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INVENTORY OF NEW YORK CITY GREENHOUSE GAS EMISSIONS

DECEMBER 2012

A GREENER, GREATER NEW YORK

The City of New York
Mayor Michael R. Bloomberg

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planYC

A GREENER, GREATER NEW YORK

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

Climate change is one of the most urgent challenges the world faces, and the City of New York is determined to take meaningful steps to address it. As we saw with Hurricane Sandy, we already face serious risks from extreme weather events, and scientists expect these risks to increase as our climate changes. That is why—since 2007, when we launched PlaNYC, our plan to build a greener, greater New York—we have been working not only to strengthen our city's resilience to extreme weather events, but also to cut our greenhouse gas (GHG) emissions.

For the sixth year, we are publishing an inventory of GHG emissions attributable to activities that occur in the city. Publicizing this data is an important way to track the investments we have made and the policies we have implemented to reduce New York City's contribution to global GHG levels. This report indicates that we are already achieving results, but that much more remains to be done.

When we started this effort, New York City's per capita GHG emissions levels were already one of the lowest among major global cities—and they remain one-third of the U.S. average. Around the world, cities are taking action against climate change, and New York City is also working diligently to reduce our GHG emissions. While urban living is generally less GHG-intensive than suburban living on a per capita basis, cities are estimated to be the source of approximately 70 percent of global GHG emissions. At a time when national governments and international bodies are not acting to reduce GHG emissions to the levels needed to avoid the most serious effects of climate change, municipal governments are using many of the tools they possess to reduce emissions: tools such as building and zoning codes, investments in lower-carbon forms of transportation, and diversion of solid waste from landfills, for example.

PlaNYC includes a range of strategies to reduce GHG emissions. In 2007, PlaNYC set an ambitious goal: to reduce citywide GHG emissions by more than 30 percent by the year 2030. We also made a commitment to measure our progress annually, with a GHG inventory like the one you are reading now. It is one of the most detailed municipal inventories in the world.

This year's inventory, covering 2011 emissions, demonstrates that we have again reduced citywide GHG emissions—and that we have achieved more than half of the reductions necessary to reach our target of a 30 percent reduction by 2030. In addition, emissions from municipal operations and properties are significantly below our base year levels.

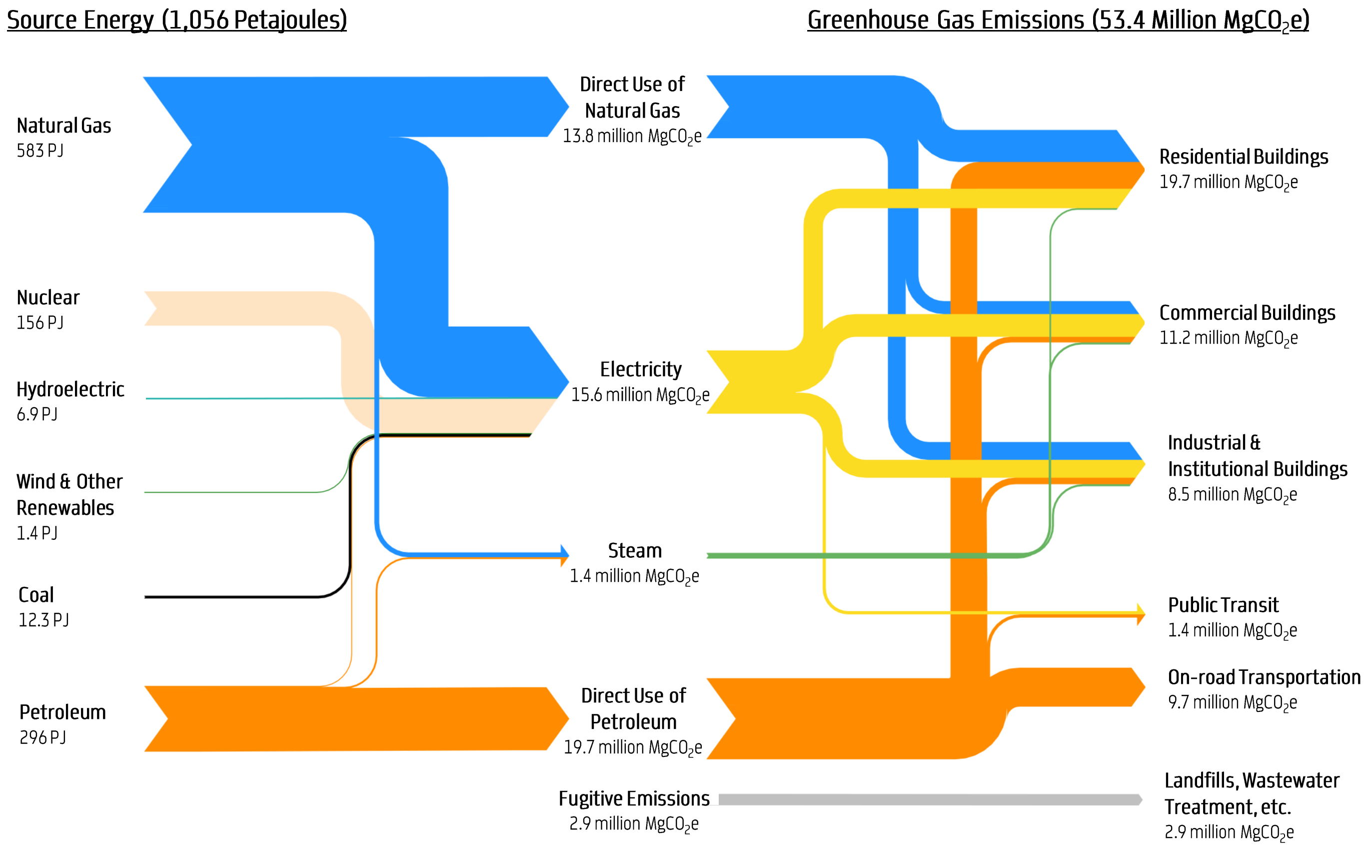
PlaNYC will not only create a greener, greater city for this and future generations of New Yorkers, but also reduce our contributions to the greenhouse gases that currently threaten the environment and the economy. I invite you to learn more in this important report.

Mayor Michael R. Bloomberg

New York City Energy Use and Greenhouse Gas Emissions

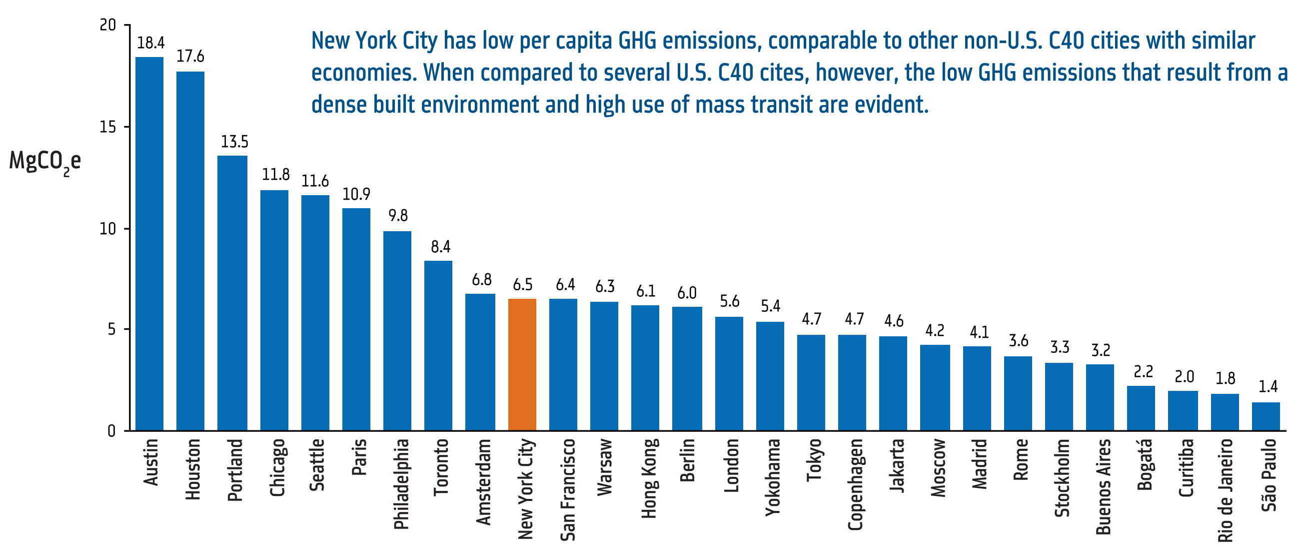
Greenhouse gases arise from the use of energy and from several industrial processes. Buildings are responsible for 74 percent of citywide greenhouse gas emissions through the use of heating fuel, natural gas, electricity, and steam. Energy use in the transportation sector contributes an additional 21 percent. The remaining emissions stem largely from fugitive emissions released at landfills and wastewater treatment plants.

Fig. 1: 2011 New York City Energy Use and Greenhouse Gas Emissions



Source: NYC Mayor's Office

Fig. 2: Per Capita GHG Emissions for C40 Cities*



*The C40 Cities Climate Leadership Group (C40) is a network of the world's megacities committed to addressing climate change.
Per capita GHG emissions from Los Angeles, Melbourne, Rotterdam, and Sydney are excluded due to incomparable data.

Source: The Carbon Disclosure Project, Measurement for Management, CDP Cities 2012 Global Report

Executive Summary

New York City's greenhouse gas emissions are 16 percent lower now than in 2005 and the city is more than halfway toward achieving the PlaNYC goal of a 30 percent reduction by 2030. Cleaner generation of electricity and steam was the leading driver of emissions reductions as less carbon-intensive natural gas displaced coal and oil-fired generation, and as the power plant fleet was modernized. New Yorkers have also become more efficient energy users. From 2005 to 2011, total energy use remained flat while the local economy, population, and building floor area grew significantly.

Human activities such as industrial processes, fossil fuel combustion, and changes in land use such as deforestation are disturbing the natural balance of greenhouse gas (GHG) emissions in the atmosphere. The continuous addition of these gases to our atmosphere and the reduction of mitigating "sinks" results in destabilizing impacts on climate and weather patterns. Even small changes in average temperatures can result in an increase in the frequency and intensity of severe weather events, ecosystem changes, loss of animal and plant species, stresses to human health, and other effects.

To mitigate these serious consequences of climate change, people have a responsibility and a self-interest in sharply reducing GHG emissions. In 2007, New York City committed to a 30 percent reduction in citywide GHG emissions below 2005 levels by 2030. It also set a goal of a 30 percent reduction in municipal government emissions below fiscal year (FY) 2006 levels by 2017. These goals are codified into law, as is the requirement that the City produce an annual assessment and analysis of its GHG emissions.

Accordingly, this inventory reports on two inter-related sets of data: the GHG emissions attributable to all activities that occur within the City of New York, including those related to individual residents, companies, non-City-owned transportation, etc., which are aggregated as the "citywide" inventory, (referred to as "community" in relevant GHG protocols) and the GHG emissions directly attributable to municipal operations of the City government, such as the energy used to heat schools and propel fire trucks, and fugitive emissions resulting from the treatment of sewage or disposal of solid waste, which are aggregated as the "City government" inventory.

This document provides critical information on the trends of GHG emissions and the many factors that influence them. Inventories help guide and document the impact of the City's ongoing sustainability efforts outlined in PlaNYC, such as efforts to make the city's buildings more energy-efficient, clean the city's power supply, develop lower-carbon transportation options, and reduce fugitive GHG emissions from solid waste disposal, wastewater treatment, and other sources.

Citywide emissions changes from 2005 to 2011:

- Citywide emissions were 16.1 percent lower in 2011 than 2005, surpassing the half-way point of the PlaNYC goal of a 30 percent reduction by 2030.
- Reduced carbon intensity of the city's electricity supply was the largest driver of GHG emissions reduction, reducing GHG emissions by more than 7 million metric tons.
- Total energy use remained flat while the local economy, population, and building floor area have grown.
- New Yorkers reduced electricity and heating fuel use per building square meter, and reduced per capita vehicle use and solid waste generation.
- Fugitive sulfur hexafluoride (SF_6) emissions from electricity distribution and methane from exported solid waste decreased significantly.

Reductions in energy use per building square meter indicate that New Yorkers used energy more efficiently in 2011 than in 2005, indicating that PlaNYC's initiatives are beginning to take effect.

Because the generation and use of electricity is the largest source of emissions attributable to activities in New York City, the transition to a less carbon-intensive electricity supply is the largest driver of both citywide GHG emissions reductions from 2005 to 2011 and City government GHG emissions from FY 2006 to FY 2011. The GHG coefficient of New York City's electricity supply declined by over 30 percent due to less expensive natural gas displacing oil- and coal-fired generation, as well as investments in new and cleaner generation, the retirement of coal-fired and other inefficient generation, and several other factors. Market forces as well as local, state, and federal policies all influenced changes in the fuel mix of the city's electricity supply.

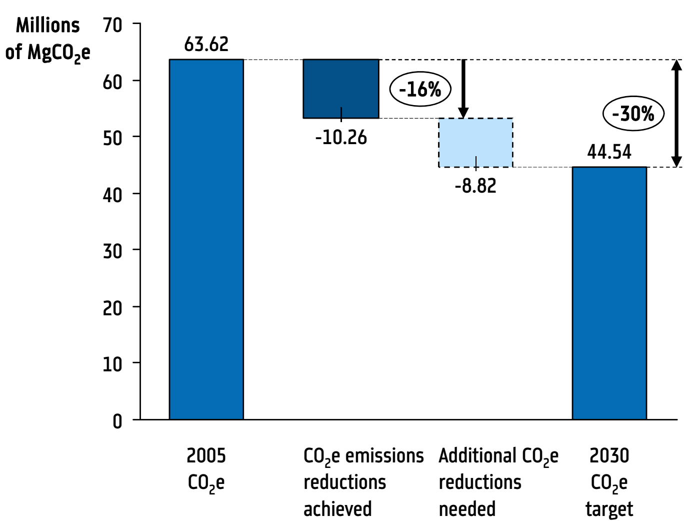
City government emissions changes from FY 2006 to FY 2011:

- City government emissions were 8.4 percent lower in FY 2011 than FY 2006, more than one-quarter of the City's goal of a 30 percent reduction by 2017.
- Reduced carbon intensity of the city's electricity supply was the largest driver, reducing GHG emissions by more than 360,000 metric tons ($MgCO_2e$).
- Buildings reduced use of more carbon-intensive heating oil while increasing natural gas, steam, and electricity use.
- Transportation fleets decreased emissions, led by reductions in solid waste export emissions and the adoption of alternative fuel and more efficient vehicles.
- Streetlights and wastewater treatment plants (WWTPs) both used less electricity, while maintaining their vital services.
- Total electricity use in buildings increased beyond weather-induced demand, reflecting programmatic additions in several agencies. Continued, ongoing energy efficiency investments have helped to moderate resulting increased electricity demand.

The City's efforts to meet its PlaNYC goal of a 30 percent reduction in government emissions below FY 2006 levels by FY 2017 are starting to pay off. The City's investments in energy efficiency upgrades to its buildings laid out in the *Long-Term Plan to Reduce Municipal Energy and Greenhouse Gas Emissions of Municipal Buildings and Operations* have already reduced energy use and emissions.[1] Reducing City government GHG emissions 30 percent by 2017 is a significant challenge, one that will require concerted efforts and continued commitment of resources. The City recognizes this challenge and is continuing to implement new strategies to ensure it reaches its target.

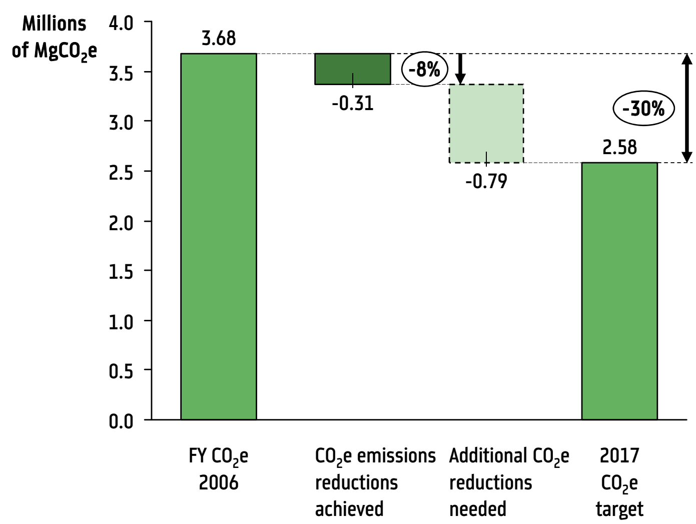
While a reduction in the carbon intensity of the city's electricity supply has been the principal driver of changes to both citywide and City government emissions to date, many of PlaNYC's initiatives are showing results and are projected to contribute further to achieving the City's GHG reduction targets. City government operations and facilities are reducing GHG emissions through measures like investments in energy efficiency retrofits in City buildings, additional and improved landfill methane capture, increased efficiency in transportation of solid waste to landfills outside the city, and the reduction of methane leaks at wastewater treatment plants. Citywide GHG emissions are being reduced through such measures as the benchmarking and reduction of energy use by large buildings in the city, the commitment of leading universities, hospitals, Broadway theaters, and commercial tenants to reduce energy, the passage of regulations to phase out the use of heavy fuel oil in the city's buildings, and the the revision of building codes to require energy savings.

