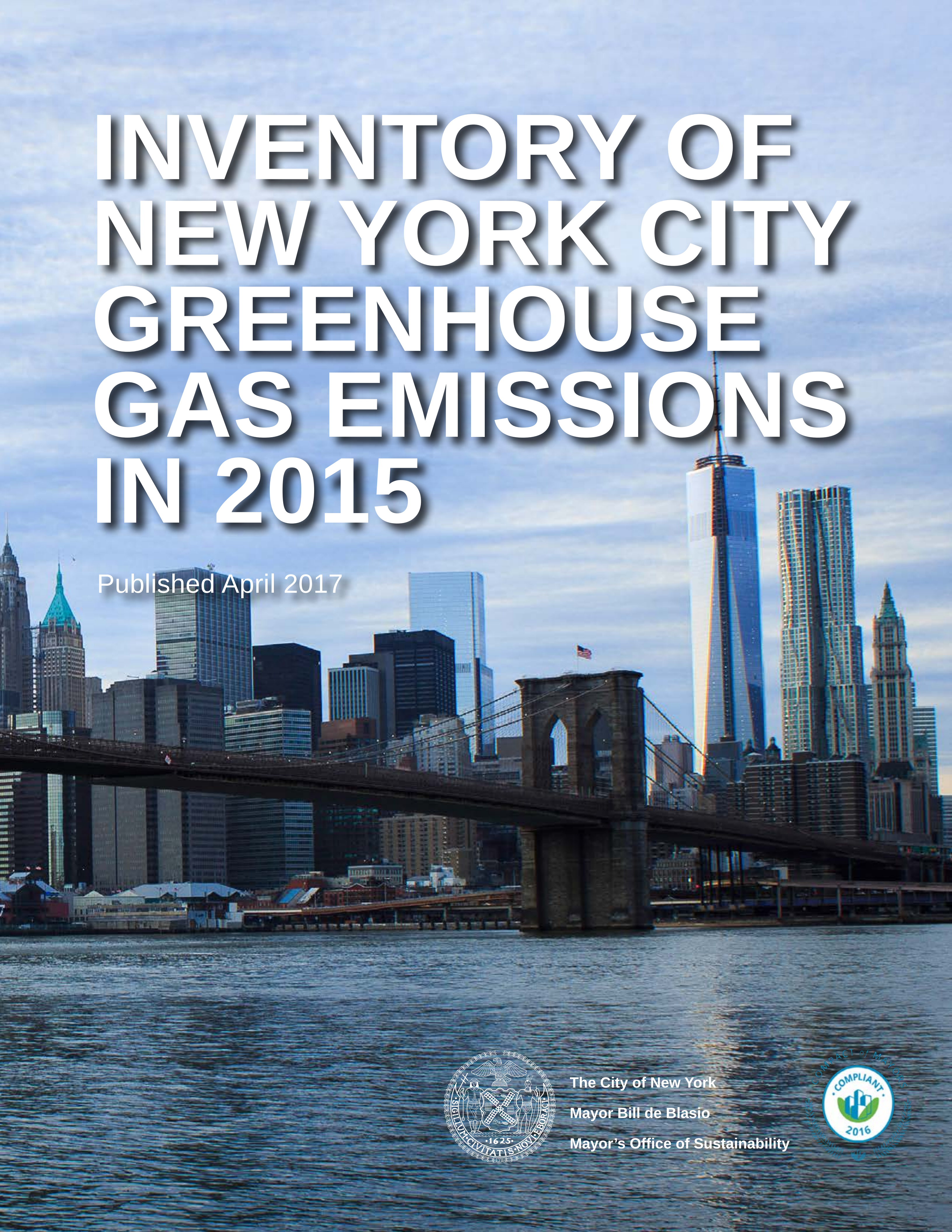
INVENTORY OF NEW YORK CITY GREENHOUSE GAS EMISSIONS IN 2015

Published April 2017



The City of New York

Mayor Bill de Blasio

Mayor's Office of Sustainability

The Inventory of New York City Greenhouse Gas Emissions is published pursuant to Local Law 22 of 2008. This report was produced by the New York City Mayor's Office of Sustainability with Cventure LLC.

The City of New York would like to thank the following for their valuable assistance in producing this report: Con Edison Company of New York, the Long Island Power Authority, the Metropolitan Transportation Authority, National Grid, New Jersey Transit, the New York Power Authority, and the Port Authority of New York and New Jersey.

Academic Citation:

City of New York Inventory of New York City's Greenhouse Gas Emissions, April 2017, by Cventure LLC, Cathy Pasion, Christianah Oyenuga, and Kate Gouin, Mayor's Office of Sustainability, New York, 2017.

This document was designed by Melanie Ho.

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INVENTORY OF NEW YORK CITY GREENHOUSE GAS EMISSIONS
April 2017

Letter from the Mayor

Friends,

Cities have an important role in climate change mitigation. Since 2007, New York City has measured its citywide and government operations greenhouse gas emissions. As one of the first cities to do so, we are able to see how we are doing in our efforts to reduce those emissions. Over the years, this inventory has provided us with valuable data to help develop the right strategies to meet our OneNYC goal of reducing greenhouse gas emissions 80 percent from 2005 levels by 2050 (80 x 50) and combat climate change.

To ensure our data is robust, we are committed to using best practices that allow us to compare our emissions with other cities. As a member of the Global Covenant of Mayors for Climate and Energy, we are compliant with the Global Protocol for Community-Scale Greenhouse Gas Emission Inventory (GPC), an international standard.

The NYC greenhouse gas inventory shows that emissions in 2015 dropped 14.8 percent since 2005. This drop comes despite economic growth and increased population. Reductions to date continue to be largely the result of switching to natural gas in the electricity grid while the city's building stock is the biggest source of the city's emissions.

Last September, we released *New York City's Roadmap to 80 x 50*, a comprehensive report to assess what is necessary from the buildings, energy, transportation, and waste sectors to reach 80 x 50. While there is much more work ahead in pursuit of our ambitious and necessary goals, we have made significant strides and outlined a strong pathway to get there.

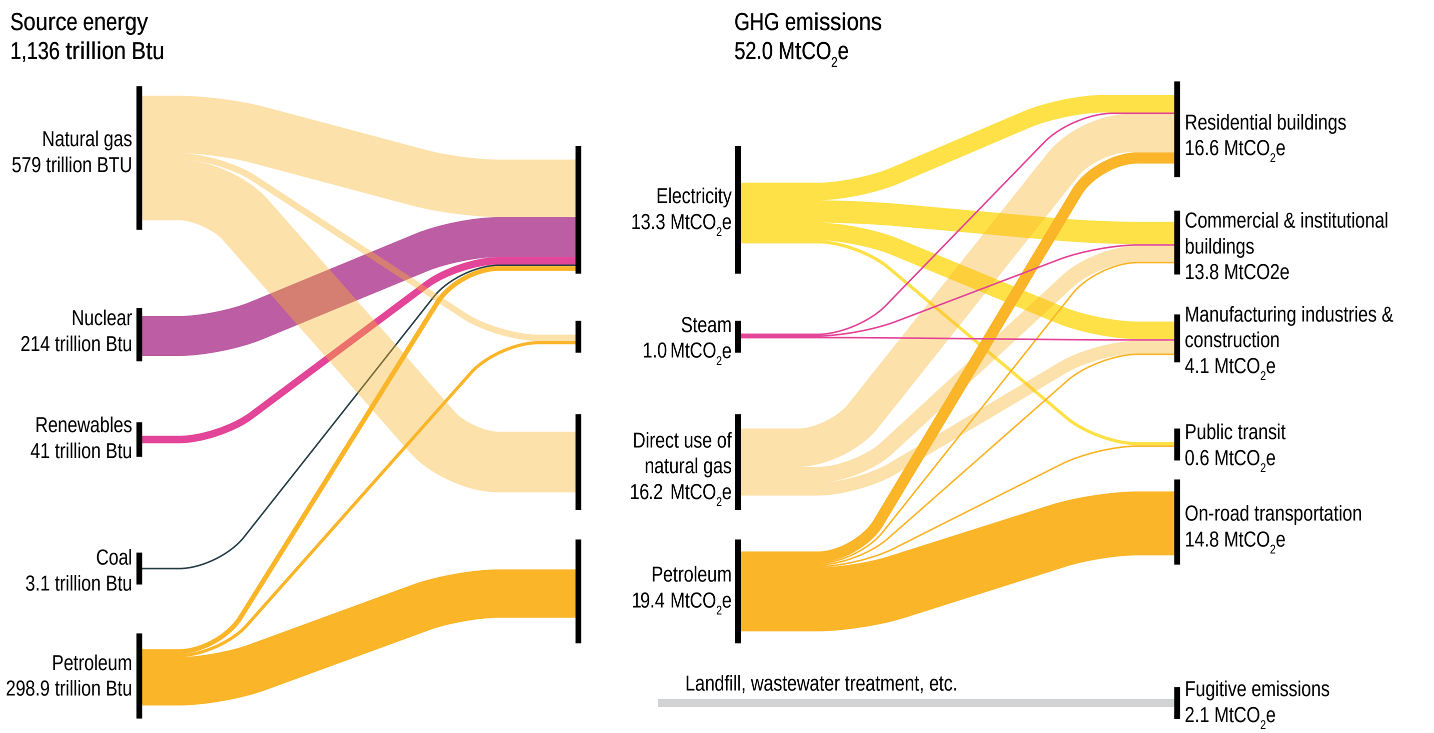
Mayor Bill de Blasio

Overview

New York City Energy Use and Greenhouse Gas Emissions

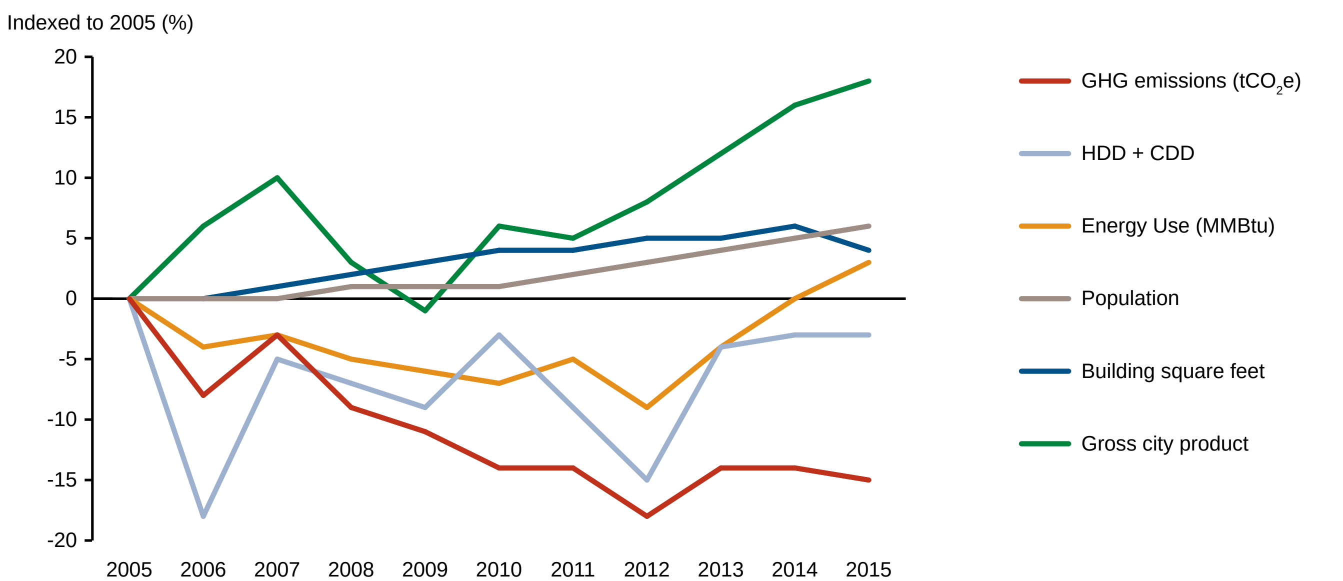
In 2015, New York City buildings were responsible for 67 percent of citywide greenhouse gas (GHG) emissions through the use of natural gas, electricity, heating oil, steam, and biofuel. The transportation sector accounted for 30 percent and the remaining GHG emissions stem largely from fugitive emissions released from landfills and wastewater treatment plants.

Fig. 1: 2015 New York City Energy Consumption and Greenhouse Gas Emissions



Source: NYC Mayor's Office

Fig. 2: Energy, GHG Emissions, and Economic Indicators



Source: NYC Mayor's Office

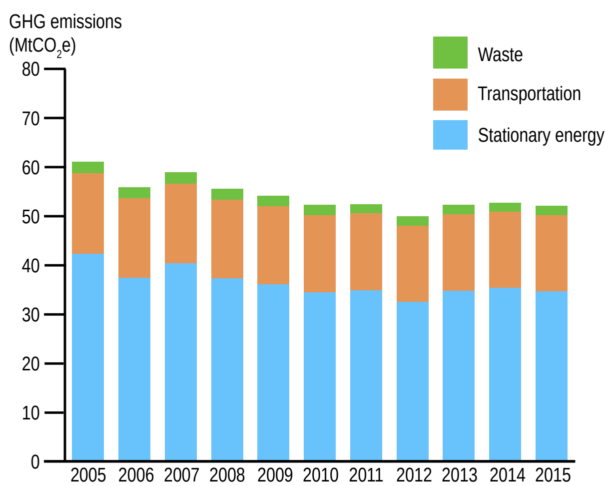
Introduction

Since 2005, greenhouse gas (GHG) emissions have decreased in New York City citywide by approximately 14.8 percent despite significant increases in New York City's population and economic activity (see Figure 2). New York City's per capita GHG emissions in 2015 was an average of 6.1 metric tons of carbon dioxide equivalent (tCO_2e) emissions per capita, significantly lower than the American average of 19 tCO_2e per capita. In the first nine years of tracking the city's emissions, cleaner and more efficient electricity generation was the most significant driver behind GHG emission reductions.

Figure 3 below shows citywide annual GHG emissions from 2005 to 2015, by sectors, as defined by the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC). GHG emissions both citywide and in City government have decreased significantly in comparison to the base years (2005 and Fiscal Year 2006, respectively). In the first five years of tracking the city's emissions, the most significant driver behind GHG emissions reductions was the switching of the fuel source for electricity generation from coal to natural gas – a less carbon-intensive energy source; and the construction of new natural gas power plants of higher efficiency.

The City of New York is compliant with the Global Covenant of Mayors for Climate and Energy, a global cooperative effort among mayors and city officials to reduce GHG emissions, track progress and prepare for the impacts of climate change. The City has committed to working with cities across the globe and to use consistent best practices in GHG emissions accounting in a shared effort to track progress toward climate mitigation goals. As a result, this GHG emissions inventory follows the guidance of GPC. New York's GHG mitigation goals are based on the GPC BASIC level – GHG emissions from stationary energy use, in-boundary transportation, and waste management.

Fig. 3: Citywide Annual GHG Emissions by Sector, 2005-2015



Source: NYC Mayor's Office

Since 2012, the rate of reduction has slowed slightly, and GHG emissions, as reported in 2013-2015, have more closely coincided with the fall and rise of temperatures. GHG emissions from stationary energy heating fuel, which contribute approximately 40 percent of the total citywide GHG emissions, track closely with the cold days of winter through increased thermal demands and heating needs. This was especially evident in the difference between the 2014 and 2015 GHG emissions inventories. 2014 was the coldest year since 2005 and had an increase in stationary heating fuel GHG emissions. In 2015, stationary heating fuel GHG emissions decreased by approximately two percent from 2014, as 2015 heating demand decreased back to below 2013 levels. GHG emissions that result from increased use of energy to meet heating needs were offset in part by energy efficiency gains from City programs and policies.

The City has developed policies and mitigation strategies to further its commitment to reducing GHG emissions 80 percent below 2005 levels by 2050 (80 x 50). As a first step in achieving this goal, the city is accelerating building retrofits, as described in the plan *One City Built to Last*, a ten-year action plan to improve energy efficiency in the city's buildings by 2025.[1] City government is committed to leading the way to this goal, targeting a 35 percent reduction in City government buildings' GHG emissions by 2025.

In order to reach 80 x 50, GHG reductions are required across all sectors. As part of the City's commitment in *One New York: The Plan for a Strong and Just City*,[2] the City has developed an integrated 80 x 50 GHG mitigation plan, *New York City's Roadmap to 80 x 50* (*Roadmap to 80 x 50*), which includes the buildings, energy supply, transportation, and solid waste sectors.[3] As New York City pursues its GHG emissions reduction target, this GHG Inventory will continue to play a key role in measuring success and provide the necessary metrics for revising and optimizing strategies.

Executive Summary

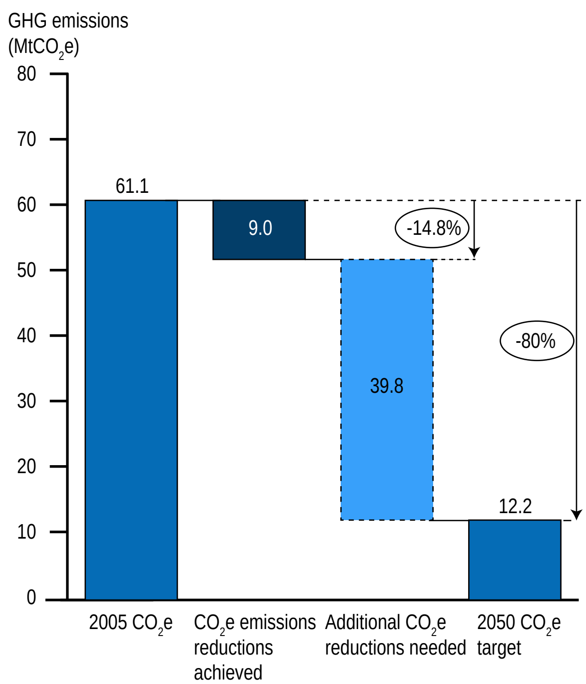
Climate change is an existential threat to our city, our country, and our planet. The United Nations Framework Convention on Climate Change has called for limiting temperature increases this century to 2 degrees Celsius, or a 50 percent reduction in global GHG emissions and an 80 percent greenhouse gas (GHG) reduction in developed countries by 2050. In December 2015, 196 countries negotiated the Paris Agreement at the United Nations Climate Change Conference, COP 21, agreeing to reduce GHG emissions to levels necessary to limit global temperature increase to less than 2 degrees Celsius. New York City has pledged to do its part by committing to reducing the city's greenhouse gas emissions by 80 percent over 2005 levels by 2050 (80 x 50). As the City works toward its 80 x 50 goal, City government operations will lead the way with a target reduction of 35 percent over fiscal year ("FY") 2006 levels by 2025.

