

Boston Community Greenhouse Gas Inventories

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Boston Community Greenhouse Gas Inventory

In equivalent CO2 tons

12/2/2009

	<u>2005</u>	<u>2006</u>	<u>2007</u>	<u>2007</u> <u>Percentage</u>
Residential				
Electricity	601,774	507,886	571,095	
Natural Gas	342,629	348,365	436,522	
Fuel Oil	420,378	425,994	397,403	
Trigen Steam	43,529	31,432	28,306	
Waste	51,777	51,116	49,301	
Subtotal	1,460,000	1,360,000	1,480,000	17.3%
Commercial/ Industrial				
Electricity	2,494,376	2,210,410	2,527,531	
Natural Gas	1,207,655	1,332,152	1,401,415	
Fuel Oil	418,532	422,431	426,330	
Trigen Steam	352,192	254,317	229,024	
Waste	130,223	130,915	132,406	
Subtotal	4,600,000	4,350,000	4,720,000	55.3%
Transportation				
VMTs				
Gasoline	1,667,519	1,658,688	1,651,146	
Diesel	348,802	349,531	349,851	
MBTA				
Electricity	204,588	185,898	195,871	
Diesel	53,719	51,420	55,819	
CNG	49,944	48,795	51,611	
Gasoline	4,986	5,001	5,230	
Subtotal	2,330,000	2,300,000	2,310,000	27.0%
Water and Sewer				
Electricity	24,595	25,396	26,431	
Natural Gas	843	911	1,048	
Fuel Oil	9,227	9,226	5,880	
Gasoline	378	359	342	
Diesel	291	347	347	
CNG	6	4	4	
Subtotal	35,000	36,000	34,000	0.4%
Total Emissions	8,430,000	8,050,000	8,540,000	
Emissions Per Capita	14.1	13.5	14.0	

GHG Emissions by Fuel	<u>2005</u>	<u>2006</u>	<u>2007</u>	<u>2007 Percentage</u>
Electric	3,325,333	2,929,590	3,320,928	38.9%
Natural Gas	1,601,071	1,730,223	1,890,596	22.1%
Fuel Oil	848,137	857,651	829,613	9.7%
Steam	395,721	285,749	257,330	3.0%
Gasoline	1,672,883	1,664,048	1,656,718	19.4%
Diesel	402,812	401,298	406,017	4.8%
Waste	182,000	182,031	181,707	2.1%

Boston Community Energy Use

12/2/2009

	<u>2005</u>	<u>2006</u>	<u>2007</u>
	(Calendar Year unless specified)		
<u>Residential</u>			
Electricity (kWh)	1,300,668,524	1,247,372,559	1,251,947,232
Natural Gas (therms)	55,457,472	56,385,947	70,654,924
Fuel Oil (gals)	36,334,931	36,820,377	34,349,140
Steam (million BTU)	491,455	436,212	382,381
Waste (tons) - FY	253,129	249,897	236,364
<u>Commercial/ Industrial</u>			
Electricity (kWh)	5,391,322,420	5,428,782,998	5,540,827,008
Natural Gas (therms)	195,469,646	215,620,610	226,831,489
Fuel Oil (gals)	36,175,407	36,512,419	36,849,432
Steam (million BTU)	3,976,319	3,529,348	3,093,812
Waste (tons)	634,886	640,024	634,793
<u>Transportation</u>			
Vehicle Miles Traveled	3,067,029,330	3,074,692,556	3,082,355,782
<u>MBTA</u>			
Electricity (kWh)	447,075,000	406,231,550	428,025,310
Diesel (gals)	5,075,978	4,858,819	5,274,388
CNG (therm)	7,884,422	7,703,067	8,147,632
Gasoline (gals)	463,817	465,613	487,285
<u>Water and Sewer</u>			
Electricity (kWh)	53,747,077	55,497,115	57,758,822
Natural Gas (therms)	137,409	147,511	169,605
Fuel Oil (gals)	797,533	800,528	508,250
Gasoline (gals)	35,175	33,433	31,870
Diesel (gals)	27,460	28,193	32,787
CNG (therms)	914	639	669

Notes for Boston Community Greenhouse Gas Inventories 2005 - 2007

In his April 2007 executive order on climate action, Mayor Thomas Menino directed that the City would report annually on its greenhouse gas (GHG) emissions. In January 2008, the City released an inventory report that included the community inventory for 2005. This report includes inventories for 2006 and 2007 as well as a revised inventory for 2005. Greenhouse gas emissions specifically from municipal operations of the City of Boston are described in a separate report.

