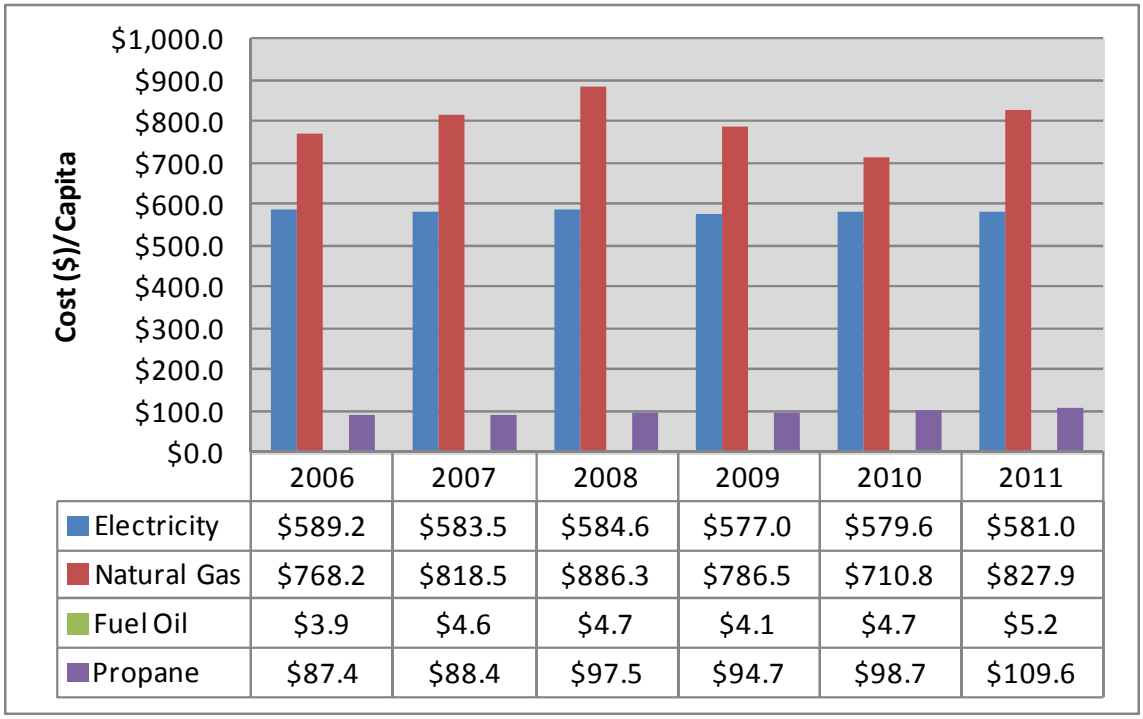
Figure 35: ICI: Energy Cost ($Million) by Source (2006 to 2011)

	2006	2007	2008	2009	2010	2011
Electricity	$78.05	$78.10	$79.07	$78.87	$80.05	$82.40
Natural Gas	$101.76	$109.56	$119.88	$107.50	$98.18	$117.42
Fuel Oil	$0.522	$0.621	$0.639	$0.562	$0.643	$0.741
Propane	$11.58	$11.83	$13.19	$12.95	$13.63	$15.54

Year	2006	2007	2008	2009	2010	2011
ICI: Energy Cost ($Millions)	$191.9	$200.1	$212.8	$199.9	$192.5	$216.1
% Change between 2006 and 2011	n/a	4.3%	10.9%	4.2%	0.3%	12.6%

Between 2006 and 2011, the ICI sector realized a 12.6% growth in energy costs from $191.9 Million in 2000 to $216.1 Million in 2011. In 2011, electricity was only responsible for 16% of the total energy consumption yet made up 38% of the total energy cost. In contrast, in 2011 natural gas was responsible for 80% of the total energy consumption yet made up only 54% of the total energy cost.

Figure 36: ICI: Energy Cost per Capita ($/Capita) by Source (2006 to 2011)



	2006	2007	2008	2009	2010	2011
Electricity	$589.2	$583.5	$584.6	$577.0	$579.6	$581.0
Natural Gas	$768.2	$818.5	$886.3	$786.5	$710.8	$827.9
Fuel Oil	$3.9	$4.6	$4.7	$4.1	$4.7	$5.2
Propane	$87.4	$88.4	$97.5	$94.7	$98.7	$109.6

Year	2006	2007	2008	2009	2010	2011
ICI: Cost per Capita	$1,449	$1,495	$1,573	$1,462	$1,394	$1,524
% Difference Compared to 2006	n/a	3.2%	8.6%	0.9%	-3.8%	5.2%

The ICI energy cost per capita increased by 5% ($75/Capita) from 2006 to 2011 ($1,449/Capita in 2006 to $1524 /Capita in 2011).

