2017 CITY OF COLUMBUS GREENHOUSE GAS INVENTORY

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Introduction

The City of Columbus recognizes the impact of climate change on the economic well-being of the region and quality of life for residents. As a member of the Global Covenant of Mayors, the City of Columbus is actively engaged in mitigating and adapting to the effects of climate change. Per the requirements of the Global Covenant of Mayors, Columbus has committed to inventorying its annual greenhouse gas emissions, setting targets for future year emissions, and creating a climate action and adaptation plan. The City of Columbus asked the Mid-Ohio Regional Planning Commission (MORPC), whose staff has extensive experience in the energy sector and developing GHG inventories, to complete the 2017 city operations and community wide greenhouse gas (GHG) inventory.

2017 Greenhouse Gas Inventory

Greenhouse Gas Inventory Tool

The 2017 GHG inventory was conducted using the ICLEI-USA ClearPath[1] tool. A comparison of the merits of two potential tools is presented in Appendix A. As ClearPath was used for all previous City of Columbus GHG inventories, using it for the 2017 inventory maintains consistency and also allows for the continued use of inventories based on data gathered from the community rather than based on more general models and assumptions. ClearPath includes separate tracks for a government operations and community wide GHG inventories. Results from each track are presented in following sections.

Greenhouse Gases

As is common practice in greenhouse gas inventories and due to the constraints of the ClearPath tool, only these greenhouse gases are included in City of Columbus inventories:

- Carbon Dioxide (CO_2)
- Methane (CH_4)
- Nitrous Oxide (N_2O)

These three gases are used to calculate a total carbon dioxide equivalent (CO_2e) value for City of Columbus emissions. In order to do so, ClearPath uses Global Warming Potential (GWP) factors for both methane and nitrous oxide. The GWP allows for the non-CO_2 gases to be presented in common terms that indicates the relative strength of their greenhouse effect in the atmosphere. ClearPath utilizes GWPs presented in Assessment Reports from the Intergovernmental Panel on Climate Change (IPCC). The GWPs are updated in each new Assessment Report from the IPCC. GWPs from the 2nd Assessment Report were used for the 2005 government operations inventory. Both government and community inventories from 2013-2017 used GWPs from the 4th

[1] http://icleiusa.org/clearpath/

Assessment Report. New GWPs are available in the 5th Assessment Report and the utility of updating the 2017 and all previous inventories to the new GWPs can be assessed.

Sectors Included

The following sectors are included in the 2017 GHG inventories:

Sectors – Government Operations Inventory
Buildings and Facilities – Electricity Use
Buildings and Facilities – Natural Gas Use
Street Lights and Traffic Signals – Electricity Use
Vehicle Fleet – On Road Fuel Use
Vehicle Fleet – Off Road Fuel Use
Solid Waste Facilities – Refuse Collection
Water and Wastewater Treatment Facilities – Electricity Use
Water and Wastewater Treatment Facilities – Natural Gas Use
Water and Wastewater Treatment Facilities – Combustion of Digester Gas
Water and Wastewater Treatment Facilities – Flaring of Digester Gas

Sectors – Community Wide Inventory
Residential Energy – Electricity Use
Residential Energy – Natural Gas Use
Commercial and Industrial Energy – Electricity Use
Commercial and Industrial Energy – Natural Gas Use
Transportation – On Road Fuel Use
Transportation – Off Road Fuel Use
Transportation – Public Transit Fuel Use
Transportation – Aviation Fuel Use
Transportation – Rail Fuel Use
Water and Wastewater Treatment Facilities – Electricity Use
Water and Wastewater Treatment Facilities – Natural Gas Use
Water and Wastewater Treatment Facilities – Combustion of Digester Gas
Water and Wastewater Treatment Facilities – Flaring of Digester Gas
Municipal Solid Waste
Biological Treatment of biosolids
Biological Treatment of yard waste and woody material
Fugitive Emissions from Natural Gas Distribution

There are several differences in the data and methodology used for the 2017 community inventory compared to previous inventories:

- Transportation and Mobile Sources (Rail Transportation): An estimate of emissions from freight rail activity within the City of Columbus is provided based on 2015 national Class I freight rail diesel fuel use (https://www.bts.gov/bts-publications/freight-facts-and-figures/freight-facts-figures-2017-chapter-6-safety-energy-and) scaled by City of Columbus population versus United States population. Inclusion of an estimate of railway emissions is required for compliance with BASIC reporting methods under the

GPC. Use of higher quality data for railway emissions estimation is recommended in future inventories (see below).

- Wastewater Treatment Plants: Higher quality data is available for estimation of emissions from combustion and flaring of digester gas from the Southerly and Jackson Pike wastewater treatment plants for 2017. Instead of relying on estimates of emissions based on the population served by the plants, measured rates of daily volumetric gas production, gas composition (percent methane) and heat content of the gas are used yielding more accurate emissions estimates.
- Fugitive Emissions from Natural Gas Distribution: An estimate of fugitive emissions from natural gas distribution is included based on overall annual community natural gas use and a default value of 0.3% (three-tenths of one percent) obtained from EDF User Guide for Natural Gas Leakage Rate Modeling Tool[2].

There are also several differences in the data and methodology used for the 2017 government operations inventory compared to previous inventories:

- Vehicle Fleet: Emissions contribution from the combustion of biodiesel by the City fleet is included.
- Buildings and Facilities and Street Lights and Traffic Signals: Purchased Renewable Energy Credits (RECs) are not included in accounting for emissions from electricity use at facilities or for lighting though the kilowatt-hour offset due to RECs will be presented for reporting to the CDP.

