CITY OF BOSTON GREENHOUSE GAS EMISSIONS INVENTORY 2005-2019

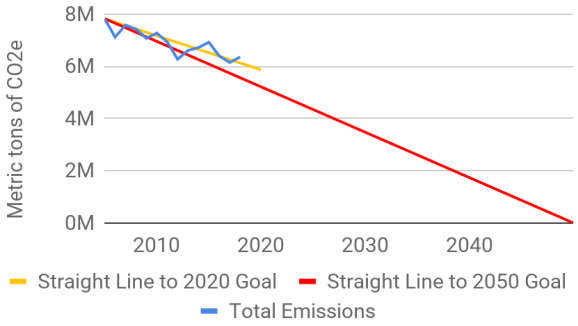
OVERVIEW

In 2019, the Boston community emitted 6.2 million metric tons of greenhouse gases (GHGs) from energy use in buildings and transportation. This is nearly a 2% decrease from 2018, when Boston emitted 6.4 million metric tons.[1] This decrease is due to cleaner electricity, lower electricity, natural gas (also known as methane gas), and fuel oil use. Overall, Boston's 2019 emissions represent a 21% reduction from 2005. Citywide emissions are reported by calendar year.

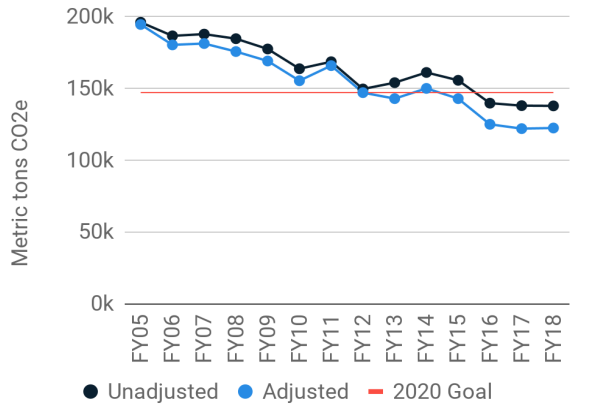
Local government operations emitted 138 thousand metric tons of GHGs, a 40% reduction from 2005 with Renewable Energy Certificates (RECs), and a 33% reduction without RECs. The City of Boston met its 2020 goal of cutting municipal emissions 25% below 2005 levels in 2015 five years ahead of schedule. Local government operation emissions are reported by fiscal year.

Greenhouse gas inventory datasets are available at:
https://data.boston.gov/dataset/greenhouse-gas-emissions

COMMUNITY-WIDE EMISSIONS



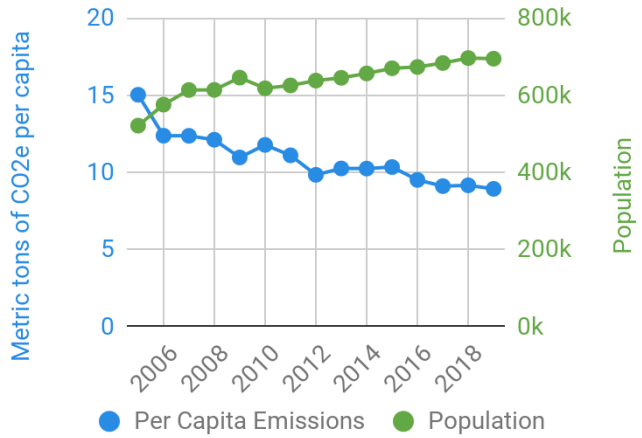
LOCAL GOVERNMENT OPERATION EMISSIONS



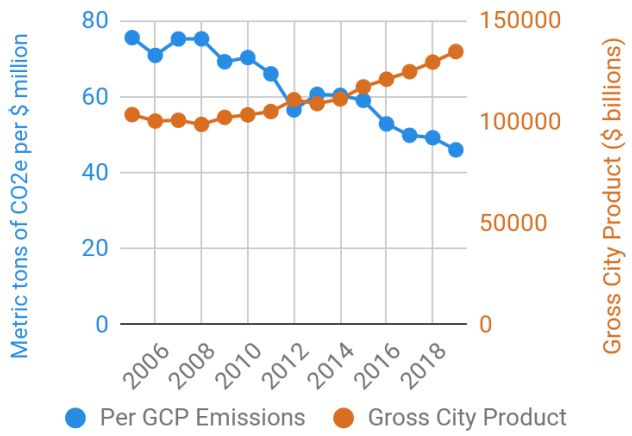
ECONOMIC & POPULATION GROWTH

The reduction in Boston's emissions has occurred at the same time that the population and the number of jobs in Boston have increased. The Boston community has grown from 520 thousand residents in 2015 to more than 694 thousand in 2019.[2] Emissions per resident over the same time period have decreased 41%, from 15 to 9 metric tons per year. Boston's economic growth, as measured by Gross City Product (GCP), has increased from 106 billion dollars to 135 billion.[3] Emissions per million dollars of GCP have decreased 39%, from 76 to 46 metric tons per million dollars.