Critical to reaching this goal is accounting for GHG emissions to better track and understand progress. In 2007, New York City began tracking and publishing an annual Inventory of New York City Greenhouse Gas Emissions both citywide and for City government operations, and has been updating the inventory annually pursuant to New York City Local Law 22 of 2008. As such, the City of New York has become a global leader in the development and implementation of city-level carbon accounting methodologies.

Methodology

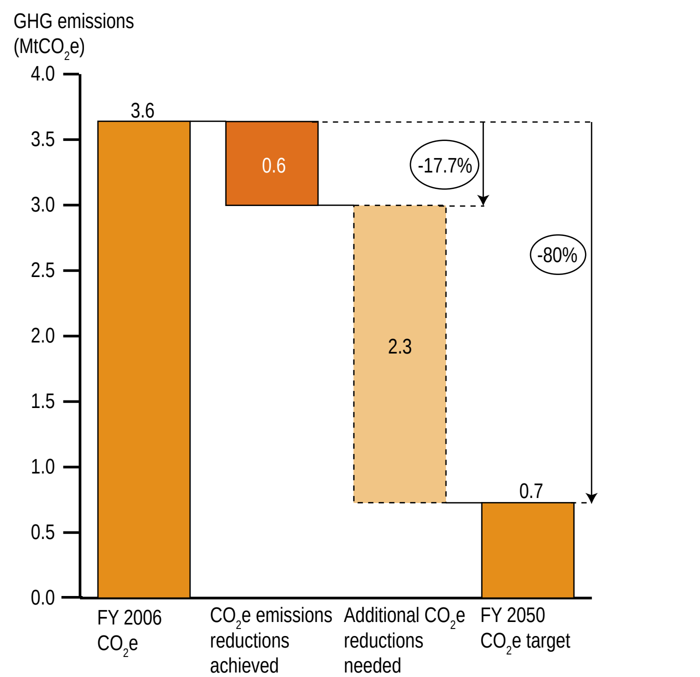
The City has committed to working with cities across the globe and to use consistent best practices in GHG emissions accounting in a shared effort to track progress toward climate

Fig. 4: Citywide $CO2_e$ Emissions Reduction Summary



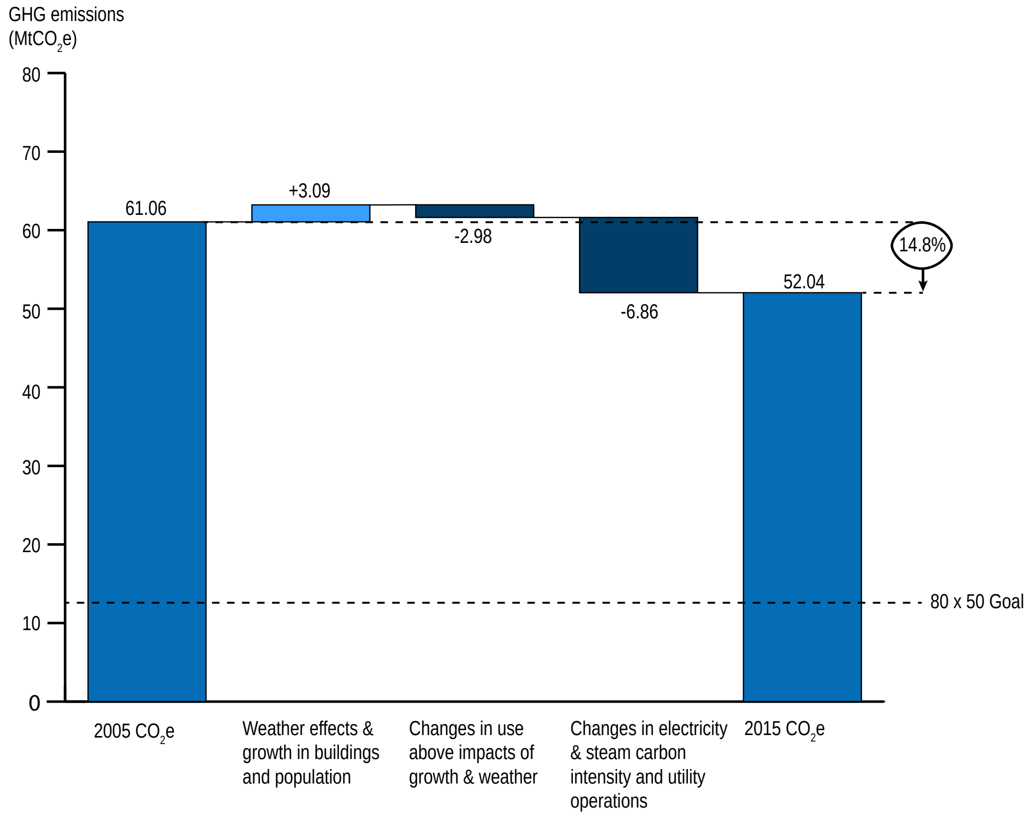
Source: NYC Mayor's Office

Fig. 5: City Government CO_2e Emissions Reduction Summary



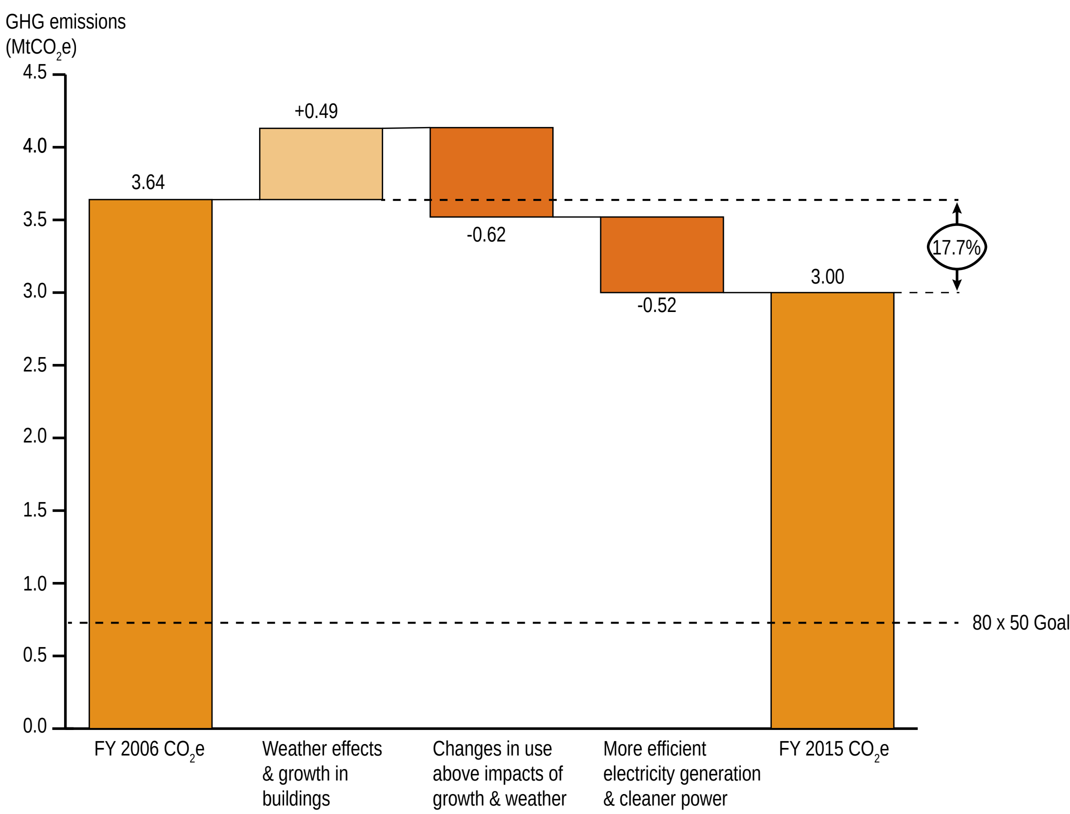
Source: NYC Mayor's Office

Fig. 6: Citywide 2005-2014 CO2e Emissions Drivers



Source: NYC Mayor's Office

Fig. 7: City Government 2006-2015 CO2e Emissions Drivers



Source: NYC Mayor's Office

mitigation goals, including following the guidance of the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC). Additional data sets were accounted for last year in the 2014 GHG Inventory for the first time to ensure compliance with the Global Covenant of Mayors for Climate and Energy, a global cooperative effort among mayors and city officials to reduce GHG emissions, track progress, and prepare for the impacts of climate change.

The Inventory of New York City Greenhouse Gas Emissions measures and reports GHG emissions from two sets of sources: (1) all activities taking place within the boundary of New York City are reported in the citywide inventory (referred to as the community inventory in GHG protocols); and (2) the activities associated with the provision of services by New York City Government (a subset of the citywide inventory), reported in the City government GHG Inventory.

The citywide GPC BASIC GHG inventory consists of all direct and indirect GHG emissions from energy used by buildings and other stationary sources; on-road transportation and public transit within the geographic borders of New York City; and fugitive GHG emissions from wastewater treatment, solid waste disposed of out of the city, and natural gas distribution within New York City.

City government emissions are calculated and reported per the Local Government Operations Protocol (LGOP).[4] The inventory reports GHG emissions from operations, facilities, or sources wholly owned by the City, or over which the City has full authority to introduce and implement operations, health and safety, and environmental policies (including both GHG- and non-GHG-related policies). GHG emissions from leased real estate and vehicles and other equipment are included. It is important to note that additional, non-City operated public entities (e.g., Metropolitan Transportation Authority) are not included within the LGOP inventory protocol by this definition of operational control.

Results

As of 2015, citywide GHG emissions have decreased by 14.8 percent relative to 2005 levels, resulting in citywide GHG emissions of 52.0 million metric tons of carbon dioxide equivalent ($MtCO_2e$) in 2015. This corresponds to a 1.3 percent decrease below the 2014 citywide GHG emissions of 52.7 $MtCO_2e$. City government GHG emissions have decreased by 17.7 percent relative to FY 2006 levels.

Much of these reductions were achieved early on, largely as a result of power plants switching their fuel source from coal to natural gas – a less carbon-intensive energy source; and through the construction of new, highly efficient natural gas power plants, both within and outside the city. Prior to 2013, electricity use had historically been the largest source of GHG emissions within the city. As the result of conversions of buildings' heating fuel supplies from heavier heating fuel oils to light fuel oil or natural gas as part of the City's Clean Heat Program, along with continued low natural gas prices making natural gas the fuel of choice for new construction, usage of natural gas has increased in the City.

Collectively these factors have resulted in an increase in natural gas use in buildings citywide of 25 percent from 2005 to 2015. Natural gas contributes approximately 31 percent of the citywide GHG emissions while electricity contributes approximately 25 percent of citywide GHG emissions.

This fall in electricity's contribution to overall GHG emissions illustrates the gains in both the cleanliness of the power supply, and increases in energy efficiency for electricity generation and its end use.

From 2012 through 2015, the rate of GHG emissions reduction citywide has slowed somewhat, and GHG emissions as reported in the 2013-2015 time period have more closely tracked the fall and rise of temperatures as indicated by Heating Degree Days (HDD). This was especially evident in the 2014 GHG emissions inventory, when 2014 was the coldest year since 2005.

Table 1 below summarizes the overall results of the 2015 citywide GHG emissions inventory. Included there are 2015 GHG emissions totals for Scope 1, 2, and 3 emissions, consistent with the GPC emissions categories of stationary, transportation and waste, respectively. Also included in Table 1 are sub-totals for each of the GHG emissions sources (by sector).

Table 1. 2015 Citywide GHG Emissions Inventory Results:
by Sector and GHG Emissions Scope

Sector	Total GHGs (MtCO_2e)			
	Scope 1	Scope 2	Scope 3	Total
Stationary Energy	21.97	12.76	-	34.73
Transportation	14.92	0.56	-	15.48
Waste	0.33	-	1.51	1.84
Total	37.22	13.32	1.51	52.04

Source: NYC Mayor's Office

Introduction

The City of New York released its first comprehensive greenhouse gas (GHG) inventory in April 2007 (2005 Inventory), which informed both the citywide and City government greenhouse gas mitigation efforts, and also established the levels from which the City's greenhouse gas mitigation goals are based. Local Law 22 of 2008 requires the City to update both the citywide and City government inventories annually and to document progress toward achieving its greenhouse gas mitigation goals.

Each year, the GHG Inventory has evolved to incorporate new and emerging carbon accounting procedures, as well as continual improvements in calculation methodologies, emission factors, data collection, and quality assurance. Past years' inventory results are then revised accordingly to reflect current methodologies and better data, and allow for more accurate comparability across multiple years. As such, both the citywide and City government base year and interim year inventory results have been updated in this April 2017 report, where applicable. The reliance on increasingly rigorous analysis to measure the City's progress toward its GHG mitigation goals and inform policy efforts demonstrates its understanding of the critical importance of reliable, consistent, and complete GHG emissions accounting.

Recognizing the important role cities play in combating climate change, the City of New York joined the Global Covenant of Mayors for Climate and Energy, a global cooperative effort among mayors and city officials to reduce GHG emissions, track progress and prepare for the impacts of climate change. The City has committed to working with cities across the globe and to use consistent best practices in GHG emissions accounting in a shared effort to track progress toward climate mitigation goals, including following the guidance of the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC). The 2015 GHG emissions inventory is GPC BASIC level compliant.

Methodology

Citywide GHG emissions are calculated and reported per the guidance of the GPC. The GHG inventory consists of all direct and indirect GHG emissions from energy used by buildings and other stationary sources, and natural gas distribution within New York City; on-road transportation, railways, marine navigation, and aviation within the geographic borders of New York City; and GHG emissions from wastewater treatment and solid waste disposed out of the city. These sources represent the GPC BASIC level of reporting, which is used to track the City's GHG mitigation goals.

City Government GHG emissions are calculated and reported per the Local Government Operations Protocol (LGOP). The City Government inventory reports GHG emissions from operations, facilities, and sources either wholly owned by the City, or over which the City has full authority to introduce and implement operations, health and safety, and environmental policies (including both GHG- and non-GHG-related policies). GHG emissions from leased real estate and vehicles and other equipment are also included. It is important to note that additional, non-City operated public entities (e.g., Metropolitan Transportation Authority) are not included by this definition of operational control.

Detailed methodology descriptions for both citywide and City Government GHG emissions are included in Appendix A.

Uncertainty

A greenhouse gas inventory is both an accounting and scientific exercise; uncertainty exists in data collection and aggregation, as well as the calculation of GHG emissions. Uncertainty is inherently part of GHG calculations, as both the development of emission factors and global warming potentials involve scientific uncertainty. Uncertainty also is a part of the modeling and estimating necessary to complete GHG inventories. While a precise margin of error has not been calculated for this GHG inventory, it is understood that all results have some uncertain elements and should be interpreted and used accordingly.

Citywide Inventory

In 2015, citywide GHG emissions were 14.8 percent lower than in 2005 levels. 2015 activities in New York City resulted in the emission of 52.0 $MtCO_2e$ in 2015. GHG emissions decreased 1.3 percent in 2015 relative to 2014.

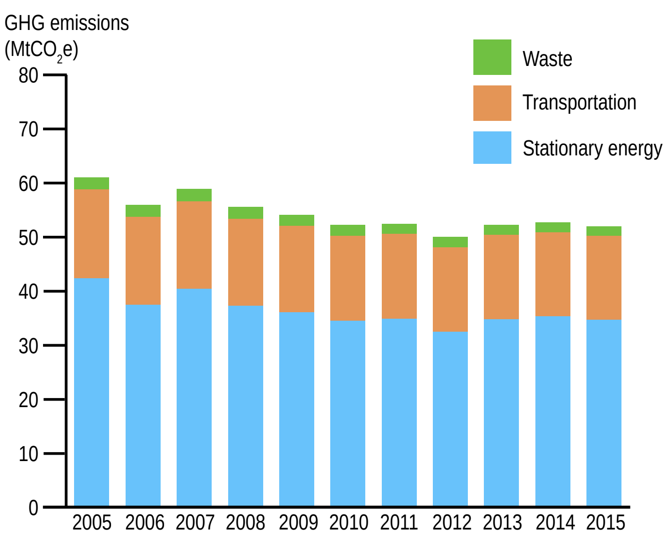
The citywide GHG inventory consists of all direct and indirect GHG emissions from energy used by buildings and other stationary sources, and fugitive natural gas within New York City; on-road transportation, railways, marine navigation, and aviation within the geographic borders of New York City; and GHG emissions from wastewater treatment, and in-city landfills, and solid waste disposed of out of the city.

- **Scope 1 GHG Emissions:** 36.1 $MtCO_2e$ (direct emissions from on-site fossil fuel combustion or fugitive emissions from within the city's boundary).
- **Scope 2 GHG Emissions:** 14.3 $MtCO_2e$ (indirect emissions from energy generated in one location, but used in another, such as electricity and direct steam).
- **Scope 3 GHG emissions included in the city's total emissions results:** 1.6 $MtCO_2e$ (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) .

Figure 8 below presents the citywide annual GHG emissions over the 2005-2015 time period, with GHG emissions reported by sector, as according to the GPC sector definitions for stationary energy, transportation and waste.

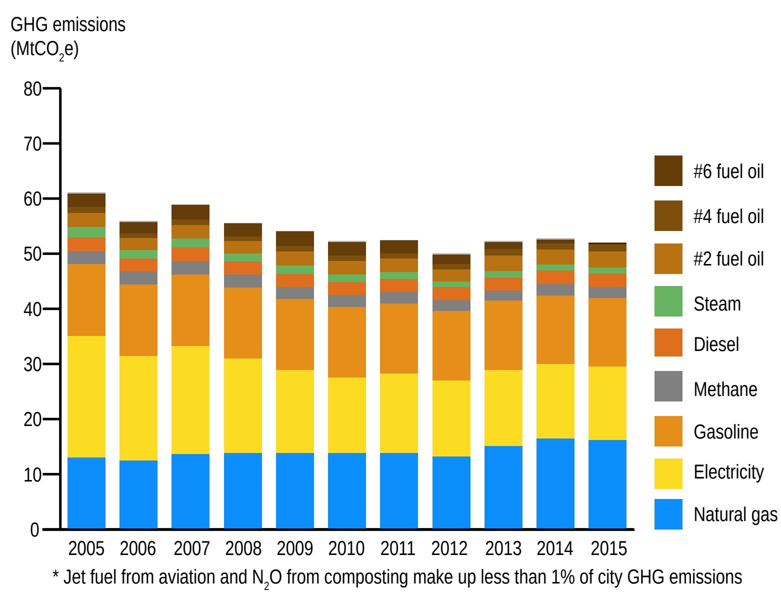
Figure 9 presents the citywide annual GHG emissions over the 2005-2015 time period, with GHG emissions reported by the following source types: heating fuel oil, electricity,

Fig. 8: Citywide Annual GHG Emissions by Sector, 2005-2015



Source: NYC Mayor's Office

Fig. 9: Citywide Annual GHG Emissions by Source, 2005-2015



Source: NYC Mayor's Office

natural gas, steam, gasoline,diesel (transportation fuel), fugitive waste/methane emissions (e.g., from landfills), and other (jet fuel from aviation, N_2O from composting, and CO_2 from waste incineration.