5.4 TRANSPORTATION SECTOR

Gasoline and diesel are the emission sources that make up the transportation sector. Table 13 and Table 14 provide a summary of the consumption, GHG emission and energy costs associated with gasoline and diesel respectively. This information was also provided in Section 4. Table 15 combines the data for gasoline and diesel to provide the energy consumption, GHG emissions and energy cost for the Transportation sector. Section 4 provides a detailed review of gasoline and diesel as emission sources. The discussion in this section will focus on the combined impact of both gasoline and diesel as the Transportation Sector.

Tale 13: Gasoline: Consumption, GHG Emissions and Cost (2000 and 2006 to 2011)

Gasoline (mobile) - Consumption, Cost and GHG Emissions for 2000 and 2006 to 2011											
Year	Consumption				Emissions			Cost			
	Million liters	Million GJ	% of Total Sources	GJ/Capita	eCO2 (kilotonnes)	% of Total Sources	eCO2 (t) per Capita	Million $	% of Total Sources	$/GJ	$/Capita
2000	139	4.82	23%	37.5	328	23%	2.6	n/a	n/a	n/a	n/a
2006	145	5.01	27%	37.8	341	27%	2.6	$131.6	28%	$26.3	$994
2007	156	5.39	24%	40.3	367	24%	2.7	$155.9	31%	$28.9	$1,164
2008	162	5.62	27%	41.5	382	27%	2.8	$162.0	30%	$28.9	$1,198
2009	160	5.53	27%	40.4	376	27%	2.8	$143.5	29%	$26.0	$1,050
2010	168	5.84	27%	42.3	397	27%	2.9	$168.1	31%	$28.8	$1,217
2011	163	5.65	26%	39.8	384	26%	2.7	$192.6	32%	$34.1	$1,358

Table 14: Diesel: Consumption, GHG Emissions and Cost (2000 and 2006 to 2011)

Diesel (mobile) - Consumption, Cost and GHG Emissions for 2000 and 2006 to 2011											
Year	Consumption				Emissions			Cost			
	Million liters	GJ	% of Total Sources	GJ/Capita	GHG Emissions (kilotonnes)	% of Total Sources	GHG Emissions per Capita (t)	Million $	% of Total Sources	$/GJ	$/Capita
2000	21	804,544	3.6%	6.3	56,784	3.9%	0.4	n/a	n/a	n/a	n/a
2006	22	838,625	3.8%	6.3	59,189	4.6%	0.4	$21	4.4%	$4.1	$156
2007	23	902,293	3.6%	6.7	63,683	4.2%	0.5	$23	4.5%	$4.3	$172
2008	24	940,207	3.7%	7.0	66,359	4.7%	0.5	$29	5.4%	$5.2	$216
2009	24	925,441	3.5%	6.8	65,317	4.7%	0.5	$21	4.2%	$3.8	$153
2010	25	977,227	3.6%	7.1	68,972	4.6%	0.5	$28	5.2%	$4.8	$201
2011	24	945,000	3.4%	6.7	66,697	4.5%	0.5	$32	5.3%	$5.7	$225

A comparison of Tables 13 and Table 14 indicates that gasoline is the dominant component of the Transportation section and in general makes up approximately 85% of the sector.

Table 15: Transportation: Consumption, GHG Emissions and Cost (2000 and 2006 to 2011)

Transportation - Consumption, Cost and GHG Emissions for 2000 and 2006 to 2011											
Year	Consumption				Emissions			Cost			
	Million liters	Million GJ	% of Total Sources	GJ/Capita	GHG Emissions (kilotonnes)	% of Total Sources	GHG Emissions per Capita (t)	Million $	% of Total Sources	$/GJ	$/Capita
2000	160	5.62	26.4%	43.8	385	26.7%	3.0	n/a	n/a	n/a	n/a
2006	166	5.85	30.4%	44.2	400	31.2%	3.0	$152	32.2%	$30.4	$1,150
2007	179	6.29	27.9%	47.0	431	28.5%	3.2	$179	35.1%	$33.2	$1,336
2008	186	6.56	30.9%	48.5	449	32.0%	3.3	$191	35.4%	$34.0	$1,414
2009	183	6.45	30.2%	47.2	442	32.0%	3.2	$164	32.9%	$29.7	$1,203
2010	194	6.81	30.2%	49.3	466	31.3%	3.4	$196	36.5%	$33.5	$1,418
2011	187	6.59	29.1%	46.5	451	30.1%	3.2	$225	37.5%	$39.8	$1,583
Difference between 2000 and 2011								Difference between 2006 and 2011			
Value	27.5	0.97	2.7%	2.7	66.3	3.4%	0.18	$72.2	5.3%	$9.4	$433.5
%	17.2%	17.2%	10.3%	6.1%	17.2%	12.6%	6.1%	47.4%	16.4%	30.8%	37.7%

Key findings of this data set include:

While the Transportation sector energy consumption (GJ) increased by 17% from 2000 to 2011, its percentage contribution to the total community energy consumption increased from 26% to 29%. **During this period the Transportation sector energy consumption per capita (GJ/capita) increased by 6% (43.8 GJ/capita in 2000 and 46.5 GJ/capita in 2011).**