BOSTON EMISSIONS PER CAPITA



BOSTON EMISSIONS PER GROSS CITY PRODUCT



BACKGROUND

In 2017, the City of Boston committed to a goal of reaching carbon neutrality by 2050.[4] This commitment underpins the City's 2019 Climate Action Plan Update, released in October 2019.[5] To measure progress, Boston follows the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC).[6] The baseline year is 2005, the first year in which consistent and reliable data was collected. Boston has interim goals to reduce citywide emissions by 25% by 2020 and by 50% by 2030.

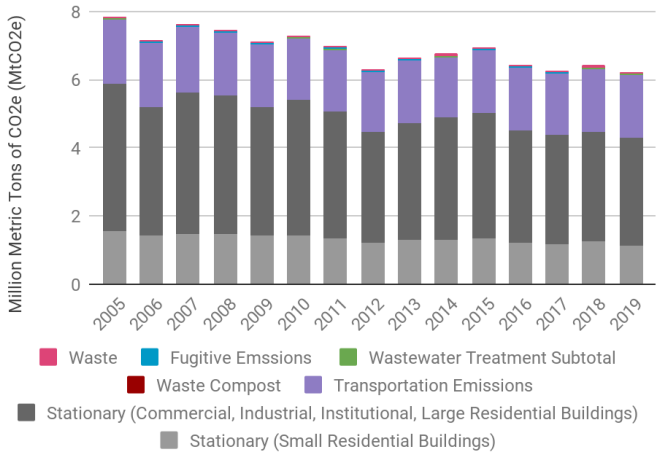
The annual GHG inventory is based on a combination of direct data and estimates for data that cannot be obtained directly (see box below). Data sources include City records, utility company reports, and information from state and federal agencies. Reporting is separated into community-wide and local government operations inventories. Because the data for these inventories is collected using separate protocols on separate timescales, the Local Government Operations Inventory should be considered to be overlapping, but not completely contained within the Citywide Inventory. Detailed notes on inventory methodologies can be found in Appendix I.

WHAT'S INCLUDED?	Energy used by buildings and other stationary sources; fugitive emissions from methane distribution within Boston limits	On-road and some off-road transportation, and public transportation trips within city limits.	Wastewater treatment within city limits.
WHAT'S NOT?	Emissions generated outside the city boundary to produce goods or services used by residents (for example, emissions from food produced elsewhere but consumed by Bostonians). Boston will continue to evaluate the benefits and challenges of "consumption-based" emissions accounting as a complement to the current inventory methodology.		

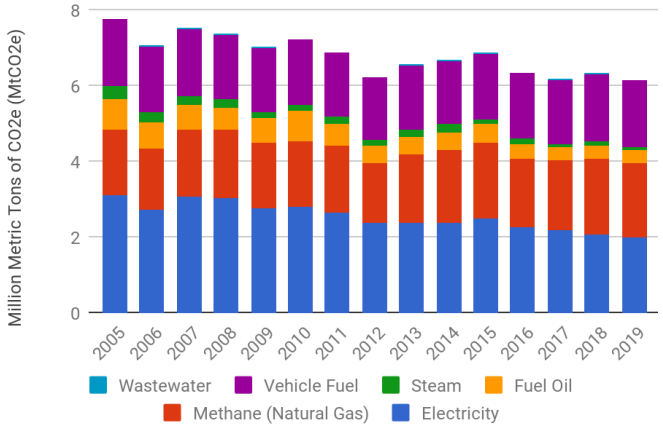
EMISSIONS BY SECTOR & SOURCE

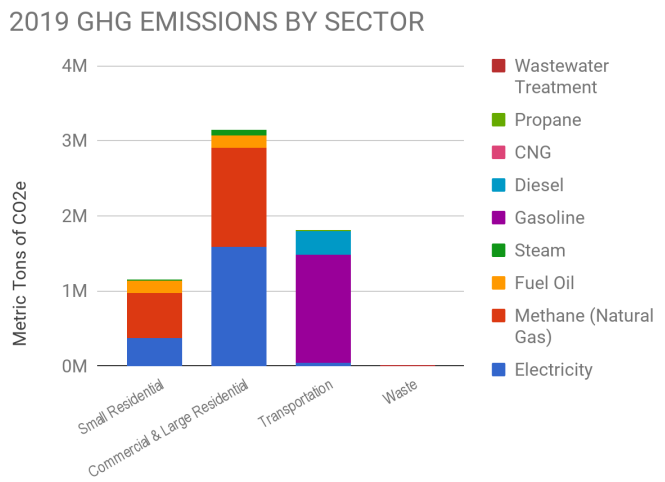
This report contains details of GHG emissions from 2005 to 2019 by energy source and sector. GHG levels reflect both the quantity of energy used and the source of that energy.