In future year inventory development, several modifications can be made to improve the accuracy and usefulness of the inventory:

- Community, New Construction Impacts: As a rapidly developing urban region, emissions from new construction are of interest in Columbus. Emissions associated with new construction can be tracked through the production and use of materials, fuel used for off-road construction equipment and land use change: (SCOPES HERE?)
    - Materials, production: Cement production is a significant source of greenhouse gas emissions. There are no cement production facilities within city boundaries so there are no Scope 1 emissions to report for Columbus. A scope 3 consumption-based approach can be used. Regional level activity data[3] on the use of cement can be scaled by population within Columbus city boundaries.
    - Stationary off-road equipment fuel use (e.g. augers, cement mixers): The Federal Highway Administration provides annual estimates of non-highway gasoline used in multiple sectors, including construction for each state[4]. This data can be scaled by population within Columbus city boundaries. A survey of local construction companies on fuel use by stationary off-road equipment can also provide this data. This emissions source would be categorized under Scope 1.
    - Land-use change: The Global Protocol for Community-Scale Greenhouse Gas Emission Inventories[5] provides a simple approach of multiplying the carbon stock

[2] https://www.edf.org/sites/default/files/US-Natural-Gas-Leakage-Model-User-Guide.pdf
[3] http://www.cement.org/docs/default-source/market-economics-pdfs/2018-fact-sheets/oh-statefacsht-18.pdf?sfvrsn=ec1ee0bf_2
[4] https://www.fhwa.dot.gov/policyinformation/statistics/2016/pdf/mf24.pdf
[5] http://www.iclei.org/fileadmin/user_upload/ICLEI_WS/Documents/Climate/GPC_12-8-14_1_.pdf

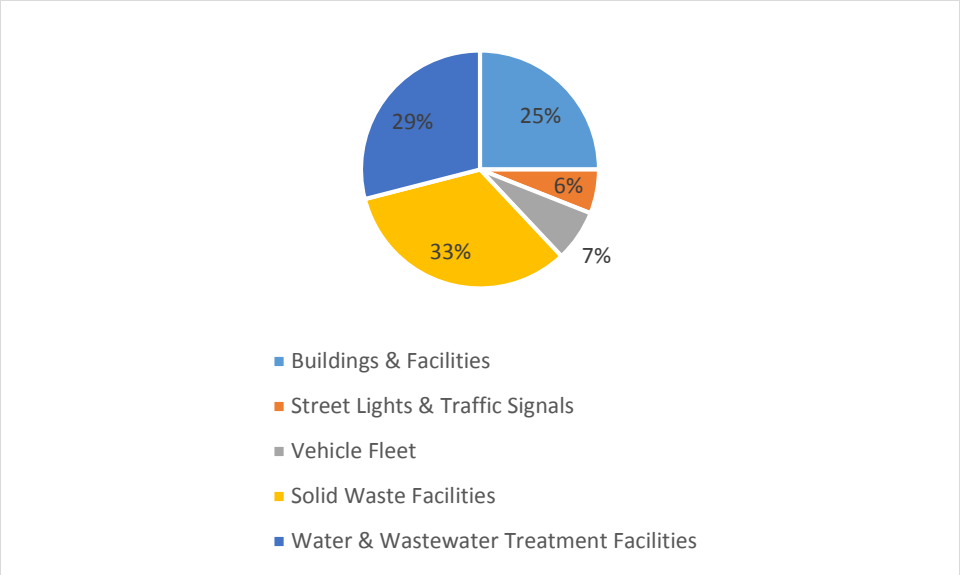
change cue to land use change by the surface area of converted land. Data on land-use type before and after conversion and the surface area of converted land is required for this method. Either land zoning or remote sensing data can be used for these purposes. The City of Columbus This emissions source would be categorized under Scope 1.

- Community, Transportation and Mobile Sources (Rail Transportation): Higher quality data can be collected for estimation of emissions from rail activity within the city. The GPC recommends the following means of collecting rail data:
    - Cities should obtain fuel consumption data from the railway operator(s) by fuel types and by application (e.g., transit system, freight, etc.) for the distance covered within the city boundary (scope 1) and the lines' extension outside the city (see scope 3).
    - Where detailed activity data are unavailable, cities can also: (see GPC, pg. 79 for further recommendations)
- Community, Transportation and Mobile Sources (Off Road): An estimation of fuel use by airport ground support vehicles and equipment is not currently included.
- Government Operations, Employee Commute: While employee commutes in non-city owned vehicles are considered Scope 3 emissions and are not required to be reported, this is a source of emissions that a city can influence through programs promoting alternative means of commuting (carpools, public transit, telecommute and flex schedule options, etc.). Tracking this source of emissions is beneficial for considering the impacts of such programs and assessing the impact of implemented programs.

2017 Government Operations Emissions

Sector relative emissions contributions

Emissions are relative to the fuel being consumed directly, the primary fuel mix of the electricity consumed, and the processes that occur during operations. Despite a lower energy use intensity and minimal, if any, emission byproducts of operations, City-owned buildings and facilities are responsible for a large portion of emissions from City government operations (25%). However, when viewed together, solid waste and water servicing account for more than half of the emissions produced by City government operations: 33% and 29%, respectively. In addition to the higher energy use intensities of both of these operations, each produces emissions as a byproduct of their processes. As City of Columbus Fleets are primarily reliant on gasoline and diesel as fuel sources, fleet vehicles accounted for 7% of emissions from government operations. Streetlights and traffic signals accounted for the remaining 6% of total City government operation emissions.



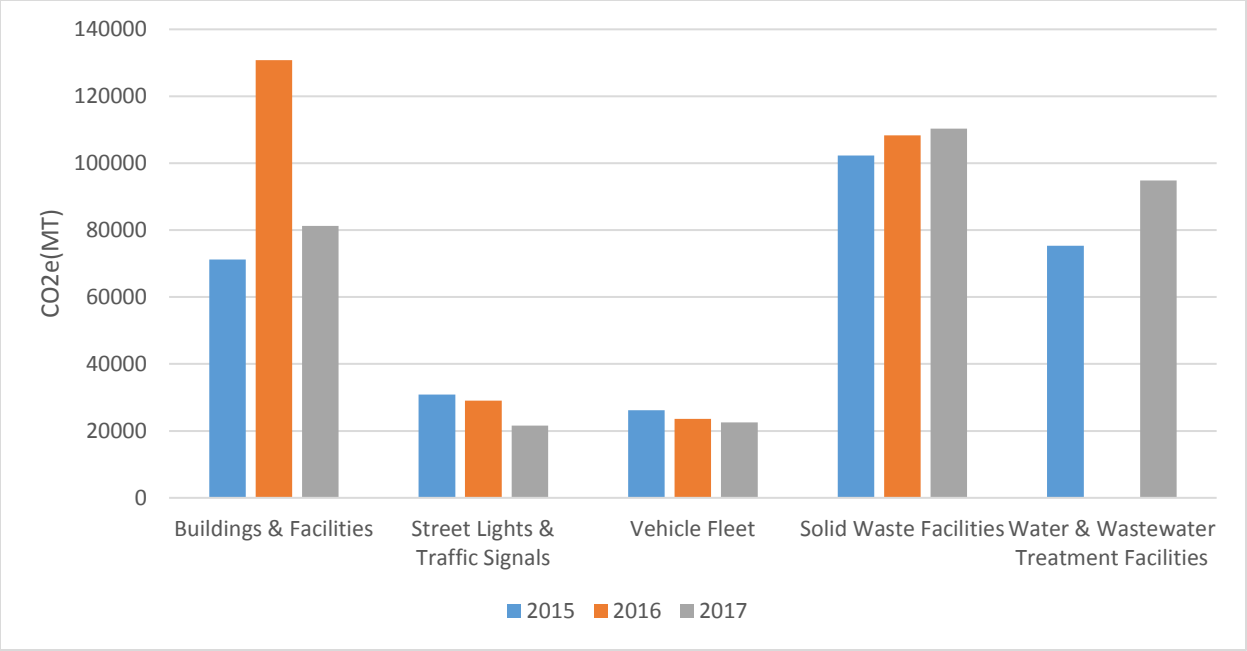
Sector emissions contributions between 2017, 2016, 2015

