APPENDIX A. CITY OF KINGSTON, NY COMMUNITY ENERGY AND GREENHOUSE GAS EMISSIONS INVENTORY REPORT

I. INTRODUCTION

This report provides an overview of the community-wide energy assessment and greenhouse gas (GHG) emissions inventory for the City of Kingston. The community-wide inventory assesses energy usage and GHG emissions resulting from residential, commercial, industrial and transportation sectors within the City of Kingston.

The energy used and the greenhouse gas emissions in the community-wide inventory are for the City of Kingston as a whole, not just the City government. Local government operations energy usage and GHG emissions are a subset of the community-wide energy usage and GHG emissions.

Although the City of Kingston government may have limited influence over the level of emissions from some activities in the community, every effort has been made to compile a complete analysis of all activities that result in greenhouse gas emissions. References to 'Kingston' pertain only to the City of Kingston.

Aggregate electricity and natural gas usage for the residential, commercial, and industrial sectors was obtained from the Central Hudson Gas and Electric Corporation for calendar year 2010. Commercial data includes all commercial building accounts such the hospital, the library, county and municipal government accounts.

Residential and commercial heating fuel data (fuel oil, kerosene and propane) was obtained from the U.S. Energy Information Administration (USEIA) and U.S. Census Bureau. To the greatest extent possible all data is for base year 2010. However some USEIA data for heating fuel is from 2009 and while some 2010 Census data was available, some housing and home heating fuel usage data was obtained from the 2005- 2009 American Community Survey.

Vehicles miles traveled data for the City of Kingston was obtained from the Ulster County Transportation Council, Ulster County Department of Planning.

New York State Energy Research and Development Authority (NYSERDA) energy pricing data was used along with ICLEI Clean Air Climate Protection 2009 software to characterize energy usage, cost and greenhouse gas emissions for the community.

Following summaries of energy usage and GHG emissions data, the community-wide information is presented in more detail according to the following:

- Community Energy Use
- Community Greenhouse Gas Emissions by Fuel
- Residential Energy Use
- Residential GHG Emissions

- Commercial Energy Use
- Commercial GHG Emissions
- Transportation
- Transportation GHG Emissions
- Solid Waste/Materials Management
- Solid Waste/Materials Management GHG Emissions
- Government Operations Energy Usage as Percentage of Community Energy Usage
- Government Operations GHG Emissions as Percentage of Community GHG Emissions

II. COMMUNITY SUMMARY

Table 1 outlines the community-wide energy usage by sector and by fuel type. Residential, commercial and industrial energy usage as well as transportation related data are depicted including vehicle miles traveled in the City of Kingston and vehicles' fuel usage. The energy data was used to generate GHG emissions for each of these sectors.

Table 1: 2010 Community-wide Energy, City of Kingston

Community-Wide Energy Usage-City of Kingston	2010 Total Usage
Residential Electricity (kWh)	62,782,267
Residential Heating Fuel Oil (Gal)	1,238,245
Residential Heating Fuel-Kerosene (Gal)	56,487
Residential LPG* Total (Gal)	252,706
Residential Natural Gas (MCF)	441,305.8
Commercial Electricity (kWh)	109,954,288
Commercial Heating Fuel Oil-Kerosene(Gal)	596,843
Commercial LPG Total (Gal)	81,670
Commercial Natural Gas (MCF)	472,746.8
Industrial Electricity (kWh)	4,492,604
Industrial Natural Gas (MCF)	22,596.5
Wood (Tons)	1,573.63
Vehicle Miles Traveled	158,782,140
Vehicle Fuel Gas (Gal)	8,613,576
Vehicle Fuel Diesel (Gal)	1,507,951

* Liquid Petroleum Gas

Community-wide energy usage is summarized in Table 2. In 2010, 177,229,159 kWh of electricity and 9,366,490 CCF of natural gas were used in the City of Kingston, along with close to 1.9 million gallons of heating fuel and over 330,000 gallons of propane. Approximately 159,000,000 vehicle miles were traveled in Kingston 2010 consuming more than 8.6 million gallons of gas and 1.5 million gallons of diesel fuel.

Table 2: 2010 Community-wide Energy Usage Summary, City of Kingston

Energy Source	2010 Total Community Usage
Electricity (kWh)	177,229,159
Natural Gas (CCF)	9,366,490
Heating Fuel Oil-Kerosene(Gal)	1,891,575
LPG Total (Gal)	334,376
Vehicle Miles Traveled	158,782,140
Vehicle Fuel Gas (Gal)	8,613,576
Vehicle Fuel Diesel (Gal)	1,507,951

A. COMMUNITY ENERGY CONSUMPTION

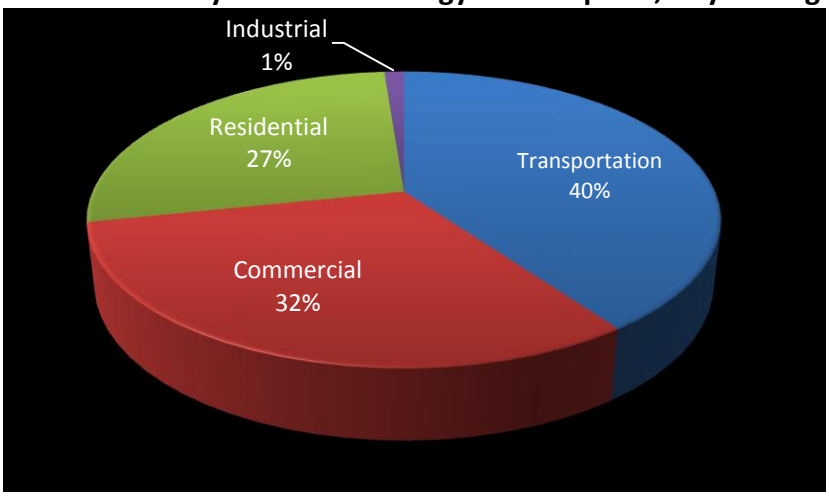
Using the ICLEI CACP 2009 software the energy data in Table 2 was used to estimate the total energy consumption for each sector. As depicted in Table 3 and displayed in Figure 1, in 2010 the transportation sector in Kingston consumed the largest percentage of the community's energy. The commercial sector is second, however the commercial and residential sectors combined, primarily energy consumed in buildings and facilities, accounted for 59% of the community's energy consumption.

Table 3: Community-wide 2010 Energy Consumption Summary, City of Kingston[1]

City of Kingston Community-Wide Usage	2010 Community Total Energy Consumption (MMBTU)	% of Total Energy Consumption
Transportation	1,284,800	40
Commercial	1,012,178	32
Residential	867,671	27
Industrial	38,472	1
Total	**3,203,121**	

[1] Energy consumption data generated by ICLEI CACP 2009 software

Figure 1: Community-wide 2010 Energy Consumption, City of Kingston



Based on 2010 U.S Census data, energy use in the City of Kingston was 134 MMBTU per capita and 287 MMBTU per household.

Table 4: City of Kingston 2010 Energy Consumption per Person & Household

2010 Community Total Energy Consumption (MMBTU)	2010 Population	Energy Used per Capita (MMBTU/capita)	2010 Total Housing Units	Energy Used per Household* (MMBTU/household)
3,203,121	23,893	134	11,147	287

* Based on total Energy Consumption. Based only on residential energy consumption, energy use is 78 MMBTU per household.