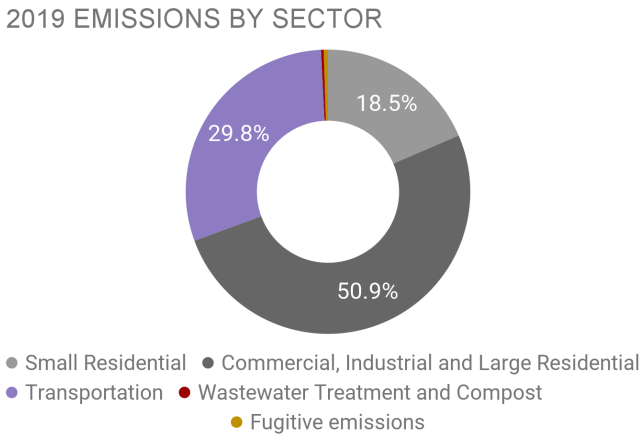
BOSTON EMISSIONS BY SECTOR



BOSTON EMISSIONS BY SOURCE







STATIONARY SECTOR

The community inventory tracks stationary sector emissions from:

- Commercial, industrial and large residential buildings, including high-rise offices, hospitals, universities and research buildings, manufacturing, and construction,
- Small residential buildings,
- Fugitive emissions from oil and natural gas (or methane gas) systems.

In Boston, energy use in stationary sources dominates, accounting for 69% of total emissions (4.3 MtCO2e). Commercial, industrial, and large residential buildings generated 51% of emissions (3.1 MtCO2e), while small residential buildings accounted for 19% of emissions (1.1 MtCO2e). Fugitive gas emissions for all sectors account for less than 1% (30 thousand tCO2e) of emissions. Emissions in the building sector stem from the use of electricity (46%), natural gas (or methane gas) (45%), fuel oil (8%), and steam (2%).

All buildings over 35,000 square feet publicly report their energy and water usage annually. Data is available at: https://data.boston.gov/dataset/building-energy-reporting-and-disclosure-ordinance

TRANSPORTATION

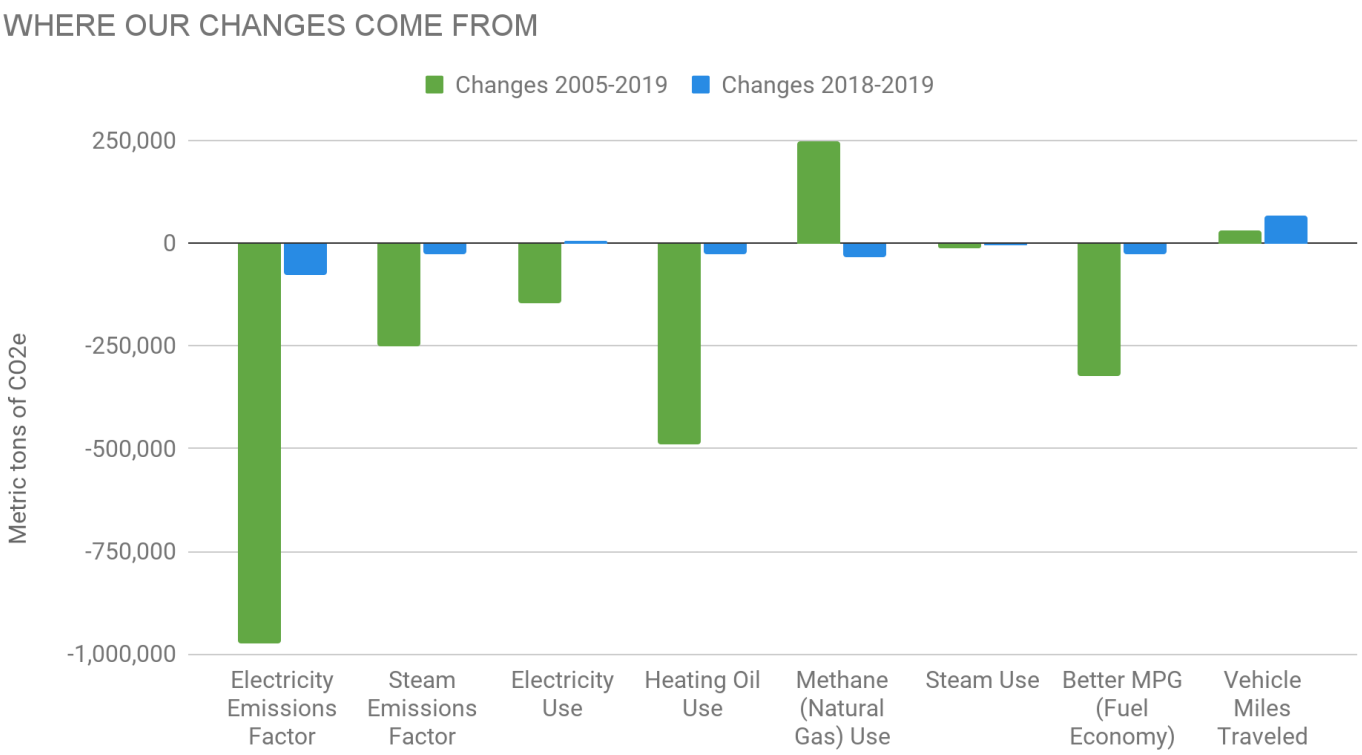
Emissions from transportation comprise 30% of the inventory (1.9 MtCO2e). This is lower than transportation's share of statewide or national emissions because of Boston's density and robust public transportation system. More than half of Bostonians get to work via a mode other than a car.[7] The inventory captures the emissions from the estimated Vehicle Miles Traveled (VMT) inside the City, plus public transportation and off-road vehicles used at the airport and wastewater treatment plant. Primary energy sources include gasoline (76%), diesel (20%), natural gas (or methane gas) (1%), electricity (2%), biodiesel and propane combined (<1%).