Compared to 2015 levels, emissions from City-owned building and facilities increased. From 2015 to 2017, this sector experienced a 14% increase in emissions. The methodological change of not including RECS as an emissions reduction is a cause for a portion of this increase. Increases in population and tax-base also require and make possible the expansion of services, which would increase the overall emissions from buildings and facilities. The causes of this trend should be investigated and include audits to better understand the energy use intensity of City-owned and operated buildings.

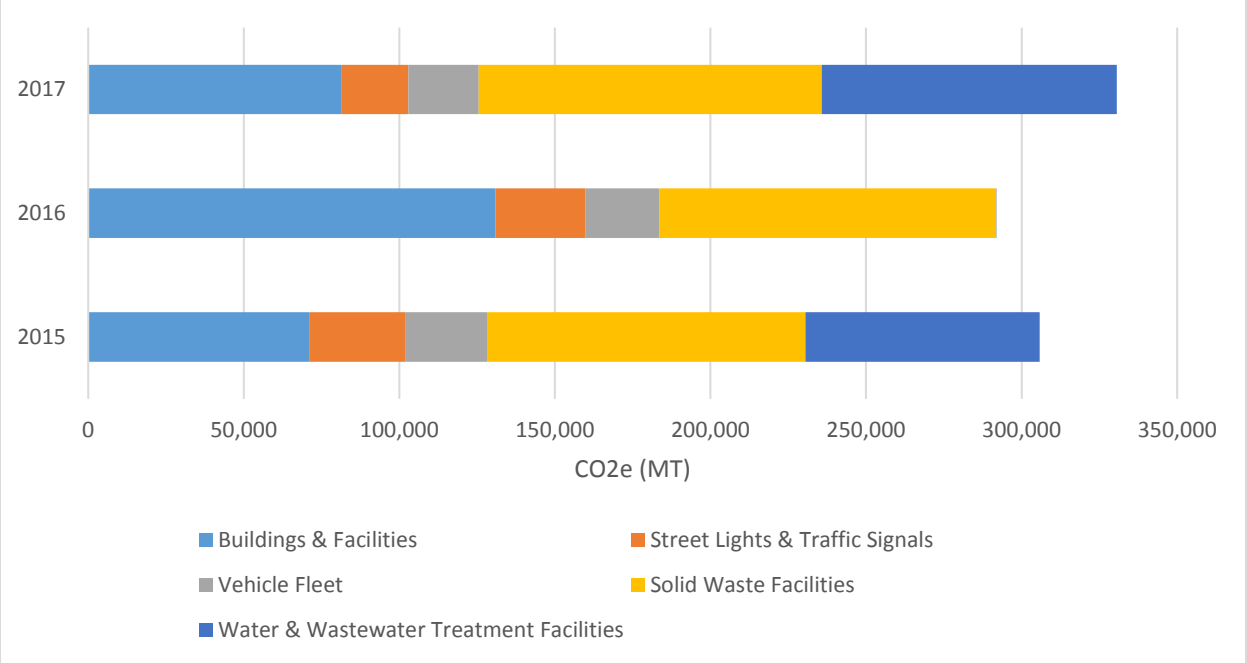
Emissions resulting from streetlight and traffic signal operations have decreased for the second year in a row (-6% from 2015 to 2016, and -26% from 2016 to 2017). LED retrofit programs are responsible for a portion of this decrease, and continued implementation of these programs would likely show similar benefits in subsequent years.

City fleet operations have also experienced a reduction in emissions over the last two years (-10% from 2015 to 2016, and -4% from 2016 to 2017). Although this reduction should be investigated further in order to realize future reductions, it can be assumed that this is a result of the efficient management of fuel consumption, and increase in the overall efficiency of the fleet, as well as a shift towards alternative fuel vehicles.

Solid waste facilities have shown an increase in emissions of 6% from 2015 to 2016, and 2% from 2016 to 2017. This increase is likely due to an increase in population, operation size and services. The same is likely for water and wastewater treatment. Although electricity and natural gas use data at treatment plants was not included in the Water and Wastewater Treatment Facilities category for the 2016 inventory, a linear trend between 2015 and 2017 would show a 13% increase in emissions in 2016 and an 11% increase in emissions from 2016 to 2017. The results should be investigated further.



