2015 Cincinnati Greenhouse Gas Inventory and Analysis

city of CINCINNATI
ENVIRONMENT & SUSTAINABILITY

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INTRODUCTION

The City of Cincinnati recognizes that climate plays an important role in the quality of life, economic well-being, and the long term sustainability of our City and region. The Green Cincinnati Plan outlines steps we can take to mitigate our region's environmental impact and adapt to anticipated changes. This greenhouse gas (GHG) inventory serves as a tool to measure our progress on our path to sustainability and provides data to inform policy and decision making.

Cincinnati's first GHG inventory was conducted in 2006, and serves as the baseline from which our climate impact is measured. This inventory of our 2015 emissions shows that Cincinnati's efforts, combined with changes in the region's energy supply, have been effective in reducing our emissions output.

What are greenhouse gases (GHG) and do they relate to climate change?

Greenhouse gases (GHG) are a variety of gases that are collecting in the Earth's atmosphere at levels that are capable of altering our climate. Elevated GHG levels cause the sun's energy to be retained in the atmosphere. This effect can have major implications for life on Earth – such as changing weather patterns, rising sea levels, and altered habitats and migration patterns.

Human activities play a significant role in the release of GHGs, primarily through the combustion of fossil fuels such as coal, oil, gasoline, diesel, and natural gas.

GHG measured for this report include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). Each of these gases has a different warming potential. To ease measurement, reporting, and comparison of results, the gases are converted into an equivalent quantity of CO_2. The results are reported here as CO_2 equivalents (CO_2e).

Global Actions

As a global concern, climate change will require global collaboration. In 2016, over 190 countries signed the Paris Agreement within the United Nations Framework Convention on Climate Change, committing to greenhouse gas reduction targets starting in 2020[1]. The agreement establishes the common goals of:

> "(a) Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;
>
> (b) Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production;

[1] http://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf

(c) Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development." [2]

The United States, which is currently responsible for 17.89% of the world's GHG emissions, is included in the list of the countries that have ratified the treaty[3]. Participating countries are charged with identifying and implementing their own strategies to meet the terms of the global agreement[4].

Cincinnati's Plan of Action

Recognizing our role as global citizens, Cincinnati has set forth ambitious GHG reduction targets first established in the 2008 Green Cincinnati Plan[5], and reconfirmed in the 2013 Green Cincinnati Plan.[6]

Emission Reduction Goals

Short Term – Reduce GHG emissions 8% below 2006 levels by 2012
Medium Term - Reduce GHG emissions 40% below 2006 levels by 2028
Long Term - Reduce GHG emissions 84% below 2006 levels by 2050

These goals, reflecting a commitment to reduce GHG emissions 2% per year starting in 2008, apply to both Cincinnati City Government and to the Cincinnati Community (everything occurring within the geographical borders of the City of Cincinnati). The goals are based on three considerations: the level of reductions necessary to stabilize the Earth's climate at a tolerable level; the commitments being made by other cities and counties across the country and around the world; and the availability of practical, affordable emission reduction measures in Cincinnati that are consistent with the multiple objectives established for this effort.

The City of Cincinnati believes that the same actions that reduce GHG emissions can yield multiple benefits, including: cleaner air and water, improved public health, monetary savings, stronger local economy, and creation of good local jobs.

Model Selection & Methodology

The 2015 greenhouse gas inventory was conducted using ClearPath, an emissions management software suite from the International Council for Local Environmental Initiatives (ICLEI)[7].

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[2] http://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf
[3] https://www.weforum.org/agenda/2016/09/what-is-the-paris-agreement-on-climate-change/
[4] The President of the United States announced the intention to withdrew from the 2015 Paris Agreement on June 1, 2017.
[5] http://www.cincinnati-oh.gov/oes/citywide-efforts/climate-protection-green-cincinnati-plan/climate-protection-action-plan/
[6] http://www.cincinnati-oh.gov/oes/linkservid/6CE53223-9206-9F36-DB7FA3444F16A1A0/showMeta/0/
[7] http://clearpath.icleiusa.org/

ClearPath was selected as one of the leading platforms for generating greenhouse gas profiles at the community-wide and government operations scale. Used by many cities around the U.S., ClearPath allows for better comparison and benchmarking with other locations.