WASTE

GHGs reported in the waste sector refer to emissions from wastewater treatment and biological treatment of organic waste and account for less than 1% of total emissions (19 thousand tCO2e). All, or almost all, of Boston's solid waste is sent to Waste-To-Energy (WTE) incineration plants that feed the electricity grid, so emissions are counted as part of regional electricity generation within this inventory. This means solid waste emissions are embedded in the emissions from electricity used in buildings and transportation.

The Carbon Free Boston analysis estimated that Boston's waste sector accounted 393 thousand tons of direct carbon emissions in 2017, if the WTE emissions are broken out from the electricity emissions factor.[8] The Zero Waste Boston initiative has issued strategies to reduce, reuse, recycle and compost at least 80 to 90% of Boston's solid waste.[9] The Carbon Free Boston analysis determined that a 90% diversion rate would reduce waste emissions by 78% relative to 2017 emissions, including the WTE emissions.

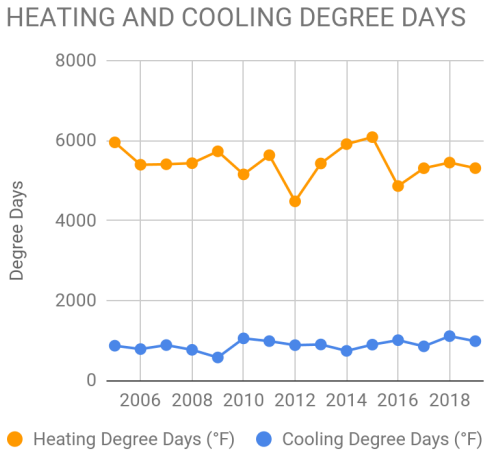
FACTORS DRIVING THE CHANGES



Short-term changes

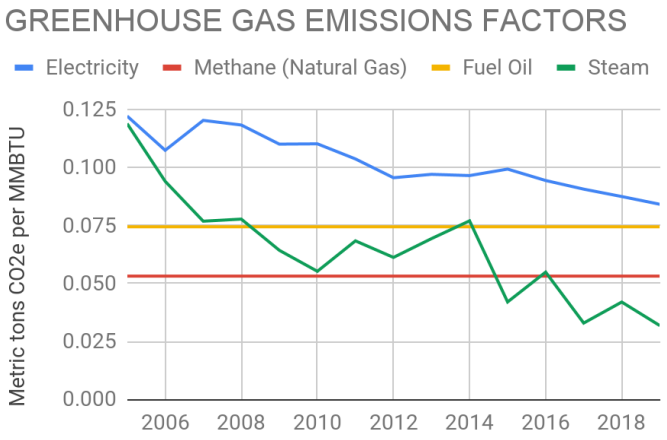
In 2019, the community's GHG emissions decreased nearly 2% (174 thousand tCO2e) from the previous year. This decrease reflects that:

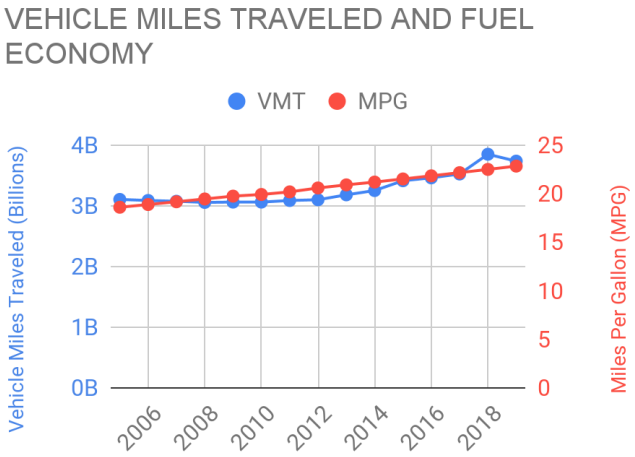
- Regional emissions per unit of electricity decreased by 3.4%.[12,13]
- Boston businesses and institutions consumed less electricity and Boston residents used less fuel oil.
- However, Boston residents, businesses and institutions used 2% less natural gas (or methane gas) than in 2018. The 2019-20 winter was slightly warmer than the 2018-19 winter.[10]



