City of Philadelphia
Office of Sustainability

2019 Greenhouse Gas Inventory

Results and Methods

April 2022

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Overview

The City of Philadelphia is committed to equitable action on mitigating climate change and enhancing resilience. Philadelphia's climate goals include achieving carbon neutrality by 2050, which is necessary to limit global temperature rise to under 2℃ (and ideally under 1.5℃).

Philadelphia's Office of Sustainability prepared a Greenhouse Gas (GHG) Inventory for the 2019 calendar year to track progress toward these goals. This report is a summary of the 2019 GHG inventory results and the methodology used to develop it.

The inventory includes the GHGs emitted in 2019 within Philadelphia's geographic boundary, as well as emissions occurring out-of-boundary because of activities within the city. 2019 emissions are compared to the 2006 (baseline) and 2014 GHG inventories to track progress and trends.

Philadelphia's Greenhouse Gas emissions decreased by 20% from 2006-2019

Philadelphia's 2019 GHG emissions were 20.5 MMTCO_2e (million metric tons of carbon dioxide equivalent)[1], a reduction of 20% from 2006 emissions, which totaled 25.6 MMTCO_2e. Philadelphia's emissions reduction exceeded the national reduction of 13% over this period. (In 2005 U.S. emissions were more than 6,600 MMTCO_2e. In 2019, they totaled 5,769 MMTCO_2e.)[2]

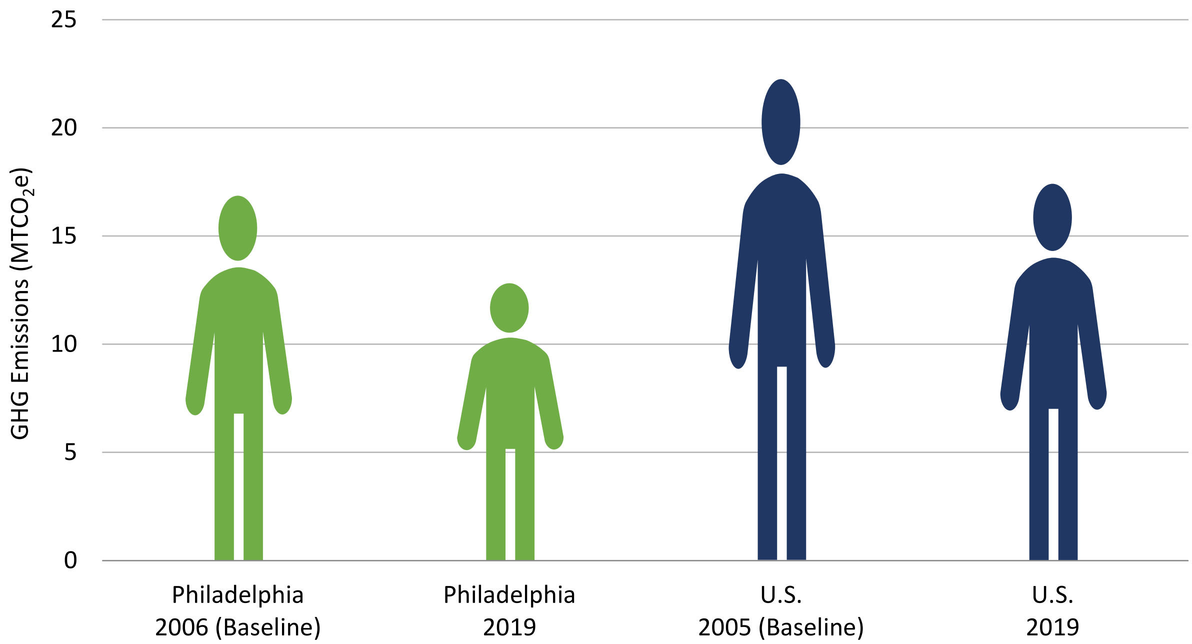
Philadelphia's 2019 per capita emissions of 13 MTCO_2e are also significantly lower than the national per capita emissions (see **Figure 1**).

Philadelphia implemented programs to reduce energy use, increase renewable energy production, reduce waste, and otherwise mitigate GHG emissions. The City launched initiatives such as Solarize Philly, C-PACE, Philadelphia's Strategic Transportation Plan - Connect, the Municipal Clean Fleet Plan, and the Philadelphia Gas Works (PGW) Diversification Study to make the city more sustainable. Philadelphia continues to expand the network of bike lanes and multi-use trails and has an increasingly energy-efficient public transportation system. Zero-waste and green space initiatives further reduce GHG emissions.

[1] MTCO_2e is the standard unit for GHG emissions. It represents the total metric tons of different greenhouse gases, weighted by the global warming potential (GWP) for each gas.

[2] Source: https://www.epa.gov/sites/default/files/2021-04/documents/us-ghg-inventory-2021-chapter-executive-summary.pdf?VersionId=K9rHAp11iIhIXEIXh9h525VQWApK09IR

Figure 1. Per Capita GHG Emissions



Philadelphia's lower per capita emissions can be attributed to dense urban development, which is generally more energy efficient than suburban areas, to Philadelphia's well-developed public transit system, efficient land use patterns, biking infrastructure, and the initiatives that Philadelphia implemented to reduce emissions. Philadelphia is also one of the most walkable cities in the country.[3]

Reaching Philadelphia's 2050 net-zero emissions goal will require expansion of existing successful programs and additional initiatives.

Modeling of reduction strategies detailed in Philadelphia's Climate Action Playbook shows that Philadelphia will require significant changes to regulations, economy, and infrastructure to meet the 2050 goal.

[3] https://www.walkscore.com/cities-and-neighborhoods/

Introduction

Philadelphia's GHG emissions reporting requirements are in accordance with the Global Protocol for Community-Scale GHG Emission Inventories (GPC, referred to as the Global Protocol in this report),[4] which is the standard for reporting local government GHG emissions inventories. The development of the Global Protocol was completed in 2014, superseding the protocols used for Philadelphia's inventories in the past.[5,6] In accordance with the Global Protocol, Philadelphia's inventories are organized by scope (Scope 1, Scope 2, and Scope 3). These scopes reflect where GHG emissions and activities generating them are occurring. The Global Protocol framework also includes reporting levels – BASIC and BASIC+, of which BASIC+ reporting is more comprehensive. For an explanation of what each scope and reporting level includes, see the **Acronyms, Abbreviations, and Definitions** list at the end of this report. The 2019 inventory and the 2006 baseline inventory for Philadelphia comply with the BASIC+ reporting standard. In addition, emissions are organized by Sector. The sectors identified in the Global Protocol and used for this inventory include:

- **Stationary Energy** – fuel and electricity use in residential and commercial buildings, manufacturing and construction, and energy industries
- **Transportation** – fuel and electricity use for commutes, travel, and transport of goods by all transportation modes (on-road, rail, waterborne, aviation)
- **Waste** (solid waste management and wastewater treatment)
- **Industrial Processes and Product Use (IPPU)** – non-energy related industrial activities that chemically or physically transform materials (e.g., iron and steel industry and manufacturing of ammonia), as well as the use of certain GHG containing products, such as refrigerants, foams, and aerosols.
- **Agriculture, Forestry, and Other Land Use (AFLOU)** – emissions associated with livestock, land use and land use change (e.g., clearing of forested), and emissions from other land practices, such as the use of fertilizers.
- **Other Scope 3** – other emissions occurring outside the geographic boundary of Philadelphia resulting from activities within Philadelphia. For this inventory **Other Scope 3** emissions include fugitive (leak) emissions of sulfur hexafluoride (SF_6) associated with transmission and distribution of electricity.

[4] GPC, https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities

[5] Philadelphia's 2006 baseline inventory, originally created using the older U.S. Community Protocol, was recently updated following the Global Protocol for consistency, allowing the City to track progress in emissions reduction.

[6] Philadelphia created a GHG inventory in 2016- with 2014 data- using GPC's BASIC reporting. The 2006 and 2019 inventories were organized using BASIC+ reporting, which accounts for a wider range of emission sources than BASIC reporting. BASIC reporting covers scope 1 and 2 emissions for stationary energy and transportation, and scope 1 and 3 emissions for waste, while BASIC+ includes transboundary transportation emissions, Industrial Processes and Product Use (IPPU), and Agriculture, Forestry, and Other Land Use (AFOLU) in addition to BASIC emissions. Thus, the BASIC emissions from the 2006, 2014, and 2019 inventories may be compared, but the total reported emissions are higher in years 2006 and 2019 due to more comprehensive reporting. Activity data such as fuel consumption is also helpful when comparing inventories and will be used to track trends in energy consumption and use.

GHG emissions are to a large extent a result of human activity. Therefore, indicators of human activity, such as population and employment are important to consider when tracking changes in emissions over time. Furthermore, it is important to consider the temperature variability when comparing GHG emissions from different years to account for differences in energy used for building heating and cooling. A good indicator of the heating and cooling needs are the heating and cooling degree days (HDD and CCD) metrics.

Table 1 and **Table 2** provide an overview of Philadelphia's key demographic and geographic indicators for 2019 and other inventory years.

Table 1. Inventory City Information

Inventory Boundary	City Information
Geographic Boundary	City of Philadelphia
Country	United States
Inventory Year	2019
Land area	348 km^2 or ~86,000 acres (excluding water)

Table 2. Demographic and Geographic Information

Year	Population	Employment	HDD	CDD
2006	1,504,950	711,418	3972 °F	1234 °F
2014	1,560,297	747,899	4776 °F	1220 °F
2019	1,584,064	790,653	4331 °F	1477 °F

Sources: United States Census Bureau, ACS Demographic and Housing Estimates for Philadelphia County, Population Estimates https://data.census.gov/cedsci/table?t=Employment&g=0500000US42101&tid=ACSDP5YSPT2010.DP03, United States Census Bureau, Selected Economic Characteristics for Philadelphia County, Population 16 and over in labor force, https://data.census.gov/cedsci/table?t=Employment&g=0500000US42101&tid=ACSDP5YSPT2010.DP03, Heating and Cooling Degree Days, Energy Star, https://portfoliomanager.energystar.gov/pm/degreeDaysCalculator

Summary of Results

Table 3 provides a summary of Philadelphia's 2019 GHG emissions by scope and sector. This summary format is consistent with the City's reporting requirements compliant with the Global Protocol.