B. COMMUNITY GREENHOUSE GAS EMISSIONS SUMMARY

Community-wide GHG emissions in the City of Kingston in 2010 were estimated at approximately 225,097 metric tons (tonnes) of CO_2e.[2]

As is depicted in Table 5 and in Figure 2 the transportation sector (gasoline and diesel use) accounted for 41% of the communities GHG emissions, with commercial energy usage contributing 32%, residential 26% and industrial approximately 1%. Emissions from waste accounted for less that 0.5% of the total.[3]

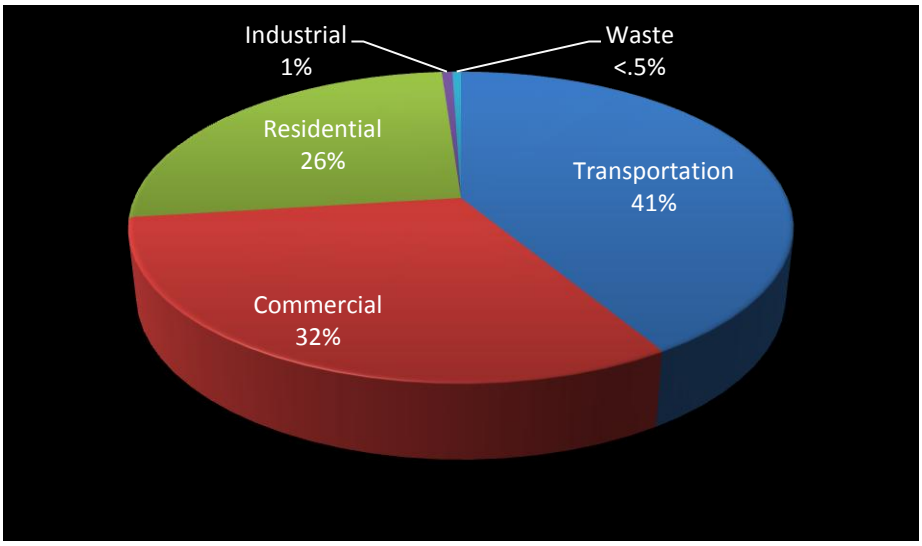
[2] All emissions estimated using ICLEI's CACP 2009 Software.
[3] Only waste collected by the City DPW is factored into these GHG emissions. Not all waste generated in the City was accounted Also emissions from waste have technically not yet been created as landfill gas is created over time.

Table 5: Community-wide 2010 GHG Emissions, City of Kingston

City of Kingston Community GHG Emissions Summary by Sector	Total CO_2e (tonnes)	% of Total
Transportation*	93,048	41
Commercial	71,281	32
Residential	58,247	26
Industrial	1,400	1
Waste	1,121	<1
Total	**225,097**	

* Includes 352 tonnes of CO_2e from Waste Transport

Figure 2: 2010 Community-wide GHG Emissions by Sector, City of Kingston



III. COMMUNITY ENERGY USE

A. COMMUNITY ELECTRICITY USAGE

In 2010 the community used 177,229,159 kWh of electricity. As depicted in Table 6 and Figure 3 the commercial sector consumed the greatest portion of electricity usage at 63% (109,954,288 kWh) and the industrial sector used the least, 3% (4,492,604 kWh).

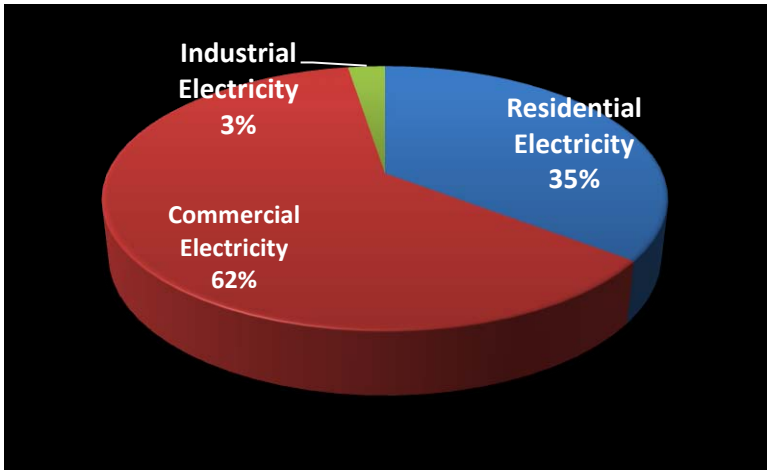
The residential sector accounted for 35% of electricity usage at 62,782,267 kWh which is equivalent to 2,676.6 kWh per capita.

Commercial electricity data encompasses municipal accounts including street lighting. The primary provider of electricity in the City of Kingston is the Central Hudson Gas and Electric Corporation. Fuel sources used by Central Hudson to generate electricity can be found in Appendix F.

Table 6: Community-wide 2010 Electricity Usage Summary, City of Kingston

City of Kingston Community-Wide Electricity Usage	2010 Community Total Usage (kWh)	% of Total Electricity Usage
Commercial Electricity (kWh)	109,954,288	62
Residential Electricity (kWh)	62,782,267	35
Industrial Electricity (kWh)	4,492,604	3
Total Electricity (kWh)	**177,229,159**	

Figure 3: Community-wide Electricity Usage- City of Kingston



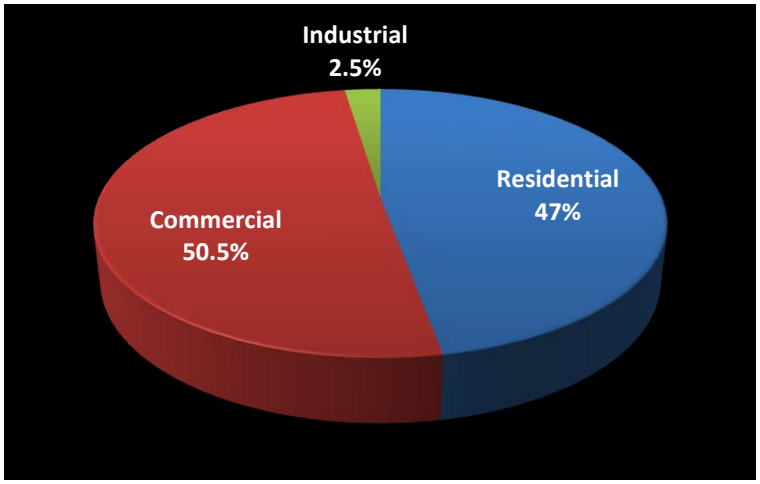
B. COMMUNITY NATURAL GAS USAGE

As illustrated in Table 7 and Figure 4, natural gas usage in 2010 in the City was fairly equally split between commercial, 50.5% and residential, 47%. Industrial usage accounted for 2.5%.

Table 7: Community-wide Natural Gas Usage Summary, City of Kingston

City of Kingston Community-Wide Natural Gas Usage	2010 Total Usage CCF	2010 Usage Therms	% of Total
Commercial	472,746.8	4,840,927.23	50.5
Residential	441,305.8	4,518,971.39	47
Industrial	22,596.5	231,388.16	2.5
Total	**936,649.1**	**9,591,286.78**	

Figure 4: 2010 Community Natural Gas Usage



C. COMMUNITY FUEL OIL AND PROPANE USAGE

According to the USEIA it is estimated that a total of 1,891,575 gallons of fuel oil and kerosene was used in the City of Kingston in 2010. Most of the fuel oil, 1,238,245 gallons, or 65% was for residential heating.

Table 8 : Community-wide Fuel Oil, City of Kingston

Community-Wide Fuel Oil Usage City of Kingston	2010 Total Usage	% of Total
Residential Heating Fuel Oil (Gal)	1,238,245	65
Residential Heating Fuel-Kerosene (Gal)	56,487	3
Commercial Heating Fuel Oil/Kerosene(Gal)	596,843	32
Total	**1,891,575**	

In 2010, according to the USEIA, 334,376 gallons of liquid propane gas was used in the City of Kingston. Seventy-six percent, or 272,706 gallons, was used by the residential sector.

`Table 9: Community-wide Propane Usage - City of Kingston

City of Kingston Community-Wide Propane Usage	2010 Total Usage (Gallons)	% of Total
Residential LPG	252,706	76
Commercial LPG	81,670	24
TOTAL	**334,376**	

D. COMMUNITY GREENHOUSE GAS EMISSIONS BY FUEL

The use of gasoline resulted in an estimated 77,285 tonnes of CO_2e, 34% of the City's total CO_2e. Diesel fuel usage accounted for another 15,411 tonnes of CO_2e, 7% of the total, resulting in transportation fuels contributing approximately 41% of the total GHG emissions or 92,696 tonnes of CO_2e as illustrated in Figure 5.