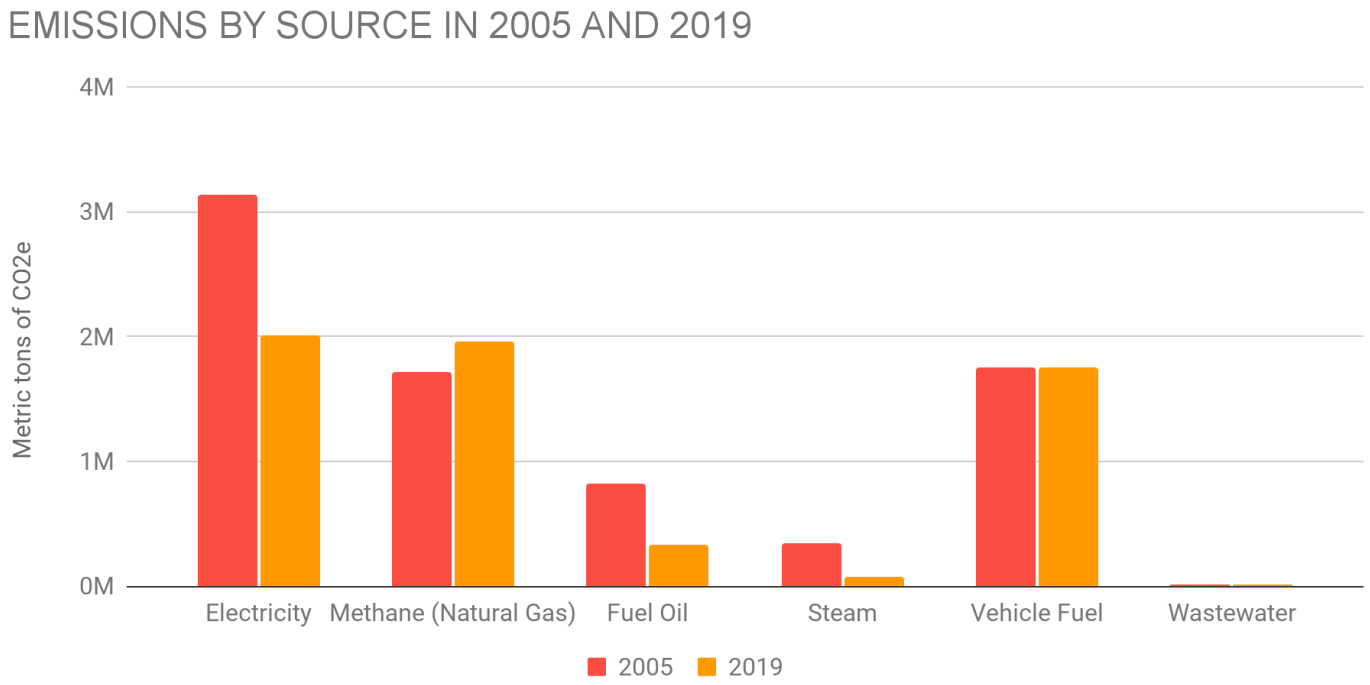
Long-term changes

Boston's GHG emissions from 2005 to 2019 have declined by 21%. 51% of GHG reductions are the result of state-level and regional action to clean the New England electric grid. As a result, the electricity emissions factor has improved continuously over time, as electricity has been less carbon-intensive. Another 25% of GHG reductions may be attributed to reduced fuel oil use. This is because many households and businesses are switching from fuel oil to natural gas (or methane gas) to heat their homes. Steam has become cleaner thanks to fuel-switching from oil to natural gas (or methane gas) and the addition of the Kendall cogeneration plant in 2014. The average fuel economy of vehicles registered in Boston has also improved from 19.8 miles per gallon (mpg) in 2009 to 21.2 mpg in 2014 (most recent year for which Boston-specific data is available).[14]





The energy-efficiency efforts of the Renew Boston program, Boston's utilities, local government and many businesses, institutions, and residents have offset much of Boston's recent growth.



UNCERTAINTY

The inventory employs measured data, projections, models, and, where data is scarce, best estimates. All of these sources have some level of uncertainty, most of which have not been quantified. Furthermore, the inventory is frequently revised as new and better data become available, models are improved, new methodology is developed, and international standards evolve.[15] For these reasons, longer term trends are likely more reliable than absolute numbers or year-to-year changes.

LOCAL GOVERNMENT OPERATIONS

BACKGROUND

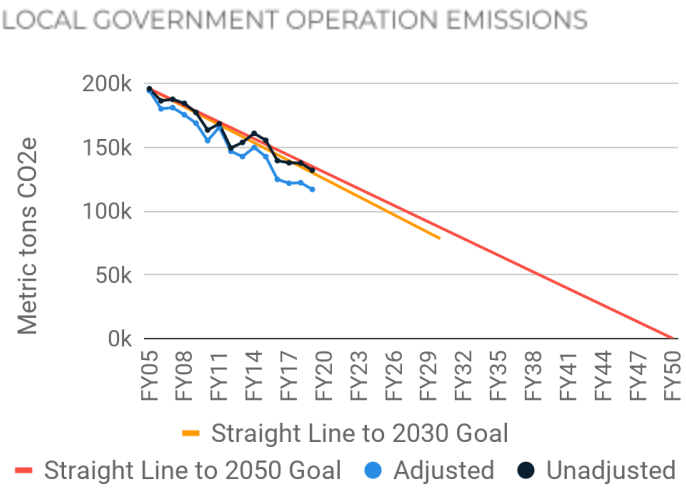
The Local Government Operations (LGO) inventory calculates all greenhouse gas emissions generated by municipal operations in the City of Boston. This includes the burning of fuels in the City's facilities, vehicles, and other equipment, and the energy used in municipal buildings, vehicles, parks, street lights, and traffic signals. The LGO inventory is based on the ICLEI greenhouse gas reporting protocol for local government operations.

