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INVENTORY OF NEW YORK CITY GREENHOUSE GAS EMISSIONS

SEPTEMBER 2009

A GREENER, GREATER NEW YORK

The City of New York
Mayor Michael R. Bloomberg

The Inventory of New York City Greenhouse Gas Emissions is published pursuant to Local Law 22 of 2008

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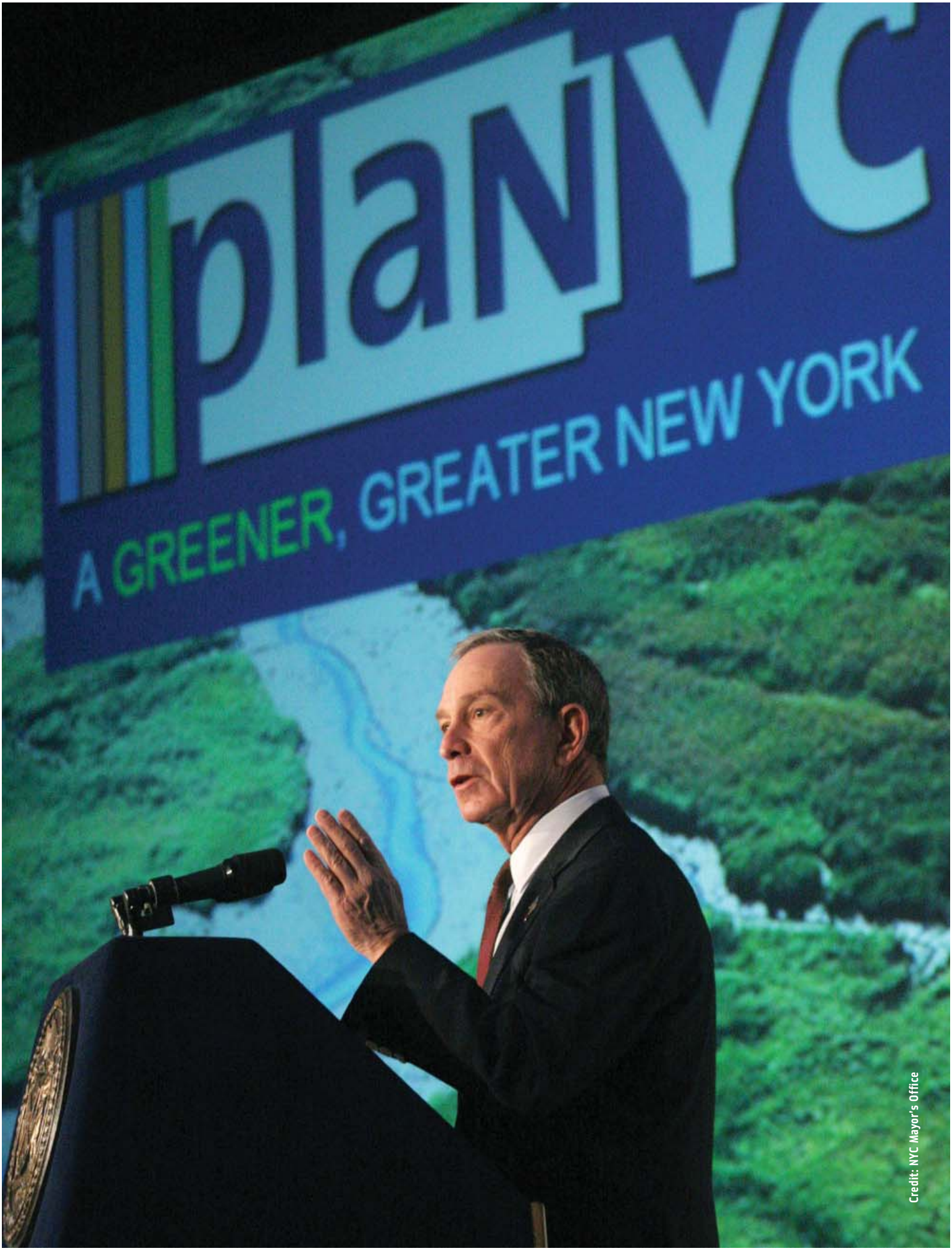


Credit: NYC Mayor's Office

Foreword by Michael R. Bloomberg, Mayor of New York City

Climate change poses serious health, security, and economic threats to the world's people and the cities in which they live. Although New York City is already the most environmentally efficient community in the United States, we have become a global leader in the battle against climate change, working both to reduce our greenhouse gas emissions and to begin to adapt to the expected impact of those changes. As the world prepares for the global climate meeting in Copenhagen, and as a national climate policy is finally under serious consideration in Washington, it is more important than ever to take stock of our own progress.

As with all great challenges, it is critical to understand the full nature of the problem before taking action. That is why one of the first initiatives of the long-term sustainability plan we unveiled in 2007, *PlaNYC*, was to measure greenhouse gas emissions and their sources. What we found was that, during the first half of this decade, New York City's greenhouse gas emissions increased, driven in part by increased personal consumption—because each New Yorker was using steadily more electricity, and traffic was increasing faster than the population. In the carbon inventory reporting 2007 emissions (which we released last year), we saw that two new, highly efficient power plants had made New York City's electricity less carbon-intensive, and thus lowered our carbon footprint even though individual consumption was rising.

This year's inventory, covering 2008 emissions, shows another encouraging sign: New Yorkers themselves are beginning to get more efficient. For the first time in recent years, per capita energy consumption has declined, even after adjusting for the impact of weather patterns beyond our control, in part because of a reduction in per capita vehicle traffic. Our electricity has continued to get cleaner, further reducing our carbon impact. And efforts by individual companies and landlords to capture serious pollutants have made an impact as well. While this inventory measures only the first full year of *PlaNYC*, the results demonstrate that significant reductions in greenhouse gas emissions are possible.

I have always believed that you cannot manage what you do not measure. Regular inventory updates such as this allow us to monitor the success of our carbon mitigation efforts and allow us to make adjustments to our initiatives as necessary. These updates also allow New Yorkers and others around the world to hold us accountable for meeting our goals—and building a greener, greater New York.

Mayor Michael R. Bloomberg

Credit: NYC Economic Development Corporation

Executive Summary

The City of New York released its first-ever comprehensive greenhouse gas inventory in April 2007, setting the benchmark from which the City's carbon reduction targets are based: a 30 percent reduction in citywide emissions below 2005 levels by 2030 and a 30 percent reduction in municipal emissions below fiscal year 2006 by 2017. In September 2008, the first annual update to these inventories was released in compliance with Local Law 22 of 2008, allowing the City to begin to track progress it is making toward its goals.

Because national standards for carbon accounting continue to evolve, each year the City updates its calculations to take into account new protocols, methodologies, and increased data availability. The City has also updated its inventories for previous years to allow consistent year-to-year comparisons. This year, these changes have resulted in decreases in both the citywide and municipal inventories for earlier years.

This report contains both the citywide inventory for calendar year 2008 and inventories of municipal government operations covering both fiscal and calendar year 2008. In 2008, New York City as a whole was responsible for 53.3 million metric tons of carbon dioxide equivalent (CO_2e) emissions, and City government was responsible for 3.8 million metric tons. These figures include emissions from energy consumption (including emissions related to power generation outside the city), vehicle traffic and transit operations within the city, and emissions from landfills, wastewater treatment facilities, and the electricity distribution network. On a per capita basis, the average New Yorker was responsible for some 6.4 metric tons of greenhouse gas emissions in 2008, compared with 19.7 for the average American, excluding non-local emissions such as the agriculture sector.

Both citywide and municipal government emissions declined from 2007 to 2008. The largest portion of this change was due to milder weather, which required less heating and cooling of buildings, and which offset increased emissions citywide due to population growth and a continued expansion of building stock. The carbon intensity of the city's electricity also declined, as it did in 2007, because the city was able to import more clean electricity from upstate New York than in 2007 due to new transmission lines to Long Island freeing up capacity for the city. Including these factors, citywide carbon emissions decreased by 3.5 percent and municipal carbon emissions decreased by 2.6 percent below 2007 levels.

Perhaps most significant is the fact that **citywide per capita energy consumption declined from 2007 to 2008**, after taking out the estimated impact of weather. **New York City is becoming more energy efficient.** An increase in emissions from transit service and decrease in per capita vehicle miles traveled also demonstrates this trend, as transit service increased to meet the demand of more New Yorkers using the city's extensive public transit network. Thus, counting only those factors under our control, citywide emissions declined by 1.3 percent and municipal emissions declined 1.2 percent below 2007 levels.

Reductions in the City's municipal emissions, beyond those driven by weather or changes to the power supply fuel mix, indicate that the City's efforts to meet its *PlaNYC* goal of a 30 percent reduction in municipal government emissions by 2017 have begun. The City's investments in energy-efficiency upgrades to its buildings, a *PlaNYC* commitment, began in fiscal year 2008, even though the *Long-Term Plan to Reduce Energy Consumption and Greenhouse Gas Emissions of Municipal Buildings and Operations* was only completed after the fiscal year was over, in July 2008. Reduced electricity use and heating fuel per City employee, coupled with reductions in vehicle emissions, show the initial impact of concerted efforts to make City government more efficient. While the fiscal year 2008 figures reported here do not yet show the rate of reductions the City needs to achieve 30 percent by 2017, many of the first year's projects were not complete until the end of the fiscal year and so will show results only in next year's inventory.

This annual inventory provides critical information on the trends of carbon emissions and the factors that influence changes to emissions over time. Future inventories will document the impact of *PlaNYC*—the City's comprehensive sustainability plan—as the City continues to strive to reduce its carbon emissions.

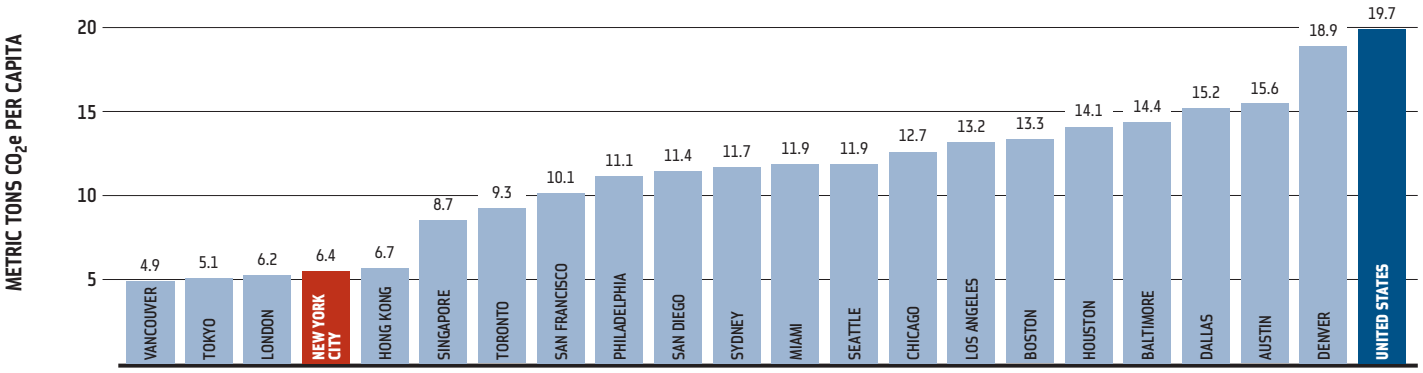
Comparison of New York City to Other Cities

Due to the high density of New York City's built environment and extensive public transit system, New Yorkers emit far less carbon than do residents of other comparable cities and emit about a third as much carbon as the average U.S. resident. Driving this low carbon emissions level is the city's high rate of commutation by public transit and walking, low automobile ownership, and low per capita electricity consumption.

GHG EMISSIONS COMPARISONS

When compared to other large cities in the United States and abroad, New York City has one of the lowest per capita carbon emissions levels and the lowest of any American city.

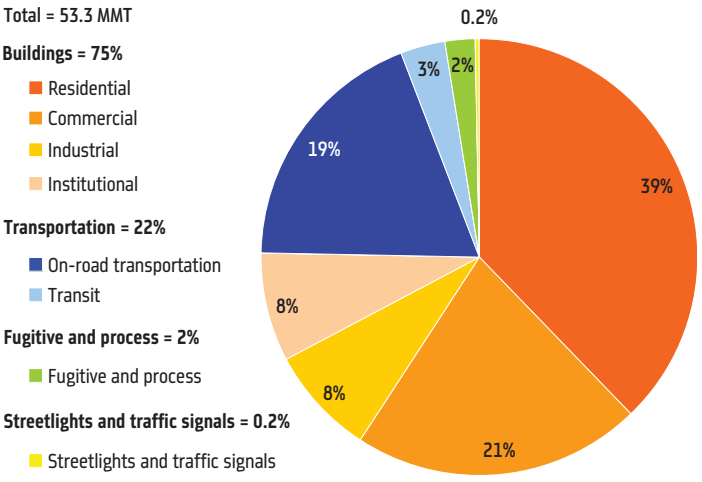
Figure 1: Per Capita Greenhouse Gas Emissions for U.S. and International Cities (excluding Agriculture and Non-Local Processes*)



* City greenhouse gas inventories do not typically include all sources of emissions included in the U.S. GHG inventory, including emissions from agriculture, chemical production, fossil fuel extraction and refinement, cement production, and other industrial sources. To allow for comparability between city and U.S. per capita GHG emissions, the U.S. per capita GHG emissions have been reduced by 0.4 metric tons per person (from 20.1 metric tons to 19.7 metric tons), which, based on the U.S. GHG inventory, is the U.S. per capita share of GHG emissions from sources not accounted for in city inventories. Per the Kyoto Protocol, national inventories do not include emissions from aviation and shipping. Accordingly, city inventories also exclude these emissions sources. Existing protocols ascribe transportation and industrial emissions to the locality in which they take place, which may not fully reflect the impact of trade and the consumption of goods.

Sources: U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007 (April 2009); New York City Mayor's Office of Long-Term Planning and Sustainability analysis; see Appendix for sources on city greenhouse gas emissions.

Figure 2: 2008 Citywide CO_2e Emissions by Sector



NEW YORK CITY GHG EMISSIONS

As with many cities, New York City's greenhouse gas emissions are dominated by two sectors: energy consumed in transportation and energy consumed in buildings. Roughly 75 percent of New York City's GHG emissions are related to buildings, and 22 percent are related to transportation.

The key drivers of transportation-related emissions are the portion of trips made by low-carbon modes, such as transit, walking, or cycling; the fuel efficiency of vehicles used; and the distances traveled.

The key drivers of building-related emissions include the types of fuel used for electricity generation; the efficiency of power plants; the size of the spaces inhabited by each person; weather demands on heating and cooling; the efficiency of buildings and workplaces; and personal efficiency measures.

TRANSPORTATION COMPARISONS

One factor behind New York City's low per capita carbon emissions is its transit system. When compared to other U.S. cities and the U.S. average, New York City has among the highest mass transit use, the most households without cars, and among the most commuters who walk to work.

Figure 3: Percentage of Commuters Using Mass Transit

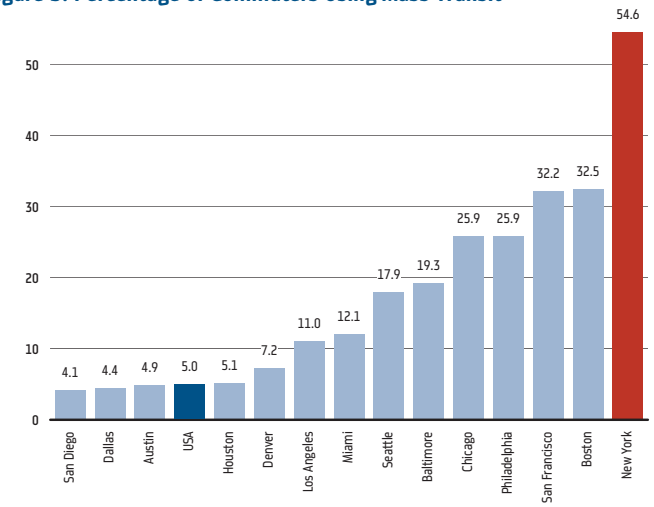


Figure 4: Percentage of Households Without Cars

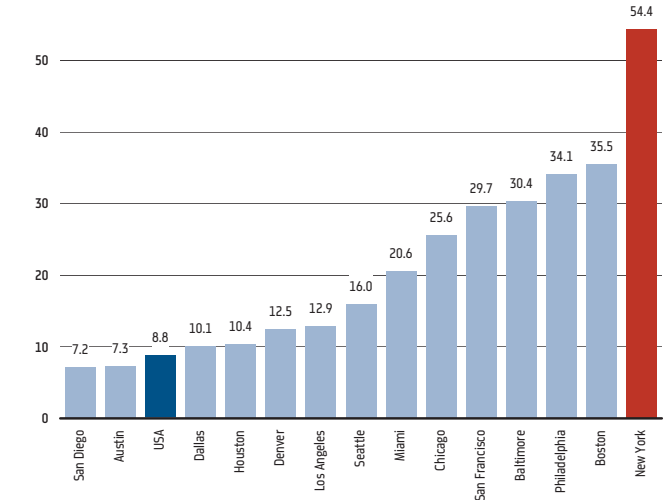
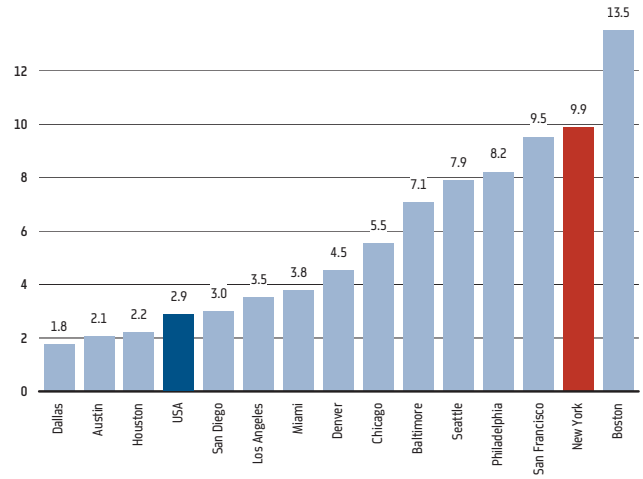


Figure 5: Percentage of Commuters Walking to Work



ELECTRICITY CONSUMPTION COMPARISONS

Electricity consumption is one indicator of the energy efficiency of buildings. New York City has among the lowest levels of per capita electricity use, both citywide and for the residential sector. This is driven largely by the fact that most New Yorkers live in apartment buildings and have smaller homes.

Figure 6: Annual Electricity Consumed Per Capita, MWh

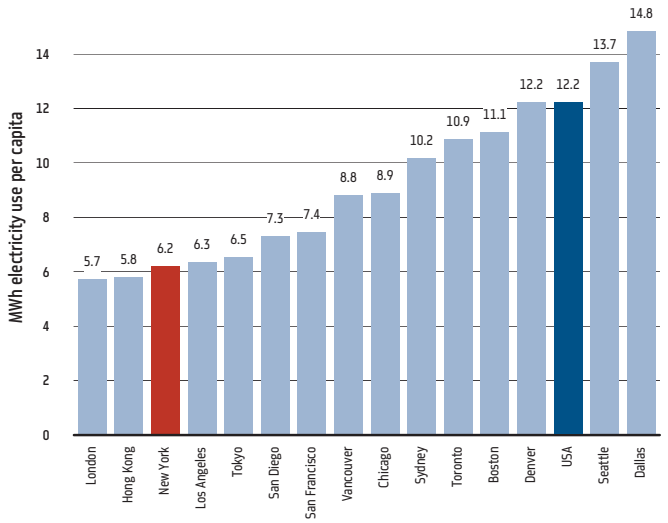
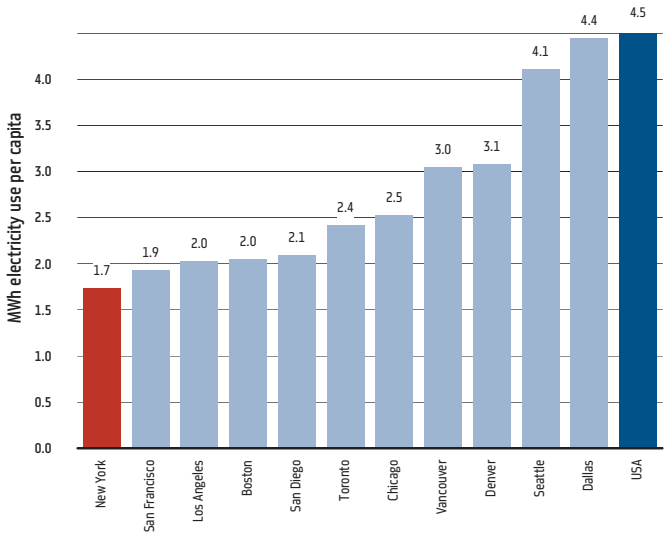


Figure 7: Annual Residential Electricity Consumed Per Capita, MWh



Source: For transportation data - U.S. Census Bureau, 2007 American Community Survey. For electricity consumption data - see Appendix for sources on municipal and U.S. electricity consumption

Credit: NYC Economic Development Corporation

Greenhouse Gas Emissions and Climate Change

There is broad consensus within the scientific community that human activity is changing the Earth's climate through increasing concentrations of greenhouse gases (GHG) in the atmosphere. Greenhouse gases occur naturally and are a key element of the earth's atmosphere because they trap energy from the sun, creating a natural "greenhouse effect." Without this effect, temperatures would be much lower than they are now, and life as it exists today would not be possible.