Electricity usage contributed 25% of community GHG emissions, 55,204 tonnes of CO_2e and natural gas usage another 22%, 49,651 tonnes of CO_2e. Fuel oil usage accounted for approximately 8% of the community-wide GHG emissions with commercially used residual fuel oil[4] accounting for 2% of Kingston community-wide GHG emissions. Propane, kerosene and transported related emission each accounted for 1% or less the community-wide GHG emissions.

Transportation of waste, 352 tonnes of CO_2e, and the future GHG emissions from City waste land filled at Seneca Meadows Landfill in western NY, 1,121 tonnes of CO_2e, accounted for less than 1% of total community GHG emissions.[5]

Table 10: Community-wide GHG Emissions by Source, City of Kingston

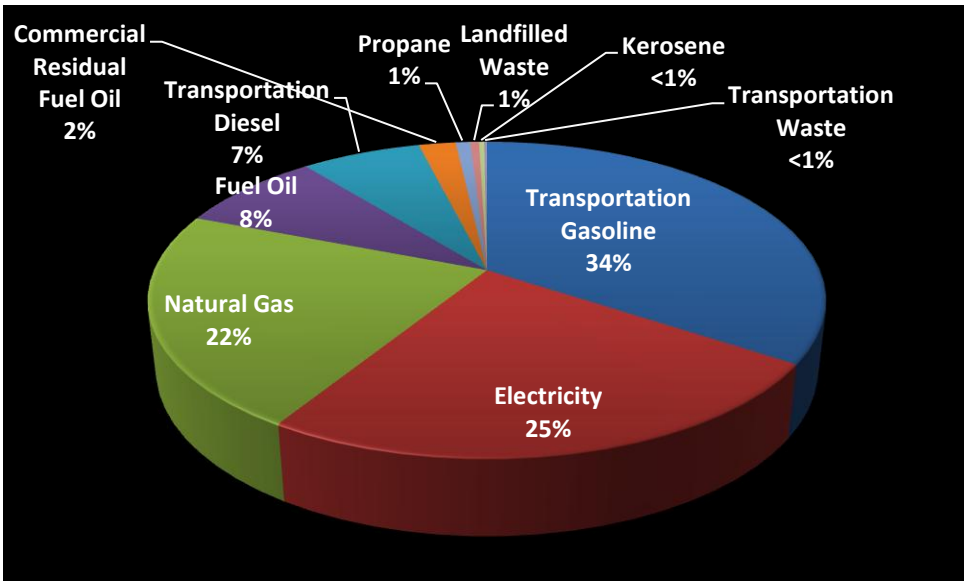
GHG Emissions by Source	CO_2 tonnes	N_20 (kg)	CH_4 (kg)	CO_2e (tonnes)	Energy (MMBtu)	% of Total CO_2e
Transportation Gasoline	75,627	5,058	4,294	77,285	1,076,581	34
Electricity	54,928	796	1,399	55,204	604,878	25
Natural Gas	49,523	95	4,702	49,651	959,129	22
Fuel Oil	18,647	183	2,740	18,762	252,124	8
Transportation Diesel	15,396	45	46	15,411	208,218	7
Commercial Residual Fuel[6]	4,735	42	714	4,763	63,043	2
Propane	1,870	33	335	1,887	30,428	1
Landfill Emissions	0	0	53,362	1,121		<1
Kerosene	655	7	97	660	8,720	<1
Transportation Waste	352	1	1	352	7,983	<1
TOTAL	**221,733**	**6,260**	**67,690**	**225,097**	**3,211,104**	

[4] A general classification for the heavier oils, known as No. 5 and No. 6 fuel oils, that remain after the distillate fuel oils and lighter hydrocarbons are distilled away in refinery operations. (Local Government Operating Protocol, May 2010).

[5] Only waste collected by the City DPW is factored into these GHG emissions. Not all waste generated in the City was accounted. Also emissions from waste have technically not yet been created as landfill gas is created over time.

[6] A general classification for the heavier oils, known as No. 5 and No. 6 fuel oils, that remain after the distillate fuel oils and lighter hydrocarbons are distilled away in refinery operations. (Local Government Operating Protocol, May 2010)

Figure 5: 2010 Community-wide GHG Emissions by Fuel Source



IV. RESIDENTIAL ENERGY USE & GREENHOUSE GAS EMISSIONS

Based on the most recent U.S. Census data, in 2010 there were a total of 11,147 housing units in the City of Kingston of which 10,217 were occupied. Of those units, 4,747 housing units were owner-occupied (46.5%) by 11,442 individuals and 5,470 units renter-occupied (53.5 %) by 11,743 individuals. There were 930 vacant housing units.

Based on the information available from the American Community Survey, in 2009 the majority of housing, 47%, (4,899) are single family units. Two family units make up 19% (1,934) of the housing stock, 12% (1,236) are 5-9 units and about 10% (1,108) are 3-5 units. The majority of housing units, 59% (6,172) were built before 1939.

A. HOME HEATING FUEL

Based on American Community Survey 2009 data[7], of the 9,410 occupied housing units, the majority, more than 53% (5,020) use utility supplied natural gas to heat their homes using 441,305.8 MCF[8] of natural gas equaling 453,221.05 MMBTU[9] and 4,518,971 therms[10] at a cost of $6,654,891 (2009 - $15.08 per MCF)[11].

[7] American Community Survey data estimates for 2005-2009 were used for breakdown of home heating fuels as 2010 data was not available when this report was prepared. There is however a significant difference in the number of total occupied housing units, an 8.5% increase or 807 additional units based on available 2010 data.

[8] MCF is the volume of 1,000 cubic feet (CF) of natural gas. Natural gas usage at a home is metered in units of hundreds of cubic feet (CCF). This is a measure of the volume of natural gas that is used. Each CCF of natural gas contains the energy value of approximately 1 therm.http://www.clearwatergas.com/bill/natural.asp

[9] Natural gas is often measured in BTUs. The heating capacity of natural gas supplied by Central Hudson is 1000 to 1025 British Thermal Units (BTUs) per cubic foot. *Email from Samuel C. Rosenberry, Supervisor, New Business & Customer Accounts, Upper Hudson Division, Central Hudson Gas & Electric, August 16, 2011*

Fuel oil and kerosene was used by 32% of homes in the City of Kingston (3,000 units) for heating in 2009. These 3,000 households used an estimated 30,827 barrels or 1,294,732 gallons of fuel oil and kerosene to heat their homes, approximately 431.6 gallons per household. The greenhouse gas emissions from the burning of fuel oil and kerosene by City of Kingston residents released 13,293 tonnes of CO_2e emissions or 4.43 tonnes of CO_2e per household.

Most of the fuel usage is fuel oil no. 1, 2, 4 (aka distillate fuel) as outlined below:

- 29, 482.02 barrels or 1,238,245 gallons of distillate fuel (Fuel Oil No. 1, 2, 4) was used for home heating by City of Kingston residents at a cost of $3,225,133 (Distillate Oil, $2.6046/gallon)[12]
- The greenhouse gas emissions from the burning of distillate fuel by City of Kingston residents released 12, 716 tonnes of CO2e emissions.[13]

Kerosene usage in 2009:

- 1,345 barrels or 56,487 gallons of kerosene was used for home heating by City of Kingston residents at a cost of $158,847 (Kerosene, $2.8121 per gallon).[14]
- The greenhouse gas emissions from the burning of kerosene by City of Kingston residents released 577 tonnes of CO_2e emissions.

In 2009 approximately 11%, 1,050 households in the City of Kingston used electricity for heating.

An estimated 226 households in the City of Kingston used propane for home heating in 2009.