Figure 10 provides additional details on the 2015 citywide GHG emissions inventory. Shown are the overall contributions to the citywide GHG inventory both by the various sectors (i.e., stationary energy, transportation, and waste) and by the individual energy/emissions source type. Stationary energy emissions are the dominant sector of the citywide 2015 GHG inventory, contributing approximately 67 percent of the total citywide GHG emissions. Natural gas and electricity contribute approximately 31 and 25 percent of the citywide total, respectively.

Key Findings

Citywide GHG emissions changes from 2005 to 2015:

- Citywide GHG emissions were reduced by 14.8 percent.
- Biofuel use in buildings increased by a factor greater than 10, representing almost

GHG Accounting Scopes

New York City's GHG inventory follows standard international conventions for municipal GHG emissions reporting.

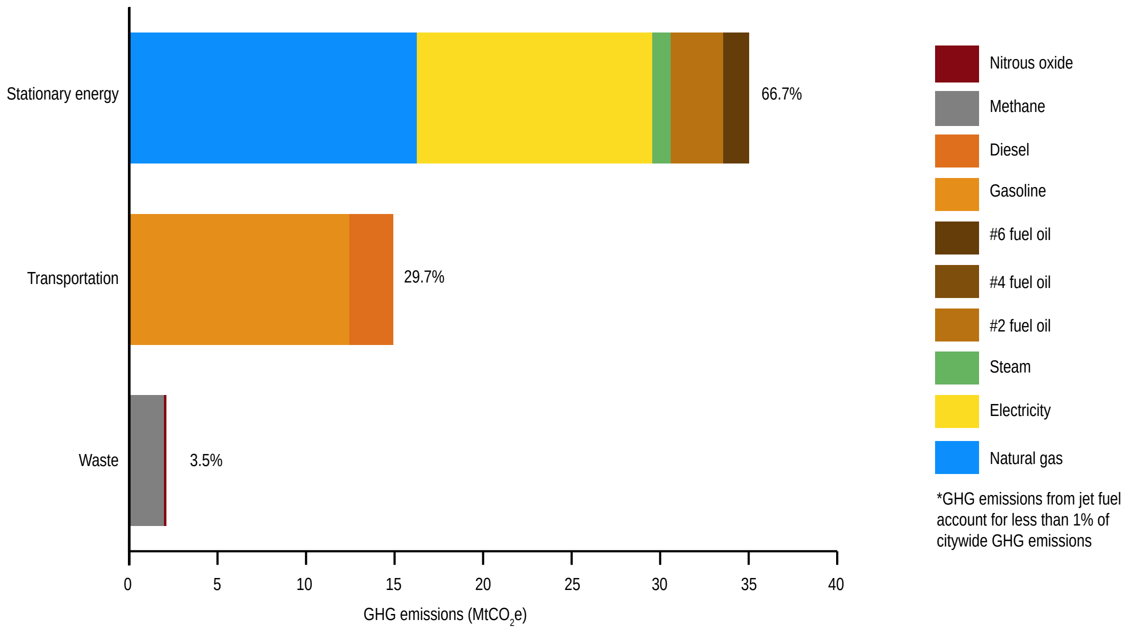
GHG accounting practice has historically classified emissions by "Scopes" per the World Resources Institute/World Business Council for Sustainable Development's Greenhouse Gas Protocol, the world's corporate GHG accounting standard and the standard upon which many other GHG accounting protocols are based, including the GPC. Following the GPC guidance, New York City defines Scopes as:

- Scope 1: Direct emissions from on-site fossil fuel combustion or fugitive emissions from within the city's boundary.
- Scope 2: Indirect emissions from energy generated in one location, but used in another, such as district electricity and district steam use.
- Scope 3: 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.

The City's inventory includes: all Scope 1 emissions from buildings and industrial facilities within the city, vehicles operated within the city, and wastewater managed within the city; all Scope 2 emissions from electricity and steam used in buildings, industrial facilities, streetlights, and transit systems within the city; and Scope 3 emissions from solid waste generated within the city but disposed of outside of the city's boundary. Examples of Scope 3 emissions that are not included in New York City's inventory include emissions from extraction and production of purchased materials, transportation of purchased fuels, and use of sold products and services.

The City may revise its GHG reporting approach to include additional sources (including consumption-based emissions) as applicable GHG protocols evolve.

Fig. 10: 2015 NYC Citywide GHG Emissions by Sector and Source



Source: NYC Mayor's Office

three percent of the total heating fuel oil market, while the overall use of regular fuel oils decreased by 25 percent.

- Reduction in #6 fuel oil use resulted in a 93 percent decrease in its GHG emissions—a direct result of the City's Clean Heat program, a program to phase out the use of heavy fuel oil in New York City by 2015.
- GHG emissions from steam decreased by 47 percent, or 0.92 $MtCO_2e$.
- Natural gas used in buildings increased by 25 percent since 2005, and is now the largest source of GHG emissions in New York City, at 31.2 percent of the citywide total. GHG emissions from natural gas were 16.2 $MtCO_2e$ in 2015.
- Electricity is responsible for 25.6 percent of citywide GHG emissions (with 24.5 percent coming from buildings, and 1.1 percent from subways and commuter rail).

Citywide GHG emissions changes from 2014 to 2015:

- GHG emissions in 2015 were 1.3 percent less than in 2014, at 52.0 $MtCO_2e$ in 2015, as compared with 52.7 $MtCO_2e$ in 2014.
- A warmer winter in 2015, with 2015 experiencing about a 8.5 percent decrease in heating degree days from 2014, resulted in heating degree days returning to below 2013 levels.

Citywide GHG Emissions by Sector

Stationary energy

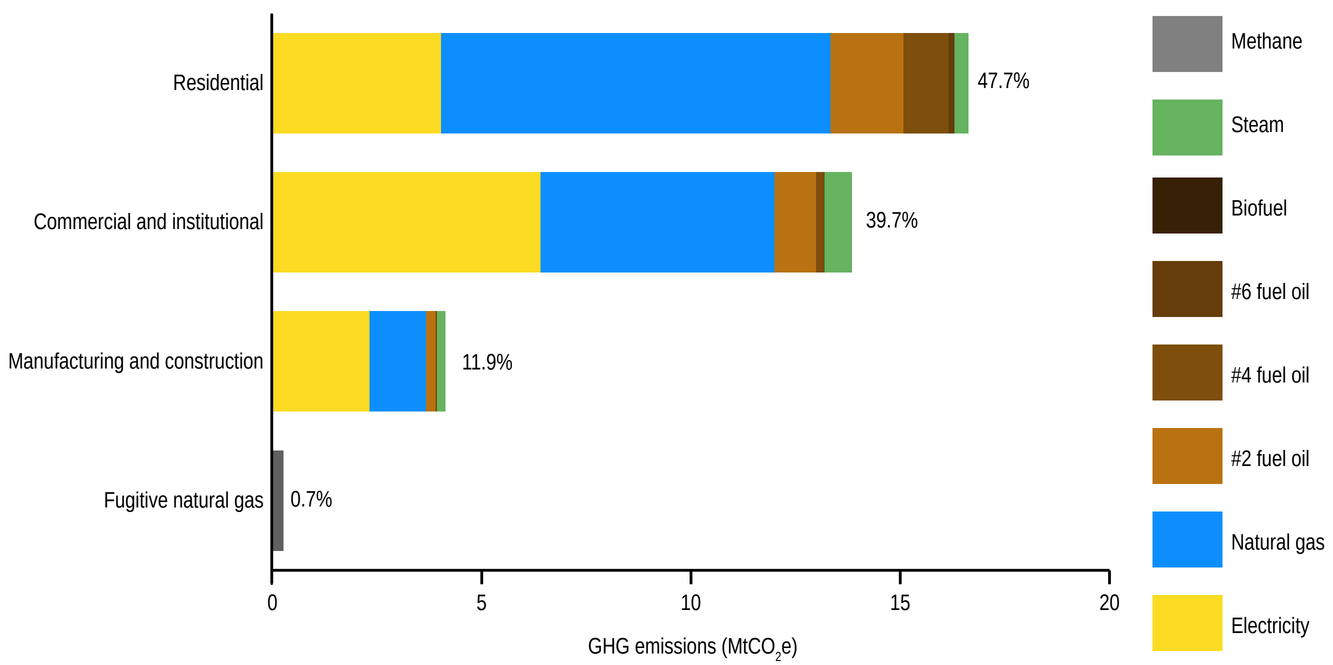
New York City's building stock is massive and diverse, ranging from small single-family homes to some of the world's largest skyscrapers. The operation of these buildings is responsible for the majority of the city's GHG emissions. This enormous building stock presents a prime opportunity for GHG mitigation measures, and the City has focused many of its GHG mitigation policies on the city's existing buildings, 75 percent of which are expected to still be in existence by 2030.

From 2005 to 2015 GHG emissions from citywide stationary energy used in buildings and facilities decreased by 18.1 percent, or 7.7 $MtCO_2e$. Less carbon-intensive electricity played the most significant role in driving down those emissions.

Note that GHG emissions from natural gas increased by 3.20 $MtCO_2e$ over the 2005-2015 time period. This evidence of increased natural gas use is due to the continued low prices of natural gas available for residential, commercial, and industrial customers; the construction of new buildings, which typically use natural gas; and the City's Clean Heat Program, which is designed to phase out the use of heavy heating oil, or #6 oil (which has been largely accomplished by the City as of 2015). Thus, while natural gas emissions rose over the 2005-2015 time period, the net environmental effect was positive in that the wider use of natural gas caused a significant decline in the burning of more highly polluting oil.

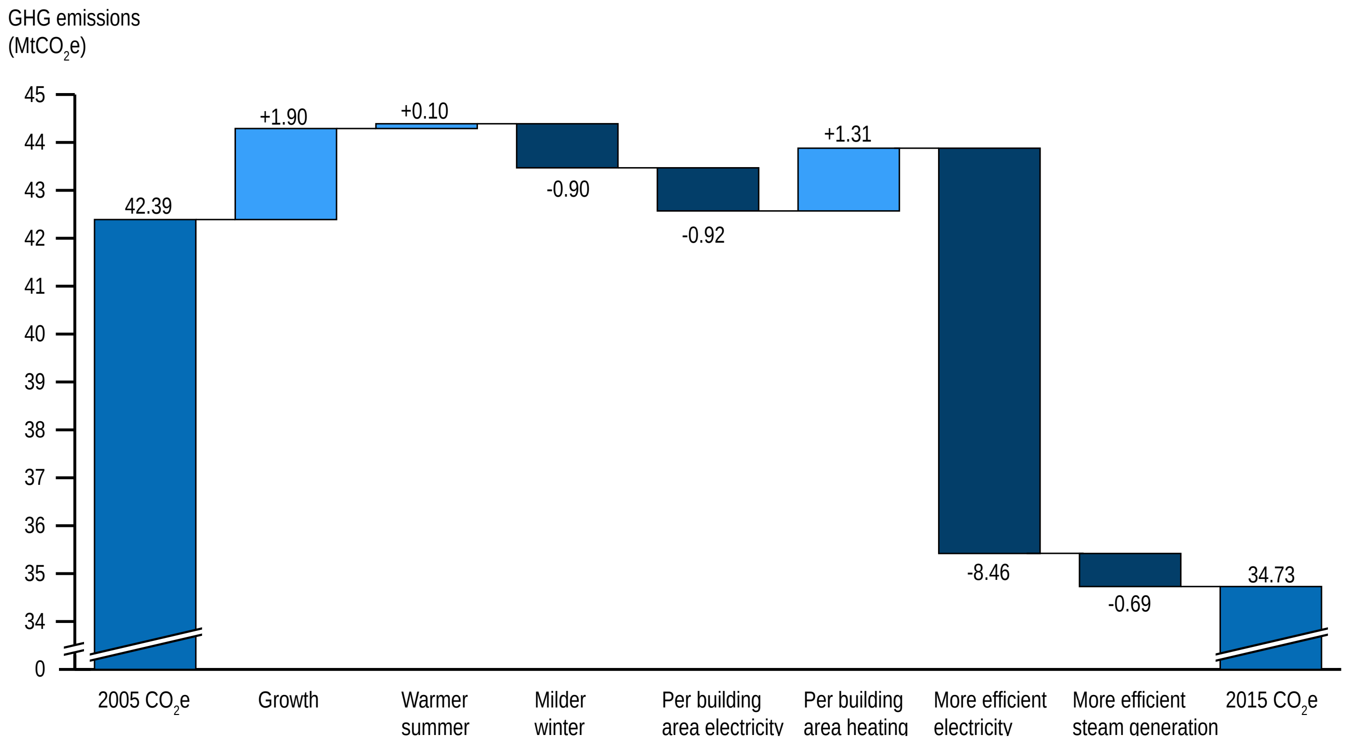
Figure 11 presents additional details on the 2015 citywide GHG Inventory's stationary energy GHG emissions by source type. Figure 10 shows that natural gas had the largest contribution to stationary energy GHG emissions with approximately 47 percent of the

Fig. 11: 2015 NYC Citywide Stationary Energy GHG Emissions by Source



Source: NYC Mayor's Office

Fig. 12: Drivers of Changes in NYC Citywide Stationary Energy GHG Emissions, 2005 to 2015



Source: NYC Mayor's Office

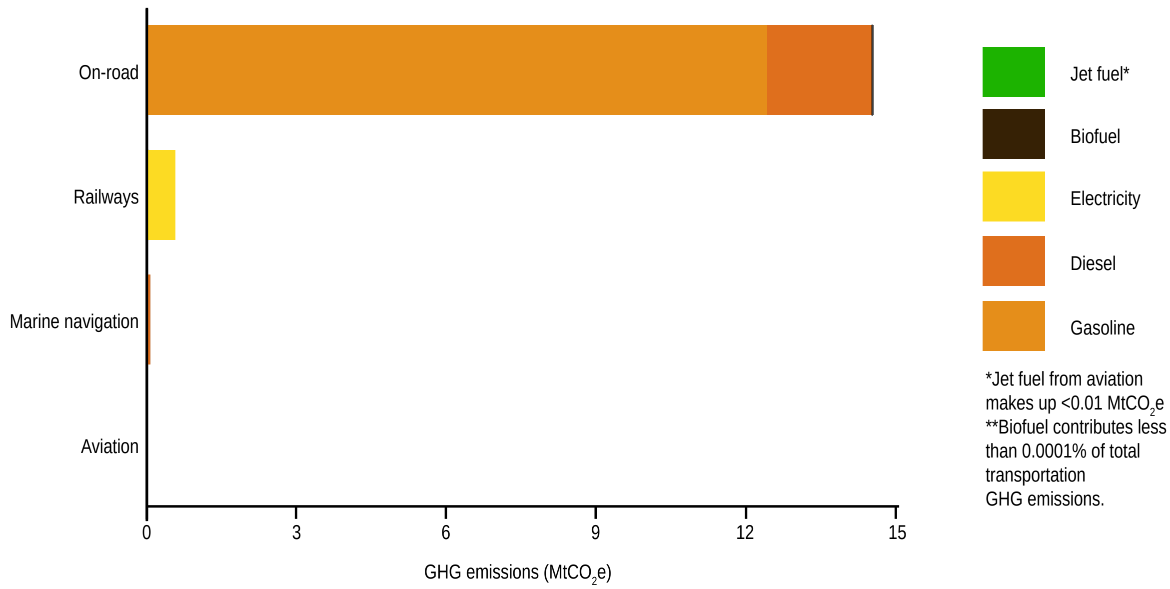
total, followed by electricity with approximately 37 percent, and heating fuel oil (#2, #4, and #6 combined) with approximately 13 percent.

For the entire 2005-2015 time period, the citywide drivers for changes in stationary energy GHG emissions were analyzed, and these results are summarized in Figure 12. As Figure 12 shows, cleaner and more efficient electricity and steam generation, increased electricity and heating fuel use efficiency per building area, and milder winter weather (in 2015) were responsible for most of the long-term GHG emissions reduction in Stationary Energy. These drivers for changes in GHG emissions more than offset the significant growth in population and buildings, resulting in a net 18 percent decrease in stationary energy GHG emissions over that time period.

Transportation

New York City has one of most extensive mass transit systems in the world, with subways, buses, commuter railways, and ferries contributing to the city's low per capita GHG emissions levels. The city is also home to more than two million vehicles, the operation of which accounted for 29 percent of the city's total GHG emissions in 2015. Transportation sources resulted in 15.5 $MtCO_2e$ GHG emissions in 2015. This is a 0.1 percent decrease from total transportation emissions in 2014.

Fig. 13: 2015 Citywide Transportation GHG Emissions by Source



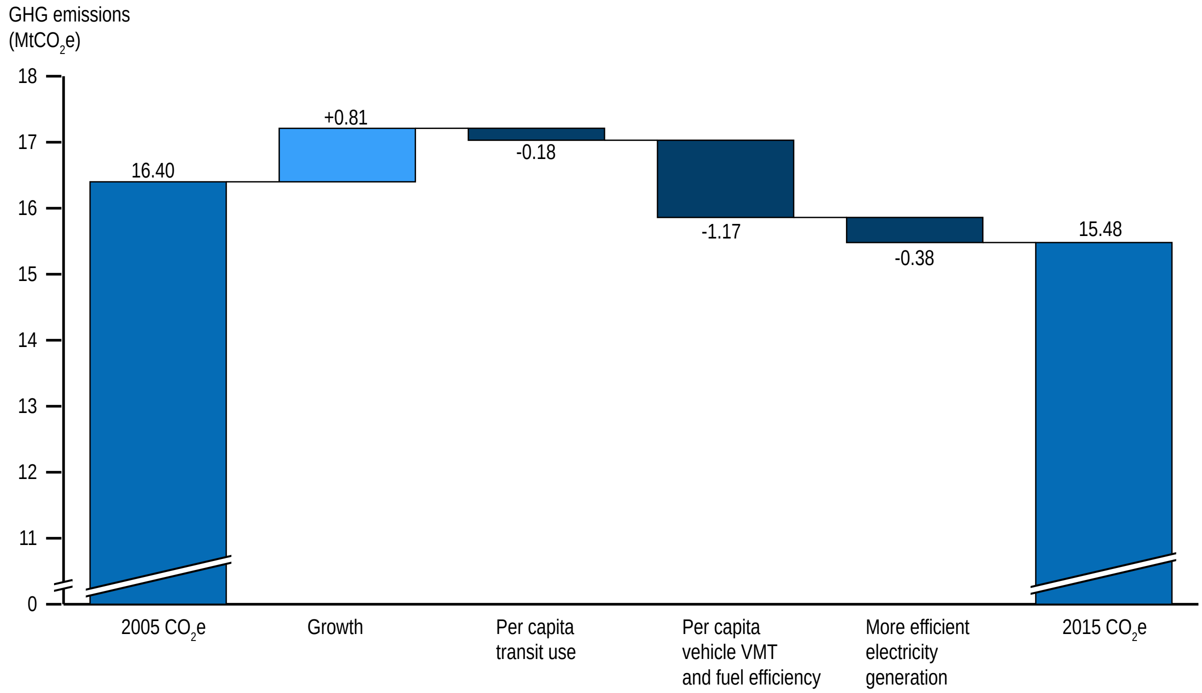
Source: NYC Mayor's Office

The city's subway and commuter rail system used approximately 4.2 percent of all electricity used in the city in 2015. As such, the large decrease in the carbon intensity of the city's electricity supply over the last ten years led to a reduction of 0.38 $MtCO_2e$ in GHG emissions citywide, after accounting for the impact of population growth. Per capita transit use also decreased slightly during this time, leading to a decrease in GHG emissions from transit-related sources.