This natural balance of GHG in the atmosphere, however, is being disturbed by human activities such as industrial processes, fossil fuel combustion, and changes in land use—actions that release large amounts of certain greenhouse gases into the atmosphere. This increase in greenhouse gas concentration traps additional energy in the lower atmosphere, thus warming it beyond its normal temperature. Industrial activity has contributed to a 30 percent increase in the global CO_2 level since the beginning of the Industrial Revolution through the combustion of fossil fuels for energy. Other anthropogenic contributions of greenhouse gases include the clearing of forests for development and agriculture, methane production from the decomposition of solid waste, and the manufacturing of chlorofluorocarbons.

The term "global climate change" refers to the destabilizing impacts on climate and weather patterns that result from continuous addition of these gases, the resultant increase in heat energy in the earth's atmosphere, and the associated changes that follow. Even small changes in the average temperatures can be accompanied by an increase in severe weather events such as storms and droughts, ecosystem change, loss of animal and plant species, stresses to human health, and alterations in regional agricultural productivity.

To better understand the impacts of climate change on New York City, Mayor Bloomberg convened the New York City Panel on Climate Change (NPCC) to develop city-specific climate change projections and advise the City on adaptation. According to the NPCC, New York City's climate will become more like present-day North Carolina's as temperatures increase by an average of 4 to 7.5 degrees Fahrenheit toward the end of the century and annual precipitation increases by 5 to 10 percent. In addition, the NPCC projects sea levels are likely to rise by 12 to 23 inches by 2100, and could reach 41 to 55 inches by the end of the century if recent trends such as accelerated ice melt in Greenland and Antarctica continue. A reduction in global GHG would likely reduce these impacts, particularly those toward the end of the century.

To help avoid some of these serious consequences of climate change, it is imperative for the global community to work together to collectively reduce GHG emissions. This is especially important in the world's cities, which have been estimated to be responsible for approximately 80 percent of the world's GHG emissions. To allow New York City to effectively manage its share of world GHG emissions, it is necessary to complete accurate and regular assessments and analyses of its GHG emissions, the results of which are presented in this inventory.

Overview

New York City meets its annual citywide greenhouse gas reduction target and is on-track to achieve PlaNYC's overarching goal

The City of New York established the overarching goal of reducing citywide greenhouse gas emissions by 30 percent below 2005 levels by 2030 in its 2007 comprehensive sustainability plan, *PlaNYC*. Following the release of *PlaNYC*, Mayor Bloomberg signed Executive Order 109 in October 2007, which mandated even more aggressive greenhouse gas reductions for municipal facilities and operations of 30 percent below fiscal year 2006 (July 1, 2005 to June 20, 2006) levels by 2017.

Informing both the citywide and municipal greenhouse gas reduction efforts was the City's first comprehensive greenhouse gas inventory, the *Inventory of New York City Greenhouse Gas Emissions*, released in April 2007 and establishing the baseline from which the city's greenhouse gas reduction targets are based.[1] In January 2008, the New York City Council passed Local Law 22 of 2008, which requires the City to complete annual updates to both the citywide and municipal greenhouse gas inventories, and to document progress the City is making toward achieving its goals. In accordance with this law, the City released its first annual updated greenhouse gas inventory, the *Inventory of New York City Greenhouse Gas Emissions* on September 17, 2008, which reported 2007 GHG emissions.[2] This document is the City's second annual greenhouse gas inventory update.

Methodologies and protocols for the quantification and assessment of greenhouse gas emissions continue to evolve, and New York City has been a leading contributor to the development of updated standards. This inventory reports three things:

- Updates to past base year and interim year inventories, applying current protocols and incorporating better data
- Total 2008 GHG emissions (carbon footprint) for New York City, both citywide and for municipal operations and facilities
- The causes driving changes in GHG emissions from past years to 2008.

This inventory presents updates to past year's base year and interim year inventory results. Such updates allow for comparability of the most recent year's inventory levels with those from past years. Shortly after the City released its first annual GHG inventory update in September 2008, the *Local Government Operations Protocol* (LGOP) was released by the California Air Resources Board (CARB), The California Climate Action Registry (CCAR), ICLEI – Local Governments for Sustainability (ICLEI), and The Climate Registry (TCR), setting the standards for U.S. local governments to use in completing municipal government GHG inventories.[3] This inventory is completed in compliance with the LGOP. As no citywide inventory protocol has been promulgated at the time of this report's publication, citywide calculations were also made using the LGOP, where applicable. Improvements in data availability and revised analysis of energy generation and transmission data has also resulted in revised electricity emissions coefficients. In short, this coefficient more accurately accounts for cleaner power that is included in the fuel mix for power imported into New York City. Improved transportation modeling has also allowed the City to reclassify some on-road transportation emissions, shifting vehicle miles traveled (VMT) from light trucks to passenger vehicles. As a result of these adjustments, both the citywide and municipal base year inventories decreased, with citywide 2005 base year emissions levels decreasing from 63.1 to 58.6 million metric tons of carbon dioxide equivalent ($MMTCO_2e$), a 7.0 percent decrease, and fiscal year 2006 base year GHG emissions decreasing 9.3 percent, from 4.1 to 3.7 MMTCO2e.[4] Tables 1 and 2 summarize these changes.

The carbon footprint for New York City and its municipal government was lower in 2008 than 2007. Once base year and interim year adjustments were made, the City reports a reduction of 1.9 $MMTCO_2e$ emissions below 2007 citywide levels in 2008, a 3.5 percent reduction. 2008 citywide GHG levels were 5.3 $MMTCO_2e$ lower than those in the 2005 base year, an overall 9.0 percent reduction. Municipal GHG emissions decreased by 0.10 $MMTCO_2e$ from fiscal year 2007 to fiscal year 2008, a 2.6 percent reduction. Total municipal GHG emissions were 0.08 $MMTCO_2e$ higher in fiscal year 2008 than in the fiscal year 2006 base year, a 2.1 percent increase, reflective of the significant increase in municipal GHG emissions from 2006 to 2007.

Figure 8: 2007 to 2008 Changes in New York City's Citywide Greenhouse Gas Footprint

New York City's citywide carbon footprint declined 3.5 percent between 2007 and 2008 due to cleaner imported electricity, milder weather, reduced sulfur hexafluoride emissions, and reduced energy consumption

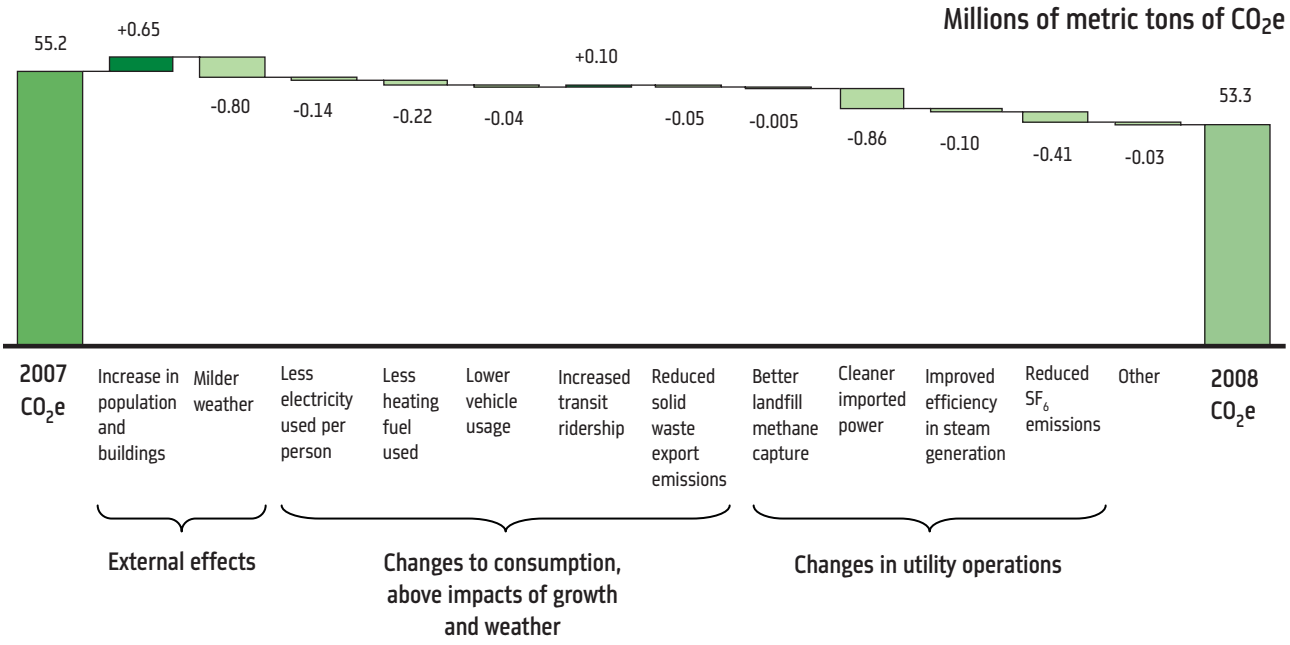


Figure 9: FY 2007 to NY 2008 Changes in New York City's Municipal Greenhouse Gas Footprint

New York City's municipal carbon footprint declined 2.6 percent between fiscal years 2007 and 2008 due to cleaner imported electricity, reduced solid waste export emissions, reduced energy consumption, and reduced wastewater treatment methane emissions

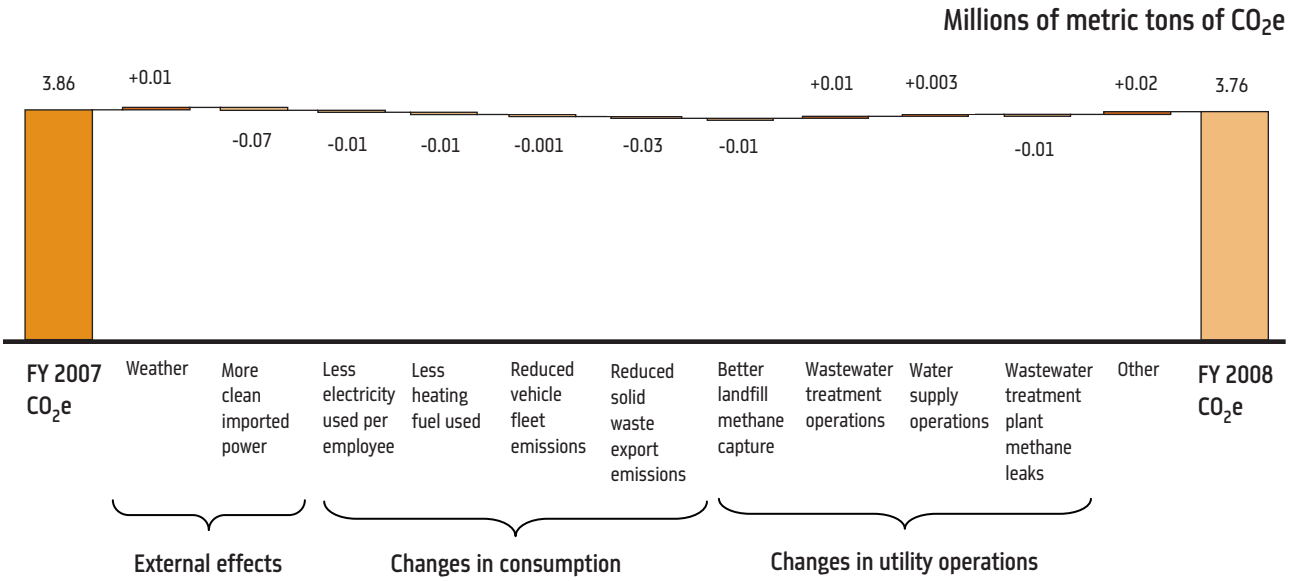


Table 1: Breakdown of Citywide CO_2e Emissions Changes, 2005 Base to 2005 Adjusted

	METRIC TONS CO_2e	CHANGE AS % OF BASE
2005 reported total CO_2e (September 2008 Inventory)	63,052,184	
Reason for change		
Revised coefficients and data		
More accurate electricity consumption data	112,523	0.18%
More accurate fuel oil consumption data	-230,943	-0.37%
Revised heating fuel coefficients	-992,080	-1.57%
Revised transportation fuel coefficients	-1,538,980	-2.44%
More accurate traffic model	497,018	0.79%
Revised landfill emissions data	-136,707	-0.22%
Revised wastewater treatment plant CH_4 emissions	-79,447	-0.13%
Revised electricity coefficient	-4,291,318	-6.81%
Changes due to LGOP standards		
Inclusion of wastewater treatment plants N_2O	64,649	0.10%
Inclusion of fugitive CH_4 from natural gas	69,483	0.11%
Inclusion of fugitive SF_6 from electricity distribution	2,037,561	3.23%
Other	39,714	0.06%
2005 adjusted total CO_2e	**58,603,657**	**-7.06%**

Table 2: Breakdown of Municipal CO_2e Emissions Changes, FY 2006 Base to FY 2006 Adjusted

	METRIC TONS CO_2e	CHANGE AS % OF BASE
FY 2006 reported total CO_2e (September 2008 Inventory)	4,067,222	
Reason for change		
Revised coefficients and data		
Revised electricity coefficient	-367,207	-9.03%
Revised residual fuel coefficient	-14,090	-0.35%
Revised gasoline coefficient and data	-13,681	-0.34%
Revised distillate fuel coefficient	-6,587	-0.16%
Revised natural gas coefficient and data	71,898	1.77%
Revised solid waste export calculation	-37,032	-0.91%
Revised steam data	-19,578	-0.48%
Revised wastewater treatment CH_4 data	-20,140	-0.50%
Revised landfill CH_4 data	-52,819	-1.30%
Steamlined methodology		
Revised allocation of water supply fuel	-7,144	-0.34%
Revised allocation of wastewater treatment fuel	8,492	-0.18%
Revised diesel fuel allocation	-2,660	-0.34%
Changes due to LGOP standards		
Inclusion of wastewater treatment N_2O	64,649	1.59%
Inclusion of mobile source HFCs	11,370	0.28%
Other	5,022	0.12%
FY 2006 adjusted total CO_2e	**3,687,714**	**-9.33%**

Understanding the causes driving changes in GHG emissions is necessary to develop policies to achieve additional carbon reductions. These changes reflect several factors, including: the impact of weather and population growth on energy use; an increase in cleaner imported power; new efficient in-city power generation; changes in the amount of methane (CH_4) emitted from the city's wastewater treatment plants and landfills; and decreased sulfur hexafluoride (SF_6) emissions used for citywide electricity distribution.

Protocol changes, revised methodology, and new data availability

The calculation of GHG emissions is a continually evolving science. Accordingly, GHG emissions reported in this inventory are understood to have been calculated using the best data and methodologies available at the time of inventory completion. Compliance with the LGOP resulted in several changes to how GHG emissions are calculated, the sources and types of GHG emissions that are reported, and the categorization of municipal emissions. The LGOP also updates numerous emissions coefficients, revising those used for previous inventories, resulting in significant changes to both the citywide and municipal base and interim year inventories. In addition, the City will now report municipal emissions in calendar year periods as well as fiscal year periods.

Complying with the LGOP resulted in reporting emissions by separate scopes, following the World Resources Institute/World Business Council for Sustainable Development's (WRI/WBCSD) *Greenhouse Gas Protocol*.[5] Aggregate totals for both citywide and municipal CO_2e emissions are also reported. Several new emissions categories were also added for the government inventory, including Scope 3 employee commute, and fugitive hydrofluorocarbons (HFCs) from vehicle cooling systems. The citywide inventory now includes fugitive CH_4 emissions from citywide natural gas distribution and fugitive SF_6 emissions from citywide electricity distribution, while both the citywide and municipal inventory include wastewater treatment process nitrous oxide (N_2O) emissions.

An emissions coefficient is a factor used to calculate the mass of CO_2e that is generated through either the combustion of fossil fuels for energy or the decomposition of organic matter in solid waste management or wastewater treatment facilities. Based on new analysis of power imported from outside of the city that resulted in including more clean power as part of the city's imported electricity, the City revised the electricity emissions coefficients for base and interim years, resulting in a decrease in the citywide 2005 base year electricity coefficient of 16.4 percent. For the citywide inventory, updated modeling of estimated on-road transportation vehicle miles traveled completed by the New York Metropolitan Transportation Council (NYMTC) resulted in the reassignment of a portion of past years' commercial light truck VMT to the passenger car category, to more accurately classify pickup trucks and sport utility vehicles. In this inventory, municipal vehicle fleet emissions were calculated using bulk fuel purchase records and City GasCard data, whereas fiscal year 2007 vehicle fleet fuel use had been calculated by means of an agency survey. Fiscal year 2006 and 2007 vehicle fuel use data have been updated using the same methodology to allow for comparability of results.

Citywide inventory results

Citywide CO_2e emissions are generated from energy used in buildings and transportation and escape as fugitive emissions from solid waste management, wastewater treatment, and natural gas and electricity distribution. From the adjusted 2005 base year, citywide CO_2e emissions decreased by 9.0 percent from 58.6 to 53.3 MMT

Table 3: 2007 to 2008 Changes in Citywide CO_2e Emissions

	METRIC TONS CO_2e	% of 2007 CO_2e
2007 citywide CO_2e	**55,241,501**	
Reasons for change		
Growth	651,944	1.18%
Milder weather in 2008 than 2007	-802,438	-1.45%
Per capita electricity consumption (e.g., electronics)	-142,512	-0.26%
Per capita natural gas/heating oil consumption	-218,344	-0.40%
Per capita VMT	-39,144	-0.07%
Per capita transit ridership	98,349	0.18%
Per capita solid waste export	-50,464	-0.09%
Improved landfill methane capture	-4,534	-0.01%
Increase in importation of cleaner power	-862,676	-1.56%
Improved efficiency in steam generation	-96,820	-0.18%
Reduced fugitive SF_6 from electricity distribution	-408,869	-0.74%
Other	-32,724	-0.06%
2008 citywide CO_2e total	**53,333,269**	**-3.45%**

Table 4: FY 2007 to FY 2008 Changes in Municipal CO_2e Emissions

	METRIC TONS CO_2e	% OF FY 2007 CO_2e
FY 2007 municipal CO_2e	**3,863,757**	
Reasons for change		
Externalities		
Weather	14,602	0.38%
Powerplants	-69,759	-1.81%
Consumption		
Per employee electricity consumption	-13,974	-0.36%
Heating fuels	-10,778	-0.28%
Vehicle fleet	-1,157	-0.03%
Solid waste export	-29,268	-0.76%
Landfills	-7,698	-0.20%
Wastewater treatment plant operations	8,531	0.22%
Water supply operations	3,353	0.09%
Wastewater treatment plant methane leaks	-11,470	-0.30%
Other	17,736	0.46%
FY 2008 municipal CO_2e total	**3,763,875**	**-2.59%**

in 2008. Driving this change was milder weather, new efficient in-city electricity generation, increased importation of cleaner electricity, and decreased fugitive SF_6 emissions, which resulted in an overall decrease in CO_2e despite increases in population, building floor area, and per-capita electricity consumption.