Fig. 3: Citywide CO_2e Emissions Reduction Summary



Source: NYC Mayor's Office

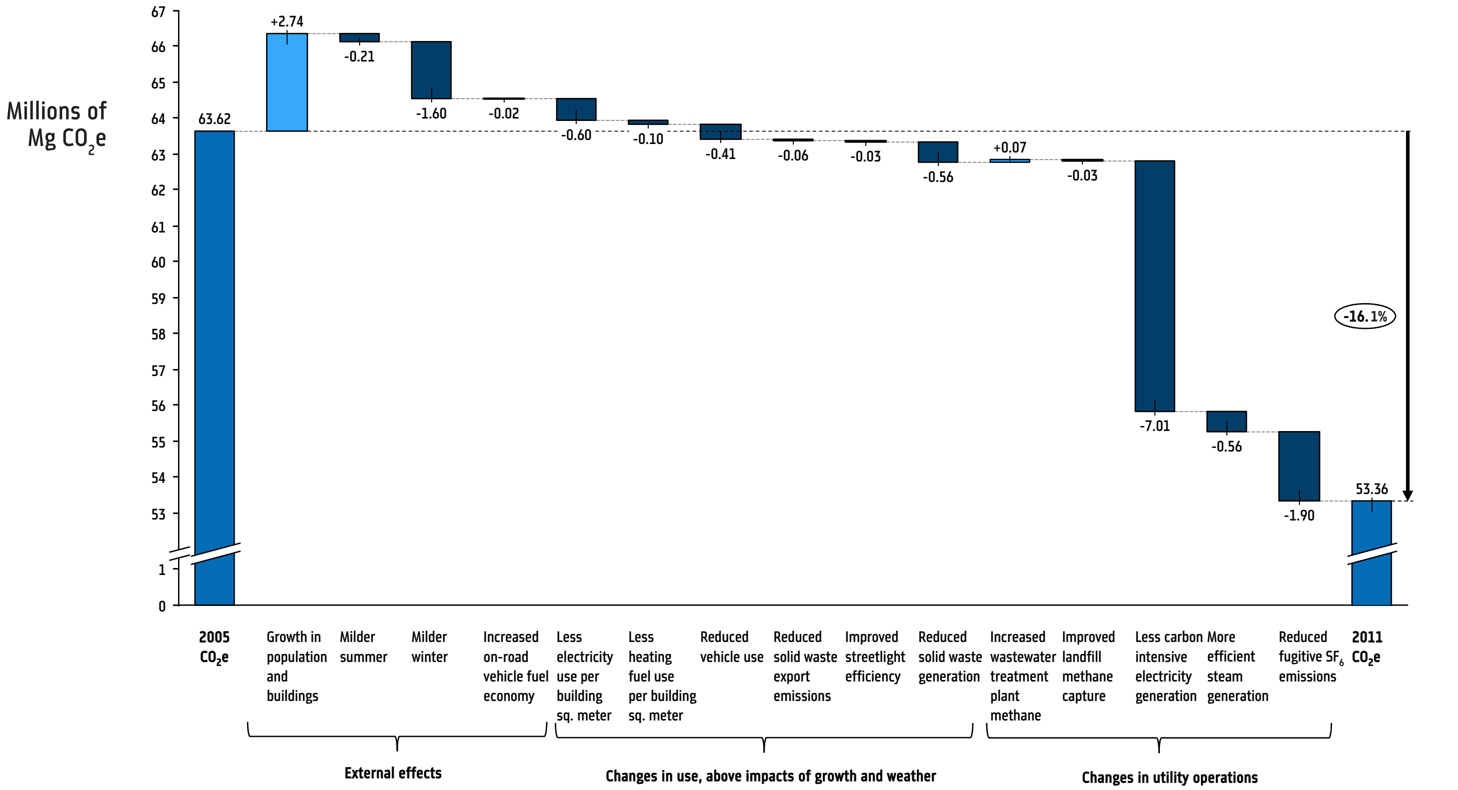
Fig. 4: City Government CO_2e Emissions Reduction Summary



Source: NYC Mayor's Office

Fig. 5: 2005 to 2011 Changes in New York City GHG Emissions

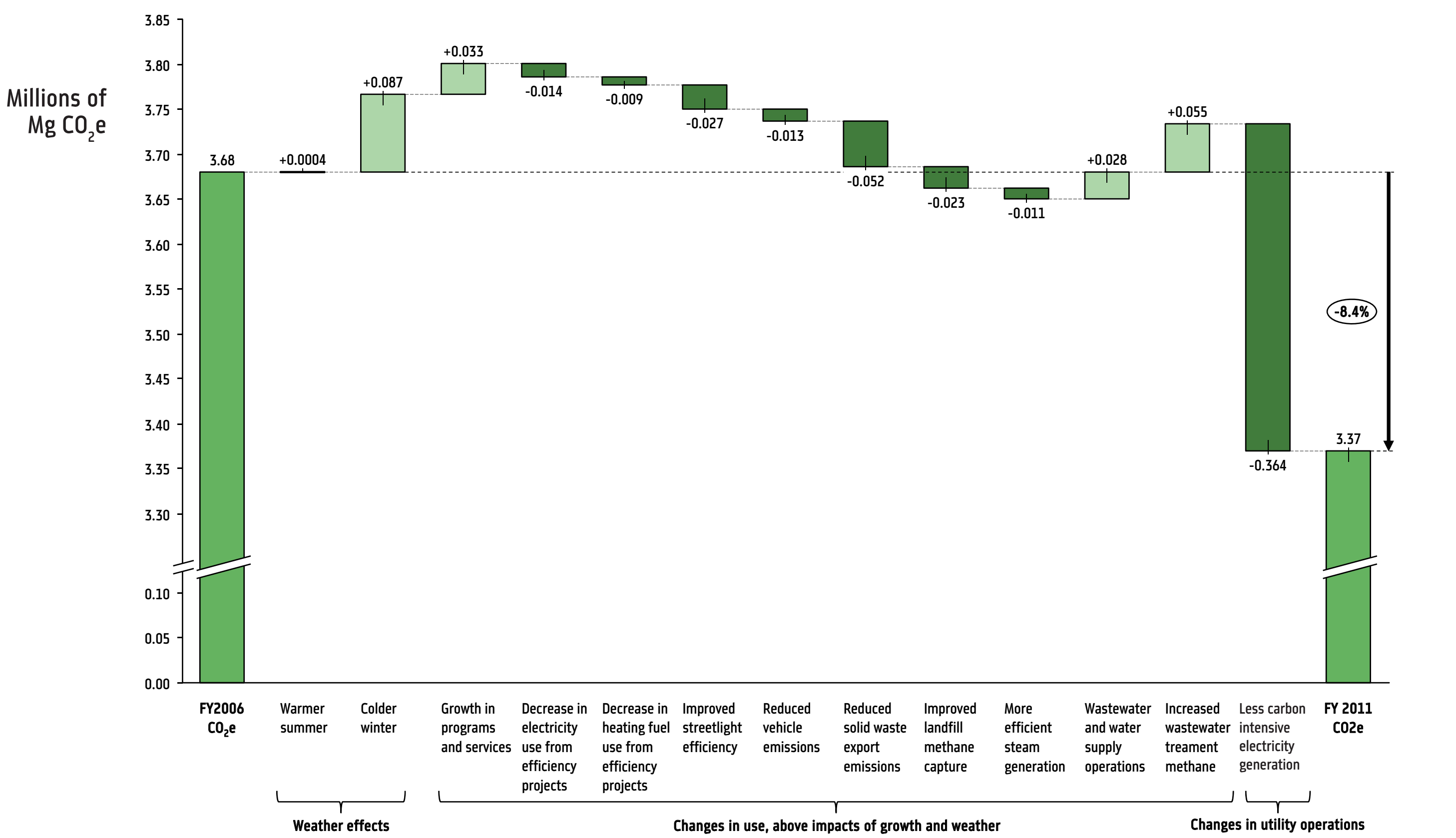
From 2005 to 2011, New York City reduced per building area energy use and per capita vehicle use and solid waste generation, while a cleaner electricity supply drove down GHG emissions. In 2011, the city reached the halfway point of its 30 percent reduction by 2030 goal.



Source: NYC Mayor's Office

Fig. 6: FY 2006 to FY 2011 Changes in New York City Government GHG Emissions

From FY 2006 to FY 2011, the New York City government began to reduce its own energy use, while a cleaner electricity supply drove down GHG emissions. In FY 2011, the City government reached the one-quarter point of its 30 percent reduction by 2017 goal.



Source: NYC Mayor's Office

Introduction

New York City reduced citywide greenhouse gases for the fifth consecutive year and is more than halfway toward its PlaNYC reduction target of 30 percent by 2030.

The City of New York established the goal of reducing citywide (community) greenhouse gas emissions by 30 percent below 2005 levels by 2030 in its comprehensive sustainability plan, PlaNYC (2007). Rigorous analysis concluded that this goal was both ambitious and achievable, and this was re-affirmed in the 2011 update to PlaNYC. As part of implementing PlaNYC, Mayor Bloomberg signed Executive Order 109 in October 2007, which mandated even more aggressive greenhouse gas reductions for municipal government facilities and operations: 30 percent below fiscal year (FY) 2006 levels by 2017.

To inform both the citywide and City government greenhouse gas reduction efforts, the City released its first comprehensive greenhouse gas inventory in April 2007 (*2005 Inventory*), establishing the base levels from which the city's greenhouse gas reduction targets are set.[2] In January 2008, the City Council passed Local Law 22 of 2008, requiring the City to update the citywide and government inventories annually to document progress the city is making. In accordance with this law, the City released its first annual updated greenhouse gas inventory in September 2008 (*2007 Inventory*),[3] and annual updates in September 2009 (*2008 Inventory*),[4] September 2010 (*2009 Inventory*),[5] and September 2011 (*2010 Inventory)*.[6] This document (*2011 Inventory*) is the City's fifth annual greenhouse gas inventory update.

Methodologies and protocols for calculating GHG inventories for cities are continually evolving and New York City has contributed significantly to the development of updated standards both in the U.S and internationally. For both the "citywide" inventory and the "City government" inventory, the document includes updates to the base year and past years' inventories, applying current protocols and methodologies and incorporating better data, which allows for comparability across multiple years. The inventory also includes explanations of the factors that are driving changes in GHG emissions.

This year, updated data, amended methodologies, and a revised electricity emissions coefficient resulted in a retroactive adjustment to FY 2006 government base year emissions levels of 3.8 percent, an increase in CY 2008 government base year emissions of 0.5 percent, and an increase in CY 2005 citywide emissions levels of 3.3 percent. The City government inventory is completed in compliance with the *Local Government Operations Protocol* (LGOP).[7] At time of publication, several efforts were underway to develop community-level greenhouse gas protocols including: ICLEI-Local Governments for Sustainability (ICLEI), C40 Cities Climate Leadership Group (C40), the World Bank, and the World Resources Institute (WRI) *Global Protocol For Community-Scale Greenhouse Gas Emissions* (GPC);[8] ICLEI – Local Governments for Sustainability USA *U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions* (USCP);[9] and the New York State Energy Research and Development Authority (NYSERDA) *New York State Regional Greenhouse Gas Protocol.*[10] This inventory is drafted to be consistent with each of these guidance documents, where appropriate and applicable. Upon final publication of these protocols, the City will update its methodology and results in future inventory updates, starting in September 2013.

Analysis of the changes in GHG emissions is critical to developing policies to achieve additional GHG reductions. Changes reflect several factors, including: the impact of weather and growth in population and building stock on energy use; an increase in cleaner imported power; new, more efficient in-city power generation and increased natural gas-fired electricity generation; changes in the amount of methane (CH_4) emitted from the city's WWTPs and landfills; the impact of more efficient streetlights; and decreased sulfur hexafluoride (SF_6) emissions used for citywide electricity distribution.

A major factor influencing the change in emissions levels from the base years was the market prices of fuels used to generate electricity (natural gas, oil, and coal), commissioning of new state-of-the-art in-city power plants—two in 2006 and one in 2011—and the retirement of inefficient generation. This reduction in the carbon-intensity of New York City's electricity supply resulted in an adjustment in the electricity emissions coefficient used in this inventory to estimate GHG emissions. An in-depth analysis of changes to the city's electricity supply is included in on page 11.

Overall, New Yorkers are becoming more efficient, as seen in the reduction in electricity and heating fuels use per building square meter. Further, total energy use remained flat while the local economy, population, and building floor area have all grown. These data show that New Yorkers used energy more efficiently in 2011 than they did in 2005, indicating that PlaNYC's initiatives are beginning to take effect.

Citywide Inventory

Citywide GHG emissions were 3.3 percent lower in 2011 than 2010 because of milder weather, less carbon-intensive electricity and steam generation, reduced solid waste generation, and reduced vehicle use. From 2005 to 2011, total energy use has remained flat while the local economy, population, and building floor area have grown.

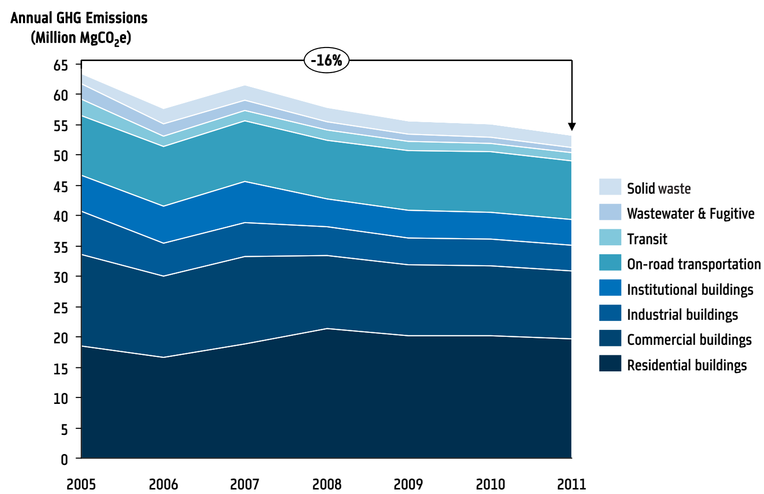
The citywide inventory consists of all direct and indirect emissions from energy used by buildings and stationary sources, on-road transportation, and public transit (excluding aviation and marine transportation) within New York City; fugitive emissions from wastewater treatment, in-city landfills, solid waste disposed outside the city, and electricity and natural gas distribution within New York City; and emissions associated with the transportation of solid waste exported outside of the city. New York's 2011 citywide GHG emissions inventory follows current standard international conventions, past City analysis and reporting precedents, and, where appropriate and applicable, new emerging citywide GHG emissions protocols. Adherence to, and consistent application of, these standards is critical to accurately assess and report citywide GHG emissions.

Citywide 2011 inventory results

In 2011 total GHG emissions in New York City were 53.4 million $MgCO_2e$, 16.1 percent below 2005 base year emissions of 63.6 million $MgCO_2e$, and 3.3 percent below 2010 emissions. 2011 GHG emissions are broken down as follows:

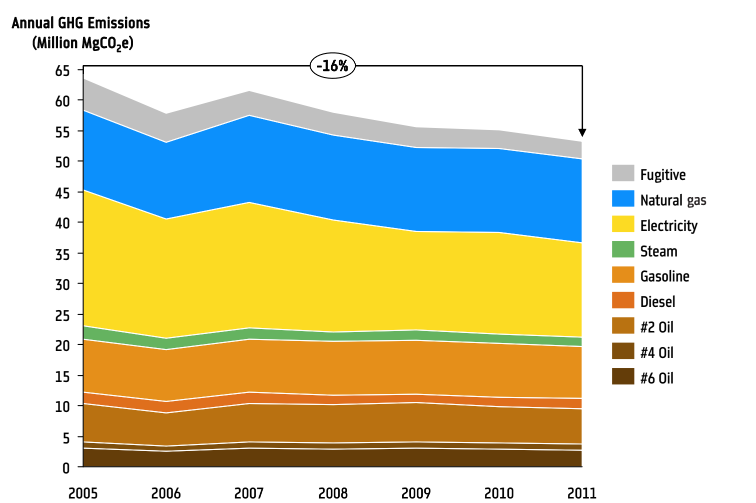
- **Scope 1 GHG emissions:** 34,380,300 $MgCO_2e$ *(direct emissions from on-site fossil fuel combustion or fugitive emissions from within the city's boundary)*
- **Scope 2 GHG emissions:** 17,011,705 $MgCO_2e$ *(indirect emissions from energy generated in one location, but used in another, such as district electricity and steam)*
- **Scope 3 GHG emissions:** 1,966,963 $MgCO_2e$ *(indirect emissions that occur outside the city's boundary as a result of activities within the city's boundary, e.g. emissions from exported solid waste included in the city's total emissions results)*
- **Scope 3 GHG emissions not included in the city's total emissions results:** 15,045,713 $MgCO_2e$ *(e.g. emissions from domestic and international aviation, reported as information items only)*
- **Additional emissions that are reported but not counted toward the city's total emissions results:** 597,567 $MgCO_2e$ *(e.g. biogenic emissions from combustion of biofuel)*

Fig. 7: 2005 to 2011 Citywide GHG Emissions by Sector



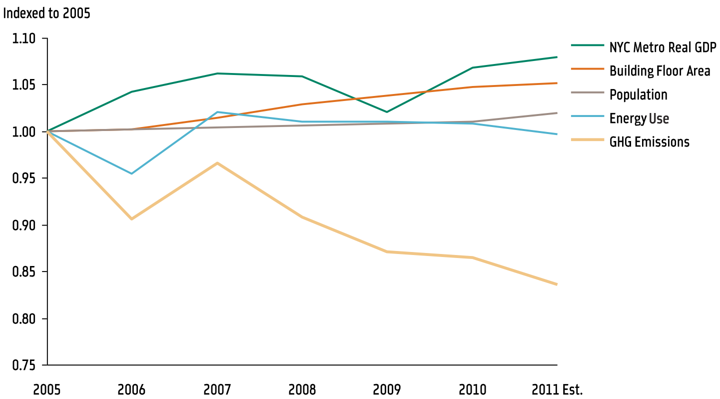
Source: NYC Mayor's Office

Fig. 8: 2005 to 2011 Citywide GHG Emissions by Source



Source: NYC Mayor's Office

Fig. 9: Energy, Emissions, and Economic Indicators



Source: NYC Mayor's Office, US Bureau of Economic Analysis, US Census Bureau, NYC Department of Finance

The economy, population, and building floor area of New York City increased while energy use and greenhouse gas emissions decreased from 2005 to 2011.

Changes to citywide emissions

The City analyzed all factors that could affect changes to citywide GHG emissions, such as weather, population growth, increase in building floor area, and changes to the city's electricity and steam supply. Using these data, the City determined drivers—such as per square meter energy use or per capita transit use—that could be influenced by future GHG mitigation policies.