Table 3. Summary of 2019 GHG Emissions by Scope and Sector (MMTCO$_2$e)

Sector		Scope 1 (Territorial)	Scope 2	Scope 3 Included in BASIC/BASIC+	Other Scope 3	Basic	Basic+
Stationary Energy	Energy Use	6.42	4.10	0.22	0.01		
	Energy generation supplied to the grid	IE					BASIC requirements
Transportation		3.87	0.15	4.19		**Key:**	BASIC+ requirements
Waste	Generated in the city	0.07	0.08	0.56			Other Scope 3
	Generated outside city	NO					Territorial emissions
IPPU		0.82					Non-applicable
AFOLU		-0.04				NO = Not Occurring IE = Included Elsewhere NE = Not Estimated	
Total	All territorial emissions	**11.14**	**4.33**	**4.97**	**0.01**	**15.3**	**20.5**

Note: This table format was adapted from the Global Protocol (GPC) Accounting and Reporting Standard for Cities.

Emissions calculated to the standard of BASIC+ reporting totaled approximately 20.5 MMTCO$_2$e. BASIC reporting accounted for approximately 15.3 MMTCO$_2$e of those emissions. Aviation emissions are the largest contributor to the difference between the BASIC and BASIC+ emissions included in **Table 3**.

Table 4 provides further detail of 2019 emissions by sector and subsector. The format used is compliant with the reporting standard used by the Global Protocol (GPC). The reference numbers included in the first column are used for consistent organization of inventories for cities across the globe.

Table 4. 2019 GPC Compliant GHG Inventory Snapshot

GPC Reference Number	GHG Emissions Source (By Sector and Sub-sector)	Total GHG ($MTCO_2e$) Scope 1	Scope 2	Scope 3	Total
I	**STATIONARY ENERGY**				
I.1	Residential buildings	2,081,584	1,192,715	64,097	3,338,396
I.2	Commercial and institutional buildings and facilities	1,142,769	2,911,494	156,466	4,210,729
I.3	Manufacturing industries and construction	680,555	IE	NE	680,555
I.4.1/2/3	Energy industries	2,204,929	IE	NE	2,204,929
I.8	Fugitive emissions from oil and natural gas systems	309,499			309,499
SUB-TOTAL STATIONARY ENERGY		**6,419,366**	**4,104,209**	**220,563**	**10,744,108**
II	**TRANSPORTATION**				
II.1	On-road transportation	3,823,386	114	IE	3,823,500
II.2	Railways	5,293	152,941	25,229	183,463
II.3	Waterborne navigation	20,171	NO	NO	20,171
II.4	Aviation	19,976	NO	4,163,747	4,183,723
II.5	Off-road transportation	IE	IE	NO	0
SUB-TOTAL TRANSPORTATION		**3,868,826**	**153,055**	**4,188,976**	**8,210,857**
III	**WASTE**				
III.1.1/2	Solid waste generated in the city	NO		371,879	371,879
III.2.1/2	Biological waste generated in the city	NO		NO	0
III.3.1/2	Incinerated and burned waste generated in the city	NO		184,295	184,295
III.4.1/2	Wastewater generated in the city	69,861	75,622	4,064	149,547
SUB-TOTAL WASTE		**69,861**	**75,622**	**560,238**	**705,721**
IV	**INDUSTRIAL PROCESSES and PRODUCT USES (IPPU)**	**822,129**			**822,129**
V	**AFOLU** (Emissions from land V.2)	**-43,740**			**-43,740**
VI	**Other Scope 3**			**14,621**	**14,621**
TOTAL		**11,134,412**	**4,332,886**	**4,984,398**	**20,453,696**

Emissions by Gas

This inventory includes the following greenhouse gases:[7]

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulfur hexafluoride (SF_6)

Greenhouse gases have different effects on the planetary climate. For example, methane is 25 times worse for the planet then CO_2 in the longer term (100 years) and 83 times worse than CO_2 in the shorter term (20-years). The Global Warming Potential (GWP) is a weighing factor that accounts for the difference in effectiveness of various GHGs, using CO_2 as the reference (meaning that the GWP value of CO_2 is 1). The International Panel of Climate Change (IPCC) updates the GWP values as scientific models improve and as the atmosphere changes and publishes the updates in their Annual Reports (AR). Emissions summarized in **Table 4** and throughout this report were calculated with

[7] Nitrogen Trifluoride (NF_3) is a greenhouse gas that is included in the U.S. and other inventories. NF_3 is emitted from just a few industrial processes, such as the production of liquid crystal display and solar panels. As there are no large industries of this type within Philadelphia, emissions from NF_3 are not included in this inventory.

GWP values from IPCC's fourth annual report (AR4), for the 100-year horizon (AR4-100). For comparison, summary GHG emissions data are also presented using the 20-year GWP values (from IPCC's sixth annual report – AR6-20) to address the greater short-term impact of methane. Reducing methane emissions is increasingly recognized as important and urgent. **Table 5** shows the GWP values.

Table 5. Global Warming Potential (GWP)

Gas	AR4-100	AR6-20
CO_2	1	1
CH_4	25	82.5
N_2O	298	273
SF_6	22,800	18,300
Source: https://www.ipcc.ch/reports/		

Figure 2 shows the contribution of different gases to the overall emissions.

Figure 2. 2019 GHG Emissions, Contribution by Gas

Figure 2a. Using 100-year GWP (AR4-100) ` **Figure 2b.** Using 20-year GWP (AR6-20)

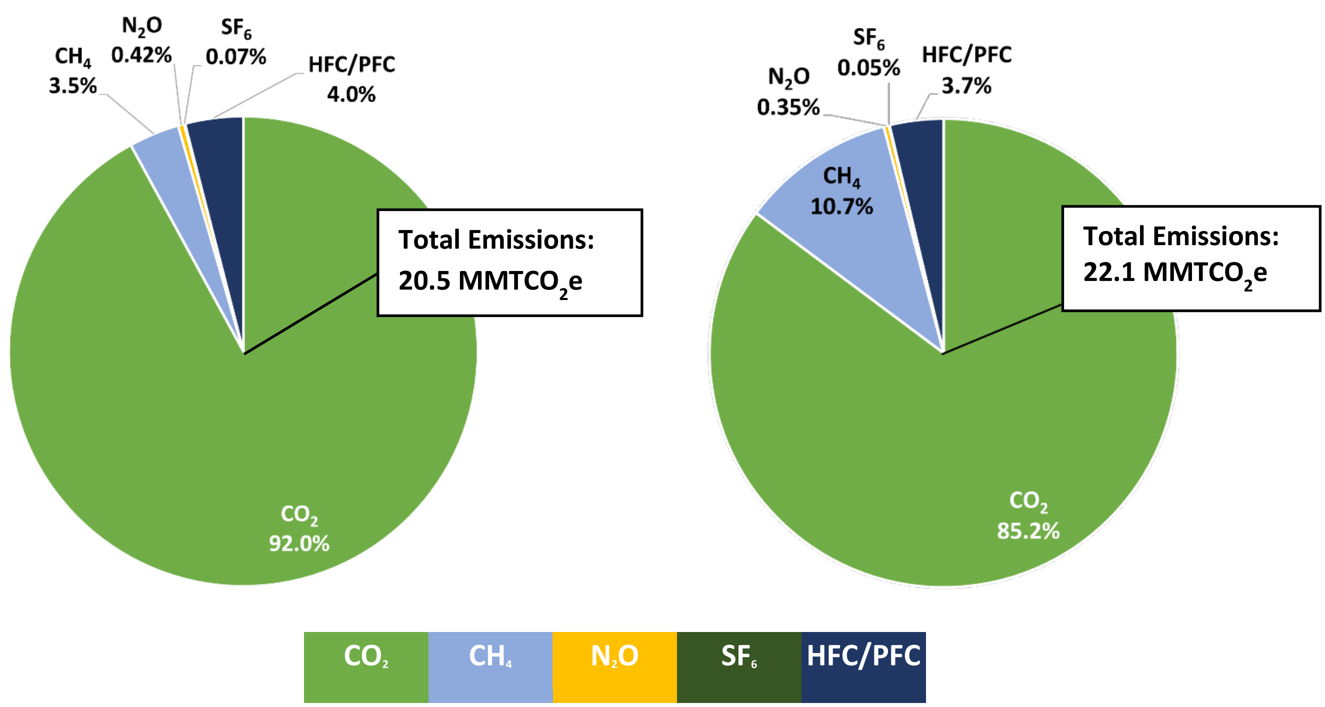


***Figure 2** shows the contributions of different gases to the overall emissions in the inventory. The figure shows that carbon dioxide (CO_2) is the predominant GHG emitted. **Figure 2a** and **Figure 2b** illustrate how the use of different Global Warming Potential (GWP) values affects the overall emissions and the contributions by gas. Using 20-year horizon GWPs (AR6-20, as shown in **Figure 2b**) results in calculated emissions that are higher than emissions calculated using the 100-year horizon GWPs (AR4, 100, as shown in **Figure 2a**). Over the shorter (20-year) time horizon, the methane (CH_4) GWP is greater and contributes more to the overall emissions (10.7% vs. 3.5%). Methane emissions included in Philadelphia's GHG inventory are primarily the result of waste decomposition in landfills and utility operational losses.*

The total emissions calculated using the 20-year horizon GWP values (from AR6-20) are **22.1 MMTCO$_2$e**, which is approximately 8% higher than the emissions of **20.5 MMTCO$_2$e** calculated using the 100-year horizon GWP values (from AR4-100).

Emissions by Scope

Table 6 summarizes 2019 GHG emissions by Scope.