Figure 13 presents additional details on the 2015 citywide GHG inventory's transportation GHG emissions by source type. Figure 13 shows that gasoline is by far the largest contributor to transportation GHG emissions, with approximately 80 percent of the total, followed by diesel with approximately 16 percent, and electricity with approximately 4 percent.

Figure 14 shows the citywide drivers for changes in transportation GHG emissions over the entire 2005-2015 time period. The significant decrease in GHG emissions associated with per capital vehicle miles traveled (VMT), along with the effects of cleaner and more efficient electricity generation (reducing subway and commuter rail GHG emissions), combined to more than offset the increase in transportation GHG emissions associated with population growth over the 2005-2015 time period. This resulted in a net five percent reduction in transportation GHG emissions over the 2005-2015 time period, and corresponds to an overall reduction of approximately 1.2 percent of the total citywide 2005 base year GHG emissions.

Fig. 14: Drivers of Changes in NYC Citywide Transportation GHG Emissions, 2005 to 2015



Source: NYC Mayor's Office

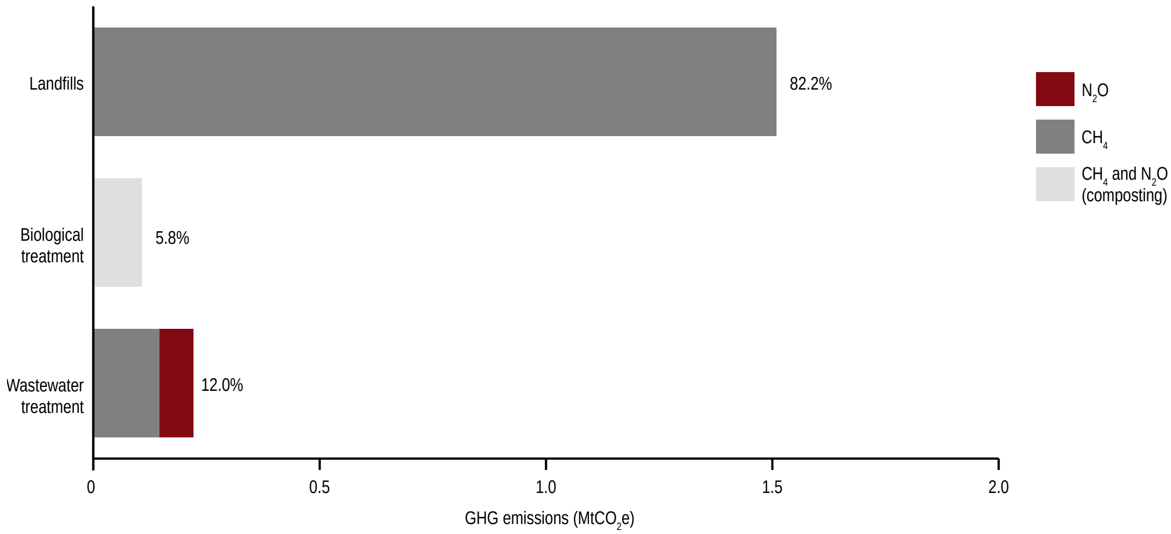
Waste

New York City's residents, workers, and visitors generate more than 20,000 tons of solid waste and use more than 1 billion gallons of water each day. The management of this solid waste and treatment of wastewater was responsible for 1.84 $MtCO_2e$ emissions in 2015.

Figure 15 presents additional details on the 2015 citywide GHG inventory's waste GHG emissions by source type. Figure 15 shows that methane is the dominant Waste GHG emissions source type, contributing over 90 percent of the total (with over 90 percent of that coming from landfills).

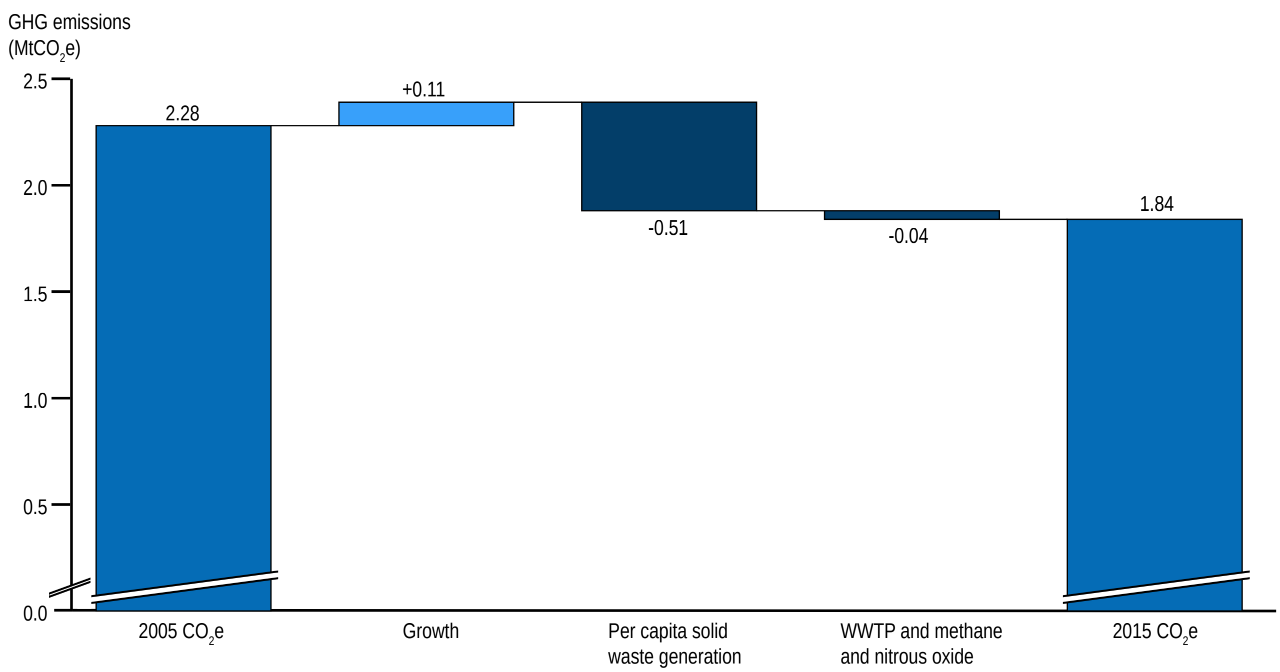
Figure 16 shows the citywide drivers for changes in waste GHG emissions over the entire 2005-2015 time period. The significant decrease in per capita solid waste generation (due in part to increased recycling and composting rates), more than offset the increase in waste GHG emissions associated with population growth. This results in a net 19 percent reduction in waste GHG emissions over the 2005-2015 time period, and corresponds to an overall reduction of approximately 0.7 percent of the total citywide 2005 base year GHG emissions.

Fig. 15: 2015 NYC Citywide Waste GHG Emissions by Source



Source: NYC Mayor's Office

Fig. 16: Drivers of Changes in NYC Citywide Waste GHG Emissions, 2005 to 2015



Source: NYC Mayor's Office

City Government Inventory

In FY 2015, City government emissions were 17.7 percent lower than FY 2006, due in part to lower methane emissions from wastewater treatment plants, which also experienced a 0.8 percent decrease from FY 2014 to FY 2015.

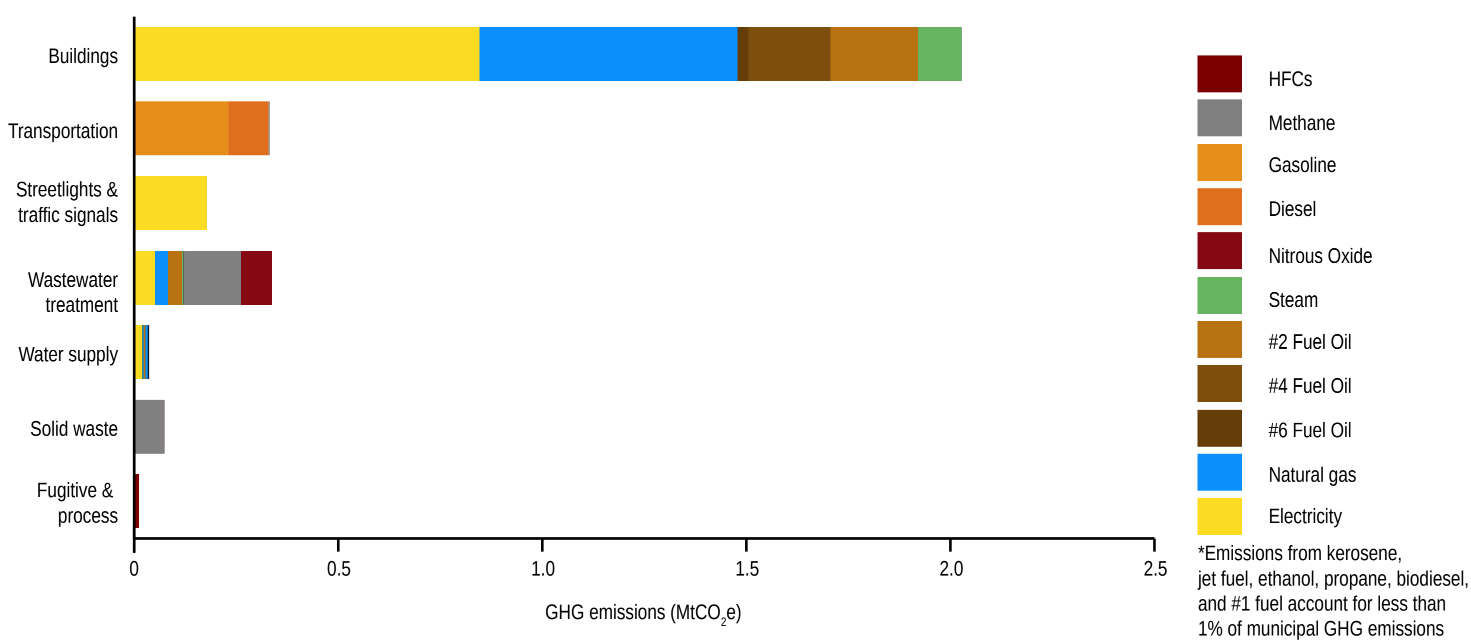
New York City's government uses large amounts of energy each year to provide services to millions of city residents, businesses, commuters, and visitors. The City's municipal buildings, wastewater treatment plants (WWTPs), and vehicle fleet are responsible for the majority of City government GHG emissions, while landfills, the transportation of solid waste, operation of streetlights and traffic signals, and the water supply system account for the remainder.

This New York City government GHG inventory is calculated and reported in accordance with the Local Government Operations Protocol (LGOP) and reports GHG emissions from operations, facilities, or sources wholly owned by the City, or over which the City has full authority to introduce and implement operations, health and safety, and environmental policies (including both GHG- and non-GHG-related policies). GHG emissions from leased real estate and vehicles and other equipment are included. It is important to note that additional non-City operated public entities (e.g., the Metropolitan Transportation Authority) are not included by this definition of operational control.

City Government FY 2015

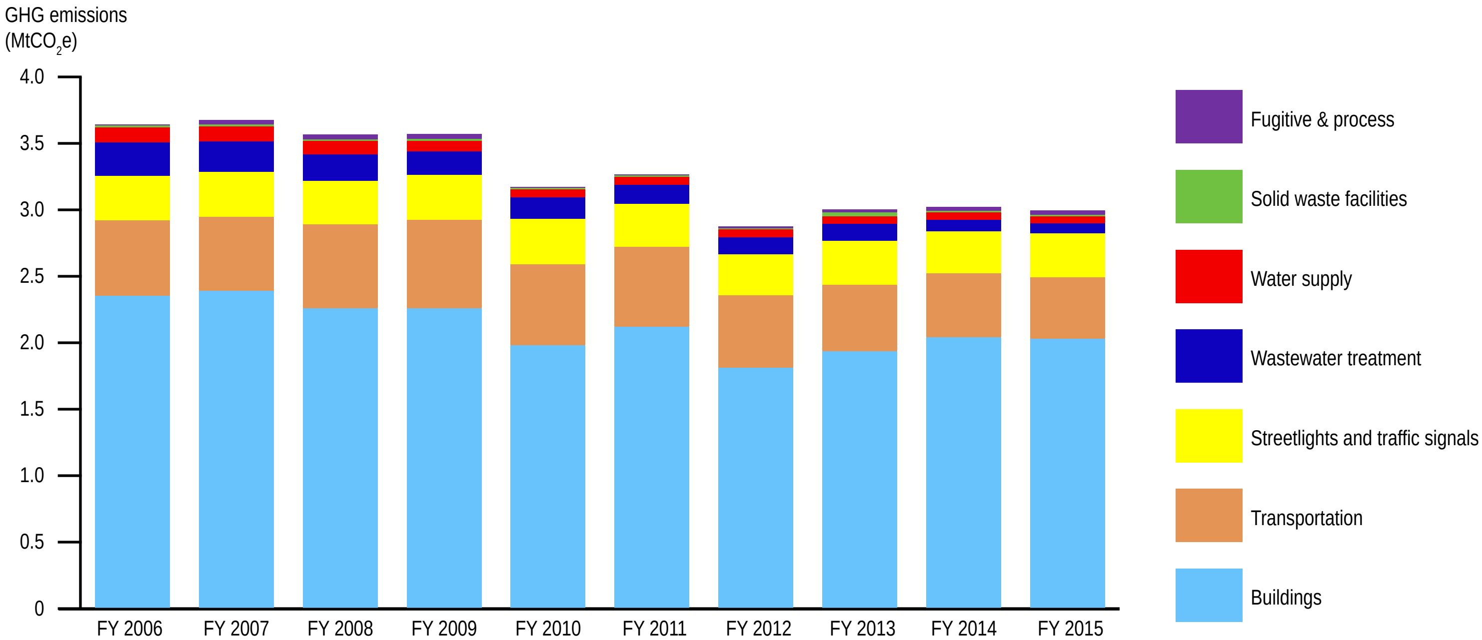
New York City's government GHG emissions were 3.0 $MtCO_2e$ in FY 2015, representing a 0.8 percent decrease from FY 2014. This FY 2015 GHG emissions level corresponds to a 17.7 percent decrease from FY 2006 base year levels for City government. FY 2015 GHG emissions are broken down as follows:

Fig. 17: FY 2015 City Government GHG Emissions by Sector and Source



Source: NYC Mayor's Office

Fig. 18: FY 2006 to FY 2015 City Government GHG Emissions by Sector



Source: NYC Mayor's Office

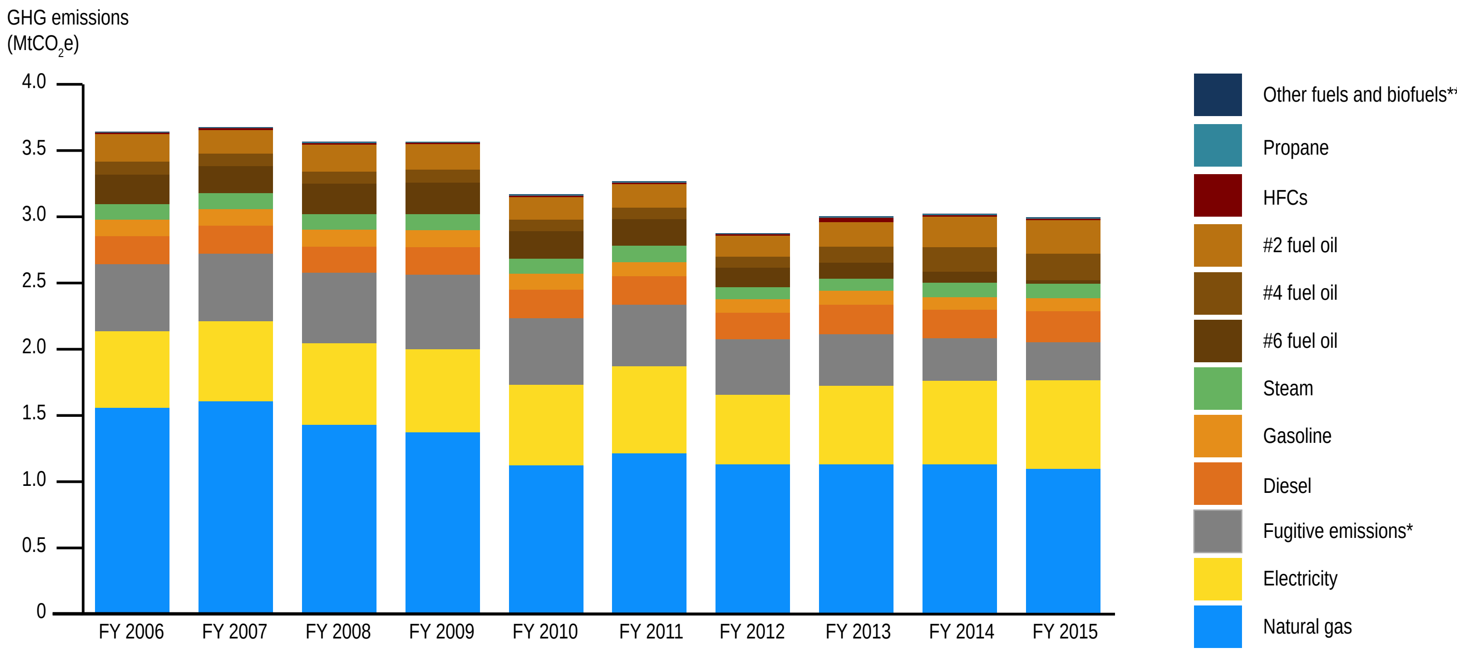
- **Scope 1 GHG emissions:** 1.79 $MtCO_2e$ (direct emissions from on-site fossil fuel combustion or fugitive emissions from within the city's boundary).
- **Scope 2 GHG emissions:** 1.21 $MtCO_2e$ (indirect emissions from energy generated in one location, but used in another, such as electricity and direct steam).