2005-2011 changes

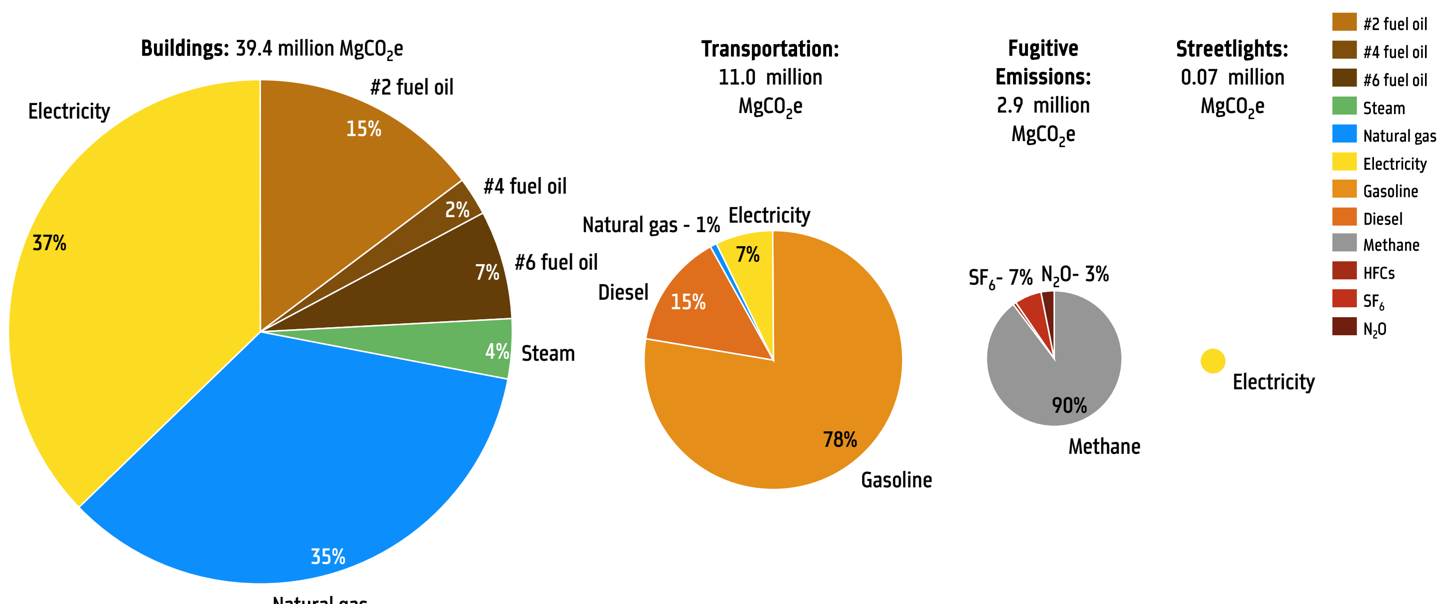
Milder winter and summer temperatures in 2011 compared to the 2005 base year, reductions in energy use per unit of building area, changes to the carbon intensity of the city's electricity and steam supply, reduced solid waste generation, and a reduction in fugitive SF_6 emissions from electricity distribution are most responsible for reducing the city's GHG emissions 16.1 percent from 2005 to 2011—more than halfway to the City's 30 percent reduction target in only five years. These reductions were offset by growth in both population and building floor area. When external factors of weather, growth, fuel economy, and electricity and steam carbon intensity are excluded, overall GHG emissions decreased by 5.7 percent during this period.

Perhaps the most important changes recognized from 2005-2011 are reductions in electricity and heating fuel use per building square meter, per capita vehicle miles traveled, and per capita solid waste generation, showing that New Yorkers became more efficient and less wasteful. During this time period gross metropolitan-area product grew 8 percent (1.3 percent CAGR), population grew 2 percent (0.3 percent CAGR), and building floor area grew 5 percent (0.8 percent CAGR) while total energy use remained flat (see Figure 9). Details of these changes are presented in Figure 5.

2010-2011 changes

Citywide GHG emissions decreased by 3.3 percent from 2010 to 2011, driven by a milder winter and summer, an increase in importation of cleaner electricity and less-carbon intensive in-city electricity generation, reduced solid waste generation, reduced on-road vehicle travel, reduced transit service, and a decrease in fugitive SF_6 emissions from electricity distribution. These major reductions were partially offset by growth in both population and building floor area and an increase in electricity and heating fuel use per building square meter (during this period the city's population growth rate was approximately double the building floor area growth rate). When weather, growth, and changes to the carbon intensity of the electricity and steam supply are excluded, citywide GHG emissions decreased only slightly by 0.8 percent. Details of these changes are presented in Figure 11.

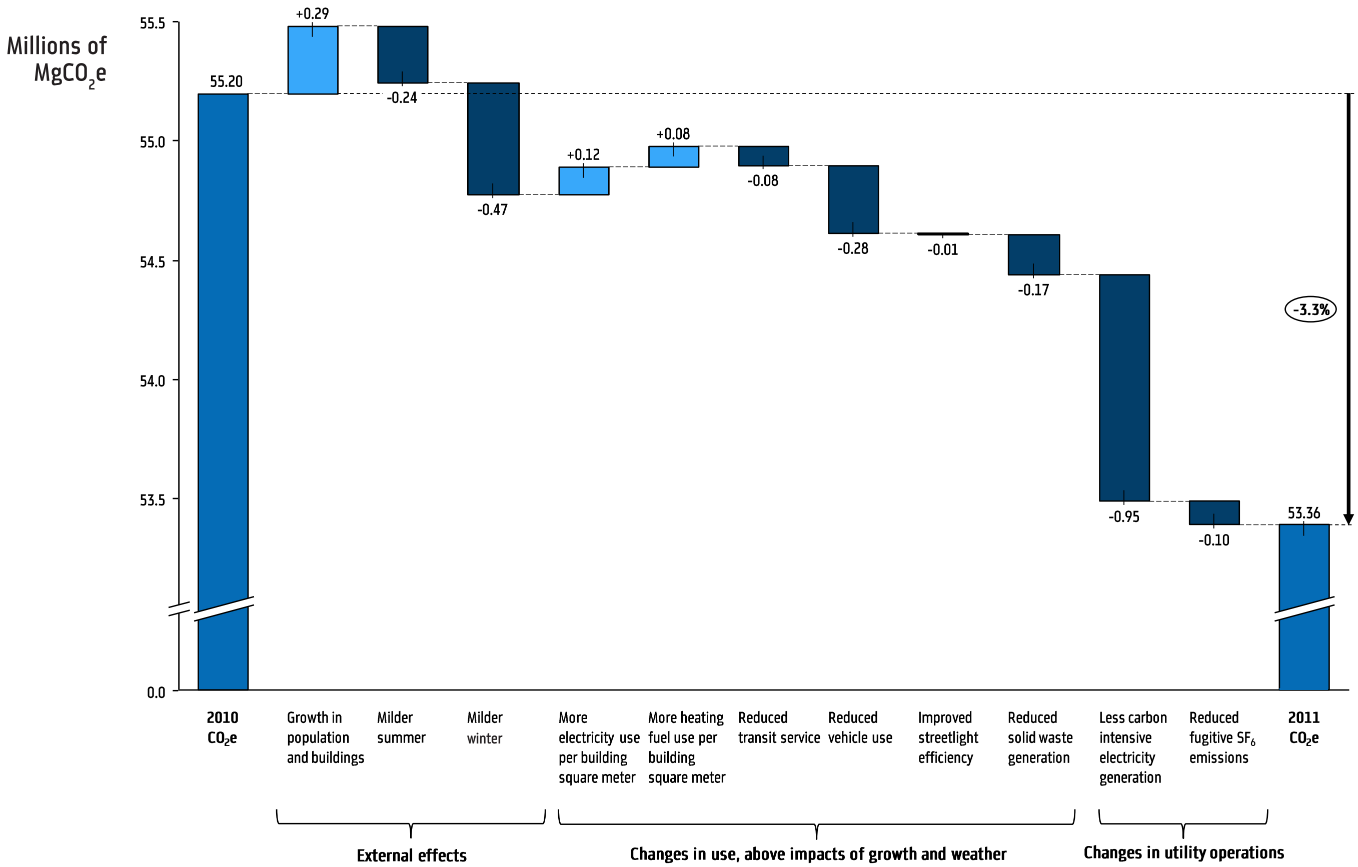
Fig. 10: 2011 Citywide GHG Emissions by Source and Sector



Source: NYC Mayor's Office

Fig. 11: 2010 to 2011 Changes in New York City GHG Emissions

From 2010 to 2011, milder weather, less road vehicle use, less solid waste generation and a cleaner electricity supply drove the largest reductions in GHG emissions.



Source: NYC Mayor's Office

Citywide methodology for analysis of change

The City calculated changes in CO_2e emissions and energy use in each sector to determine the effect of factors driving such changes, such as growth, weather, and changes in carbon intensity of the city's electricity and steam supply. The change in population was applied to all non-building emission sources, while the change in building floor area was applied to building emissions sources to determine the collective net impact these drivers had on GHG emissions. The City conducted regression analyses for each building energy source (due to data availability City government steam and fuel oil use was used as a proxy for citywide use) using data on monthly energy use and heating degree and cooling degree days to determine the correlation of weather to building energy use. This was used to calculate the impact of energy use beyond that resulting from changes in weather. The results of this analysis determined the expected use of electricity, fuel oil, natural gas, and steam for each year, which were divided by the use of each energy source in the earlier year for each period to determine a weather impact factor. This factor was then multiplied by the building's energy use for each source to determine the impact weather had on the use of building energy use. The results of regression analyses for electricity, natural gas, steam, and fuel oil are shown in Appendix G.

Per capita and per building square meter trends were determined by subtracting the rate of overall population (for non-building sectors) and building floor area change and the weather impact factor, and the carbon intensity change from the change in GHG emissions for each energy source in each sector. The impact of revisions and updates to electricity and steam coefficients was determined by calculating the change in carbon intensity for each energy source in each sector, and multiplying this factor by the percentage that each energy source in each sector contributed to the inventory total. All citywide data sources are detailed in Appendix A.

Forthcoming protocols

As several relevant citywide level protocols are currently under development, this inventory is completed consistent with past New York City inventories and current standard practice, unless specified otherwise. Several additional emissions sources are likely to be included in future updates to this report, including: demand-based motor vehicle use, emissions from local and intercity marine transportation, emissions from local aviation, emissions from water use, off-road emissions (vehicles and construction equipment), and lifecycle and/or consumption based emissions. Should these sources be included in future inventories, past years' results will be updated accordingly.

Electricity Supply

The carbon intensity of New York City's electricity supply has decreased by 31 percent since 2005. This reduction resulted from increased natural gas-fired generation due to changes in energy market prices, new and repowered generation, and the retirement of old generation in New York State.

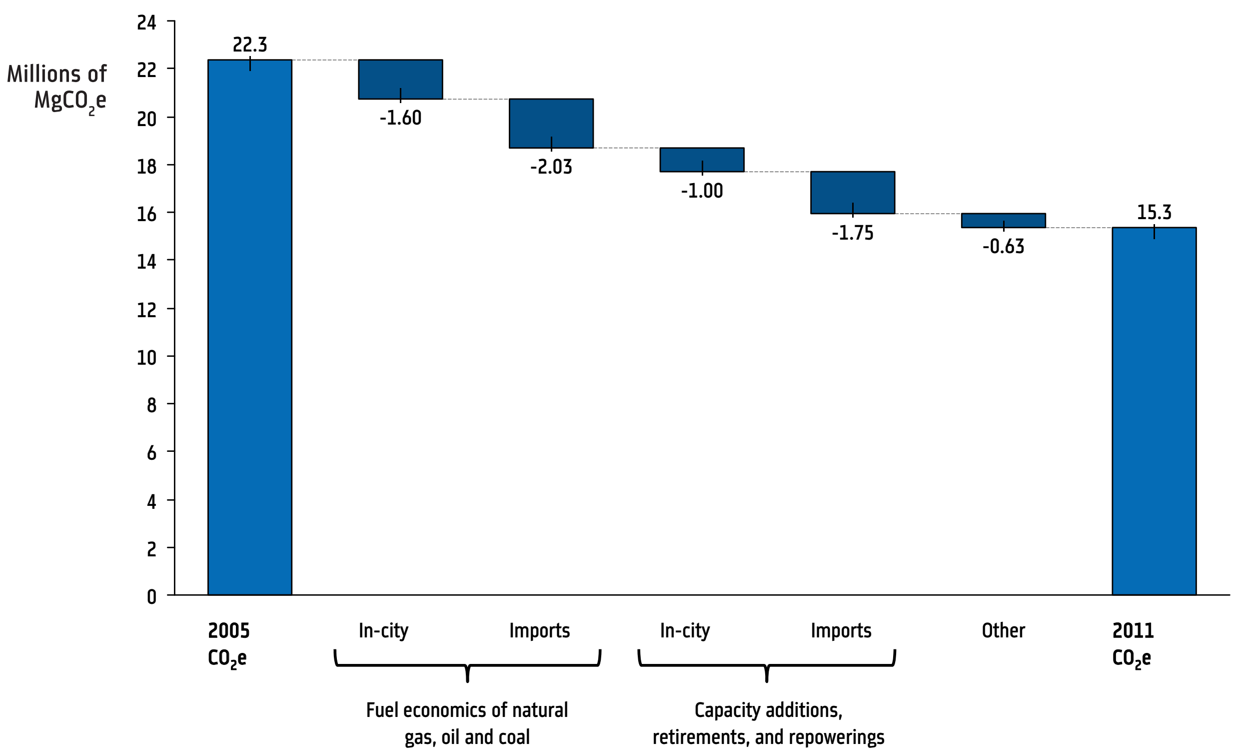
Electricity accounted for 45 percent of New York City's total energy use in 2011—the largest single category of source energy use. From 2005 to 2011, the gradual decarbonization of the electricity fuel mix and improvements in the average power plant efficiency were responsible for a decrease of 7.0 million $MgCO_2e$, or 68 percent of the decrease in citywide emissions from 2005.* This section describes the major drivers behind the reduction in emissions from electricity consumed in New York City.

Despite an increase in citywide annual electricity demand of 2 percent from 2005 to 2011 (CAGR of 0.27 percent), the amount of energy required to generate electricity and the resulting GHG emissions decreased by 14 percent and 31 percent respectively. There are several factors leading to GHG reductions in the electricity supply:

- Changes in market prices for oil, gas, and coal, and environmental regulations have moved electricity generation toward the use of less GHG-intensive fuels,
- Capital investments in new and repowered generation have increased the thermal efficiency of the electricity supply,
- The retirement of almost 400 megawatts (MW) of coal-fired generation in the Hudson Valley region.

Fig. 12: Electricity Emissions Drivers: 2005 vs. 2011

The reduction in GHG emissions from electricity use in New York City is a result of less expensive natural gas supplies, investment in new and more efficient generation, and the retirement of coal-fired generation in the Hudson Valley region.

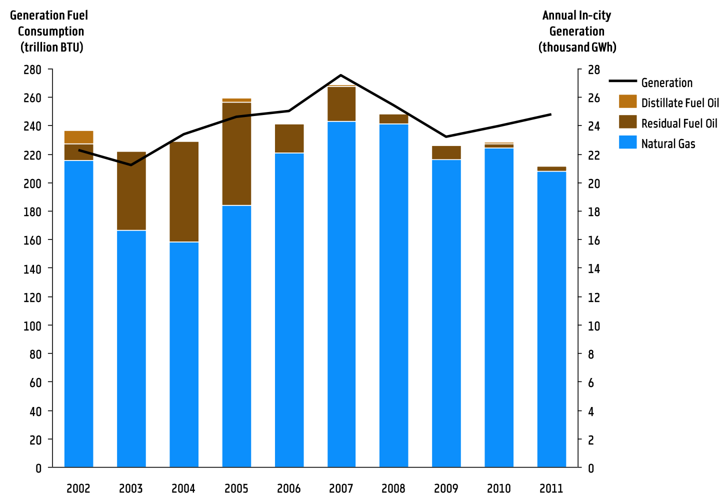


* Generation data is modeled by the Ventyx, Velocity Suite based on data reported by generators to the EPA, Nuclear Regulatory Commission, and the EIA.

Other factors that are attributable to lower electricity emissions are a calculated reduction in transmission and distribution losses, an increase in nuclear generation imported into New York City, and small generator capital changes.

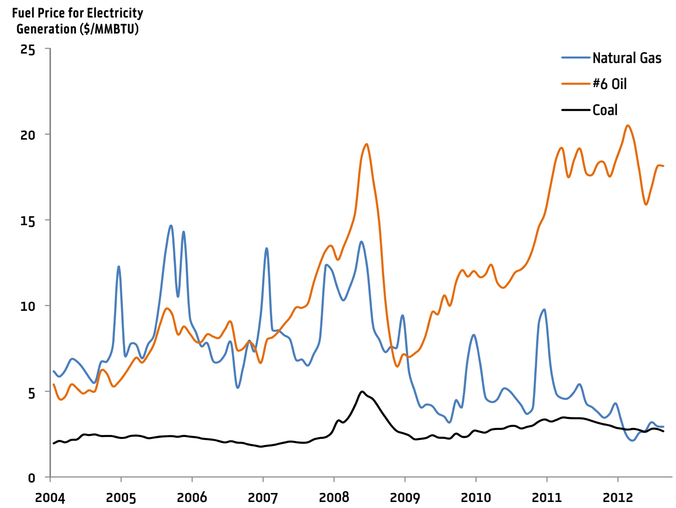
Source: NYC Mayor's Office

Fig. 13: Fuel Purchases for In-city Electric Power Generation



Source: NYC Mayor's Office, US Energy Information Administration

Fig. 14: Fuel Prices for Electric Power Generation in New York State



Source: NYC Mayor's Office, US Energy Information Administration

Power sector overview

In 2011, the installed electric generation capacity of power plants in New York City was 10,297 MW, or 91 percent of the 11,373 MW all-time peak demand that occured in July 2011. Roughly 49 percent of this capacity is natural gas-fired, 45 percent is dual-fuel (oil and gas) capable, and 6 percent is oil-fired. More than one-half of in-city generation units are older than 40 years, primarily steam and combustion turbine units that have annual capacity factors lower than 35 percent. In-city generation capacity served 46 percent of the annual generation demand in 2011, with the balance imported from the Hudson Valley region (37 percent), upstate New York (15 percent), and New Jersey (2 percent) according to the NYC electricity supply methodology.

Fuel economics

The largest source of GHG emissions reductions from the electricity sector—4.1 million $MgCO_2e$ (56 percent)—was caused by significant reductions in the price of natural gas relative to coal and fuel oil. From 2008 to 2011, natural gas prices across the U.S. have decreased to historic levels (in real terms) as a result of a 25 percent increase in domestic production of lower cost natural gas resources. Conversely, the price of fuel oil—more closely tied to trends in global oil prices—has increased significantly since 2005 (see Figure 14). Meanwhile, the price of coal has also increased steadily.

These factors had two effects on the electricity supply:

- **Fuel switching from oil to natural gas**: Operators of dual-fuel capable generation units within the city burned increasing amounts of gas and decreasing amounts of fuel oil to remain competitive in the electricity market. An additional regulatory factor was the change in the number of hours generators were required to use fuel oil under the New York Independent System Operator (NYISO)'s Minimum Burn Rule. From 2005 to 2011, the amount of oil used for generation in New York City decreased from 30 percent of the total fuel mix to only 2 percent; this resulted in a reduction of 1.6 million $MgCO_2e$ annually (see Figure 13).
- **Reduced competitiveness of fuel oil and coal-fired plants**: Generation from coal- and oil-fired units declined due to higher fuel prices (relative to natural gas) and the impact of state and federal environmental regulations. For example, generation from the 1,200 megawatt (MW) residual fuel oil-fired Roseton Generating Station and the 500 MW coal-fired Danskammer Generating Station in Orange County decreased significantly since 2005, reducing annual GHG emissions by 2 million $MgCO_2e$. The capacity factors for these generators decreased from 33 percent to 3 percent, and from 65 percent to 25 percent, respectively, since 2005.