Table 6. 2019 GHG Emissions by Scope

Scope	2006 GHG Emissions (MMTCO$_2$e)	2014 GHG Emissions (MMTCO$_2$e)	2019 GHG Emissions (MMTCO$_2$e)
Scope 1	12.39	12.49	11.14
Scope 2	7.38	5.58	4.33
Scope 3	5.80	0.61*	4.98
Total	**25.6**	**18.68***	**20.5**

Note: The 2014 inventory did not include all scope 3 emissions that the 2006 and 2019 inventories included. Therefore, the Scope 3 and total emissions from the 2014 inventory are not comparable with the 2019 and baseline emissions.

Emissions by Sector and Emissions Compared to Baseline GHG Inventory

Table 7 summarizes emissions by sector and by year. It also shows the percent contribution of each sector to the overall emissions (for each year) and the percent change in emissions by sector in 2019, as compared with the 2006 baseline.

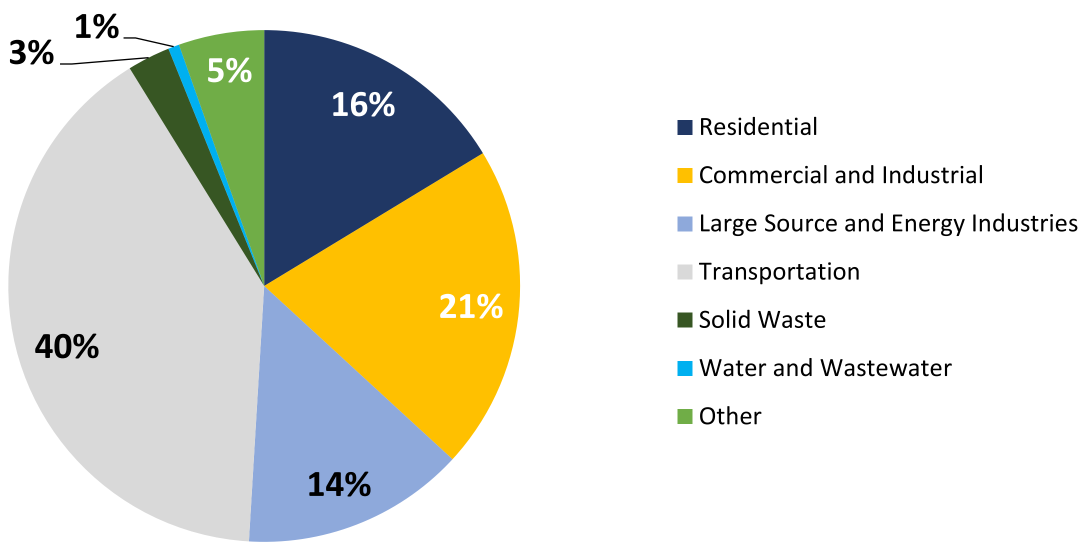
Table 7. Philadelphia City-Wide GHG Emissions by Sector

Sector	2006 Emissions (MMTCO$_2$e)	2006 Sector Contribution	2014 Emissions (MMTCO$_2$e)	2014 Sector Contribution	2019 Emissions (MMTCO$_2$e)	2019 Sector Contribution	% Emissions Change 2006-2019
Residential	4.33	16.9%	3.97	21.2%	3.34	16.3%	-22.9%
Commercial and Industrial	6.75	26.4%	6.01	32.1%	4.21	20.5%	-37.6%
Manufacturing+ Energy Industries	4.12	16.1%	3.06	16.4%	2.89	14.1%	-29.9%
Transportation*	7.92	30.9%	3.20	17.1%	8.21	40.0%	3.7%
Solid Waste	1.17	4.6%	0.61	3.3%	0.56	2.7%	-52.1%
Water and Wastewater	0.17	0.7%	0.03	0.1%	0.15	0.7%	-11.8%
Other	1.11	4.3%	1.80	9.6%	1.10	5.4%	-0.9%
Total	**25.6**	**100%**	**18.7**	**100%**	**20.5**	**100%**	**-20%**

***Note:** 2006 and 2019 transportation emissions include Scope 3 emissions from aviation and railways.

Figure 3 illustrates the contribution by sector to 2019 emissions (including Scope 1, 2, and 3). Emissions reported here for 2019 for Manufacturing and Energy Industries correspond to emissions included in **Table 4** under Global Protocol Reference Numbers 1.3 and 1.4.1/2/3.

Figure 3. Contributions to GHG Emissions by Sector, 2019



Results and Methodology by Sector

Stationary Energy

Emissions from the **Stationary Energy** sector include emissions from fuel and electricity use in residential, commercial, and institutional buildings and facilities. They also include emissions from manufacturing industries and construction, energy industries, and fugitive emissions from fossil fuel systems, such as gas leaks from distribution mains. Utilities commonly aggregate information on energy use by commercial and industrial customers. For this reason, commercial and industrial emissions are aggregated in Philadelphia's inventory. Energy use and the associated emissions from institutional buildings (e.g., libraries, court houses, museums, etc.) are also aggregated within the commercial and industrial subsector.

Residential, Commercial, and Industrial Emissions from Gas Use

Utility gas (also referred to as natural gas) is the primary fuel used for heating and cooking in Philadelphia's homes and businesses. Gas is also used to power cooling equipment, to generate electricity, and in industrial processes.

Two utilities provided information on 2019 gas consumption – Philadelphia Gas Works (PGW), Philadelphia's municipally owned gas utility, and PECO (which provides gas to a small number of

Philadelphia customers). Emissions from this energy use were calculated using U.S. Environmental Protection Agency (EPA) emission factors.[8]

Table 8 shows total gas consumption in million British Thermal Units (MMBTU) by subsector and residential gas consumption per capita for 2006, 2014, and 2019.

Table 8. Gas Consumption

Year	Residential (MMBTU)	Per Capita (MMBTU)	Commercial (MMBTU)	Industrial (MMBTU)	Total (MMBTU)
2006	34,361,453	23	27,369,851		61,731,304
2014	41,704,877	27	40,649,443		82,354,320
2019	36,560,527	23	20,372,985	7,387,716	64,321,227

Note: For 2006 and 2014, gas consumption was aggregated for commercial and industrial customers. For 2019, more detailed data is available from PGW. Industrial energy use in 2019 is summarized here for comparison of total energy used in 2006 and 2019.

PGW provided gas usage data for every year. Total consumption and consumption per capita were higher in 2014 than in 2006 and 2019. One reason for this is that the 2014 winter was colder (with more heating degree days than 2006 and 2019), resulting in more gas demand.

Table 9 shows GHG emissions for gas use by subsector for 2006, 2014, and 2019.

Table 9. Emissions from Gas Consumption

Year	Residential ($MTCO_2e$)	Commercial ($MTCO_2e$)	Industrial ($MTCO_2e$)	Total ($MTCO_2e$)
2006	1,827,163	1,455,386		3,282,550
2014	2,140,587	2,086,415		4,227,002
2019	1,941,905	1,082,107	392,397	3,416,409

Note: Industrial emissions for 2019 are summarized here for comparison with 2006 and 2014. In **Table 4**, 2019 industrial emissions from use of gas are reported under GPC Reference Number I.3 (along with other sources).

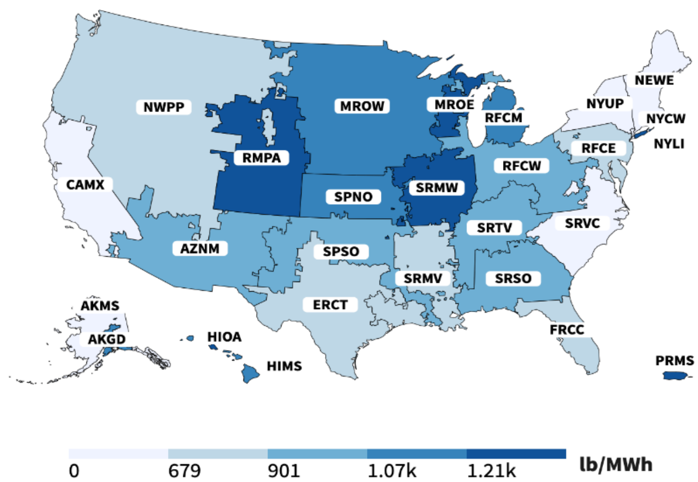
Residential, Commercial, and Industrial Emissions Associated with Electricity Use

Electricity is used in homes, businesses, institutions, and industries for lighting, cooling, and powering equipment and machinery. Electricity can also be used for heating, cooking, water heating, and for charging electric vehicles. Electricity supplied to Philadelphia customers is generated from a variety of sources, including fossil fuels. Combustion of fossil fuels produces CO_2, CH_4, and N_2O

[8] EPA, https://www.epa.gov/sites/default/files/2015-11/documents/emission-factors_2011.pdf

emissions. The shift away from coal for electricity production resulted in a significant benefit in reducing emissions from electricity use. Philadelphia is within the ReliabilityFirst Corporation East (RFCE) subregion, shown in **Figure 4.**

Figure 4. Map of Subregions and CO_2 Emission Rates, 2019



Source: EPA, eGRID, https://www.epa.gov/egrid/data-explorer.

