2016 Greenhouse Gas Inventory
City of Charlottesville

VERSION 0.1 RELEASE: MARCH 2019

Introduction

BACKGROUND

The 2016 Greenhouse Gas Inventory is the fifth inventory compiled by the City of Charlottesville. Previous greenhouse gas (GHG) inventories include the years of 2000 (baseline inventory), 2006, 2009, and 2011. GHG inventories support the work of the Climate Protection Program, established to pursue the City's commitments to reducing the greenhouse gas emissions associated with its community-wide activities.

The City of Charlottesville first committed to greenhouse gas reductions by joining the US Mayors Climate Protection Agreement in 2006. This commitment has been restated in the City Council Vision 2025: A Green City, Comprehensive Plans (2007, 2013, 2018 – currently being draft), and joining the Global Compact of Mayors (the Compact) in 2017.

By joining the Compact, Charlottesville has committed to taking action in three phases that include requirements for covering climate mitigation and climate action.

Phase 1:	Inventory
Phase 2:	Target
Phase 3:	Plan

The 2016 GHG Inventory completes the requirements for Phase 1 and was submitted via CDP, one of the Compact approved reporting platforms, in its 2018 reporting cycle. Confirmation from CDP is anticipated by December 2018. Per the Compact of Mayors standards, the 2016 inventory was developed according to the *Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories* (GPC). Previous City of Charlottesville inventories were developed according to the U.S. Community Protocols. While a majority of items were required by both protocol standards, there were some differences, such as in the water and wastewater sector. These differences have been noted where they appear.

WHAT THIS DOCUMENT PROVIDES

GHG inventories can take many forms. Some are a simple provision of data, often summarized into a data table showing the high-level tracked data points. Others can be presented in a simple executive summary type document with a limited amount of analytical content. Other inventories are part of an

annual GHG report or sustainability report. Considering the upcoming phases of the Compact of Mayors, this inventory document has been developed with the intent of providing data in a simple, clear format that can be utilized easily as an informational resource for analysis and community considerations regarding reduction commitments, reduction strategies and efforts, and resulting achievements.

This document details the methodology used to produce the 2016 GHG Inventory and changes from previous inventories. It includes summary charts, tables, and comparisons of the 2016 GHG Inventory to the 2000 Baseline Inventory and the previous inventory, 2011. Additional charts and tables will be available as a supplement and will be available online.

WHAT WE KNOW

The data presented in this inventory shows a downward trend in emissions and energy reductions. The more dramatic decrease in emissions compared to energy, however, relays a story that reflects the significance that policy, economic, and industry changes can have on local accomplishments. With that backdrop and looking forward, there are three important points worth reflecting on:

1. Success in reducing Charlottesville's community-wide emissions requires participation of the community; local government action and success within its own footprint is insufficient to meet reduction goals.
2. There is increasing pressure and interest in achieving emissions reductions at an environmentally meaningful scale. Adopted goals must be coupled with a plan forward that takes into account economic affordability and community inclusiveness.
3. There is greater opportunity and a growing availability of options for Charlottesville to utilize as it charts forward its path of climate action. A great deal of local actions are available to continue to decrease energy needs within our community. These typically come in the form of energy efficiency, which is also one of the less expensive forms of emissions and energy reductions. Opportunities are also occurring within Virginia which can continue to aid and supplement local policies and action, particularly when specific strategies and local resources have been positioned to work in coordination to leverage results.

UPCOMING / NEXT STEPS

Following the release of the 2016 GHG Inventory, Charlottesville will move to Phase 2 of the Compact of Mayors. "Phase 2: Target" includes setting a GHG reduction target(s) and assessing climate vulnerabilities. A proposed reduction target is expected to be presented to City Council for adoption by June 2019.

User Guide for the City of Charlottesville 2016 Greenhouse Gas Inventory

ICLEI – LOCAL GOVERNMENTS FOR SUSTAINABILITY

ICLEI - Local Governments for Sustainability (ICLEI) represents over 850 cities, towns, counties, and their associations worldwide. ICLEI-Local Governments for Sustainability was founded in 1990 to promote biodiversity, climate resilience, eco-mobility, sustainable procurement, sustainable cities, and sustainable water management among others. ICLEI supports its members with tools and resources that strengthen their commitment to sustainability. The City of Charlottesville joined ICLEI's Cities for Climate Protection (CCP) Campaign in March 2007. The campaign provides assistance to cities looking to adopt policies and implement quantifiable measures to reduce local greenhouse gas emissions, improve air quality, and enhance urban livability and sustainability. Key tools available to the membership include a software called Clean Air and Climate Protection (CACP) and ClearPath and online inventory emissions reporting tool, both used for calculating greenhouse gas emissions and criteria air pollutants.