Generator additions and retirements

Since 2005, power companies and utilities have invested billions of dollars in modernizing power generation assets within New York City and statewide. These investments included new combined cycle power plants, incremental capital improvements to existing power generation units, and retirement of some older facilities, resulting in a reduction of 2.75 million $MgCO_2e$, which represents roughly 40 percent of the electricity supply GHG reductions (see Figure 12).

In-city

From 2005 to 2011, New York City led the state with the most power generation capacity added and retired in any region. Power companies and utilities built more than 2,000 MW of new generation, and retired over 1,000 MW of old generation in New York City. The following major investments and retirements reduced New York City's annual GHG emissions by 1 million $MgCO_2e$:

- **East River Cogeneration**: Con Edison developed 356 MW of new cogeneration capacity at the East River generating facility, replacing 160 MW of old generation units in 2005.
- **Astoria Energy and Astoria Energy II**: Over 1,100 MW of state-of-the-art combined cycle gas turbine units began operation: Astoria Energy in 2006 and Astoria Energy II in 2011. This inventory includes six months of operation of the Astoria Energy II facility, which began operation in July 2011.
- **NYPA Astoria Generation**: NYPA developed 500 MW of combined cycle generation at this site in 2006. In January 2010, NYPA retired the Charles Poletti 885 MW steam turbine unit built in 1977.
- **Bayonne Energy Center**: Over 500 MW of advanced simple cycle turbines began operation in 2012. Although located in Bayonne, New Jersey, the facility is directly connected to the New York City bulk power system. The calculations in this report do not include generation from the Bayonne Energy Center because it was not yet in operation in 2011.

Lifecycle Emissions

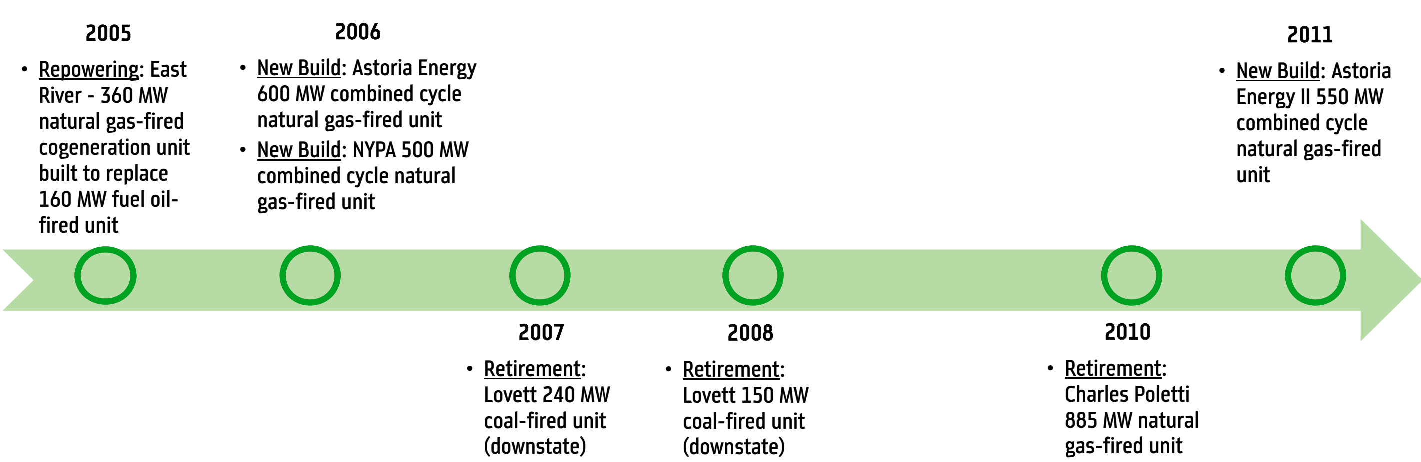
Combustion of natural gas yields approximately 30 percent fewer greenhouse gas emissions than oil and 45 percent fewer emissions than coal on a per MMBTU basis. While this GHG inventory only reports emissions from combustion, it is critical to understand emissions from the entire "lifecycle" of fossil fuels—from fuel extraction, processing, transmission, and distribution, to the ultimate point of combustion. The City recently published a study conducted by ICF International that examined the lifecycle emissions of gas and coal fired power generation.[11] Though continued scientific research is needed, the study found that gas used in the power sector leads to between 36 and 47 percent fewer GHG emissions than coal. The study also compared the use of natural gas and heavy heating oil in New York City's building sector and found that gas yielded approximately 20 percent fewer GHG emissions. As forthcoming GHG protocols are published, the City's future GHG inventories are likely to include analyses of lifecycle GHG emissions.

Distributed generation within New York City has also continued to grow. Small cogeneration reached approximately 150 MW in 2011, from a level of approximately 80 MW in 2005. Solar photovoltaic capacity has grown more than eight-fold since 2007 from just over 1 MW to nearly 12 MW as of June 30, 2012.

Rest of state

Fifty-four percent of New York City's required electricity was imported from outside the city in 2011. To measure the carbon intensity of the city's electricity supply, the city considers all in-city generation to be used within the city; all imported electricity is considered to be drawn, in order, from: plants having bilateral contracts with utilities serving the city; electricity generated in New Jersey and transmitted over the Linden VFT transmission line; plants in NYISO zones G, H, and I (other than contracts); and from the rest of New York State (ROS).

Fig. 15: Selected New Generation and Retirements: 2005-2011



Source: NYC Mayor's Office

The City is beginning to look at opportunities for GHG emissions reductions beyond its 30 percent citywide reduction target. Future mitigation strategies will require collaboration with other jurisdictions in the New York metropolitan area and the rest of New York State, which may result in a revision of the City's methodology for calculating the carbon intensity of its electricity supply to ensure equitable estimation of the carbon intensity of each region's electricity supply.

Other factors

Incremental upgrades to the electricity supply have resulted in reductions in CO_2e emissions for New York City. From 2005-2011, approximately $48 million in capital investments in incremental upgrades to the Indian Point Energy Center resulted in an additional power output of 0.1 million MWh of nuclear generation, displacing an estimated 0.26 million metric tons of CO_2e from fossil fuel generation. The combination of transmission and distribution losses—calculated to decrease from 4.83 percent in 2005 to 3.36 percent in 2011—and small generator capital changes also resulted in a GHG reduction of 0.36 million metric tons CO_2e.[12]

Prospects for future emission reductions

Over the past five years, the competitive economics of natural gas and environmental regulations have helped to decarbonize the power sector in the region. These changes have resulted in tangible environmental and public health benefits. Today, in-city power generation is almost exclusively natural gas-fired, except on the hottest summer days when oil-fired peak generators are activated. This means that we have effectively reached the limit of achievable reductions from power-sector fuel switching in New York City. However, roughly one-half of New York City's generation fleet is more than 40 years old, and significant opportunities remain to improve the thermal efficiency and modernize that fleet. Upstate, several coal-fired power plants remain in operation with the prospect for gas repowering or retirement.

Large reductions of GHG emissions are also within reach through fuel switching in the Con Edison steam system and in the city's building sector. Con Edison is currently in the process of switching its 59th Street and 74th Street Steam Plants from using heavy oil to natural gas. By the expected completion date in 2014, the Con Edison steam system will be approximately 95 percent natural gas-fired. Over the same period, increasing numbers of buildings are expected to convert their boilers from heavy heating oil in response to the City's mandate that will phase out No. 6 oil by 2015, as well as the resources offered by the NYC Clean Heat program to accelerate conversions to the cleanest fuels. Fuel switching to natural gas and blends of biodiesel in the 10,000 buildings that still use heavy heating oil has the potential to reduce up to 1.3 million Mg-CO_2e. According to ICF International, full conversion of all 10,000 buildings to natural gas would increase peak gas demand in New York City by 30 percent.

Over the coming years, public policy and regulatory outcomes are expected to play an increasing role in the power sector. Key uncertainties include the potential retirement of nuclear and upstate coal plants spurred by environmental regulations; potential transmission improvements and repowering of older gas and coal-fired generation as part of Governor Cuomo's Energy Highways Initiative; regional and federal carbon policy; prospective development of large-scale renewables including expanded integration of upstate wind, new off-shore wind developments, and new transmission concepts to integrate Canadian hydropower, which are at various stages of regulatory review; and the growth of distributed renewable energy and cogeneration in New York City with appropriate state and local incentives.

City Government Inventory

City government GHG emissions were 1.0 percent lower in FY 2011 than FY 2010 because of less carbon-intensive electricity and steam generation, improved methane capture at wastewater treatment plants, and reduced vehicle emissions.

A considerable amount of energy is used each year by New York City's government to provide services to millions of city residents, commuters, and visitors each year. Most of the City's GHG emissions result from the operation of municipal buildings, WWTPs, and the municipal vehicle fleet. Fugitive emissions from landfills, the transportation of solid waste, and the operation of streetlights and the water supply system result in additional emissions.

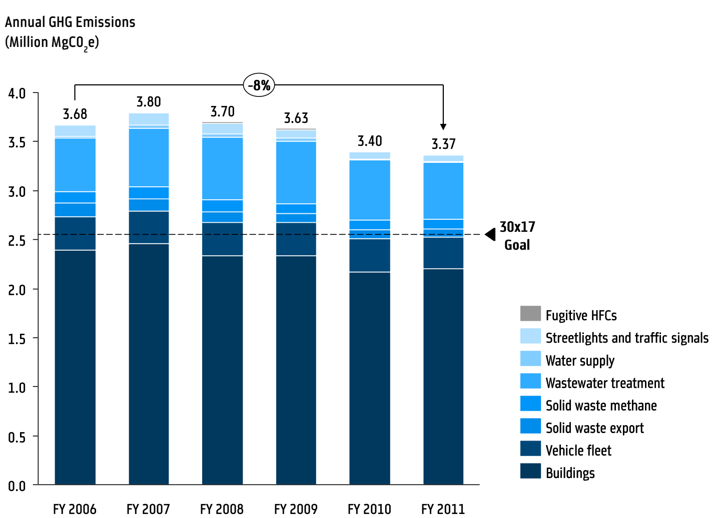
The New York City government GHG inventory is calculated in accordance with the LGOP and consists of emissions from operations, facilities, or sources wholly owned by the City government or over which the City has full authority to introduce and implement operational, health and safety, and environmental policies (including both GHG- and non-GHG-related policies).[13] Emissions from leased buildings, facilities, and vehicles are included. Other non-City public entities—most notably the MTA—are not included by this definition of operational control.

City government FY 2011 results

New York City's government GHG emissions were 3.37 million Mg-CO_2e in FY 2011, resulting in a 1.0 percent decrease from FY 2010 and an 8.4 percent decrease from FY 2006 base year emissions. FY 2011 GHG emissions are broken down as follows:

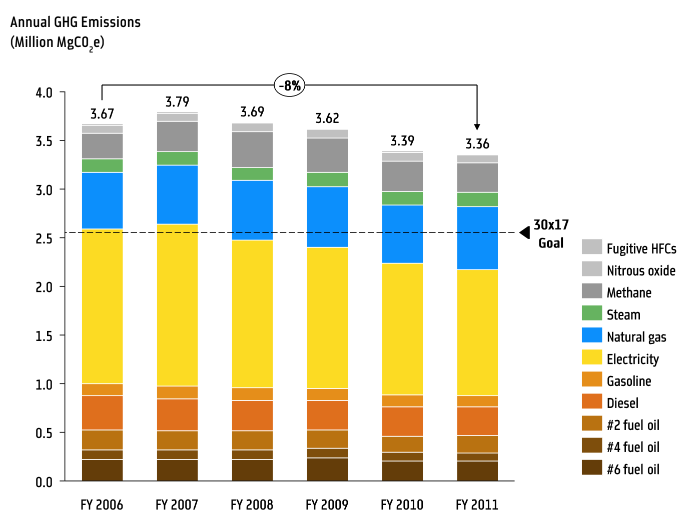
- **Scope 1 GHG emissions:** 1,929,728 MgCO_2e,
- **Scope 2 GHG emissions:** 1,439,813 MgCO_2e,
- **Scope 3 GHG emissions:** 365,542 MgCO_2e,
- **Additional emissions but not not counted toward the city's total emissions results** (e.g. biogenic emissions from combustion of biofuel): 14,223 MgCO_2e.

Fig. 16: 2006-2011 City Government GHG Emissions by Sector



Source: NYC Mayor's Office

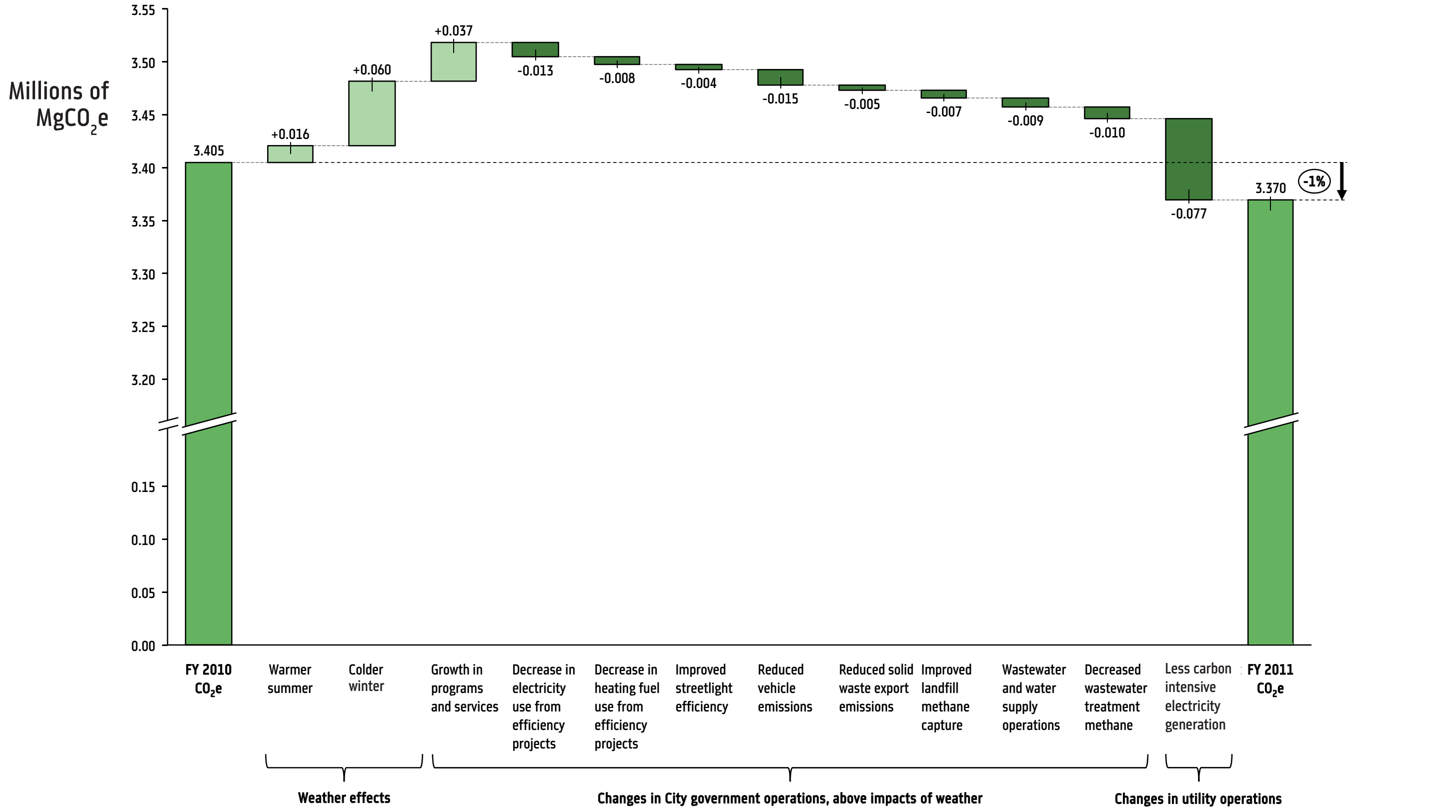
Fig. 17: 2006-2011 City Government GHG Emissions by Source



Source: NYC Mayor's Office

Fig. 18: 2010 to 2011 Changes in New York City Government GHG Emissions

From FY 2010 to FY 2011, a cleaner electricity supply drove the largest reduction in GHG emissions for city government.



Source: NYC Mayor's Office

Most of the City's FY 2011 emissions were from three sectors: the operation of municipal buildings, wastewater treatment facilities, and the municipal vehicle fleet accounted for 92 percent of GHG emissions. Use of electricity and natural gas in buildings, diesel in the vehicle fleet, and the generation of methane from landfills and wastewater treatment plants accounted for the majority of emissions by source, resulting in 67 percent of emissions. As shown in Figure 16, these percentages have not changed significantly since FY 2006—however; a decrease in emissions from fuel oil has been offset by an increase in emissions from natural gas and steam, as the City's buildings continue to switch to cleaner heating fuels.

In accordance with the LGOP, wastewater and water supply emissions are reported separately by source as shown in Figure 19. Electricity use in both sectors accounted for most energy-related emissions (35 percent of wastewater and 87 percent of water supply emissions), while CH_4 resulted in an additional 35 percent of emissions from WWTPs.