Figure 5 shows the mix of fuels used to produce electricity in the region, based on data from the EPA.[9]

Figure 5. Source Energy Used to Produce Electricity in the Region

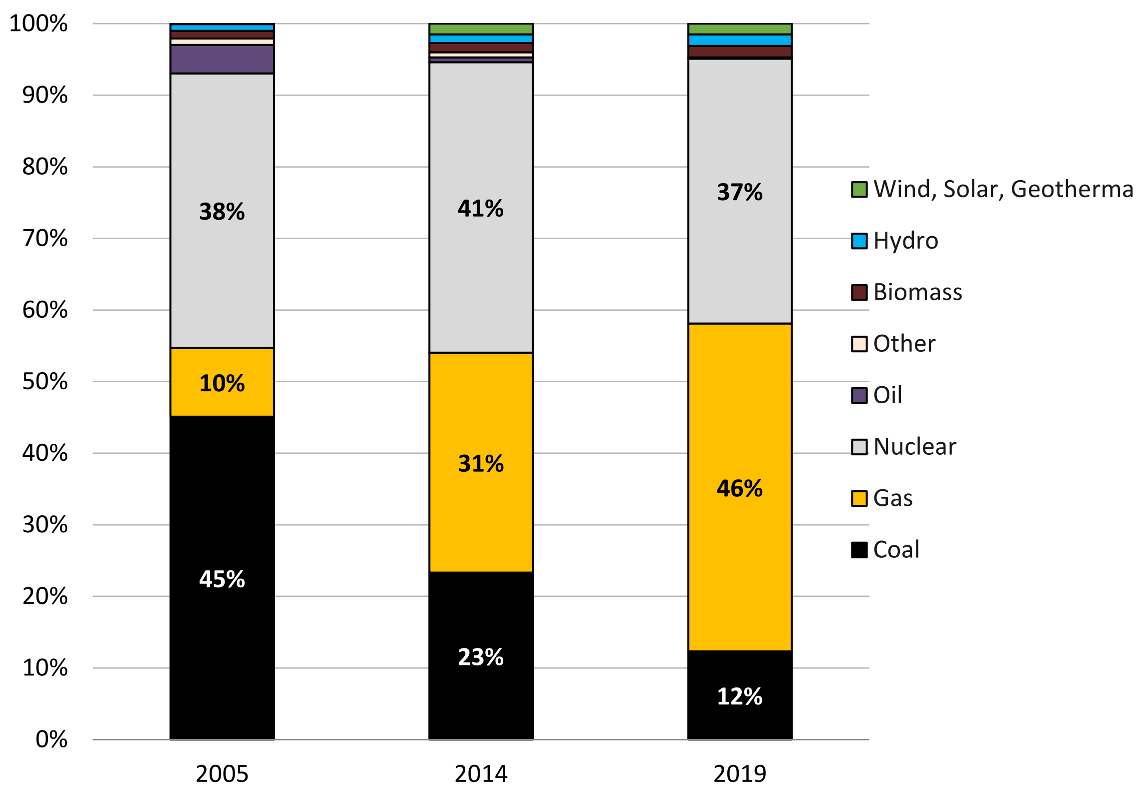


Table 10 shows the emission rates which were used to calculate emissions from electricity use in Philadelphia.

Table 10. Electricity Emission Rates

GHG	2005 Emission Rate	2014 Emission Rate	2019 Emission Rate	Emission Rate Units
CO_2	1,139.07	829.4	695.00	CO_2 lbs/MWh
CH_4	30.27	73.9	53.00	CH_4 lbs/GWh
N_2O	18.71	11.2	7.00	N_2O lbs/GWh

Source: EPA, eGRID, RFCE region https://www.epa.gov/egrid/egrid-2019-summary-tables
Note: 2006 emissions from electricity use are based on 2005 eGRID emissions rates, as EPA did not publish a 2006 eGRID summary.

Table 11 shows the electricity consumption within residential and commercial buildings and industrial facilities (total and per capita), as provided by PECO, the electricity distribution company serving Philadelphia.

Table 11. Residential, Commercial and Industrial Electricity Use

Year	Residential Electricity Use (GWh)	Residential Use Per Capita (kWh)	Commercial and Industrial Electricity Use (GWh)	Commercial and Industrial Use Per Capita (kWh)
2006	3,822	2,540	9,279	6,165
2014	3,902	2,501	9,480	6,076
2019	3,765	2,377	9,191	5,802

Table 12 shows total emissions from electricity use by residential and commercial buildings and industrial facilities.

Table 12. Emissions from Electricity Use ($MMTCO_2e$)

Subsector	2006	2014	2019
Residential	1.99	1.52	1.19
Commercial & Industrial	4.82	3.69	2.91
Total	**6.81**	**5.21**	**4.10**

Stationary electricity use and associated emissions declined in 2019, as compared with the 2006 baseline. Philadelphia's population increased by more than 5% between 2006 and 2019 and both the number of cooling degree days and heating degree days was greater in 2019 than it was in 2006 (see **Table 2**). The number of heating and cooling degree days are indicators of energy demand for heating and cooling. Although Philadelphia had more residents and greater heating and cooling demands in 2019 as compared with 2006, electricity consumption in 2019 slightly decreased, indicating that the energy efficiency improvements and energy conservation efforts may have started to have an effect.

Over the same period, emissions associated with electricity use dropped by almost 40%, mainly due to a decreased regional reliance on coal for electricity production. While less carbon intensive than coal, the use of natural gas to generate electricity results in GHG emissions that would need to be cut for Philadelphia to reach the stated climate goals.

Electricity Losses

Not all electricity produced at power plants reaches customers. Rather, 5-6% of the energy dissipates in the conductors (electric wires), transformers, and other equipment used for transmission, transformation, and distribution of power.[10] This electricity is referred to as "grid losses" or "transmission and distribution losses." The emissions associated with Philadelphia's contribution to these losses are based on the 2019 loss factor of 5.1% and the 2019 emission rates listed in **Table 8**.[11]

Table 13 shows the electricity grid losses for 2006 and 2019 by sector and subsector, along with the associated total emissions.

Table 13. Electricity Grid Losses and Grid Loss Emissions

Year	Residential (GWh)	Commercial (GWh)	Transportation (GWh)	Water & Wastewater Treatment (GWh)	Total Emissions ($MTCO_2e$)
2006	264.4	642.0	59.4	17.5	510,846
2019	202.3	493.9	26.0	12.8	232,853

Note: This table includes electricity losses associated with both stationary sources and transportation. Electricity losses in the region substantially decreased between 2006 and 2019 from a rate of 6.5% to 5.1%. Total emissions associated with electricity grid loss dropped by over 54%.
Source: Total electricity consumption by sector and subsector provided by PECO. Electricity losses and associated emissions are calculated using EPA's eGRID: https://www.epa.gov/egrid/egrid-2019-summary-tables

Emissions from Production of Steam

Philadelphia's steam system is a network of pipes (also referred to as "the Steam Loop") that carry pressurized steam. In 2019, this system was operated by Vicinity to deliver steam to buildings in and near Center City. The steam system also includes three generating facilities – Grays Ferry, Edison Street, and Schuylkill. The emissions from these facilities, summarized in **Table 14**, are included in

[10] EPA, https://www.epa.gov/egrid/egrid-questions-and-answers#egrid5aa
[11] U.S. Environmental Protection Agency (EPA), eGRID, https://www.epa.gov/egrid/egrid-2019-summary-tables

Philadelphia's inventory. The emissions are based on information obtained from the U.S. EPA Greenhouse Gas Reporting Program (GHGRP).[12,13]

Table 14. Emissions from Steam Producing Facilities

Year	Emissions ($MTCO_2e$)
2006	839,757
2014	757,217
2019	757,107

Source: U.S. EPA, Greenhouse Gas Reporting Program (GHGRP) https://www.epa.gov/ghgreporting.
Note: The 2014 inventory reported steam emissions associated with the Schuylkill and Edison Street generating facilities only. For a direct comparison with the 2006 and 2019 inventories, 2014 emissions reported here also include the Grays Ferry facility.

Emissions from Other Fuel Use in the Residential and Commercial Subsectors

Gas and electricity use are the main sources of emissions in the Residential and Commercial subsectors. Other fuels, such as fuel oil, are also used in some homes and businesses. As multiple delivery companies distribute these fuels, centralized information on non-utility fuel consumption is not available. To account for the emissions from the use of non-utility fuels, the American Community Survey[14] information (prepared by the U.S. Census Bureau) served as the basis for estimating consumption.

Table 15 summarizes the 2019 non-utility fuel use in residential and commercial buildings.

Table 15. Non-Utility Fuel Use, 2019

Fuel	Residential Fuel Use (MMBTU)	Commercial Fuel Use (MMBTU)
Distillate Fuel Oil No. 2	1,355,967	588,888
Propane	463,936	201,484
Coal or Coke	26,865	11,667
Wood	4,953	2,151
Total	**1,851,721**	**804,190**

Note: Commercial fuel use includes consumption in some institutional and industrial buildings and facilities.
Source: American Community Survey, 2019: https://data.census.gov/cedsci/

[12] U.S. Environmental Protection Agency (EPA), Greenhouse Gas Reporting Program (GHGRP) https://www.epa.gov/ghgreporting

[13] Vicinity provided activity and emissions data for their Edison Street and Schuylkill facilities, as well as information on the steam energy delivered and number of customers served. Vicinity provides electricity to the regional grid operator (PJM) and not directly to Philadelphia customers.

[14] American Community Survey https://data.census.gov/cedsci/

Table 16 shows the 2019 emissions associated with the energy use summarized in **Table 15**, calculated using EPA emission factors.[15] **Table 16** also shows non-utility fuel use and emissions for the 2006 baseline and 2014 for comparison.

Table 16. Non-Utility Fuel Use and Emissions

Year	Total Fuel Use (MMBTU)	Total Emissions ($MTCO_2e$)
2006	7,166,213	525,710
2014	3,877,154	249,454
2019	2,655,911	200,341

Total fuel use and the resulting emissions decreased significantly between inventory years. This could be a result of switching from oil and other non-utility fuels to gas, as well as improvements in building energy efficiency.

Residential, Commercial, and Industrial Building and Facility Energy Use Summary

To meet GHG reduction goals, efforts are under way to electrify transportation and buildings (e.g., to enable the use of electricity for heating). It is therefore important to track the use of gas, electricity, steam, and other fuels in buildings, as well as to prepare for the increases in electricity demand over time. To meet GHG reduction goals, it will be important to ensure that the electrification effort does not outpace the transition to renewable electricity. **Table 17** summarizes the total GHG emissions from residential, commercial, and industrial subsector energy use.

