Town of Hampton

Community Greenhouse Gas Inventory

July, 2014

Contents

Abstract

The Town of Hampton, located in Southern New Brunswick joined The Federation of Canadian Municipalities' Partners for Climate Protection Program (PCP) in 2004. A corporate inventory was developed for municipal emissions in Hampton in 2011, and now a community inventory is needed to complete Milestone 1 of the PCP program. Both inventories utilize 2006 as their base year. The year 2006 was chosen as the baseline for the corporate emissions inventory since this was the earliest year sufficient data was available (Dillon Consulting, 2011). Hampton's community greenhouse gas (GHG) emissions were found to be 39,493 tonnes (t) eCO_2. Transportation emissions were the highest at 41% of the total emissions in Hampton. Emissions in the building sector were 40% in the residential sector, 18% in the commercial sector and 0.25% in the industrial sector. Solid waste accounted for 1% of GHG emissions in Hampton. A Business As Usual (BAU) forecast shows what GHG emission levels will be if no preventative actions are taken; Hampton's BAU shows community GHG emissions in Hampton will increase by 25.9% from 2006-2024 due to an expected increase in population.

Introduction

Over the last 150 years, there has been growing evidence to prove that the earth's climate is changing. Climate conditions vary naturally over time, but the pace at which our climate is changing is too rapid to believe that it is natural. Humans are accelerating the rate at which the climate is changing by producing large amounts of GHGs which accumulate in the atmosphere (Environment Canada, 2013). GHGs are generated from burning fossil fuels such as petroleum products, coal and natural gas; which are used to heat & cool buildings, for transportation and are also generated during the decomposition of solid waste (FCM, 2014).

The Federation of Canadian Municipalities developed the PCP program to decrease GHG emissions and promote sustainable development within Canadian municipalities (FCM, 2014). Milestone 1 consists of developing a GHG emissions inventory for corporate and community emissions. An emissions inventory is developed to give the community a snapshot of their current GHG emissions and provide a future GHG emissions forecast. The emissions inventory serves as a tool for completing Milestones 2 and 3. Milestone 2 consists of choosing an emissions reduction target and a timeline to reduce emissions (i.e. 20% below 1990 levels). Setting a target will give the community a clear goal to work toward and a timeline for doing so. Milestone 3 is to develop a Local Action Plan outlining a strategy for reaching emission reduction goals.

Community Profile

Hampton is a small community located 35km Northeast of Saint John, New Brunswick. Hampton borders along the Kennebecasis River, a tributary of the Saint John River. The town is home to 4,004 people and 1,669 residences (Statistics Canada, 2012). The 132 commercial buildings in Hampton contain grocery stores, restaurants, gas stations and auto parts & hardware stores. There is not a large amount of industry in Hampton, and there are only two industrial buildings within the town.

Hampton joined the PCP program in 2004 and completed a corporate GHG emissions inventory in 2011 as part of Milestone 1. This report will conclude the

requirements for Milestones 1 by completing the community GHG emissions inventory and forecast.

Methodology

The community inventory has been compiled for the year 2006 since this was also the baseline year for the corporate emissions inventory. The inventory quantification support spreadsheet provided by PCP was used to develop the community inventory (PCP, 2010). GHGs measured for this inventory are: carbon dioxide (CO_2), nitrous oxide (N_2O), and methane (CH_4) (FCM, 2014). GHG emissions are expressed in tonnes of equivalent carbon dioxide (eCO_2) which is a measure of GHG emissions compared their global warming potential. GHG emissions multiplied by their global warming potential give the amount of global warming potential per unit of pollutant or, eCO_2 (U.S.EPA, 2013). New Brunswick's electricity emissions coefficient in 2006 was 0.440 (t/unit of fuel) which was used to calculate eCO_2 in this inventory. This coefficient was developed for Canada's national GHG inventory report. Other emissions coefficients can be found in Appendix 3.

Inventory Summary

The community emissions inventory is divided into five sectors:

1. Residential Emissions
2. Commercial Emissions
3. Industrial Emissions
4. Transportation Emissions
5. Solid Waste.

Hampton's GHG emissions in 2006 were calculated to be 39,493 tonnes of eCO_2. Table 1 and Figure 1 summarize Hampton's energy use in the year 2006. Since transportation emissions were estimated by using an average of 1.55 vehicles per household and average vehicle usage statistics, Hampton's transportation emissions was the largest contributor, at 41%, to the community inventory sectors. Residential

building emissions come in at 40% and commercial at 17%. Hampton has an exceptionally low industrial sector and therefore emissions numbers are somewhat negligible at 0.25% (See Table 1 for actualized figures). Hampton is an environmentally conscious community with both recycling and compost programs in place. Due to these existing waste reduction programs, solid waste emissions makeup 1% of Hampton's GHG emissions (Figure 1).

Table 1: Community eCO_2 (t) emissions breakdown by sector for the Town of Hampton in 2006.