- An estimated 252,706 gallons of propane were used for home heating by City of Kingston residents at a cost of $706,718 (Propane, $2.7966 per gallon),[15] approximately 950 gallons per household.
- The greenhouse gas emissions from the burning of propane by City of Kingston residents released 1,426 tonnes of CO_2e emissions.

Similar percentages of home heating fuel usage can be presumed for 2010 housing data, estimating that approximately 5,450 housing units use utility gas for home heating; about 3,257 homes use fuel oil or

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One BTU is the heat required to raise the temperature of one pound of water by one degree Fahrenheit. A wooden kitchen match produces approximately 1 BTU, and air conditioners for household use typically produce between 5,000 and 15,000. One cubic foot of natural gas produces approximately 1,000 BTUs, so 1,000 cu.ft. of gas is comparable to 1 MBTU. MBTU is occasionally expressed as MMBTU. 1 MMBTU is 1 million BTU.
http://www.energyvortex.com/energydictionary/british_thermal_unit_(btu)__mbtu__mmbtu.html
US Energy Information Administration, http://205.254.135.7/tools/faqs/faq.cfm?id=45&t=8

[10] A Therm is a measurement of energy content of gas and is equal to 100,000 BTU whereas CCF is the measurement of space or volume of gas. A CCF is approximately equivalent to 1.024 therms.

[11] New York State Residential Energy Prices in Nominal Dollars, 1995–2009
http://www.nyserda.org/energy_information/residential_energy05_09.pdf

[12] Ibid

[13] CACP 2009

[14] New York State Residential Energy Prices in Nominal Dollars, 1995–2009
http://www.nyserda.org/energy_information/residential_energy05_09.pdf

[15] New York State Residential Energy Prices in Nominal Dollars, 1995–2009
http://www.nyserda.org/energy_information/residential_energy05_09.pdf

kerosene and 1,140 that use electricity for heating. Greenhouse gas emissions would have been expected to rise accordingly based on the increase in housing units.

Table 11: 2009 Home Heating Fuels, City of Kingston

HOME HEATING FUEL	Housing Units	Margin of Error	Percentage of Total Units	Margin of Error
Occupied Housing Units	**9,410**	**+/-321**	**9,410**	**(X)**
Utility gas	5,020	+/-353	53.3%	+/-3.4
Bottled, tank, or LP gas	226	+/-103	2.4%	+/-1.1
Electricity	1,050	+/-196	11.2%	+/-2.0
Fuel oil, kerosene, etc.	3,000	+/-341	31.9%	+/-3.5
Coal or coke	0	+/-123	0.0%	+/-0.4
Wood	73	+/-70	0.8%	+/-0.7
Solar energy	0	+/-123	0.0%	+/-0.4
Other fuel	26	+/-24	0.3%	+/-0.3
No fuel used	15	+/-23	0.2%	+/-0.2

2009 Data from American Community Survey includes both owner and renter occupied.

B. RESIDENTIAL GHG EMISSIONS

The City of Kingston's residential sector generated an estimated 58,247 tonnes of CO_2e or 26% of community-wide GHG emissions in 2010. This estimate was calculated using 2010 electricity and natural gas consumption data provided by Central Hudson, and only includes consumption from residential buildings. Data on residential equipment usage, such as lawnmowers or on-site electricity generation, is not included in this inventory. GHG emissions associated with residential transportation and residential waste generation are included separately in the Transportation and Waste Sector emissions totals.

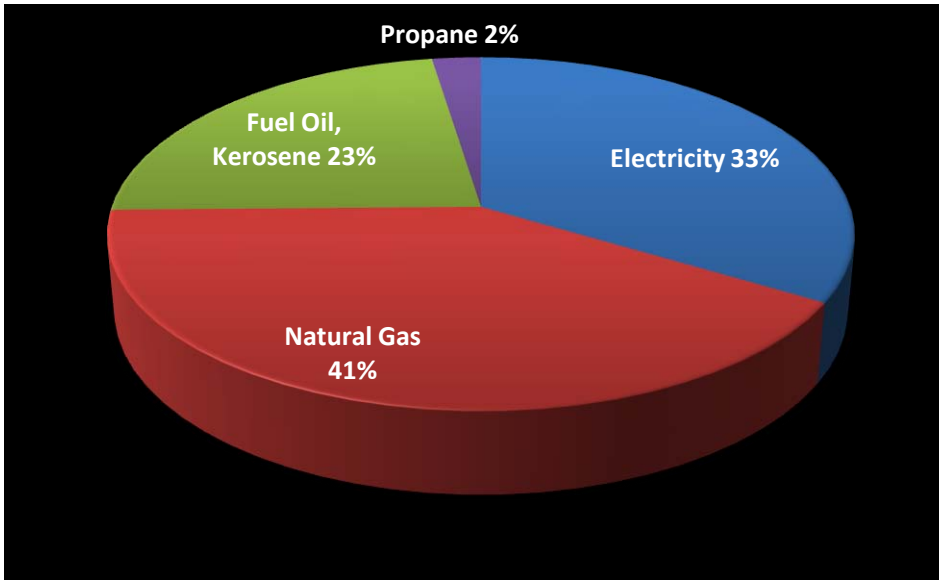
Table 11 and Figure 6 illustrate the breakdown of residential GHG emissions by fuel source. According to the USEPA, GHG emissions associated with home electricity use are about twice those associated with heating[16], however for the City of Kingston more than 41% of residential GHG emissions were generated from the use of natural gas. Natural gas is typically used in residences as a fuel for home heating, water heating and cooking. Approximately 34 percent of residential GHG emissions were generated through electricity and 25% by fuel oil, kerosene and propane used for home heating.

[16] http://www.epa.gov/climatechange/emissions/ind_home.html

Table 12: Residential GHG Emissions Summary by Fuel Source, City of Kingston

Residential GHG Emission Sources 2010	CO_2 (tonnes)	N_2O (tonnes)	CH_4 (tonnes)	CO_2e (tonnes)	Energy (MMBtu)	% of CO_2e
Electricity	19,458	282	496	19,556	214,274	34
Natural Gas	23,910	45	2,259	23,971	451,897	41
Fuel Oil, Kerosene	13,212	129	1,942	13,293	178,518	23
Propane	1,413	25	253	1,426	178,518	2
TOTALS	**57,993**	**481**	**4,950**	**58,246**	**867,685**	

Figure 6: Residential GHG Emissions Summary by Fuel Source, City of Kingston



C. GREENHOUSE GAS EMISSIONS PER HOUSEHOLD

Table 13 provides information on residential emissions on a per household basis. Based on residential energy usage occupied households in the City of Kingston generated 58,246 metric tons (tonnes) of CO_2e (GHG emissions) in 2010, Based on 9,410 occupied households (2009 ACS data); GHG emissions are estimated to be 6.19 metric tons (tonnes) of CO_2e per occupied household.[17]

Per household emissions can be a useful metric for measuring progress in reducing greenhouse gases and for comparing one's emissions with neighboring cities and against regional and national averages. According to the USEPA, approximately 4 tonnes of CO_2e (almost 9,000 pounds) per person per year (about 17% of total U.S. emissions) are emitted from people's homes[18]. The three main sources of GHG gas emissions from homes are electricity use, heating and waste.

[17] 2010 US Census data 11,147 households, 5.22 tonnes of CO_2e per household
[18] http://www.epa.gov/climatechange/emissions/ind_home.html

Table 13 : 2010 Greenhouse Gas Emissions per Household[19]

Greenhouse Gas Emissions per Household	
Number of Occupied Housing Units	9,410
Total Residential GHG Emissions (metric tons CO_2e)	58,247
Residential GHG Emissions/Household (metric tons CO_2e)	6.19

*Does not include transportation related GHGs

D. GHG EMISSIONS FROM WOOD USED FOR HOME HEATING

The use of wood as a fuel source creates GHG emissions however these are not included in the total GHG emissions because it is presumed that the carbon from wood will return to the atmosphere whether burned or through natural decomposition.