Table 17. GHG Emissions from Energy Use in Buildings and Facilities, 2019

Fuel	Residential ($MTCO_2e$)	Commercial & Industrial ($MTCO_2e$)	Total ($MTCO_2e$)
Gas	1,941,905	1,474,504	3,416,409
Electricity	1,192,715	2,911,494	4,104,209
Electricity Losses	64,097	156,466	220,563
Steam	25,212	720,917	757,107*
Other Fuels (oil, kerosene, LPG, gasoline)	139,679	60,662	200,341
Total	**3,363,609**	**5,324,043**	**8,698,630***

*__Note__: The total steam emissions reported here also include emissions (10,978 $MTCO_2e$) from steam supplied to the transportation sector. The steam emissions are reported here to provide information on emissions attributable primarily to building energy needs. In **Table 4**, emissions associated with steam production are not included under GPC Reference Numbers I.1 or I.2. The emissions are instead reported under Reference Number I.4.1/2/3 (Energy Industries). Since the steam production facilities also co-generate electricity, emissions associated with both use and production of that electricity are included in the inventory. This potential double counting could not be eliminated with the available information.

[15] EPA, https://www.epa.gov/climateleadership/ghg-emission-factors-hub

Figure 6 illustrates the contribution of residential and non-residential buildings to energy use emissions.

Figure 6. 2019 GHG Emissions by Subsector

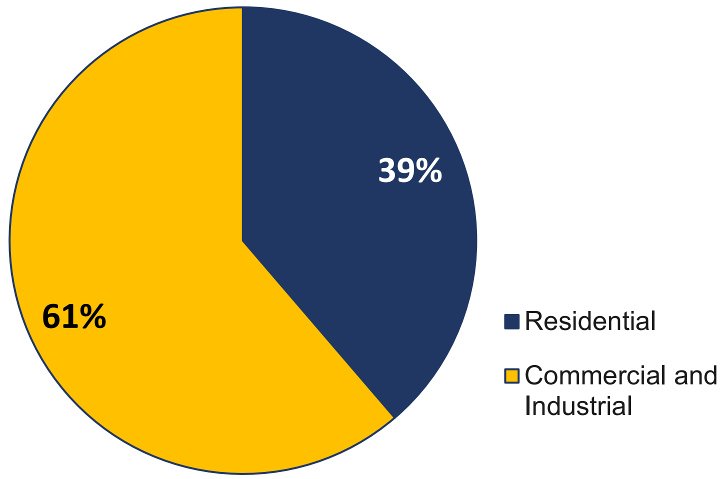
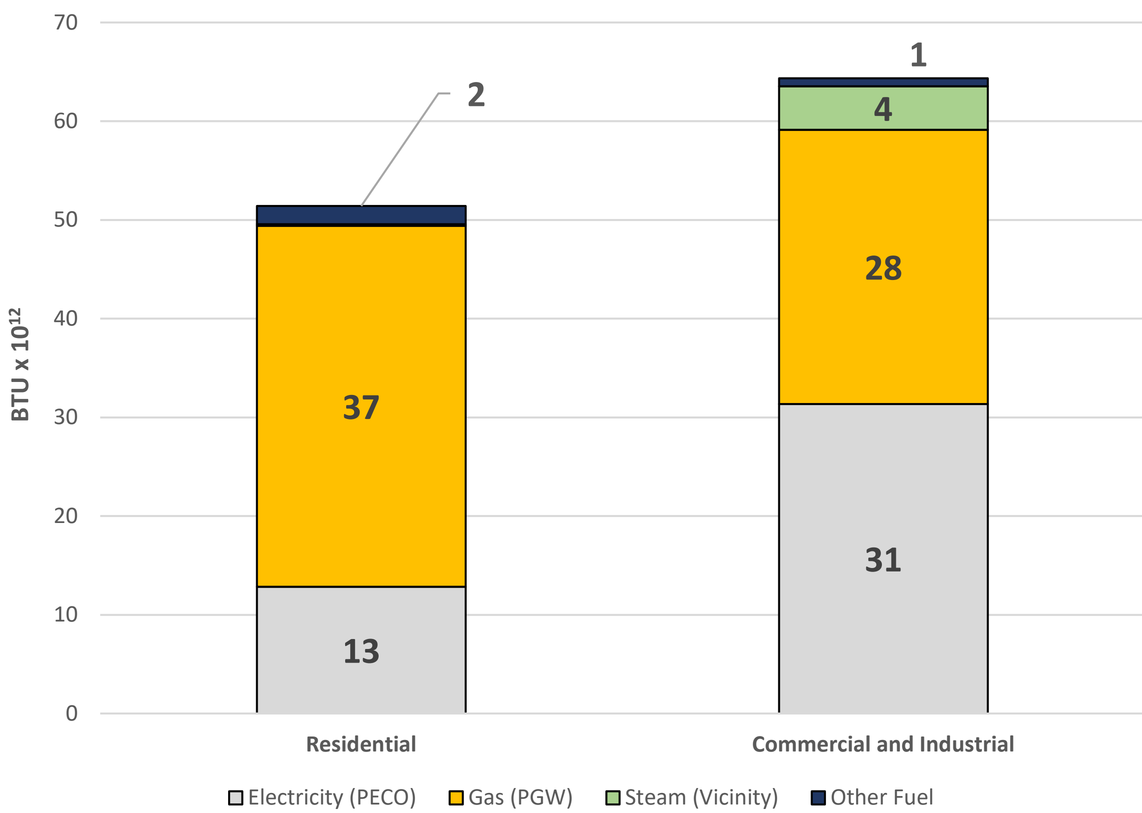


Figure 7 shows the contribution of the various energy sources to the energy used in residential and non-residential buildings and facilities.

Figure 7. 2019 Energy Use in Buildings



Emissions from Large Industrial and Commercial/Institutional Sources

Table 18 summarizes the emissions from large and industrial sources, including energy production facilities. The emissions sources include the Philadelphia Refinery, steam loop, energy facilities serving a university campus and a hospital campus, and other manufacturing and energy production sources. All of these sources report emissions to the U.S. EPA annually. In **Table 4**, these emissions are included under Reference Numbers I.3 and I.4. Emissions under Reference Number I.3 also include emissions from gas use in the industrial sector (reported in **Table 9**).

Table 18. Large Source GHG Emissions 2006-2019

Year	Total Emissions ($MTCO_2e$)
2006	4,116,042
2014	3,821,607
2019	2,493,087
Note: Total emissions are based on the emissions from large sources within Philadelphia included in U.S. EPA's GHGRP database.	

Large source emissions decreased significantly in 2019, primarily due to the Philadelphia Refinery shutting down halfway through the calendar year. The refinery was a major emitter of GHGs in Philadelphia, and the dramatic reduction of emissions following its closure will also improve air quality in the area.

Gas Losses

Leaks from gas pipelines and other gas system losses release methane into the atmosphere, producing the so called "fugitive emissions." Leaks often begin as pipes crack due to age and from shifting through freeze-thaw cycles. **Table 19** shows the emissions from these losses in 2019, as well as for 2014 and the 2006 baseline, illustrating a steady decrease in emissions over the years.[16] Improving gas infrastructure (pipes and transmission meters) reduces pipeline loss, leading to a reduction in emissions.

Table 19. GHG Emissions from Gas System Losses (Fugitive Emissions)

Year	GHG Emissions ($MTCO_2e$)
2006	600,225
2014	479,598
2019	309,499

[16] PGW provided an estimate of the 2019 annual gas losses (approximately 765 million cubic feet). Emissions were calculated assuming that gas is 85% methane and a methane density of 0.042 lbs per cubic foot (per EPA's AP-42).

Transportation

The transportation sector includes on-road vehicles (e.g., cars, trucks, and buses), non-road vehicles and equipment (e.g., construction equipment, lawnmowers, golf carts), commuter and regional passenger rail, freight rail, waterborne navigation, and aviation.

On-road

Table 20 shows the motor vehicle miles traveled (VMT) attributable to Philadelphia and the associated GHG emissions, as provided by the Delaware Valley Regional Planning Commission (DVRPC).[17]

Table 20. Estimated VMT and Emissions for On-road Vehicles

Year	Cars and Trucks Vehicle Miles Traveled (VMT)	Emissions ($MTCO_2e$)
2006	5,955,491,110	3,303,724
2014	5,585,588,070	2,921,428
2019	7,348,444,421	3,696,421

Source: Delaware Valley Regional Planning Commission (DVRPC)

In 2019, light-duty vehicles (passenger cars and vans) accounted for 68% of on-road vehicle emissions summarized in **Table 19**, while trucks and buses contributed 32%. Vehicle use and vehicle emissions have increased as compared with the baseline, both in Philadelphia and nation-wide[18]. In Philadelphia, 2019 VMT was 23% greater than the 2006 baseline, while the associated GHG emissions were approximately 12% greater in 2019. The emissions increase was not proportional to the VMT increase, likely due to improvements in vehicle fuel efficiency.

The vehicle miles and emissions summarized in **Table 20** do not include transit buses. To account for those emissions, SEPTA provided data on fuel and electricity used in 2019 for buses and other SEPTA on-road vehicles. Total 2019 on-road emissions, including SEPTA, were approximately 3.8 $MMTCO_2e$.

Railways

SEPTA provided information on electricity used for trolleys, subways, and rail in 2019.. Philadelphia's GHG inventory also includes emissions associated with trips on Amtrak, originating or destined to Philadelphia. The 2019 emissions estimate is based on the annual Amtrak ridership for Philadelphia (total of 4.51 million passenger trips),[19] the estimated average trip length (114

[17] DVRPC used the EPA MOVES model to calculate emissions. DVRPC used a combined emissions factor from MOVES, which accounts for a mix of gasoline and diesel use by various vehicle types (e.g., cars, vans, and various size trucks).

[18] U.S. Department of Energy, https://afdc.energy.gov/data/10315

[19] PennDOT, Pennsylvania State Rail Plan, March 2021. https://www.penndot.gov/Doing-Business/RailFreightAndPorts/Planning/Documents/2020 Pennsylvania State Rail Plan/2020 Pennsylvania State Rail Plan.pdf (In accordance with protocols, 50 percent of the total trips originating from and destined to Philadelphia were allocated to Philadelphia.)

miles),[20] information on Amtrak's electricity use per passenger mile,[21] and the emission rates summarized in **Table 10**.