Sector	Energy (GJ)	Total eCO_2 (t)
Residential	145,036	15,643
Commercial	65,696	6,949
Industrial	1,062	101
Transportation	233,815	16,389
Community Waste	-	409
Total	**445,611**	**39,493**

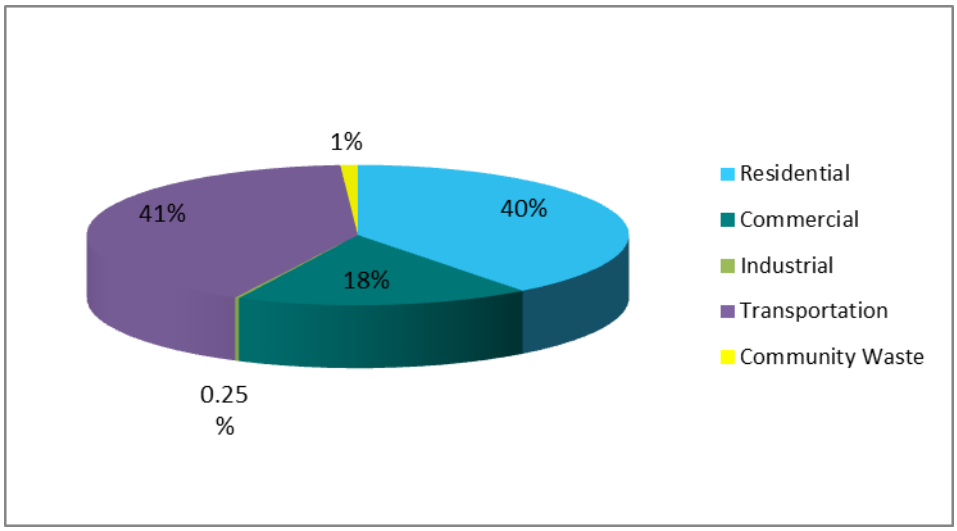

Figure 1: Community eCO_2 breakdown by sector for the Town of Hampton, 2006.

Electricity use was the largest emission source in Hampton, coming in at 47% of the total emissions (Figure 2). Gasoline emissions were 29% of the total emissions, diesel was 12%, fuel oil was 10%, and propane accounted for 1% of the total emissions in the town (Figure 2). Solid waste was 1% of Hampton's total emissions (Figure 2).

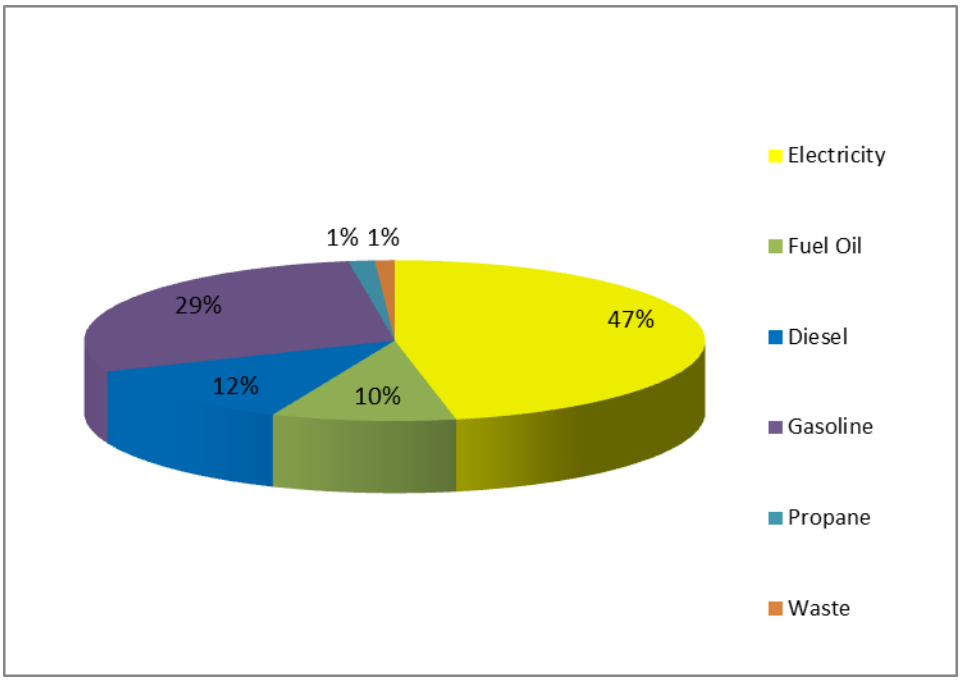

Figure 2: Community eCO_2 breakdown by emission source for the Town of Hampton, 2006.

Residential Emissions

Residential emissions were calculated using electricity values provided by NB Power and Natural Resources Canada's *Comprehensive Energy Use Database.* Based on the *Comprehensive Energy Use Database,* New Brunswick's energy usage was 58.4% electricity, 22.4% heating oil, 0.7% propane, and 16% wood (NR Can, 2014). In order to estimate energy use, these percentages are assumed to reflect Hampton's energy usage. NB Power provided a value of 29, 162, 541 kWh of electricity use. Assuming that this value is 58.4% of Hampton's energy use, the total energy use can be estimated as 50,280,243 kWh. The values for heating oil and propane were then estimated using percentages provided in the *Comprehensive Energy Use Database* (Table 2) and the total energy use (NR Can, 2014). The values for propane and heating oil were then converted from kWh to L using Natural Resources Canada's conversion factor of 7.38 kWh/L and 11.25 kWh/L respectively (NR Can 2014). Heating with wood is considered carbon neutral as it releases stored carbon and is therefore not counted in the emissions inventory (FCM, 2014).