Changes to City government emissions

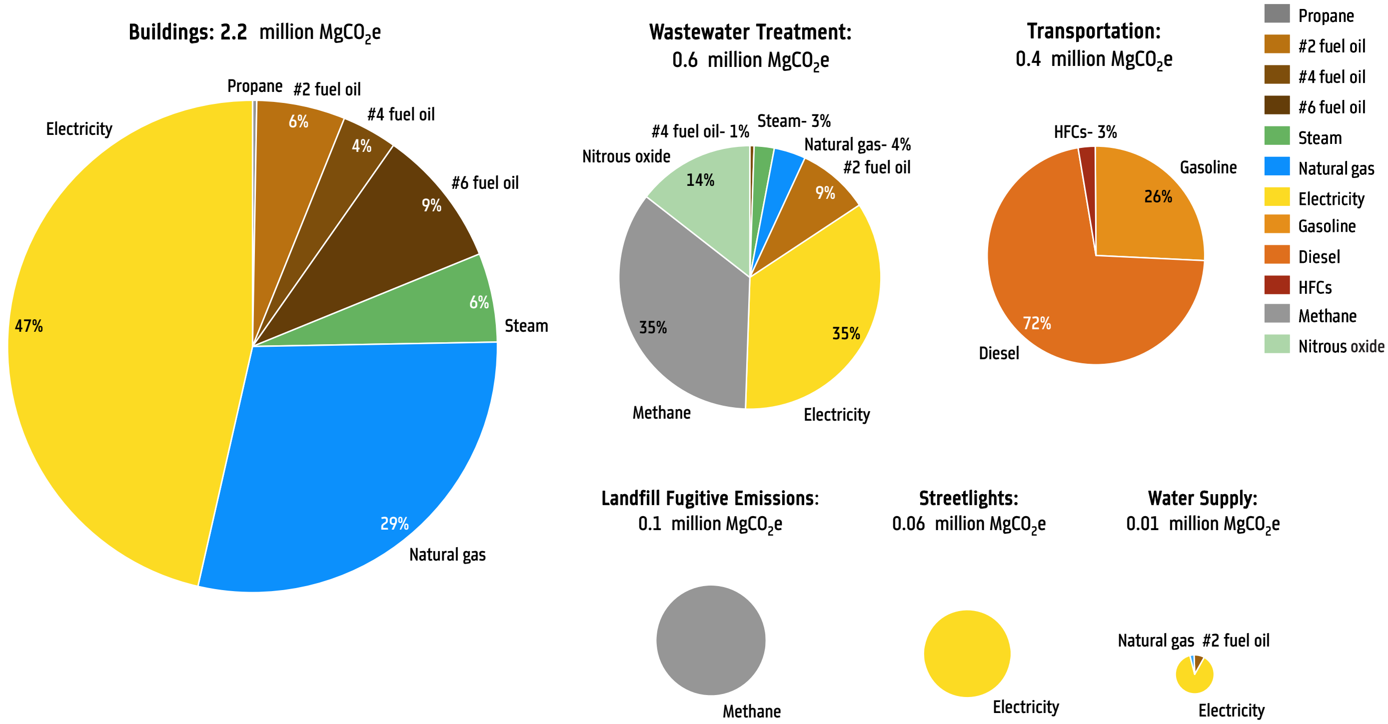
All changes in City government GHG emissions from FY 2006 to FY 2011 and FY 2010 to FY 2011 were analyzed to understand the reasons for changes beyond those governed by external effects such as weather.

City government FY 2006 to FY 2011 changes

Government GHG emissions decreased by 8.4 percent from FY 2006 to FY 2011, from 3.68 to 3.37 $MgCO_2e$. As seen in previous years, a continued reduction in the carbon intensity of the city's electricity supply is principally responsible for this change, combined with increased energy efficiency and clean distributed generation projects in City buildings, improved efficiency of streetlights and traffic signals, and improved efficiency in solid waste export transportation as part of the City's Solid Waste Management Plan (SWMP). Increases in energy use in WWTP supply operations between between FY 2006 and FY 2009 and increased wastewater treatment plant CH_4 leaks all contributed to partially offset emissions reductions. When weather and the carbon intensity of the city's power supply are excluded, emissions are shown to have decreased by less than one percent over this period. Details of these changes from actions taken by City government are reported in Figure 6.

Since FY 2006, CH_4 emissions from the City's WWTPs have increased by 37 percent as critical emissions control equipment underwent emergency repair. However, investments by the City to repair system leaks and upgrade CH_4 emissions control equipment have resulted in a 20 percent reduction of CH_4 emissions since the CH_4 emissions peak in FY 2009. By the end of FY 2013, 76 percent of CO_2e emissions from CH_4 releases at the WWTPs will be reduced. By the end of FY 2015, the City plans to reduce all

Fig. 19: FY 2011 City Government GHG Emissions by Sector and Source



Source: NYC Mayor's Office

known, uncontrolled CH_4 emissions through additional system repairs, such as replacement of flares, digester domes, and digester gas piping.

City government FY 2010 to FY 2011 changes

City government GHG emissions decreased 1.0 percent from FY 2010 to FY 2011, from 3.41 to 3.37 MgCO$_2$e due to a reduction in the carbon intensity of the city's power supply, electricity and heating fuels savings from energy efficiency and clean distributed generation investments, reduced emissions from the City's vehicle fleet, reduced emissions from long-haul transport of solid waste, increased methane capture at wastewater treatment plants, and improved streetlight and traffic signal efficiency. Details of these changes are reported in Figure 18.

City government methodology for analysis of changes

The results of most factors responsible for changes to City government GHG emissions were calculated in the same manner as in the citywide inventory. Changes to GHG levels and energy use were measured for each energy or emissions source in each sector and the effect of weather on changes to energy use in City government buildings was calculated to obtain a weather impact factor. Reductions in electricity and heating fuel use from investments in energy efficiency retrofit and clean distributed generation projects in City buildings were calculated to measure GHG reductions. These reductions were added to measured (net) increases in electricity and heating fuel use to determine the increase in GHG emissions attributed to the expansion of City government programs and services.

GHG Mitigation Measures

As detailed in this inventory, citywide and City government GHG emissions reductions have already been achieved through various PlaNYC initiatives. Below are select examples of some of these measures.

City government GHG mitigation measures

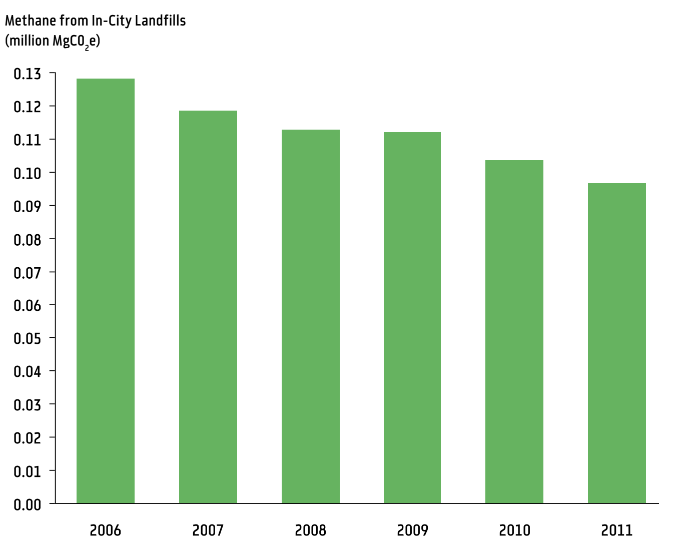
Landfills

The City manages six landfills, all of which no longer accept the disposal of solid waste. Because these landfills are now closed, the generation of CH_4 is declining slowly as landfilled organic material decomposes. The Department of Sanitation (DSNY) and Department of Environmental Protection (DEP) have installed and improved CH_4 control systems at these landfills, which have resulted in an annual reduction of more than 31,000 $MgCO_2e$ below FY 2006 levels, a 25 percent reduction.

Long-Haul Export of Solid Waste

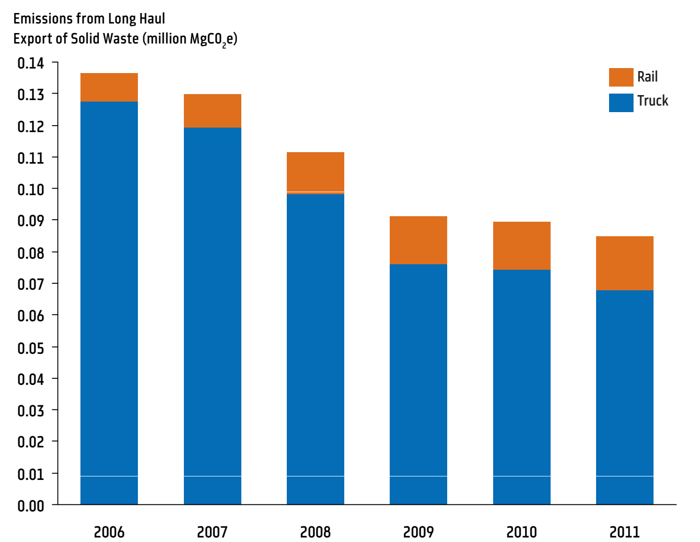
The three million tons of solid waste generated each year by residents, government, and non-profit institutions is collected by DSNY and disposed of in landfills or waste-to-energy facilities outside of the city. The City's Solid Waste Management Plan (SWMP) requires the City to transition from truck-based to marine barge and rail transportation. Because trains are far more fuel efficient than trucks, the City has reduced annual GHG emissions from long-haul export of solid waste by more than 51,000 $MgCO_2e$ since FY 2006, a 38 percent reduction. Full SWMP implementation is expected to result in a total annual GHG reduction of more than 104,000 $MgCO_2e$ below FY 2006 levels by FY 2017, a 76 percent reduction for this emissions category.

Fig. 20: City Government GHG Emissions from Landfills



Source: NYC Mayor's Office

Fig. 21: City Government GHG Emissions from Long-Haul Export of Solid Waste



Source: NYC Mayor's Office

Wastewater Treatment Plants

CH_4 emissions from the City's WWTPs have increased by 37 percent since FY 2006 as critical emissions control equipment underwent emergency repair. Recent investments by DEP to repair system leaks and upgrade CH_4 emissions control equipment have resulted in a 20 percent reduction of CH_4 emissions since their peak in FY 2009. By the end of FY 2013, additional investments will result in a 76 percent reduction in CH_4 emissions. By the end of FY 2015, the City expects to reduce all of its fugitive CH_4 emissions from wastewater treatment through additional system repairs, such as replacement of flares, digester domes, digester gas piping, and the increased use of CH_4 to heat anaerobic digesters and WWTPs.

Citywide GHG mitigation measures

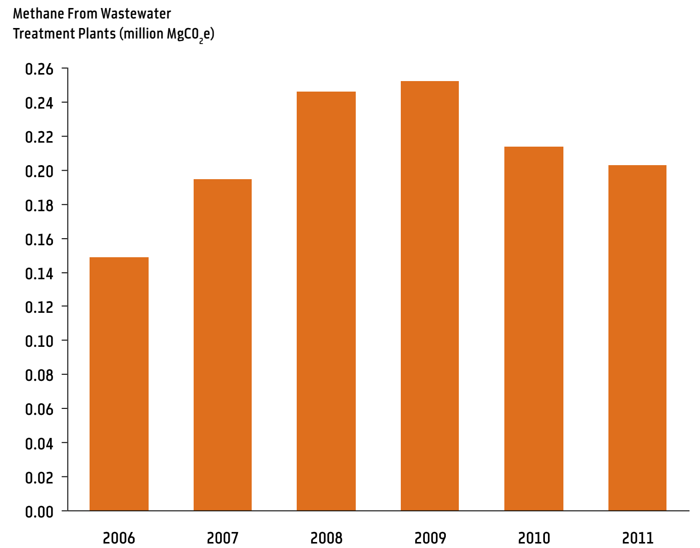
Benchmarking

In August 2012, the Mayor's Office released the *New York City Local Law 84 Benchmarking Report*, analyzing 2010 energy and water use for New York City's largest buildings. This information is the first step in increasing knowledge about buildings' energy use and demonstrates opportunities for building owners to save energy and money by making their buildings more efficient. The report is required under Local Law 84 of 2009, which mandates that all privately-owned properties with individual buildings over 50,000 square feet or multiple buildings with a combined square footage over 100,000 square feet annually measure and report their energy and water use. The benchmarking report shows that energy use varies greatly between property types, uses, and locations, with some properties using three to five times more energy per square foot than buildings with similar uses.

Mayor's Carbon Challenge

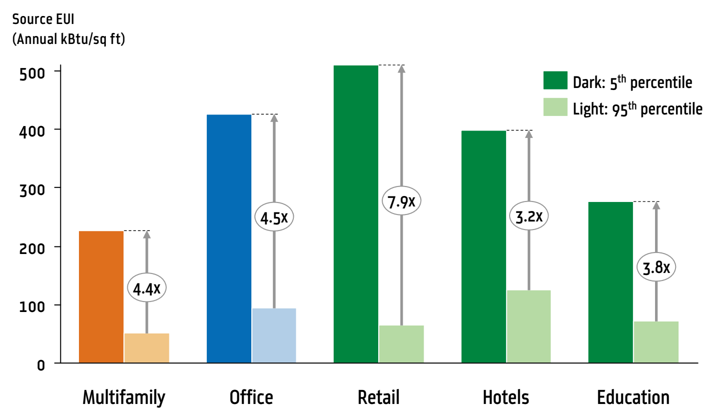
The Mayor's Carbon Challenge invites leaders in the institutional and private sectors to match New York City's goal to reduce GHG emissions from municipal sources by 30 percent over ten years. Since its launch in 2007, 17 leading universities and the 11 largest hospital systems in the city have accepted the Challenge, along with 40 Broadway theaters that have pledged to green their productions. Together, universities and hospitals account for nearly 4 percent of citywide emissions, meaning that a 30 percent reduction from these sources would translate to more than a one percent reduction in citywide emissions, assuming no change in their baseline square footage. The majority of universities and hospitals are well on their way to meeting the Mayor's Carbon Challenge, and in 2012, four universities and one hospital crossed the finish line. The Mayor's Carbon Challenge will expand to New York City's largest commercial building tenants and later to residential condos and co-ops.

Fig. 22: City Government CH_4 Emissions from Wastewater Treatment Plants



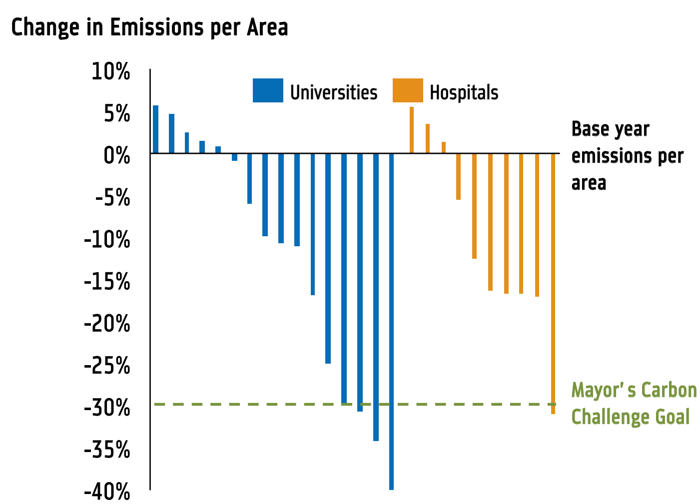
Source: NYC Mayor's Office

Fig. 23: Variation in Source Energy Use Intensity (EUI) In Five Sectors



Source: NYC Mayor's Office

Fig. 24: GHG Emissions from Mayor's Carbon Challenge Participants



Source: NYC Mayor's Office

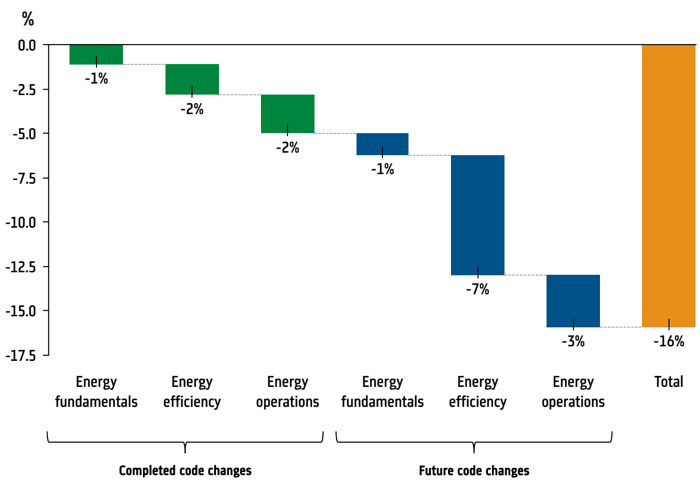
Green Codes Task Force

Significant reductions in citywide GHG emissions are projected through implementation of the proposals of the New York City Green Codes Task Force to revise the City's construction codes for environmental benefits. To date, 38 of 111 proposals have been enacted into law or adopted as City policy. The City has prioritized 42 of the remaining Green Codes proposals to pursue before the end of 2013. The City estimates that the proposals that have thus far been adopted will reduce citywide GHG emissions by 2030 by roughly 5 percent, and that the proposals scheduled to be incorporated by the end of 2013 should result in an additional 7 to 11 percent GHG emissions reduction.

Clean Heat

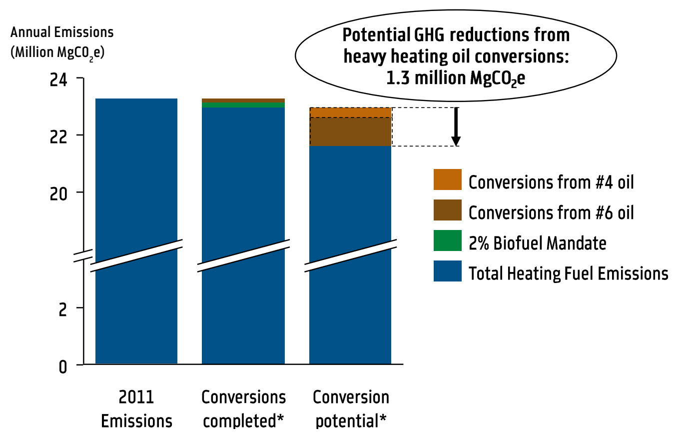
Only 10,000 buildings in New York City burn highly-polluting No. 6 and No. 4 heating oil, but these buildings contribute more soot pollution than all cars and trucks on the City's roads. In April 2011, DEP issued regulations phasing out the use of highly polluting and GHG-intensive No. 6 and No. 4 heating oils. The NYC Clean Heat program was created to improve air quality by accelerating heating oil conversions to the cleanest fuels before these regulations mandate that buildings do so. As of September 2012, nearly 800 conversions have taken place, reducing fine particulate matter emissions from the use of heavy oil by 20 percent and GHG emissions by over 130,000 $MgCO_2e$. The total GHG reduction potential of all No. 6 and No. 4 conversions is 1.3 million $MgCO_2e$—2 percent of the total citywide GHG emissions in 2005. Additionally, as of October 1, 2012, all heating oil delivered in New York City contains 2 percent biodiesel, as required by Local Law 43 of 2010. This biodiesel regulation will reduce GHG emissions by over 200,000 $MgCO_2e$.

Fig. 25: GHG Emissions Reductions Below 2005 from Green Codes (%)



Source: NYC Mayor's Office

Fig. 26: GHG Emissions from Building Heating Fuels



*Conversion potentials assume that remaining conversions are to natural gas.