Based on data gathered from the U.S. Energy Information Administration it was estimated that 1,573.63 tons of wood was used as fuel in the City of Kingston in 2010. This created 193 tonnes of CO_2e or 2,270 tonnes of $BioCO_2$.

Table 14: City of Kingston Community GHG Emissions -Wood

GHG Emissions by Source	CO_2 (tonnes)	N_20 (kg)	CH_4 (kg)	CO_2e (tonnes)	Bio CO_2 (tonnes)	Energy (MMBtu)
Wood Home Heating	0	102	7,648	192	2,270	24,202

E. PER CAPITA GHG EMISSIONS

Per capita emissions can be a useful metric for measuring progress in reducing greenhouse gases and for comparing one community's emissions with neighboring cities and against regional and national averages. That said, due to differences in emission inventory methods, it can be difficult to get a directly comparable per capita emissions number, and one must be cognizant of these differences in methods when comparing figures.

As detailed in Table 15, dividing the total 2010 community GHG emissions by the 2010 population yields a result of an estimated 9.43 tonnes of CO_2e per capita for the City of Kingston. It is important to understand that this number is not the same as the carbon footprint of the average individual living in City of Kingston (which would include lifecycle emissions, emissions resulting from air travel, etc.). This is also not the same as the GHG emissions per household given above in Section IV.C.

[19] Based on the 2010 census data of 10,217 occupied households 2010 GHG emissions are estimated to be 5.70 metric tons (tonnes) of CO_2e per occupied household.

Table 15 : City of Kingston 2010 Greenhouse Gas Emissions per Capita

2010 Greenhouse Gas Emissions per Capita	
2010 Population	23,893
Community GHG Emissions (metric tons CO_2e)	225,097
GHG Emissions / Resident (metric tons CO_2e)	9.43

According to the New York State Climate Action Council Interim Report, from 1990 to 2008 New York residents emitted, on a per-capita basis, about 13.7 metric tons of CO_2e. Over the same time period the Council found the national average to be about 24.4 metric tons of CO_2e. [20] While not for the same time period, the City of Kingston per capita GHG emissions of 9.42 metric tons (tonnes) of CO_2e per capita is significantly lower than both the New York and national average.

V. COMMERCIAL ENERGY USE & GREENHOUSE GAS EMISSIONS

More specific information such as the square footage of commercial space in the City of Kingston and specific data on fuel usage within the commercial sector was unavailable or was beyond the scope and time frame for preparation of this report. A more specific analysis of energy usage within the commercial sector of Kingston may be useful in the future.

A. COMMERCIAL GHG EMISSIONS

The City of Kingston's commercial sector generated as estimated 71,281 tonnes of CO_2e or 32% of community-wide GHG emissions in 2010.

Table 16 outlines the breakdown of commercial GHG emissions by fuel type. The majority of commercial GHG emissions, 34,249 tonnes or 48% were generated from the use of electricity.

Table 16: Commercial 2010 GHG Emissions Summary by Fuel Source

Commercial GHG Emission Sources 2010	CO_2 (tonnes)	N_2O (kg)	CH_4 (kg)	CO_2e (tonnes)	Energy (MMBtu)	% of CO_2e
Electricity	34,078	494	868	34,249	375,271	48
Natural Gas	25,613	48	2,420	25,679	484,093	36
Fuel Oil	6,009	59	883	6,046	81,246	8
Residual Fuel Oil	4,735	42	714	4,763	63,043	7
Propane	457	8	82	461	7,432	<1
Kerosene	82	1	12	83	1,094	<1
Residual Fuel Oil	0	42	714	28	63,043	<1
TOTALS	70,974	652	4,979	71,281	1,012,179	

[20] Chapter 3 Inventory and Forecast of New York State's Greenhouse Gas Emissions, New York State Climate Action Council Interim Report November 9, 2010, p.3-10.

VI. TRANSPORTATION

In 2010, there were 158,782,140 vehicle miles traveled in the City of Kingston.[21] The vehicle miles traveled (VMT) includes miles from all vehicle use within the City of Kingston's boundaries (whether on local roads or State highways passing through the City of Kingston).

A. TRANSPORTATION FUEL USAGE

Based on the miles traveled it is estimated that in 2010, 10,121,527 gallons of fuel were used.[22] Most fuel is estimated to be gasoline, 8,613,576 gallons or 85%, with 1,507,951 gallons being diesel fuel.

Table 17: Community-wide Vehicle Fuel Usage

Community-Wide Vehicle Fuel Usage	2010 Total Usage (Gallons)	% of Total
Gasoline	8,613,576	85
Diesel Fuel	1,507,951	15
TOTAL	10,121,527	

It is estimated that 93%, or 147,684,000 vehicle miles traveled in the City of Kingston in 2010 were by gasoline vehicles. The majority of the miles traveled, 65%, are by passenger vehicles using 57% of the gas.

Approximately 7% of the vehicles miles traveled are done so by diesel vehicles using 1,507,951 gallons of diesel fuel. Most of these miles are by heavy duty diesel vehicles, 77%, which use 91% of the diesel fuel.

Table 18: Vehicle Miles Traveled and Gasoline Usage by Vehicle Type

Vehicle Type	Gas VMT	% of Gas VMT	Gas Gallons	% of Gas Gallons	% of Total VMT
Heavy Duty	-	-	-	-	
Light Truck	51,451,200	35	3,678,113	43	
Passenger	96,232,800	65	4,935,464	57	
TOTALS	**147,684,000**		**8,613,577**		93

Table 19: Vehicle Miles Traveled and Diesel Fuel Usage by Vehicle Type

Vehicle Type	Diesel VMT	% of Diesel VMT	Diesel Gallons	% of Diesel Gallons	% of Total VMT
Heavy Duty	8,575,200	77	1,375,352	91	
Light Truck	2,064,400	19	110,346	7	
Passenger	476,400	4	22,253	1	
TOTALS	**11,116,000**		**1,507,951**		**7**

[21] Ulster County Transportation Council

[22] Gas and diesel fuel estimates made using ICLEI's CACP 2009 Software

B. CITY OF KINGSTON VMT BY ROAD CLASS

Vehicles miles traveled in the City of Kingston are broken down by the Federal Highway Administration's functional class system [23] in Table 20.

Table 20: City of Kingston Vehicles Miles Traveled (VMT) by Functional Class 2010

Functional Systems for Urban Areas	City of Kingston Estimated Daily VMT	City of Kingston Estimated Annual (VMT)
Urban Principal Arterial - Interstate (87, 587)	62,558	20,644,140
Urban Principal Arterial - Other Freeways and Expressways	55,813	18,418,290
Urban Principal Arterial - Other (no control of access)	47,395	15,640,350
Urban Minor Arterial	132,346	43,674,180
Urban Collector	66,523	21,952,590
Urban Local Street	116,523	38,452,590
TOTAL	**481,158**	**158,782,140**

The principal and minor arterial road systems include Interstate I -87 and 587, Route 32 and Route 209 as well as other principal arterial roadways. These roadways are defined as the highest traffic volume corridors, and carry the major portion of trips entering and leaving the City. This includes the majority of through movements desiring to bypass the central city. The local and minor arterial streets located within City of Kingston boundaries augment the principal arterial system but offer a lower level of traffic mobility and may carry local bus routes and provide intra-community continuity, but ideally should not penetrate identifiable neighborhoods.

The collector and local streets provide access, service and traffic circulation within residential neighborhoods, commercial and industrial areas. These roadways collect traffic from local streets in residential neighborhoods and channel it into the arterial system. Local streets offer the lowest level of vehicle mobility.

C. TRANSPORTATION GHG EMISSIONS

The City of Kingston's transportation sector generated as estimated 92,696 tonnes of CO_2e[24] or more than 41% of community-wide GHG emissions in 2010.