INVENTORY METHODOLOGY

The City of Charlottesville's 2016 GHG Inventory adheres to the methodologies presented in the World Resource Institute's "Global Protocol for Community-Scale Greenhouse Gas Emission Inventories: An Accounting and Reporting Standard for Cities." This protocol, the GPC, was developed to offer cities and local governments a robust, transparent and globally-accepted framework to consistently identify, calculate, and report on city GHGs. The GPC has been adopted as a central component of the Compact of Mayors, the world's largest cooperative effort among mayors and city officials to reduce greenhouse gas emissions, track progress, and prepare for the impacts of climate change.

Greenhouse gas emissions in this inventory were quantified using calculation-based methodologies that determine emissions based on activity data and emission factors. To calculate emissions accordingly, the following basic equation is used: Activity Data x Emission Factor = Emissions. Activity data refers to the relevant measurement of energy use or other greenhouse gas-generating processes such as fuel consumption by fuel type, metered annual electricity consumption, and annual vehicle miles traveled. Known emission factors are used to convert energy usage or other activity data into associated quantities of emissions. Emissions factors are usually expressed in terms of emissions per unit of activity data (e.g. metric tons CO_2/kWh of electricity).

This inventory presents GHG emissions in terms of equivalent carbon dioxide units, or CO_2e. This standard is calculated using the Global Warming Potential (GWP) of each gas, which is a measure of the amount of warming a greenhouse gas may cause, measured against the amount of warming caused by carbon dioxide. Converting all emissions to equivalent carbon dioxide units allows for the

consideration of different greenhouse gases in comparable terms. For example, one metric ton of methane (CH_4) emissions is equal to 25 metric tons of CO_2e.

CITY BOUNDARY

A community-scale inventory represents the total quantity of greenhouse gas (GHG) emissions associated with the community within its jurisdictional boundary during a specific year. Embedded within the community GHG emissions inventory are emissions from municipal government operations and activities. As in previous inventories, the data associated with the municipal government, the City of Charlottesville, is identified distinctly as the Municipal. Different from previous inventories, the 2016 GHG Inventory is able to represent emissions associated with non-municipal government activities separately from commercial activities. Emissions associated with non-municipal government activities are reported in the Other Governmental Sector, separate from the Commercial Sector.

Another adjustment from previous inventory years, this inventory does not include the emissions associated with the entirety of the University of Virginia (UVA) main grounds' energy consumption, formerly reported in the Commercial/Institutional Sector emissions category. In previous iterations of the Charlottesville GHG Inventory, including the baseline calculation, UVA's total energy consumption for buildings located both in the City of Charlottesville and the County of Albemarle was included in the City's total emissions. With the development of UVA's climate action planning efforts, Albemarle County's upcoming climate planning process, and in collaborative initiatives such as the Local Climate Action Planning Process (LCAPP), the University, City, and the County are better positioned to provide a more precise representation of each entity's footprint and allow for targeted emission reduction strategies to be developed in parallel. (For more information on UVA's reports, plans, and guides, please see: https://sustainability.virginia.edu/news/reports.html.) In reflection of this and to maintain consistency when comparing data from different inventory years, the data presented in this document for the 2000, 2011, and 2016 inventories do not include emissions associated with the University of Virginia (UVA) main grounds' energy consumption, and the Commercial/Institutional Sector has been renamed as Commercial Sector.

For this updated inventory, the scope of the community emissions was expanded to include emissions associated with the management of potable water and wastewater by the community. This addition follows the latest recommendation from the Global Protocol for Community-Scale Greenhouse Gas Emissions Inventories. The protocol defines a minimum set of six basic emissions generating activities that must be included in all protocol-compliant GHG emissions inventories:

1. Stationary Energy
2. Transportation
3. Waste – including solid waste and wastewater
4. Industrial Processes and Product Use (IPPU)
5. Agriculture, Forestry, and Other Land Use (AFOLU)
6. Other Scope 3 Activities

All information necessary to calculate emissions from municipal operations was readily available. Electricity and natural gas consumption data came from detailed tracking of utility bills by the Public Works Department (PWD). Similarly, fuel consumption data (in gallons by fuel type) was provided by the PWD based on data from three main fueling locations as well as from individual departments with their own fuel sources (i.e., Fire Department, and Parks & Recreation Department). Government-generated waste for the 2011 inventory was estimated by the private vendor who provides contracted waste collection services to all facilities and parks, including city schools. Total landfilled tonnage calculations are based on the size of the container and the frequency of pick-up.