Source: NYC Mayor's Office

APPENDICES

Appendix A

Citywide Inventory Methodology

Con Edison provided data on citywide electricity and steam use, and natural gas use in the Bronx, Manhattan, and parts of Queens. National Grid reported natural gas use data for Brooklyn, parts of Queens, and Staten Island. The Long Island Power Authority (LIPA) reported electricity use data for the Rockaways area of Queens. Fuel oil use was estimated using fuel oil boiler permit data from the New York City Department of Environmental Protection (DEP), joined with the Department of City Planning PLUTO database to estimate the amount of fuel oil burned per square foot of building floor area. The New York Metropolitan Transportation Council (NYMTC) provided on-road transportation vehicle-miles-traveled (VMT) data. Energy use data for public transit were provided by the Metropolitan Transportation Authority (MTA) for New York City Transit (NYCT) subways and buses, Staten Island Railway (SIR), 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 by New Jersey Transit (NJT) for its commuter rail and buses.

Data used to calculate fugitive and process CH_4 and process N_2O from wastewater treatment were provided by DEP. CH_4 emissions were 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 is produced for every pound of volatile organic solids destroyed. N_2O emissions were calculated by applying the daily nitrogen load discharged by each of the City's 14 WWTPs to the formula in the LGOP. [15]

Fugitive CH_4 emissions from in-city landfills was calculated from landfill gas collection data provided by the New York City Department of Sanitation (DSNY) and DEP per the LGOP.[16] Fugitive CH_4 from exported solid waste was calculated using waste disposal figures for residential, commercial, and construction and demolition waste and applying emissions factors from the USCP, which were taken from EPA's Waste Reduction Model (WARM).[17] Fugitive CH_4 from natural gas distribution was calculated using data provided by National Grid and Con Edison. Fugitive SF_6 from electricity distribution was calculated using data provided by Con Edison.

All DSNY-managed municipal solid waste (residential, government and some institutional solid waste) generated in New York City is exported to landfills by private contractor and waste-to-energy facilities by DSNY. Fuel use 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 each disposal facility. Fuel use was calculated by estimating how many trucks and trains are needed to transport the waste, and applying fuel economy figures to the weighted average distance to receiving landfills.

Fugitive emissions of hydroflourocarbons (HFCs) from municipal vehicle cooling and refrigeration systems were calculated from data provided by the New York City Department of Citywide Administrative Services (DCAS), including the number of regular vehicles and refrigeration vehicles in operation in the City government's vehicle fleet, as well as the type of refrigerant used by each system. The City estimated fugitive refrigerant emissions by applying a default emissions factor per the LGOP.[18]

Scope 3 aviation emissions were calculated using fuel use data from the PANYNJ. Emissions coefficients in the LGOP were applied to the total volume of jet fuel and aviation gasoline loaded onto airplanes at LaGuardia and John F. Kennedy airports, as modeled by PANYNJ using the numbers of passengers departing from each airport during the year of analysis.[19]

GHG emissions were calculated from all data acquired as described using emissions coefficients in the LGOP, unless otherwise noted.[20] All emissions coefficients and fuel economy figures are reported in Appendix J.

Appendix B

City Government Inventory Methodology

All data used to complete the 2011 City government GHG inventory were acquired from City agencies or fuel vendors. Electricity, natural gas, and steam usage for the City's buildings, facilities, and streetlights was provided by DCAS. Fuel vendors and DEP supplied heating and vehicle fuel usage. Calculation of GHG emissions from fuel uses the volume of fuel delivered as an estimate of the volume of fuel used.

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

The City government inventory also reports emissions associated with employee commuting as a Scope 3 information source. These were estimated using the U.S. Census Bureau's Public-Use Microdata Sample dataset, which reports the means of transportation to work for City employees.[21] The methodology used for the 2011 Inventory is consistent with past New York City inventories.

Emissions from the decomposition of solid waste generated by City employees are also considered a Scope 3 information source and is therefore not counted toward the City government total emissions. These emissions were calculated by multiplying the number of employees by the estimated annual volume of solid waste generated by each employee, as calculated by DSNY.

Appendix C

Emissions Coefficients Methodologies

Electricity emissions coefficient

The City has developed its own electricity emissions coefficient, rather than using the U.S. Environmental Protection Agency's (EPA) eGRID coefficient. The City has done this for several reasons:

- The eGRID coefficient is regionally based, and includes Westchester County and New York City electricity generation,
- The eGRID coefficient does not include electricity that is imported into New York City from New Jersey or New York beyond Westchester County, which is a significant amount of the City's electricity supply,
- The eGRID coefficient is based on data that are several years old—the most recent eGRID coefficient is based on 2009 generation data—which does not allow the City to measure the impact of changes to the power supply that occurred during the year of analysis.

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) and New Jersey's Public Service Electric and Gas (PSEG) territories. From these data, New York City's electricity emissions coefficient was calculated by taking the following steps:

1. All electricity generated within New York City (NYISO Zone J) imported to New York City on the basis of bilateral contracts between power generators and the New York Power Authority (NYPA) or Consolidated Edison of New York (Con Edison), and all measured electricity flows from New Jersey's PSEG territory over the Linden-VFT transmission line was assumed to be used by New York City.
2. Additional imported electricity volume was calculated by subtracting the combined in-city generation, bilateral contracts, and PSEG imports from New York City's required energy.
3. Due to existing transmission constraints, imported power was assumed to be generated in the downstate region (NYISO Zones G, H, and I), with the balance of the energy requirement imported from the rest of New York State (NYISO Zones A-F, and K).
4. Emissions coefficients for both in-city and imported generation were calculated for CO_2, CH_4, N_2O, and CO_2e based on each plant's heat rate (efficiency) and primary fuel used for generation.
5. Energy use attributed to steam generation at in-city cogeneration plants was deducted from the energy input used to calculate each plant's emissions coefficient, using Con Edison's steam system data, to avoid double counting emissions resulting from this generation.
6. A transmission and distribution loss factor, calculated by subtracting Con Edison's and the Long Island Power Authority's (LIPA) reported electricity deliveries from the NYISO energy requirement was applied to derive the City's electricity emissions coefficient. This coefficient is presented in detail in Appendix I.

The City encourages all entities in New York City, public and private, to use this coefficient to complete GHG inventories. Revised electricity emissions coefficients were applied to past years' inventory results.

Steam emissions coefficient

The City developed its own steam emissions coefficient in cooperation with Con Edison, as in past inventories. The revised steam coefficient is applied to citywide and government 2011 inventories. The steam emissions coefficient is presented in detail in Appendix H.

The steam emissions coefficient used by New York City is developed in cooperation with Con Edison and takes into account the impact of generating steam by means of co-generation. This coefficient is intended to be used for macro, city-scale analyses, as the accounting methodology used by Con Edison (as recommended by the EPA and approved by the New York State Public Service Commission (PSC)) allocates the majority of fuel used for cogenerated steam to electricity generation, which is accounted for in the City's electricity coefficient. As such, applying this steam coefficient to more granular, project-specific analyses may not yield appropriate results.

Exported solid waste

The emissions factors used to calculate emissions from solid waste exported out of New York City to landfills and waste to energy facilities were revised based on updated factors from the EPA's Waste Reduction Model (WARM), which will be included in the final version of the U.S. Community Protocol going forward. This updated methodology was also applied to previous years' GHG emissions results.[22]

Appendix D

City Government Calendar Year Results

City government CY 2011 results

Carbon emissions for New York City government in CY 2011 were just below that of fiscal year 2010, at 3.30 million $MgCO_2e$. This corresponds to a 2.4 percent decrease from calendar year 2010 and a 13.8 percent decrease from calendar year 2008, when calendar year emissions were first reported. CY 2011 GHG emissions are broken down as follows:

- Scope 1 GHG emissions: 1,892,389 $MgCO_2e$
- Scope 2 GHG emission: 1,403,332 $MgCO_2e$
- Scope 3 GHG emissions: 359,674 $MgCO_2e$
- Additional emissions reported as information items only, not counted toward the City's total emissions results (e.g. biogenic emissions from combustion of biofuel): 14,046 $MgCO_2e$

City government CY 2008 to CY 2011 changes

From CY 2008 to CY 2011, municipal GHG emissions decreased 13.8 percent, from 3.82 to 3.30 $MgCO_2e$. In addition to a milder winter, the main factors of this change were a reduction in the carbon intensity of the city's electricity supply, increased CH_4 capture at WWTPs, reduced vehicle emissions, more efficient streetlights and traffic signals, and improved efficiency in solid waste export transportation from truck to rail as part of the City's SWMP. When weather, and the carbon intensity of the city's electricity supply are excluded, emissions are shown to have decreased by 1.6 percent.

City government CY 2010 to CY 2011 changes

From CY 2010 to CY 2011, City government GHG emissions decreased 2.4 percent, from 3.38 to 3.30 $MgCO_2e$. In addition to a milder winter and summer, the main factors of this change were a reduction in the carbon intensity of the city's power supply, reduced landfill CH_4, reduced energy use in wastewater and water supply operations, and improved efficiency in solid waste export transportation from truck to rail as part of the City's SWMP. When weather and the carbon intensity of the city's power supply are excluded, emissions are shown to have increased by 2.6 percent.

Appendix E

Acronym Definitions

New York City Agencies:

DCAS – New York City Department of Citywide Administrative Services

DEP – New York City Department of Environmental Protection

DSNY – New York City Department of Sanitation

Other entities:

C40 – C40 Cities Climate Leadership Group

CARB – California Air Resources Board

CCAR – California Climate Action Registry

Con Edison – Consolidated Edison Company of New York

EIA – United States Energy Information Administration

EPA – United States Environmental Protection Agency

ICLEI – ICLEI-Local Governments for Sustainability

LIPA – Long Island Power Authority

LIRR – Long Island Railroad

MTA – Metropolitan Transportation Authority

MNR – Metro North Rail Road

NJT – New Jersey Transit

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

PANYNJ – Port Authority of New York and New Jersey

PATH – Port Authority Trans-Hudson Corporation

PSC – New York State Public Service Commission

PSEG – Public Service Enterprise Group

SIR – Staten Island Railway

TCR – The Climate Registry

WRI – World Resources Institute

The following acronyms are used throughout this report:

BAU – business as usual

Btu – British thermal units

CAGR -- compound annual growth rate

CDD – cooling degree days

CEMS – Continuous Emissions Monitoring System

CH_4 – methane

CO_2 – carbon dioxide

CO_2e – carbon dioxide equivalent

CY – calendar year

eGRID – Emissions and Generation Resource Integrated Database

FY – fiscal year

GDP – gross domestic product

GHG – greenhouse gas

GJ – gigajoule

GWh – gigawatt hour

GPC – Global Protocol for Community-Scale Greenhouse Gas Emissions

HDD – heating degree days

HFCs – hydrofluorocarbons

kBtu – one thousand British thermal units

kg – kilogram

km – kilometer

LGOP – Local Government Operations Protocol

Mg – megagram (metric ton)

MMBtu – million British thermal units

MW – megawatt

N_2O – nitrous oxide

PPA – power purchase agreement

ROS – rest of state

SF_6 – sulfur hexafluoride

SWMP – Solid Waste Management Plan

T&D – transmission and distribution

USCP – United States Community Protocol for Accounting and Reporting Greenhouse Gas Emissions

VFT – variable frequency transformer

VMT – vehicle miles traveled

WARM – Waste Reduction Model

WWTP– wastewater treatment plant

Appendix F

Endnotes

1. City of New York, *Long Term Plan to Reduce Energy Use and Greenhouse Gas Emissions of Municipal Buildings and Operations*, available online at http://nytelecom.vo.llnwd.net/o15/agencies/planyc2030/pdf/ecse_long_term_plan.pdf.

2. City of New York, *Inventory of New York City Greenhouse Gas Emissions* (April 2007), available online at http://www.nyc.gov/html/om/pdf/ccp_report041007.pdf. The City is amending the convention to which these documents refer to avoid confusion. All past inventory documents will now be referred to by the year of citywide emissions analysis—e.g. the inventory released in April 2007 reporting citywide 2005 emissions will be the 2005 Inventory.

3. 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.

4. City of New York, *Inventory of New York City Greenhouse Gas Emissions* (September 2009), available online at http://www.nyc.gov/html/planyc2030/downloads/pdf/greenhousegas_2009.pdf.

5. City of New York, *Inventory of New York City Greenhouse Gas Emissions* (September 2010), available online at http://nytelecom.vo.llnwd.net/o15/agencies/planyc2030/pdf/greenhousegas_2010.pdf

6. City of New York, *Inventory of New York City Greenhouse Gas Emissions* (September 2011), available online at http:// www.nyc.gov/html/om/pdf/2011/pr331-11_report.pdf.

7. 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*, Version 1.1 (May 2010), available online at http://www.theclimateregistry.org/downloads/2010/05/2010-05-06-LGO-1.1.pdf.

8. *Global Protocol For Community-Scale Greenhouse Gas Emissions*, Pilot Version 1.0 (May 2012), available online at http://www.ghgprotocol.org/files/ghgp/GPC_PilotVersion_1.0_May2012_20120514.pdf.

9. ICLEI Local Governments for Sustainability USA, *U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions*, Public Comment Draft (July 2012), available online at http://www.icleiusa.org/library/documents/community-protocol-public-comment-draft-final-2.

10. New York State Energy Research and Development Authority, *New York State Regional Greenhouse Gas Protocol*.

11. ICF International 2012, *Assessment of New York City Natural Gas Market Fundamentals and Life Cycle Fuel Emissions*, report to the Mayor's Office of Long-Term Planning and Sustainability, New York City Mayor's Office, New York, NY.

12. Generation data obtained from the Ventyx Velocity Suite. According to Entergy Corporation, the power level of Indian Point 3 increased by approximately 37 megawatts at an approximate cost of $48 million. As part of the power increases, chevron separators were installed in the moisture separators to improve steam quality and increase reliability of the main turbines and steam generators. An estimated cost of approximately $12.8 million was included in the overall estimate for the moisture separators. Similar costs were incurred for a similar power level increase for Indian Point 2.

13. *Local Government Operations Protocol* (LGOP) Version 1.1 (May 2010), pp 14.

14. LGOP Version 1.1 (May 2010), pp 127.

15. LGOP Version 1.1 (May 2010), pp 113.

16. LGOP Version 1.1 (May 2010), pp 98

17. USCP Pilot Version 1.0 (May 2012), Appendix E, pp 19.

18. LGOP Version 1.1 (May 2010), pp 78.

19. LGOP Version 1.1 (May 2010), pp 203.

20. LGOP Version 1.1 (May 2010), pp 201.

21. U.S. Census Bureau, American Community Survey Public-Use Microdata Sample, available online at http://www.census.gov/main/www/pums.html.

22. U.S. Environmental Protection Agency, *Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model* (WARM), available online at http://www.epa.gov/climatechange/waste/SWMGHGreport.html

Appendix G

Weather Impacts on Emissions

In PlaNYC, the City estimated that more than 40 percent of all energy used within the city's buildings was used to heat or cool building spaces. As 74 percent of the city's GHG emissions are related to buildings, heating and cooling directly affects over 30 percent of the city's carbon footprint

To fully understand the impact of year-on-year changes in GHG emissions, the extent of weather's impact on energy use must be accounted for and is a key component in determining causes for interannual changes in the GHG carbon footprint. Steam (used for both heating and cooling), electricity (used for cooling via air-conditioners), natural gas (used for heating), and building oil (used for heating) use figures are correlated with monthly heating degree days (HDD) and cooling degree days (CDD).

The resulting correlation graphs show the relationship with each type of energy use and its corresponding weather statistics, and the strength of their relationship.

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.

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.)

Fig. 27: Correlation of Cooling & Heating Degree Days to Steam Use

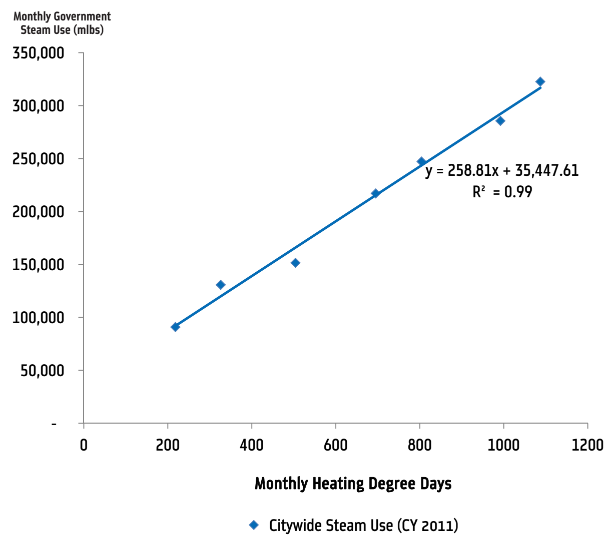


Fig. 29: Correlation of Cooling Degree Days to Electricity Use

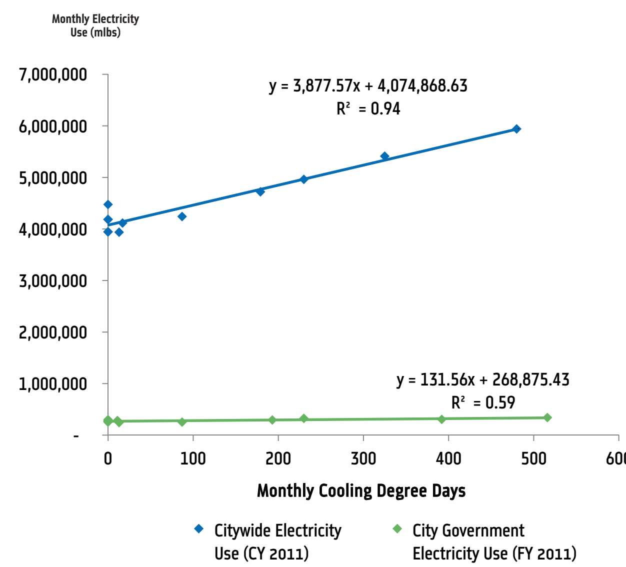


Fig. 28: Correlation of Heating Degree Days to Natural Gas Use

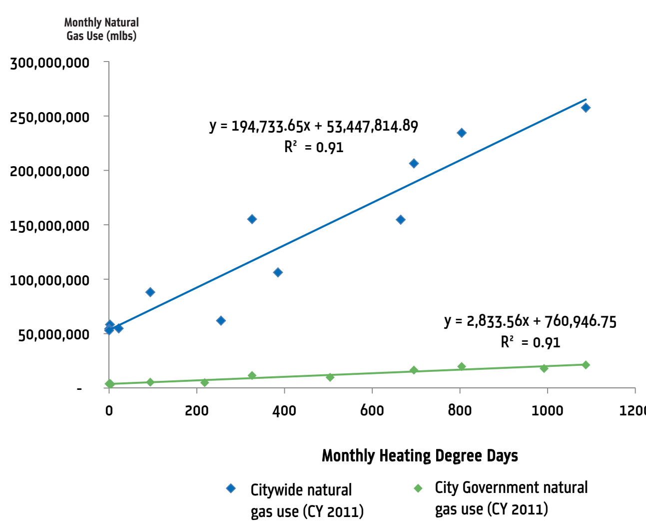
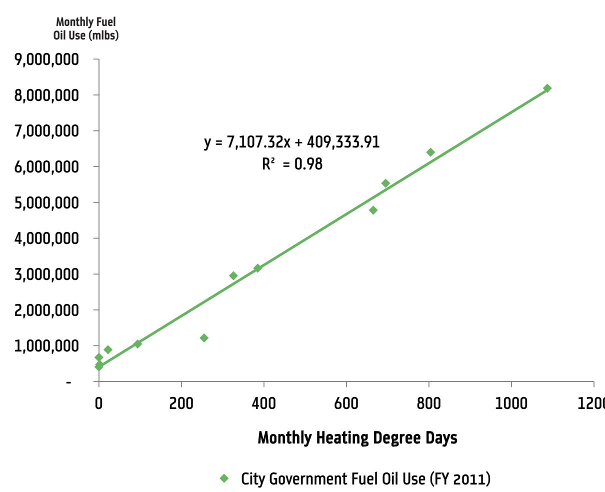