ClearPath's model prescribes separate inventories for Government and Community. The results of each are reported below. The results of the two tracks are combined to calculate Cincinnati's total emissions profile. The reported results represent the City's best estimate of GHG emissions.

The baseline year for the analysis is 2006, the most recent year for which reliable data is available. The results of the 2015 analysis are compared to the results of 2006 to gauge progress toward our emissions targets.

Gases Measured

This inventory attempts to measure the emissions of greenhouse gases including:

- Carbon Dioxide (CO_2)
- Methane (CH_4) – Global Warming Potential (GWP) is 30-34 times as potent as CO_2
- Nitrous Oxide (N_2O): GWP is approximately 300 times as potent as CO_2.

These gases have varying Global Warming Potentials (GWP), meaning they trap different amounts of heat in the Earth's atmosphere.[8] To simplify measurement and reporting, the emissions of each gas have been aggregated as metric tons of carbon dioxide equivalent (mt CO_2e).

Activities Analyzed

This inventory attempts to measure the emissions of greenhouse gases associated with the following activities in the geographic limits of the City of Cincinnati:

- Transportation
- Industrial Energy
- Commercial Energy
- Residential Energy
- Water and Wastewater
- Recycling and Waste

[8] https://www.epa.gov/ghgemissions/understanding-global-warming-potentials

2015 GOVERNMENT EMISSIONS

The Government emissions inventory includes emissions generated from municipal operations, including energy used in water and waste water treatment, city building and facilities operations, streetlights, traffic signals, vehicle fleet and aviation fuel use. The relative amounts generated by each of these activities are outlined in Figure 1. Together, these operations generated approximately 275,736 mt CO_2e (metric tons carbon dioxide equivalent), representing a 36.3% reduction from 432,617 mt CO_2e reported in 2006. The changes from 2006 to 2015 can be seen in Figure 2.

This reduction can be attributed to a number of factors, including but not limited to:

1. Street light conversion to LEDs
2. Facility energy improvement upgrades/retrofits
3. Upgrades to Metropolitan Sewer District's incinerators
4. Installation of solar panels on some City owned facilities.