Table 21 shows the electricity used for passenger rail and the associated GHG emissions.

Table 21. Passenger Rail Electricity Consumption

Year	SEPTA Electricity Use (kWh)	Estimated Amtrak Electricity Use (kWh)	Total Passenger Rail Emissions ($MTCO_2e$)
2006	353,955,501	114,271,664	243,265
2014	717,724,551		279,346
2019	363,916,189	118,861,394	152,941

Note: Emissions in this table do not include transmission and distribution losses. 2014 transportation electricity use is combined for SEPTA and Amtrak.

Emissions from freight rail are based on tons of freight moved by rail in the greater Philadelphia region[22] and information on nation-wide rail freight emissions[23] scaled by tonnage. Freight rail GHG emissions were approximately 22,300 $MTCO_2e$ in 2019. Over 76% of these emissions occurs outside of the City's boundary and are therefore included under Scope 3 emissions. The emissions from freight rail decreased by approximately 12% between 2019 and the 2006 baseline, mostly because of decreased demand for coal and the consequent reduction in rail transport of coal.

Waterborne Navigation

Philadelphia's inventory includes emissions associated with the shipping of freight via Philadelphia's Port.[24] The emissions are based on the estimated amount of freight,[25] fuel use,[26] and the applicable emission factor[27] from the EPA.

[20] Based on the average of track miles for Philadelphia-New York and Philadelphia-DC, which are the most common trips on Amtrak originating or destined to Philadelphia.

[21] 1,585 BTU/passenger mile, U.S.-wide for 2019, based on the Bureau of Transportation Statistics, https://www.bts.gov/content/energy-intensity-amtrak-services

[22] Oak Ridge National Laboratory (ORNL)'s Freight Analysis Framework (FAF) database, https://www.ornl.gov/content/freight-analysis-framework

[23] EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2019, https://www.epa.gov/sites/default/files/2021-04/documents/us-ghg-inventory-2021-main-text.pdf?VersionId=yu89kg1O2qP754CdR8Qmyn4RRWc5iodZ

[24] Philadelphia's port includes area of the Delaware River, "from the lower dock at Hog Island, below the mouth of Schuylkill River, to the mouth of Poquessing Creek, the upper limit of the city, 23 miles and Schuylkill River from its mouth to Fairmount Dam, 8.4 miles," based on information from the U.S. Army Corps of Engineers Waterborne Commerce Statistics Center (WCSC).

[25] U.S. Army Corps of Engineers Waterborne Commerce Statistics Center (WCSC) provides annual data on tonnage of marine freight shipped to and from major U.S. ports for the years 2000-2019. WCSC reports tonnage by cargo type, including coal products, petroleum products, chemicals, food and farm products, and others.

[26] Philadelphia staff estimated the fuel use for marine freight in support of the original 2006 GHG inventory, following the Procedures for Emission Inventory Preparation Volume IV: Mobile Sources and Waterborne Commerce of the United States 1989. The 2006 estimated fuel use was 4 million gallons. For the 2019 inventory, the 2006 fuel use was scaled to 2019 based on tonnage shipped.

Between 2018 and 2019 alone, the total amount of freight shipped to or from the Philadelphia port decreased from 26.7 to 16.3 million tons – close to a 39% reduction. This is likely due to the closure of the Philadelphia Refinery, since shipments of petroleum products dropped from 18 million tons to under 8 million tons. Between 2006 and 2019, GHG emissions decreased by approximately 58%.

Table 22 shows the amount of freight moved through the Philadelphia Port and the associated emissions.

Table 22. Marine Freight Activity and Emissions

Year	Marine Freight (Tons)	Marine Freight GHG Emissions ($MTCO_2e$)
2006	38,597,178	47,724
2019	16,313,307	20,171
Note: The 2014 inventory did not include marine freight emissions.		

Aviation

Aviation emissions reported in **Table 23** are based on information available from the Philadelphia Airports (PHL) 2019 GHG inventory summary.[28]

Table 23. Aviation Emissions

Source	2006 GHG Emissions ($MTCO_2e$)	2019 GHG Emissions ($MTCO_2e$)
Aircraft emissions	4,059,646	4,163,747
Auxiliary Power Units	NE	6,947
Ground Support Equipment	10,640	13,029
Total Emissions	**4,070,285**	**4,183,723**

Aviation emissions increased in 2019 as compared with the 2006 baseline. This is likely due to increased aviation activity, as summarized in **Table 24**.

Table 24. Aviation Activity

Activity	2006	2019	Growth
Total Passengers	31,768,272	33,018,886	3.9%
Total Air Cargo (tons)	566,761	607,500	7.2%
Sources: https://www.phl.org/drupalbin/media/AAR1206.pdf https://www.phl.org/drupalbin/media/AAR1219.pdf			

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27 U.S. EPA, Emission Factors for GHG Inventories, https://www.epa.gov/sites/default/files/2018-03/documents/emission-factors_mar_2018_0.pdf

28 Philadelphia International Airport Greenhouse Gas Emissions Inventory https://www.phl.org/drupalbin/media/phl2016_ghgei.pdf and PHL GHG Inventory Report final 083109b Philadelphia's city-wide inventory for 2014 does not include emissions from aviation, which is a major reason why the total 2014 emissions are lower for 2014 compared with 2006 and 2019.

Off-road

Off-road emission sources include equipment and vehicles such as construction equipment, agricultural equipment, lawnmowers, golf carts, etc. Acquiring activity and emissions data for off-road vehicles is challenging, and inventories commonly exclude the emissions from these sources. In the EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks, emissions from off-road mobile sources made up a negligible percent of total emissions. Due to the smaller impact and the lack of data, off-road emissions were not estimated (NE) for any of Philadelphia's inventories.

In summary, aviation contributes to more than 50% of transportation emissions in Philadelphia. Excluding aviation, cars contribute approximately 60%, trucks contribute approximately 30%, transit (SEPTA) contributes approximately 6%, and Amtrak, freight rail, and marine subsectors contribute less than 1% each to the overall transportation emissions.

Waste and Wastewater

Philadelphia's waste is hauled outside of the city and incinerated in Waste-to-Energy (WTE) combustion facilities or brought to landfills. Information on 2019 waste disposal was sourced from the Pennsylvania Department of Environmental Protection (PADEP) Waste Management Bureau,[29] Philadelphia's Municipal Waste Management Plan (MWMP)[30], and the Philadelphia Streets Department[31]. Emissions are based on calculations within the ClearPath tool. [32]

Solid waste disposal

When organic matter decomposes in a landfill, methane is released into the atmosphere. Emissions from landfilled waste are based on total amount of waste landfilled (over 900,000 tons) and waste characterization information provided by the Streets Department. Emissions from waste landfilled in 2019 were 371,879 $MTCO_2e$.

Incineration and open burning

In 2019, Philadelphia disposed of approximately 530,000 tons of waste at Waste-to-Energy (WTE) facilities outside of the city. The resulting emissions from solid waste incineration were approximately 184,295 $MTCO_2e$.

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29 https://www.dep.pa.gov/Business/Land/Waste/SolidWaste/MunicipalWaste/Pages/MW-Disposal-Info.aspx
30 https://www.phila.gov/documents/municipal-waste-management-plan/
31 Philadelphia Streets Department data was used for waste characterization and attribution of total emissions from waste to the Commercial and Residential subsectors.
32 https://icleiusa.org/clearpath/

Based on information reported by the Streets Department and the PADEP, the amount of waste generated in Philadelphia decreased significantly between 2006 and 2019, as shown in **Figure 8.**

Figure 8. Tons of Waste Disposed by Year and Type of Waste Management

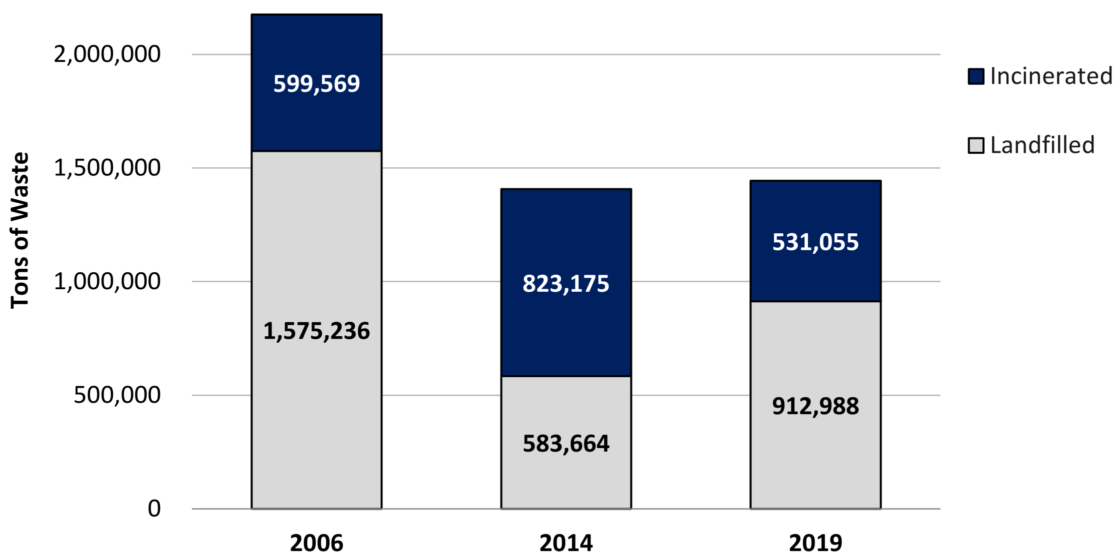
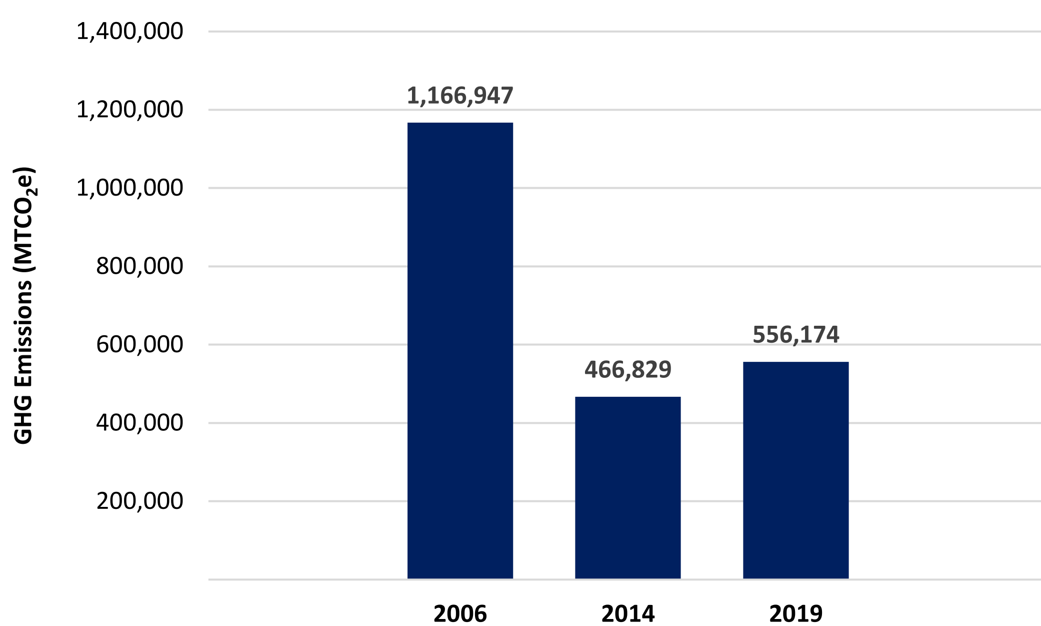