Table 2: Energy use and eCO_2 (t) for residential buildings in the Town of Hampton (2006).

	Usage (kwh)	NR Can Percentage	NR Can Conversion Factor kwh/L	Usage	Total eCO_2 (t)
Electricity	29,162,541.0	58.4	-	29,162,541 kWh	12,832
Propane	351,961.7	0.7	7.38	47,691 L	2,738
Heating Oil	11,262,774.4	22.4	11.25	1,001,135 L	74
Wood	8,245,959.0	16.4	-	8,245,959 kWh	-
Total	**50,280,243.0**	**100**	**-**	**-**	**15,643**

Based on this data, residential emissions are 40% of the Town of Hampton's GHG emissions (Figure 1). Electricity use accounts for 82% of the total residential emissions (Table 2). Emission reduction strategies should therefore be heavily focused on the conservation of electricity in the residential sector.

Commercial Emissions

Commercial Emissions were calculated using energy use percentages from Natural Resources Canada's *Comprehensive Energy Use Database* for Atlantic Canada. Electricity use in Atlantic Canada was 50.6% of the commercial energy budget, followed by 18.4% for heating oil and 7.3% propane use (NR Can, 2014). NB Power data showed electricity use of 12,727,277 kWh in the commercial sector. Assuming that this value reflects the *Comprehensive Energy Use Database's* energy use percentage of 50.6% for electricity use, total energy usage in Hampton's commercial sector can be estimated at 22,727,280 kWh. The values for fuel oil and propane could be calculated using total energy usage and energy use percentages for Atlantic Canada (Table 3).

Table 3: Total energy use and eCO_2 (t) for commercial buildings in the Town of Hampton (2006).

	Usage (kwh)	NR Can Percentage	NR Can Conversion Factor (kwh/L)	Usage	Total eCO_2 (t)
Electricity	12,727,277.0	50.6	-	12,727,277 kWh	5,600
Propane	1,590,909.6	7.3	7.38	215,570.4 L	1,017
Heating Oil	4,181,818.5	18.4	11.25	371,717.2 L	333
Total	**22,727,280.0**	**-**	**-**	**-**	**6,950**

Based on this data, energy emissions in the commercial sector are 18% of Hampton's GHG emissions (Figure1). Electricity emissions in the commercial sector are 80% of the total commercial emissions. Climate protection projects should therefore be focused mostly on electricity use reduction and energy efficiency.

Industrial Emissions

Hampton's industrial sector is very small and only includes two industrial buildings. Energy use values were determined using provided NB Power data and energy use percentages from Natural Resources Canada's *Comprehensive Energy Use Database*. Electricity use was 21%, Fuel oil use was 16% and diesel was 7% of the energy use in Atlantic Canada (NR Can, 2014). Energy use data was estimated assuming that the value provided by NB Power for electricity use (143,040 kWh) was 21% of the industrial energy use giving a total energy usage of 681,143. Values for diesel and heating oil could then be calculated using energy use percentages in Atlantic Canada and the estimated total energy use (Table 4).

Table 4: Energy use and eCO_2 (t) for industrial buildings in the Town of Hampton (2006).

	Usage (kwh)	NR Can Percentage	NR Can Conversiton Factor (kwh/L)	Usage	Total eCO_2 (t)
Electricity	143,040.0	21	-	143,040 kWh	63
Diesel	47,680.0	7	10.66	4,472 L	26
Heating Oil	108,982.9	16	11.25	9,687 L	12
Total	**681,143.0**	**-**	**-**	**-**	**102**

Based on this information, industrial emissions in Hampton were 0.25% (Figure 1). Industries in Hampton will be encouraged to increase energy efficiency, but, unless there is a large increase in industrial development in Hampton, industrial emissions reduction should not be a main target for emission reduction strategies.

Transportation

Transportation in the Town of Hampton was estimated using PCP's Milestone tool to determine annual vehicle kilometers travelled (VKT). VKT was calculated based on the number of residences in Hampton (provided by Statistics Canada, 2012) and PCP's assumption of 1.55 light duty vehicles per household. VKT is then broken down into percentage by vehicle type and fuel and multiplied by total VKT, vehicle efficiency, and global warming potential (gasoline/diesel emissions coefficient). Fuel efficiencies are estimated by Natural Resources Canada's *Vehicle Survey* and the BC Ministry of Environment *Methodology for Reporting BC Public Sector Greenhouse Gas Emissions* (PCP, 2010). Transportation does not include off road vehicles such as boats or ATV's.

Table 5: Transportation emissions (eCO_2) in tonnes in the Town of Hampton (2006).

	Autos	Light Truck	Heavy Truck	Bus	Total	Total Fuel Used (L)
Gasoline	5,476	5,496	433	0	**11,405**	4,675,127
Diesel	15	149	4,683	4	**4,851**	1,775,399
Propane	134	0	0	0	**134**	86,468
CNG	0	0	0	0	**0**	0
Ethanol Blend (10%)	0	0	0	0	**0**	0
Total	**5,625**	**5,645**	**5,116**	**4**	**16,389**	-

Gasoline use was 70% of total fuel used in Hampton (Table 5). Emissions reduction should focus on using alternatives to gasoline and diesel such as ethanol or biodiesel. Alternate fuels have a lower eCO_2 coefficient and therefore emit fewer GHG emissions (PCP, 2010). Other ways to decrease transportation emissions would be to use public transit, carpool, and walk or bike when travelling short distances.