From 2007, citywide CO_2e emissions decreased from 55.2 to 53.3 MMT, a 3.5 percent reduction. Several factors contributed to this reduction, including milder weather, a decrease in per capita energy consumption, an increase in importation of cleaner electricity, and additional reduction of fugitive SF_6. These factors allow the City to report an overall reduction in CO_2e levels, despite increases in both population and building floor area. Figure 8 and Table 3 summarize the changes in citywide emissions levels from 2007 to 2008.

The most significant factors influencing the change in emissions levels from both 2005-2008 and 2007-2008 were changes to the electricity emissions coefficient. In 2006, two new state-of-the-art power plants came online: New York Power Authority's (NYPA) Astoria Combined Cycle Power Plant and SUEZ Astoria Energy. Together, these plants added 1000 megawatts (MW) of clean energy capacity to New York City's electricity grid, displacing electricity generated from more carbon-intensive power plants. In 2007, the Long Island Power Authority's (LIPA) Neptune electricity transmission line went into service, connecting New Jersey to Long Island. This allowed New York City to import more power from upstate New York (a greater percentage of which is generated from cleaner sources, in particular hydropower), as this upstate power was no longer committed for delivery to Long Island. This change is responsible for a 1.6 percent reduction in citywide CO_2e from 2007-2008, or approximately 0.86 MMT.

Weather has a significant effect on energy consumption, and its impact varies each year. From 2005 to 2008, average cooler summers and warmer winters combined to reduce CO_2e emissions by 4.5 percent, where from 2007 to 2008 a cooler summer and warmer winter resulted in a 1.5 percent CO_2e reduction. Changes in heating degree days (HDD) and cooling degree days (CDD), which reflect the demand for energy required to heat or cool a home, business, institution, or industrial facility, are reported in the Appendix.

Municipal operations inventory results

New York City's municipal government provides essential services to residents, commuters, and visitors, consuming significant amounts of energy while doing so. From fiscal year 2006 to 2008, municipal emissions increased by 2.1 percent from 3.69 to 3.76 $MMTCO_2e$. This increase is due primarily to an increase in electricity and building heating fuel consumption, an increase in gasoline consumption by the City's vehicle fleet, and an increase in fugitive methane emissions from wastewater treatment plants, as some methane flare equipment is currently under repair. Reduced carbon intensity of the city's power supply, reductions in transportation emissions, and milder weather all helped to mitigate this increase.

Municipal GHG emissions were reduced significantly from fiscal year 2007 to 2008, decreasing 2.6 percent from 3.86 to 3.76 $MMTCO_2e$, as the percentage of cleaner imported electricity increased citywide, thereby reducing the city's electricity emissions coefficient. Reductions in electricity and heating fuel consumption, fugitive methane leaks from wastewater treatment plants and landfills, and transportation emissions all contributed to this decrease. Figure 9 and Table 4 summarize the changes in municipal operations from 2007 to 2008.

Updates and Revisions

Base and interim year results were revised due to protocol changes, revised methodology, and improved data availability

The techniques and methods for calculating municipal GHG emissions are continually evolving, as new protocols are adopted, methodologies are developed, and improved data become available. Accordingly, and as recommended by the LGOP, the City has revised its citywide 2005 and municipal fiscal year 2006 base year and interim year GHG emissions levels to reflect changes since the *Inventory of New York City Greenhouse Gas Emissions* reporting citywide 2007 and municipal fiscal year 2006 emissions was published.

Protocol changes

Per the LGOP, this report characterizes direct and indirect GHG emissions into three scopes for both citywide and municipal inventories, following the WRI/WBCSD's *Greenhouse Gas Protocol*. Categorizing GHG emissions into scopes allows for separate accounting of direct and indirect emissions and improves transparency, while reporting Scope 3 emissions provides important information on emissions not considered to contribute to a reporting entity's total emissions level. The scope categories are as follows:

Scope 1: All direct GHG emissions (with the exception of direct CO_2 from biomass combustion), e.g. emissions from stationary combustion of fuel (other than for the generation of grid electricity or steam), mobile combustion of fuels from transportation sources, process emissions (from physical or chemical processing), and fugitive emissions (e.g. HFCs from mobile source refrigeration, CH_4 from landfills or wastewater treatment, N_2O from wastewater treatment, and SF_6 from electricity distribution).

Scope 2: Indirect GHG emissions associated with the consumption of purchased or acquired electricity, steam, heating, or cooling. Indirect emissions are a consequence of energy consumption that takes place within a reporting entity's boundaries but occur at sources owned or controlled by another entity. Scope 2 emissions from electricity and steam generation occur at the facility where the electricity or steam is generated, which may be within or outside of New York City's boundaries.

Scope 3: All indirect emissions not covered in Scope 2, such as upstream and downstream emissions, emissions resulting from the extraction and production of purchased materials and fuels, transport-related activities in vehicles not owned or controlled by the reporting entity (e.g. employee commuting and business travel), outsourced activities, waste disposal, etc.[6] Scope 3 emissions are not counted toward a reporting entity's total. Scope 3 sources reported in this inventory include CO2 emissions from biogenic sources, including biodiesel and ethanol, fugitive CH4 emissions from exported solid waste, and aviation emissions from New York City airports.

The LGOP also requires the reporting of emissions from all six greenhouse gases regulated under the Kyoto Protocol—carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). In compliance with this requirement, this report presents emissions of each gas separately and as one aggregated "roll-up" figure for both the citywide and municipal inventory.

Revised methodology

The City is continuously working to improve the accuracy of its GHG emissions reporting. To ensure the most accurate and detailed GHG inventory possible, several methodologies were revised from those used in the first inventory update, following the guidance of the LGOP.

Fuel emissions coefficient and fuel economy

The principal methodology revision to past inventories was to emission coefficients and fuel economy estimates used to calculate GHG emissions. An emissions coefficient is the factor used to calculate the mass of CO_2e generated through either the combustion of fossil fuels or the decomposition of organic matter in wastewater treatment or solid waste management facilities. Developing and applying accurate emissions coefficients is critical to ensure the most accurate GHG emissions reporting possible. In past years' inventories, the City had relied on ICLEI's 2003 release of the Clean Air and Climate Protection Software (CACPS 2003) to

Table 5: Summary of Changes to Emissions Coefficients

ENERGY SOURCE	UNIT	COEFFICIENT USED FOR INVENTORY FOR 2007 (LBS CO_2e/UNIT)	FUEL ECONOMY USED FOR INVENTORY FOR 2007 (MILES PER UNIT)	REVISED COEFFICIENT	REVISED FUEL ECONOMY	% CHANGE IN COEFFICIENT	% CHANGE IN FUEL ECONOMY
Stationary source							
Natural gas	therm	12.36		11.73		-5.1%	
Distillate fuel oil	gallon	23.14		22.49		-2.8%	
Residual fuel oil	gallon	27.67		26.08		-5.7%	
Propane	gallon	13.51		12.74		-5.7%	
Kerosene	gallon	23.62		21.65		-8.4%	
Electricity	MWh	985.02		774.72		-21.3%	
Steam	Mlb	166.66		158.38		-5.0%	
Mobile source							
Diesel - heavy trucks and buses	gallon	21.17	5.48	22.40	6.30	5.8%	14.9%
Gasoline - passenger cars	gallon	21.47	17.60	19.83	19.14	-7.6%	8.8%
Gasoline - light trucks	gallon	21.40	13.87	19.85	13.92	-7.2%	0.4%
CNG - bus	gallon	12.67	5.52	11.70	5.58	-7.7%	1.1%
Jet fuel	gallon	21.10		21.32		1.1%	
Ships and boats - diesel fuel	gallon	21.16		22.59		6.7%	
Locomotives - diesel fuel	gallon	21.47		22.59		5.2%	

provide all emissions coefficients and vehicle fuel economy estimates, except for emissions coefficients for electricity and steam, which the City developed. Following the guidance of the LGOP, this year all emissions coefficients except for electricity and steam are taken from the LGOP, while vehicle fuel economy estimates are used from ICLEI's 2009 release of the Clean Air and Climate Protection Software (CACPS 2009). Additionally, in past years, the City relied on CACPS 2003 to organize all data and calculate emissions. To allow for greater ease of data organization and reporting, the City elected to complete all data organization, analysis, and emissions calculations using Microsoft Excel. Changes to coefficients are detailed in Table 5.

Electricity emissions coefficient

As in past years, the City has chosen to develop its own custom electricity emissions coefficient, rather than using the U.S. Environmental Protection Agency's (EPA) eGRID coefficient as recommended by the LGOP. The City does this for several reasons. The eGRID coefficient is regionally based, and is based on all Westchester County and New York City electricity generation. The eGRID coefficient is based on data that are several years old—the most recent eGRID coefficient is based on 2005 generation data—this does not allow the City to measure the impact of changes to the power supply that occurred during the year of analysis. Also, the eGRID coefficient does not include imported power—New York City imports a significant volume of electricity from upstate New York, the amount of which increased in 2008, resulting in an increase in imported electricity generated by cleaner sources.

The City used power plant data from EPA's Continuous Emissions Monitoring System (CEMS) database and the U.S. Energy Information Administration's (EIA) EIA-923 database (previously titled EIA-906) to calculate the CO_2e emissions coefficient from electricity. Data from these sources were acquired from a data warehouse (Ventyx, Velocity Suite) and were organized to develop specific emissions coefficients for each plant in the New York Independent System Operator's (NYISO) territory. From these data, New York City's electricity emissions coefficients were calculated by taking the following steps:

1. All electricity generated within New York City (NYISO Zone J) and all electricity imported to New York City through bilateral contracts between power generators and the New York Power Authority (NYPA) and Consolidated Edison of New York (ConEd) was added to determine the known quantity of consumption generated by these sources.

2. Emissions coefficients for both in-city generation and bilateral contracts were developed for CO_2, CH_4, N_2O, and CO_2e based on each plant's heat rate (efficiency) and primary fuel used for generation.

3. Imported electricity volume was calculated by subtracting the combined in-city generation plus bilateral contracts' generation from New York City's required energy, as listed in NYISO's *2009 Load & Capacity Data "Gold Book."*[7]

4. Energy use attributed to steam generation at in-city cogeneration plants was deducted from the energy input used to calculate each plant's emissions coefficients, using ConEd's steam system data, to avoid double counting emissions resulting from this generation.

5. The emissions coefficient for imported power was calculated by assigning 600 megawatts (MW) from NYISO Zones A and D and 42 MW of upstate hydropower to New York City per NYPA agreement, with the balance of imported power assumed to be generated in NYISO Zones G, H, and I, as recommended by NYPA.

6. Emissions coefficients for imported power were developed for CO_2, CH_4, N_2O, and CO_2e based on the heat rate of each plant in each zone from which imported power was being generated to develop a single coefficient for each of NYISO Zone A and D, and for NYISO Zone G, H, and I combined.

7. A weighted average coefficient was developed for each GHG, based on the generation of the supplying sector.

8. A transmission and distribution loss factor, calculated by subtracting ConEd and the Long Island Power Authority's (LIPA) reported delivered electricity deliveries from the NYISO energy requirement, was applied to each coefficient. The electricity coefficient is presented in detail in the Appendix.

The LGOP does allow municipalities to use a utility-specific electricity coefficient, so long as that coefficient has been verified by a third party to the standard of the California Climate Action Registry (CCAR) Power/Utility Protocol. At the time of this report's publication, CCAR is transitioning the responsibility of developing the Power/Utility Protocol to The Climate Registry (TCR), which will assume the responsibility for developing standards for third-party verification of electricity emissions coefficients. While New York City's electricity emissions coefficient has not been officially verified, the methodology has been reviewed and endorsed by the EPA, ConEd, and NYPA. As such, the City encourages all entities in New York City, public and private, to use this coefficient in completing their own GHG inventories. Revised electricity emissions coefficients were applied to past years' inventories and used for this inventory.

Steam emissions coefficient

As in past inventories, the City developed its own steam emissions coefficient in cooperation with ConEd. An increase in the percentage of steam generated by co-generation resulted in a decrease in the amount of energy required to generate each unit of steam (measured in units of a thousand pounds, or Mlbs). The revised steam coefficient is applied to citywide and municipal 2008 inventories. The steam emissions coefficient is presented in detail in the Appendix.

Fuel oil consumption calculation for citywide inventory

In both the first inventory and the first annual update, the City used estimated fuel oil data published by the New York State Energy and Research Development Authority (NYSERDA) in the *Petroleum Infrastructure Study* (2006) to calculate GHG emissions from citywide fuel oil use.[8] For this report, the City has used a different methodology to more accurately estimate fuel oil use. The New York City Department of Environmental Protection (DEP) maintains a database of all permits for fuel oil boilers with capacity equal to or greater than 350,000 British Thermal Units (BTU) per hour. These data were processed using the City's property database to determine the building square footage each fuel oil boiler was responsible for heating. The average number of gallons of oil required to heat a square foot of building space was obtained from the City's *City Environmental Quality Review (CEQR) Technical Manual*, which estimates that residential space in New York requires 0.38 gallons per square foot of #2 oil and 0.36 gallons per square foot of #4 and #6 oil for heat per year, while commercial space requires 0.36 gallons of #2 oil per square foot and 0.34 gallons of #4 and #6 oil per square foot for heat per year.[9] As DEP's database only includes boilers with a capacity equal to or greater than 350,000 Btu/hour, #2 fuel oil used in smaller boilers was estimated using the U.S. Census Bureau's *2008 New York City Housing and Vacancy Survey*, which estimates that 29 percent of residences using fuel oil for heat are in buildings consisting of less than 15 units, the threshold below which boilers are assumed by industry experts advising the City to have a capacity of less than 350,000 Btu/hour[10]. Therefore, to ensure the most accurate estimate of fuel use possible, this additional percentage was added to DEP's reported #2 fuel oil consumption. Estimated fuel oil use was then classified by fuel oil type and building class. 2008 estimated fuel oil consumption was used to estimate past years' consumption based on changes in heating degree days.[11]

Building and vehicle fuel calculation for municipal inventory

In the first inventory, the City relied on data reported to the City's Office of Management and Budget (OMB) by City agencies for budget development purposes to calculate GHG emissions from building heating oil and vehicle fuel use. The inventory for 2007 emissions relied on a detailed agency survey to compile building fuel oil and vehicle fuel use. Upon review, both methods revealed the potential for inaccurate reporting of fuel consumption data—accordingly, the City used a different methodology for this report. For this report, with the exception of fuel oil purchased by the City's Department of Environmental Protection (DEP), all building fuel oil data were compiled from data maintained by the City's Department of Citywide Administrative Services (DCAS), which maintains records of fuel delivered to City agencies. Data for bulk vehicle fuel delivered to agencies that maintain fueling facilities were similarly compiled. Except for DEP vehicle fuel use data, DCAS also provided data for vehicle fuel purchased for use in City vehicles at private fueling stations using the City's GasCard.[12] Data for fuel consumption for past years were applied to previous inventories to adjust fuel consumption estimates.

The LGOP requires that the City report emissions from water supply and wastewater treatment as separate sectors. However, DEP fuel use data from DCAS were not differentiated between DEP's Bureaus of Water Supply, Water Treatment, and Water and Sewer Operations. Therefore, DEP bulk fuel oil and vehicle fuel purchase data were obtained directly from DEP, thus ensuring the appropriate breakdown and compliance with the protocol. While assumed to provide a more comprehensive approach, it is important to note that this methodology does not completely eliminate the potential for inaccurate reporting of fuel use. In part, bulk fuel delivery data only indicate where and when fuel is delivered, and does not specify when such fuel is combusted. Efforts are underway to develop a comprehensive fuel tracking system for both vehicle and building fuel, ensuring that future GHG inventories will have access

to increasingly improved fuel data quality. In addition, tracking improvements are underway to streamline the documentation of fuel types and their end uses. This will aid in the appropriate allocation of fuel used for space heating, engines, pumps, generators, and vehicles, and help to direct future policy decisions regarding fuel consumption and efficiency upgrades.

Biodiesel
The City uses some biodiesel in both vehicles and as building heating fuel. Consumption of fuel containing various percentages of biodiesel was reported by DCAS. As CO_2 from biodiesel is considered to be biogenic, the biodiesel portion of each fuel was separated out and reported as a Scope 3 emission source.

Ethanol Content in Gasoline
The LGOP requires that greenhouse gas emissions from biogenic sources be classified as Scope 3 emissions. CO_2 emissions from ethanol are considered biogenic and are therefore counted separately from gasoline, which is a Scope 1 direct emissions source. The State of New York requires that all gasoline contain up to 10 percent ethanol, though the actual percentage varies from about 4 percent to 13 percent.[13] The City obtained inspection records from the New York State Department of Agriculture and Markets for gas stations throughout New York State. The average ethanol content was applied to both citywide and municipal gasoline consumption data for each year of analysis, thereby allowing for the differentiation of Scope 1 and Scope 3 emissions.

New data sources

As the City's inventory methodology improves, the City is able to include additional or increasingly accurate emissions data sources. This report includes four new categories of fugitive emissions—N_2O from wastewater treatment (reported in both municipal and citywide inventories), CH_4 from citywide natural gas distribution, HFCs used as refrigerants in the municipal vehicle fleet, and SF_6 from insulators that are part of the city's electricity generation system. Each of these sources were also applied to past years' base year and interim year inventories to ensure comparability. While the LGOP specifies the inclusion of fugitive HFCs from municipal buildings' cooling, refrigeration, and fire suppression systems, lack of data availability prevented the inclusion of these emission sources. These sources will be included in future inventories as data allow, ensuring the reporting of an increasingly accurate GHG emissions profile. Fugitive HFCs from citywide mobile and building cooling and refrigeration systems and building fire suppression equipment were also not included due to both lack of data availability and the absence of a citywide protocol specifying proper accounting of these sources.

N_2O is emitted as a result of wastewater treatment processes and as fugitive emissions from discharged effluent at the City's 14 wastewater treatment plants operated by DEP. N_2O emissions calculations are based on the populations served and the amount of nitrogen discharged by the wastewater treatment plants.

Due to some leakage at delivery points and some theft of service, natural gas distribution involves "unaccounted for gas," the amount of which depends on the delivery area and the distributor. Con Edison and National Grid, the city's natural gas distributors, provided average percentages of distribution losses for their respective natural gas distribution systems for each year of analysis, which were applied to citywide natural gas consumption data to estimate fugitive CH_4 emissions from this source.

Air conditioners and refrigeration systems in City vehicles are a source of fugitive refrigerant emissions from the leakage of HFCs, refrigerants used in City vehicles. Although the total annual refrigerant emissions is relatively small, due to HFCs' high global warming potential, municipal fleet air conditioning and refrigeration systems are a significant emissions source that warrants inclusion in the citywide and municipal inventories.

Sulfur hexafluoride (SF_6) is used to insulate electricity transmission and distribution equipment. Because of its high global warming potential, even small amounts of fugitive SF_6 contribute significantly to CO_2e levels. Con Edison has reduced its SF_6 emissions by 84 percent from 1996-2008 through equipment repair and replacement efforts, resulting in significant reductions in CO_2e emissions from this source.

Citywide Results

Citywide carbon emissions were 3.5 percent lower in 2008 than 2007 due to weather, cleaner electricity, and improvements in New York City's energy efficiency.

Citywide inventory methodology

To accurately and consistently assess and report a city's GHG emissions, a clear scope of analysis and boundaries specifying which sources are included in such an assessment is essential. Following standard international convention for the completion of citywide GHG inventories, the citywide inventory consists of all direct and indirect emissions from energy used by buildings, streetlights and traffic signals, on-road transportation, and public transit (excluding aviation and marine transportation) within New York City, and fugitive emissions from wastewater treatment, solid waste management, and electricity and natural gas distribution within New York City.