Figure 1. 2015 Greenhouse Gas Emissions from City Government Operations

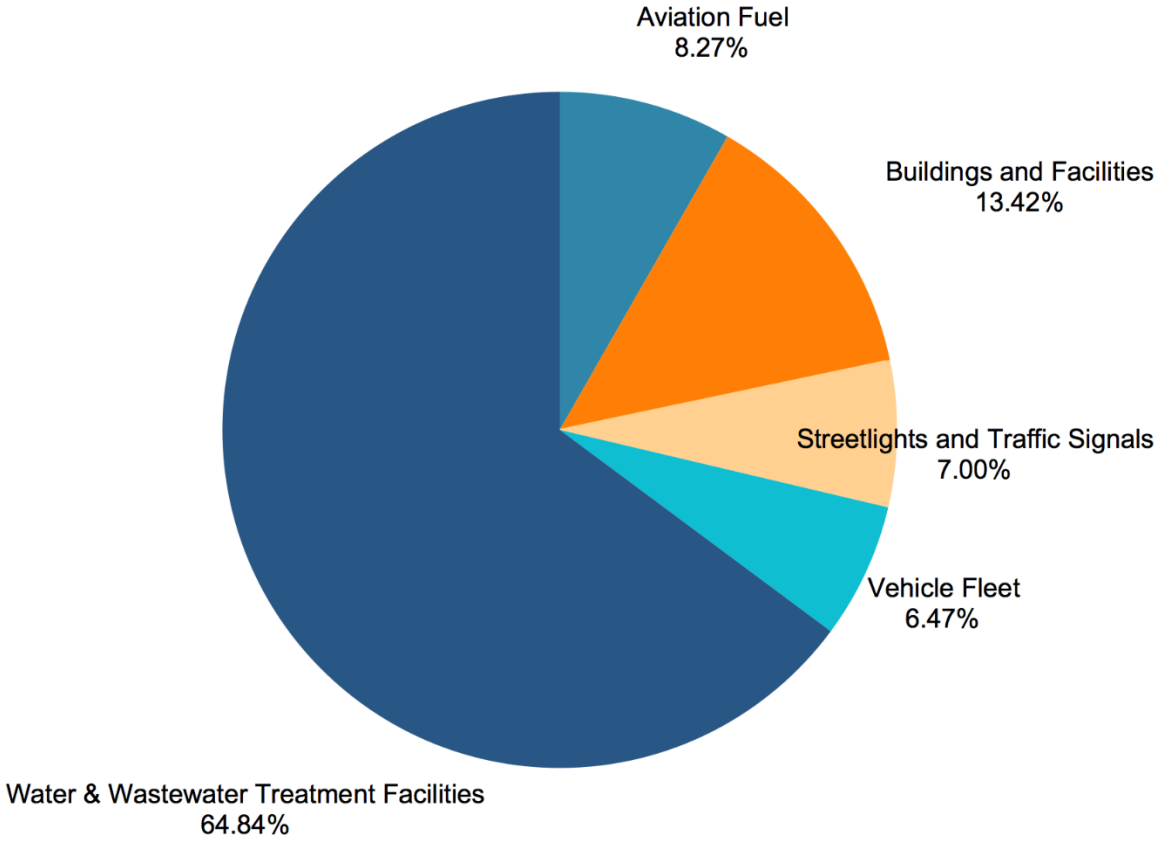
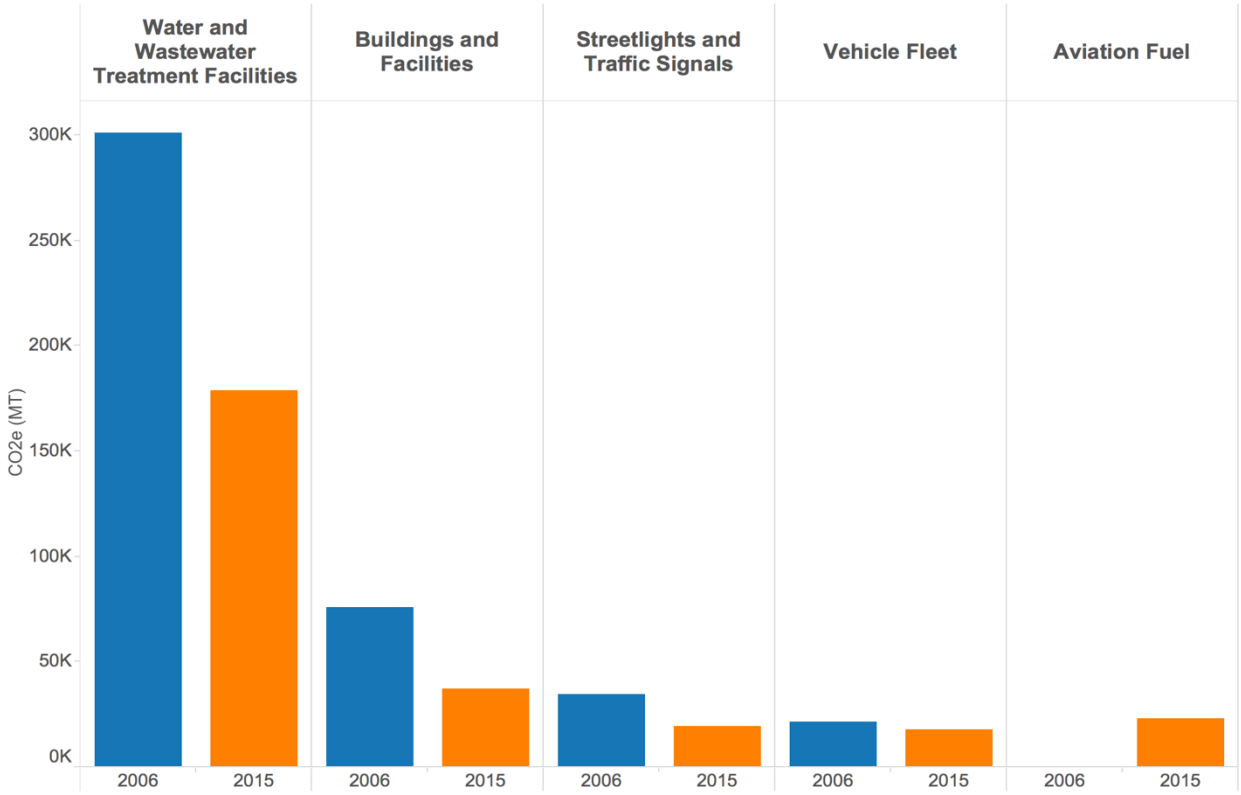