Solid Waste

Solid waste tonnage was provided by Fundy Region Solid Waste, a landfill 53 km outside of the Town of Hampton, which collects solid waste, recyclables and compost for the City of Saint John, and surrounding areas. Even though emissions from waste will be released outside of Town limits, they are still included in our inventory as downstream emissions in the Town of Hampton. Solid waste collected in the Town of

Hampton in 2006 was 849 tonnes, which equates to 409 tonnes of eCO_2 emissions. In 2006, 643 tonnes of solid waste was diverted from the landfill (357t through recycling and 286t through composting) which resulted in 1% of Hampton's GHG emissions being attributed to solid waste (Figure 1).

Greenhouse Gas Emissions Forecast

Forecasted emissions in the Town of Hampton are done in a Business As Usual (BAU) scenario up to 2024. Growth is estimated based on Census information provided by Statistics Canada and the growth rate for Hampton between 2006 and 2011 was estimated to be 7.2% for five years or 1.44% per year (Statistics Canada, 2012). The estimated growth in each sector between 2006 and 2024 is 25.9%, based on the expected population growth in the Town of Hampton (Table 6 & Figure 3). The growth rate is applied based on the assumption that with an increase in population there will also be an increase in GHG emissions.

Table 6: Forecasted eCO_2 (t) emissions from 2006 to 2024 by sector in Hampton.

	Current emissions	% Change Expected	Emissions in Forecast year
Residential	15,643	25.9%	19,695
Commercial	6,950	25.9%	8,749
Industrial	102	25.9%	128
Transportation	16,389	25.9%	20,634
Waste	409	25.9%	515
Total Emissions (t CO_2e)	39,493		49,722

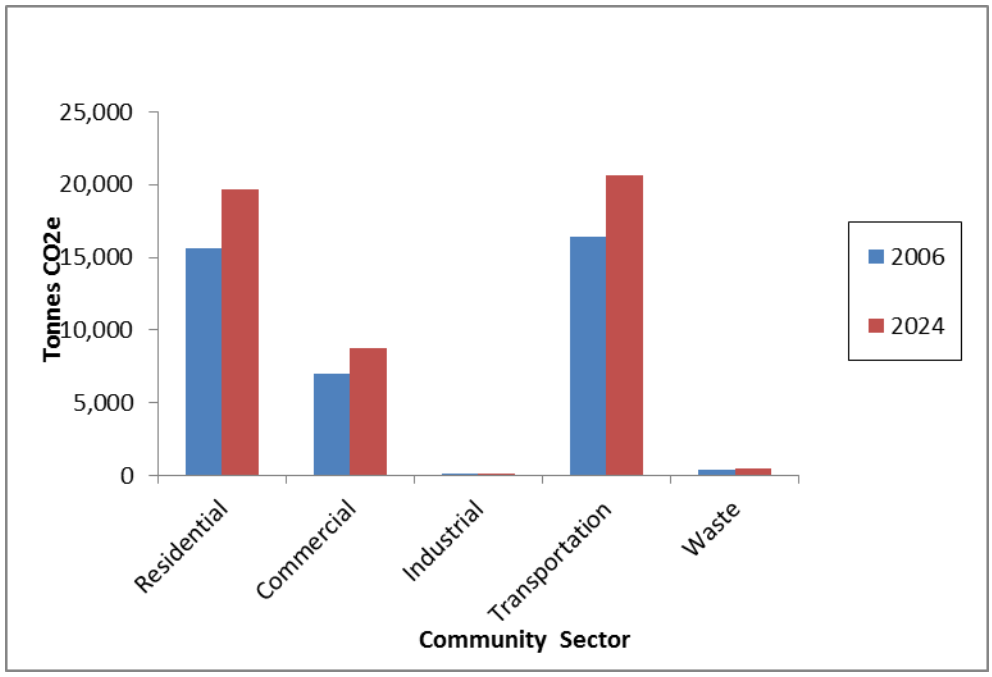

Figure 3: Community forecast emissions by sector.

It is estimated that total GHG emissions in Hampton will rise from 39,493t eCO_2 to 49,722t eCO_2 if no actions are taken to decrease GHG emissions (Table 6).

Conclusion

After completing the community inventory, community emissions in the Town of Hampton are estimated at 39,493t eCO_2. Emissions in the building sector are divided into residential, commercial and industrial areas and are respectively 40%, 18%, 0.25% of Hampton's GHG emissions. Transportation emissions in the town are the largest sector with 41% of Hampton's total emissions. Community waste is 1% of total emissions due to waste management programs already in place. A BAU forecast showed that emissions in the Town of Hampton will rise by 25.9% from 2006-2024 if no emissions reduction actions are taken.

There are many ways that emissions can be reduced through decreasing energy use, walking, carpooling or using public transit and reducing waste by recycling and composting. Emission reduction will only be successful with strong involvement from the community members of the Town of Hampton. Incentives and action plans will need to be developed in order to make emission reduction possible.