The City government GHG emissions are shown in Figure 17, broken down into water supply, wastewater treatment, buildings, streetlights, solid waste methane and transportation. Buildings are, by far, the largest contributor to City government operations' GHG emissions at 68 percent, with wastewater treatment and transportation contributing at 15 percent and 11 percent of the City government total, respectively.

City government operations' GHG emissions from FY 2006 to FY 2015, by municipal sector, are shown in Figure 18. City government GHG emissions have decreased significantly in comparison to the FY 2006 base year, with FY 2015 GHG emissions being 17.7 percent below FY 2006 GHG emissions. Figure 18 also shows the effects of the cold winters in FY 2013 and FY 2014, which resulted in an increase in GHG emissions from FY 2012. Most of those increases occurred in the buildings sector (based on increased thermal heating demands). However, due to the warmer winter of FY 2015, the building sector GHG emissions decreased to below FY 2013 levels.

Figure 19 presents City government annual GHG emissions over the FY 2006-FY 2015 time period, with GHG emissions reported by source type. Electricity use is the largest contributor to FY 2015 City government GHG emissions with 37 percent of the City government total, followed by natural gas with 22 percent of the total, and fuel oil with 16 percent.

Fig. 19: FY 2006 to FY 2015 City Government GHG Emissions by Source



*Fugitive emissions are comprised of nitrous oxide and methane
**Other fuels and biofuels is comprised of ethanol, biofuel, kerosene, #1 fuel oil, and jet fuel

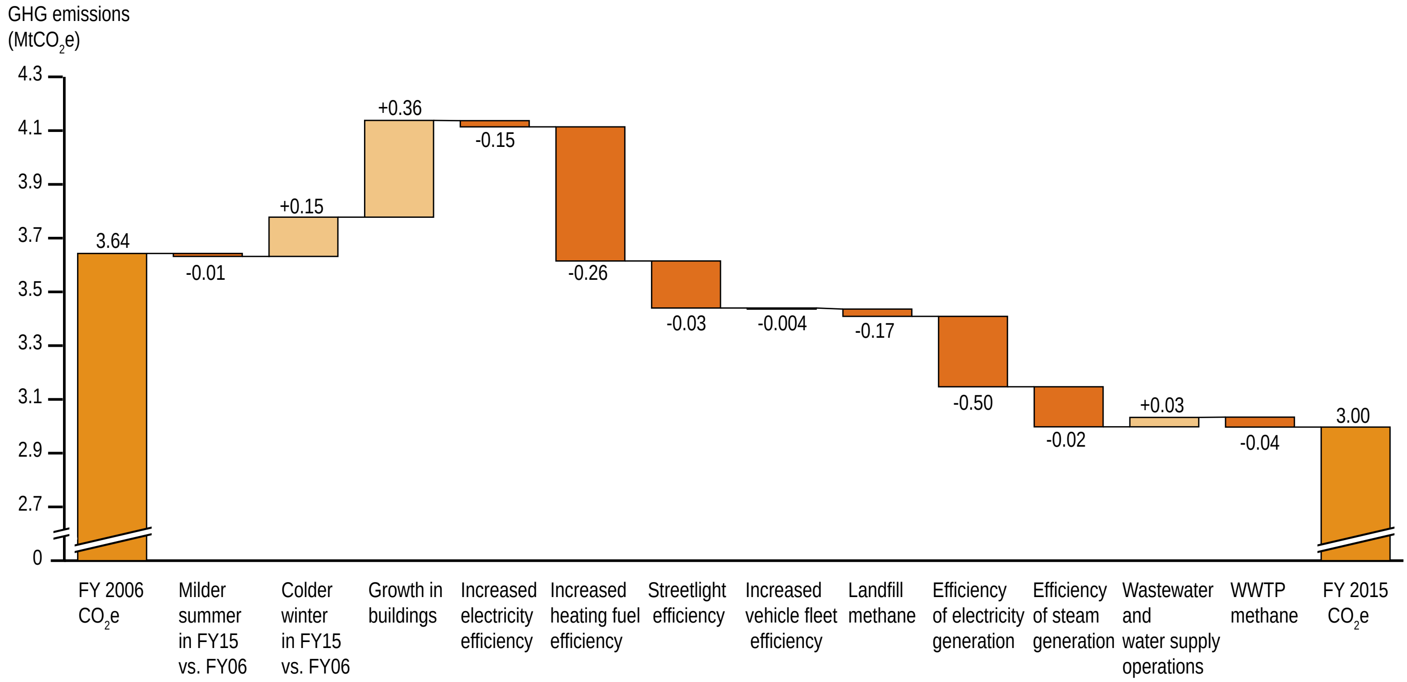
Source: NYC Mayor's Office

Although weather and growth in building floor area have influenced an increase in GHG emissions, City government operations have offset this increase. Cleaner electricity since FY 2006 was the largest single driver of GHG emissions reduction in the FY 2015 City government inventory. However, as of FY 2015, municipal operations and policy drivers now play a more significant role in overall GHG emissions reductions than electricity supply and utility operations.

The amount of methane produced from landfills within the city has also decreased significantly with time. Landfills within the city are now closed and as the waste decomposes the rate of methane generation steadily decreases. Streetlights also use less electricity through conversions to LED technology while maintaining their vital services. Transportation fleets have decreased GHG emissions through the adoption of alternative fuels, more fuel efficient vehicles, and fleet size reduction measures.

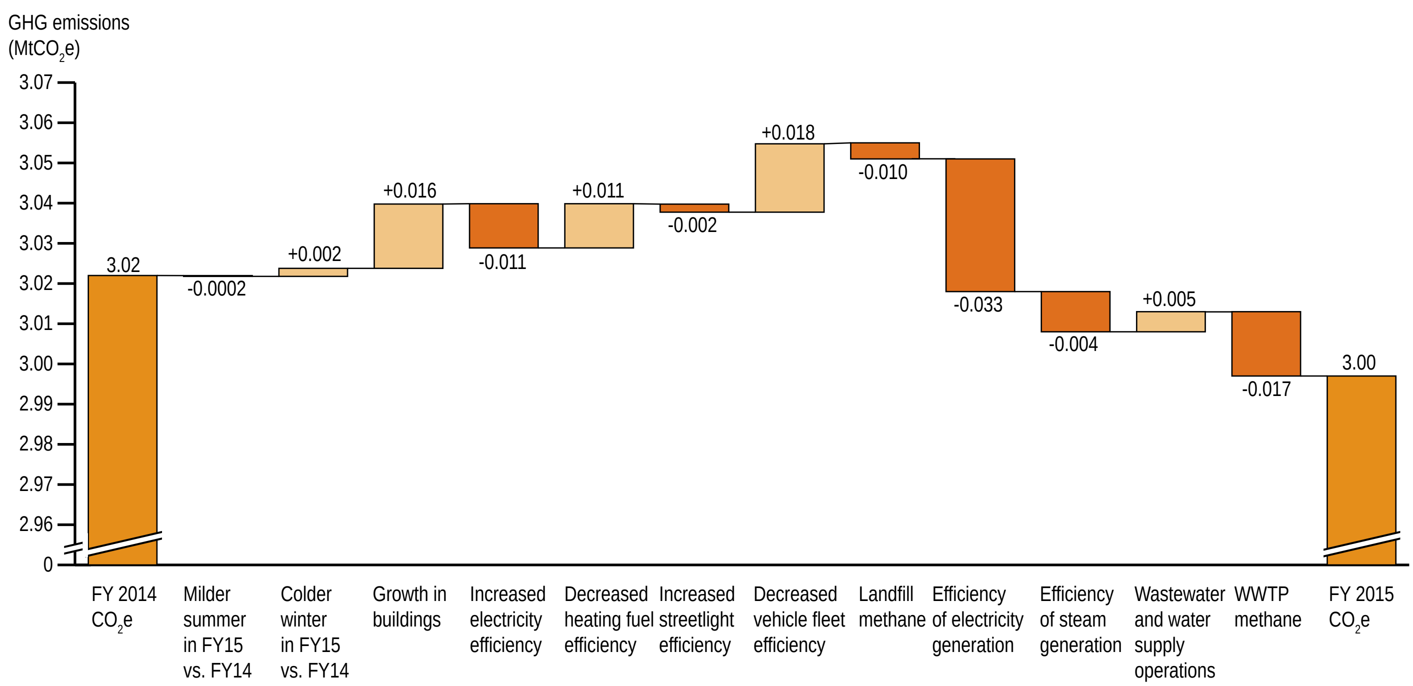
Figure 20 summarizes the results of the City government drivers of GHG emissions for FY 2006-FY 2015. As Figure 23 shows, increased building heating fuel use efficiency and cleaner and more efficient electricity generation were the two largest drivers for GHG emissions reduction in City government, followed by increased electricity use efficiency and landfill methane emissions reductions. These City government GHG emissions reduction drivers, as well as a colder winter in FY 2015 than in FY 2006, result in a net 17.7 percent reduction in City government GHG emissions between FY 2015 and FY2005 base year emissions level.

Fig. 20: City Government FY 2006 to FY 2015 GHG Emissions Drivers



Source: NYC Mayor's Office

Fig. 21: City Government FY 2014 to FY 2015 GHG Emissions Drivers



Source: NYC Mayor's Office

A similar analysis of emissions drivers was also performed for the year-by-year changes from FY 2014 to FY 2015; the results of that analysis are shown in Figure 21. Figure 21 clearly shows the effects of a reduction of heating fuel energy efficiency, producing a 0.02 $MtCO_2e$ emissions increase over FY 2014, as well as a reduction in wastewater treatment plant CH_4 emissions of 0.02 $MtCO_2e$, and an increase in vehicle fleet GHG emissions of 0.02 $MtCO_2e$. These three effects, combined with all of the other emissions drivers, collectively produced a total net decrease in City government GHG emissions in FY 2015 of 0.8 percent below the FY 2014 GHG emissions level.

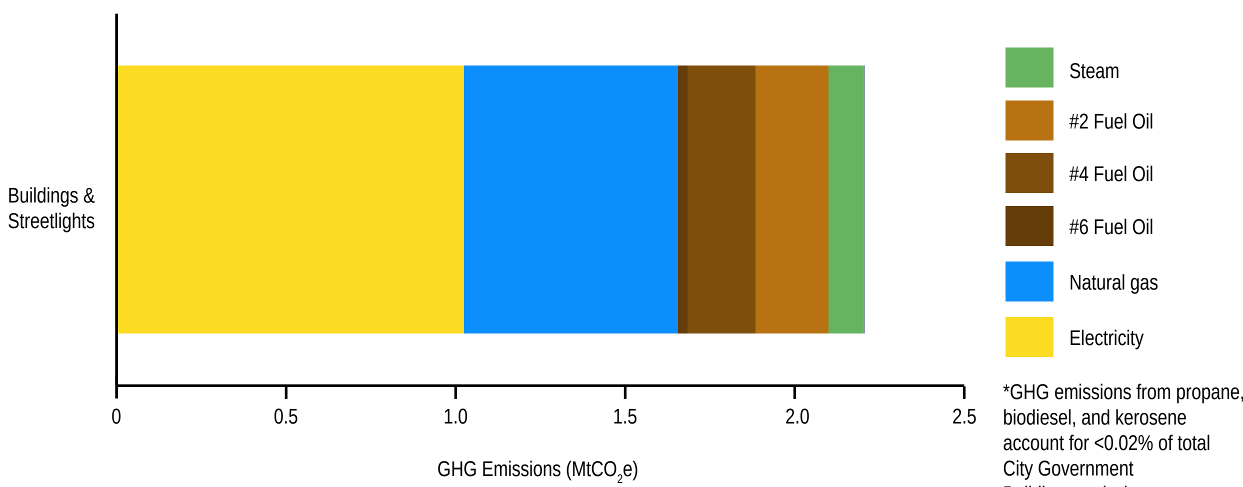
City Government GHG Emissions by Sector

Buildings

Figure 22 presents the additional details on the FY 2015 City government GHG inventory's buildings GHG emissions by fuel type. Figure 22 shows that electricity use was the largest source of GHG emissions with 42 percent of the total, followed by natural gas with 31 percent, and heating oil (#2, #4, and #6 combined) with 22 percent.

Figure 20 summarizes the City government drivers for change in buildings and streetlights GHG emissions, over the FY 2006-FY 2015 time period. As Figure 23 shows, increased heating fuel use efficiency per building area, cleaner and more efficient electricity generation, and increased electricity use efficiency per building area were responsible for most of the long-term GHG emissions reduction in City government buildings. These drivers for change in emissions more than offset the growth in buildings and the somewhat colder winter in FY 2015 than in FY 2006.This resulted in a net 14 percent decrease in building GHG emissions over this time period, corresponding to an overall 9 percent reduction in total City government GHG emissions from the FY 2006 base year GHG emissions level.

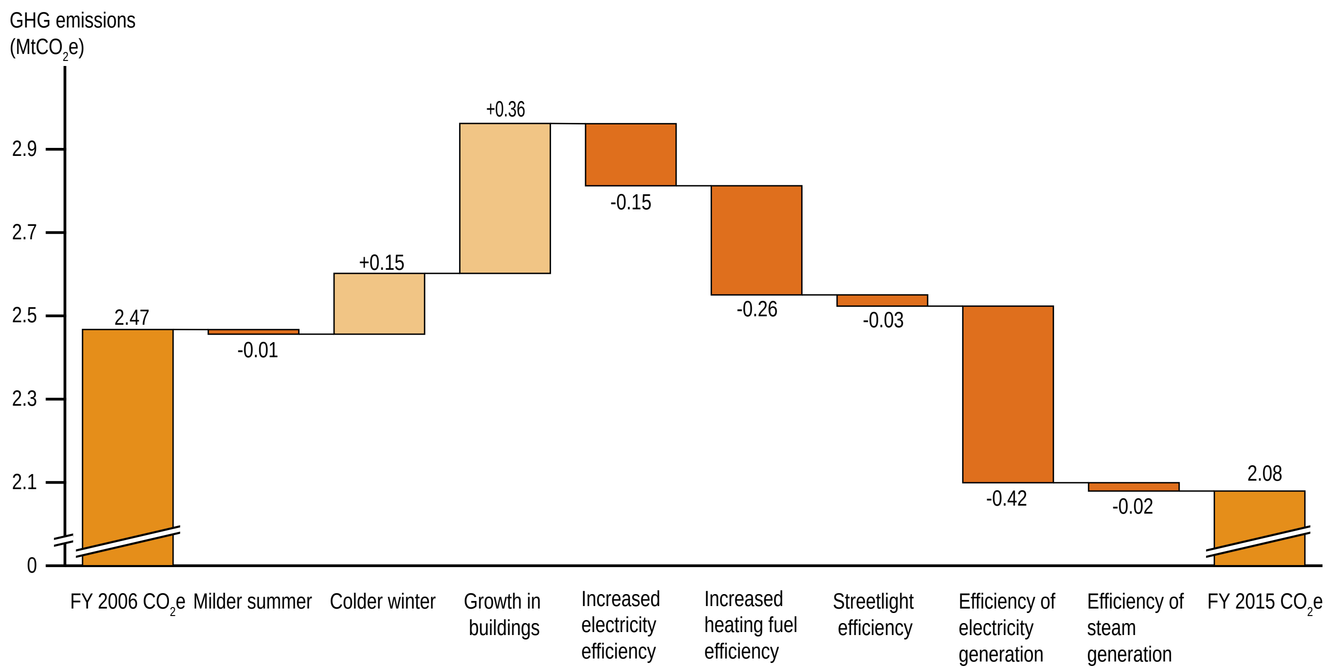
Fig. 22: FY 2015 City Government Buildings and Streetlights GHG Emissions by Source



*GHG emissions from propane, biodiesel, and kerosene account for <0.02% of total City Government Buildings emissions

Source: NYC Mayor's Office

Fig. 23: Drivers of Changes in NYC City Government Buildings and Streetlights GHG Emissions



Source: NYC Mayor's Office

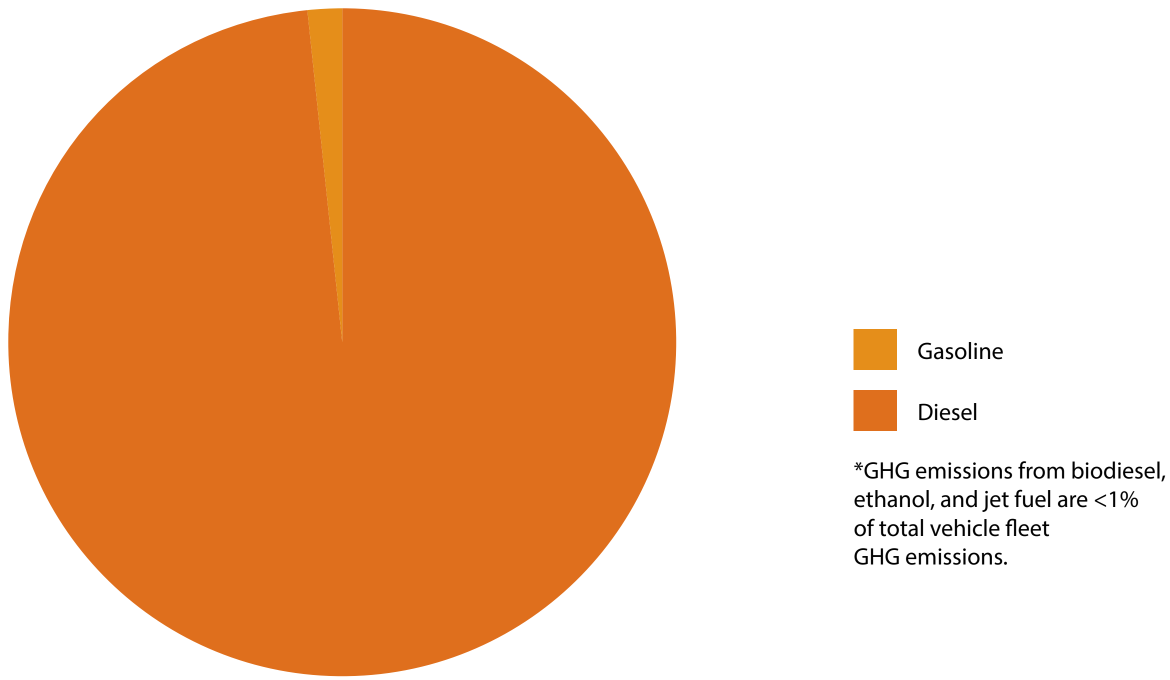
Vehicle fleet

New York City operates the largest municipal vehicle fleet in the U.S. with over 28,000 fleet units. City government vehicle fleet sources resulted in 0.33 $MtCO_2e$ GHG emissions in FY 2015, representing approximately 11 percent of the total City government FY 2015 GHG inventory. This is an approximate 5 percent increase from total vehicle fleet GHG emissions in FY 2014, and a 1 percent decrease compared to FY 2006 base year GHG emissions.