While the GHG emissions from the Transportation sector increased by 17% from 2000 to 2011, the percentage contribution of the ICI sector to the total GHG emissions increased from 26.7% to 30.1%. **During this period the Transportation sector GHG emissions per capita increased 6% from 2000 to 2011 (3.0 in 2000 and 3.2 in 2011).**

The cost of Transportation energy increased by 47.4% from 2006 to 2011 ($152 Million in 2006; $225 Million in 2011). The Transportation sector proportion of the total community energy cost increased 32.2% in 2006 to 37.5 in 201). The Transportation cost per GJ increased by 30.8% ($30.4/GJ in 2006 and $39.8/GJ in 2011). **Between 2006 and 2011, the Transportation sector energy cost per capita increased by 37.7% from $1,150/Capita to $1,583/Capita.**

6.0 CONFOUNDING FACTORS

There are several factors which influence the energy consumption and the resulting GHG emissions for the Kingston community. The following factors are reviewed:

- Population Growth
- Electricity Emission Coefficient Changes
- Heating Degree Days and Cooling Degree Days Changes

6.1 POPULATION GROWTH

To determine the population to apply to the Kingston Community GHG inventory the following two data sets were used: Statistics Canada Census data (including the 2011 Census data) and the City of Kingston Planning Department's estimate of the 2011 Kingston Community student population.

Census population data is available for 2001, 2006 and 2011. Proportional estimates were made to estimate the populations for 2000, 2007, 3008, 2009 and 2010.

Table 16: Estimated Population (2000 and 2006 to 2011)

Year	Kingston Census	Proportional Estimate	Estimated Student Population Serviced by Kingston	Estimated Total Kingston Population	Difference from 2000
2000		113,590	14,785	128,375	
2001	114,195		14,864	129,059	0.5%
2006	117,206		15,256	132,462	3.2%
2007		118,437	15,416	133,853	4.2%
2008		119,682	15,578	135,260	5.3%
2009		120,939	15,742	136,681	6.4%
2010		122,210	15,907	138,117	7.6%
2011	123,363		18,460	141,823	10.4%

Based on these assumptions it is estimate that the population has increased by 10.4% from 2000 to 2011. These population estimates were used to determine the annual per capita estimates for consumption (GJ), GHG emissions and cost.

We estimated that between 2000 and 2011 the energy consumption per capita (GJ/Capita) increased by 10.7%. Therefore there are factors outside of population growth that are influencing energy consumption growth.

6.2 ELECTRICITY EMISSION COEFFICIENT CHANGES

The Ontario electricity GHG emission factor varies from year to year with changes to the Ontario Generation Mix. The Ontario electricity emission factors presented within the National Inventory Report (NIR) – Environment Canada (1990-2008) was applied to the 2006 to 2009 inventory. The Ontario electricity emission factors presented within the most recent National Inventory Report – Environment Canada (1990 to 2010) was applied to the 2011 Community GHG Inventory Update. The most recent NIR not only provided revised emission factors for 2009 but also restated historical Ontario electricity emission factors. Therefore, to ensure meaningful year to year comparisons, the emission factors applied to the City of Kingston Community GHG Inventory for the years 2000 and 2006 to 2009 had to be restated. The Ontario emission factor for 2010 was applied to 2011. Table 17 provides a comparison of the Ontario electricity emission factor applied in the 2006 to 2009 inventory and the current inventory update (2010 and 2011).

Table 17: Comparison of Ontario Electricity GHG Emission from NIR Reports

Year	Emission Factor NIR (1990-2008): Ontario kg CO2/kwh	Emission Factor NIR (1990-2010): Ontario kg CO2/kwh	Difference between NIR-2008 and NIR - 2010	Difference between 2000 based on NIR (1990 -2010)
2000	0.28	0.31	10.7%	N/A
2006	0.18	0.21	16.7%	-32.3%
2007	0.2	0.24	20.0%	-22.6%
2008	0.17	0.17	0.0%	-45.2%
2009	0.17	0.12	-29.4%	-61.3%
2010		0.15		-51.6%
2011*		0.15		-51.6%

*: The Ontario Emission Factor for 2010 from the NIR (1990 to 2010) was applied to 2011.