Fig. 30: Correlation of Heating Degree Days to Fuel Oil Use



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

Appendix H

Steam Emissions Coefficients

2005 STEAM EMISSIONS COEFFICIENTS					
To convert metered kg of steam to GJ		Steam coefficients - kg per metric ton delivered to buildings			
Steam Generation Efficiency	Total GJ input per metric ton steam	CO_2	CH_4	N_2O	CO_2e
104%	3.0939	190.520	0.00611	0.00109	190.9856

2006 STEAM EMISSIONS COEFFICIENTS					
To convert metered kg of steam to GJ		Steam coefficients - kg per metric ton delivered to buildings			
Steam Generation Efficiency	Total GJ input per metric ton steam	CO_2	CH_4	N_2O	CO_2e
125%	2.4357	155.695	0.00484	0.00084	156.0589

2007 STEAM EMISSIONS COEFFICIENTS					
To convert metered kg of steam to GJ		Steam coefficients - kg per metric ton delivered to buildings			
Steam Generation Efficiency	Total GJ input per metric ton steam	CO_2	CH_4	N_2O	CO_2e
120%	2.5226	161.529	0.00504	0.00088	161.9076

2008 STEAM EMISSIONS COEFFICIENTS					
To convert metered kg of steam to GJ		Steam coefficients - kg per metric ton delivered to buildings			
Steam Generation Efficiency	Total GJ input per metric ton steam	CO_2	CH_4	N_2O	CO_2e
123%	2.4630	153.961	0.00458	0.00078	154.2974

2009 STEAM EMISSIONS COEFFICIENTS					
To convert metered kg of steam to GJ		Steam coefficients - kg per metric ton delivered to buildings			
Steam Generation Efficiency	Total GJ input per metric ton steam	CO_2	CH_4	N_2O	CO_2e
115%	2.770	165.498	0.00501	0.00086	165.8690

2010 Steam Emissions Coefficient					
To convert metered kg of steam to GJ		Steam coefficient - kg per metric ton delivered to buildings			
Steam Generation Efficiency	Total GJ input per metric ton steam	CO_2	CH_4	N_2O	CO_2e
129%	2.4615	142.691	0.00405	0.00066	142.9816

2011 STEAM EMISSIONS COEFFICIENTS					
To convert metered kg of steam to GJ		Steam coefficients - kg per metric ton delivered to buildings			
Steam Generation Efficiency	Total GJ input per metric ton steam	CO_2	CH_4	N_2O	CO_2e
123%	2.5847	142.849	0.00373	0.00057	143.104

Appendix I

Electricity Emissions Coefficients

2005 ELECTRICITY EMISSIONS COEFFICENTS

	Generation (GJ)	CO_2 (Mg)	CO_2/GJ (kg)	CH_4 (Mg)	CH_4/GJ (kg)	N_2O (Mg)	N_2O/GJ (kg)	CO_2e (Mg)	CO_2e/GJ (kg)	Source energy (GJ)	Source GJ/GJ
In-city	88,618,432	13,938,769	157.290	274.78	0.00310	29.72	0.00034	13,953,753	157.459	274,115,501	3.093
Contract	63,154,249	2,041,214	32.321	43.42	0.00069	4.34	0.00007	2,043,216	32.353	175,030,245	2.771
Market procurement (G, H, I)	42,652,519	6,316,022	148.081	142.34	0.00334	75.59	0.00177	6,342,445	148.700	121,027,376	2.838
Total	194,425,200	22,521,649	115.837	465.62	0.00239	112.36	0.00058	22,566,003	116.065	571,569,805	**2.940**
Total 2005 NYC electricity use	185,030,541		Coefficient with transmission and distribution losses								
Transmission and distribution loss rate	-4.83%		120.499		0.00249		0.00059		120.734		

2006 ELECTRICITY EMISSIONS COEFFICENTS

	Generation (GJ)	CO_2 (Mg)	CO_2/GJ (kg)	CH_4 (Mg)	CH_4/GJ (kg)	N_2O (Mg)	N_2O/GJ (kg)	CO_2e (Mg)	CO_2e/GJ (kg)	Source energy (GJ)	Source GJ/GJ
Total	191,145,600	19,483,628	101.931	350.69	0.00183	114.48	0.00060	19,523,913	102.141	530,574,952	**2.776**
Total 2006 NYC electricity use	181,779,844		Coefficient with transmission and distribution losses								
Transmission and distribution loss rate	-4.90%		107.182		0.00193		0.00063		107.404		

2007 ELECTRICITY EMISSIONS COEFFICENTS

	Generation (GJ)	CO_2 (Mg)	CO_2/GJ (kg)	CH_4 (Mg)	CH_4/GJ (kg)	N_2O (Mg)	N_2O/GJ (kg)	CO_2e (Mg)	CO_2e/GJ (kg)	Source energy (GJ)	Source GJ/GJ
Total	197,100,000	20,490,670	103.961	380.45	0.00193	105.30	0.00053	20,531,065	104.166	545,104,748	**2.766**
Total 2007 NYC electricity use	188,202,200		Coefficient with transmission and distribution losses								
Transmission and distribution loss rate	-4.51%		108.876		0.00202		0.00056		109.090		

2008 ELECTRICITY EMISSIONS COEFFICENTS

	Generation (GJ)	CO_2 (Mg)	CO_2/GJ (kg)	CH_4 (Mg)	CH_4/GJ (kg)	N_2O (Mg)	N_2O/GJ (kg)	CO_2e (Mg)	CO_2e/GJ (kg)	Source energy (GJ)	Source GJ/GJ
Total	197,406,000	18,292,678	92.665	335.34	0.00170	100.33	0.00051	18,327,855	92.843	520,646,315	**2.637**
Total 2008 NYC electricity use	186,150,634		Coefficient with transmission and distribution losses								
Transmission and distribution loss rate	-5.70%		98.268		0.00180		0.00054		98.457		

2009 ELECTRICITY EMISSIONS COEFFICENTS

	Generation (GJ)	CO_2 (Mg)	CO_2/GJ (kg)	CH_4 (Mg)	CH_4/GJ (kg)	N_2O (Mg)	N_2O/GJ (kg)	CO_2e (Mg)	CO_2e/GJ (kg)	Source energy (GJ)	Source GJ/GJ
Total	191,160,000	16,092,212	84.182	306.54	0.00160	85.50	0.00045	16,120,898	84.332	479,457,933	**2.508**
Total 2009 NYC electricity use	182,649,671		Coefficient with transmission and distribution losses								
Transmission and distribution loss rate	-4.45%		88.104		0.00168		0.00047		88.261		

2010 ELECTRICITY EMISSIONS COEFFICENTS

	Generation (GJ)	CO_2 (Mg)	CO_2/GJ (kg)	CH_4 (Mg)	CH_4/GJ (kg)	N_2O (Mg)	N_2O/GJ (kg)	CO_2e (Mg)	CO_2e/GJ (kg)	Source energy (GJ)	Source GJ/GJ
In-city	86,233,586	11,021,452	127.809	209.44	0.00243	21.24	0.00025	11,032,435	127.936	218,889,569	2.538
Contract	31,737,395	1,800,860	56.742	40.37	0.00127	4.04	0.00013	1,802,626	56.798	81,597,491	2.571
Market procurement (G, H, I)	56,673,573	2,318,994	40.918	39.13	0.00069	31.53	0.00056	2,329,592	41.105	158,573,038	2.798
Market procurement (ROS)	19,386,178	1,306,119	67.374	13.39	0.00069	10.79	0.00056	1,310,520	67.601	26,598,854	1.372
PSEG Imports	4,379,669	490,015	64.289	7.68	0.00101	3.79	0.00050	491,350	64.464	13,056,367	2.981
Total	198,410,400	16,937,439	84.315	310.01	0.00155	71.39	0.00035	16,966,523	84.459	498,715,319	**2.514**
Total 2010 NYC electricity use	190,666,800		Coefficient with transmission and distribution losses								
Transmission and distribution loss rate	-3.90%		**87.739**		0.00161		0.00037		87.889		

2011 ELECTRICITY EMISSIONS COEFFICENTS

	Generation (GJ)	CO_2 (Mg)	CO_2/GJ (kg)	CH_4 (Mg)	CH_4/GJ (kg)	N_2O (Mg)	N_2O/GJ (kg)	CO_2e (Mg)	CO_2e/GJ (kg)	Source energy (GJ)	Source GJ/GJ
In-city	89,328,565	11,338,416	126.929	216	0.002	21.91	0.00025	11,349,738	127.056	225,121,498	2.520
Contract	33,546,524	1,860,287	55.454	35	0.00105	3.51	0.00010	1,862,112	55.508	86,718,208	2.585
Market procurement (G, H, I)	54,463,329	1,359,152	24.955	24	0.00044	17.52	0.00032	1,365,089	25.064	151,055,052	2.774
Market procurement (ROS)	13,466,559	794,721	59.014	6	0.00044	4.33	0.00032	797,191	59.198	16,946,742	1.258
PSEG Imports	3,811,022	423,024	55.500	7	0.00090	2.81	0.00037	424,041	55.633	11,130,854	2.921
Total	194,616,000	15,775,601	79.973	288	0.00146	50.00	0.00025	15,798,172	80.087	490,972,355	**2.523**
Total 2011 NYC electricity use	188,085,600		Coefficient with transmission and distribution losses								
Transmission and distribution loss rate	-3.36%		82.750		0.00151		0.00026		82.867		

Unit Conversions

1 GWh = 3600 GJ

1 short ton = 0.907185 Mg

1 lbs/MWh = 0.125998 kg/GJ

1 MMBtu =1.055060 GJ

1 MMBtu/GWh = 0.000293 GJ/GJ

Appendix J

Fuel Emissions Coefficients

2011 FUEL EMISSIONS COEFFICIENTS							
	UNIT	GREENHOUSE GAS (Kg/UNIT)					FUEL EFFICIENCY (Km/UNIT)
		CO_2	CH_4	N_2O	CO_2e	GJ/UNIT	
Stationary source							
Natural gas (buildings)	GJ	50.25326	0.00474	0.00009	50.38216	0.99995	
Natural gas (industrial)	GJ	50.25326	0.00095	0.00009	50.30254	0.99995	
#2 fuel oil (buildings)	liter	2.69627	0.00040	0.00002	2.71147	0.03846	
#2 fuel oil (industrial)	liter	2.69627	0.00011	0.00002	2.70534	0.03846	
#4 fuel oil (buildings)	liter	2.89423	0.00042	0.00002	2.91031	0.04069	
#4 fuel oil (industrial)	liter	2.89423	0.00012	0.00002	2.90383	0.04069	
#6 residual fuel oil (buildings)	liter	2.97590	0.00044	0.00002	2.99242	0.04181	
#6 residual fuel oil (industrial)	liter	2.97590	0.00012	0.00002	2.98576	0.04181	
100% biodiesel*	liter	2.49683	0.00004	0.00000	2.49876	0.03567	
Propane (industrial)	liter	1.47748	0.00007	0.00001	1.48346	0.02536	
Kerosene (industrial)	liter	2.68187	0.00011	0.00002	2.69075	0.03762	
Mobile source							
On-road							
Diesel - buses	liter	2.69720	0.00002	0.00002	2.70253	0.03849	5.38
Diesel - light trucks	liter	2.69720	0.00000	0.00000	2.69851	0.03849	4.38
Diesel - heavy-duty vehicles	liter	2.69720	0.00001	0.00001	2.70082	0.03849	3.65
Diesel - passenger cars	liter	2.69720	0.00000	0.00000	2.69854	0.03849	6.73
Gasoline - light trucks	liter	2.31968	0.00012	0.00017	2.37403	0.03484	6.21
Gasoline - passenger cars	liter	2.31943	0.00015	0.00016	2.37200	0.03484	8.72
100% biodiesel (B100) - heavy trucks*	liter	2.49710	0.00004	0.00000	2.49903	0.03568	3.65
100% ethanol (E100) - passenger cars*	liter	1.51899	0.00022	0.00027	1.60857	0.02342	6.58
Compressed natural gas - bus	GJ	50.28833	0.10395	0.00925	55.33978	1.00000	0.003233282
Off-road							
Aviation gasoline	liter	2.19527	0.00186	0.00003	2.24333	0.03350	
Diesel, locomotives	liter	2.52840	0.00007	0.00008	2.55529	0.03763	
Diesel, ships and boats	liter	2.69720	0.00021	0.00007	2.72293	0.03866	
Jet fuel	liter	2.69749	0.00020	0.00007	2.72289	0.03866	

* Per the LGOP, CO_2 from biofuels is considered biogenic and is reported as an information source
** Per the LGOP, building usage here is identified as residential, commerical, or institutional

Appendix K

Citywide GHG Emissions Summary

	UNITS	2005			2010			2011		
		CONSUMED	$MgCO_2e$	Source GJ	CONSUMED	$MgCO_2e$	Source GJ	CONSUMED	$MgCO_2e$	Source GJ
Buildings										
#2 fuel oil	liters	2,330,793,867	6,319,001	89,648,959	2,196,468,297	5,954,831	84,482,415	2,148,590,012	5,825,834	82,640,880
#4 fuel oil	liters	362,931,089	1,056,169	14,768,600	342,015,072	995,301	13,917,473	334,559,879	973,674	13,614,102
#6 fuel oil	liters	1,008,031,614	3,016,403	42,143,219	949,937,922	2,842,565	39,714,471	929,231,318	2,780,655	38,848,781
Electricity	GJ	174,059,153	21,014,798	512,159,873	178,090,456	15,652,183	447,638,338	177,356,713	14,697,073	447,429,366
Natural gas	GJ	258,698,683	13,032,381	258,698,683	271,992,112	13,701,775	271,992,112	271,788,024	13,693,268	271,788,024
Steam	kg	11,694,104,807	2,233,406	36,180,740	10,569,902,787	1,511,301	26,017,955	10,125,305,153	1,448,966	24,805,576
Transportation										
Biodiesel B5 - transit bus	liters	-	-	-	-	-	-	-	-	
CNG - transit bus	GJ	249,113	13,786	249,113	1,420,989	78,637	1,420,989	1,365,414	75,562	1,420,989
Diesel - commuter rail	liters	5,207,217	14,179	201,286	5,064,028	13,789	195,751	5,189,708	14,131	195,773
Diesel - heavy trucks	liters	354,347,537	956,907	13,638,620	326,200,350	881,007	12,555,252	319,229,257	862,179	12,556,620
Diesel - light trucks	liters	29,530,997	79,696	1,136,630	35,234,181	95,080	1,356,142	34,457,788	92,985	1,356,290
Diesel - non-transit bus	liters	68,793,026	185,923	2,647,801	7,545,275	20,391	290,413	7,151,847	19,328	290,445
Diesel - passenger cars	liters	13,842,098	37,354	532,774	14,166,357	38,228	545,254	13,876,803	37,447	545,314
Diesel - solid waste transport - rail	liters	3,029,923	8,250	117,135	5,671,501	15,443	219,257	6,594,574	17,957	219,257
Diesel - solid waste transport - truck	liters	48,753,438	131,674	1,876,694	28,064,413	75,797	1,080,300	25,710,509	69,439	1,080,300
Diesel - transit bus	liters	182,539,690	493,340	7,025,841	188,631,878	509,784	7,260,325	178,796,163	483,202	7,261,117
Electricity - subway and commuter rail	GJ	9,823,257	1,185,998	28,904,417	10,118,346	889,291	25,432,916	9,644,365	799,203	29,014,354
Gasoline - light trucks	liters	429,097,993	919,214	14,461,233	440,373,688	946,065	14,846,296	430,672,973	921,417	14,847,914
Gasoline - passenger cars	liters	3,545,245,331	7,597,884	119,479,978	3,629,210,490	7,790,907	122,351,394	3,555,082,243	7,600,342	122,364,729
Streetlights and traffic signals										
Electricity	GJ	1,148,131	138,618	3,378,315	855,804	75,216	2,151,100	802,041	66,463	2,023,361
Fugitive and process emissions										
CH_4 - exported solid waste*	Mg	117,865	2,475,157		100,969	2,120,341		93,660	1,966,863	
CH_4 - landfills	Mg	5,651	118,667		4,802	100,846		4,427	92,969	
CH_4 - natural gas distribution	GJ	809,581	318,789		851,182	335,170		781,844	318,400	
CH_4 - wastewater treatment plants	Mg	6,545	137,444		9,416	197,730		9,935	208,801	
HFCs - municipal vehicle fleet	Mg	10	12,623		9	11,235		9	11,235	
N_2O - wastewater treatment process	Mg	286	88,547		285	88,435		285	88,248	
SF_6 - electricity distribution	kg	85,254	2,037,561		10,813	258,434		8,085	193,229	
TOTAL Scope 1			36,575,792	566,626,566		34,951,452	572,227,846		34,380,300	557,643,785
TOTAL Scope 2			24,799,409	580,130,132		18,127,991	501,240,309		17,011,705	498,588,773
TOTAL Scope 3 included in total			2,475,157			2,120,341			1,966,863	
TOTAL Scope 1, 2, and 3*			**63,623,769**	**1,147,249,911**		**55,199,784**	**1,073,468,155**		**53,358,868**	**1,056,232,558**
Scope 3* (not counted toward city total)										
Aviation emissions			14,345,894			13,710,939			15,045,713	
TOTAL Scope 3			**14,947,822**			**14,321,074**			**15,643,280**	
Information items										
Biogenic CO_2 from ethanol and biodiesel	Mg		601,928			610,135			597,567	
TOTAL information items	Mg		601,928			610,135			597,567	

* Per the forthcoming GCP, emissions from solid waste managed outside a City's boundary are considered a Scope 3 source that counts toward a city's total emissions figure. Other Scope 3 sources (e.g. aviation emissions) are reported as infromation only.