2008 citywide GHG emissions were calculated using data from multiple sources. Data on consumption of citywide electricity and steam, and natural gas in the Bronx and Manhattan were provided by ConEd from customer billing data. National Grid reported natural gas consumption data for Brooklyn, Queens, and Staten Island from customer billing data. The Long Island Power Authority (LIPA) reported electricity consumption data for the Rockaways area of Queens. Fuel oil use was estimated using DEP fuel oil boiler permit data, merged with the City property database to estimate the amount of fuel oil burned per square foot of building floor area. On-road transportation vehicle-miles-traveled data were provided by the New York Metropolitan Transportation Council (NYMTC), based on modeling results from the Best Practices Model (BPM) that were post-processed using PPSuite (proprietary software), which incorporates inputs used for air-quality conformity modeling. Energy consumption data for public transit were provided by the Metropolitan Transportation Authority (MTA) for New York City Transit (NYCT) subways and buses, MTA Metro-North Rail Road (MNR) and Long Island Railroad (LIRR) commuter rail, and MTA Bus Company buses; by the Port Authority of New York and New Jersey (PANYNJ) for Trans-Hudson (PATH) commuter rail; and New Jersey Transit (NJT) for its commuter rail and buses. Energy consumption used to calculate GHG emissions included all electricity used for traction and non-traction power (station lighting, etc.) for NYCT subways and MNR, LIRR, PATH, and NJT commuter rail operated within New York City; all diesel, B5 biodiesel, and compressed natural gas for NYCT, MTA Bus Company, and NJT buses; and diesel fuel consumed within NYC's borders for MNR, LIRR, NJT, and PATH commuter trains.

Data used to calculate fugitive and process CH_4 and process and fugitive N_2O from wastewater treatment were provided by DEP. CH_4 emissions are calculated based on the destruction of volatile material in anaerobic digesters. Based on the measured concentration and flow of volatile organic solids, it is estimated that 15 cubic feet of digester gas are produced for every pound of volatile organic solids destroyed. N_2O emissions are calculated by applying the population served by the wastewater treatment system to the formula in the LGOP.

Fugitive CH_4 from landfills was calculated by applying landfill gas collection data provided by DSNY to a formula specified in the LGOP. Fugitive CH_4 from natural gas distribution was calculated using volumes of "unaccounted for gas" provided by National Grid and ConEd. Fugitive SF_6 from electricity distribution was calculated by data provided by ConEd.

All DSNY-managed municipal solid waste (residential and institutional solid waste) generated in New York City is exported to landfills or waste-to-energy facilities outside of the city by private contractor under contract to the City. Fuel consumed by trains and trucks exporting solid waste out of the city is calculated using data provided by DSNY detailing the mass of waste transported, mode of transport, and distance to disposal facility by applying U.S. Department of Transportation factors that assume one gallon of diesel fuel moves one (short) ton of solid waste 59 miles by truck and 202 miles by rail.[14]

Table 6: New York City Citywide Greenhouse Gas Emissions

SECTOR AND EMISSIONS SOURCE	METRIC TONS CO_2e				% CHANGE 2007-2008	% CHANGE 2005-2008
	2005	2006	2007	2008		
Buildings						
Distillate fuel oil	5,231,879	4,446,637	5,202,406	5,089,777	-2.2%	-2.7%
Electricity	20,578,828	17,981,534	18,109,575	17,067,006	-5.8%	-17.1%
Residual fuel oil	2,778,633	2,361,594	2,762,980	2,703,163	-2.2%	-2.7%
Natural gas	13,043,606	12,561,697	13,674,652	13,645,106	-0.2%	4.6%
Steam	2,305,206	1,871,536	1,949,577	1,712,267	-12.2%	-25.7%
Transportation						
CNG - bus	12,529	77,435	77,435	80,277	3.7%	540.7%
Diesel - bus	673,520	641,106	640,847	691,869	8.0%	2.7%
Diesel - commuter rail	14,096	14,210	14,347	14,436	0.6%	2.4%
Diesel - heavy trucks	1,098,107	1,098,834	1,098,396	1,102,873	0.4%	0.4%
Diesel - solid waste export, rail	58,394	67,619	72,683	77,846	7.1%	33.3%
Diesel - solid waste export, truck	193,499	179,662	158,170	104,193	-34.1%	-46.2%
Electricity - subways and commuter rail	1,161,582	998,525	1,006,077	1,011,308	0.5%	-12.9%
Gasoline - light trucks	928,308	929,117	921,909	924,082	0.2%	-0.5%
Gasoline - passenger cars	7,987,542	7,919,145	7,868,909	7,834,365	-0.4%	-1.9%
Streetlights and traffic signals						
Electricity	135,764	118,861	115,361	109,844	-4.8%	-19.1%
Fugitive and process emissions						
CH_4 - landfills	128,700	125,330	113,506	109,703	-3.4%	-14.8%
CH_4 - natural gas distribution	69,483	66,916	72,844	72,717	-0.2%	4.7%
CH_4 - wastewater treatment plants	89,148	148,455	259,103	261,642	1.0%	193.5%
HFCs - municipal fleet	12,622	11,200	11,378	11,580	1.8%	-8.3%
N_2O - wastewater treatment process	64,649	64,649	64,649	64,649	0.0%	0.0%
SF_6 - electricity distribution	2,037,561	1,486,813	1,046,696	644,565	-38.4%	-68.4%
Total Scope 1	**34,422,276**	**32,334,590**	**34,060,910**	**33,432,845**	**-1.8%**	**-2.9%**
Total Scope 2	**24,181,381**	**20,970,456**	**21,180,590**	**19,900,425**	**-6.0%**	**-17.7%**
TOTAL Scope 1 and 2	**58,603,657**	**53,166,183**	**55,241,501**	**53,333,269**	**-3.5%**	**-9.0%**
Scope 3						
Biogenic CO_2 from fuel	643,552	622,959	605,447	591,529	-2.3%	-8.1%
Exported solid waste methane	2,699,120	2,702,362	2,691,282	2,687,027	-0.2%	-0.5%
Aviation emissions	14,345,894	14,146,259	15,733,804	14,343,938	-8.8%	-0.0%
TOTAL Scope 3	**17,688,566**	**17,471,580**	**19,030,533**	**17,622,494**	**-7.4%**	**-0.4%**

Fugitive emissions of HFCs from municipal fleet cooling and refrigeration systems were calculated from data provided by DCAS, which provided the number of regular vehicles and refrigeration vehicles in operation in the municipal vehicle fleet, as well as the type of refrigerant used by each system. The City estimated fugitive refrigerant emissions by applying a default operating emissions factor provided by the LGOP. Municipal fleet vehicles use HFC-134a in cooling systems, while refrigeration vehicles use a refrigerant blend, R404A.

Scope 3 aviation emissions were calculated using fuel consumption data from the PANYNJ. Aviation GHG emissions were calculated by applying the emissions coefficients in the LGOP to the total volume of jet fuel and aviation gasoline loaded onto airplanes at LaGuardia and John F. Kennedy airports. Scope 3 fugitive emissions generated from the decomposition of solid waste exported out of the city were calculated using waste disposal data from DSNY.

GHG emissions were calculated from all data acquired as described using emissions coefficients in the LGOP. Fuel economy estimates for on-road vehicle were obtained from CACPS 2009. All emissions coefficients and fuel economy figures are reported in the Appendix.

Citywide inventory results

In 2008 total GHG emissions in New York City were 53.3 MMTCO2e, 9.0 percent below 2005 base year emissions of 58.6 $MMTCO_2e$. 2008 GHG emissions are broken down as follows:

- Scope 1 GHG emissions: 33,432,845 $MTCO_2e$
- Scope 2 GHG emissions: 19,900,425 $MTCO_2e$
- Scope 3 GHG emissions (reported for information only): 17,622,494 $MTCO_2e$

2008 citywide GHG emissions were 3.5 percent below the 2007 level of 55.2 $MMTCO_2e$. This significant annual reduction—a greater percentage reduction than from 2005 to 2007—ensures that New York City is on track toward achieving the 30 percent GHG reduction mandated by Local Law 22 of 2008. While reporting overall GHG emissions levels indicates progress the City is making toward achieving this requirement, understanding the drivers of these changes is critical to ensuring the most efficient development and implementation of policies necessary to keep the City on track to fulfilling this mandate.

Figure 10: 2008 Citywide CO_2e Emissions by Sector

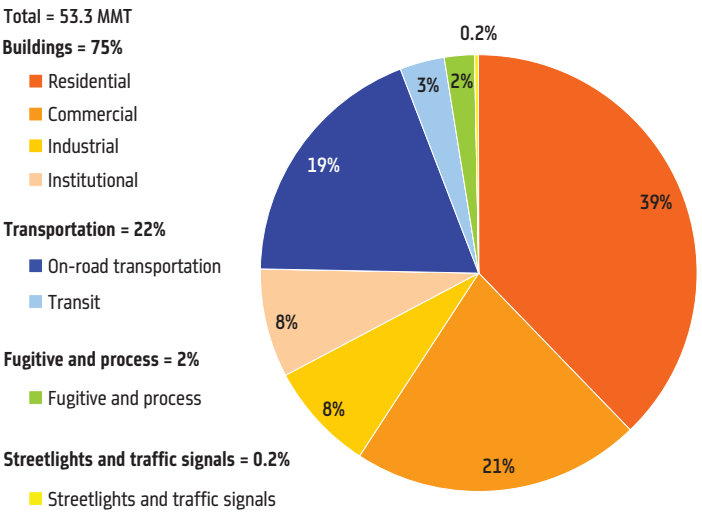
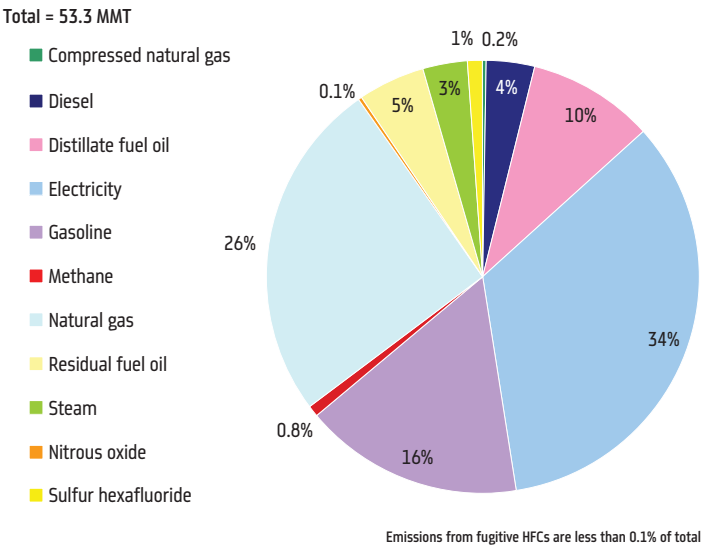


Figure 11: 2008 Citywide CO_2e Emissions by Source



Emissions from fugitive HFCs are less than 0.1% of total

Figure 12: 2005 to 2008 Citywide CO_2e Emissions by Sector

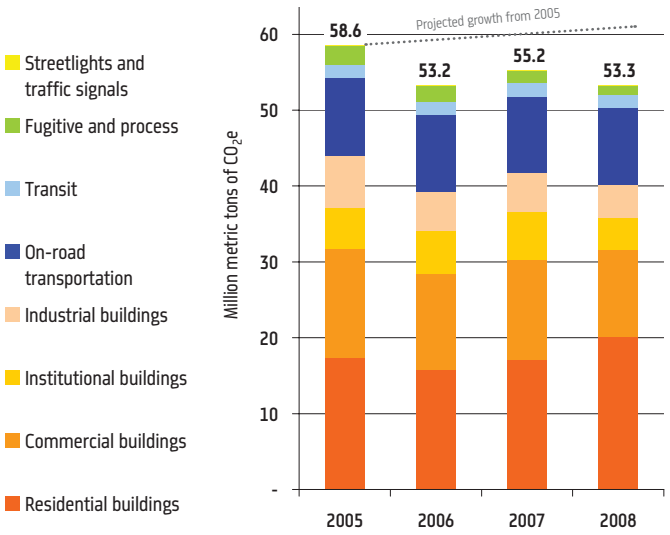
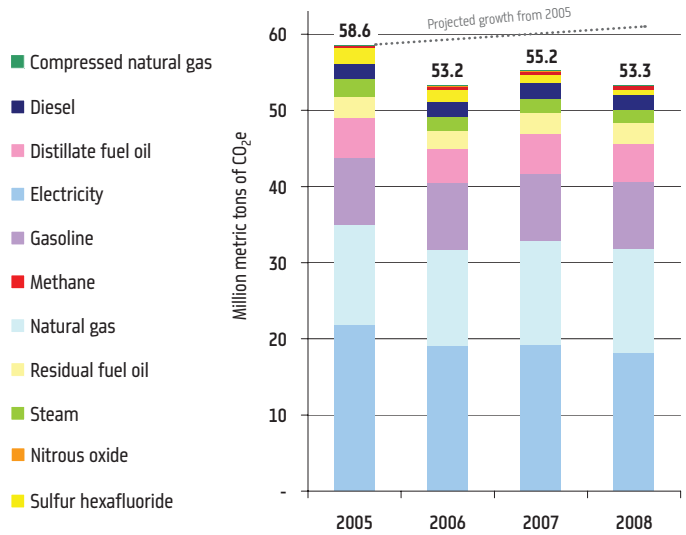


Figure 13: 2005 to 2008 Citywide CO_2e Emissions by Source



Emissions from fugitive HFCs are less than 0.1% of total

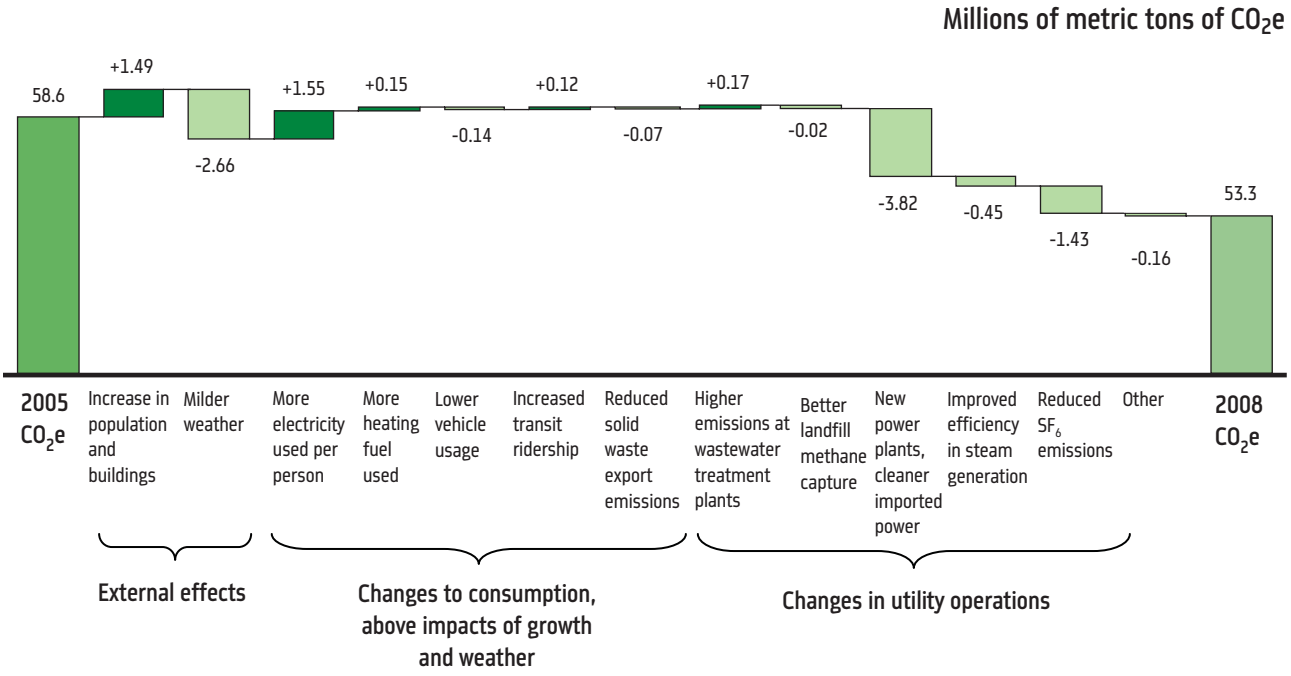
Changes to citywide emissions

To fully understand causes of changes in New York City GHG emissions, the City analyzed all externalities that might influence these changes, such as weather, population growth, increase in building floor area, and changes to the city's electricity supply. From these data, the City was then able to determine drivers that could be influenced by policy changes, such as per capita energy or transit consumption. To calculate the impact of these drivers, the City first compared the changes in CO_2e emissions and consumption of each energy source from each sector. The percentage of population change was applied to all non-building emission sources, while the percentage change in building floor area was applied to building emissions sources to determine the collective net impact these drivers had on GHG emissions. To determine the impact of energy consumption beyond that driven by changes in weather, the City conducted regression analyses for each building energy source, using monthly energy consumption data and heating degree and cooling degree data to determine the correlation of weather to building energy use. This factor was then applied to the change in heating and cooling degree days to determine the extent to which weather impacted energy consumption. The results of regression analyses for electricity, natural gas, steam, and fuel oil are shown in the Appendix.

Per capita trends were determined by subtracting the percentage of overall population change and the weather impact factor from the change in consumption for each energy source in each sector. The impact of revisions to various coefficients was determined by calculating the change in carbon intensity for each energy source in each sector, and multiplying this factor times the percentage that each energy source in each sector contributed to the inventory total.

Figure 14: 2005 to 2008 Changes in New York City's Citywide Greenhouse Gas Footprint

New York City's citywide carbon footprint declined 9.0 percent between 2005 and 2008, due to more efficient power plants, cleaner imported electricity, milder weather, and reduced sulfur hexafluoride emissions offsetting increased energy consumption



Changes from 2005 to 2008

When all factors influencing the change in New York City's citywide GHG emissions from 2005 to 2008 are analyzed, milder weather, changes to the City's electricity coefficient, and a reduction in fugitive SF_6 from electricity distribution are most responsible for reducing the city's GHG emissions 9.0 percent. These reductions were tempered by increases in per capita energy consumption and growth in population and building floor area. When externalities of weather, growth, and power supply carbon intensity are excluded, overall GHG emissions rise slightly during this period, increasing by 0.6 percent. Details of these changes are presented in Figure 14 and Table 7.

Changes from 2007 to 2008

Citywide GHG emissions decreased by 3.5 percent from 2007 to 2008, driven by milder weather (cooler summer and warmer winter), an increase in importation of cleaner electricity, and a decrease in fugitive SF_6 emissions from electricity distribution. These three major reductions were most tempered by growth in population and building floor area. When weather, growth, and changes to the carbon intensity of the electricity supply are excluded, citywide carbon emissions decreased 1.3 percent. Perhaps the most significant change is seen in reductions in per capita electricity and heating fuel use, showing that New York City as a whole is becoming more energy efficient. Details of these changes are presented in Figure 8 and Table 3 .