Under the protocol, emissions that are not under the operational control of the City government or involve leased properties are excluded. Emissions from the Boston Housing Authority, the Massachusetts Water Resources Authority (MWRA), and the Boston Planning and Development Agency (BPDA) are not included in the inventory. Those from the Boston Public Health Commission (BPHC) and the Boston Water and Sewer Commission (BWSC) are included.

While the timeframe for the citywide inventory is the calendar year, the LGO inventory is conducted based on the fiscal year (FY), July-June. Because the data for these inventories is collected using separate protocols and on different timescales, the LGO should be considered to be largely overlapping but not completely contained within the citywide inventory.

OVERALL EMISSIONS

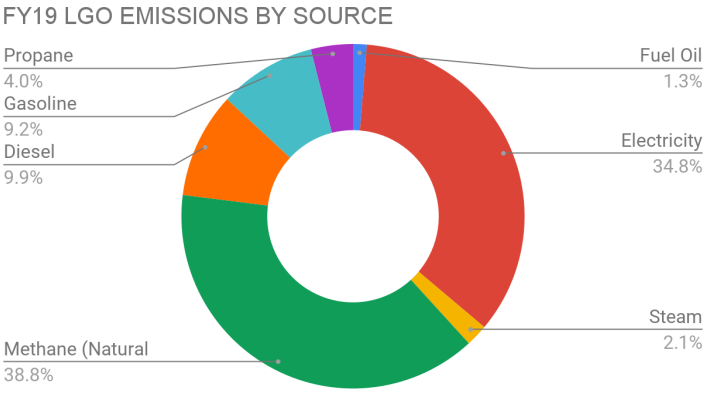
FY19 municipal emissions are down nearly 33% from 2005, before including adjustments for the purchase of renewable energy credits. Adjusting for the City of Boston's purchases of Green-E Certified Renewable Energy Certificates (RECs) equal to approximately one fourth of our total electricity consumption, emissions in FY19 are down more than 40% from 2005 levels. The City of Boston met its municipal 2020 goal of a 25% reduction 5 years ahead of schedule.



EMISSIONS BY ENERGY SOURCE

Boston's LGO emissions are dominated by building energy consumption. Electricity and gas consumption by buildings each make up about one third of total GHG emissions. Transportation fuels, diesel and gasoline, together make up one fourth of total municipal GHG emissions.

Similar to the community-wide inventory, Boston's municipal operations GHG inventory trends are driven by a number of external and internal factors. Diesel consumption is continuing to decrease as Boston Public Schools switches its fleets from diesel- to propane-powered school buses. The continued downward trend in the regional electric grid emissions rate also contributed to reduced emissions.