Sources

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Appendix 1: Detailed Inventory Data

Residential Emissions

Fuel Type	Units	Total Use	Total eCO_2 (t)
Electricity	kWh	29,162,541	12,832
Natural Gas	m^3	0	0
District Energy	GJ	0	0
Fuel Oil	L	1,001,136	2,738
Diesel	L	0	0
Propane	L	47,691	74
Total		**-**	**15,643**

Indicators	*Indicator Values*	*Total eCO_2/Indicator*
Population:	*4,004*	*3.906947404*
Households:	*1790*	*8.739339332*

Commercial Emissions

Fuel Type	Units	Total Use	Total eCO_2 (t)
Electricity	kWh	12,727,277.0	5,600
Natural Gas	m^3	0	0
District Energy	GJ	0	0
Fuel Oil	L	371,717	1,017
Diesel	L	0	0
Propane	L	215,570	333
Total		-	**6,950**

Industrial Emissions

Fuel Type	Units	Total Use	Total eCO_2 (t)
Electricity	kWh	143040	63
Natural Gas	m^3		0
District Energy	GJ		0
Fuel Oil	L	9687.34	26
Diesel	L	4,473	12
Propane	L		0
Total		**-**	**102**

Transportation Emissions

Total Annual Vehicle Kilometers Travelled (VKT): 49,951,751

eCO_2 Emissions (t)

	Autos	Light Truck	Heavy Truck	Bus	Total	Total Fuel Used (L)
Gasoline	5,476	5,496	433	0	**11,405**	4,675,127
Diesel	15	149	4,683	4	**4,851**	1,775,399
Propane	134	0	0	0	**134**	86,468
CNG	0	0	0	0	**0**	0
Ethanol Blend (10%)	0	0	0	0	**0**	0
Total	**5,625**	**5,645**	**5,116**	**4**	**16,389**	-

**If modeled VKT data is not available for your community, consider the following option to estimate this total.
VKT can be estimated by looking at the number of households in your community

Number of households	1,669
Average vehicles per household	1.55
Average distance per vehicle	16,118
Estimated annual VKT	41,696,460

Percentage Breakdown of VKT by Vehicle Type and Fuel (%)

	Cars	Light Truck	Heavy Truck	Bus	Total
Gasoline	53.17%	32.67%	1.20%	0.00%	**87.04%**
Diesel	0.15%	0.93%	10.59%	0.01%	**11.68%**
Propane	1.28%	0.00%	0.00%	0.00%	**1.28%**
Compressed Natural Gas	0.00%	0.00%	0.00%	0.00%	**0.00%**
Ethanol Blend (10%)	0.00%	0.00%	0.00%	0.00%	**0.00%**
Total	**0.546**	**0.336**	**0.1179**	**0.0001**	**100.00%**

Vehicle Efficiency for Different Fuels (L/100km)*

	Cars	Light Truck	Heavy Truck	Bus
Gasoline	9	14.7	31.5	35.7
Diesel	7.7	12.5	34.5	32
Propane	14.4	15.3	0	0
Compressed Natural Gas**	5.4	8.3	0	0
Ethanol Blend (10%)	8.9	13.2	0	0

"* Efficiencies are from NR Can 2007 Vehicle Survey and BC Ministry of the Environment 2011 Methodology for Reporting BC Public Sector Greenhouse Gas Emissions
** expressed in kg/100km"