Table 7: 2005 to 2008 Changes in Citywide CO_2e Emissions

	METRIC TONS CO_2e	% OF 2005 CO_2e
2005 citywide CO_2e	58,603,657	
Reasons for change		
Growth	1,488,039	2.54%
Milder weather in 2008 than 2005	-2,661,958	-4.54%
Per capita electricity consumption (e.g., electronics)	1,554,300	2.65%
Per capita natural gas/heating oil consumption	154,329	0.26%
Per capita VMT	-137,689	-0.23%
Per capita transit consumption	117,747	0.20%
Per capita solid waste export	-74,614	-0.13%
Increase in wastewater treatment plant methane	170,867	0.29%
Improved landfill methane capture	-21,345	-0.04%
New, more efficient electricity generation; increase in importation of cleaner power	-3,817,434	-6.51%
Improved efficiency in steam generation	-453,055	-0.77%
Reduced fugitive SF_6 from electricity distribution	-1,430,174	-2.44%
Other	-159,400	-0.27%
2008 citywide CO_2e total	53,333,269	-8.99%

Table 8: 2008 Citywide Emissions by Scope and GHG

SCOPE	GREENHOUSE GAS (METRIC TONS)					
	CO_2	CH_4	N_2O	HFCs	SF_6	CO_2e
Scope 1	31,972,174	24,170	958	9	27	33,432,845
Scope 2	19,857,087	397	113			19,900,425
Scopes 1 and 2	51,829,261	24,568	1,071	9	27	53,333,269

Municipal Results

New York's municipal emissions were 2.6 percent lower in fiscal year 2008 due to cleaner electricity, reduced energy consumption, and lower methane and solid waste emissions

Municipal inventory methodology

For both fiscal and calendar year 2008, the City followed the LGOP's guidance in measuring GHG emissions based on operational control, measuring emissions from operations, facilities, or sources wholly owned by the City government or over which the City has full authority to introduce and implement operational and health, safety, and environmental policies (including both GHG- and non-GHG-related policies).[15] Emissions from leased vehicles and facilities were also included. The operation of New York City's government, which ensures the provision of services to the city's residents, commuters, and visitors, requires a substantial amount of energy. In fiscal year 2008, the majority of emissions, 77 percent, resulted from the operation of municipal buildings, facilities, and the municipal vehicle fleet. Other significant sources of greenhouse gases resulting from City operations include streetlights and traffic signals, landfills, the water supply system, wastewater treatment facilities, and the exportation of solid waste.

All data used to calculate municipal GHG emissions were acquired from City agencies. Metered data provided by utilities is maintained by DCAS, which provided comprehensive electricity, natural gas, and steam consumption data for the City's buildings, facilities, and streetlights. Building and facility fuel oil use data were provided by DCAS from inspection records of bulk fuel deliveries, and by DEP for wastewater treatment and supply fuel oil. Vehicle fuel use data were provided by DCAS and DEP and included data from bulk vehicle fuel inspection records, bulk delivery records from the City's fuel vendors, and data detailing fuel purchased using the City's GasCard. Calculation of GHG emissions from both building and vehicle bulk fuel considers fuel volume delivered as an estimate of fuel volume consumed.

Data used to calculate fugitive and process emissions were provided by several agencies: data used to calculate fugitive and process CH_4 and N_2O emissions from wastewater treatment were provided by DEP; fugitive CH_4 from the City's landfills was calculated from data provided by DEP and DSNY; fugitive HFCs from municipal vehicle fleet cooling and refrigeration systems were calculated from data provided by DCAS; and emissions from the long-haul export of solid waste were calculated from data provided by DSNY. All calculations were made as described in the citywide inventory methodology section.

As required by the LGOP, the municipal inventory also reports emissions associated with employee commuting as a required Scope 3 source. Employee commuting emissions were estimated using the U.S. Census Bureau's Public-Use Microdata Sample data set, which indicated the means of transportation to work for City employees.[16] For passenger car trips, distance traveled to work was estimated using employees' reported time of commute, applying an average road network speed of 15 miles per hour. The resultant VMT was used to calculate CO_2e. Subway and bus emissions were estimated using MTA NYCT ridership statistics and total CO_2e emissions from these sources to develop an average per person share of CO_2e. This per person share was applied to the total number of work trips for City employees, calculated by multiplying the number of employees times twice the number of work days per year (238).

Emissions from the decomposition of solid waste generated by City employees are also considered a Scope 3 source. These emissions were calculated by multiplying the number of employees times the amount of solid waste estimated to be generated by each employee annually, as calculated by DSNY. The composition of waste generated by office workers was determined from DSNY's *Waste Characterization Study*, while the composition of waste generated by uniformed employees was taken from CACPS 2009.

Table 9: New York City Municipal Greenhouse Gas Emissions

SECTOR AND EMISSIONS SOURCE	METRIC TONS CO_2e				% CHANGE FY 2007 - 2008	% CHANGE FY 2006 - 2008
	FY 2006	FY 2007	FY 2008	CY 2008		
Buildings						
Distillate fuel oil	229,652	244,680	225,172	227,539	-8.0%	-2.0%
Electricity	1,169,578	1,197,197	1,159,955	1,160,970	-3.1%	-0.8%
Natural gas	552,029	575,436	572,257	545,844	-0.6%	3.7%
Residual fuel oil	241,050	222,553	242,533	244,451	9.0%	0.6%
Steam	132,238	142,249	136,563	133,984	-4.0%	3.3%
Streetlights and traffic signals						
Electricity	116,008	112,501	107,125	107,366	-4.8%	-7.7%
Wastewater treatment						
Distillate fuel oil	45,382	50,209	49,655	45,822	-1.1%	9.4%
Electricity	222,696	221,328	211,416	213,375	-4.5%	-5.1%
Methane	148,455	260,372	248,903	261,642	-4.4%	67.7%
Natural gas	19,560	30,094	39,046	38,038	29.7%	99.6%
Nitrous oxide	64,649	64,649	64,649	64,649	0.0%	0.0%
Propane	-	3	5	3	69.9%	100.0%
Steam	206	247	361	355	46.4%	75.4%
Water supply						
Distillate fuel oil	1,422	1,573	2,340	1,992	48.7%	64.5%
Electricity	23,536	24,072	24,012	23,476	-0.2%	2.0%
Kerosene	-	156	208	239	33.7%	100.0%
Natural gas	2,672	2,712	3,444	3,797	27.0%	28.9%
Propane	6,241	6,774	7,528	6,812	11.1%	20.6%
Steam	271	291	318	305	9.3%	17.2%
Transportation						
Diesel and biodiesel - trucks	154,513	156,749	152,440	164,048	-2.7%	-1.3%
Diesel - marine vessels	43,290	44,141	44,880	43,364	1.7%	3.7%
Diesel - solid waste export, rail	62,729	72,509	72,162	77,846	-0.5%	15.0%
Diesel - solid waste export, truck	186,765	172,744	143,822	104,193	-16.7%	-23.0%
Ethanol (E85)	166	111	147	159	31.7%	-11.9%
Gasoline	123,889	126,862	129,240	124,716	1.9%	4.3%
Jet fuel	2,197	2,533	2,256	2,209	-10.9%	2.7%
Solid waste facilities						
Methane	127,148	119,452	111,755	109,703	-6.4%	-12.1%
Other fugitive and process emissions						
HFCs from municipal vehicle fleet	11,370	11,563	11,685	11,580	1.1%	2.8%
Total Scope 1	**2,023,180**	**2,165,874**	**2,124,124**	**2,071,201**	**-1.9%**	**5.0%**
Total Scope 2	**1,664,533**	**1,697,884**	**1,639,750**	**1,679,120**	**-3.4%**	**-1.5%**
Total Scope 1 and 2	**3,687,714**	**3,863,757**	**3,763,875**	**3,718,476**	**-2.6%**	**2.1%**
Scope 3						
Biogenic CO_2e from fuel	13,625	13,746	20,940	22,445	52.3%	53.7%
Employee commute	224,207	223,248	237,830	229,769	6.5%	6.1%
Employee solid waste	174,178	176,400	179,015	176,856	1.5%	2.8%
Total Scope 3	**412,010**	**413,394**	**437,785**	**429,070**	**5.9%**	**6.3%**

Municipal inventory results

Fiscal year 2008 results

In fiscal year 2008, the operation of New York City's government resulted in the emission of 3.76 $MMTCO_2e$, 2.1 percent above fiscal year 2006 levels. These emissions are broken down by scopes as follows:

- Scope 1 GHG emissions: 2,124,124 $MTCO_2e$
- Scope 2 GHG emissions: 1,639,750 $MTCO_2e$
- Scope 3 GHG emissions (reported for information only): 437,785 $MTCO_2e$

Fiscal year 2008 municipal GHG emissions were 2.6 percent below the fiscal year 2007 level of 3.86 $MTCO_2e$. As with citywide emissions, to allow the City to understand reasons for changes in GHG emissions reflected by this inventory beyond those governed by externalities such as weather and emissions coefficients, the City analyzed all changes in municipal GHG emissions for fiscal year 2006 to 2008 and fiscal year 2007 to 2008.

Changes to municipal emissions

Changes to municipal GHG emissions were measured similarly to those measured for citywide GHG emissions, with a slightly different calculation process. Similar to citywide changes, changes to CO_2e levels and energy consumption were calculated for each energy source in each sector. Externalities of changes in population (number of city employees) and weather (correlated to energy use) were subtracted from the percentage change in energy consumption to determine the per capita trend for each energy source in each sector, while the change in carbon intensity due to coefficient revisions was calculated by dividing the reduction in CO_2e by the change in consumption for each energy source in each sector. Each of these factors was used to determine the change in CO_2e emissions, factoring in weather, the change in number of City employees, the per capita trend, and the coefficient change, where applicable. The percentage of the total change was then calculated for each category of change analyzed.

Figure 15: FY 2008 Municipal CO_2e Emissions by Sector

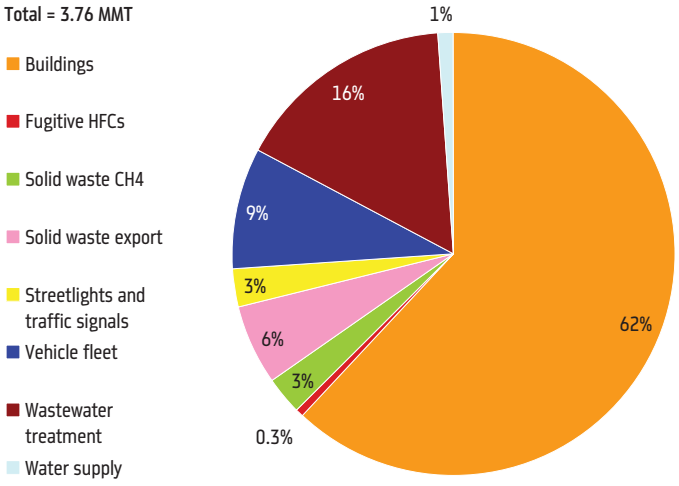
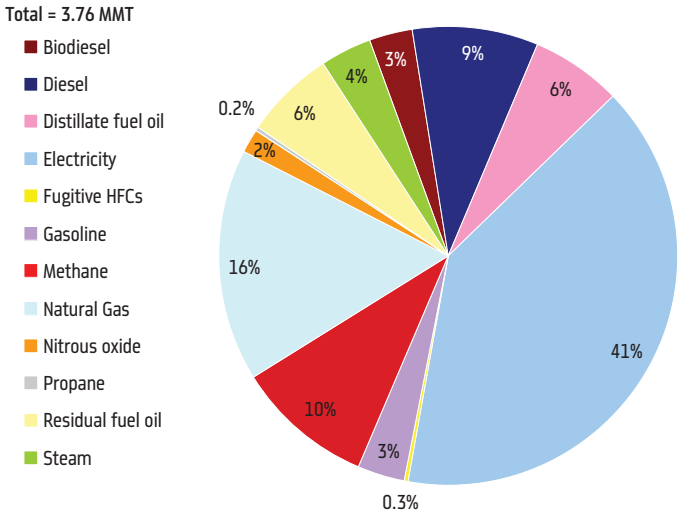


Figure 16: FY 2008 Municipal CO_2e Emissions by Source



Emissions from ethanol (E85), kerosene, and jet fuel are less than 0.1% of total

Figure 17: FY 2005 to 2008 Municipal CO_2e Emissions by Sector

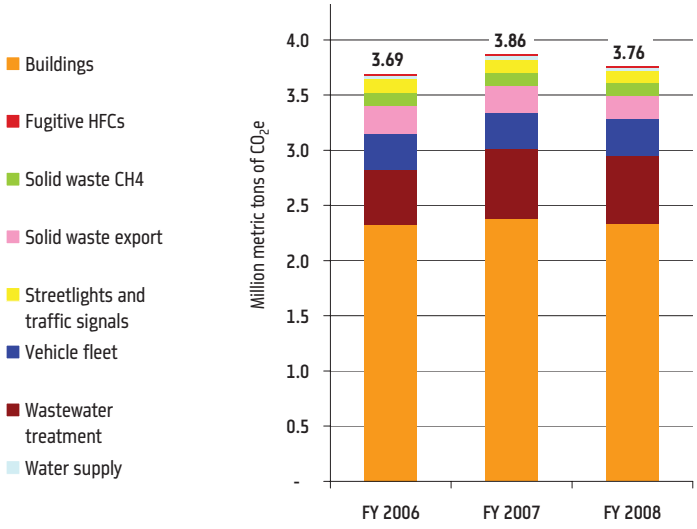
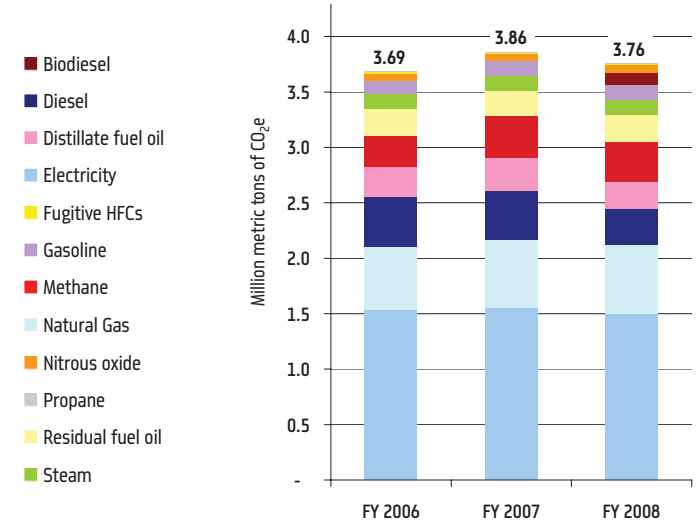


Figure 18: FY 2005 to 2008 Municipal CO_2e Emissions by Source



Emissions from ethanol (E85), kerosene, and jet fuel are less than 0.1% of total

Municipal 2006 to 2008 changes

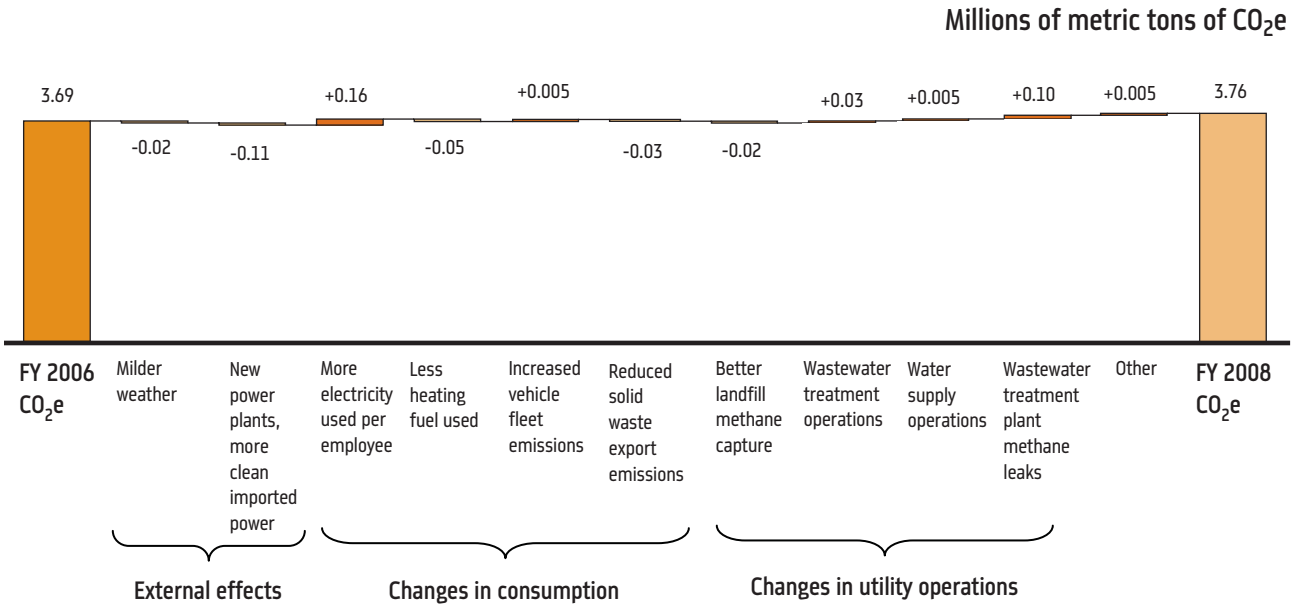
Municipal GHG emissions increased from 2006 to 2008 by 2.1 percent, from 3.69 to 3.76 $MMTCO_2e$. The principal factors leading to this increase were an increase in electricity consumption in City buildings and an increase in methane leaks from wastewater treatment plants, as methane flare equipment was undergoing repair. Reductions in the carbon intensity of the city's power supply, a decrease in the consumption of building heating fuels (weather adjusted), and a change in solid waste export transportation from truck to rail as part of the City's Solid Waste Management Plan (SWMP) all contributed to mitigating the increase in GHG emissions. When externalities of weather and the carbon intensity of the city's power supply are excluded, emissions are shown to have increased 5.6 percent over this period. Details of these changes are reported in Figure 19 and Table 10.

Municipal 2007 to 2008 changes

Municipal GHG emissions decreased by 2.6 percent from 2007 to 2008, from 3.86 to 3.76 $MMTCO_2e$. The principal reasons for this decrease were a reduction in the carbon intensity of the city's power supply and the continued transition from truck to rail for exporting solid waste. Electricity and building heating fuel consumption (after being adjusted for the impact of weather) also decreased. When weather and the carbon intensity of the city's power supply are excluded, municipal carbon emissions decreased 1.2 percent over this period. Details of these changes are reported in Figure 9 and Table 4.

Figure 19: FY 2007 to NY 2008 Changes in New York City's Municipal Greenhouse Gas Footprint

New York City's municipal carbon footprint increased 2.1 percent between FY 2006 and 2008, due to increased energy consumption per employee, increased wastewater treatment methane emissions, and increased energy consumption from wastewater treatment operations



Calendar year 2008 results

Per the LGOP, the City is now reporting emissions from City operations and facilities on a calendar year basis, as well as by fiscal year in compliance with Local Law 22 of 2008. In calendar year 2008, municipal operations and facilities were responsible for the emission of 3.72 $MMTCO_2e$. The breakdown of calendar year 2008 GHG emissions by scope is as follows:

- Scope 1 GHG emissions: 2,186,012 $MTCO_2e$
- Scope 2 GHG emissions: 1,532,464 $MTCO_2e$
- Scope 3 GHG emissions (reported for information only): 433,666 $MTCO_2e$

As this inventory reports calendar year municipal GHG emissions for the first time, comparison to past calendar years is not possible. In future years, analyses of changes in GHG emissions levels from calendar year 2008 levels will be made. A comparison to fiscal year 2008 results, however, shows continued GHG emissions reductions, with CO_2e decreasing 1.2 percent. Due to an increase in heating degree days in calendar year 2008, when the impact of weather is excluded, calendar year 2008 GHG emissions decreased 1.5 percent below fiscal year 2008 levels.