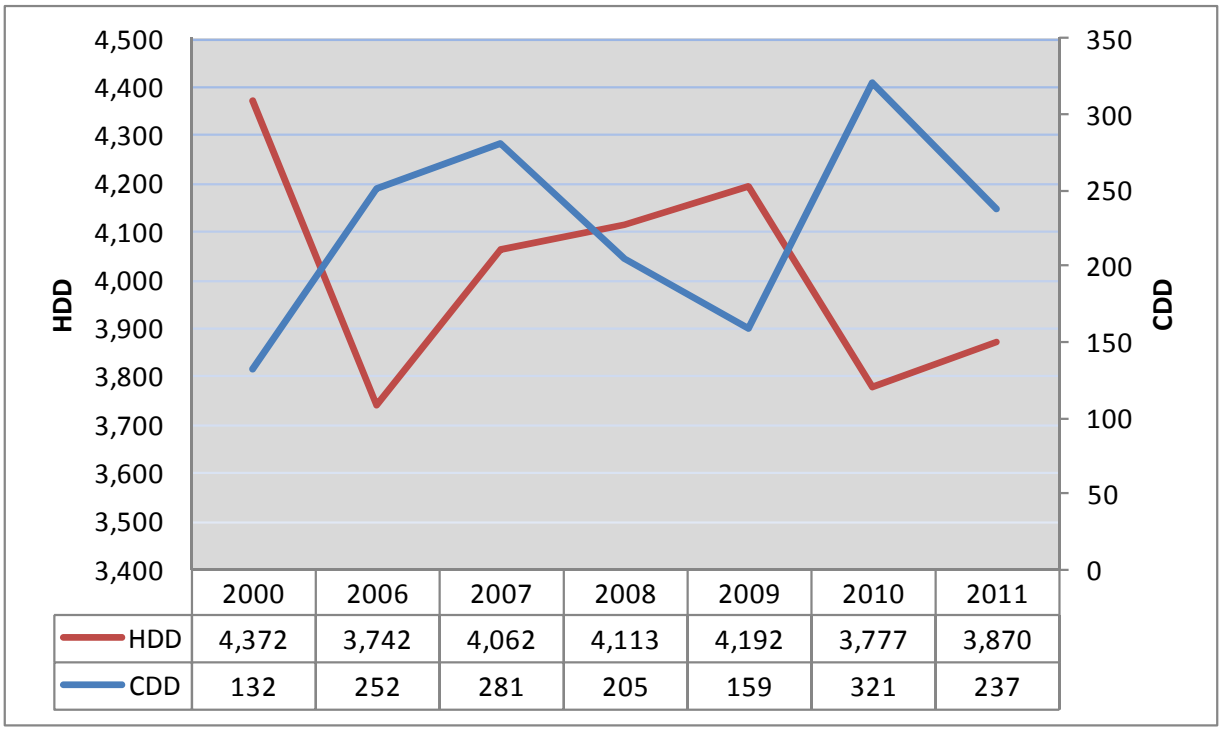
Table 17 indicates that Ontario electricity emission factors reported by Environment Canada varied significantly between the NIR (1990 to 2008) and NIR (1990 to 2010). The changes in historical emission factors are due to improved methodologies in emission factor estimates. It is anticipated that each year a NIR update is provided these historical emission factors will be restated. The year to year decrease in the Ontario electricity emission factors is due to improvements in the Ontario electricity energy mix. Between 2000 and 2011, the Ontario electricity emission factor decreased by 51.6%.

6.3 IMPACT OF HEATING DEGREE DAYS AND COOLING DEGREE DAYS

Heating and Cooling Degree Days

Heating Degree Day (HDD) is a measure of the energy needed to heat a building and Cooling Degree Day (CDD) is a measure of the energy needed to cool a building. The number of degrees that a day's average temperature is below 18 degrees Celsius is the number of HDD for that day. For example, if the average temperature for a day was 10 degrees Celsius then the HDD for that day would be 8 degrees Celsius. Similarly, the number of degrees that a day's average temperature is above 18 degrees Celsius is the number of cooling degree days. Figure 37 provides a summary of the annual HDD and CDD from 2000 and 2006 to 2011.

Figure 37: Annual HDD and CDD (2000 and 2006 to 2011)



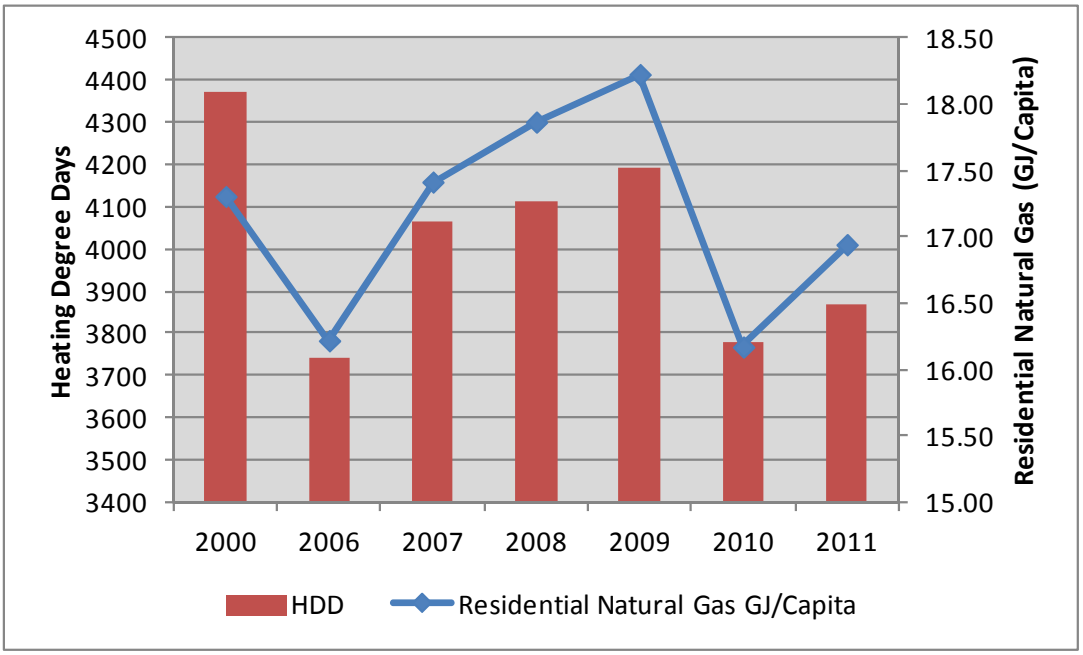
	2000	2006	2007	2008	2009	2010	2011
HDD	4,372	3,742	4,062	4,113	4,192	3,777	3,870
CDD	132	252	281	205	159	321	237