Community Waste

Waste to landfill (tonnes):	849
eCO2 Emissions (t):	409

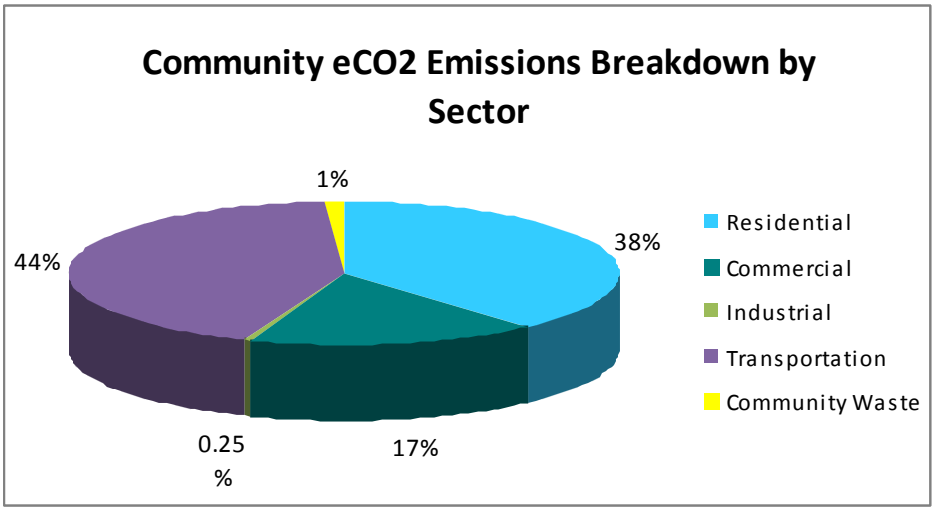
Community Summary

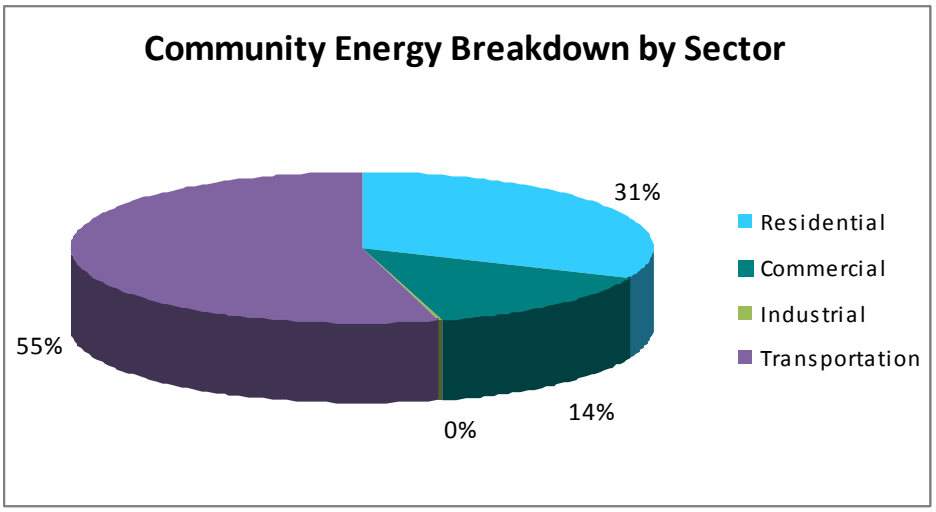
Energy Usage and eCO_2 Emissions by Sector

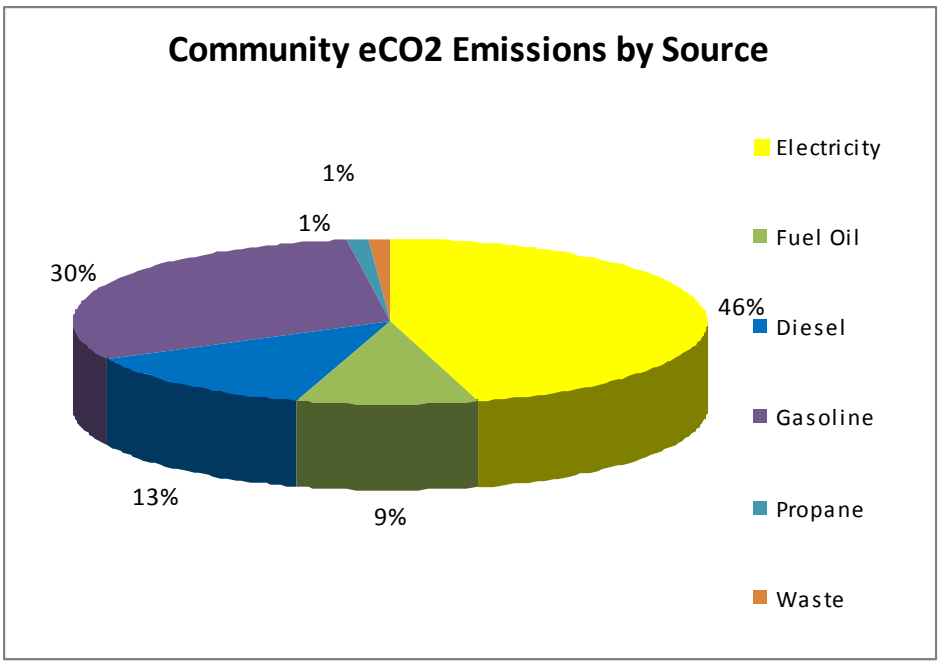
Sector	Energy (GJ)	Total eCO_2 (t)
Residential	145,036.27	15,643.42
Commercial	65,696.91	6,949.56
Industrial	1,062.12	101.91
Transportation	250,766.99	17,577.71
Community Waste	-	409
Total	**462,562.30**	**40,681.56**

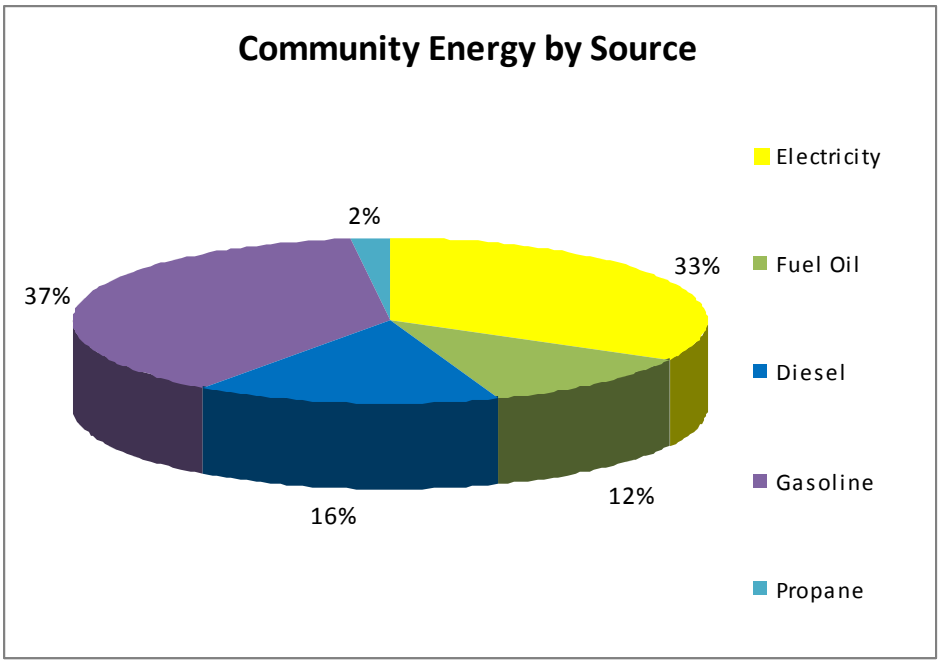
Energy Usage and eCO_2 Emission by Source