Table 10: FY 2006 to FY 2008 Changes in Municipal CO_2e Emissions

	METRIC TONS CO_2e	% OF FY 2006 CO_2e
FY 2006 municipal CO_2e	**3,687,714**	
Reasons for change		
Externalities		
Weather	-21,397	-0.58%
Powerplants	-110,795	-3.00%
Consumption		
Per employee electricity consumption	160,325	4.35%
Heating fuels	-47,082	-1.28%
Vehicle fleet	4,908	0.13%
Solid waste export	-33,510	-0.91%
Landfills	-15,393	-0.42%
Wastewater treatment plant operations	28,746	0.78%
Water supply operations	5,409	0.15%
Wastewater treatment plant methane leaks	100,448	2.72%
Other	4,503	0.12%
FY 2008 municipal CO_2e total	**3,763,875**	**2.07%**

Table 11: FY 2008 Municipal Emissions by Scope and GHG

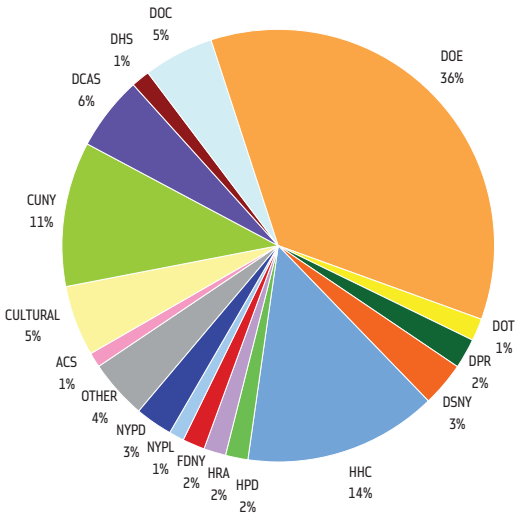
SCOPE	GREENHOUSE GAS (METRIC TONS)					
	CO_2	CH_4	N_2O	HFCs	SF_6	CO_2e
Scope 1	1,678,165	17,327	227	9	-	2,124,125
Scope 2	1,636,180	33	9	-	-	1,639,750
Scopes 1 and 2	**3,314,345**	**17,360**	**236**	**9**	**-**	**3,763,875**

Table 12: Calendar Year 2008 Municipal Emissions by Scope and GHG

SCOPE	GREENHOUSE GAS (METRIC TONS)					
	CO_2	CH_4	N_2O	HFCs	SF_6	CO_2e
Scope 1	1,729,725	17,834	226	9	-	2,186,012
Scope 2	1,529,126	31	9	-	-	1,532,464
Scopes 1 and 2	**3,258,851**	**17,865**	**235**	**9**	**-**	**3,718,476**

Figure 20: FY 2008 Municipal Buildings CO_2e Emissions by Agency

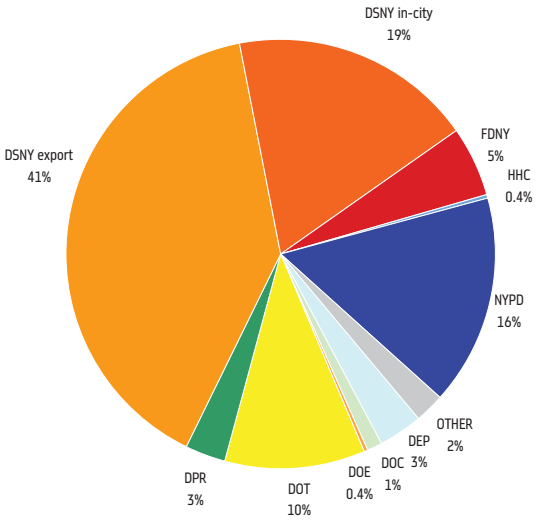
Total = 2.34 MMT



Does not include DEP emissions. A list of agency acronyms is in the Appendix

Figure 21: FY 2008 Municipal Vehicle CO_2e Emissions by Agency

Total = 0.54 MMT



Includes DSNY solid waste export. A list of agency acronyms is in the Appendix

Figure 22: FY 2008 Municipal Buildings CO_2e Emissions by Source

Total = 2.34 MMT

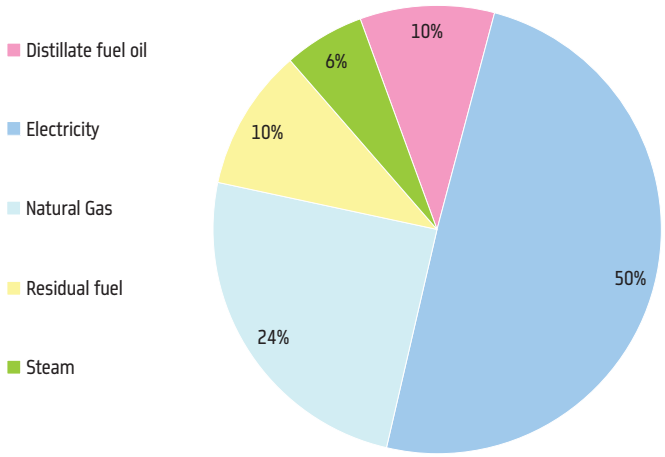
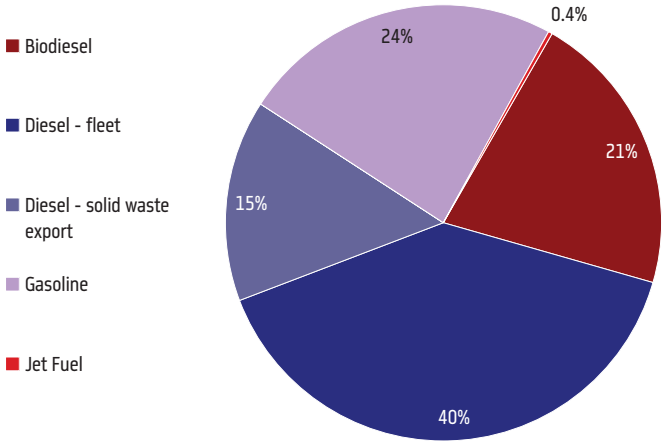


Figure 23: FY 2008 Municipal Vehicle CO_2e Emissions by Source

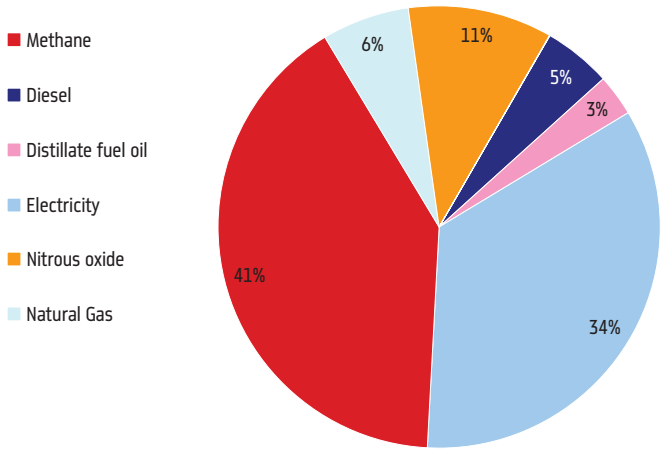
Total = 0.54 MMT



Emissions from ethanol (E85) are less than 0.1% of sector total

Figure 24: FY 2008 Municipal Wastewater CO_2e Emissions by Source

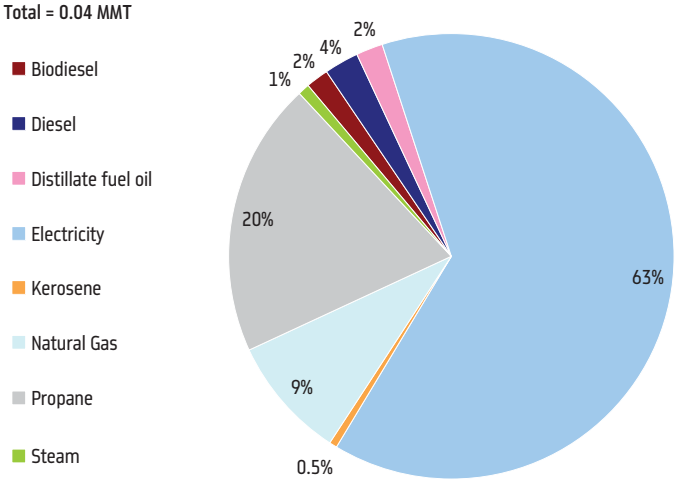
Total = 0.61 MMT



Wastewater emissions from propane and steam are less than 0.1% of sector total

Figure 25: FY 2008 Municipal Water Supply CO_2e Emissions by Source

Total = 0.04 MMT



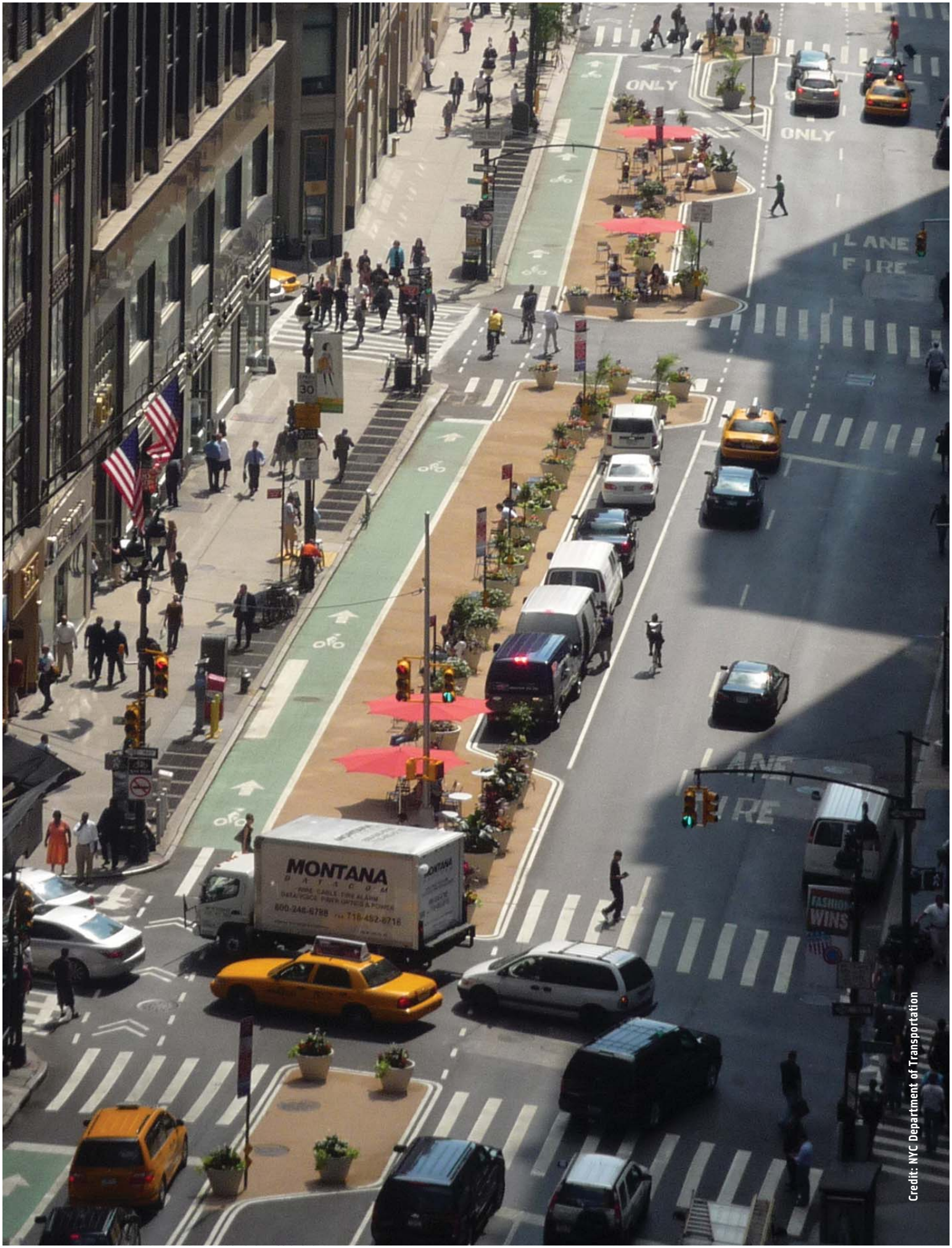
Conclusion

This annual updated greenhouse gas inventory provides the City with the most comprehensive and current information on the sources and trends of New York City greenhouse gas emissions possible. Additionally, it estimates the impact that drivers of change such as weather, population, policy decisions, infrastructure investments, and consumer behavior have on carbon emissions levels. Perhaps most importantly, this inventory update shows, for the first time, that New Yorkers are themselves becoming more efficient, and that *PlaNYC's* greenhouse gas reduction goals are achievable. Future inventories will build on this information, allowing the City to continuously monitor the effectiveness of *PlaNYC's* initiatives and the City's *Long-Term Plan to Reduce Energy Consumption and Greenhouse Gas Emissions of Municipal Buildings and Operations*.

Citywide greenhouse gas emissions decreased by 3.5 percent from 2007, showing that the City is on track to achieve *PlaNYC's* overarching goal of a 30 percent reduction in citywide carbon emissions by 2030. This decrease, despite continued growth in population and the city's building stock, highlights the benefits of reduced energy consumption by the city's residents, workers, and visitors and also demonstrates the emissions reductions achieved through less carbon-intensive electricity generation.

Municipal government emissions decreased by 2.6 percent below fiscal year 2007 levels, showing that the City's goal of a 30 percent reduction in municipal greenhouse gas emissions by 2017 is achievable once the initiatives of the *Long-Term Plan* are fully implemented. This decrease also demonstrates the impact of reduced energy consumption by the City's employees. Comparison of calendar year 2008 to fiscal year 2008 results show a continued decrease in emissions, which further demonstrates the impact of the City's efforts.

This inventory incorporates the most current protocols, methodologies, and data available. The City continues to strive to develop the most accurate and useful assessment of carbon emissions possible, and future inventory efforts will incorporate changes to analysis techniques and procedures as appropriate. Continued collaboration with other cities, both domestically and internationally, will allow for future comparability of inventory results and the sharing of carbon mitigation best practices. In addition, the City will seek to gain additional insight into New York City's greenhouse gas emissions, by further refining the analysis of causes as well as developing more local-level emissions inventories.



Credit: NYC Department of Transportation

APPENDICES

Acronym Definitions

New York City Agencies:

ACS - New York City Administration for Children's Services
DCAS - New York City Department of Citywide Administrative Services
DOC - New York City Department of Correction
DEP - New York City Department of Environmental Protection
DHS - New York City Department of Homeless Services
DOT - New York City Department of Transportation
DPR - New York City Department of Parks and Recreation
DOE - New York City Department of Education
DSNY - New York City Department of Sanitation
FDNY - New York City Fire Department
HPD - New York City Department of Housing Preservation and Development
HRA - New York City Human Resources Administration
NYPD - New York City Police Department
OMB - New York City Office of Management and Budget

Other Entities:

CARB - California Air Resources Board
CCAR - California Climate Action Registry
ConEd - Con Edison of New York
CULTURAL - Cultural institutions
CUNY - City University of New York
EIA - United States Energy Information Administration
EPA - United States Environmental Protection Agency
HHC - New York City Health and Hospitals Corporation
ICLEI - ICLEI-Local Governments for Sustainability
LIPA - Long Island Power Authority
LIRR - Long Island Rail Road
MTA - Metropolitan Transportation Authority
MNR - Metro-North Railroad
NJT - New Jersey Transit
NOAA - National Oceanic and Atmospheric Administration
NYCT - New York City Transit
NYISO - New York Independent System Operator
NYMTC - New York Metropolitan Transportation Council
NYPA - New York Power Authority
NYSERDA - New York State Energy Research and Development Authority
PATH - Port Authority Trans-Hudson Corporation
TCR - The Climate Registry
WBCSD - World Business Council for Sustainable Development
WRI - World Resources Institute

The following acronyms are used throughout this report:

Btu - British thermal units
BPM - Best Practices Model
CACPS - Clean Air and Climate Protection software
CDD - cooling degree days
CEMS - Continuous Emissions Monitoring System
CH_4 - methane
CO_2 - carbon dioxide
CO_2e - carbon dioxide equivalent
FY - fiscal year
GHG - greenhouse gas
GIS - geographic information systems
HDD - heating degree days
HFCs - hydrofluorocarbons
kWh - kilowatt hour
LGOP - Local Government Operations Protocol
MMBtu - million British thermal units
$MMTCO_2e$ - million metric tons of carbon dioxide equivalent
MT - metric ton
$MTCO_2e$ - metric tons of carbon dioxide equivalent
MW - megawatts
MWh - megawatt hour
N_2O - nitrous oxide
SF_6 - sulfur hexafluoride
SWMP - Solid Waste Management Plan
VMT - vehicle miles traveled

Endnotes

1 City of New York, *Inventory of New York City Greenhouse Gas Emissions* (April 2007), available online at http://www.nyc.gov/html/planyc2030/downloads/pdf/emissions_inventory.pdf

2 City of New York, *Inventory of New York City Greenhouse Gas Emissions* (September 2008), available online at http://www.nyc.gov/html/planyc2030/downloads/pdf/inventory_nyc_ghg_emissions_2008_-_feb09update_web.pdf

3 California Air Resources Board (CARB), The California Climate Action Registry (CCAR), ICLEI – Local Governments for Sustainability (ICLEI), and The Climate Registry (TCR), *Local Government Operations Protocol* (2008), available online at http://www.icleiusa.org/action-center/tools/lgo-protocol-1

4 Carbon dioxide equivalent is a common unit of reporting that allows greenhouse gases with different impacts on global climate change to be added together as reported as one comprehensive unit. Following standard international convention and the LGOP, this report uses global warming potentials reported in the Intergovernmental Panel on Climate Change's *Second Assessment Report* (SAR), 1996.

5 World Resources Institute/World Business Council for Sustainable Development's (WRI/WBCSD), *Greenhouse Gas Protocol*, available online at http://www.ghgprotocol.org/files/ghg-protocol-revised.pdf

6 The LGOP provides flexibility in the assignment of CO_2e emissions into scopes. New York City elected for CO_2e emission from long-haul transport of municipal solid waste to be reported as a Scope 1 source to allow for the significant expected reduction in CO_2e from implementation of the City's Solid Waste Management Plan (SWMP) to be reflected as a reduction below the base year inventory level.

7 New York Independent System Operator (April 2009), Table I-4a: Historic Energy Requirements and Coincident Peaks, available online at http://www.nyiso.com/public/webdocs/services/planning/planning_data_reference_documents/2009_LoadCapacityData_PUBLIC.pdf

8 New York State Energy Research and Development Authority, *Petroleum Infrastructure Study* (2006), available online at http://www.nyserda.org/Energy_Information/PetroleumInfrastructureStudy.pdf

9 Available online at http://www.nyc.gov/html/oec/downloads/pdf/CEQR_Technical_Manual_Appendices.pdf

10 U.S. Census Bureau, *2008 New York City Housing and Vacancy Survey* (2009), Table 42. Available online at http://www.census.gov/hhes/www/housing/nychvs/2008/nychvs08.html

11 The correlation of weather to heating fuel oil use was calculated using municipal fuel oil records. The regression analysis graph used for this calculation is in the Appendix.

12 The City's GasCard is a procurement card used to purchase vehicle fuel from private fuelling stations for use in City fleet vehicles.