DATA COLLECTION

Electricity

For **Residential, Commercial**, and **Industrial** electricity consumption, Charlottesville uses a total consumption number provided by Dominion Energy for each sector. This number represents electricity purchased from Dominion Energy. As such, the data does not include behind the meter (e.g. onsite) solar power generation nor offsite renewable energy or renewable energy credit purchases.

Other Governmental: Dominion Energy provides a total electricity consumption amount for the Governmental sector. Based on conversations held with Dominion Energy, this number includes electricity consumption from all Municipal buildings, traffic and street lighting, other governmental facilities such as federal court houses, and the UVA facilities located within Charlottesville. The Dominion Energy included portion of UVA's purchased electricity specifically represents electricity purchased by UVA owned buildings within the City of Charlottesville's jurisdiction. For reporting purposes, the 2000, 2011, and 2016 Charlottesville GHG Inventory numbers presented here remove these inclusions from Dominion's Governmental number.

Municipal: For the City of Charlottesville, electricity usage is broken up into two categories, **buildings** and **traffic signals & streetlights**. Municipal building electricity is determined through a bottom-up approach, by aggregating the utility bill consumption for each of the buildings under municipal operation. The electricity consumption for traffic signals and streetlights come directly from Dominion Energy per an identified list of utility accounts.

Natural Gas

Charlottesville receives the majority of its natural gas consumption data from Charlottesville Gas, the main supplier of natural gas to the city's facilities. Charlottesville Gas provides its information by different sectors, such as Residential, Commercial, and Government, and data sets, such as Irrigation, Multi-Family, and Schools. For city Inventory purposes, the **Residential** sector includes Charlottesville Gas' data sets Residential – Irrigation, Multi-Family, and non-Multi-Family. The **Commercial** sector is comprised of the data sets Commercial and Commercial – Schools and Irrigation. The **Other Governmental** sector includes the data sets Government – Multi-Family, Residential – Government, Government Institutional – General and Schools Only.

Charlottesville Gas also provides a portion of UVA's natural gas consumption in the Government Institutional – General category. This is the natural gas consumed specifically by UVA owned buildings within the City of Charlottesville's jurisdiction. UVA's natural gas consumption data has been removed from the **Other Governmental** sector data for the 2000, 2011, and 2016 Charlottesville GHG Inventory numbers presented here.

The City's inventory calculates its **Municipal** sector's natural gas consumption by aggregating the utility bill consumption for each of the buildings under municipal operation. This total is subtracted from Charlottesville Gas' Governmental total to provide a final Governmental Sector natural gas consumption number as well.

Other Stationary Energy Sources: Wood, Fuel Oil, Propane

Data on wood, fuel oil, and propane is not available from suppliers at a comprehensive or granular enough level for Charlottesville. Instead, data for these energy sources is calculated proportionally based on household data from the American Community Survey and an equivalent average of energy units per residential account for natural gas.

Transportation

Transportation information is provided by two different sources, the Virginia Department of Transportation (VDOT) Daily Vehicle Miles Traveled Traffic Data tables and the City of Charlottesville's fuel consumption numbers. VDOT's mileages are categorized into 2 and 4 Tire Vehicles, Buses, Single Unit Trucks, and Combination Trucks. These mileages are then manipulated using the "Percentages of Total VMT" provided by ClearPath to calculate total mileages for Passenger Vehicles, Light Trucks, and Heavy Trucks for both Gasoline and Diesel.

The Municipal transportation values are provided by the City of Charlottesville by department and by fuel type. These numbers are then aggregated to by entered into ClearPath as Passenger Vehicles, Light Trucks, and Heavy Trucks for both Gasoline and Diesel. It is assumed that all Diesel consumption from VDOT vehicles is captured within the Municipal numbers and therefore the total VDOT mileages are not entered into ClearPath. The VDOT gasoline numbers for Passenger vehicles and Light Trucks however remove the Municipal gasoline consumption from their totals and are reported separately.

Waste

The City of Charlottesville's Waste 2016 numbers are provided by the Thomas Jefferson Planning District Commission's Solid Waste Management Plan. The Thomas Jefferson Solid Waste Planning Unit (TJSWPU) includes the Counties of Albemarle, Fluvanna, and Greene, the City of Charlottesville, and the Towns of Stanardsville and Scottsville and the Management Plan provides a breakdown of waste generated by type, as reported to the Virginia Department of Environmental Quality. The waste categories in this plan are aggregated to meet the ClearPath waste classifications including mixed municipal solid waste, office paper, corrugated cardboard, food scraps, and grass. These totals

were then divided by the total amount of waste generated in the TJSWPU to determine a percentage of total waste for each category. These percentages are the numbers entered into ClearPath.