Energy Type	Total Use	Energy (GJ)	Total eCO_2 (t)
Electricity	42,032,858	151,318	18,494
Fuel Oil	1,382,540	53,643	3,781
Diesel	1,908,585	73,098.82	5,215.03
Gasoline	5,014,066	175,492.32	12,231.97
Propane	355,998	9,010.31	549.68
Waste	-	-	409
Total	**50,694,048**	**462,562.30**	**40,681.56**




Community Energy Breakdown by Sector
31%
55%
0%
14%
Residential
Commercial
Industrial
Transportation


Community eCO2 Emissions by Source
1%
1%
30%
46%
13%
9%
Electricity
Fuel Oil
Diesel
Gasoline
Propane
Waste


Community Energy by Source
Electricity
Fuel Oil
Diesel
Gasoline
Propane
2%
33%
37%
12%
16%

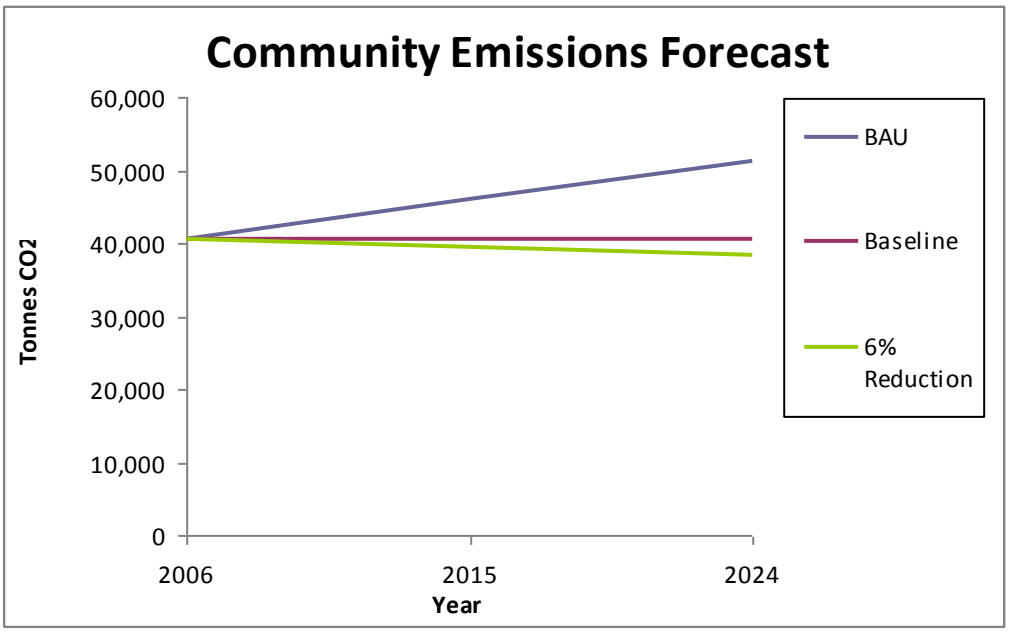
Business as Usual Forecast

Community info

Base Year	2006
Forecast Year*	2024
Reduction Target by Forecast Year* (%)	6%

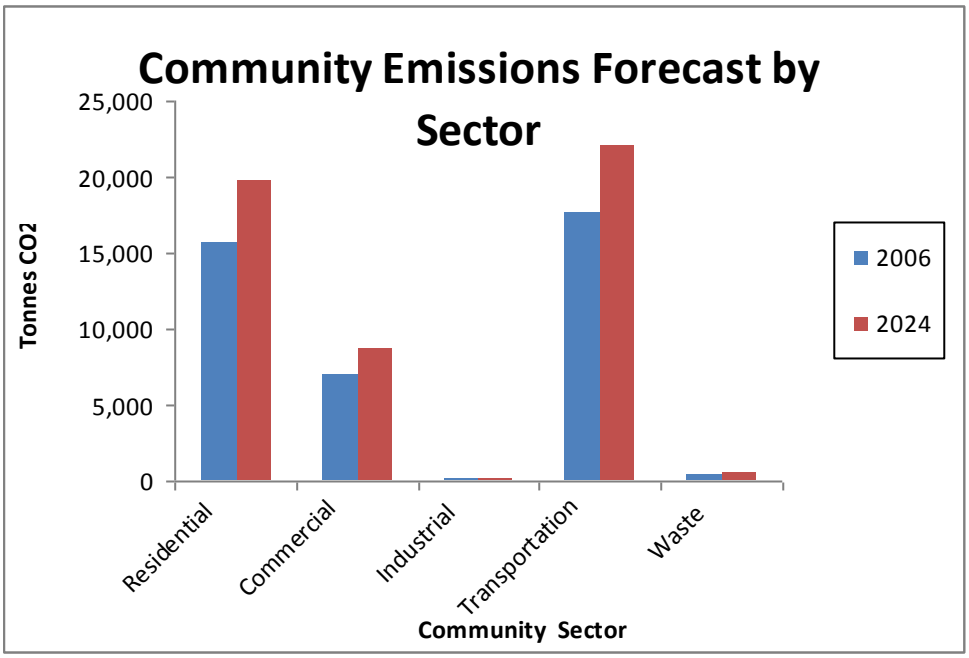
* PCP recommends calculating a BAU estimate for approximately 10 years after the baseline year