1. Many technical, policy, and data-collections issues concerning the calculation of GHG inventories remain open. The City of Boston participates in regional and national forums to discuss these issues. Consequently, these inventories are subject to revision.
 2. Boston GHG inventories are overseen by staff of the Boston Air Pollution Control Commission. However, these inventories could not have been completed nor achieved whatever level of accuracy they have without a large amount of work, cooperation, and guidance from colleagues in many City departments and independent authorities, several departments of the Commonwealth of Massachusetts, ICLEI, Boston's energy utilities, and a variety of local institutions.
 3. Please direct any comments or questions about the inventories to Carl Spector, Executive Director, Air Pollution Control Commission, carl.spector@cityofboston.gov. Suggestions for improving the accuracy or completeness of the inventory are welcome.
 4. *Software.* To calculate greenhouse gas emissions, the City of Boston uses [Clean Air and Climate Protection \(CACP\) software](#) developed by [ICLEI](#) and the [National Association of Clean Air Agencies](#). The CACP software contains fuel-specific, region-specific, and, in some cases, use-specific factors that convert energy and waste data into greenhouse gas emissions. The software is continually updated to reflect both temporal changes (for example, the fuel mix that produces electricity in a given region changes year by year) and changes in scientific understanding (for example, the factor for converting methane emissions into equivalent CO₂).
 5. *Electricity emission factor.* The municipal and community GHG inventories use the electricity emission factor based on the area served by [ISO-New England](#), the regional transmission organization. The ISO-NE electricity emission factor is about 7 percent lower than the factor used by the [Commonwealth of Massachusetts](#) for their statewide GHG emissions inventory released in July 2009. The Commonwealth's emission factor is based primarily on power plants located in Massachusetts.
- In 2006 many electrical generating units temporarily switched from oil to natural gas due to change in their relative prices. As a result, the electricity emissions factor in 2006 was about 10% lower than those of 2005 and 2007. This contributed to the emission dip in 2006.
6. *Time frame.* The municipal inventory is based on the City's fiscal year, July 1 to June 30. The community inventory is based on the calendar year, except for residential waste and water and sewer data, which are based on the fiscal year.
 7. *Units.* The current inventories' unit of measurement is tons (short tons) of [equivalent carbon dioxide \(eCO₂\)](#). Many other reports use metric tons or tonnes: 1 ton = 0.907 metric tonne.

8. *Approach.* The community inventory mixes top-down and bottom-up inventory methods and estimates based on models. It cannot have the same degree of precision as the municipal inventory, which is based on actual energy purchases. For this reason, the totals are rounded off (and perhaps should have been rounded one level further),

9. *Scope.* The goal of the community inventory is to include all GHG emissions associated with all activities—residential, commercial/industrial, institutional, transportational—within city boundaries. Most government activity is in the commercial/industrial category.

10. *Revised 2005 inventory.* The previously published 2005 GHG emissions inventory has been revised to include new data and an expanded scope.

11. *Natural gas.* Data on natural gas consumption in Boston were provided by [National Grid](#) (formally Keyspan). National Grid reported natural gas sales in two categories according to account type—residential (types 3801–3832; 3901–3932) and commercial/industrial (types 3841–3853; 3941–3984). However, large residential sites—that is, those with more than four units that are not separately metered—are included in the commercial/industrial category. (This is true only for natural gas, not for electricity.) Natural gas used by the Trigen steam plant near South Station is subtracted from the National Grid data to prevent double counting.

12. *Electricity.* Data on electricity consumption in Boston was provided by [NStar](#). For 2005 and 2006, NStar reported electricity sales according to rate type—residential (types R1–R4) and commercial/industrial (types G1–G3, T1–T2, and S1–S3; these last rates are for street lighting). For 2007, NStar reported only the totals for residential and commercial/industrial, without a breakdown of the various rate types.

13. *Steam.* Boston’s largest steam plant is run by [Trigen Energy](#), which provided data on actual fuel use and on steam supplied by category (residential, commercial, medical, and educational). The actual fuel used varies significantly due to variation in commodity prices (for example, in 2005, their fuel use was: 88% heavy fuel oil, 3% light fuel oil, and 9% natural gas; in 2007: 40% heavy fuel oil, 2% light fuel oil, and 58% natural gas). We used this data to calculate annual GHG emission factor specifically for this source.