The transportation analysis includes emissions from all vehicle use within the City of Kingston's boundaries (whether on local roads or State highways passing through the City of Kingston).

[23] Functional classification is the process by which streets and highways are grouped into classes, or systems, according to the character of service they are intended to provide. Basic to this process is the recognition that individual roads and streets do not serve travel independently in any major way. Rather, most travel involves movement through a network of roads. It becomes necessary then to determine how this travel can be channelized within the network in a logical and efficient manner. Functional classification defines the nature of this channelization process by defining the part that any particular road or street should play in serving the flow of trips through a highway network. http://www.fhwa.dot.gov/planning/fcsec2_1.htm

[24] Does not include 352 tonnes of CO_2e from transportation of Municipal Solid Waste.

Transportation is the largest contributor of greenhouse gas emissions in the City of Kingston. The transportation sector also accounts for the largest share of GHG emissions in New York State.[25]

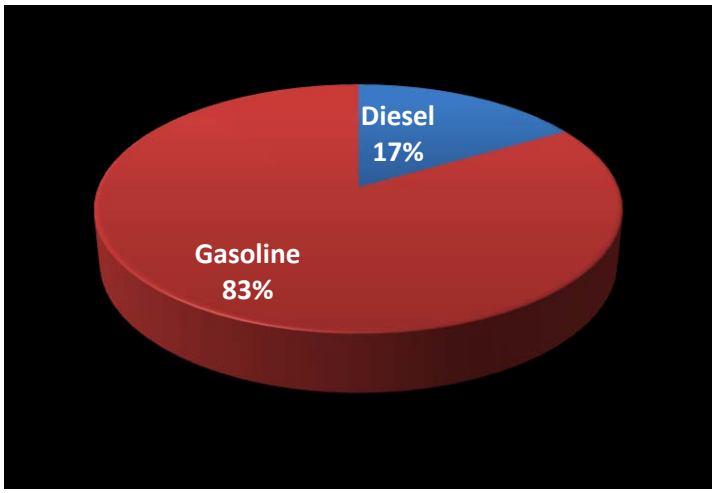
As illustrated in Table 21 and Figure 7, in 2010 the use of gasoline accounted for 83% of the transportation GHG emissions with diesel fuel accounting for 17%.

Table 21: Transportation GHG Emissions by Fuel Source

Transportation GHG Emissions *	CO_2 (tonnes)	N_20 (kg)	CH_4 (kg)	CO_2e (tonnes)	Energy (MMBtu)	% of CO_2e
Diesel	15,396	45	46	15,411	20,8218	17
Gasoline	75627	5,058	4,294	77,285	1,076,581	83
TOTAL	**91,023**	**5,102**	**4,340**	**92,696**	**1,284,799**	

*Does not include 352 tonnes of CO_2e from Waste Transport

Figure 7: Transportation GHG Emissions by Fuel Source



D. VMT GHG EMISSION BY FUNCTIONAL ROAD CLASS

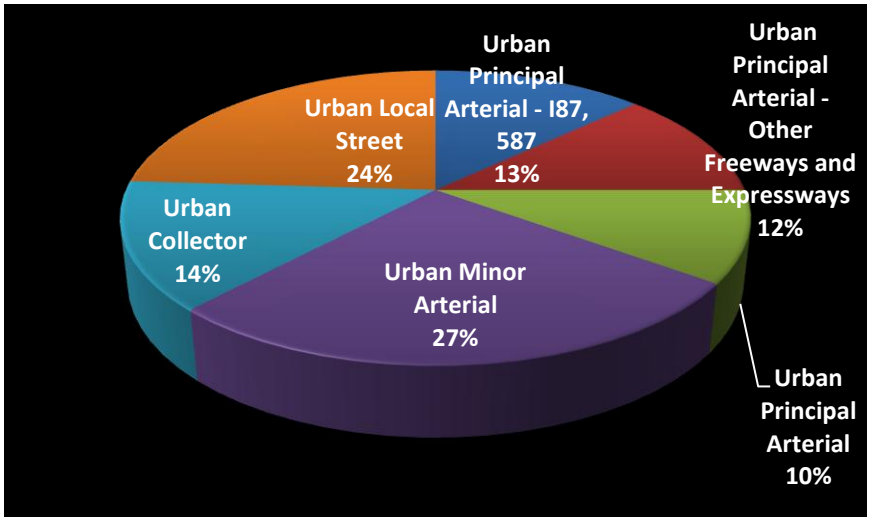
The total GHG emissions from the transportation sector in 2010 were 92,697 tonnes of CO_2e. Since the majority of miles are traveled on the minor arterial roads and local streets, these road systems have the largest impact on GHG emissions, accounting for more than half of all transportation related GHG emissions as illustrated in Table 22 and Figure 8.

[25]Transportation accounted for 34 percent of New York's gross GHG emissions in 2008. Chapter 3 Inventory and Forecast of New York State's Greenhouse Gas Emissions, New York State Climate Action Council Interim Report November 9, 2010, p.3-14.

Table 22: City of Kingston GHG Emissions by Functional Class 2010

Functional Road Class Systems for Urban Areas	CO_2e (tonnes)	% of CO_2e
Urban Principal Arterial - Interstate (87, 587)	12,048	13
Urban Principal Arterial - Other Freeways and Expressways	10,741	12
Urban Principal Arterial - Other (no control of access) *	9,130	10
Urban Minor Arterial **	25,491	27
Urban Collector ***	12,813	14
Urban Local Street ****	22,474	24
TOTAL	**92,697**	

Figure 8: Transportation GHG Emissions by Functional Road Class 2010



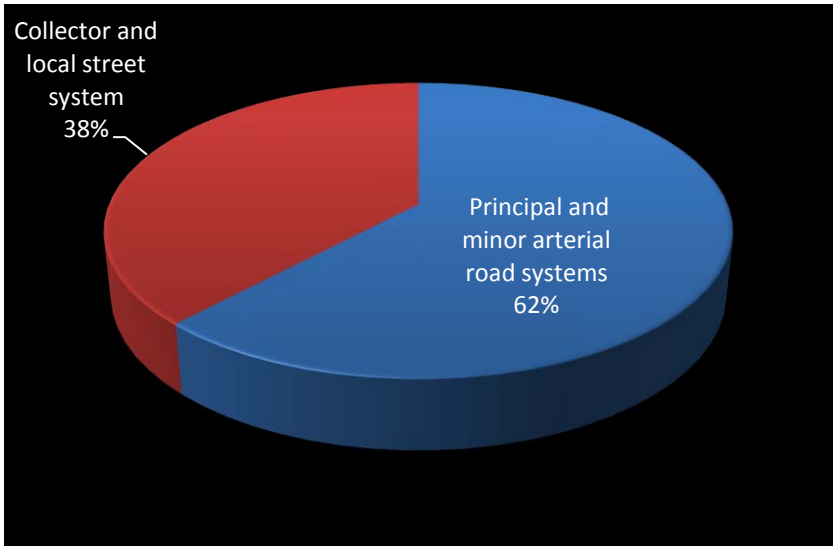
Functional road systems can be summarized into two groups: 1) the principal and minor arterial road systems and 2) the collector and local streets.

Table 23 shows that nearly 62% of the City of Kingston's transportation-related greenhouse gas emissions were generated from vehicle miles traveled (VMT) on principal and minor arterial road systems as defined above. The remaining 38% of City of Kingston's transportation-related greenhouse gas emissions were generated from VMT on the collector and local street system.

Table 23: Transportation GHGs Functional Class Summary

City of Kingston Transportation GHG by Functional Highway Class	CO_2e (tonnes)	% of Total CO_2e
Principal and minor arterial road systems	57,410	**62**
Collector and local street system	35,287	**38**
TOTAL	**92,697**	

Figure 9: Transportation GHG Emissions Functional Road Class Summary



Transportation information from railroad use[26] for the movement of goods within the City of Kingston and transportation emissions from the use of fuel and movement of motor craft on the City of Kingston's waterfront (the Rondout) were not available at the time of this report and therefore transportation emission from these sources are not included in this analysis.[27]

Since there are no airports located within the geographic boundaries of the City of Kingston it is reasonable to exclude air travel from this inventory.