Figure 2. Changes in Cincinnati's Greenhouse Gas Emissions from Municipal Operations from 2006 and 2015



Cincinnati Government Emissions

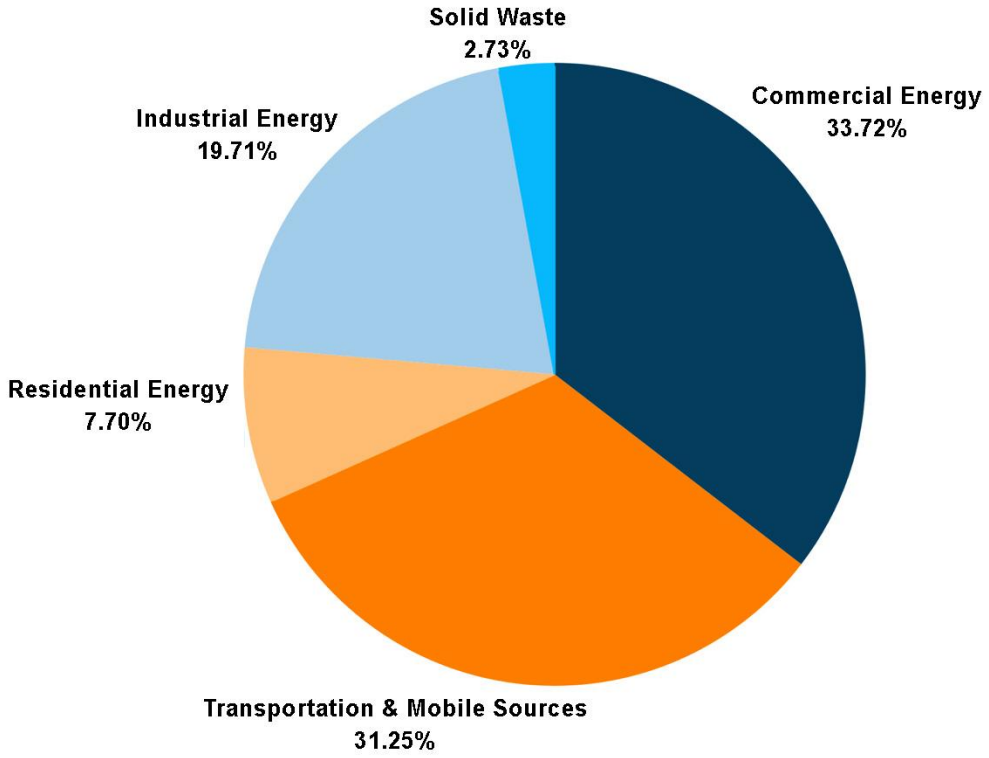
Sector	2006 mtCO2e	2015 mtCO2e	2006-2015 Change
Water & Wastewater Treatment Facilities	301,265	178,742	-40.67%
Buildings & Facilities	75,649	36,986	-51.11%
Aviation (Lunken Airport)**	Not measured	22,808	NA
Street Lights & Traffic Signals	34,250	19,292	-43.67%
Vehicle Fleet	21,453	17,908	-16.52%
Total	432,617	275,736	-36.26%

**Aviation fuel sold at Lunken Airport was not included in the 2006 analysis.

2015 COMMUNITY EMISSIONS

The Community emissions inventory includes emissions generated from commercial, industrial, and residential gas and electric consumption, motor vehicle transportation, and solid waste generation. The relative amounts generated by each sector are outline in Figure 3. Together, these sectors generated approximately 7.3M mt CO_2e in 2015, representing a 17.4% reduction from 8.9M mt CO_2e reported in 2006. The changes seen from 2006 to 2015 can be seen in Figure 4.