Figure 24 presents additional details on the FY 2015 City government GHG inventory's vehicle fleet GHG emissions by fuel type. The largest contributors to the total vehicle fleet GHG emissions were diesel trucks with approximately 49 percent of the vehicle fleet total, followed by gasoline with approximately 30 percent, and diesel marine vessels with approximately 21 percent.

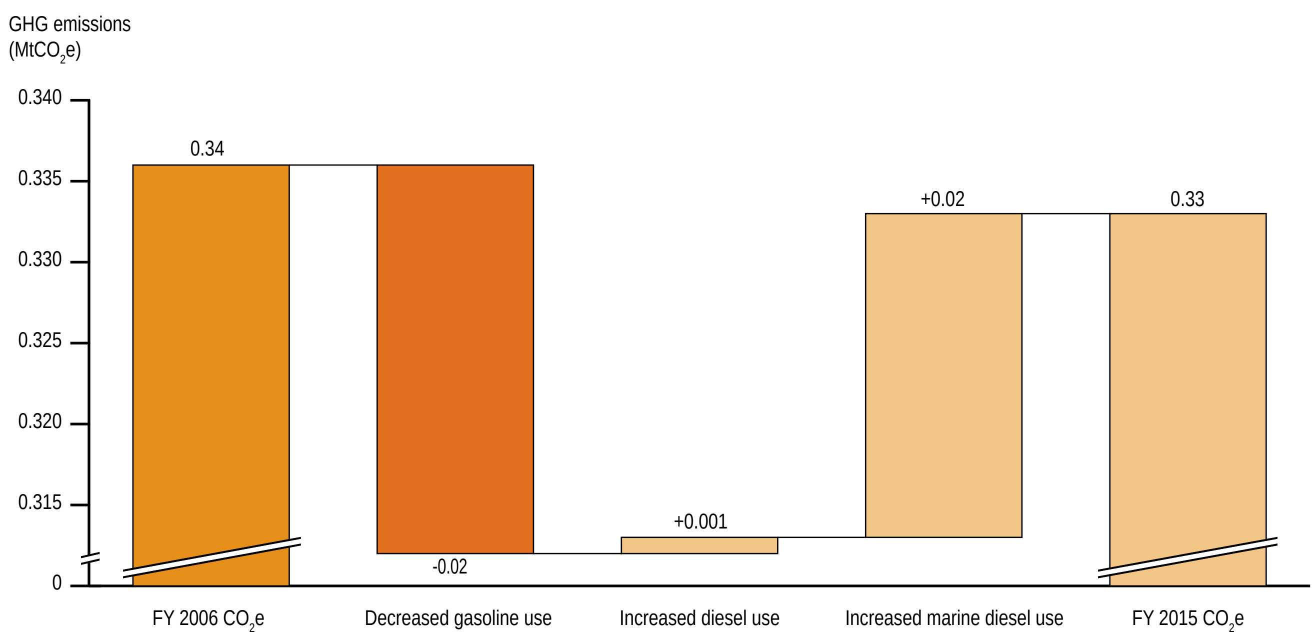
Figure 25 shows the changes in City government vehicle fleet GHG emissions over the entire FY 2006-FY 2015 time period. As Figure 32 shows, the major change over this time period was approximately a 24,000 tCO2e reduction in vehicle fleet gasoline GHG emissions (corresponding to an approximately 20 percent reduction in City government vehicle fleet gasoline use), and an approximate 19,000 tCO_2e increase in diesel-marine vessels GHG emissions (corresponding to a 38 percent increase in City government marine-vessel diesel use). The overall net effect is a 1 percent decrease in City government vehicle fleet GHG emissions over the FY 2006 to FY 2015 time period, which produced a net 0.1 percent reduction in total City government GHG emissions from its FY 2006 base year emissions level.

Fig. 24: FY 2015 City Government Vehicle GHG Emissions by Source



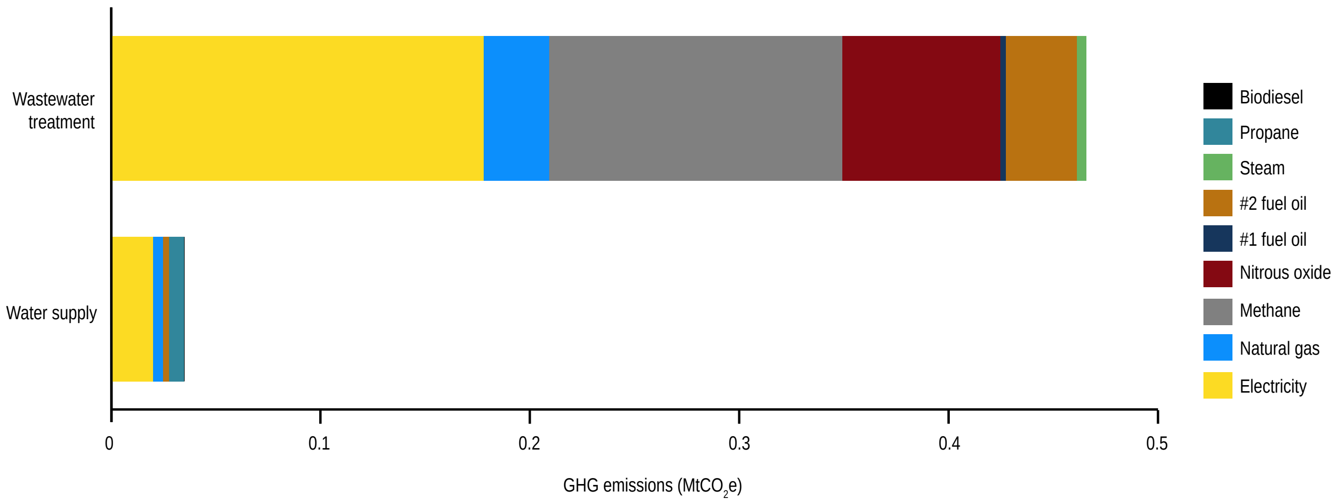
Source: NYC Mayor's Office

Fig. 25: FY 2006 to FY 2015 Changes to City Government Vehicle Fleet GHG Emissions



Source: NYC Mayor's Office

Fig. 26: FY 2015 Water Supply and Wastewater Treatment GHG Emissions by Source



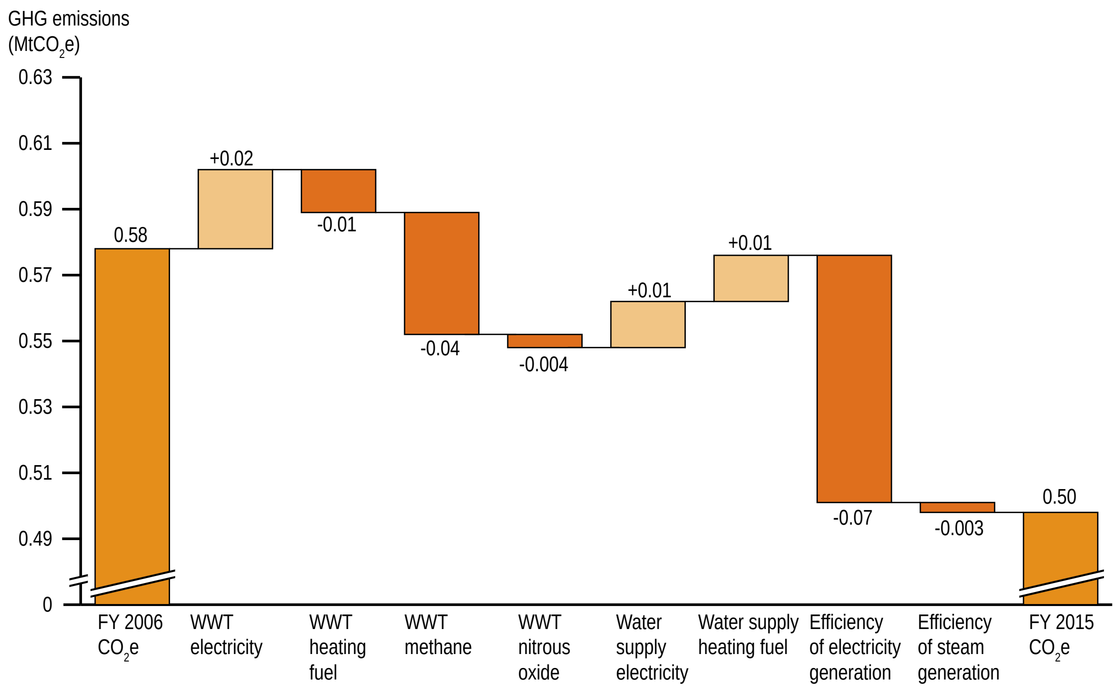
Source: NYC Mayor's Office

Water supply and wastewater treatment

The New York City Department of Environmental Protection (DEP) is responsible for protecting public health and the environment by supplying clean drinking water, collecting and treating wastewater, and reducing air, noise, and hazardous substances pollution. The water is delivered from a watershed that extends more than 125 miles from the city, comprising 19 reservoirs and three controlled lakes. Approximately 7,000 miles of water mains, tunnels, and aqueducts bring water to homes and businesses throughout the five boroughs, and 7,500 miles of sewer lines and 96 pump stations take wastewater to 14 in-city treatment plants. Approximately one billion gallons of water is supplied each day almost entirely by gravity to nine million residents of New York City and the surrounding counties of Orange, Ulster, Westchester, and Putnam, while approximately 1.3 billion gallons of wastewater is collected and treated each day.

While the majority of this system is designed to operate by gravity, it still requires a large amount of energy to operate—almost one million source MMBtus per year. As such, GHG emissions from water supply and wastewater treatment accounted for approximately 17 percent of total City government GHG emissions in FY 2015 (see Figure 26). The wastewater treatment (WWT) process alone accounted for approximately 93 percent of the City's water supply and wastewater treatment GHG emissions. Federal and state mandates to meet new air and water quality standards, such as requiring the construction and activation of new facilities or changes to water and wastewater treatment protocols, has led to an approximately 30 percent increase in DEP's energy use between FY 2006 and FY 2015.

Fig. 27: FY 2006 to FY 2015 Changes to City Government Water Supply and Wastewater Treatment GHG Emissions



Source: NYC Mayor's Office

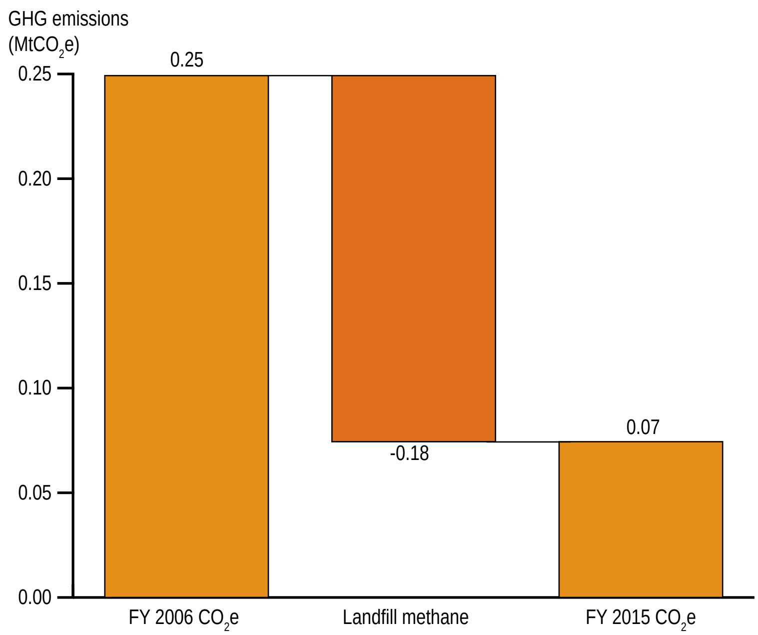
Figure 27 presents the changes in City government water supply and wastewater treatment GHG emissions over the entire FY 2006-FY 2015 time period. As Figure 27 shows, the major GHG emission reductions were due to cleaner and more efficient electricity generation, wastewater treatment plant (WWTP) methane and nitrous oxide reductions, and WWTP fuel use reductions. Increases were observed in WWTP electricity use, water supply electricity use, and water supply fuel use. The combined effect of all these changes was a net 14 percent reduction in emissions from its FY2006 base year emissions level.

Solid waste

The New York City Department of Sanitation (DSNY) collects and manages more than 10,000 metric tons of solid waste per day, transporting it to waste to energy facilities and landfills located outside the city. The Department leads the City's efforts to contribute zero waste to landfills by 2030, a key component of OneNYC.

DSNY and DEP operate six closed landfills within New York City's boundary. As these landfills are closed and no longer accepting solid waste, GHG emissions from the decomposition of waste in these landfills is decreasing over time. Figure 28 below shows the changes in City government Solid Waste GHG emissions over the entire FY 2006– FY 2014 time period. Landfill methane GHG emissions have been reduced by approximately 165,000 tCO_2e, which corresponds to a 4.6 percent reduction from the City government FY 2006 base year total GHG emissions level.

Fig. 28: FY 2006 to FY 2015 Changes to City Government Solid Waste GHG Emissions



Source: NYC Mayor's Office

APPENDICES

Appendix A
Methodology and Restatements of Previous Years GHG Emissions

The Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) provides a robust and clear framework that builds on existing methodologies for calculating and reporting citywide GHG emissions. The GPC sets out requirements and provides guidance for calculating and reporting citywide GHG emissions, consistent with the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories (i.e., the "IPCC Guidelines").

The GPC requires cities to report their GHG emissions using two distinct but complementary approaches:

- The scopes framework, which allows cities to comprehensively report all GHG emissions attributable to activities taking place within the geographic boundary of the city, by categorizing the emission sources into in-boundary sources (scope 1, or "territorial"), grid-supplied energy sources (scope 2), and out-of-boundary sources (scope 3).
- The city-induced framework measures GHG emissions attributable to activities taking place within the geographic boundary of the city. This covers selected scope 1, 2, and 3 emission sources. It provides two reporting levels demonstrating different levels of completeness. The BASIC level covers emission sources that occur in almost all cities (stationary energy, in-boundary transportation, and in-boundary generated waste), and the calculation methodologies and data are more readily available.
- New York City is utilizing the city-induced framework as the basis for its reporting, and is reporting to the GPC BASIC level.

Citywide Inventory Methodology

Stationary energy

Con Edison (Con Ed) provided data on use of citywide electricity and steam, and natural gas 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. More details on the methodology for estimating electricity and steam coefficients are contained in Appendix B. Heating fuel oil use was provided by private heating fuel oil suppliers, per Local Law 43 of 2010, which requires heating fuel oil providers to report fuel oil deliveries by fuel type to the City on an annual basis.

Transportation

On-road transportation vehicle miles traveled (VMT) data was generated using the New York Best Practices Model (NYBPM). 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 Railroad (MNR), Long Island Rail Road (LIRR) commuter rail, and MTA Bus Company buses; by the Port Authority of New York and New Jersey (PANYNJ) for Trans-Hudson (PATH) commuter rail; and New Jersey Transit (NJT) for its commuter rail and buses. In-bound-ary aviation GHG emissions were calculated from total jet fuel used by City government operated helicopters (NYPD, DOHMH, DEP). In-boundary marine navigation GHG emissions were calculated based on total fuel sales for City government operated marine vessels (DOT, NYPD, FDNY, DEP).

Waste

Data used to calculate fugitive and process methane and process nitrous oxide from wastewater treatment were provided by DEP. Methane 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. Nitrous oxide emissions were calculated by applying the daily nitrogen load discharged by each of the City's 14 wastewater treatment plant to the formula in the LGOP. Per the GPC, biogenic carbon dioxide was also calculated from combustion of anaerobic digester gas (ADG) and from fugitive ADG.

Fugitive methane from exported solid waste sent to landfills was calculated using waste disposal figures for residential, commercial, and construction and demolition waste provided by DSNY, and applying emission factors from the GPC. Carbon dioxide, methane, and nitrous oxide from solid waste sent to waste-to-energy facilities was calculated using methodology in the GPC. Methane and nitrous oxide from composting was calculated using the GPC. Fugitive methane from natural gas distribution was calculated using data provided by National Grid and Con Ed.

GHG emissions were calculated from all data acquired as described using emission factors in Appendix H, I, and J, unless otherwise noted.[5]

City Government Inventory Methodology

All data used to complete the FY 2015 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 the Department of Citywide Administrative Services (DCAS). Fuel vendors and DEP supplied heating and vehicle fuel usage. Calculation of GHG emissions from fuel is based upon the volume of fuel delivered as an estimate of the volume of fuel used.

Fugitive and process GHG emissions were calculated using data provided by several agencies: DEP for methane and nitrous oxide emissions from wastewater treatment; DEP and DSNY for fugitive methane emissions from landfills; and DCAS for hydrofluorocarbons (HFC) from municipal vehicle fleet cooling and refrigeration systems. All calculations were made as described in the citywide inventory methodology section.

2015 GHG Methodology Refinements and Updates

As part of New York City's GHG emissions inventory program's core principle of continuous improvement, there were several areas of the 2015 GHG emissions inventory development in which significant improvements were made to the GHG emissions calculation methodology. These included the following:

- Electricity emission factors development
- Heating fuel oil supplier missing data substitution estimates
- Vehicle miles traveled (VMT) and associated mobile source GHG emissions
- Solid waste-associated GHG emissions

Each of these 2015 GHG inventory methodology improvements is described in more detail in the sections below.

Electricity emission factors

As part of the 2015 GHG inventory development, New York City applied some advanced modeling techniques, which had been developed recently as part of the City's development of the *New York City's Roadmap to 80 x 50* (*Roadmap to 80 x 50*) GHG mitigation plan, to the citywide GHG emissions inventory. This model, Xpand,[5] was used in the development of the *Roadmap to 80 x 50* to generate various scenarios for electricity plant generation in the State to meet future electricity demand in New York City. Xpand is an economic dispatch/generation capacity expansion model which identifies the least-cost combination of unit dispatch, expansions, and retirements, and considers both environmental and policy requirements through linear optimization.