Based on this data we can see that the year 2000 (baseline) had the lowest number of CDD and the highest number of HDD in comparison to 2006 to 2011. This means that since 2000 more energy has had to be used in the summer to cool our buildings and less energy has had to be used in the winter to heat our buildings. By the dramatic drop in HDD in 2006 we see that it was an exceptional warm winter. Similarly, we see that in 2009 the summer was relatively cool (comparable to 2000). In 2011, the Kingston community experienced an 11.5% decrease in HDD and a 79% increase in CDD in comparison to the baseline year of 2000.

The Relationship between HDD and Residential Consumption of Natural Gas

Simple regression analysis revealed that a significant relationship exists **between HDD and residential GJ/capita from natural gas**. No other significant relationships were identified. Figure 38 shows the relationship between HDD and residential natural gas consumption per capita.

Figure 38: Residential: Relationship between HDD and GJ/Capita consumption of Natural Gas



Consumption

Equation of the Relationship between HDD and Residential Natural Gas (GJ/Capita)

HDD = 220.69 * Residential Natural Gas (GJ/Capita) +17.31

For every 100 decrease in HDD; the Residential Natural Gas (GJ/Capita) decreases by 0.53.

GHG Emissions

Equation of the Relationship between HDD and Residential Natural Gas (GHG Emissions/Capita)

HDD = 220.69 *Residential Natural Gas GHG Emissions/Capita + 0.868

For every 100 decrease in HDD; the Residential GHG Emissions due to natural gas decreases by 0.46.

7.0 BENCHMARKING TO OTHER SINGLE TIER MUNICIPALITIES

7.1 SELECTION OF BENCHMARK MUNICIPALITIES

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. In the 2006 to 2009 inventory, these three communities were compared against Kingston. Oshawa did not have updated data available to allow a comparison within the current inventory. Therefore, only London and Guelph energy consumption per capita and GHG emissions per capita are compared to Kingston. Due to the change in the historical Ontario electricity emission factors it would be misleading to compare the previous energy and consumption data previously cited for Oshawa with the updated data for Kingston, Guelph and London.

The following documents were reviewed for benchmarking purposes:

London*: 2011 Inventory Update provided by Manager of Air Quality.*

Guelph: Draft Report: The City of *Guelph Energy and Emissions Monitoring Report 2011 (September, 2012) – Currently a confidential document*.

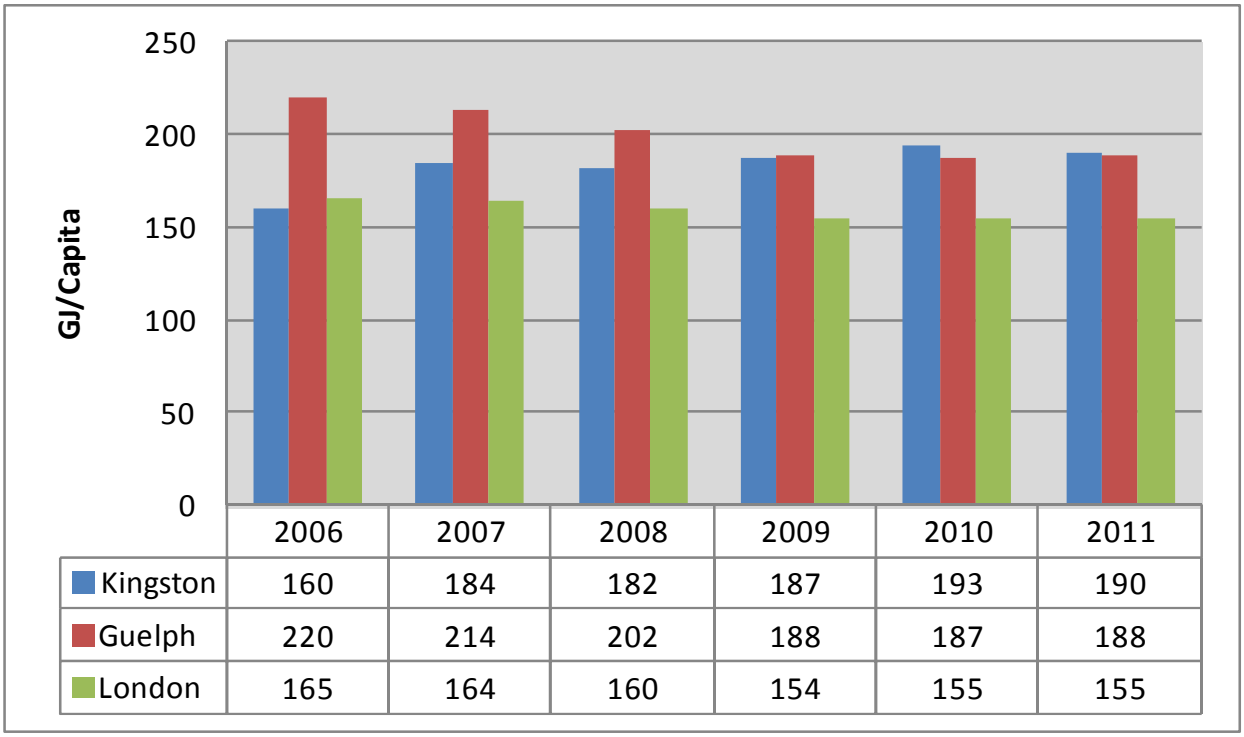
Oshawa: Current data was not available for Oshawa. Their inventory has not yet been updated.