13 New York State Department of Agriculture and Markets.

14 U.S. Department of Transportation Maritime Administration, *Environmental Advantages of Inland Barge Transportation*, August 1994, available at http://ntl.bts.gov/lib/6000/6300/6301/837.pdf

15 LGOP (September 2008), pp 14.

16 U.S. Census Bureau, available online at http://www.census.gov/main/www/pums.html

City Comparison Data Sources

Greenhouse Gas Emissions Per Capita Comparisons

Austin: http://www.coolaustin.org/downloads/ACPP_Annual_Report_5.20.09_FINAL.pdf
Baltimore: http://www.ci.baltimore.md.us/government/planning/sustainability/downloads/presentations/102008GHG_Emissions_Inventory_Presentation.pdf
Boston: http://www.cityofboston.gov/climate/pdfs/Report2005GHGinventory.pdf
Chicago: http://www.chicagoclimateaction.org/filebin/pdf/CNTClimateResearchSummary91708.pdf
Dallas: http://www.greendallas.net/contact_us.html
Denver: http://www.greenprintdenver.org/docs/Denver_GHG_Inventory_Report.pdf
Hong Kong: http://www.epd.gov.hk/epd/english/climate_change/files/GHG_Inventory_Table_1990_2007.pdf
Houston: Personal communication with Houston Mayor's Office
London: http://www.london.gov.uk/mayor/publications/2009/docs/monitoring_report5-2.pdf.
Los Angeles: http://www.environmentla.org/ead_department.htm
Miami: http://www.miamigov/msi/pages/Climate%20Action/MiPlan%20Final%20062608.pdf
Philadelphia: http://www.phila.gov/green/
San Diego: http://www.sandiego.gov/environmental-services/sustainable/pdf/action_plan_07_05.pdf
San Francisco: http://www.sfenvironment.org/downloads/library/climateactionplan.pdf
Seattle: http://www.seattle.gov/climate/docs/2005%20Seattle%20Inventory%20Full%20Report.pdf
Singapore: http://app.mewr.gov.sg/web/Contents/Contents.aspx?ContId=683
Sydney: http://cityofsydney.nsw.gov.au/Environment/GreenhouseAndAirQuality/CurrentStatus/Default.asp
Tokyo: http://www2.kankyo.metro.tokyo.jp/kikaku/kikouhendouhousin/data/ClimateChangeStrategyPress.pdf
Toronto: http://www.toronto.ca/teo/pdf/ghg-aq-inventory-june2007.pdf
USA: U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007 (April 2009)
Vancouver: http://vancouver.ca/sustainability/documents/Progress2007.pdf

Transportation Comparisons

U.S. Census Bureau, 2007 American Community Survey

Electricity Consumption Per Capita Comparisons

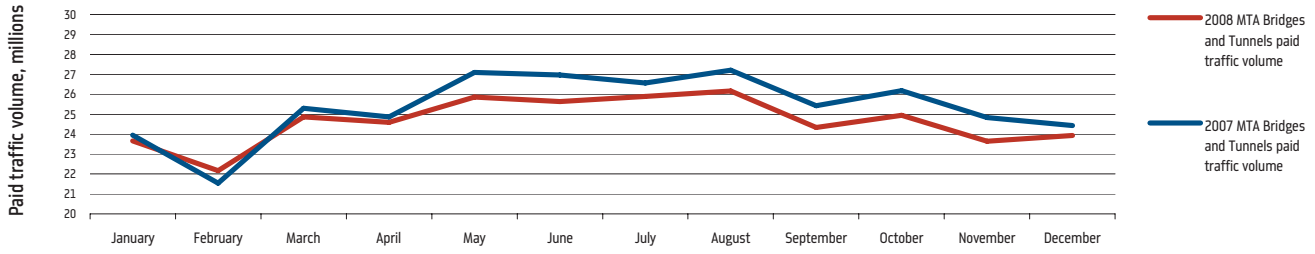
Boston: Personal communication with Boston Mayor's Office
Chicago: Personal communication with Chicago Mayor's Office
Dallas: Personal communication with Dallas Mayor's Office
Denver: http://www.greenprintdenver.org/docs/Denver_GHG_Inventory_Report.pdf
Hong Kong: http://www.iea.org/Textbase/stats/electricitydata.asp?COUNTRY_CODE=HK
Los Angeles: Personal communication with Seattle Mayor's Office
San Diego: Personal communication with San Diego Mayor's Office
San Francisco: http://www.thehdmt.org/indicators/view/2
Seattle: Personal communication with Seattle Mayor's Office
Sydney: https://www.energyaustralia.com.au/energy/ea.nsf/AttachmentsByTitle/Electricity+Network+Performance+Report+0607/$FILE/ENPR_06-07_FINAL.pdf
Tokyo: http://www.toukei.metro.tokyo.jp/tnenkan/2006/tn06qa070200.xls
Toronto: http://www.toronto.ca/energy/pdf/ep4t-stakeholder-presentation-043007.pdf
USA: http://www.eia.doe.gov/cneaf/electricity/epm/table5_1.html
Vancouver: Personal communication with Vancouver Mayor's Office

Economic Impacts on Emissions

In this report, the City has identified that, on a per-capita basis, New Yorkers have become less vehicle-reliant and less energy-consuming. Calendar year data, however, preclude separating out the efficiency-promoting impacts of the high energy prices the world experienced in the first half of 2008, and the consumption-reducing impacts of the global economic downturn that became most vivid in the late summer of 2008.

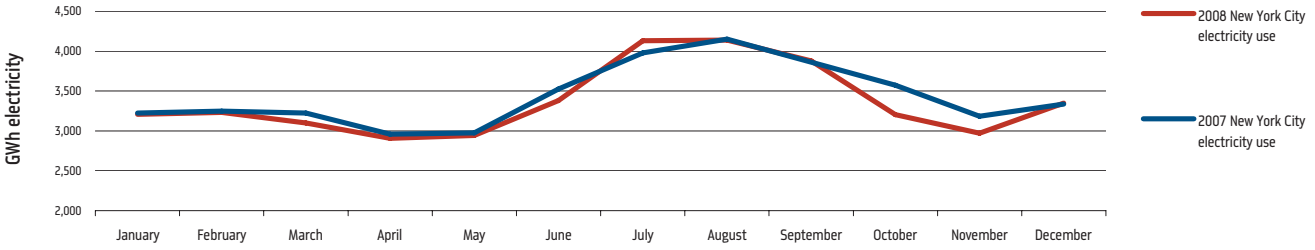
A full analysis of the drivers of per-capita declines in energy consumption and traffic is beyond the scope of this study. However, the data presented below suggest that efficiency efforts in the first half of 2008 did play a role. The number of vehicles paying to cross MTA bridges and tunnels began to decline on a year-on-year basis in March 2008, even though subway ridership continued to grow until late 2008; it is likely that the high gasoline prices of early 2008, rather than the economic downturn, caused this early shift. Similarly, the monthly citywide electricity consumption, taken alongside fluctuations in weather shown in figure 28, suggests that some move toward greater electricity efficiency had begun in early 2008 before the combined impacts of the economic downturn and a milder late summer and early fall reduced electricity consumption in the second half of the year.

Figure 26: MTA Bridges and Tunnels Monthly Paid Traffic Volume, 2007 and 2008



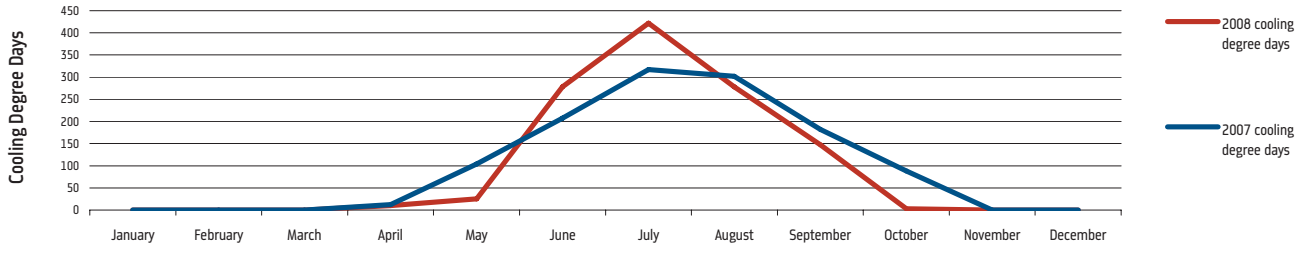
Source: MTA Bridges and Tunnels

Figure 27: New York City Monthly Electricity Use, 2007 and 2008



Source: Con Edison. Does not include NYPA electricity

Figure 28: Monthly Cooling Degree Days, 2007 and 2008



Source: National Oceanographic and Atmospheric Administration

Steam Emissions Coefficients

2005 STEAM EMISSIONS COEFFICIENT

To convert metered lbs of steam to Btu		Steam Fuel Breakdown & Emissions Coefficients						Steam Coefficient per MMBtu Delivered to Buildings divided by fuel mix percentage			
Lbs of steam generated per lb of steam delivered (1/0.85)	1.1718		CO_2 (lbs/ MMBTU)	CH_4 (lbs/ MMBtu)	N_2O (lbs/ MMBtu)	CO_2e (lbs/ MMBtu)	% of mix	CO_2 (lbs/ MMBTU)	CH_4 (lbs/ MMBtu)	N_2O (lbs/ MMBtu)	CO_2e (lbs/ MMBtu)
Steam Generation Efficiency	103.5%	Residual fuel Oil	173.91	0.0070	0.0014	174.4850	54.09%	94.0707	0.0038	0.0008	94.3839
Difference between delivery and generation	113.2%	Natural gas	117.08	0.0023	0.0002	117.2009	45.88%	53.7197	0.0011	0.0001	53.7752
Steam btu/lb at generation	1193	Kerosene	159.54	0.0070	0.0014	160.1140	0.02%	0.0387	0.0000	0.0000	0.0388
Water btu	18	Average		0.0163	0.0030		100.0%	**147.8291**	**0.0048**	**0.0009**	**148.1979**
Net btu/lb	1175							Steam Coefficient per Mlb Delivered to Buildings			
Total btu input/lb steam	**1330.15**							CO_2 (lb/Mlb)	CH_4 (lb/Mlb)	N_2O (lb/Mlb)	CO_2e (lb/Mlb)
								196.6349	**0.0064**	**0.0011**	**197.1255**

2006 STEAM EMISSIONS COEFFICIENT

To convert metered lbs of steam to Btu		Steam Fuel Breakdown & Emission Coefficients						Steam Coefficient per MMBtu Delivered to Buildings divided by fuel mix percentage			
Lbs of steam generated per lb of steam delivered (1/0.85)	1.1718		CO_2 (lbs/ MMBTU)	CH_4 (lbs/ MMBtu)	N_2O (lbs/ MMBtu)	CO_2e (lbs/ MMBtu)	% of mix	CO_2 (lbs/ MMBTU)	CH_4 (lbs/ MMBtu)	N_2O (lbs/ MMBtu)	CO_2e (lbs/ MMBtu)
Steam Generation Efficiency	124.6%	Residual fuel Oil	173.91	0.0070	0.0014	174.4850	49.33%	85.7849	0.0034	0.0007	86.0705
Difference between delivery and generation	94.0%	Natural gas	117.08	0.0023	0.0002	117.2009	50.63%	59.2750	0.0012	0.0001	59.3363
Steam btu/lb at generation	1193	Kerosene	159.54	0.0070	0.0014	160.1140	0.04%	0.0700	0.0000	0.0000	0.0702
Water btu	18	Average		0.0163	0.0030		100.0%	**145.1299**	**0.0046**	**0.0008**	**145.4770**
Net btu/lb	1175							Steam Coefficient per Mlb Delivered to Buildings			
Total btu input/lb steam	**1104.83**							CO_2 (lb/Mlb)	CH_4 (lb/Mlb)	N_2O (lb/Mlb)	CO_2e (lb/Mlb)
								160.3437	**0.0051**	**0.0009**	**160.7271**

2007 STEAM EMISSIONS COEFFICIENT

To convert metered lbs of steam to Btu		Steam Fuel Breakdown & Emissions Coefficients						Steam Coefficient per MMBtu Delivered to Buildings divided by fuel mix percentage			
Lbs of steam generated per lb of steam delivered (1/0.85)	1.1718		CO_2 (lbs/ MMBTU)	CH_4 (lbs/ MMBtu)	N_2O (lbs/ MMBtu)	CO_2e (lbs/ MMBtu)	% of mix	CO_2 (lbs/ MMBTU)	CH_4 (lbs/ MMBtu)	N_2O (lbs/ MMBtu)	CO_2e (lbs/ MMBtu)
Steam Generation Efficiency	120.3%	Residual fuel Oil	173.91	0.0070	0.0014	174.4850	49.05%	85.3073	0.0034	0.0007	85.5914
Difference between delivery and generation	97.4%	Natural gas	117.08	0.0023	0.0002	117.2009	50.13%	58.6931	0.0012	0.0001	58.7537
Steam btu/lb at generation	1193	Kerosene	159.54	0.0070	0.0014	160.1140	0.82%	1.3010	0.0001	0.0000	1.3058
Water btu	18	Average		0.0163	0.0030		100.0%	**145.3015**	**0.0046**	**0.0008**	**145.6509**
Net btu/lb	1175							Steam Coefficient per Mlb Delivered to Buildings			
Total btu input/lb steam	**1144.24**							CO_2 (lb/Mlb)	CH_4 (lb/Mlb)	N_2O (lb/Mlb)	CO_2e (lb/Mlb)
								166.2602	**0.0053**	**0.0009**	**166.6600**

2008 STEAM EMISSIONS COEFFICIENT

To convert metered lbs of steam to Btu		Steam Fuel Breakdown & Emissions Coefficients						Steam Coefficient per MMBtu Delivered to Buildings divided by fuel mix percentage			
Lbs of steam generated per lb of steam delivered (1/0.85)	1.1655		CO_2 (lbs/ MMBTU)	CH_4 (lbs/ MMBtu)	N_2O (lbs/ MMBtu)	CO_2e (lbs/ MMBtu)	% of mix	CO_2 (lbs/ MMBTU)	CH_4 (lbs/ MMBtu)	N_2O (lbs/ MMBtu)	CO_2e (lbs/ MMBtu)
Steam Generation Efficiency	122.6%	Residual fuel Oil	173.91	0.0070	0.0014	174.4850	42.62%	74.1248	0.0030	0.0006	74.3716
Difference between delivery and generation	95.1%	Natural gas	117.08	0.0023	0.0002	117.2009	57.02%	66.7587	0.0013	0.0001	66.8276
Steam btu/lb at generation	1193	Kerosene	159.54	0.0070	0.0014	160.1140	0.36%	0.5692	0.0000	0.0000	0.5713
Water btu	18	Average		0.0163	0.0030		100.0%	**141.4527**	**0.0043**	**0.0007**	**141.7705**
Net btu/lb	1175							Steam Coefficient per Mlb Delivered to Buildings			
Total btu input/lb steam	**1117.18**							CO_2 (lb/Mlb)	CH_4 (lb/Mlb)	N_2O (lb/Mlb)	CO_2e (lb/Mlb)
								158.0283	**0.0048**	**0.0008**	**158.3834**

Electricity Emissions Coefficients

2005 ELECTRICITY EMISSIONS COEFFICIENT

										Zone G, H, I (minus Indian Point contracted)				
	Generation	CO_2	CO_2/MWh	CH_4	CH_4/MWh	N_2O	N_2O/MWh	CO_2e	CO_2e/MWh	Generation	CO_2	CH_4	N_2O	CO_2e
	GWh	tons	lbs	tons	lbs	tons	lbs	tons	lbs	MWh	tons	tons	tons	tons
In-city	25,452	16,584,670	1303.207	386.9	0.0304	49.9	0.0039	16,608,265	1,305.061	11,209,977	6,400,469	185.51	67.21	6,424,690
Contract	17,339	2,352,852	271.398	46.7	0.0054	4.7	0.0005	2,355,283	271.678					
NYISO Zone A	3,697	1,596,102	863.524		0.0102		0.0139	1,604,474	868.053					
NYISO Zone D	1,559	190,384	244.195		0.0049		0.0005	190,581	244.447					
Market procurement (G, H, I)	5,960	3,403,001	1141.924	98.6	0.0331	35.7	0.0120	3,415,879	1,146.245					
Total	**54,007**	**24,127,011**	**893.477**		**0.0205**		**0.0043**	**24,174,482**	**895.235**					
Total 2005 NYC consumption	51,397								**CO_2e coefficient (lbs CO_2e/MWh)**					
Transmission and generation loss rate	-4.8%										CO_2e coefficient reported in inventory for 2007 (lbs/MWh)			Difference
Emissions with transmission and distribution losses			**936.65**		**0.0215**		**0.0045**		**938.493**		**1122.470**			**-16.4%**

2006 ELECTRICITY EMISSIONS COEFFICIENT

										Zone G, H, I (minus Indian Point contracted)				
	Generation	CO_2	CO_2/MWh	CH_4	CH_4/MWh	N_2O	N_2O/MWh	CO_2e	CO_2e/MWh	Generation	CO_2	CH_4	N_2O	CO_2e
	GWh	tons	lbs	tons	lbs	tons	lbs	tons	lbs	MWh	tons	tons	tons	tons
In-city	27,293	15,662,420	1147.744	332.0	0.0243	37.3	0.0027	15,680,953	1,149.102	8,337,385	2,989,366	48.31	43.89	3,003,987
Contract	15,047	1,658,231	220.400	32.9	0.0044	3.3	0.0004	1,659,943	220.627					
NYISO Zone A	3,697	1,616,273	874.436	18.7	0.0101	26.7	0.0144	1,624,939	879.125					
NYISO Zone D	1,559	187,704	240.758	3.7	0.0048	0.4	0.0005	187,898	241.006					
Market procurement (G, H, I)	5,500	1,972,010	717.099	31.9	0.0116	29.0	0.0105	1,981,655	720.607					
Total	**53,096**	**21,096,637**	**794.660**		**0.0158**		**0.0036**	**21,135,388**	**796.120**					
total 2006 NYC consumption	50,494								**CO_2e coefficient (lbs CO_2e/MWh)**					
Transmission and generation loss rate	-4.9%									change from 2005	CO_2e coefficient reported in inventory for 2007 (lbs/MWh)			Difference
Emissions with transmission and distribution losses			**833.60**		**0.0166**		**0.0038**		**835.128**	**-11.0%**	**1035.294**			**-19.3%**

2007 ELECTRICITY EMISSIONS COEFFICIENT

										Zone G, H, I (minus Indian Point contracted)				
	Generation	CO_2	CO_2/MWh	CH_4	CH_4/MWh	N_2O	N_2O/MWh	CO_2e	CO_2e/MWh	Generation	CO_2	CH_4	N_2O	CO_2e
	GWh	tons	lbs	tons	lbs	tons	lbs	tons	lbs	MWh	tons	tons	tons	tons
In-city	27,562	14,983,042	1087.234	312.1	0.0226	34.0	0.0025	15,000,152	1,088.475	8,464,661	4,173,652	81.39	54.94	4,192,391
Contract	16,481	1,907,481	231.478	37.9	0.0046	3.8	0.0005	1,909,452	231.717					
NYISO Zone A	3,697	1,449,805	784.374	17.0	0.0092	23.7	0.0128	1,457,509	788.542					
NYISO Zone D	1,559	177,803	228.058	3.5	0.0045	0.4	0.0005	177,986	228.293					
Market procurement (G, H, I)	5,451	2,687,876	986.136	52.4	0.0192	35.4	0.0130	2,699,944	990.563					
Total	**54,750**	**21,206,007**	**774.649**		**0.0154**		**0.0036**	**9,609,548**	**776.075**					
Total 2007 NYC consumption	52,278								**CO_2e coefficient (lbs CO_2e/MWh)**					
Transmission and generation loss rate	-4.5%									change from 2006	CO_2e coefficient reported in inventory for 2007 (lbs/MWh)			Difference
Emissions with transmission and distribution losses			**809.62**		**0.0161**		**0.0037**		**811.109**	**-2.9%**	**985.020**			**-17.7%**

2008 ELECTRICITY EMISSIONS COEFFICIENT

										Zone G, H, I (minus Indian Point contracted)				
	Generation	CO_2	CO_2/MWh	CH_4	CH_4/MWh	N_2O	N_2O/MWh	CO_2e	CO_2e/MWh	Generation	CO_2	CH_4	N_2O	CO_2e
	GWh	tons	lbs	tons	lbs	tons	lbs	tons	lbs	MWh	tons	tons	tons	tons
In-city	24,214	13,060,303	1078.721	271.3	0.0224	29.5	0.0024	13,075,131	1,079.946	8,710,589	3,334,154	51.75	50.06	3,350,759
Contract	15,091	1,524,348	202.017	30.3	0.0040	3.0	0.0004	1,525,923	202.226					
NYISO Zone A	3,697	1,380,703	746.988	1.9	0.0085	23.2	0.0125	1,388,218	751.054					
NYISO Zone D	1,559	171,008	219.342	0.4	0.0044	0.3	0.0004	171,184	219.569					
Market procurement (G, H, I)	10,273	3,932,308	765.541	61.0	0.0119	59.0	0.0115	3,951,892	769.353					
Total	**54,835**	**20,068,670**	**731.966**		**0.0139**		**0.0042**	**20,112,349**	**733.559**					
Total 2008 NYC consumption	51,758								**CO_2e coefficient (lbs CO_2e/MWh)**					
Transmission and generation loss rate	-5.6%									change from 2007				
Emissions with transmission and distribution losses			**773.04**		**0.0147**		**0.0044**		**774.724**	**-4.5%**				