A key feature of the model is that the power transmission/distribution is based on a zonal distribution modeling of transmission constraints. It models transmission constraints between various regions, integrating flow constraints based on previous studies which modeled interregion transfer capabilities, based on the New York Independent System Operator (NYISO) 2014 Reliability Needs Assessment. All of the assumptions input to the Xpand model, which were applied retroactively to the New York City 2005-2014 GHG inventories' electricity data as part of this year's 2015 GHG inventory development, were confirmed by a technical advisory group as part of the 80 x 50 process.

This updated modeling considered maximum zone generation and transmission constraints. The primary result of this is that the model better represents where electricity is coming from, and the associated generation characteristics of that electricity, to meet New York City demand.

The primary differences between the Xpand model's approach to the 2005-2015 electricity generation and GHG emissions coefficient methodology, and the methodology approach used in the 2014 and previous years' GHG inventory developments, are as follows:

- The City's previous (2005-2014) methodology assigned all Zone J (New York City) generation to Zone J GHG emissions, ignoring that portion of the relatively high emission factor Zone J generation which may be exported out of the City; those electricity exports out of New York City were much higher in 2014-2015 than in 2005.
- Several major Con Ed power purchase agreements (PPAs) expired in 2014 (from three large combined cycle plants in NYISO Zones C and F: upstate/western New York), which were accounted for this year.
- In addition to the three combined cycle PPAs, Xpand also models all of the other power supply contracts for importing power into New York City: four hydro plants, one wind plant, and one nuclear unit (Indian Point 2).
- This more rigorous modeling approach, including transmission constraints and Zone J exports, resulted in a greater percentage of power imports to New York City from the lower GHG emission coefficient upstate generation facilities (NYISO Zones A-F).
- The previous methodology's generation allocation had NYISO Zones A-F providing the very last "balance" of the city's power demand needs (if any, at that point in the prior approach's assumed allocation scheme): after NYISO Zone J, PPA's, NYISO Zones G-I (Westchester, Rockland, Orange, etc. suburban New York City counties), and New Jersey/PSE&G imports; resulting in no market procurement from NYISO Zones A-F estimated previously in 2014.

Heating fuel oil supplier missing data substitution estimates

Characterizing heating fuel oil use citywide in the New York City GHG emissions inventory has evolved over the last ten years. Initially, heating fuel oil usage citywide was estimated based on building square footage data, permit data for heating boiler ratings, and energy usage intensity factors for heating fuel oil in buildings. Starting with the 2012 GHG inventory, based on Local Law 43 of 2010 (LL43), citywide heating fuel oil data were collected directly from the heating fuel oil suppliers. Data were collected at that time for previous years, and preliminary estimates were then made for missing data gaps in the historical record.

More recently, one of the major heating fuel oil suppliers to New York City sold all of their New York City retail assets in December 2013 to a new supplier to the local market. These substantial retail assets were then re-sold, by the first buyer, to an existing New York City retail heating fuel oil supplier in May 2014. As part of the 2014 GHG emissions inventory development, a very limited analysis of that original major supplier's historical market share trend was used to make a forward projection, and estimate the missing 2013 and 2014 heating fuel oil delivery data associated with the sales of their retail assets.

With a full year's worth of 2015 actual data successfully collected from the second purchaser of those retail assets for the 2015 GHG inventory, in this year's GHG inventory development New York City developed a more thorough, comprehensive approach to address the challenges of developing estimates, as a substitution for missing heating fuel oil supplier data. Based on all available data collected from suppliers' LL43 forms, for all suppliers with large volumes of retail sales and missing data in any of the years between 2007 and 2015, estimates were made for the missing year(s).

- 2013: Because the heating degree days (HDDs) for 2013 and 2015 were approximately the same, a linear interpolation was made for 2013 missing data; this was based on the 2012 data from the missing supplier (the last full year's worth of data obtained from that supplier before their December 2013 sale of all their retail assets), and the 2015 data from the final buyer (in May 2014) of those retail assets.

- 2014: Calculate the average of the sum of the 2013 missing supplier estimate from above, the final buyer's 2013 actual data, and the final buyer's 2015 actual data. This average value is then multiplied by 1.05, as 2014 had approximately 5 percent more HDDs than 2013 or 2015.
- Identify a set of "core suppliers", defined as those suppliers with a complete set of data between the years 2007 and 2015. These suppliers represent a large majority of the heating fuel oil sales in New York City.
- For all suppliers, convert gallon values into MMBtu.
- For each supplier/year combination, calculate the share of each supplier's sales (in MMBtu) as a percentage of the total sales of the core suppliers (in MMBtu) for each year.
- Focusing on the percent of sales for a supplier relative to the total core vendors' sales, fill any missing data gaps by interpolation techniques. For example, if Supplier A had 1.2 percent of the core suppliers' total sales in 2012, and 1.4 percent of total core suppliers' sales in 2014, estimate missing 2013 sales as 1.3 percent of total core suppliers' sales in 2013.
- For each year, use the total sales of the core suppliers (MMBtu) and each supplier's percent values of the total core suppliers' sales and calculate the sales of each individual vendor (MMBtu). With this approach, any change in sales due to changes in weather (HDD) is reflected in the sales of the core suppliers, and automatically reflected in the estimated sales of non-core suppliers.
- For each supplier, use the historical fuel distribution (i.e., percent sales of each heating fuel oil type) to calculate MMBtu by fuel type.
- For each supplier, use the calculated MMBtu sales by heating fuel oil type to convert into gallons.
- Sum up all gallons across all suppliers by heating fuel oil type to calculate the overall heating fuel oil activity data.

Vehicle miles traveled (VMT) and associated mobile source GHG emissions

On-road VMT data are generated by the New York Metropolitan Transportation Council's (NYMTC) New York Best Practice Model (NYBPM), to create some of the necessary data inputs to calculate mobile source GHG emissions, as part of the citywide GHG emissions inventory. Transportation modelers for the City's 80 x 50 plan development utilized the NYBPM model outputs as one set of input data to model mobile source GHG emissions, an approach applied to the City's GHG emissions inventory development to ensure consistency of results. The U.S. EPA's Motor Vehicle Emissions Simulator (MOVES) model, a state-of-the-science model for estimating emissions from mobile sources under a wide set of user-defined conditions, is the model used to estimate on-road energy consumption and GHG emissions for the New York City citywide GHG inventory.

MOVES can estimate GHG emissions and energy consumption at a wide variety of geographic scales including, as in the case of the New York City citywide inventory, individual county, multi-county, and/or metropolitan regions. It can create an annual GHG emissions inventory for any calendar year from 1999 through 2050. The latest version of the MOVES model (MOVES2014a) accounts for all national fuel economy and GHG standards for cars and trucks as of October 2015. A post processor, PPSUITE, is also used for the GHG inventory, to analyze highway operating conditions, calculate highway speeds, compile VMT and vehicle type mix data, and prepare MOVES runs and process outputs.

In part due to the complexity associated with collecting various mobile sources' input data, and the continuous improvements in the City's GHG inventory modeling, several mobile source GHG methodology refinements were made as part of the 2015 inventory. Some of these include the following:

- Following GPC guidance, 50 percent of transboundary trips in the induced activity method (trips "induced" by the City, i.e., trips begin, end, or fully contained in the City), counted as in-boundary trips as Scope 1 GHG emissions and 50 percent were counted as out-of-boundary trips as Scope 3 GHG emissions (not reported per the GPC BASIC reporting framework), for all vehicles.

- Total Scope 1 VMT collected all trans-boundary Scope 1 VMT for all vehicle categories in the 2015 GHG inventory.
- New PPSuite adjustment factors were developed to apply to the BPM VMT data to produce a corrected VMT, by applying that adjustment factor to seasonal VMT data.
- Data in the 2015 GHG inventory provided VMT data at the county level, broken out by functional road class.
- Updated, individual annual fuel economy data for 2010-2015 were included for many vehicle types (instead of a single fixed value over that entire time period).
- Additional MOVES modeling runs were made by the New York City 80 x 50 plan modelers in support of the 2015 GHG inventory, beyond the limited set available during the 2014 GHG inventory development, including:
    - VMT splits as a percentage of total VMT, by fuel type and by sector/vehicle type.
    - 2010 on-road VMT annual data from the BPM model, as used in the 2014 GHG inventory, were adjusted by the applicable PPSuite factor.
    - More rigorous mapping and apportionment of BPM to MOVES categories, which are designated differently from each other.
- Collectively, all of these additional modeling runs have improved the precision and accuracy of the 2015 GHG inventory's mobile source GHG emissions calculations, as compared to that of 2014.

Solid waste-associated GHG emissions

GHG emissions from the management of solid waste were calculated using methodologies outlined in the GPC, applying updated waste generation and characterization data. Previous GHG inventories (2005-2014) used waste generation data provided by DSNY, and applied waste characterization data from DSNY's 2005 Waste Characterization Study (for Residential and Construction and Demolition Waste)[6] and 2004 Commercial Waste Study.[7] These data were then applied to methane generation factors from the EPA's Waste Reduction Model (WARM), per the guidance in ICLEI's U.S. Community Protocol.

As part of the development of the *Roadmap to 80 x 50*, waste generation estimates were revised for commercial waste, as previous estimates were determined to be too low. The *Roadmap to 80 x 50* waste consultant developed revised commercial waste generation values by incorporating industry studies, such as CalRecycle's 2014 Generator-Based Characterization of Commercial Sector Disposal and Diversion in California, with New York's 2004 commercial waste study to generate a per-employee waste generation factor. These factors were applied to employment data using North American Industry Classification System (NAICS) codes to estimate total commercial waste generation.

Because the *Roadmap to 80 x 50* waste generation estimates were developed for 2015, previous years' total waste masses used for GHG emissions calculations were revised. Revisions include scaling these masses by a factor based on the difference between the forecasted 2015 mass, historically used generation data, and the revised 2015 mass, which incorporated revised commercial waste mass. The methodology for calculating waste generation for residential waste and construction and demolition (C&D) waste did not change for the 2015 inventory.

Aligned with the *Roadmap to 80 x 50* analysis, waste characterization was determined using the EPA's WARM model. The resulting mass of each specific waste material in WARM aggregated up to the GPC's waste categories: food, garden waste/plant debris, paper, wood, textiles, industrial waste, and other (inorganic). As in the City's previous GHG inventories, a Waste Commitment method was used, with all methane emissions from future decomposition of landfilled solid waste counted in the year of disposal.

Previous New York City GHG inventories have counted GHG emissions from closed landfills within New York, in addition to projected GHG emissions from waste generated in the year of analysis. Further consideration of this decision led to the exclusion of GHG emissions from in-city landfills in the community inventory, as including these sources would effectively be counting both GHG emissions from waste generated before the 2005 base year and projected GHG emissions from currently-generated waste. Fresh Kills Landfill, the last New York City landfill to accept solid waste, stopped accepting solid waste in 2001.

GHG emissions from composting were also calculated using the GPC's formula. All GHG emissions from incineration in waste-to-energy facilities were assumed to be incorporated in the electricity emission factor, and were not reported separately to avoid double-counting this source.

Restatements of previous years' GHG emissions results

Each year, New York City reviews past years' GHG inventory results and makes adjustments where needed based on a number of factors. This year, several revisions were made that affected past citywide and City government reported GHG emissions. Revised activity data (fuel oil use and solid waste generation); revised mobile source energy use and GHG emissions modeling; revised solid waste GHG emissions modeling (per GPC guidance); and updated electricity and steam emission factors all played a role in these revisions.

Appendix B
Emission Factors Methodologies

Electricity emission factor

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

- The eGRID factor is regionally based on all Westchester County and New York City electricity generation.
- The eGRID factor 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 electricity supply.
- The eGRID factor is based on data that is several years old—the most recent eGRID factor is based on 2012 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 CO2e emissions coefficient from electricity. Data from these sources were acquired from ABB Enterprise Software and were organized to develop specific emission factors for each plant in the New York Independent System Operator's (NYISO) and PJM Public Service Electric and Gas (PSEG) territories. From these data, New York City's electricity emission factors were calculated by taking the following steps:

1. All electricity generated within New York City (NYISO Zone J), all electricity imported to New York City through bilateral contracts between power generators and the New York Power Authority (NYPA) and Consolidated Edison of New York (Con Ed), and measured electricity flows from New Jersey's PSEG territory over the Linden-VFT transmission line (PJM) were added to determine the known quantity of use from these sources.

2. Additional imported electricity volumes were modeled based on zonal distribution transmission constraints on imports into Zone J; power exports out of Zone J; updated status and modeling of New York City PPAs; and least cost modeling based prioritization of market procurements from other zones for additional imported power to New York City.

3. Emission factors for both in-city and imported generation were calculated for carbon dioxide, methane, nitrous oxide, and CO_2e based on each plant's heat rate (efficiency) and primary fuel used for generation.

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

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

Steam emission factor

The City developed its own steam emission factors in cooperation with ConEd, as in past inventories. The revised steam factors were applied to community and City government 2015 inventories. The steam emission factor is presented in detail in Appendix H.

The steam emission factor used by New York City takes into account the impact of generating steam by means of co-generation. This factor is intended to be used for macro, city-scale analyses, as the accounting methodology used by ConEd (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.

Appendix C
Acronym Definitions

NYC agencies

DCAS – New York City Department of Citywide Administrative Services

DEP – New York City Department of Environmental Protection

DOHMH – New York City Department of Health and Mental Hygiene

DOT – New York City Department of Transporation

DSNY – New York City Department of Sanitation

Other entities

C40 – C40 Cities Climate Leadership Group

Con Ed – Consolidated Edison 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

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

Acronyms used throughout report

Btu – British thermal units

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

GHG – greenhouse gas

GWh – gigawatt hour

GPC – Global Protocol for Community-Scale Greenhouse Gas Emission Inventories

HDD – heating degree days

HFCs – hydrofluorocarbons

kg – kilogram

km – kilometer

LGOP – Local Government Operations Protocol

MMBtu – million British thermal units

MW – megawatt

$MtCO_2e$ – million metric tons of carbon dioxide equivalent

N_2O – nitrous oxide

PPA – power purchase agreement

ROS – rest of state

SF_6 – sulfur hexafluoride

SWMP – Solid Waste Management Plan

tCO_2e – metric ton of carbon dioxide equivalent

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

VFT – variable frequency transformer

VMT – vehicle miles traveled

WARM – Waste Reduction Model

Appendix D
Weather Impacts on Emissions

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 inter-annual 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 correlate with monthly heating degree days (HDD) and cooling degree days (CDD).

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

The exclusion of weather from year-by-year changes is based on these estimates; it is presented as an estimate rather than a detailed analysis. Further refinement of these methods will be necessary to make precise claims for exactly how weather affected greenhouse gas emissions.

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.

Appendix E
Steam Emission Factors

	NYC Steam Emissions Factors					
Year	MMBtu/metric ton of steam	Steam emissions factors- kg per metric ton delivered to buildings				
		CO_2	CH_4	N_2O	CO_2e
2005	2.8761	165.7703	0.0053	0.0009	166.1850
2006	2.4382	132.8644	0.0041	0.0007	133.1826
2007	2.5226	137.8423	0.0043	0.0008	138.1739
2008	2.4609	132.0984	0.0039	0.0007	132.3949
2009	2.6251	142.5200	0.0043	0.0007	142.8481
2010	2.3331	122.4715	0.0035	0.0006	122.7282
2011	2.4225	122.6074	0.0032	0.0005	122.8326
2012	2.1083	102.7037	0.0025	0.0004	102.8749
2013	2.1638	104.8528	0.0025	0.0003	105.0162
2014	2.3022	110.6113	0.0024	0.0003	110.7578
2015	2.2011	107.0042	0.0023	0.0003	107.1492

*Note: 64% of steam in 2012 is generated through cogeneration

Appendix F
Electricity Emission Factors

NYC Electricity Emission Factor				
Year	$kgCO_2$/MWh	$kgCH_4$/MW	kgN_20/MWh	$kgCO_2e$/MWh
2005	428.1620	0.0086	0.0023	429.0771
2006	377.0922	0.0065	0.0023	377.9291
2007	378.8847	0.0068	0.0023	379.7286
2008	333.8455	0.0058	0.0019	334.5704
2009	301.1264	0.0054	0.0015	301.7056
2010	263.5869	0.0048	0.0013	264.0865
2011	279.2523	0.0052	0.0010	279.6817
2012	268.0371	0.0052	0.0008	268.3923
2013	269.2007	0.0051	0.0007	269.5332
2014	264.4634	0.0050	0.0006	264.7683
2015	256.6938	0.0051	0.0007	257.0192

Appendix G
Fuel Emission Factors

2015 FUEL EMISSION FACTORS						
	UNIT	GREENHOUSE GAS (kg/UNIT)				
		CO_2 (fossil)	CO_2 (biogenic)	CH_4	N_2O	CO_2e
Stationary source						
Natural gas (buildings)	GJ	50.2559		0.0050	0.000100	50.411
Natural gas (industrial)	GJ	50.2559		0.0010	0.000100	50.311
#2 fuel oil (buildings)	liter	2.7020		0.0004	0.000022	2.719
#2 fuel oil (industrial)	liter	2.7020		0.0001	0.000022	2.711
#4 fuel oil (buildings)	liter	2.8961		0.0004	0.000023	2.914
#4 fuel oil (industrial)	liter	2.8961		0.0001	0.000023	2.906
#6 fuel oil (buildings)	liter	2.9834		0.0004	0.000024	3.001
#6 fuel oil (industrial)	liter	2.9834		0.0001	0.000024	2.994
Biodiesel (biogenic carbon)	liter		2.0094	0.0000	0.000004	0.002
Propane	liter	1.4846		0.0001	0.000015	1.491
Kerosene	liter	2.6812		0.0001	0.000022	2.690
On-road mobile source						
Gasoline - passenger cars	liter	2.3421		0.000168	0.000265	2.425
Gasoline - light trucks	liter	2.3421		0.0002	0.0003	2.425
Diesel passenger cars	liter	2.6799		0.000002	0.000004	2.681
Diesel - light trucks	liter	2.6799		0.000003	0.000004	2.681
Diesel - heavy duty vehicles	liter	2.6799		0.000012	0.000011	2.683
Diesel - bus	liter	2.6799		0.000017	0.000016	2.685
Biodiesel - heavy duty trucks	liter		2.0094	0.000037	0.000004	0.002
Ethanol (E100) - passenger car	liter		1.5285	0.000340	0.000414	1.660
CNG - buses	GJ	50.247		0.065902	0.005866	53.642
Off-road						
Jet Fuel	liter	2.4660		0.0000	0.000079	2.490
Aviation gasoline	liter	2.1955		0.001865	0.000029	2.251
Diesel - rail locomotive	liter	2.6799		0.000211	0.000069	2.706
Diesel - marine (in port)	liter	2.6799		0.000016	0.000119	2.716