7.2 ENERGY CONSUMPTION AND GREENHOUSE GAS EMISSION COMPARISON

The most significant emission sources for all communities included: natural gas, electricity, gasoline and diesel. The methodologies to determine the energy consumption for the Kingston, London and Guelph community inventories were compared. All communities sourced electricity and natural gas data through utility companies. London and Guelph used Kent Marketing data to obtain estimates of gasoline and diesel consumption within the community. Within the Kingston community inventory, estimates of diesel consumption were made using Statistics Canada data in addition to the Kent Marketing Services data. In comparison to London and Guelph the Kingston community diesel consumption estimates are over estimated. Therefore, to compare Kingston to London and Guelph the diesel values were restated to reflect the same estimate methodology.

Figure 39 compares the energy consumption per Capita (GJ/Capita) for Kingston, London and Guelph.

Figure 39: Community Comparison Energy Consumption per Capita (GJ/Capita)

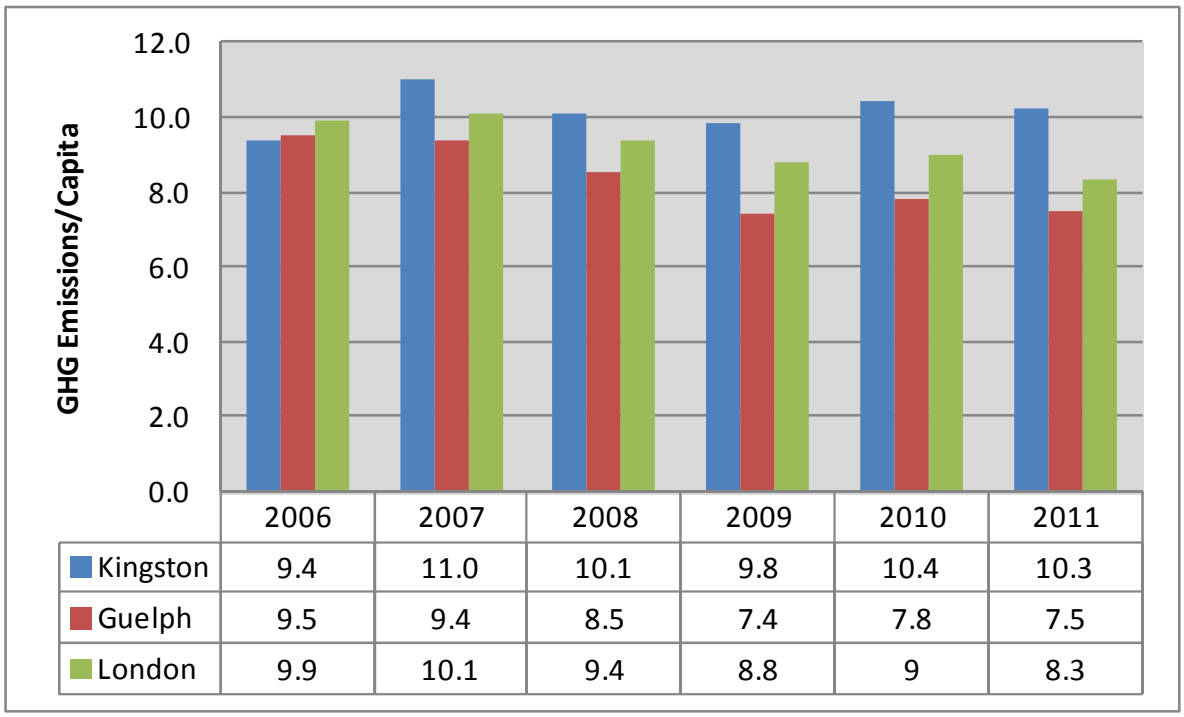


	2006	2007	2008	2009	2010	2011
Kingston	160	184	182	187	193	190
Guelph	220	214	202	188	187	188
London	165	164	160	154	155	155