VII. SOLID WASTE/MATERIALS MANAGEMENT

The City of Kingston DPW provides solid waste collection to all of its residents and to some of its businesses and institutions. The DPW is also responsible for the curbside collection of recyclable commingled containers and mixed paper. Scrap metal, yard waste and brush are also collected separately at curbside.

The City of Kingston DPW does not provide solid waste and recycling services to all generators with the City. Businesses and institutions such as the Kingston Hospital and the Kingston School District, contract with private haulers. Due to the limited timeframe for preparation of this report collecting the waste data generated by all sectors in the City of Kingston was beyond the scope of this report as was the transportation related information from private haulers. Therefore the waste generation and transportation data used and the greenhouse gas emissions reported are a partial picture of the waste related greenhouse gas emissions.

[26] Staff attempted to include railroad emissions however efforts to obtain fuel consumption and other rail/freight data from CSX were unsuccessful. Staff recommends pursuing a detailed railroad GHG emissions inventory.

[27] Staff attempted to include City of Kingston's Port GHG emissions data in this report, however, upon investigation, discovered that detailed data would need to be gathered individually from each of the Rondout tenants, requiring a substantial amount of staff time to investigate. Given that the constraints for gathering Port data would have delayed this report significantly, staff recommends pursuing a detailed Port GHG emissions inventory.

Summary information on energy use and greenhouse gas emissions associated with the solid waste management by the City of Kingston DPW can be found in the Local Government Report.

A. SOLID WASTE/MATERIALS MANAGEMENT GHG EMISSIONS

Solid waste management is analyzed separately due to the potential for landfills to produce methane, a greenhouse gas. The evaluation and reporting of GHG emissions, primarily methane (CH_4), from landfills is usually done by a local government if they own and operate a landfill within their community. The City of Kingston does not own or operate its own landfill. The waste the City DPW collects is transported to the Ulster County Resource Recovery Agency (UCRRA) and then trucked to a landfill in western New York. The City government has control over the operation of the waste collection it performs but once the waste leaves the City the transportation and ultimate disposal of the waste is not within the City's jurisdiction.

However, due to the potential for the decomposition of waste in landfills to emit methane (CH_4) and due to the fact that the City of Kingston has a variety of active programs to reduce waste, mainly through recycling and composting, it was determined that it was important to begin to get an idea of the emissions associated with both the generation and transportation of waste materials in the City of Kingston.

Based on the fact that the waste collected by the City DPW is from residents and businesses in the community and based on the fact that the most significant form of GHG emissions from waste is from the generation of methane from a landfill outside of Kingston, waste related GHG emissions are provided in this report. Again, this is a partial picture of waste related GHG emissions, being there is additional waste generated in Kingston that is hauled, transported and disposed of by private companies, not by the City DPW.

The City's operation of the transfer station and the fuel used by DPW refuse packers to collect and transport garbage and recyclable materials are part of the overall GHG emissions associated with solid waste management. The emissions from the electricity used at the transfer station and the emissions associated with the use of the DPW refuse packers are reported in the *Local Government Operations Energy and Greenhouse Gas Emissions Report.* And in Appendix N.

Waste related greenhouse gas emission sources are analyzed separately to enable policy development to address energy usage associated with waste management, waste reduction and GHG reduction targets.

B. LANDFILL GHG EMISSIONS

In 2010 the City of Kingston collected 13,827.1 tons of material: 8,768.8 tons of garbage, 1,538.49 tons from curbside recycling and 3,519 tons of other recyclables. For purposes of this inventory all 8,768.8 tons of trash generated by the City of Kingston was transported from UCCRA to Seneca Meadows Landfill.

The GHG emissions are an estimate of methane generation from the anaerobic decomposition of organic wastes (such as paper, food scraps, plant debris, wood, etc.) that are sent to and deposited at the Seneca

Meadows Landfill in western New York.[28] The waste generation emissions are the estimated future emissions from waste that was sent to this landfill by the City of Kingston in the base year 2010.

The landfill GHG emissions will be released over time as the waste that was deposited in the landfill in 2010 decomposes over the full 100+ year cycle of its decomposition. It is assumed that waste will not begin to generate methane until 6 months after it is deposited in the landfill, and only a small portion of the waste will decompose in the first year.

To generate CH_4 emission from the landfills, City waste was categorized separated based on the waste types in the CACP software[29]. Using a waste composition analysis done by UCCRA the waste composition of the material that the City of Kingston is sending to Seneca Meadows is identified in Table 24. The waste type determines the methane produced by the waste as it decomposes in the landfill.

Attempts to contact officials at Seneca Meadows to obtain the annual landfill gas recovery rate data were unsuccessful. Therefore the default factor of a 75% methane recover factor[30] was used for Seneca Meadows to determine the percentage of all generated emissions that was likely escaping into the atmosphere (fugitive emissions).[31] It is important to note, however, that the Seneca Meadows site uses landfill methane gas, a byproduct of organic waste decomposition, to power a 17.6 megawatt/hour capacity industrial development initiative located adjacent to the landfill. The landfill gas is collected from the landfill and piped to the gas plant to burn as fuel in the engine generators. Seneca Meadows reported collecting 2,953,837,274 cubic feet of gas to generate 143,685 mega-watt hours of energy in 2009. This facility is expected to provide the equivalent power to satisfy the requirements of approximately 20,000 homes annually.

[28] Waste generation emissions figures are the product of a modeling exercise that estimates the future emissions that will result from the full decomposition of the organic waste sent to any landfill in the base year 2010. The model used to run this estimation is based on the U.S. EPA Waste Reduction Model (WARM). In order to estimate the relative quantities of various types of waste included in the general disposal figures obtained from the City, waste characterization figures were utilized from the Local Government Operations Greenhouse Gas Emissions Inventory Instructions Part 2: CACP 2009 v3.0 Data Entry July 2011.

[29] CACP 2009 Software uses the EPA Waste Reduction Model (WARM) to calculate GHG emissions from landfills. http://www.epa.gov/climatechange/wycd/waste/calculators/Warm_home.html

[30] Methane recovery factor specified by the U.S. EPA AP 42 guidelines on emissions factors is 75%.
The AP 42 emission factors for waste/landfills in the controlled emissions section states that landfill gas collection systems are not 100% efficient in collecting gas and therefore emissions of methane will still occur. Based on reported collection efficiencies between 60% – 85%, a value of 75% collection efficiency is stated as most commonly used, and is used in this Protocol as conservative default collection efficiency. EPA AP 42 Emission Factors, Solid Waste Disposal, pg 2, 4-6 (1998).

[31] See Appendix E for more information on methods and emissions factors used in the Waste Sector analysis.

Table 24: Waste Composition

Materials	% of Waste Type based on UCCRA Waste Comp Analysis
Paper	31
Food	14
Plant	7
Wood/Textiles	10
All Other*	38

*'All Other' includes metals, plastics, glass, organic and miscellaneous waste such as electronics, diapers, and C&D waste.

The City of Kingston's trash that was landfilled at Seneca Meadows Landfill in 2010 will generate 53,362 kg of CH_4 which is equivalent to 1,121 tonnes of CO_2e. The methane produced from the waste sector is 79% of the total community wide CH_4 as depicted in Table 25.

Table 25: Methane Emission by Sector

Sector	CH_4 (kg)	% of CH_4 Emissions
Residential	4,950	7
Commercial	4,980	7
Industrial	59	<1
Transportation	4,340.5	6
Waste	53,362	79
TOTAL	**67,691.5**	

Again it is important to note that the fugitive methane released by the decomposition of organic waste is over time in the landfill, future GHG emissions, not 2010 GHG emissions as are all other GHG emissions identified in this report.