Appendix H
Citywide GHG Emissions Summary

		CY 2005			CY 2014			CY 2015			Change from 2014			Change from 2005		
Sector	Units	Consumed	tCO_2e	Source MMBtu	Consumed	tCO_2e	Source MMBtu	Consumed	tCO_2e	Source MMBtu	Consumed	tCO_2e	Source MMBtu	Consumed	tCO_2e	Source MMBtu
Stationary Energy																
Residential (small and large residential)																
#2 fuel oil	liter	555,115,513	1,509,205	20,485,363	593,685,897	1,614,067	21,908,722	642,371,709	1,746,430	23,705,369	8%	8%	8%	16%	16%	16%
#4 fuel oil	liters	294,735,132	858,782	11,486,968	303,965,661	885,678	11,846,717	371,262,975	1,081,765	14,469,554	22%	22%	22%	26%	26%	26%
#6 fuel oil	liters	733,787,288	2,202,564	29,446,928	232,103,338	696,690	9,314,321	48,457,191	145,451	1,944,590	-79%	-79%	-79%	-93%	-93%	-93%
Biofuel	liters	2,723,585	5	92,994	34,445,648	59	1,176,108	34,527,400	59	1,178,900	0%	0%	0%	1,168%	1,168%	1,168%
Electricity	kWh	14,168,364,734	6,079,321	133,021,044	15,050,281,601	3,984,838	132,480,574	15,701,860,145	4,035,680	148,976,038	4%	1%	12%	11%	-34%	12%
Natural gas	GJ	180,307,273	9,088,939	179,443,212	187,277,654	9,440,303	186,380,189	184,436,188	9,297,070	183,552,340	-2%	-2%	-2%	2%	2%	2%
Steam	kg	1,998,982,584	332,201	5,749,261	2,914,003,579	322,749	6,708,579	2,671,762,180	286,277	6,099,429	-8%	-11%	-9%	34%	-14%	6%
Commercial and Institutional (commercial, institutional, and streetlights)																
#2 fuel oil	liters	314,564,916	855,215	11,608,353	336,421,430	914,636	12,414,921	364,010,009	989,642	13,433,019	8%	8%	8%	16%	16%	16%
#4 fuel oil	liters	52,603,950	153,274	2,050,179	54,251,403	158,075	2,114,387	66,262,542	193,072	2,582,507	22%	22%	22%	26%	26%	26%
#6 fuel oil	liters	90,043,029	270,277	3,613,432	28,481,398	85,491	1,142,960	5,946,181	17,848	238,621	-79%	-79%	-79%	-93%	-93%	-93%
Biofuel	liters	685,603	1	23,409	8,670,941	15	296,060	8,691,520	15	296,762	0%	0%	0%	1,168%	1,168%	1,168%
Electricity	kWh	26,226,076,079	11,253,009	246,226,018	24,796,507,342	6,565,330	218,272,030	24,916,358,669	6,403,983	236,401,315	0%	-2%	8%	-5%	-43%	-4%
Natural gas	GJ	60,301,084	3,039,660	60,012,112	113,182,819	5,705,326	112,640,429	110,953,139	5,592,932	110,421,433	-2%	-2%	-2%	84%	84%	84%
Steam	kg	7,457,786,326	1,239,372	21,449,291	5,463,998,032	605,180	12,579,142	5,318,470,947	569,870	12,141,662	-3%	-6%	-3%	-29%	-54%	-43%
Manufacturing and construction (industrial)																
#2 fuel oil	liters	72,520,283	196,673	2,676,208	77,559,117	210,338	2,862,155	83,919,431	227,587	3,096,869	8%	8%	8%	16%	16%	16%
#4 fuel oil	liters	11,333,710	32,943	441,718	11,688,659	33,974	455,552	14,276,502	41,496	556,410	22%	22%	22%	26%	26%	26%
#6 fuel oil	liters	6,952,951	20,819	279,022	2,199,279	6,585	88,257	459,153	1,375	18,426	-79%	-79%	-79%	-93%	-93%	-93%
Biofuel	liters	121,709	0	4,156	1,539,277	3	52,557	1,542,930	3	52,682	0%	0%	0%	1,168%	1,168%	1,168%
Electricity	kWh	8,779,889,926	3,767,250	82,430,834	8,933,385,640	2,365,278	78,636,406	9,030,045,419	2,320,895	85,675,224	1%	-2%	9%	3%	-38%	4%
Natural gas	GJ	18,090,325	910,089	18,003,634	26,874,908	1,352,024	26,746,119	26,789,018	1,347,703	26,660,640	-0%	-0%	-0%	48%	48%	48%
Steam	kg	2,237,335,898	371,812	6,434,787	1,639,199,412	181,554	3,773,743	1,595,541,286	170,961	3,642,499	-3%	-6%	-3%	-29%	-54%	-43%
Fugitive natural gas																
CH_4 - natural gas distribution	GJ	442,833	207,588	-	560,457	262,728	-	551,495	258,527	-	-2%	-2%	0%	25%	25%	0%
Transportation																
On-Road																
Passenger cars	VMT	19,318,051,038	12,881,945	192,791,648	19,959,361,647	12,431,643	188,141,550	20,031,919,734	12,379,304	187,598,017	0%	-0%	-0%	4%	-4%	-3%
Medium duty trucks	VMT	487,628,577	387,786	5,670,969	503,816,344	399,075	5,869,409	505,647,835	401,210	5,896,144	0%	1%	0%	4%	3%	4%
Heavy duty trucks	VMT	632,294,047	1,419,991	19,772,771	653,284,152	1,461,692	20,334,624	655,658,982	1,466,398	20,398,002	0%	0%	0%	4%	3%	3%
Buses	VMT	346,001,787	687,896	9,548,307	294,114,348	571,213	8,215,958	305,464,091	586,859	8,633,174	4%	3%	5%	-12%	-15%	-10%
Railways																
Electricity - subway and commuter rail	kWh	2,223,041,708	953,856	20,871,239	2,154,131,108	570,346	18,961,806	2,163,557,443	556,076	20,527,391	0%	-3%	8%	-3%	-42%	-2%
Diesel - commuter rail	liters	5,207,218	14,098	192,691	5,470,547	14,811	202,435	5,452,200	14,761	201,756	-0%	-0%	-0%	5%	5%	5%
Marine Navigation																
Diesel - marine navigation	liters	18,247,504	49,962	673,386	14,092,419	38,585	520,051	25,241,030	69,110	931,467	79%	79%	79%	38%	38%	38%
Biofuel	liters	-	-	-	-	-	-	45,333	0.1	1,548						
Gasoline - marine navigation	liters	-	-	-	-	-	-	8,718	21	291						
Aviation																
Jet fuel - aviation	liters	933,093	2,426	33,610	898,529	2,336	32,365	1,016,754	2,643	36,623	13%	13%	13%	9%	9%	9%
Waste																
Landfills																
Exported solid waste - landfills	MT	7,420,036	2,021,979	-	5,999,846	1,634,973	-	5,538,963	1,509,381	-	-8%	-8%	0%	-25%	-25%	0%
Biological treatment																
CH4 and N_2O - composting	MT	26,351	4,991	-	36,980	7,004	-	564,146	106,849	-	0%	0%	0%	0%	0%	0%
Wastewater treatment																
CH_4 - wastewater treatment plants	MT	6,536	163,402	-	5,699	142,468	-	5,842	146,058	-	3%	3%	0%	-11%	-11%	0%
N_2O - wastewater treatment plants	MT	286	85,120	-	255	75,866	-	251	74,871	-	-1%	-1%	0%	-12%	-12%	0%
TOTALS			61,062,452	1,084,533,543		52,740,933	1,084,168,127		52,042,186	1,119,368,701		-1.3%	3.2%		-14.8%	3.2%

Appendix I

City Government GHG Emissions Summary

		FY 2006			FY 2014			FY 2015			Change from 2014			Change from 2006		
Sector	Units	Consumed	$MgCO_2e$	Source MMBtu	Consumed	$MgCO_2e$	Source MMBtu	Consumed	$MgCO_2e$	Source MMBtu	Consumed	$MgCO_2e$	Source MMBtu	Consumed	$MgCO_2e$	Source MMBtu
Buildings																
#2 fuel oil	liter	56,816,067	154,467	2,096,677	70,910,242	192,785	2,616,792	78,897,011	214,499	2,911,527	11.3%	11.3%	11.3%	38.9%	38.9%	38.9%
#4 fuel oil	liter	32,426,496	94,482	1,263,786	64,366,872	187,549	2,508,626	69,193,895	201,613	2,696,754	7.5%	7.5%	7.5%	113.4%	113.4%	113.4%
#6 fuel oil	liter	75,041,558	225,248	3,011,422	27,215,138	81,690	1,092,145	9,042,569	27,143	362,879	-66.8%	-66.8%	-66.8%	-87.9%	-87.9%	-87.9%
Biodiesel	liter	-	-	-	8,221,533	100	280,715	8,391,778	102	286,528	2.1%	2.1%	2.1%			
Electricity	kwh	3,199,648,988	1,209,240	29,041,147	3,312,388,423	877,016	29,157,403	3,295,468,753	846,999	31,266,734	-0.5%	-3.4%	7.2%	3.0%	-30.0%	7.7%
Kerosene	liter	-	-	-	122,922	331	4,549	93,092	250	3,445	-24.3%	-24.3%	-24.3%			
Natural gas	GJ	11,068,300	557,932	11,015,259	11,793,163	594,470	11,736,649	12,523,395	631,280	12,463,381	6.2%	6.2%	6.2%	13.1%	13.1%	13.1%
Propane	liter	4,086,926	6,095	99,310	121,242	181	2,946	119,359	178	2,900	-1.6%	-1.6%	-1.6%	-97.1%	-97.1%	-97.1%
Steam	kg	781,066,529	104,024	1,904,376	949,238,782	105,136	2,185,325	985,295,718	105,574	2,168,698	3.8%	0.4%	-0.8%	26.1%	1.5%	13.9%
Transportation																
Gasoline	liter	51,838,820	122,621	1,728,914	40,172,978	95,026	1,339,838	41,594,920	98,390	1,387,262	3.5%	3.5%	3.5%	-19.8%	-19.8%	-19.8%
Ethanol	liter	5,972,192	-	134,695	4,463,664	516	100,672	4,622,552	535	104,256	3.6%	3.6%	3.6%	-22.6%		-22.6%
Diesel - trucks	liter	60,061,625	161,136	2,222,552	62,443,468	167,527	2,310,691	60,530,889	162,396	2,239,917	-3.1%	-3.1%	-3.1%	0.8%	0.8%	0.8%
Biodiesel - trucks	liter	-	-	-	5,763,384	7	196,784	6,595,968	8	225,212	14.4%	14.4%	14.4%			
Diesel - marine vessels	liter	18,247,504	49,962	673,386	18,418,732	50,431	679,704	25,107,072	68,744	926,523	36.3%	36.3%	36.3%	37.6%	37.6%	37.6%
Jet fuel	liter	933,093	2,426	33,610	856,478	2,227	30,850	942,008	2,449	33,931	10.0%	10.0%	10.0%	1.0%	1.0%	1.0%
Streetlights and traffic signals																
Electricity	kwh	306,246,001	115,739	2,779,597	207,758,448	55,008	1,828,800	201,195,422	51,711	1,908,901	-3.2%	-6.0%	4.4%	-34.3%	-55.3%	-31.3%
Wastewater treatment																
#1 fuel oil	liter	-	-	-	11,364	31	420	5,364	14	198	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
#2 fuel oil	liter	18,314,093	49,667	675,843	12,456,176	33,781	459,669	12,776,429	34,649	471,487	2.6%	2.6%	2.6%	-30.2%	-30.2%	-30.2%
#4 fuel oil	liter	1,129,823	3,284	44,034	-	-	-	-	-	-				-100.0%	-100.0%	-100.0%
Electricity	kwh	596,089,952	225,280	5,410,323	684,431,069	181,216	6,024,726	692,309,021	177,937	6,568,486	1.2%	-1.8%	9.0%	16.1%	-21.0%	21.4%
Natural gas	liter	380,655	19,150	378,831	634,233	31,907	631,194	622,039	31,294	619,058	-1.9%	-1.9%	-1.9%	63.4%	63.4%	63.4%
Steam	kg	106,123,696	14,134	258,748	37,389,543	4,141	82,809	37,549,979	4,023	82,650	0.4%	-2.8%	-0.2%	-64.6%	-71.5%	-68.1%
Methane	Mg CH_4	7,068	176,698	-	6,266	156,648	-	5,597	139,913	-	0.0%	-10.7%	0.0%	0.0%	-20.8%	0.0%
Nitrous oxide	Mg N_2O	268	79,916	-	257	76,689	-	253	75,523	-	0.0%	-1.5%	0.0%	0.0%	-5.5%	0.0%
Water supply																
#2 fuel oil	liter	234,386	637	8,650	881,580	2,397	32,533	1,000,355	2,720	36,916	13.5%	13.5%	13.5%	326.8%	326.8%	326.8%
Biodiesel	liter	-	-	-	30,132	0	1,029	45,854	0	1,566	52.2%	52.2%	52.2%			
Electricity	kwh	23,253,033	8,788	211,053	70,753,346	18,733	622,809	77,505,486	19,920	735,356	9.5%	6.3%	18.1%	233.3%	126.7%	248.4%
Natural gas	GJ	2,921	147	2,907	72,930	3,669	72,581	97,449	4,902	96,982	33.6%	33.6%	33.6%	3236.1%	3236.1%	3236.1%
Propane	liter	-	-	-	4,249,354	6,337	103,257	4,919,859	7,337	119,550	15.8%	15.8%	15.8%			
Solid waste facilities																
Methane	Mg CH_4	9,969	249,217	-	3,386	84,649	-	2,975	74,386	-	0.0%	-12.1%	0.0%	0.0%	-70.2%	0.0%
Fugitive and process emissions																
HFCs - municipal vehicle fleet	kg	8,722	12,513	-	8,211	11,781	-	8,377	12,019	-	0.0%	2.0%	0.0%	0.0%	-3.9%	0.0%
TOTALS			3,642,804	62,995,119		3,021,976	64,103,516		2,996,507	67,721,097		-0.8%	5.6%		-17.7%	7.5%

Appendix J

Heating and Cooling Degree Days

Heating and Cooling Degree Days, Central Park 2005-2015 Using 65 Degrees (°F) Base Temperature

	YEAR	ANNUAL TOTAL	% CHANGE FROM PREVIOUS YEAR	% CHANGE FROM BASE YEAR
	Calendar years			
Heating degree days	2004	4,787	-	-
Heating degree days	2005	4,733	-1.1%	-
Heating degree days	2006	3,987	-15.58%	-15.58%
Heating degree days	2007	4,705	18.0%	-0.6%
Heating degree days	2008	4,598	-2.3%	-2.9%
Heating degree days	2009	4,760	3.5%	0.6%
Heating degree days	2010	4,447	-6.6%	-6.0%
Heating degree days	2011	4,335	-2.5%	-8.4%
Heating degree days	2012	3,978	-8.2%	-16.0%
Heating degree days	2013	4,670	17.4%	-1.3%
Heating degree days	2014	4,875	4.4%	3.0%
Heating degree days	2015	4,460	-8.5%	-5.8%
Cooling degree days	2004	1,053	-	-
Cooling degree days	2005	1,472	39.8%	-
Cooling degree days	2006	1,130	-23.2%	-23.2%
Cooling degree days	2007	1,212	7.3%	-17.7%
Cooling degree days	2008	1,163	-4.0%	-21.0%
Cooling degree days	2009	876	-24.7%	-40.5%
Cooling degree days	2010	1,549	76.8%	5.2%
Cooling degree days	2011	1,331	-14.1%	-9.6%
Cooling degree days	2012	1,277	-4.1%	-13.2%
Cooling degree days	2013	1,272	-0.4%	-13.6%
Cooling degree days	2014	1,128	-11.3%	-23.4%
Cooling degree days	2015	1,581	40.2%	7.4%
	Fiscal years			
Heating degree days	2005	4,713	-	-
Heating degree days	2006	4,261	-9.6%	-
Heating degree days	2007	4,460	4.7%	4.7%
Heating degree days	2008	4,470	0.2%	4.9%
Heating degree days	2009	4,835	8.2%	13.5%
Heating degree days	2010	4,377	-9.5%	2.7%
Heating degree days	2011	4,726	8.0%	10.9%
Heating degree days	2012	3,715	-21.4%	-12.8%
Heating degree days	2013	4,637	24.8%	8.8%
Heating degree days	2014	4,962	7.0%	16.5%
Heating degree days	2015	4,974	0.2%	16.7%
Cooling degree days	2005	1,066	-	-
Cooling degree days	2006	1,435	34.6%	-
Cooling degree days	2007	1,177	-18.0%	-18.0%
Cooling degree days	2008	1,202	2.1%	-16.2%
Cooling degree days	2009	1,051	-12.6%%	-26.8%
Cooling degree days	2010	1,112	5.8%	-22.5%
Cooling degree days	2011	1,442	29.7%	0.5%
Cooling degree days	2012	1,317	-8.7%	-8.2%
Cooling degree days	2013	1,285	-2.4%	-10.5%
Cooling degree days	2014	1,234	-4.0%	-14.0%
Cooling degree days	2015	1,229	-0.4%	-14.4%

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

Appendix K
Endnotes

[1] City of New York, 2014, available at http://www.nyc.gov/html/builttolast/assets/downloads/pdf/OneCity.pdf

[2]City of New York, 2014, available at http://www.nyc.gov/html/onenyc/downloads/pdf/publications/OneNYC.pdf

[3]City of New York, 2016, available at http://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/New%20York%20City's%20Roadmap%20to%2080%20x%2050_Final.pdf

[4]ICLEI-USA, 2010, available at https://s3.amazonaws.com/icleiusaresources/lgo_protocol_v1_1_2010-05-03.pdf

[5]Xpand, a proprietary model licensed to the Brattle Group from the Lantau Group, is a capacity expansion model that endogenously determines the last-cost strategy to meet load given a series of constraints.

[6]City of New York, 2005, available at http://www1.nyc.gov/assets/dsny/docs/about_2004-2005-waste-characterization_0815.pdf

[7]City of New York, 2004, available at http://www1.nyc.gov/assets/dsny/about/inside-dsny/commercial-waste-management-study-2004.shtml