Figure 3. 2015 Community Emissions by Sector



This reduction can be attributed to a number of factors, including but not limited to:

1. Incentives for commercial energy upgrades offered by Duke
2. Grid decarbonization
3. 100% Renewable energy offered to residents and businesses through the City's Energy Aggregation Program
4. Population loss from 2006 to 2015 (approximately 10%)
5. Improved waste diversion

Sector changes from 2006 to 2015 can be seen in Figure 4.

Figure 4. Cincinnati Community Greenhouse Gas Emission Changes from 2006-2015

Cincinnati Community Emissions

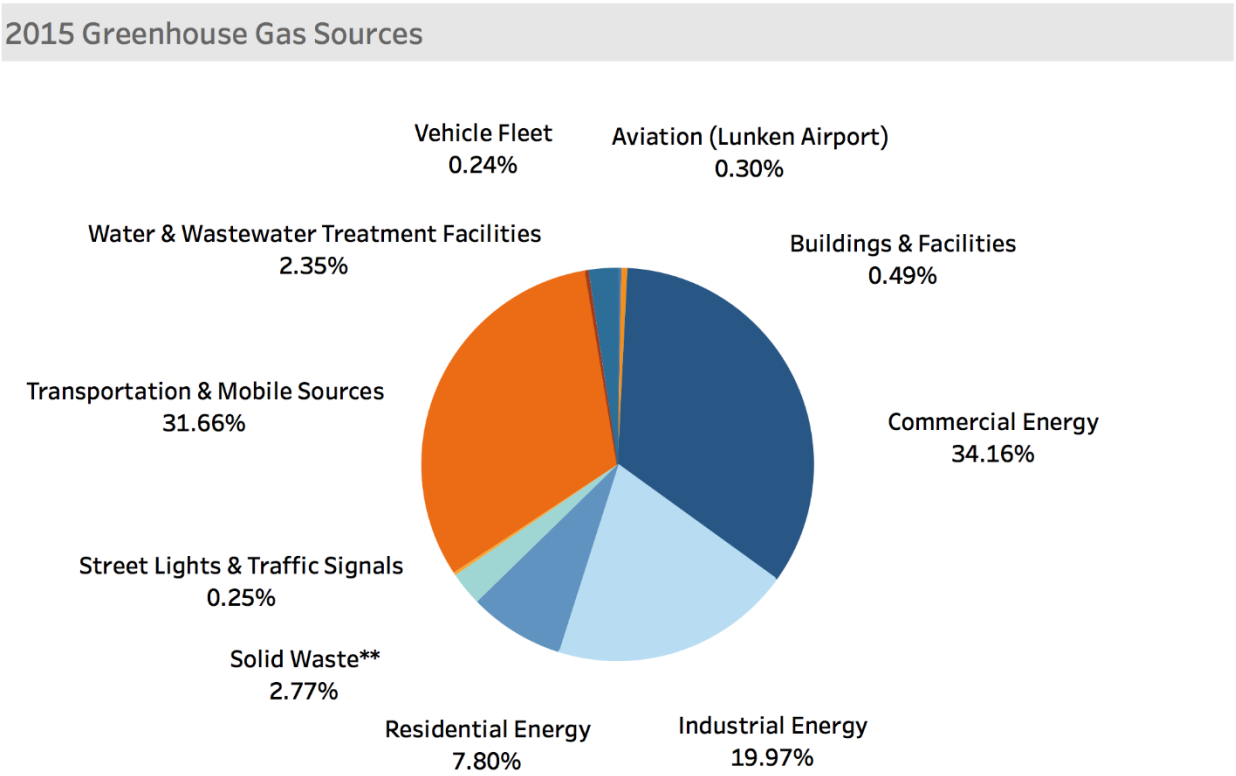
Sector	2006 mtCO2e	2015 mtCO2e	2006-2015 Change
Commercial Energy	3,449,657	2,594,101	-24.80%
Transportation & Mobile Sources	2,251,539	2,404,500	6.79%
Industrial Energy	1,324,833	1,516,458	14.46%
Residential Energy	1,571,401	592,648	-62.29%
Solid Waste**	282,458	210,348	-25.53%
Total	8,879,888	7,318,055	-17.59%