Figure 9 summarizes the GHG emissions from solid waste disposal between 2006 and 2019

Figure 9. GHG Emissions from Solid Waste



Recycling has increased, especially in the residential sector. Based on the Philadelphia's Municipal Waste Management Plan, Philadelphia residents recycled 2.6 times more waste in 2018 than they did in 2007, while recycling in the commercial sector increased by around 5% during the same period.[33]

Wastewater Treatment and Discharge

Philadelphia Water Department (PWD) operates the City's drinking water system (treating and pumping clean water to residences and businesses), as well as the wastewater (sewage) system, including three wastewater treatment plants. The emissions from energy used to operate these facilities (electricity, gas, and other fuels) are included in Philadelphia's GHG inventory. The biological treatment of waste at wastewater treatment plants produces biogas, which is approximately 68% methane and can be used as fuel. Unused (fugitive) methane emissions from the wastewater treatment process are included as process emissions in the inventory. In addition, the wastewater treatment process includes nitrogen removal, to maintain the quality of waters to which treated sewage is discharged. The beneficial removal of nitrogen from water, results in the emissions of nitrous oxide, a GHG accounted for in Philadelphia's inventory.

Emissions from energy use for water supply and wastewater treatment are based on data provided by PWD, the electricity emission rates summarized in **Table 9**, emissions from electricity losses, and applicable EPA emission factors for use of gas and other fuels. Electricity use for water supply and wastewater treatment in 2019 resulted in GHG emissions of approximately 75,000 $MTCO_2e$. Emissions from use of PGW supplied gas for energy in water and wastewater treatment operations were approximately 34,000 $MTCO_2e$. Most of this energy was used for wastewater treatment. Approximately 8% was used for drinking water supply. Emissions associated with other fuel use, including gasoline, diesel, and fuel oil, resulted in under 9,000 $MTCO_2e$.

Process emissions in 2019 were approximately 27,000 $MTCO_2e$ in 2019, calculated based on information from PWD and the GHG inventory protocol for local government operations.[34]

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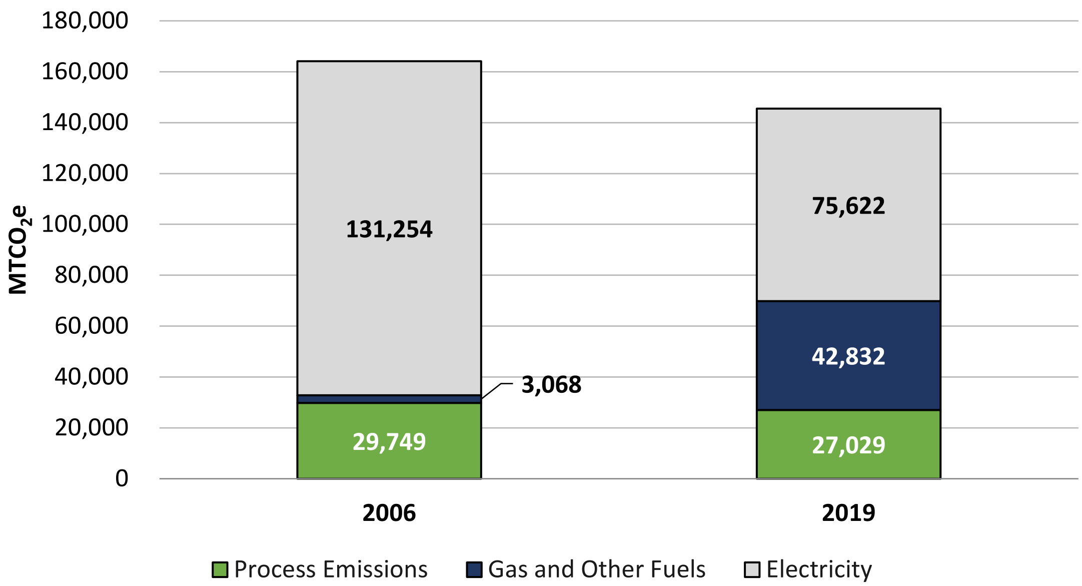
[33] City of Philadelphia, Municipal Waste Management Plan, 2020. https://www.phila.gov/documents/municipal-waste-management-plan/

[34] Process emissions are based on Equations 10.8 and 10.9 in the Local Government Operations Protocol, developed by ICLEI, The Climate Registry, Climate Action Reserve, and the California Air Resources Board. https://ww2.arb.ca.gov/local-government-operations-protocol-greenhouse-gas-assessments

Figure 10 shows the emissions from water supply and wastewater treatment by emission source.

Figure 10. Emissions from Water Supply and Wastewater Treatment



Between 2006 and 2019, GHG emissions from wastewater treatment decreased substantially. One reason for this decrease is the beneficial use of the biogas generated at the Northeast Water Pollution Control Plant to produce electricity and provide energy for the wastewater treatment process. The cogeneration plant started operations in 2013. In 2019, the plant produced more than 36,000 MWh of electricity for on-site use. Of that amount, 27,000 MWh was produced using biogas, which displaced the use of electricity from the grid, thereby avoiding more than 9,000 of $MTCO_2e$. Another initiative that led to decreased emissions from water and wastewater treatment was the installation of solar panels at the Southeast Water Pollution Control Plant. In 2019, the system generated approximately 340,000 kWh of renewable electricity, thereby avoiding approximately 113 $MTCO_2e$ that would have resulted from the use of grid electricity. Finally, emissions also decreased because of a decline in the use of coal to generate electricity supplied by the grid, as illustrated in **Figure 5**.

Industrial Processes and Product Uses (IPPU)

The **Industrial Processes and Product Uses** sector includes emissions from non-energy uses of fossil fuels, chemicals, and other substances.

Product use

The product use subsector includes emissions from the use of alternatives to Ozone-Depleting Substances (ODS). Many ozone depleting substances, found in refrigerants, aerosols, air conditioners, and other products, were phased out as part of the Clean Air Act and the Montreal

Protocol. Hydrofluorocarbons (HFCs) and Perfluorocarbons (PFCs) are often used as substitutes for these substances. These products don't have the same ozone-depleting properties as the previously used substances but do contribute to climate change. Emissions from the use of these products were calculated by scaling the national emissions of ODS substitutes[35] by population[36]. The national use of ODS substitutes increased between 2006 and 2019, which is also reflected in Philadelphia's emissions inventory.

Table 25 shows the total and per capita emission of ODS substitutes in Philadelphia.

Table 25. ODS Substitutes Emissions

Year	Emissions ($MTCO_2e$)	Emissions Per Capita ($MTCO_2e$)
2006	547,290	0.36
2019	822,129	0.52

Agriculture, Forestry and Other Land Use (AFOLU)

The inventory accounts for emission reduction benefits of Philadelphia's trees (carbon sequestration). Emissions reduced by trees are based on information on tree canopy cover from the Tree Canopy Assessment Report[37] and the U.S. Forest Service's i-Tree Canopy tool[38]. Of the City's land area of approximately 86,000 acres, 17,356 acres had tree canopy in 2018, which sequestered 78,804 $MTCO_2e$. There was a net benefit of 43,740 $MTCO_2e$ sequestered, accounting for 2008 to 2018 canopy losses.

Other agriculture, forestry, and fishing activities were not estimated (NE) in the 2006 or 2019 inventories.[39] While there are some agricultural, fishing, and forestry-related activities in Philadelphia (generally for educational purposes, community engagement, or entertainment), there are no large-scale operations within these subsectors. The resulting emissions are therefore not significant.

Other Scope 3

Sulfur hexafluoride (SF_6) is an insulator, used in circuit breakers, switches, and other electrical equipment. SF_6 is a potent GHG, with a GWP of 22,800. During transmission and distribution of electricity, some SF_6 leaks from equipment and during equipment installation, maintenance, and decommissioning. SF_6 emissions are included in the inventory under Other Scope 3.

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[35] EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2019, https://www.epa.gov/sites/default/files/2021-04/documents/us-ghg-inventory-2021-main-text.pdf?VersionId=yu89kg1O2qP754CdR8Qmyn4RRWc5iodZ

[36] United States Census Bureau, 2019 U.S. population (https://www.census.gov/newsroom/press-releases/2019/popest-nation.html).