Fuel Emissions Coefficients

2008 FUEL EMISSIONS COEFFICIENTS						
	UNIT	GREENHOUSE GAS (LBS/UNIT)				FUEL EFFICIENCY (MILES/UNIT)
		CO_2	CH_4	N_2O	CO_2e	
Stationary source						
Natural gas	therm	11.69773	0.00110	0.00002	11.72771	
Distillate fuel oil	gallon	22.36636	0.00336	0.00018	22.49386	
Kerosene	gallon	21.52120	0.00327	0.00018	21.64530	
Propane	gallon	12.65977	0.00221	0.00012	12.74347	
Residual fuel oil	gallon	26.00487	0.00363	0.00020	26.14248	
Mobile source						
On-road						
Diesel, bus	gallon	22.37692	0.00007	0.00007	22.39907	6.300
Diesel, heavy-duty vehicles	gallon	22.37692	0.00007	0.00007	22.39907	6.300
Gasoline, light trucks	gallon	19.42273	0.00097	0.00133	19.85496	13.918
Gasoline, passenger cars	gallon	19.42273	0.00117	0.00124	19.83200	19.143
Biodiesel 100 (B100), heavy trucks*	gallon	20.85573	0.00000	0.00000	20.85574	4.131
Ethanol (E100), passenger cars*	gallon	12.25770	0.00188	0.00228	13.00529	15.466
Compressed natural gas, bus	therm	11.69707	0.00002	0.00000	11.69824	5.579
Off-road						
Aviation gasoline	gallon	19.42273	0.01552	0.00024	19.82383	
Jet fuel	gallon	21.09824	0.00060	0.00068	21.32260	
Diesel, locomotives	gallon	22.37692	0.00176	0.00057	22.59165	
Diesel, ships and boats	gallon	22.37692	0.00163	0.00057	22.58887	

* Per the LGOP, CO_2 from biofuels is considered biogenic and is reported as a Scope 3 source

Heating and Cooling Degree Days

Figure 27: Heating and Cooling Degree Days, Central Park 2005-2008 Using 65 Degrees (°F) Base Temperature

	YEAR	ANNUAL TOTAL	% CHANGE FROM PREVIOUS YEAR
Calendar years			
Heating degree days	2005	4,733	
Heating degree days	2006	3,987	-15.76%
Heating degree days	2007	4,705	18.01%
Heating degree days	2008	4,598	-2.27%
Cooling degree days	2005	1,472	
Cooling degree days	2006	1,130	-23.23%
Cooling degree days	2007	1,212	7.26%
Cooling degree days	2008	1,163	-4.04%
Fiscal years			
Heating degree days	2006	4,261	
Heating degree days	2007	4,460	4.67%
Heating degree days	2008	4,470	0.22%
Cooling degree days	2006	1,435	
Cooling degree days	2007	1,177	-17.98%
Cooling degree days	2008	1,202	2.12%

Source: http://cdo.ncdc.noaa.gov/pls/plclimprod/somdmain.somdwrapper?datasetabbv=DS3220&countryabbv=&georegionabbv=NAMER

Weather Impacts on Emissions

Because so much of New York City's energy consumption is devoted to providing heat and air conditioning, weather plays a major role in short-term changes in annual GHG emissions. In *PlaNYC*, the City estimated that more than 40 percent of all energy consumed in the city's buildings is for heating and cooling; because 75 percent of the city's emissions are related to buildings, weather directly affects more than 30 percent of the city's GHG footprint.

As a result, understanding year-on-year changes in GHG emissions requires taking weather into account. In this report, the City has estimated the impact of weather on key components of the GHG footprint—steam (used for both heating and cooling), electricity (for air conditioning), natural gas (for heating), and fuel oil (for heating). The City has compared monthly consumption figures for each fuel type for data sets available, with the extent to which weather varies from 65° Fahrenheit (an outside temperature at which a minimum of either heating or cooling should be required). The weather fluctuations are measured in degree days, in which one day at 66° would be one cooling degree day, and one day at 75° would be ten cooling degree days. (Conversely, one day at 55° would be ten heating degree days.)

These graphs show the relationship between weather and certain fuel types. Fuel oil consumption is almost entirely dependent on weather fluctuations; electricity (which is used for many things other than air conditioning) is least, but roughly half of all fluctuations in electricity consumption are correlated to weather. The exclusion of weather from year-on-year changes is based on these estimates; it is presented as an estimate rather than a detailed analysis, and further refinement of these methods will be necessary to make precise claims for exactly how weather affected greenhouse gas emissions.

Figure 29: Correlation of Cooling and Heating Degree Days to Steam Use

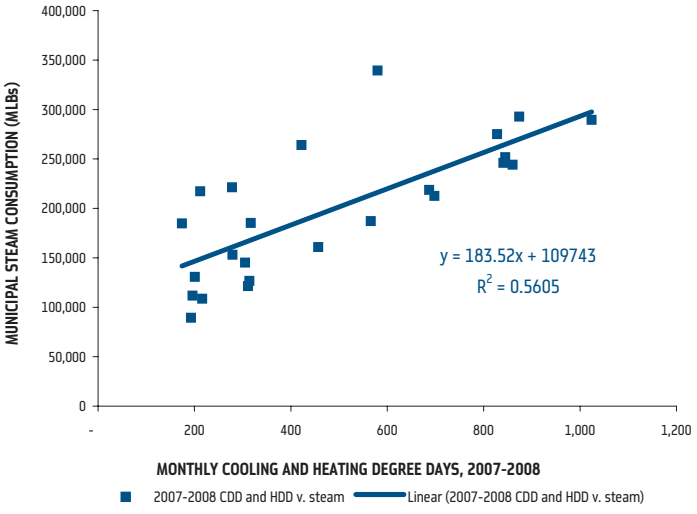


Figure 30: Correlation of Cooling Degree Days to Electricity Use

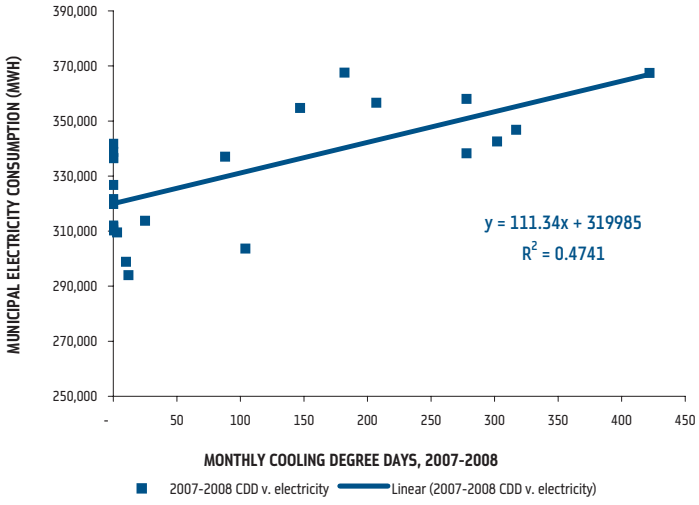


Figure 31: Correlation of Heating Degree Days to Natural Gas Use

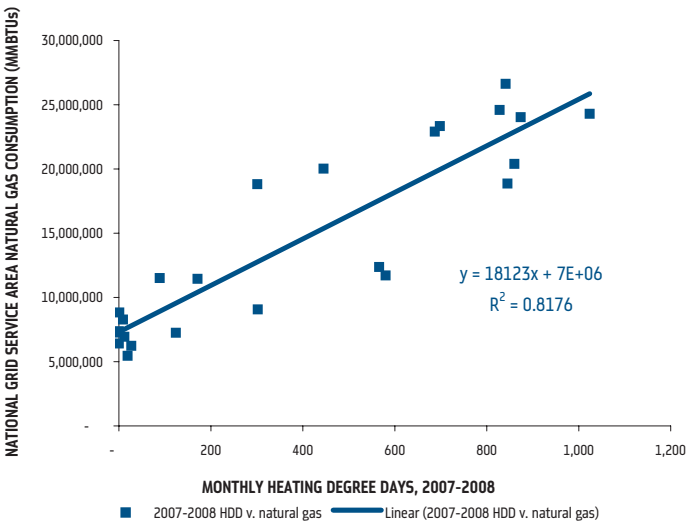
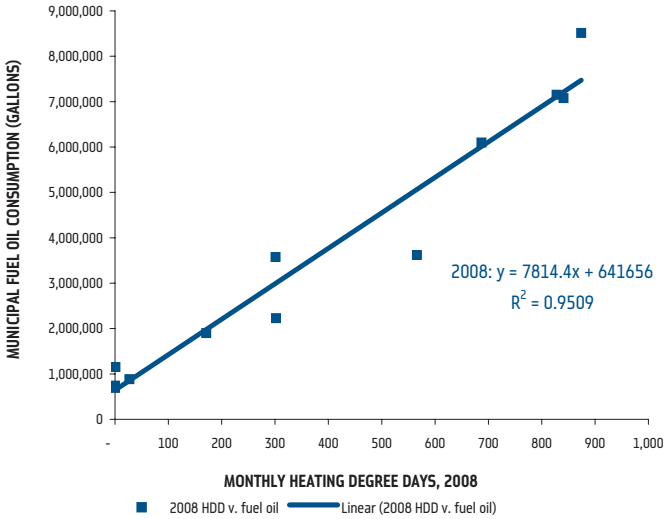


Figure 32: Correlation of Heating Degree Days to Fuel Oil Use



Source: NOAA (CDD and HDD), citywide natural gas consumption, and municipal fuel oil, steam, and electricity consumption

Citywide GHG Emissions Summary

	UNITS	2005			2006			2007			2008		
		CONSUMPTION	$MTCO_2e$	MMBTU	CONSUMPTION	$MTCO_2e$	MMBTU	CONSUMPTION	$MTCO_2e$	MMBTU	CONSUMPTION	$MTCO_2e$	MMBTU
Buildings													
Distillate fuel oil	gallons	512,776,350	5,231,879	71,117,196	435,814,800	4,446,637	60,443,362	509,887,713	5,202,406	70,716,570	498,848,992	5,089,777	69,185,604
Electricity	kWh	48,341,915,006	20,578,828	164,989,471	47,468,763,615	17,981,534	162,009,432	49,222,433,013	18,109,575	167,994,652	48,567,357,167	17,067,006	165,758,898
Natural gas	therms	2,451,990,068	13,043,606	245,199,007	2,361,398,806	12,561,697	236,139,881	2,570,616,509	13,674,652	257,061,651	2,565,062,442	13,645,106	256,506,244
Residual fuel oil	gallons	234,325,008	2,778,633	35,076,222	199,155,648	2,361,594	29,811,704	233,004,978	2,762,980	34,878,626	227,960,579	2,703,163	34,123,528
Steam	mlbs	25,781,088	2,305,206	34,288,847	25,670,988	1,871,536	28,362,035	25,789,515	1,949,577	29,509,480	23,833,964	1,712,267	26,626,858
Transportation													
CNG - bus	therms	2,361,134	12,529	236,113	14,593,305	77,435	1,459,331	14,593,305	77,435	1,459,331	15,128,859	80,277	1,512,886
Diesel - bus	gallons	66,395,066	673,520	8,125,833	63,199,730	641,106	8,765,201	63,075,144	640,847	8,747,922	68,378,618	691,869	9,483,463
Diesel - commuter rail	gallons	1,375,601	14,096	168,355	1,400,047	14,210	194,173	1,400,047	14,347	194,173	1,408,756	14,436	195,381
Diesel - heavy trucks	gallons	108,250,584	1,098,107	13,248,367	108,322,183	1,098,834	15,023,255	108,278,998	1,098,396	15,017,266	108,549,986	1,102,873	15,054,849
Diesel - solid waste export - rail	gallons	5,698,407	58,394	697,406	6,661,953	67,619	923,949	7,092,842	72,683	983,710	7,596,634	77,846	1,053,581
Diesel - solid waste export - truck	gallons	19,075,008	193,499	2,334,516	17,710,952	179,662	2,456,340	15,592,292	158,170	2,162,502	10,255,163	104,193	1,422,293
Electricity - subways and commuter rail	kWh	2,728,682,604	1,161,582	9,312,910	2,635,967,148	998,525	8,996,475	2,734,550,607	1,006,077	9,332,937	2,877,865,744	1,011,308	9,822,067
Gasoline - light trucks	gallons	113,920,733	928,308	14,310,293	114,032,502	929,117	14,167,181	112,917,446	921,909	14,028,648	112,775,983	924,082	14,011,073
Gasoline - passenger cars	gallons	980,220,434	7,987,542	123,131,596	971,933,099	7,919,145	120,751,117	963,801,052	7,868,909	119,740,807	957,216,831	7,834,365	118,922,796
Streetlights and traffic signals													
Electricity	kWh	318,925,241	135,764	1,088,482	313,776,281	118,861	1,070,909	313,555,546	115,361	1,070,155	312,580,297	109,844	1,066,827
Fugitive and process emissions													
CH_4 - landfills	MT	6,129	128,700		5,968	125,330		5,405	113,506		5,224	109,703	
HFCs - municipal fleet	MT	9	12,622		9	11,200		9	11,378		9	11,580	
CH_4 - natural gas distribution	therms	37,213,922	69,483		35,839,016	66,916		39,014,319	72,844		39,200,475	72,717	
CH_4 - wastewater treatment plants	MT	4,245	89,148		7,069	148,455		12,338	259,103		12,459	261,642	
N_2O - wastewater treatment process	MT	209	64,649		209	64,649		209	64,649		209	64,649	
SF_6 - electricity distribution	pounds	187,952	2,037,561		137,149	1,486,813		96,551	1,046,696		59,457	644,565	
Total Scope 1			**34,422,276**	**513,644,903**		**32,334,590**	**490,135,494**		**34,060,910**	**524,991,205**		**33,432,845**	**521,471,699**
Total Scope 2			**24,181,381**	**209,679,710**		**20,970,456**	**200,438,851**		**21,180,590**	**207,907,225**		**19,900,425**	**203,274,651**
TOTAL Scope 1 and 2			**58,603,657**	**723,324,613**		**53,166,183**	**690,574,344**		**55,241,501**	**732,898,430**		**53,333,269**	**724,746,349**
Scope 3													
Biogenic CO_2 from fuel			643,552			622,959			605,447			591,529	
Exported solid waste landfill gas			2,699,120			2,702,362			2,691,282			2,687,027	
Aviation emissions			14,345,894			14,146,259			15,733,804			14,343,938	
TOTAL Scope 3			**17,688,566**			**17,471,580**			**19,030,533**			**17,622,494**	

Municipal GHG Emissions Summary

	UNITS	FY 2006			FY 2007			FY 2008			CY 2008		
		CONSUMPTION	$MTCO_2e$	MMBTU	CONSUMPTION	$MTCO_2e$	MMBTU	CONSUMPTION	$MTCO_2e$	MMBTU	CONSUMPTION	$MTCO_2e$	MMBTU
Buildings													
Distillate fuel oil	gallons	22,508,188	229,652	3,121,671	23,981,074	244,680	3,325,947	22,069,094	225,172	3,060,773	22,312,339	227,539	3,094,509
Electricity	kWh	3,087,522,959	1,169,578	10,537,621	3,254,020,244	1,197,197	11,105,871	3,300,869,846	1,159,955	11,265,767	3,303,755,994	1,160,970	11,275,618
Natural Gas	therms	103,772,646	552,029	10,377,265	108,142,419	575,274	10,814,242	107,575,157	572,257	10,757,516	102,609,982	545,844	10,260,998
Propane	gallons				27,956	162	2,545						
Residual fuel oil	gallons	20,328,026	241,050	3,042,912	18,768,141	222,553	2,809,412	20,453,024	242,533	3,061,623	20,614,802	244,451	3,085,840
Steam	Mlbs	1,813,855	132,238	2,026,405	1,881,702	142,249	2,102,202	1,900,890	136,563	2,123,639	1,864,991	133,984	2,083,534
Streetlights and traffic signals													
Electricity		306,246,001	116,008	1,045,208	305,782,427	112,501	1,043,626	304,843,185	107,125	1,040,420	305,529,815	107,366	1,042,764
Wastewater treatment													
Distillate fuel oil	gallons	4,447,923	45,382	616,884	4,920,952	50,209	682,489	4,866,711	49,655	674,966	4,492,773	45,822	623,105
Electricity	kWh	587,886,001	222,696	2,006,437	601,576,209	221,328	2,053,161	601,624,495	211,416	2,053,326	607,198,511	213,375	2,072,350
Methane	MT		148,455			260,372			248,903			261,642	
Natural Gas	therms	3,677,037	19,560	367,704	5,657,225	30,094	565,723	7,339,970	39,046	733,997	7,150,481	38,038	715,048
Nitrous oxide	MT		64,649			64,649			64,649			64,649	
Propane	gallons				481	3	44	817	5	74	471	3	43
Steam	Mlbs	2,822	206	3,153	3,262	247	3,644	5,024	361	5,613	4,945	355	5,524
Water supply													
Distillate fuel oil	gallons	139,367	1,422	19,329	154,189	1,573	21,385	233,216	2,340	32,345	199,776	1,992	27,707
Electricity	kWh	62,132,608	23,536	212,057	65,428,474	24,072	223,305	68,332,051	24,012	233,215	66,804,052	23,476	228,000
Kerosene	gallons				15,841	156	2,139	21,176	208	2,859	24,386	239	3,292
Natural Gas	therms	502,343	2,672	50,234	509,724	2,712	50,972	647,374	3,444	64,737	713,863	3,797	71,386
Propane	gallons	1,079,769	6,241	98,310	1,171,819	6,774	106,691	1,302,280	7,528	118,569	1,178,524	6,812	107,302
Steam	Mlbs	3,720	271	4,156	3,850	291	4,301	4,426	318	4,945	4,241	305	4,738
Transportation													
Diesel and biodiesel - trucks	gallons	15,216,757	154,513	2,110,419	15,452,221	156,749	2,143,076	15,577,983	152,440	2,160,518	16,802,382	164,048	2,330,330
Diesel - marine vessels	gallons	4,265,000	43,290	591,515	4,348,900	44,141	603,151	4,481,941	44,880	621,603	4,333,623	43,364	601,032
Diesel - solid waste export, rail	gallons	6,180,180	62,729	857,132	7,143,726	72,509	990,767	7,041,958	72,162	976,652	7,596,634	77,846	1,053,581
Diesel - solid waste export, truck	gallons	18,392,980	186,765	2,550,931	17,028,924	172,744	2,361,750	14,155,661	143,822	1,963,255	10,255,163	104,193	1,422,293
Ethanol (E85)	gallons	123,000	166	15,281	82,515	111	10,251	76,340	147	9,484	94,389	159	11,727
Gasoline	gallons	15,170,768	123,889	1,884,787	15,548,762	126,862	1,931,749	15,801,166	129,240	1,963,107	15,297,459	124,716	1,900,527
Jet fuel	gallons	227,126	2,197	30,662	261,864	2,533	35,352	233,303	2,256	31,496	228,414	2,209	30,836
Solid waste facilities													
Methane	MT		127,148			119,452			111,755			109,703	
Other fugitive and process emissions													
HFCs - municipal fleet	MT		11,370			11,563			11,685			11,580	
Total Scope 1			**2,023,180**	**25,735,038**		**2,165,874**	**26,457,683**		**2,124,124**	**26,233,575**		**2,071,201**	**25,339,556**
Total Scope 2			**1,664,533**	**15,835,036**		**1,697,884**	**16,536,111**		**1,639,750**	**16,726,925**		**1,679,120**	**17,323,524**
Total Scope 1 and 2			**3,687,714**	**41,570,074**		**3,863,757**	**42,993,794**		**3,763,875**	**42,960,500**		**3,718,476**	**42,052,084**
Scope 3													
Employee commute			224,207			223,248			237,830			22,445	
Biogenic CO_2e from fuel			13,625			13,746			20,940			234,365	
Employee solid waste			174,178			176,400			179,015			176,856	
Scope 3 Total			**412,010**			**413,394**			**437,785**			**429,070**	

Figures and Tables

All calculations presented in this report are based on data submitted to the New York City Mayor's Office. While every effort has been made to ensure these data's accuracy, the possibility for errors exists. This report is not intended to be a flawless accounting of New York City's carbon emissions, but is rather intended to provide guidance from which policy decisions may be based. The City of New York does not accept responsibility for the completeness or accuracy of this report, and it shall not be held liable for any damage or loss that may result, either directly or indirectly, as a result of its use.

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