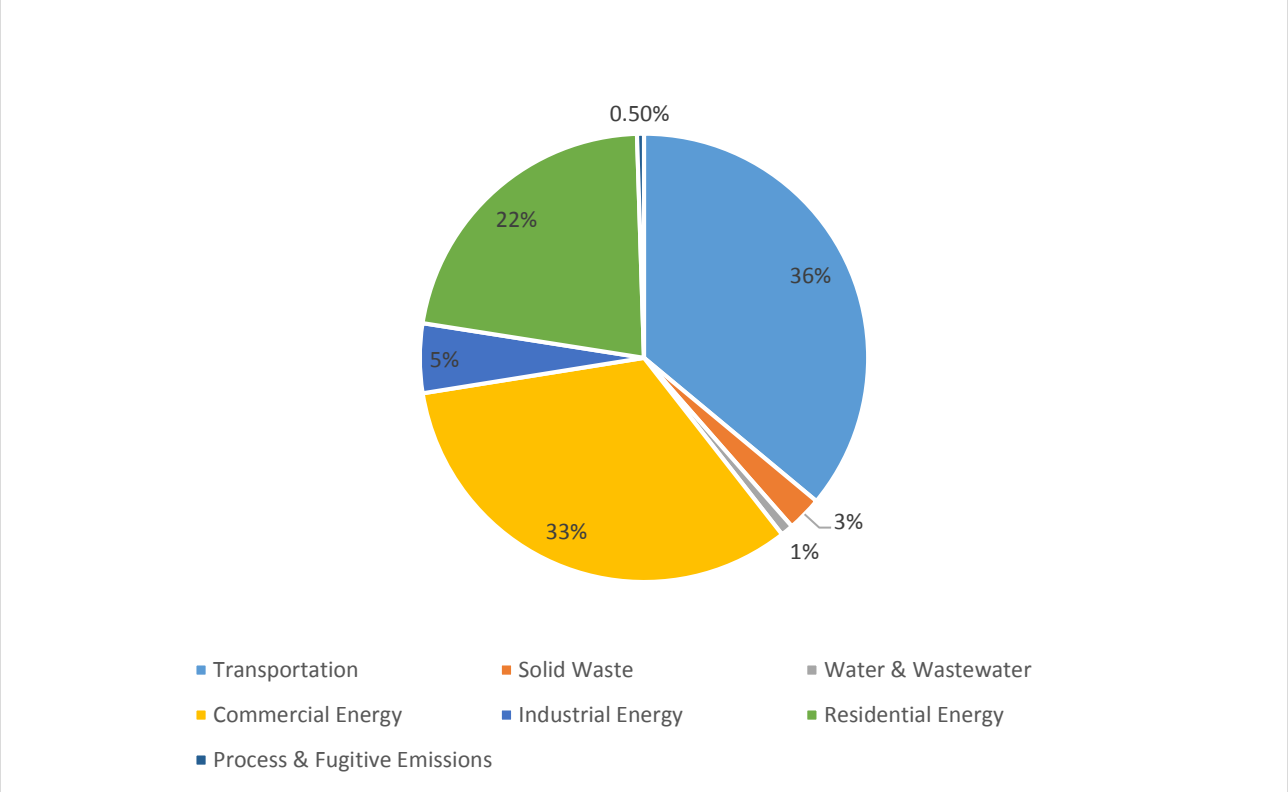
Note - Emissions from energy use at Waste and Wastewater Treatment Facilities is included in Buildings and Facilities in 2016



2017 Community Wide Emissions

Sector relative emissions contributions

The transportation sector accounted for the greatest portion of emissions on a community-wide basis. Although 2017 census data is not available for the City of Columbus at this time, it can be assumed based on historical data that roughly 80% of people commute via single-occupancy vehicles[6]. As population increases, so do commute times due to increased congestion. Whereas vehicle efficiency is increasing due to increased standards and the adoption of fuel-efficient and alternative fuel vehicles, it is not expected to offset the increase in vehicles on the road. As is typical of similar-sized cities in the United States, commercial and residential sectors make up the next two largest contributors to emissions in the City of Columbus (30% and 23%, respectively). The industrial sector accounts for 6% of total emissions in 2017, which is in line with its contribution to the City's economic activity. Solid waste and water services make up 4% of emissions, with the final 0.5% being accounted for by process and fugitive emissions.



Sector emissions contributions between 2017, 2016 and 2015

In 2017, the transportation sector overtook commercial to be the largest source of emissions on a City-wide basis. With a 9% increase from 2016 to 2017, transportation accounted for 38% of City-wide emissions, while commercial energy decreased from a 36% share of total emissions in 2016, to a 33% share in 2017. This decrease in the emissions resulting from commercial energy may be a

[6] https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF

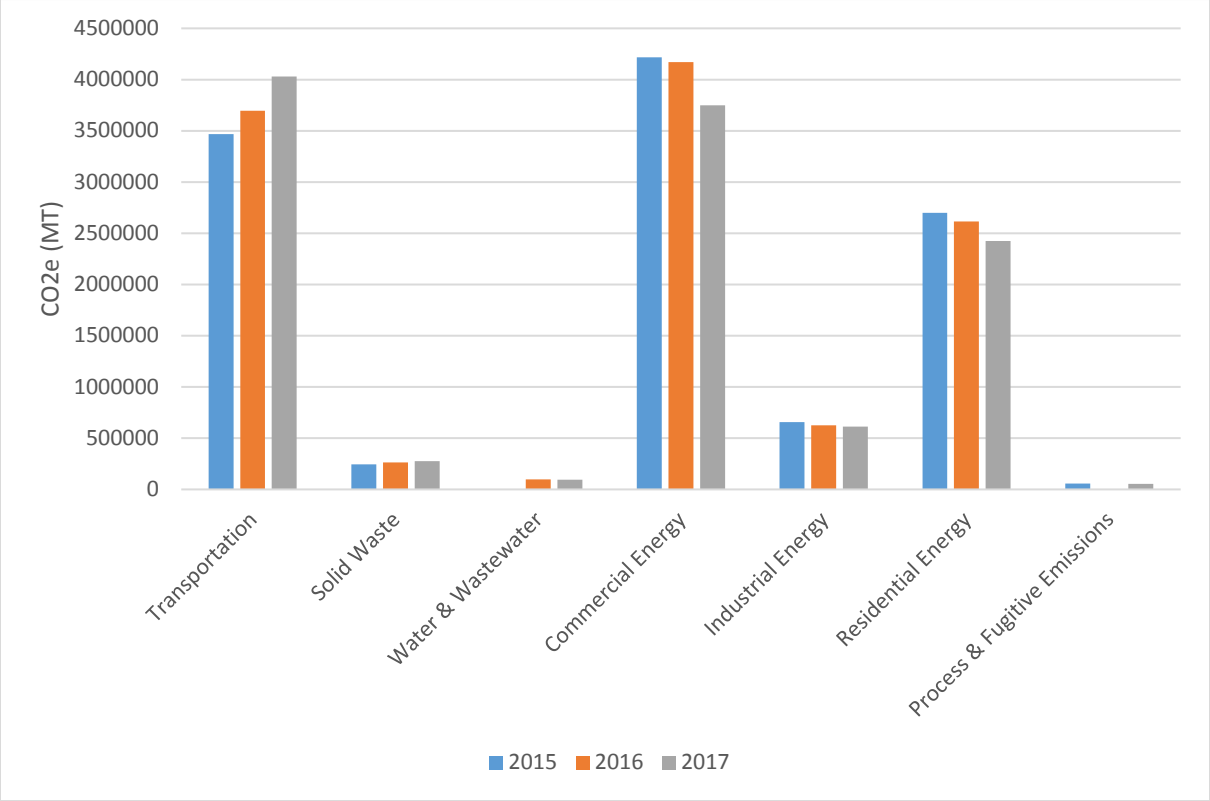
result of changes in the generation mix for electricity, a result of energy efficiency measures, fewer accounts, changes in the City's economic profile, or perhaps a blend of some or all of these. Further investigation is warranted both to ensure accuracy of the data and to encourage similar activities if the reduction can be associated to them.