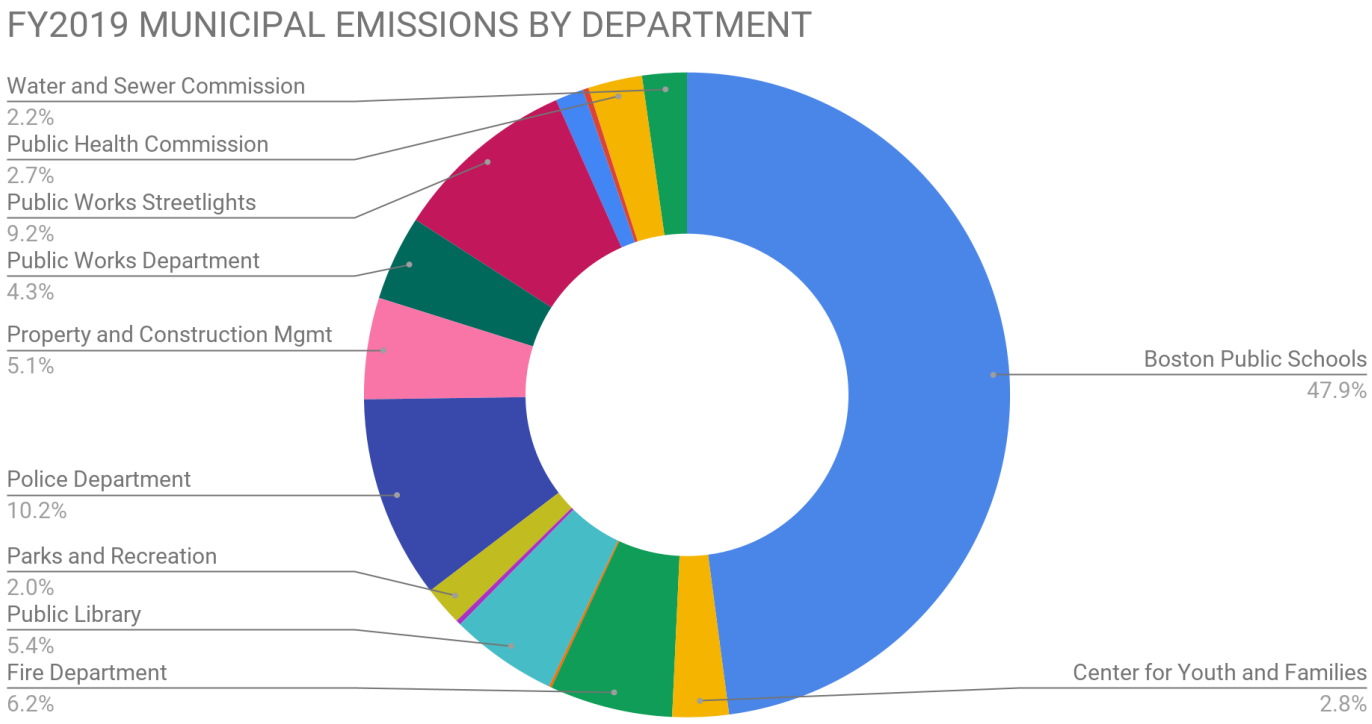


DEPARTMENTAL EMISSIONS

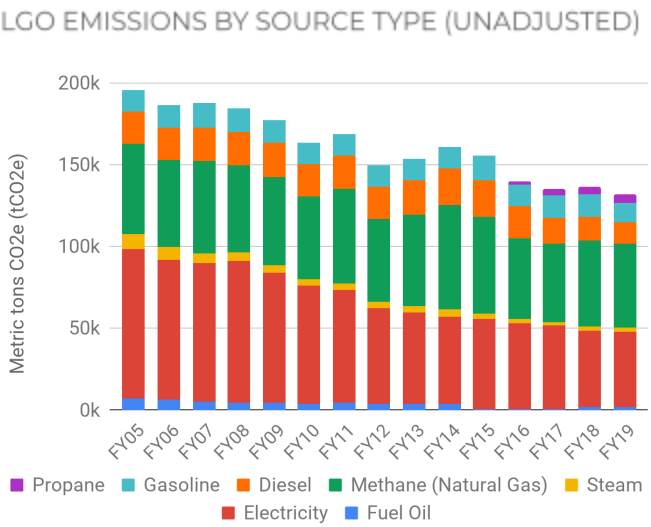
As the department with the largest building portfolio and the second largest vehicle inventory (after Boston Police Department), Boston Public Schools (BPS) represent the largest source of municipal emissions. BPS owns and operates approximately 11 million of the City's 16.5 million square feet of building space across the roughly 127 school buildings in the district.[16] These buildings represent over a third of municipal electricity consumption and two thirds of municipal gas consumption. The BPS Department of Transportation (DOT) fleet includes over 700 school buses and uses 73% of all the diesel fuel consumed by municipal government. BPS has continued their replacement of the oldest, dirtiest diesel buses to lower emissions propane engines; propane buses represented more than half of the fleet in 2020. Since BPS-DOT is on a roughly 10 year replacement cycle, these lower emissions vehicles will provide emissions reductions over the next decade.

The next largest source of GHG emissions from municipal operations is the Boston Police Department (BPD) at about 10.2% of total municipal emissions. In FY19, BPD operated approximately 660,000 square feet of building area and managed a fleet of over 1,000 vehicles. These buildings accounted for 7% of electricity and 5% of natural gas (or methane gas) consumed by City of Boston departments. The BPD fleet accounted for roughly 63% of all gasoline consumed by City of Boston vehicles in FY19.

The third largest source of GHG emission from municipal operation is the Public Works Department's street lighting inventory. The 66,000 electric street lights and the 2,800 natural gas (or methane gas) street lights (found in Boston's historic districts) account for 9% of total municipal GHG emissions. Street lighting used to make up a much larger share of Boston's municipal GHG profile; however, aggressive conversions of electric street lights to LEDs dating back to 2010 have cut emissions from street lights in half. While gas lamps comprise just 4% of total street light fixtures, they produce 37% of GHG emissions from street lights.



FACTORS DRIVING THE CHANGES



- The electricity emissions factor decreased as described in the community inventory.
- Emissions from natural gas (or methane gas) and fuel oil use have decreased since FY05 as the City converted some older schools from oil to gas, and opened new, energy-efficient buildings that use natural gas (or methane gas) for heat and hot water.
- Beginning in FY15, Boston saw a dramatic reduction in fuel oil use due to the closure of the Boston Public Health Commission's Long Island facility, which relied primarily on fuel oil as a heating source.
- Electricity use has decreased over the long term, primarily driven by the near complete conversion of Boston's 66,000 electric streetlights to more efficient LED fixtures. Boston has also invested in building energy efficiency measures on a project-by-project basis, and is engaging in deeper energy efficiency retrofits as part of the Renew Boston Trust.[17]
- Steam use has decreased over the long term due to the reduction in steam use at City Hall and Copley Library and the conversion of the West End Branch library from steam to gas.
- Boston Public Schools have adopted a policy to transition the bus fleet from diesel to propane, which offers a slight carbon benefit but reduces nitrogen dioxide (NOx) emissions by up to 95% compared to diesel.