[37] O'Neil-Dunne, Tree Canopy Assessment, Philadelphia Parks and Recreation, December 2019. https://treephilly.org/wp-content/uploads/2019/12/Tree-Canopy-Assessment-Report-Philadelphia-2018.pdf

[38] USDA Forest Service, i-Tree tools for assessing and managing forests and community trees, https://www.itreetools.org/. This resource includes information on the annual amount of carbon dioxide sequestered per acre of urban tree cover in the U.S.

[39] The 2014 inventory did not include AFOLU sector emissions (marked as not estimated — NE).

Philadelphia's 2019 SF_6 were estimated by scaling the nationwide loss of SF_6 reported in the 2019 U.S. GHG Inventory[40] by the 2019 electricity use.[41,42] **Table 26** shows estimated SF_6 emissions for Philadelphia from 2006 to 2019. SF_6 emissions have decreased drastically due to industry improvements facilitated by the EPA.[43]

Table 26. SF_6 Emissions

Year	SF_6 ($MTCO_2e$)
2006	47,169
2014	33,141
2019	14,621

Summary

Philadelphia achieved a 20% reduction in Greenhouse Gas emissions from 2006 to 2019. The main reasons for the reduction include:

- Decrease in coal use in generating electricity in the region
- Closure of Philadelphia's refinery
- Building energy efficiency improvements
- Public transit emission reductions
- Decrease in waste and wastewater emissions

Sustainability projects that did not directly lead to emissions decrease helped to counter increases that otherwise would have occurred. For example, improvements to bike infrastructure led to increases in bike commutes to work, which offset some of the growth in the use of cars and increased emissions from freight deliveries.

Reaching net zero emissions will require the expansion of current programs as well as additional efforts. Greenhouse gasses will be tracked and reported regularly per GCOM and C40 protocol. Climate action can provide the opportunity to reach GHG reduction goals while increasing social equity, creating jobs, and improving infrastructure. Net zero can only be achieved through ambitious and bold climate action, and Philadelphia intends to pursue this in a way that prioritizes the communities most burdened by pollution, most burdened by energy and transportation costs, as well

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40 EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2019, Table 4-108, https://www.epa.gov/sites/default/files/2021-04/documents/us-ghg-inventory-2021-main-text.pdf?VersionId=yu89kg1O2qP754CdR8Qmyn4RRWc5iodZ

41 EPA, eGRID Summary Tables 2019, https://www.epa.gov/sites/default/files/2021-02/documents/egrid2019_summary_tables.pdf

42 The 2019 SF_6 loss factor was calculated to be approximately 1.01 $MTCO_2e$ per GWh (using AR4-100 GWP). The factor was applied to the total of approximately 14,050 gigawatt hours (GWh) of electricity used in Philadelphia in 2019. The same methodology was used in the 2006 inventory. For the 2014 inventory, the estimate SF_6 losses were provided by PECO.

43 U.S. EPA, Overview of SF6 Emissions Sources and Reduction Options in Electric Power Systems (epa.gov)

as the communities most vulnerable to climate change, while benefiting the future wellbeing of all citizens.

Methodology Summary

Stationary Energy

- PGW and PECO provided data on gas consumption (**primary data**). PGW also provided data on pipeline losses. Emission factors are from EPA's "Emission Factors for Greenhouse Gas Inventories" (2018).
- PECO provided data on electricity consumption in buildings (**primary data**). Total emissions, as well as grid losses, are based on emissions rates and loss factor from the EPA's eGRID database.
- Philadelphia Steam Loop emissions are based on 2019 data from the EPA's Greenhouse Gas Reporting Program (GHGRP) (**secondary data**). The company that operates the Steam Loop, Vicinity Energy, supplied primary data used in analysis of energy use by subsector.
- Large source and industrial emissions are also based on EPA's GHGRP data (**secondary data**). Emissions from large energy production facilities (including the Refinery and the Steam Loop) were separated from other entries for categorization and reporting purposes.
- Emissions from the use of non-utility fuels in buildings are based on American Community Survey (ACS) data on home heating fuel (**secondary data**).

Transportation

- DVRPC provided on-road VMT estimates and emissions (**primary data**).
- SEPTA provided **primary data** on electricity usage and fuel consumption for its fleet, which includes buses, trolleys, subways, trains, customized community transportation (CCT), and City Non-Revenue vehicles.
- Emissions from marine freight shipments are based on data from the Army Corps of Engineers on freight tonnage and archived data from the City of Philadelphia on fuel use for marine freight (**secondary data**).
- Emissions from rail freight shipments are based on tonnage data from the FHWA's Freight Analysis Framework database and an emissions factor derived from the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990–2019 (**secondary data**).
- Emissions from Amtrak are based on ridership data from Amtrak's 2019 Ridership Report, data from the 2020 Pennsylvania State Rail Plan, and an emissions factor from the Bureau of Transportation Statistics (**secondary data**).
- Emissions from aviation activities are based on the 2019 Greenhouse Gas inventory for the Philadelphia International Airport (PHL) (**secondary data**).

Waste and Wastewater

- Emissions from solid waste are based on solid waste disposal data from the PADEP Waste Receipts and from the Philadelphia Streets Department (**primary data**).
- Wastewater emissions are based on **primary data** from the Philadelphia Water Department. (PWD).

Other

- Emissions from changes in canopy are based on data from Tree Philly's Canopy Assessment and emissions factors the U.S. Forest Service's i-Tree website (**secondary data**)
- Emissions from the use of ODS Substitutes are based on data from the Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2019 (**secondary data**), scaled by population
- SF_6 emissions are estimated from nationwide SF_6 emissions (from the U.S. Inventory of U.S. Greenhouse Gas Emissions and Sinks, 1990-2019) by scaling to electricity consumption (**secondary data**)

Acronyms, Abbreviations, and Definitions

AFOLU: Abbreviation of Agriculture, Forestry, and Other Land Use; an emissions sector.

BASIC and BASIC+ reporting: The Global Protocol for Community-Scale GHG Emission Inventories (GPC) provides a framework for attributing emissions to a municipality. BASIC+ is a higher standard of reporting, and accounts for more Scope 3 emissions than BASIC reporting. It requires municipalities to calculate IPPU and AFOLU emissions.

GHG: Greenhouse Gases. GHGs trap heat in the atmosphere, causing a greenhouse effect that increases global temperatures. GHGs that should be reported under GPC protocol, when applicable, are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3).

GHGRP: Through the Greenhouse Gas Reporting Program (GHGRP), EPA collects and reports greenhouse gas emissions from large sources at the facility-level.

GPC: The Global Protocol for Community-Scale Greenhouse Gas Emission Inventories: Accounting and Reporting Standard for Cities. This GHG Protocol was developed by the World Resources Institute, C40, and ICLEI. Protocols provide guidance for determining which emissions to attribute to a city, and how to measure, categorize, and report emissions data.

GWP: Global Warming Potential. GWP is a measure of the relative effectiveness of a gas to affect the planetary climate, with carbon dioxide (CO_2) as the reference. GWPs account for the lifetime and radiative forcing of the gas over a set period of time (e.g., 20 years, 50 years, 100 years). Radiative forcing is a measure of the influence a gas has in altering the balance of incoming and outgoing energy in the atmosphere. There are 20-year GWPs that reflect short-term warming effects, and 100-year GWPs that predict long-term warming. GWP values are updated as scientific models improve and as the atmosphere changes. The GWP value of CO_2 is 1. Other gases have varying values depending on their potency as greenhouse gases as compared with CO_2.

ICLEI: ICLEI- Local Governments for Sustainability is an international NGO (non-governmental organization) that provides sustainability tools and consulting for cities and local governments, with a particular focus on climate mitigation and adaptation strategies.

IPPU: Industrial Processes and Product Use; an emissions sector.

IPCC: The Intergovernmental Panel on Climate Change is the United Nation's body on climate change research. The panel releases assessment reports with leading climate science data.

IPCC's AR4: IPCC's Fourth Assessment Report, released in 2007. While many recent inventories used GWP values from the Second Assessment Report (SAR), emissions in current inventories are calculated with AR4 GWP values.

IPCC's AR6: IPCC's Sixth Assessment Report, the first part of which was released in 2021. The report contains technical information on 'The Physical Science Basis' of climate change.

ODS substitutes: Ozone-depleting substances used in aerosols, foams, refrigerants, and more were phased out by amendments to the Clean Air Act and the Montreal Protocol. The substances used to replace these often contain HFCs and PFCs, which are not harmful to the ozone, but do have significant global warming effects.

MOVES: U.S. EPA's Motor Vehicle Emission Simulator is an emission model used to develop emission factors and emission from on-road and non-road vehicles. Engine, brake wear, and tire wear emission factors for various vehicle types, based on the fuel type (e.g., gasoline, diesel, or natural gas), meteorological conditions, vehicle speeds, vehicle age, roadway type and grade, number of starts per day, engine soak time, and various other factors that influence emissions, such as inspection maintenance programs are included in the model.

MTCO$_2$e: Metric Tons of Carbon Dioxide equivalent is a unit representing total metric tons of different greenhouse gases, weighted by the global warming potential (GWP) for each gas. This is achieved by multiplying the quantity of each GHG emitted by its GWP and summing up the results.

Scopes: Following the Global Protocol, emissions are grouped into three different **Scopes**, depending on where the activities that generate those emissions occur and where the emissions occur. **Scope 1** emissions result from sources located within the city boundary. Examples of **Scope 1** emissions include emissions from fuel used for home heating and cooking (primarily natural gas), emissions from gasoline and diesel-fueled vehicle use within city boundaries, and emissions from industries located within the city boundary. **Scope 2** emissions result from the use of energy produced regionally but used within the city boundary. Generally, **Scope 2** emissions result from the use of grid-supplied electricity, heat, or steam (e.g., for lighting, heating, and cooling). **Scope 3** emissions are generated outside the city boundary because of activities taking place within the city. Examples of **Scope 3** emissions include waste generated within the city but disposed of or managed outside of the city and emissions from flights arriving at and leaving Philadelphia.

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2019 Greenhouse Gas Inventory
Results and Methods