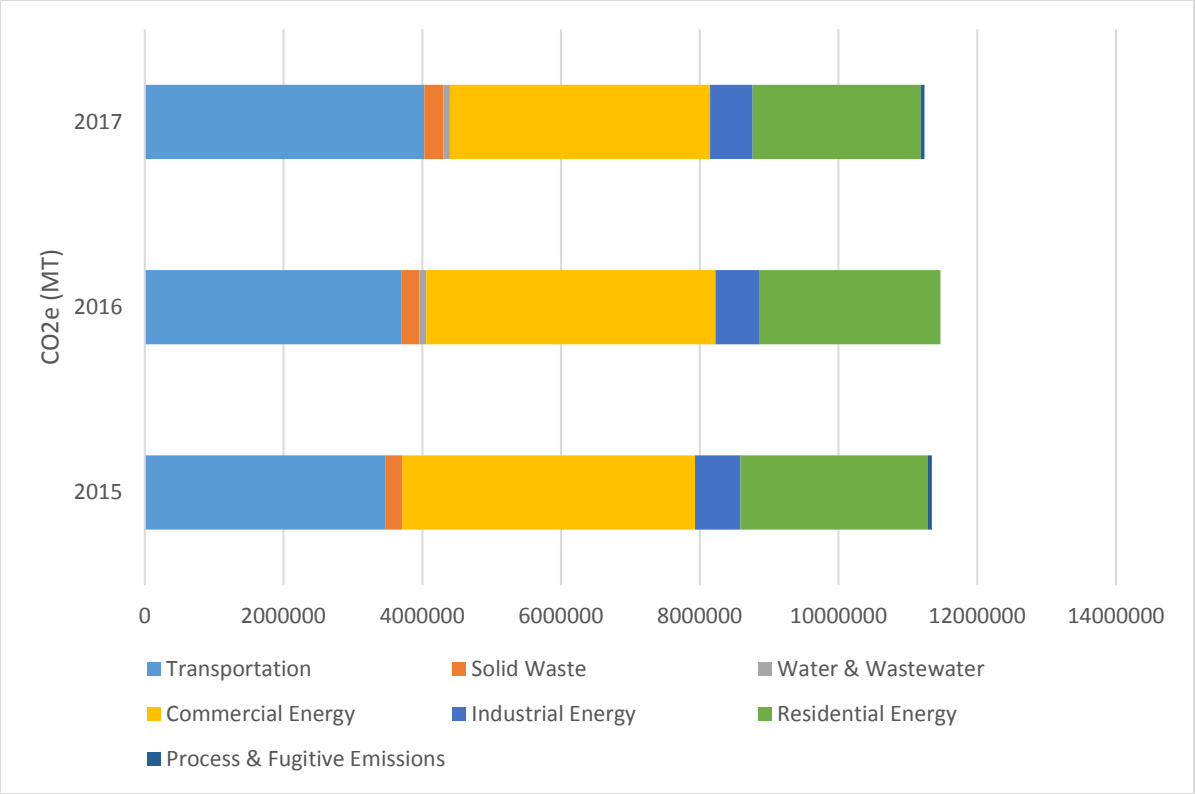
Emissions from solid waste operations is growing, but at nearly half the rate that it did from 2015 to 2016. Consistently it accounts for just over 2% of the City's total emissions. Water and Wastewater operations similarly account for less than 1% of the City's total emissions. A minor decrease is shown from 2016 to 2017.

Industrial energy and processes emissions are 2% lower in 2017 than in 2016. This sector's share of total emissions has remained relatively constant over the last two inventories.

The residential sector provides another potential success story for the City of Columbus. Emissions have decreased 3% from 2015 to 2016, and another 7% from 2016 to 2017. Since an increase in the number of households is expected when 2017 data is released, this reduction is most likely a result of greater efficiency in new homes and appliances, as well as a change in the generation mix for electricity.

Fugitive emissions were not included in the 2016 report. Calculated as a function of the emissions from other sectors, it would not be expected to fluctuate greatly as a proportion of total emissions.





2017 CDP Reporting Guidance

6.0 Do you have an emissions inventory for your local government operations to report?

Yes

6.1 Please state the dates of the accounting year or 12-month period for which you are reporting an emissions inventory for your local government operations.

January 1, 2017 – December 31, 2017

6.7 Please provide total (Scope 1 + Scope 2) GHG emissions for your local government operations, in metric tonnes CO2e. Scopes are a common categorization method.

Scope 1: All direct GHG emissions

Scope 2: Indirect GHG emissions associated with the consumption of purchased or acquired electricity, steam, heating, or cooling.

Response Options

Please complete the following table:

Total Scope 1 + Scope 2 emissions (metric tonnes CO2e)	Total Scope 1 emissions (metric tonnes CO2e)	Total Scope 2 emissions (metric tonnes CO2e)	Comment
220252	51848	168404	

6.8 Do you measure local government Scope 3 emissions?

Response Options

Select one of the following options:

- Yes

If Yes is selected in response to 6.8:

6.8a Please complete the table.

Response Options

Please complete the following table. You are able to add rows by using the "Add Row" button at the bottom of the table.

Source of Scope 3 emissions	Emissions (metric tonnes CO2e)	Comment
Select from: • Waste related Scope 3 emission sources	110,308	

6.9 Please indicate if your local government operations emissions have increased, decreased, or stayed the same since your last emissions inventory, and please describe why.

Response Options

Please complete the following table:

Change in emissions	Reason for change	Please explain
• Increased	If "Increased" is selected: • Increased energy/electricity consumption • Improved data accuracy • Change in accounting methodology	

6.10 Has the GHG emissions data you are currently reporting been externally verified or audited in part or in whole?

Response Options

Select one of the following options:

- No

If Yes is selected in response to 6.10:

6.10a Please provide the following information about the emissions verification process.