C. GHG EMISSIONS FROM TRANSPORTATION OF WASTE

The GHG emissions associated with the transportation of waste are based on the movement of the material from UCRRA to the Seneca Meadows Landfill. The emissions associated with the transportation of waste are estimated as well.

As seen in Table 26 one trailer headed to the landfill can carry approximately 28.5 tons of trash. Based on 8,768.8 tons collected by the City of Kingston in 2010, it is estimated that there were approximately 308 trips needed to haul the City's garbage to Seneca Meadows. Also as seen in Table 25 a round trip to Seneca Meadows is 470 miles. The number of trips, 308, multiplied by the number of miles, 470, resulted in 144,760 miles traveled to transport the City's garbage in 2010. Based on an estimated 112 gallons of diesel fuel used for each round trip, it was estimated that 34,496 gallons of diesel fuel were used to transport garbage in 2010. Hauling 8,768.8 tons, approximately 3.93 gallons of diesel fuel was used per

ton of garbage. Based on a cost of $2.55 per gallon, total cost to haul city garbage to Seneca Meadows in 2010 was approximately $87,985.

Based on the amount of fuel and the miles traveled, transportation emissions generated from the transportation of solid waste from the UCCRA facility to Seneca Meadows in 2010 was 352 tonnes of CO_2e. The fuel usage, costs and associated GHG emissions from the collection and transportation of waste by City of Kingston DPW refuse packers can be found in Appendix J.

Table 26: Transporting City of Kingston Solid Waste to Seneca Landfill[32]

Transporting City of Kingston Trash 2010	
No. of Miles to Seneca Falls LF from Ulster Transfer Station (R/T)	470
Fuel Used –R/T (Diesel Gallons)	112
Total Waste Transported - 2010 (tons)	8,768.8
Tonnage of Garbage per trailer	28.5
Number of Trailers 2010 for City of Kingston MSW*	308
VMT City of Kingston MSW	144,760
Fuel Used to Transport City of Kingston MSW (Diesel Gallons)	34,496
Cost to Transport City of Kingston Trash**	$87,965

*Based on 28.5 tons of trash per trailer (Estimated 308 trailers of garbage go to Seneca LF with City of Kingston Garbage – 8,768.80 tons of City garbage/28.50 tons per trailer = 308 trailers full)
**Average Fuel Cost 2010 (price per gallon) $2.55 (34,496 gallons x $2.55/gallon)

Recyclable materials are shipped to several different markets in several different locations many of which are intermediary markets and not ultimate locations. Therefore it was not feasible to collect the fuel usage, miles and associated GHG emission from the transportation of recyclable materials.

The total Scope 3 GHG emissions associated with the transport and disposal of solid waste is 1,473 tonnes of CO_2e, less than 1% percent of total 2010 emissions for the community of the City of Kingston. The methane emissions associated with the waste sector are significant. It is also important to note that this is a partial picture of methane emissions as these numbers do not reflect the total waste generated within the City of Kingston.

[32] **Data From UCRRA:**
Total trash 2010: City of Kingston: 8,768.80 tons
Percentage of trash from City of Kingston that went to:
High Acres Landfill: 0%
Seneca Meadows Landfill: 100%
Approximate tonnage of trash per trailer: 28.50 tons
Miles to Seneca R/T from UCCRA: 470 miles
Gallons of fuel used R/T to Seneca Meadows Landfill (1 trailer), From UCRAA: 112 gallons
Average fuel cost for 2010 (1 gallon): $2.55 per gallon (excludes taxes)
Estimated 308 trailers of garbage go to Seneca LF with City of Kingston Garbage:
8,768.80 tons of City garbage/28.50 tons per trailer = 308 trailers full
Estimated 144,760 vehicle miles traveled (308 trailers x 470 miles round trip)
Estimated 34, 496 gallons of diesel fuel (308 trailers x 112 gallons per trip)
Estimated Cost $87,964.8 (34,496 gallons x $2.55/gallon)

Table 27: City of Kingston Scope 3 Solid Waste GHG Emissions

Solid Waste Scope 3 GHG Emissions	CO_2 (tonnes)	N_20 (kg)	CH_4 (kg)	CO_2e (tonnes)	Energy (MMBtu)	% of Total CO_2e
Landfill Emissions	0	0	53,362	1,121		<1
Transportation Waste	352	1	1	352	7983	<.2
TOTALS	**3522**		**53,363**	**1,473**		
TOTAL Community GHG Emissions	**184,838**	**6,259**	**67,690**	**188,200**	**3,211,118**	

VIII. GOVERNMENT OPERATIONS AS PERCENTAGE OF COMMUNITY

A. ENERGY USAGE

In 2010 the City of Kingston government operations used approximately 4% of the community's total electricity, 1% of the natural gas, and less than half a percent of propane and fuel oil. Government operations consumed 6% of the total diesel fuel but only 1% of the gasoline.

City of Kingston government operations energy usage is discussed in more detail in Appendix B. *City of Kingston Government Operations Energy and GHG Emissions Inventory Results.*

Table 28: City Government and Community 2010 Energy Usage *

Energy Source	2010 Community Usage	2010 Government Operations Usage	Government Operations % of Total Usage
Electricity (kWh)*	177,229,159	6,461,721	4
Natural Gas (CCF)*	9,366,490	113,267	1
Heating Fuel Oil-Kerosene(Gal)	1,891,575	4,582	<0.5
LPG Total (Gal)	334,376	1044.1	<0.5
Vehicle Miles Traveled	158,782,140	1,874,932	1
Vehicle Fuel Gas (Gal)	8,613,576	84,403	1
Vehicle Fuel Diesel (Gal)	1,507,951	83,513	6

*These percentages do not include the Kingston Housing Authority, Kingston Water Department and Dietz Stadium which were analyzed as part of the local government operations. This use of the electricity and natural gas by the Kingston Housing Authority is primarily for 'residential' purposes. The KHA used 1,337,647 kWh of electricity in 2010, about ¾ of a percent of the community's total electricity. The KHA used 283,795 CCF of natural gas in 2010 which would result in the City Government percentage of natural gas going from 1% up to 4.3% of the total community usage.

B. GREENHOUSE GAS EMISSIONS

In 2010, the City of Kingston government resulted in the release of an estimated 7,281 tonnes of CO_2e. This includes the GHGs generated by City employee commuting, the Kingston Housing Authority, Kingston Water Department and Dietz Stadium.[33]

Not including employee commuting, the Kingston Housing Authority, Kingston Water Department and Dietz Stadium, City government operations resulted in the release of an estimated 4,587 tonnes of CO_2e.

As seen in Table 29, City of Kingston government operations accounted for approximately 2.04% of the total GHG emissions in the City of Kingston in 2010. Including KHA, KWD and Dietz Stadium in the operations, GHG emissions were approximately 3.23% of the total. Government operations energy usage and GHG emissions are discussed in greater detail in the '*Local Government Operations Energy and Greenhouse Gas Emissions Report.*

Table 29: City Government and Community GHG Emissions

2010 Community CO_2e	2010 Government Operations CO_2e*	Government Operations CO_2e % of Total *	2010 Government Related Total CO_2e**	Government Related CO_2e % of Total**
225,097	4,587	2.04	7,281	3.23

* Does not include KHA, KWD and Dietz Stadium

** Includes KHA, KWD and Dietz Stadium

IX. CONCLUSION

The City can make great strides in reducing energy use and GHG emissions by addressing the land use and transportation sector and by recognizing and realizing opportunities to reduce vehicle miles traveled and vehicle fuel usage.

In addition, through focused and concerted strategies in both the residential and commercial sector, electricity saving measures can realize significant energy and GHG reductions.

The energy and GHG emissions information contained in this report will be useful as the City of Kingston embarks on an update to its Comprehensive Master Plan and Zoning Code.

[33] Kingston Housing Authority, Kingston Water Department and Dietz Stadium are not a part of regular government operations but were included in government analysis because City has some operational control over these entities.