Since 2006, London has consistently had the lowest energy consumption per capita of the three municipalities. While Guelph had the highest per capita consumption in 2006, it has consistently reduced its per capita energy consumption to 2011. During this period Kingston's GJ/Capita increased by 30 GJ/Capita from 2006 to 2011, while Guelph and London experienced a GJ/Capita reduction of 32 GJ/Capita and 10 GJ/Capita respectively.

Figure 40 compares the GHG Emissions/Capita for Kingston, London and Guelph.

Figure 40: Community GHG Emissions per Capita Comparison (GHG Emissions/Capita)

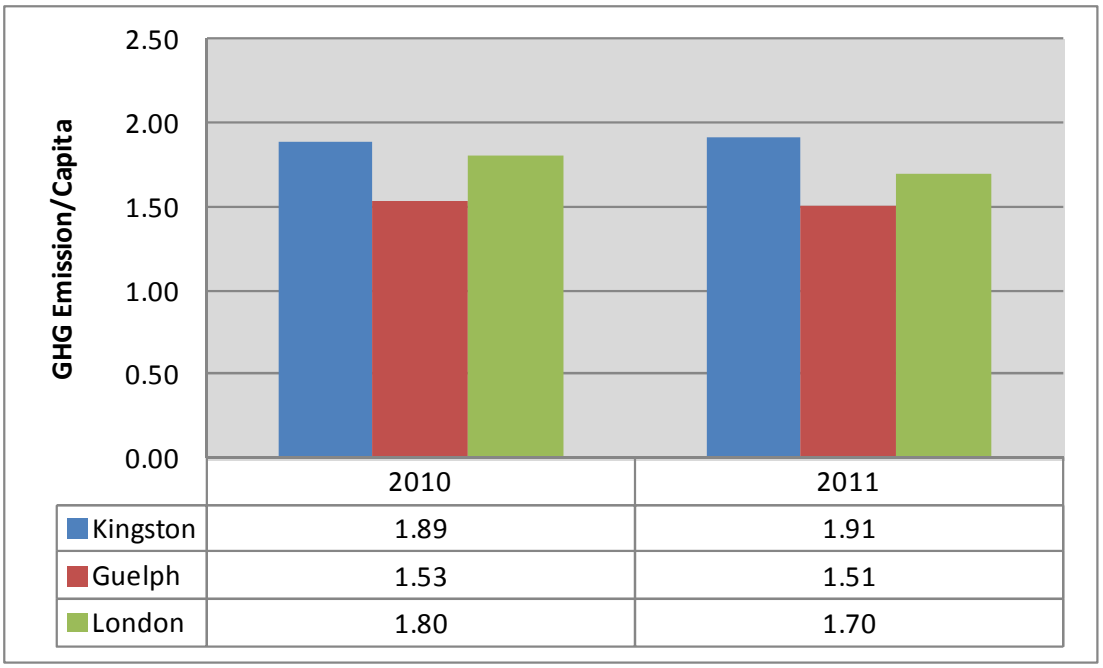


	2006	2007	2008	2009	2010	2011
Kingston	9.4	11.0	10.1	9.8	10.4	10.3
Guelph	9.5	9.4	8.5	7.4	7.8	7.5
London	9.9	10.1	9.4	8.8	9	8.3

In 2006, the three municipalities had comparable GHG Emissions/Capita. Guelph and London have relatively consistently reduced their GHG Emissions/Capita from 2006 to 2011 realizing a reduction of 2 tonnes of GHG Emissions/Capita and 1.6 tonnes of GHG Emissions/Capita respectively. During this same period, Kingston experienced an increase of 0.9 tonnes of GHG Emissions/Capita.

Figures 41, 42 and 43 provide a comparison of the GHG Emissions/Capita for the residential, ICI and transportation sectors. For 2011, Kingston, London and Guelph are within 0.4 tonnes of GHG Emissions/Capita of each other – with Kingston reporting the highest value. A more notable difference is evident in the ICI sector where Kingston is 85% greater than London and 43% greater than Guelph. This suggests that the ICI composition in Kingston is significantly different than that present in London and Guelph. The transportation sectors compare well, with Kingston ranking in the middle (below London and above Guelph).