Response Options

Please complete the following table:

Name of verifier	Year of verification	Attach verification certificate	Comments
Text field	Numerical field	Attach your document here.	Text field

6.10b Please explain why your local government operations inventory is not verified and describe any future plans for verification.

We will allow City staff to choose the response to this question.

Response Options

Please complete the following table:

Reason	Comments
Select from: • Verification under consideration • Lack of funding / resources • Lack of expertise / knowledge • Verification is not prioritised • Data is internally verified • Other: please specify	

7.0 Does your city have a city-wide emissions inventory to report?

By selecting Yes below, you are indicating that you have fuel and/or greenhouse gas (GHG) emissions data from the entire city area over which the city government can exercise a degree of influence through the policies and regulations they implement (sometimes referred to as 'geographic' or 'community' emissions) to report at this time.

Response Options

- Yes

7.1 Please state the dates of the accounting year or 12-month period for which you are reporting a city-wide GHG emissions inventory.

January 1, 2017 – December 31, 2017

7.3 Does your city have a city-wide emissions inventory that aligns with the Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories (GPC)?

Response Options

Select one of the following options:

- Yes

7.3a Please provide a summary of emissions by sector and scope as defined in the Global Protocol for Community Greenhouse Gas Emissions Inventories (GPC) in the table below.

Response Options

Please complete the following table:

Sector and scope (GPC reference number)	Emissions (metric tonnes CO2e)
Stationary Energy: energy use – Scope 1 (I.X.1)	1957785

Sector and scope (GPC reference number)	Emissions (metric tonnes CO2e)
Stationary Energy: energy use – Scope 2 (I.X.2)	4272227
Stationary Energy: energy use – Scope 3 (I.X.3)	0
Stationary Energy: energy generation supplied to the grid – Scope 1 (I.4.4)	0
Transportation – Scope 1 (II.X.1)	3373272
Transportation – Scope 2 (II.X.2)	0
Transportation – Scope 3 (II.X.3)	656348.4
Waste: waste generated within the city boundary – Scope 1 (III.X.1)	9282.15
Waste: waste generated within the city boundary – Scope 3 (III.X.2)	267359.7
Waste: waste generated outside the city boundary – Scope 1 (III.X.3)	0
Industrial Processes and Product Use – Scope 1 (IV)	0
Agriculture, Forestry and Land Use – Scope 1 (V)	0
TOTAL Scope 1 (Territorial) emissions	5340340
TOTAL Scope 2 emissions	4539586
TOTAL Scope 3 emissions	749215.2
TOTAL BASIC emissions	10629141
TOTAL BASIC+ emissions	10629141

7.4 Please give the name of the primary protocol, standard, or methodology you have used to calculate your city's city-wide GHG emissions.

Response Options

Please complete the following table:

Primary protocol	Comment
Select from: • U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions (ICLEI)	Text field

Question 7.4 is required for the Global Covenant of Mayors.

If No or In progress is selected in response to 7.3:

7.4a Which gases are included in your city-wide emissions inventory?

Response Options

Select all that apply:

- CO2
- CH4
- N2O

7.4b Please provide a breakdown of your GHG emissions by scope. Where values are not available, please use the comment field to indicate the reason why.

Response Options

Please complete the following table:

Scope	Metric tonnes CO2e	Level of confidence	Comments
Scope 1 emissions excluding emissions from grid-supplied energy generation	5340446	Select from: • High	Text field
Scope 1 emissions from grid-supplied energy generation within the city boundary	0	Select from: • High • Medium • Low	Text field
Total Scope 1 emissions (Row 1 + Row 2)	5340446	Select from: • High	Text field
Total Scope 2 emissions	4272226	Select from: • High	Text field
Total (Scope 1 + Scope 2) emissions	9612672	Select from: • High	Text field
Total Scope 3 emissions	1016574	Select from: • High	Text field

If Yes is selected in response to 7.0:

7.5 Please attach your city-wide inventory in the table below.

If you have an inventory in the format of the GPC, please attach it below. You can download the GPC Reporting Tool (CIRIS) here. If you are using the ClearPath tool, please attach both extracts in the table below. If your inventory is not in the format of a GPC, you can also attach it below.

ClearPath GPC format table file: 2017 Community inventory_by_sector_gpc_reference_number.xlsx

Response Options

Please complete the following table.You are able to add rows by using the "Add Row" button at the bottom of the table.

Emissions inventory format	Document title	Attachment	Level of confidence	Comment on level of confidence
Select from: • GPC format: ClearPath (ICLEI)	2017 Community inventory_by_sector_gpc_reference_number.xlsx	Attach your document here.	Select from: • High	Text field

[Add Row]

7.9 Does your city have a breakdown by source of city-wide Scope 3 emissions?

Response Options

Select one of the following options:

- Yes

7.9a Please provide a breakdown of your city's scope 3 emissions.

Response Options

Please complete the following table.You are able to add rows by using the "Add Row" button at the bottom of the table.

Source of Scope 3 emissions	Emissions (metric tonnes CO2e)	Comment
Select from: • Water • Wastewater • Aviation • Waste	1016574	Text field

7.9b Please explain why not and detail your plans to do so in the future, if any.

Response Options

Please complete the following table:

Reasoning	Explanation
Select from: • Lack of data • Low data quality • Lack of knowledge/capacity • Lack of funding/resources • Scope categorization not used • Not required by national authorities • Not required by international agreements • Local government Scope 3 emissions have been assessed as insignificant • Scope 3 calculations are in progress • Other: please specify	

7.10 Do you have any credits or offsets resulting in a change to your city's net emissions that you would like to report?

Response Options

Select one of the following options:

- Yes

If Yes is selected in response to 7.10

7.10a Please provide details on the credits or offsets.

This value only includes RECs from DPU accounts, not from AEP.

Response Options

Please complete the following table. You are able to add rows by using the "Add Row" button at the bottom of the table.

Type of offset or credit	Emissions saved (metric tonnes CO2e)	Sector	Comment
Select from: • Renewable energy credits	18607	Select from: • Stationary energy (buildings) • Residential buildings • Public buildings • Commercial buildings • Industrial buildings	Text field

[Add Row]

If Yes is selected in response to 7.0

7.11 Please indicate if your city-wide emissions have increased, decreased, or stayed the same since your last emissions inventory, and please describe why.