Note: All GJ figures represent source GJ.

	UNITS	% CHANGE 2010 - 2011			% CHANGE 2005 - 2011		
		CONSUMED	$MgCO_2e$	Source GJ	CONSUMED	$MgCO_2e$	Source GJ
Buildings							
#2 fuel oil	liters	-2.18%	-2.18%	-2.18%	-7.82%	-7.80%	-7.82%
#4 fuel oil	liters	-2.18%	-2.18%	-2.18%	-7.82%	-7.81%	-7.82%
#6 fuel oil	liters	-2.18%	-2.18%	-2.18%	-7.82%	-7.82%	-7.82%
Electricity	GJ	-0.41%	-6.10%	-0.05%	1.89%	-30.06%	-12.64%
Natural gas	GJ	-0.08%	-0.06%	-0.08%	5.06%	5.07%	5.06%
Steam	GJ	-4.21%	-4.12%	-4.66%	-13.42%	-35.12%	-31.44%
Transportation							
Biodiesel B5 - transit bus	liters	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
CNG - transit bus	GJ	-3.91%	-3.91%	-3.91%	448.11%	448.11%	448.11%
Diesel - commuter rail	liters	2.48%	2.48%	2.48%	-0.34%	-0.34%	-0.34%
Diesel - heavy trucks	liters	-2.14%	-2.14%	-2.14%	-9.91%	-9.90%	-9.91%
Diesel - light trucks	liters	-2.20%	-2.20%	-2.20%	16.68%	16.67%	16.68%
Diesel - non-transit bus	liters	-5.21%	-5.21%	-5.21%	-89.60%	-89.60%	-89.60%
Diesel - passenger cars	liters	-2.04%	-2.04%	-2.04%	0.25%	0.25%	0.25%
Diesel - solid waste transport - rail	liters	16.28%	16.28%	16.28%	117.65%	117.65%	117.65%
Diesel - solid waste transport - truck	liters	-8.39%	-8.39%	-8.39%	-47.26%	-47.26%	-47.26%
Diesel - transit bus	liters	-5.21%	-5.21%	-5.21%	-2.05%	-2.05%	-2.05%
Electricity - subway and commuter rail	GJ	-4.68%	-10.13%	-4.33%	-1.82%	-32.61%	-15.82%
Gasoline - light trucks	liters	-2.20%	-2.20%	1.07%	0.37%	0.24%	3.76%
Gasoline - passenger cars	liters	-2.04%	-2.04%	-8.76%	0.28%	0.03%	-6.57%
Streetlights and traffic signals							
Electricity	GJ	-6.28%	-11.64%	-5.94%	-30.14%	-52.05%	-40.11%
Fugitive and process emissions							
CH_4 - exported solid waste	t	-7.24%	-7.24%		-20.54%	-20.54%	
CH_4 - landfills	Mg	-7.81%	-7.81%		-21.66%	-21.66%	
CH_4 - natural gas distribution	GJ	-8.15%	-5.00%		-3.43%	-0.12%	
CH_4 - wastewater treatment plants	Mg	5.52%	5.60%		51.80%	51.92%	
HFCs - municipal vehicle fleet	Mg	0.00%	0.00%		-11.00%	-10.99%	
N_2O - wastewater treatment process	Mg	-0.21%	-0.21%		-0.34%	-0.34%	
SF_6 - electricity distribution	kg	-25.23%	-25.23%		-90.52%	-90.52%	
TOTAL Scope 1			-1.63%	-2.55%		-6.00%	-1.59%
TOTAL Scope 2			-6.16%	-0.53%		-30.77%	-14.13%
TOTAL Scope 3 included in total			-7.24%			-20.54%	
TOTAL Scope 1 and 2			**-3.34%**	**-1.61%**		**-16.13%**	**-7.93%**
Scope 3							
Aviation emissions			9.74%			4.88%	
TOTAL Scope 3			**9.23%**			**4.65%**	
Information Items							
Biogenic CO_2 from ethanol and biodiesel			-2.06%			-0.72%	
TOTAL information items			-2.06%			-0.72%	

Appendix L

City Government GHG Emissions Summary

	UNITS	FY 2006			FY 2010			FY 2011			CY 2008		
		CONSUMED	$MgCO_2e$	SOURCE GJ	CONSUMED	$MgCO_2e$	SOURCE GJ	CONSUMED	$MgCO_2e$	SOURCE GJ	CONSUMED	$MgCO_2e$	SOURCE GJ
Buildings													
#2 fuel oil	liters	56,816,067	154,055	2,185,191	42,752,123	115,921	1,644,281	46,838,010	127,000	1,801,427	56,362,852	152,826	2,167,760
#4 fuel oil	liters	32,426,496	94,371	1,319,448	29,700,154	86,437	1,208,512	28,033,289	81,586	1,140,686	28,034,021	81,588	1,140,716
#6 fuel oil	liters	75,041,558	224,556	3,137,129	68,720,191	205,640	2,872,863	67,193,640	201,072	2,809,045	78,012,725	233,447	3,261,339
Biodiesel	liters				477,864	0.92	17,047	239,376	0.46	8,539	69,631	0.13	2,484
Electricity	GJ	11,518,736	1,237,160	31,971,468	12,010,989	1,055,633	30,188,557	12,354,733	1,023,803	31,166,437	13,006,665	1,280,598	34,302,336
Kerosene	liters				37,593	101	1,414	63	0.17	2			
Natural gas	GJ	11,068,300	557,645	11,067,713	11,393,850	574,047	11,393,245	12,530,186	631,298	12,529,521	11,608,809	584,877	11,608,809
Propane	liters	4,086,926	6,063	103,652	7,273,174	10,789	184,461	4,605,107	6,832	116,794			
Steam	kg	781,066,529	121,892	2,007,102	844,084,145	120,688	2,077,614	905,309,589	129,553	2,339,865	838,807,553	129,426	2,179,579
Transportation													
Diesel - trucks	liters	60,061,625	162,215	2,311,612	59,954,846	161,927	2,307,503	61,233,609	165,381	2,356,719	63,597,015	171,782	2,447,947
Biodiesel - trucks	liters				2,425,744	4.6918	86,535	2,239,955	4	79,908			
Diesel - marine vessels	liters	18,247,504	49,681	705,325	19,353,969	52,693	748,094	18,280,116	49,769	706,586	16,402,763	44,658	634,020
Diesel - solid waste transport - rail	liters	3,286,291	8,949	127,040	5,623,564	15,313	217,393	6,220,342	16,938	240,463	4,807,000	13,091	185,826
Diesel - solid waste transport - truck	liters	47,229,856	127,573	1,817,950	27,513,045	74,308	1,059,019	25,133,443	67,881	967,425	35,029,146	94,618	1,348,326
Ethanol	liters				95,901	56	2,484	17,275	13	464	357,262	216	9,580
Gasoline	liters	57,345,407	123,306	1,934,077	57,246,657	122,893	1,929,851	50,371,878	108,134	1,698,094	57,900,883	125,170	1,955,424
Jet fuel	liters	933,093	2,384	35,107	844,094	2,157	31,759	783,874	2,003	29,493	864,548	2,209	32,528
Streetlights and traffic signals													
Electricity	GJ	1,102,486	118,412	3,355,153	817,813	71,877	2,055,500	770,764	63,871	1,961,695	1,099,907	108,294	2,900,774
Wastewater Treatment													
#1 and #2 fuel oil	liters	18,314,093	49,546	704,375	18,208,754	49,229	700,670	19,071,722	51,566	733,555	16,408,962	44,392	631,102
#4 fuel oil	liters	1,129,823	3,281	45,973	1,196,692	3,475	48,694	1,122,601	3,260	45,679	596,183	1,731	24,259
Biodiesel	liters				2,713	0.01	97	379	0.00	14			
Electricity	GJ	2,145,924	230,481	5,956,238	2,417,511	212,472	6,076,201	2,413,207	199,976	6,141,930	2,254,193	221,941	5,944,960
Kerosene	liters												
Methane	Mg		148,426			213,485			202,997			252,035	
Natural gas	GJ	380,655	19,148	380,635	602,279	30,296	602,247	446,645	22,467	446,621	748,723	37,663	748,723
Nitrous oxide	Mg		83,134			91,160			83,357			85,983	
Propane	liters										1,784	3	45
Steam	kg	106,123,696	16,562	272,705	80,591,571	11,523	198,367	105,527,584	15,101	272,747	2,243,052	346	5,828
Water Supply													
#1 and #2 fuel oil	liters	234,386	634	9,015	329,608	892	12,677	276,694	748	10,648	738,904	1,999	28,419
Biodiesel	liters				7,212	0.01	257	3,914	0.01	140	17,247	0.03	615
Electricity	GJ	83,711	8,991	232,348	73,610	6,469	185,011	90,607	7,508	230,606	241,098	23,738	635,845
Kerosene	liters										92,301	248	3,473
Natural gas	Mg	2,921	147	2,921	2,796	141	2,796	6,509	327	6,508	79,525	4,000	79,525
Propane	liters										4,460,711	6,617	113,132
Steam	kg										1,917,367	296	4,982
Solid waste facilities													
Methane	Mg		119,499			103,844			96,450			105,548	
Other fugitive and process emissions													
HFCs - municipal fleet	Mg		11,370			11,407			10,645			11,580	
Scope 1	Mg		1,945,983	25,887,162		1,926,214	25,071,898		1,929,728	25,728,318		2,056,279	26,424,054
Scope 2	Mg		1,733,497	43,795,016		1,478,663	40,781,250		1,439,813	42,113,279		1,764,639	45,974,305
TOTAL Scope 1 and 2	Mg		**3,679,480**	**69,682,179**		**3,404,877**	**65,853,149**		**3,369,541**	**67,841,597**		**3,820,918**	**72,398,359**
Scope 3* (not counted toward City total)													
Employee commute	Mg		224,207			197,411			192,733			234,365	
Employee solid waste	Mg		174,178			176,993			172,809			176,856	
TOTAL Scope 3	Mg		**398,385**			**374,404**			**365,542**			**411,221**	
Information items													
Biogenic CO_2e from fuel	Mg		8,966			16,490			14,223			22,445	
TOTAL information items	Mg		8,966			16,490			14,223			22,445	

* Per the forthcoming GCP, emissions from solid waste managed outside a City's boundary are considered a Scope 3 source that counts toward a city's total emissions figure. Other Scope 3 sources (e.g. aviation emissions) are reported as infromation only.

Note: All GJ figures represent source GJ

	CY 2010			CY 2011			% CHANGE FY 2006 - 2011			% CHANGE FY 2010 - 2011		
	CONSUMED	$MgCO_2e$	SOURCE GJ	CONSUMED	$MgCO_2e$	SOURCE GJ	CONSUMED	$MgCO_2e$	SOURCE GJ	CONSUMED	$MgCO_2e$	SOURCE GJ
Buildings												
#2 fuel oil	41,216,173	111,756	1,585,207	44,522,426	120,721	1,712,368	-17.56%	-17.56%	-17.56%	9.56%	9.56%	9.56%
#4 fuel oil	28,811,003	83,849	1,172,332	28,628,821	83,319	1,164,919	-13.55%	-13.55%	-13.55%	-5.61%	-5.61%	-5.61%
#6 fuel oil	66,302,027	198,404	2,771,771	61,832,581	185,029	2,584,925	-10.46%	-10.46%	-10.46%	-2.22%	-2.22%	-2.22%
Biodiesel	497,216	0.96	17,738	224,908	0.44	8,023				-49.91%	-49.91%	-49.91%
Electricity	12,201,066	1,072,339	30,666,299	12,114,673	1,003,910	30,560,855	7.26%	-17.25%	-2.52%	2.86%	-3.02%	3.24%
Kerosene							-100.00%	-100.00%	-100.00%	-99.83%	-99.83%	-99.83%
Natural gas	11,483,851	578,581	11,483,241	11,789,541	593,983	11,788,915	13.21%	13.21%	13.21%	9.97%	9.97%	9.97%
Propane							12.68%	12.68%	12.68%	-36.68%	-36.68%	-36.68%
Steam	862,219,675	123,282	2,122,252	871,816,782	124,760	2,253,299	15.91%	6.28%	16.58%	7.25%	7.34%	12.62%
Transportation												
Diesel - trucks	58,949,875	159,213	2,268,824	62,855,786	169,762	2,419,152	1.95%	1.95%	1.95%	2.13%	2.13%	2.13%
Biodiesel - trucks	2,408,099	4.6577	85,906	2,120,499	4	75,646				-7.66%	-7.66%	-7.66%
Diesel - marine vessels	18,848,725	51,317	728,564	19,667,625	53,547	760,217	0.18%	0.18%	0.18%	-5.55%	-5.55%	-5.55%
Diesel - solid waste transport - rail	5,670,883	15,441	219,222	6,593,855	17,955	254,902	89.28%	89.26%	89.28%	10.61%	10.61%	10.61%
Diesel - solid waste transport - truck	28,061,355	75,789	1,080,125	25,707,707	69,432	989,529	-46.78%	-46.79%	-46.78%	-8.65%	-8.65%	-8.65%
Ethanol	39,992	26	1,047	22,805	15	599				-81.99%	-76.13%	-81.33%
Gasoline	55,552,097	119,255	1,872,726	51,134,027	109,771	1,723,787	-12.16%	-12.30%	-12.20%	-12.01%	-12.01%	-12.01%
Jet fuel	856,591	2,189	32,229	706,094	1,804	26,567	-15.99%	-15.99%	-15.99%	-7.13%	-7.13%	-7.13%
Streetlights and traffic signals												
Electricity	777,865	68,366	1,955,096	777,406	64,422	1,978,601	-30.09%	-46.06%	-41.53%	-5.75%	-11.14%	-4.56%
Wastewater Treatment												
#1 and #2 fuel oil	18,408,885	49,751	708,577	19,883,313	53,790	764,736	4.14%	4.08%	4.14%	4.74%	4.75%	4.69%
#4 fuel oil	1,085,273	3,151	44,160	744,498	2,162	30,294	-0.64%	-0.64%	-0.64%	-6.19%	-6.19%	-6.19%
Biodiesel										-86.05%	-86.05%	-100.00%
Electricity	2,376,190	208,841	5,972,343	2,364,024	195,900	6,016,751	12.46%	-13.24%	3.12%	-0.18%	-5.88%	1.08%
Kerosene				131	0.35	5						
Methane		197,917			208,801			36.77%			-4.91%	
Natural gas	579,820	29,166	579,789	428,677	21,564	428,654	17.34%	17.34%	17.34%	-25.84%	-25.84%	-25.84%
Nitrous oxide		88,248			86,079			0.27%			-8.56%	
Propane												
Steam	1,312,696	188	3,231	2,600,445	372	6,721	-0.56%	-8.82%	0.02%	30.94%	31.05%	37.50%
Water Supply												
#1 and #2 fuel oil	812,271	2,197	31,246	931,254	2,519	35,821	18.05%	17.96%	18.12%	-16.05%	-16.12%	-16.00%
Biodiesel	17,073	0.03	609	15,812	0.03	564				-45.73%	-45.73%	-45.73%
Electricity	166,670	14,648	418,910	163,328	13,535	415,691	8.24%	-16.49%	-0.75%	23.09%	16.06%	24.64%
Kerosene	16,518	44	622									
Natural gas	48,375	2,433	48,372	47,209	2,375	47,206	122.82%	122.82%	122.82%	132.81%	132.81%	132.81%
Propane	4,804,886	7,128	121,861	4,146,959	6,152	105,174						
Steam	3,330,275	476	8,197	3,025,461	433	7,820						
Solid waste facilities												
Methane		100,846			92,969			-19.29%			-7.12%	
Other fugitive and process emissions												
HFCs - municipal fleet		11,235			10,638			-6.37%			-6.68%	
Scope 1		1,887,943	24,854,167		1,892,389	24,922,004		-0.84%	-0.61%		0.18%	2.63%
Scope 2		1,488,139	41,146,329		1,403,332	41,239,738		-16.94%	-3.84%		-2.63%	-13.46%
TOTAL Scope 1 and 2		**3,376,082**	**66,000,496**		**3,295,720**	**66,161,742**		**-8.42%**	**-2.64%**		-1.04%	-7.99%
Scope 3* (not counted toward City total)												
Employee commute		195,027			189,618			-14.04%			-2.37%	
Employee solid waste		174,959			170,055			-0.79%			-2.36%	
TOTAL Scope 3		**369,986**			**359,673**			**-6.77%**			-2.85%	
Information items												
Biogenic CO_2e from fuel		16,171			14,046			58.63%			-13.75%	
TOTAL information items	TOTAL information items											

*** All GJ figures represent source GJ**

Appendix M

Heating and Cooling Degree Days

Heating and Cooling Degree Days, Central Park 2005-2010 Using 65 Degrees (°F) Base Temperature

	YEAR	ANNUAL TOTAL	% CHANGE FROM PREVIOUS YEAR
	Calendar years		
Heating degree days	2005	4733	
Heating degree days	2006	3987	-15.76%
Heating degree days	2007	4705	18.01%
Heating degree days	2008	4598	-2.27%
Heating degree days	2009	4760	3.52%
Heating degree days	2010	4447	-6.58%
Heating degree days	2011	4335	-2.52%
Cooling degree days	2005	1472	
Cooling degree days	2006	1130	-23.23%
Cooling degree days	2007	1212	7.26%
Cooling degree days	2008	1163	-4.04%
Cooling degree days	2009	876	-24.68%
Cooling degree days	2010	1549	76.83%
Cooling degree days	2011	1331	-14.07%
	Fiscal years		
Heating degree days	2006	4261	
Heating degree days	2007	4460	4.67%
Heating degree days	2008	4470	0.22%
Heating degree days	2009	4835	8.17%
Heating degree days	2010	4377	-9.47%
Heating degree days	2011	4726	7.97%
Cooling degree days	2006	1435	
Cooling degree days	2007	1177	-17.98%
Cooling degree days	2008	1202	2.12%
Cooling degree days	2009	1051	-12.56%
Cooling degree days	2010	1112	5.80%
Cooling degree days	2011	1442	29.68%

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

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