Figure 41: Residential GHG Emissions/Capita (2010 and 2011)

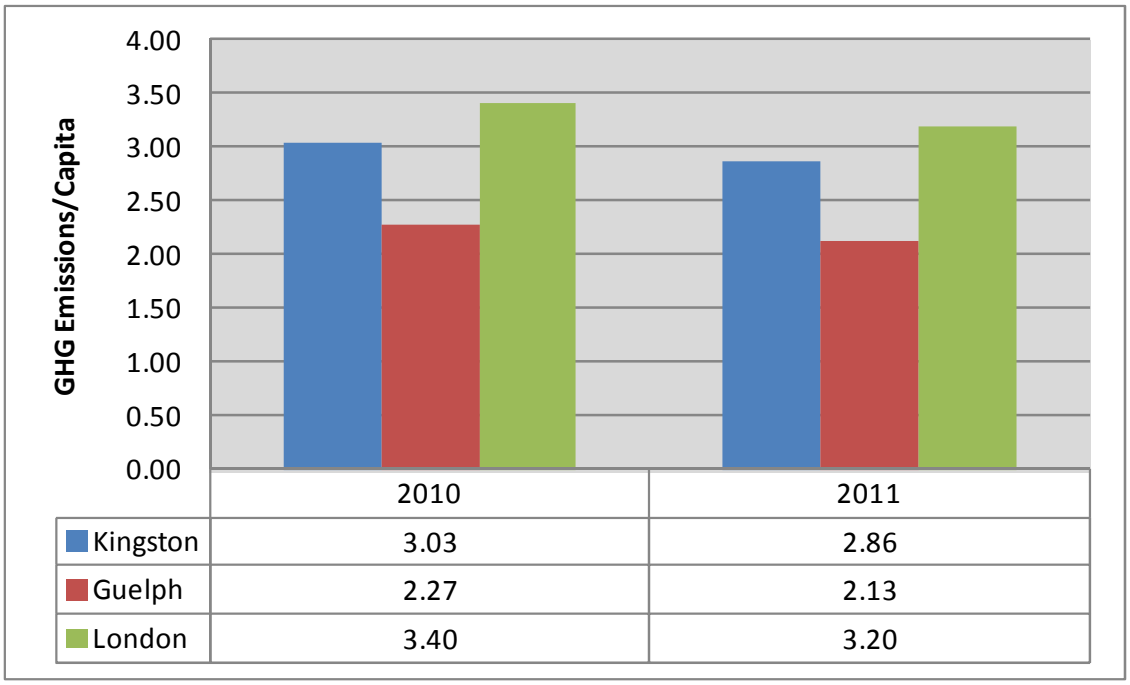


	2010	2011
Kingston	1.89	1.91
Guelph	1.53	1.51
London	1.80	1.70

Figure 42: ICI GHG Emissions/Capita (2010 and 2011)

	2010	2011
Kingston	5.40	5.37
Guelph	3.88	3.74
London	3.30	2.90

Figure 43: Transportation GHG Emissions/Capita (2010 and 2011)



	2010	2011
Kingston	3.03	2.86
Guelph	2.27	2.13
London	3.40	3.20

8.0 RECOMMENDATIONS FOR SUBSEQUENT COMMUNITY GHG INVENTORIES and NEXT STEPS

The following recommendations are offered to help the Kingston Community advance on its objectives to reduce its GHG emissions as well as to improve the quality and management of its energy consumption and cost data for future inventories.

- The Kingston Community GHG emission reduction target is to achieve a 10% reduction in GHG emissions by 2014 in comparison to the baseline year (2000). Since 2000, the Kingston community has experienced a 4.13% increase in GHG emissions and a 5.17% reduction in GHG emissions per capita. The Kingston community may want to revisit their GHG reduction target and/or the year for achieving the reduction goal.

- The Kingston Community should develop a GHG Local Action Plan with a strong emphasis on the implementation component of the plan. The FCM provides funding for the development of Local Action Plans. This could be completed in the same time frame as a Corporate GHG reduction Plan (which could assist in meeting the requirements of Reg.397/11 for corporate facilities).

- Given that in 2011, the Kingston community spent $599 Million on energy and that the historical community spend on energy is consistently increasing, it is recommended that the Kingston community Local Action Plan tie opportunities for GHG reduction to opportunities for energy cost savings in order to prioritize GHG reduction initiatives and strategies.

- Based on detailed sector analysis of the benchmarking communities (London and Guelph) it is noted that Kingston has higher energy consumption per capita and GHG emissions per capita because its ICI sector consumes much more energy than these two comparison communities. It is suggested that when Statistics Canada Census labour data is available in 2013 that the division of labour by employment type be compared for Kingston, London and Guelph. This may help to identify the difference in the energy consumption for the ICI sectors. Based on this analysis it may be determined that while it is meaningful to compare Kingston's residential and transportation sectors to London and Guelph it may not be appropriate to compare Kingston's ICI sector because of the differences in the composition of its labour market.

- To obtain a breakdown of the ICI sector into its components (industrial, commercial and institutional), the City of Kingston would have to work with Hydro One and Utilities Kingston to determine how they could revise client base identifiers so that this data could be mined in the future.

- On a sector basis, 50% of the Kingston Community GHG emissions are from the ICI sector and within the ICI sector natural gas is responsible for the majority of the GHG emissions. It would be of value to further subdivide this sector to better understand the consumption trends and habits so that potential reduction opportunities could be identified.