Response Options

Please complete the following table:

Change in emissions	Reason for change	Please explain
Select from: • Decreased	If "Decreased" is selected: • Behavioural change • Technological change	

7.12 Has the city-wide GHG emissions data you are currently reporting been externally verified or audited in part or in whole?

Response Options

Select one of the following options:

- No

7.12b Please explain why your city-wide emissions inventory is not verified and describe any plans to verify your city-wide emissions in the future.

We will allow City staff to choose the response to this question.

Response Options

Please complete the following table:

Reason	Comments
Select from: • Verification under consideration • Lack of funding / resources • Lack of expertise / knowledge • Verification is not prioritised • Data is internally verified • Other: please specify	

7.13 Since your last submission, have you needed to recalculate any past city-wide GHG emission inventories previously reported to CDP?

Response Options

Select one of the following options:

- No

7.13a Please provide your city's recalculated total city-wide emissions figures for any previous inventories along with Scope 1, 2 and 3 breakdowns where applicable.

No response necessary

9.1 How much (in MW capacity) renewable energy is installed within the city boundary in the following categories?

We will allow City Staff to provide the response to this question. MORPC currently has values for solar installed within the county but not within city boundaries (though this can be calculated if needed).

Response Options

Please complete the following table:

Type	MW capacity
Renewable district heat/cooling	Numerical field
Solar PV	Numerical field
Solar thermal	Numerical field
Ground or water source	Numerical field
Wind	Numerical field
Other: please specify	Numerical field

Appendix A: Greenhouse Gas Inventory Tool Comparison

Greenhouse Gas Inventory Tools

Several potential greenhouse gas emissions inventory tools exist. We reviewed the utility of two widely used tools: ICLEI-USA's ClearPath[7] emissions management software suite and The World Bank's CURB tool[8].

ClearPath

ICLEI-USA's ClearPath tool is provided as a recommended resource for all members of the Global Covenant of Mayors. It includes inventory, forecast, planning and monitoring modules.

The inventory tool is flexible. It includes a range of direct and indirect emissions sources that can be included or omitted from the inventory to suit each unique community. It can also be used to catalog indirect emissions sources that are not required for reporting but that may be relevant for local GHG programs and goals.

ClearPath inventories emphasize using local data such as community and government fuel and electricity consumption rather than alternative or proxy data. The benefits of this method include a rigorous inventory that truly reflects local emissions for a community or region. A potential issue with the method is gaps in the inventory due to difficulties in obtaining data for all emissions sources for a community or government.

[7] http://icleiusa.org/clearpath/
[8] http://www.worldbank.org/en/topic/urbandevelopment/brief/the-curb-tool-climate-action-for-urban-sustainability

ClearPath includes tracks to inventory both local government operations and community-wide greenhouse gas (GHG) emissions. The tracks are consistent with widely accepted, U.S.-based protocols, the Local Government Operations Protocol and the U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, respectively.

CURB Tool

The Climate Action for Urban Sustainability (CURB) Toolkit is a valuable resource for assessing interventions at a city or regional level. Collaboratively developed for the World Bank Group and the C40 Cities Climate Leaders group, the CURB tool utilizes modeling and assumptions to generate a greenhouse gas baseline, forecast of emissions, and general cost and environmental scenarios for different policy decisions.

The inputs required for utilizing the tool are fully customizable, but its strength is in providing assumptions when data are unavailable. That being said, the CURB tool is most often used in areas where the ClearPath tool is too robust in its data requirements. It is recommended in the CURB toolkit to upload a GPC-compliant inventory and avoid proxy data as much as possible in order to achieve the most accurate results.

Both tools provide forward looking capabilities. By incorporating growth rates and cost data, the CURB tool is able to provide a general order of magnitude of change for technological interventions and policy decisions. These insights are meant to assist city and regional officials in deciding which actions provide the greatest impact for the most reasonable cost. Whereas the CURB tool could be regarded as a "next step" after completing a GPC-compliant inventory with the ClearPath tool, it would be unnecessary due to the availability of data required to utilize the planning options provided by ClearPath.

Appendix B: Previous Year Inventory Methodology

The ICLEI-USA ClearPath tool was used to create both government operations and community wide inventories for the City of Columbus. Government operations inventories exist for 2005 and 2013-2016. Community inventories exist for 2013-2016. Below is an accounting of what sectors were included in the 2015 and 2016 government and community inventories and any associated emission factors used. A listing of sectors not included in the inventory due to either non-applicability or lack of data is also included.

Government Operations Inventory

According to the Local Government Operations Protocol (2010)[9], all local governments should report all direct and indirect (scope 1 and 2) emissions from the following sectors:

- Buildings and Facilities
- Streetlights and Traffic Signals

[9] https://s3.amazonaws.com/icleiusaresources/lgo_protocol_v1_1_2010-05-03.pdf

- Water Delivery Facilities
- Port Facilities
- Airport Facilities
- Vehicle Fleet
- Transit Fleet
- Power Generation Facilities
- Solid Waste Facilities
- Wastewater Facilities
- Other Process and Fugitive Emissions

Local governments can choose whether to report on activities and sources under their operational control or under their financial control. City of Columbus government operations inventories are reported based on activities and sources under operational control of the city.

City of Columbus 2016 Government Inventory Included Sectors

Sector	Data	Emission Factors
Buildings and Facilities	Electricity Use, Grey (kWh)	EPA eGrid 2014 proxy for 2016
Buildings and Facilities	Electricity Use, Green (kWh)	Zero emissions factor for gov't Wind RECs**
Buildings and Facilities	Natural Gas Use (MMBtu)	U.S. default factors, LGOP*
Street Lights and Traffic Signals	Electricity Use, Grey (kWh)	EPA eGrid 2014 proxy for 2016
Street Lights and Traffic Signals	Electricity Use, Green (kWh)	EPA eGrid 2014 proxy for 2016
Vehicle Fleet	City Fleet Gasoline, on road (Gallons)	2016 Community Protocol Transportation Factor Set
Vehicle Fleet	City Fleet E85, on road (Gallons)	2016 Community Protocol Transportation Factor Set
Vehicle Fleet	City Fleet Diesel, on road (Gallons)	2016 Community Protocol Transportation Factor Set
Vehicle Fleet	City Fleet CNG, on road (Gallons)	2016 Community Protocol Transportation Factor Set
Vehicle Fleet	City Fleet Gasoline, off road (Gallons)	U.S. default factors, LGOP*
Vehicle Fleet	City Fleet E85, off road (Gallons)	U.S. default factors, LGOP*
Vehicle Fleet	City Fleet Diesel , off road (Gallons)	U.S. default factors, LGOP*
Vehicle Fleet	City Fleet CNG, off road (Gallons)	U.S. default factors, LGOP*
Vehicle Fleet	City Fleet Propane, off road (Gallons)	U.S. default factors, LGOP*
Vehicle Fleet	City Helicopter Jet A Fuel (Gallons)	U.S. default factors, LGOP*
Waste and Wastewater Treatment	Facility Electricity Usage, Grey (kWh)	EPA eGrid 2014 proxy for 2016