**Solid Waste totals were estimated based on Hamilton County waste totals.

2015 CITYWIDE EMISSIONS

Taken together, Government and Community emissions total approximately 7.6M tons CO_2e, representing a citywide reduction of 18.4% since the 2006 baseline was established at 9.3M tons CO_2e. Analysis shows that Community emissions comprise 96.4% of Cincinnati's emissions, while Government emissions account for 3.6%. The largest increases in emissions occurred in the industrial energy and vehicular travel sector, while the largest reductions were seen in the commercial and residential energy sectors. When comparing all emissions sources, the transportation, commercial energy, and residential energy sectors comprise over 85% of all emissions in Cincinnati, as seen in Figure 5. The relative changes seen in each sector are seen in Figure 6.

Figure 5. Cincinnati Greenhouse Gas Emissions by Sector



Significant Contributing Factors

Grid Decarbonization

From 2006 to 2015, the energy grid that powers the Cincinnati region has changed in ways that have reduced the greenhouse gas emissions generated by the power we use. While coal accounted for the generation of 86% of our regional energy in 2006, that percentage dropped to 59% in 2015. This shift is largely explained by the surge in natural gas usage, which accounted for 23% of energy in

2015, compared to 2% in 2006.[9] Together, these shifts have resulted in a 10.3% reduction in GHG emissions associated with our City's grid energy use.

Population Changes

The population of City of Cincinnati declined from 332,185 in 2006 to 298,550 in 2015.[10] The direct impact of this change on our emissions profile is difficult to measure, but certainly contributes to the reduction we have seen since 2006.

100% Green Energy through Utility Aggregation

Enabled by energy deregulation, the City of Cincinnati's electric aggregation program is able to provide 100% renewable energy to participating residents and businesses. Through this program, the City purchases 405 mWh of electricity, effectively eliminating over 250,000 mt CO_2e from the atmosphere.

City Facility Energy Performance Improvements

Since 2006 the City of Cincinnati has made significant investment in energy improvements for City facilities in the form of LED lighting upgrades, HVAC enhancements, and pump and incinerator improvements made by the Metropolitan Sewer District. These improvements have collectively reduced the emissions associated with facility operations by 51%.

Commercial Energy Consumption

Commercial energy consumption saw a 24.8% reduction from 2006 to 2015. This reduction is explained by the commercial energy efficiency incentives offered by Duke Energy in the region.[11]

Waste Reduction and Landfill Diversion

Cincinnati was an early adopter of radio frequency identification (RFID) tag technology in our waste and recycling carts. The technology allows the city to better track participation in waste and recycling programs. The data collected has been used to improve our recycling outreach efforts, helping to drive a 25.3% reduction in solid waste related emissions.