	Current emissions	% Change Expected**	Emissions in Forecast year	Explanation for % change expected
Residential	15,643	25.9%	19,695	Est. population increase of 25.9%
Commercial	6,950	25.9%	8,749	
Industrial	102	25.9%	128	
Transportation	17,578	25.9%	22,130	
Waste	409	25.9%	515	
Total Emissions (t CO_2e)	40,682		51,218	



Data for Line Graph

BAU	2006	40,682
	2015	45,950
	2024	51,218
Baseline	2006	40,682
	2015	40,682
	2024	40,682
6% Reduction	2006	40,682
	2015	39,461
	2024	38,241



Data for Bar Graph	Baseline	BAU
Residential	15643.4	19,695
Commercial	6949.6	8,749
Industrial	101.9	128
Transportation	17577.7	22,130
Waste	409.0	515

Appendix 2: NB Power Data

Rate Category	Service City	Total KWh for Service City	Count of Contract Accounts for Service City
GS1	HAMPTON	1,918,299	83
Total for Rate Category		1,918,299	#
GS2	HAMPTON	10,808,978	49
Total for Rate Category		10,808,978	#
NOT_METERD	HAMPTON	11,268	9
Total for Rate Category		11,268	
REC_LIGHT	HAMPTON	10,170	1
Total for Rate Category		10,170	
RES_RURAL	HAMPTON	1,108,492	66
Total for Rate Category		1,108,492	#
RES_SEASON	HAMPTON	10,329	2
Total for Rate Category		10,329	
RES_URBAN	HAMPTON	28,044,020	1,722
Total for Rate Category		28,044,020	1,722
SM_INDUST	HAMPTON	143,040	2
Total for Rate Category		143,040	
Total for Report		42,054,596	1,934

**GS1 and GS2 represent commercial properties.

Appendix 3: Emission Coefficients

Tonnes $eC0_2$/unit of fuel

TypeName	BaseUnit	EnergyCoefficient	eCO_2Coefficient (t CO2e/base unit)
Alta Bitum. Coal	(tonnes)	30.4	1.7
B.C. Bitum. Coal	(tonnes)	30.4	1.7
CNG	(kilograms)	0.007612	0.003022
Coal - Anthracite	(tonnes)	27.7	2.39
Coal - Cdn Bitum.	(tonnes)	27.7	2.765488
Coal - Lignite	(tonnes)	15	1.49
Coal - Sub-Bitum.	(tonnes)	18.3	1.74
Coal - U.S. Bitum.	(tonnes)	29	2.46
Coke	(tonnes)	28.83	2.48
Diesel (mobile/road)	(litres)	0.03868	0.002732
District Energy	(GJ)	1	0.05847
Electricity (2000)	(MWh)	3.6	0.190
Ethanol Blend (10%)	(litres)	0.03244	0.002196
Fuel Oil	(litres)	0.03868	0.002735
Gasoline (mobile/road)	(litres)	0.03466	0.002440
Heavy Fuel Oil	(litres)	0.04173	0.003145
Kerosene	(litres)	0.03768	0.002544
Landfill Gas Electricity	(GJ)	0.999955453	0
Landfill Methane	(GJ)	1	0
MSW	(GJ)	1	0
Man. Bitum. Coal	(tonnes)	30.4	2.52
N.B. Bitum. Coal	(tonnes)	27	2.23
N.S. Bitum. Coal	(tonnes)	28.5	2.3
Natural Gas	(cubic metres)	0.03806	0.00189
Propane	(litres)	0.02553	0.00154
Solar	(GJ)	1	0
Wood	(cords)	25	0
Diesel (stationary)	(litres)		0.002790
Biodiesel (B5)	(litres)		0.002596
Biodiesel (B10)	(litres)		0.002459
Biodiesel (B20)	(litres)		0.002186
Ethanol (E85)	(litres)		0.000366

Notes:

- The emissions factor for diesel (mobile combustion) is taken from Canada's NIR (Annex 8). Assumes light-duty diesel vehicles (LDDVs) with 'Advanced Control' (i.e. Model years 1996-2003). [2,663 g CO2 + 0.051 g CH4 + 0.22 g N2O = 0.00268 tonnes CO_2e/L].

- The emissions factor for gasoline (mobile combustion) is taken from Canada's NIR (Annex 8). Assumes both light-duty gasoline vehicles (LDGVs) and light-duty gasoline trucks (LDGTs) with 'Tier 1: 1994-2003'.
- Every District Energy (DE) system is unique, please enter an emission factor for the local DE system in the yellow cell above to accurately calculate the emissions
- The emissions factor for stationary diesel refers to diesel that is not used for road transportation.
- The emission factor for CNG was taken from the NIR and converted from L into kg as this is the unit that is used to purchase this fuel. The conversion was done using the density of natural gas at STP (0.6937 kg/m^3)
- All emission factors from mobile source are tailpipe emissions and do not take into account life cycle analysis
- Unless otherwise stated, all values are taken from Canada's NIR, 1990-2011.