Waste and Wastewater Treatment	Facility Electricity Usage, Green (kWh)	Zero emissions factor for gov't RECs**
Waste and Wastewater Treatment	Combustion of Digester Gas (Population based, # of people served)	U.S. default factors, LGOP*
Waste and Wastewater Treatment	Natural Gas Usage (MMBtu)	U.S. default factors, LGOP*
Solid Waste Facilities	Refuse Collection Data (Tons)	U.S. Community Protocol default factors

*LGOP = Local Government Operations Protocol (2010)

**REC = Renewable Energy Certificate

City of Columbus 2016 Government Inventory Sectors – NOT Included

Sector
Transit Fleet
Employee Commute
Electric Power Production
Process and Fugitive Emissions

Community Wide Inventory

According to the U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions[10], the following basic emissions generating activities must be included in a community inventory:

- Use of electricity by the community
- Use of fuel in residential and commercial stationary combustion equipment
- On-road passenger and freight motor vehicle travel
- Use of energy in potable water and wastewater treatment and distribution
- Generation of solid waste by the community

City of Columbus 2016 Community Inventory Sectors - Included

Sector	Data	Emission Factors	Notes

[10] http://icleiusa.org/publications/us-community-protocol/

Residential Energy	Electricity Use, Columbus Power (kWh)	EPA eGrid 2014 proxy for 2016	
Residential Energy	Electricity Use, AEP (kWh)	EPA eGrid 2014 proxy for 2016	
Residential Energy	Natural Gas Use (MMBtu)	Community Protocol Default Factors*	
Commercial Energy	Electricity Use, Columbus Power (kWh)	EPA eGrid 2014 proxy for 2016	
Commercial Energy	Electricity Use, AEP (kWh)	EPA eGrid 2014 proxy for 2016	
Commercial Energy	Natural Gas Use (MMBtu)	Community Protocol Default Factors*	
Industrial Energy	Electricity Use, Columbus Power (kWh)	EPA eGrid 2014 proxy for 2016	
Industrial Energy	Electricity Use, AEP (kWh)	EPA eGrid 2014 proxy for 2016	
Industrial Energy	Natural Gas Use (MMBtu)	ICLEI U.S. Community Protocol Default Factors	
Transportation and Mobile Sources	Transportation, on road, Passenger Vehicles, Gasoline	2016 Community Protocol Transportation Factor Set*	
Transportation and Mobile Sources	Transportation, on road, Passenger Vehicles, Diesel	2016 Community Protocol Transportation Factor Set*	
Transportation and Mobile Sources	Transportation, on road, Freight, Gasoline	2016 Community Protocol Transportation Factor Set*	
Transportation and Mobile Sources	Transportation, on road, Freight, Diesel	2016 Community Protocol Transportation Factor Set*	
Transportation and Mobile Sources	Transportation, off road, Agriculture	U.S. default factors, LGOP***	
Transportation and Mobile Sources	Transportation, off road, Lawn and Garden	U.S. default factors, LGOP***	
Transportation and Mobile Sources	Transportation, off road, Construction	U.S. default factors, LGOP***	
Transportation and Mobile Sources	Transportation, off road, Aviation	U.S. default factors, LGOP***	
Transportation and Mobile Sources	Transportation, off road,	U.S. default factors, LGOP***	

	Recreational Vehicles		
Transportation and Mobile Sources	Public Transit, COTA, Gasoline Transit Buses	2016 Community Protocol Transportation Factor Set*	
Transportation and Mobile Sources	Public Transit, COTA, Diesel Transit Buses	2016 Community Protocol Transportation Factor Set*	
Transportation and Mobile Sources	Public Transit, COTA, CNG Transit Buses	2016 Community Protocol Transportation Factor Set*	
Transportation and Mobile Sources	Public Transit, COTA, Diesel Paratransit Buses	2016 Community Protocol Transportation Factor Set*	
Transportation and Mobile Sources	Public Transit, COTA, Gasoline Paratransit Buses	2016 Community Protocol Transportation Factor Set*	
Transportation and Mobile Sources	Aviation Gasoline	2016 Community Protocol Transportation Factor Set*	
Transportation and Mobile Sources	Aviation Kerosene Jet Fuel	2016 Community Protocol Transportation Factor Set*	
Transportation and Mobile Sources	Aviation, City Police Helicopter	2016 Community Protocol Transportation Factor Set*	
Water and Wastewater	Water Treatment Plant Energy Use	EPA eGrid 2014 proxy for 2016	
Water and Wastewater	Wastewater Treatment Plant Energy Use	EPA eGrid 2014 proxy for 2016	
Water and Wastewater	Combustion of Digester Gas	Community Protocol Default Factors*	
Water and Wastewater	Flaring of Digester Gas	Community Protocol Default Factors*	
Water and Wastewater	Combustion of Biosolids/Sludge	Community Protocol Default Factors*	
Solid Waste	Municipal Solid Waste	Community Protocol Default Factors*	
Solid Waste	Biological Treatment of Solid Waste (yard waste woody material to composting)	Community Protocol Default Factors*	
Solid Waste	Biological Treatment of Solid Waste	Community Protocol Default Factors*	

	(biosolids to composting)		

*Community Protocol Default Factors - ICLEI U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions (2013)

**2016 Community Protocol Transportation Factor Set - https://www.epa.gov/sites/production/files/2015-11/documents/emission-factors_nov_2015.pdf

***U.S. default factors, LGOP - Local Government Operations Protocol (2010)

City of Columbus 2015 and 2016 Community Inventory Sectors – NOT Included

Sector
Agriculture
Process and Fugitive Emissions