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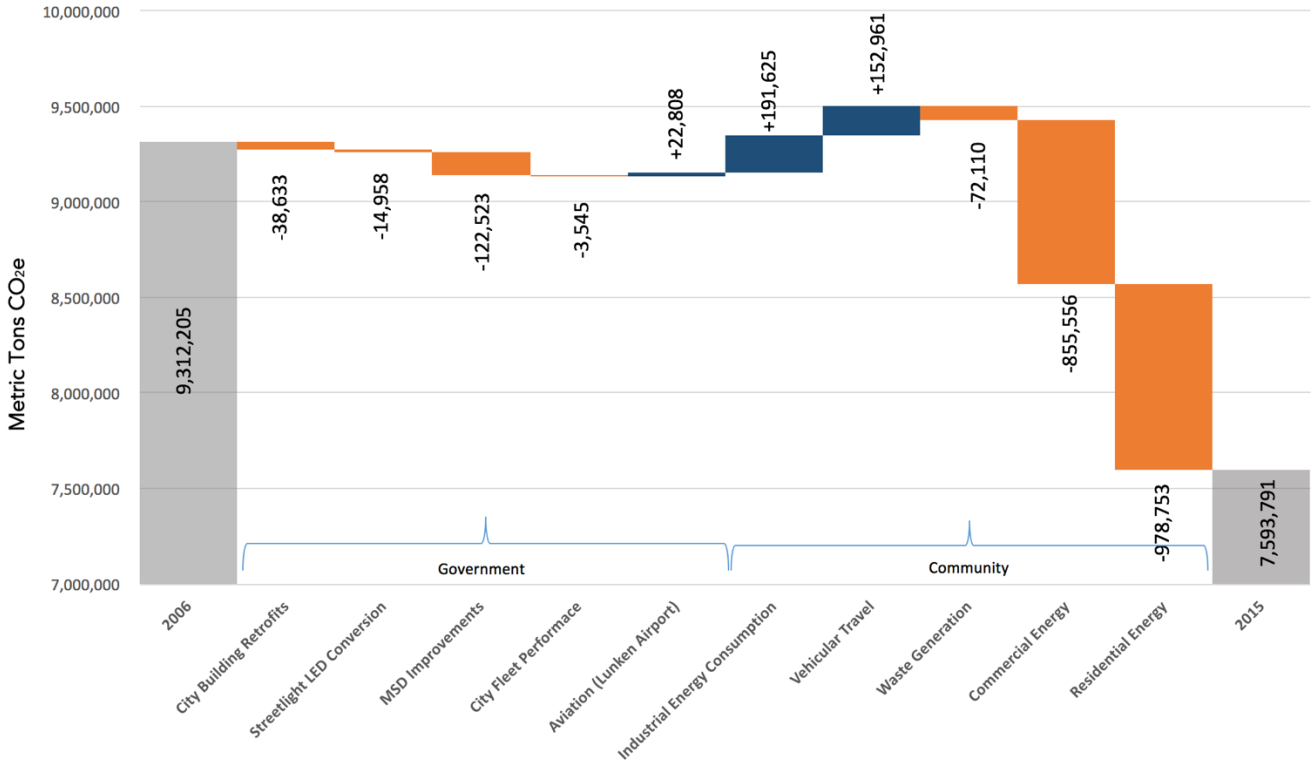
[9] https://www.puco.ohio.gov/puco/index.cfm/be-informed/consumer-topics/how-does-ohio-generate-electricity/

[10] http://www.census.gov/quickfacts/table/PST045215/3915000

[11] https://www.duke-energy.com/business

Figure 6. Changes in Cincinnati Greenhouse Gas Emissions by Sector from 2006-2015