INVENTORY METHODOLOGY SUMMARY

COMMUNITY INVENTORY PROTOCOL

In 2015, the City of Boston signed on to the Global Covenant of Mayors (GCoM), which required the City to follow the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC). ICLEI Local Governments for Sustainability, whose guidance the City already followed, was a co-developer of the GPC, so the differences were not major. The two main changes were in the categories in which the data is collated, and in two new categories of emissions collected. The GPC requires the ethanol content of gasoline to be reported as a separate biogenic source of emissions, and for an accounting of fugitive gas emissions from the natural gas (or methane gas) supply system.

Boston's GHG inventories are reported in CO2 equivalents (or CO2e), a universal unit of measurement that accounts for the global warming potential (GWP) of different greenhouse gases. Boston's inventory includes carbon dioxide (CO2), natural gas (CH4), and nitrous oxide (N2O), and uses Global Warming Potentials (GWPs) from the latest version of the International Panel on Climate Change (IPCC) Guidelines (currently 5AR). The formula used to determine the CO2e from a given energy use is Activity Data x Emissions Factor^{1+2+3} = GHG Emissions from Activity.

Boston currently reports at the GCP BASIC level, which covers scope 1 and scope 2 emissions from stationary and transportation sources, as well as scope 1 and scope 3 emissions from waste.

Scope 1: GHG emissions from sources located within the city boundary
Scope 2: GHG emissions occurring as a consequence of the use of grid-supplied electricity, heat, steam, and cooling within the city boundary
Scope 3: Emissions that occur outside the city boundary as a result of activities taking place within the city boundary

Our full methodology may be found in "Boston Greenhouse Gas Inventory Methodology," most recently updated for the 2016 inventory year.[18]

2019 Data Revisions

- The City received updated natural gas (or methane) consumption data for 2017 and 2018, in addition to 2019.

MUNICIPAL INVENTORY METHODOLOGY

The Local Government Operations inventory methodology for calculating GHG emissions is based on the ICLEI greenhouse gas reporting protocol for local government operations, developed by ICLEI and the National Association of Clean Air Agencies. The protocol categorizes emissions as direct (Scope 1) or indirect (Scope 2). Direct emissions come from the burning of natural gas (or methane gas), fuel oil, gasoline, diesel fuel, and other fuels in the City's facilities, vehicles, and other equipment. Indirect emissions come from the burning of fuels in facilities owned and operated by others to produce electricity, and steam that the City uses. Emissions that are not under the operational control of the City government, or involve leased properties, are excluded. Emissions from the Boston Housing Authority, the Massachusetts Water Resources Authority (MWRA), and the Boston Planning and Development Agency (BPDA) are not included in the inventory. Those from the Boston Public Health Commission (BPHC), and the Boston Water and Sewer Commission (BWSC) are included.

In 2013 the City invested in an Enterprise Energy Management System (EEMS) and an Energy Manager to track and report local government energy consumption, cost, and GHG emissions. Prior to 2013, reporting relied on annual data collection from numerous stakeholders in the auditing, budget and purchasing offices. This manual process sometimes led to inconsistent data collection. Now the process is almost entirely automated, and with complete invoice data for over 7 calendar years, the City can track progress towards energy and GHG reduction goals on a monthly basis. By tracking this data more closely, the City is able to identify which departments, buildings or assets are contributing most to our overall portfolio, and, in the process, has identified billing errors leading to over $1.2M in reimbursement credits for the City.

One notable correction in accounting methodology was a double-count identified in fleet fuels in FY15, corrected in the FY16 inventory. When the City began reporting vehicle fuels based on delivery point in FY15, it did not account for the fact that Boston Public Health Commission (BPHC), and Emergency Medical Services (EMS) fueled their vehicles at the Department of Public Works (DPW) and Boston Fire Department (BFD) fueling stations. Fueling reports from BPHC and EMS were counted separately even though their fuel use was already included in the DPW and BFD. This correction results in an approximately 141,000 gallon reduction between diesel and gasoline for the FY15 inventory. The correction is included in the new FY16 inventory, and all years FY05-FY14 are not affected by this correction.

Another notable correction was made to the FY17 electricity consumption. For every City of Boston electricity account, the City receives two bills: one from the local distribution company (Eversource) and one from the City's energy supplier. The electricity consumption for each bill should be the same month-to-month but there are some scenarios where they do not match. The City has decided to source the electricity consumed by a particular account from the local distribution company bill as opposed to the energy supply bill. In FY17, the total electricity consumed by Boston Public Schools (BPS) was calculated based on energy supply bills. In this report, the City has retroactively adjusted the BPS consumption figure to reflect the values listed on the local distribution company bills. The result is that the Chart titled "LGO Emissions by Source Type (Unadjusted)" will show a nominally higher GHG emissions contribution from electricity than the same chart did in last year's Climate Action Report.

Finally, the City reviews historical electricity, steam, natural gas (or methane gas), and fuel oil consumption every year and retroactively updates consumption figures from previous fiscal years based on the latest bill corrections and recently discovered errors. These annual adjustments are typically insignificant.

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Massachusetts Port Authority (Massport)
Massachusetts Water Resources Authority (MWRA)
Eversource
National Grid
Vicinity

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