14. *Residential fuel oil.* According to the [Massachusetts Energy Consumers Alliance](#), the average Massachusetts household using fuel oil used 866.5 gallons in the 2004-2005 heating season and 742.7 gallons in 2005-2006. We averaged these to numbers to estimate 804.6 gallons per household for the 2005 calendar year. The [U.S. Census Bureau](#) estimates that 45,159 households in Boston used fuel oil as their primary heating source in 2005. Multiplication of these two numbers gives an estimate of 36,334,931 gallons of heating oil for the residential sector of the Boston community. We performed similar calculations based on census data and on average fuel oil use in 2006-2007, 2007-2008, and 2008-2009 to estimate total usage for 2006, 2007, and 2008.

15. *Commercial/industrial fuel oil.* According to the federal [Energy Information Administration](#), buildings in the Northeast that used fuel oil used an average of 0.2 gallons per square foot for heating in 2003. A [2003 Department of Energy study](#) found that about 52 percent of commercial structures used fuel oil. (Updated reports for 2006 for both values are expected in the near future, and we will adjust the inventory, if there is a substantial change.) The City of Boston’s [Assessing Department](#) determined that, in 2005, there were 318.6 million and, in 2009, 330.5 million square feet of commercial/industrial building space in Boston. The total area of commercial space for 2006 through 2008 was interpolated

from these two data points. Multiplication of average usage, the percentage of commercial buildings using fuel oil, and the the total area of commercial space gives an estimate of total heating oil use for the commercial/industrial sector of the Boston community.

16. *Transportation.* The Commonwealth's [Central Transportation Planning Staff](#) (CTPS) has developed a computer model to estimate the number of miles traveled by all vehicles, except transit vehicles, on a high-traffic mid-week day in eastern Massachusetts in 2000 and 2010. At our request, CTPS used the same model to estimate daily vehicle miles traveled (VMTs) in Boston for 2000 and 2010. To calculate annual VMTs, CTPS advised us that a multiplier of 340 was appropriate, taking into account the weekend, holiday, and summer traffic patterns. We then used a linear interpolation between the 2000 and 2010 numbers to estimate VMTs for 2005, 2006, and 2007. The CACP software translated VMTs into GHG emissions by using the regional fleet mix to determine the distribution of vehicle types and assigning to these vehicle types a representative fuel mileage.

17. *MBTA fuel usage.* The MBTA provided data on its 2005 to 2007 system-wide usage of gasoline, diesel fuel, electricity, and natural gas for all vehicles, though not broken down by vehicle type, which the CACP software requires. Therefore, for the sake of estimation, all gasoline was assigned to passenger vehicles, and all diesel fuel and natural gas to transit buses.

18. *Waste.* The waste figure is an estimate of GHG emissions from the disposal of all non-hazardous waste—residential, commercial, industrial, and institutional—generated in Boston. According to the City's Department of Public Works, total municipally controlled waste—that is residential waste and waste from municipal buildings—was 236,364 tons in 2007. DPW has little control over waste disposal technology, but believes that most of Boston's waste is incinerated. Therefore, the emissions number was calculated for the incineration of 236,364 tons. Commercial waste was calculated using the disposal rate per employee broken down by job sectors in the Massachusetts Department of Environmental Protection's [Commercial Waste Disposal Assessment Report](#) and combined with yearly employment figures for Boston provided by the [Massachusetts Executive Office of Labor and Workforce Development](#).

19. *Water and Sewer.* The Massachusetts Water Resources Authority and the Boston Water and Sewer Commission both provide service for Boston. The water and sewer category here includes only the MWRA; see the municipal inventory for BWSC emissions, which are incorporated into the commercial/industrial category. The MWRA provides water and sewer services to 2.5 million people and more than 5,500 businesses in 61 communities in eastern and central Massachusetts. At our request, the MWRA allocated to Boston its pro rata share of its total annual energy used based on measurements of actual water and sewer flows. For FY05 through FY07, the Boston share was about 32 percent of the total.

20. *Per capita emissions.* The residential population of Boston was 596,638 in 2005, 595,698 in 2006, and 608,352 in 2007, according to the Boston Redevelopment Authority. The daytime population on an average work day is about twice the residential population.

December 2, 2009