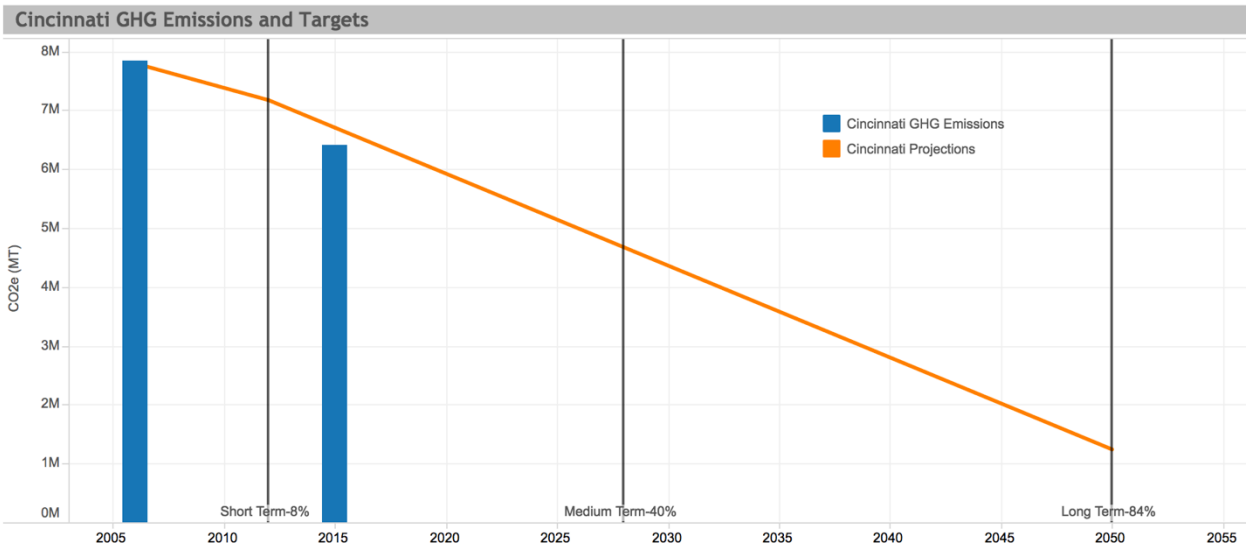


LOOKING AHEAD

From 2006 to 20015, Cincinnati achieved a city-wide 18.4% reduction in GHG emissions. Based on targets originally established in the 2008 Green Cincinnati Plan, this decrease indicates that the city has met its goal of a 2% reduction in GHG emissions per year. Cincinnati emissions since 2006, projected emissions, and target reductions can be seen in Figure 7.

The City of Cincinnati will continue to work to reduce the region's emissions through the implementation of recommendations outlined in the 2013 Green Cincinnati Plan.

Figure 7. Cincinnati Greenhouse Gas Emissions and Targets



Carbon Emission Trends. Figure 7 shows the short, medium and long term goals of the community, government and the two categories put together, which makes up Cincinnati as a whole. The target lines shows a 2% decrease each year starting in 2008 while the actual trend lines only have the 2006 and 2015 data. To be more accurate, more data points will have to be included over the years.

ACKNOWLEDGEMENTS

This report was prepared by the City of Cincinnati's Office of Environment and Sustainability (OES). OES would like to recognize the efforts of Forrest Channing Hunter and Brittany Dodson for their technical support in producing this inventory, and Nichole Henger for assistance in developing the data visualizations. Thank you to the following organizations which provided data and support in producing this inventory: City of Cincinnati, OKI Regional Council of Governments, METRO, Hamilton County Department of Environmental Services, Duke Energy.

APPENDIX

Key Sources

Electricity and Natural Gas Consumption

Industrial, Commercial, and Residential

Energy consumption for Industrial, Commercial, and Residential accounts within the zip codes of Cincinnati were provided by Michael Pahutski of Duke Energy. Zip codes straddling the border of the City of Cincinnati, were determined to be inside or outside of the City based on a 2006 evaluation of population density within the zip code.

City of Cincinnati

City of Cincinnati Energy electric and natural gas consumption were provided by Michael Forrester, Energy Manager, City of Cincinnati's Office of Environmental and Sustainability.

Grid Emissions

eGRID Data 2012 (latest version)
https://www.epa.gov/sites/production/files/2015-10/documents/egrid2012_summarytables_0.pdf

Fuel Consumption

Aviation Fuel

Aviation fuel sales at the city-owned Lunken Airport were provided by Airport Manager Fred Anderton. 50% of Lunken fuel sales were attributed to the City's emissions.

Diesel, E85, Gasoline, Propane

City of Cincinnati fleet's consumption of diesel, e85, propane and unleaded was provided by the Office of Performance and Data Analytics.

Propane consumption for the State of Ohio was reported by the US Energy Information Administration (EIA, https://www.eia.gov/). Cincinnati's consumption was estimated based on the population of Cincinnati as a proportion of the state's Ohio's population.

Vehicle Miles Travelled

Vehicle Miles Travelled (VMT) were provided for Hamilton County by OKI Regional Council of Governments. Hamilton County VMT was multiplied by a factor of .4 to account for Cincinnati's proportional responsibility.

Public Transportation

Bus travel data and fuel consumption were provided by Kim Lahman, Sustainability Manager for METRO, as captured by the National Transportation Database.

Emissions from bus transit were estimated using data from the Alternative Fuel Data Center. http://www.afdc.energy.gov/data/10310

Waste

City waste tonnage was estimated based on county waste tonnage provided by Hamilton County Solid Waste District. The composition of the city's waste stream was taken from the 2012 Hamilton County Waste Composition Study.