Waste emissions in ClearPath also need the population of the City to accurately calculate emissions. The Solid Waste Management Plan provides the population for the entire TJSWPU, including the City and surrounding counties, as well as a waste per capita number. To calculate the total amount of waste generated in Charlottesville, a City population number was multiplied by the waste per capita value in the Management Plan and then entered in ClearPath.

Wastewater

Municipal Wastewater emissions were calculated in ClearPath based on population and Moore's Creek Wastewater Treatment Center's description of levels of methane flaring.

Emissions Summaries

GHG emissions for the inventories are calculated by collecting activity data (such as number of kilowatt hours [kWh] consumed) and multiplying that data by emissions factors that represent the carbon dioxide equivalents (CO_2e) for the types of fuel that activity consumed. Carbon dioxide equivalents are important because they allow us to speak uniformly about the impact of different greenhouse gases. For example, the impact of one metric ton of methane (CH_4) is equal to the impact of 25 metric tons of CO_2. Activity data is collected in aggregate by sector by fuel type from utilities and publically available data sources. For example: electricity consumed by the residential sector is collected as a single number, not by individual household; transportation data is calculated using vehicle counts from the Virginia Department of Transportation and cannot be allocated between the residential or commercial sectors; onsite renewable energy generation that reduces purchases from the utilities is not available as a data set.

Reductions in greenhouse gas emissions can come from two sources:

- Switching to a fuel source with a lower emissions factor (such as renewable energy) – If a fuel source changes, such as the fuel used for electricity production, its emissions factor will change accordingly. This creates the opportunity for emissions factors to differ between inventory years and for community emissions to change while energy consumption remains the same. Previously, this used to be a closer relationship, but with changes in the fuel sources (such as the 28% decline in emissions from the U.S. power sector since 2005[1]), it is possible to see reductions in emissions while seeing increases or no change in energy use.

- Reducing energy use through efficiency and conservation (activity data reductions) – Strategies such as energy efficiency and energy conservation include activities such as insulating and air sealing homes and buildings and installing better performing equipment, thereby reducing the amount of energy needed to adequately provide heating and cooling. This approach also applies to other sectors such as transportation. Please note that onsite renewable energy generation will also appear in the inventory data as a reduction of energy use.

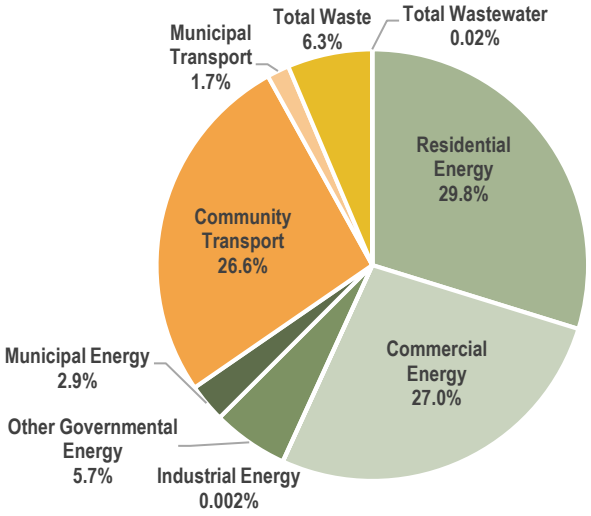
Evidence of both causes of emissions reductions (fuel switching and energy efficiency/conservation) are visible when comparing the 2016 inventory data to earlier inventories.

The following pages provide summary charts and tables of the 2000, 2011, and 2016 greenhouse gas inventories. The content is organized to show sector, subsector and fuel types as well as community-wide data and municipal-only data.

[1] *U.S. Energy Information Administration*

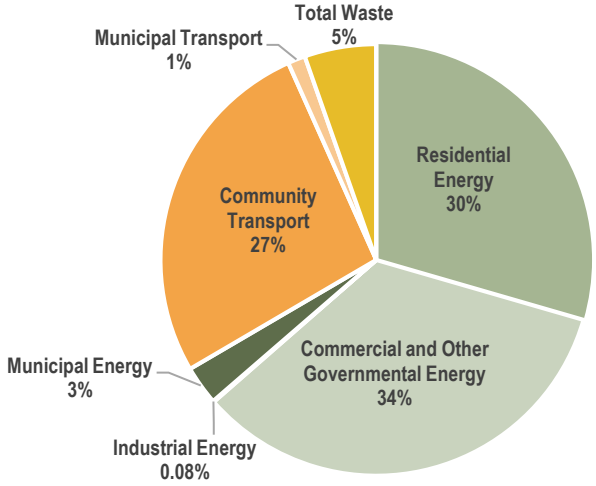
Community-Wide Emissions Data

2016



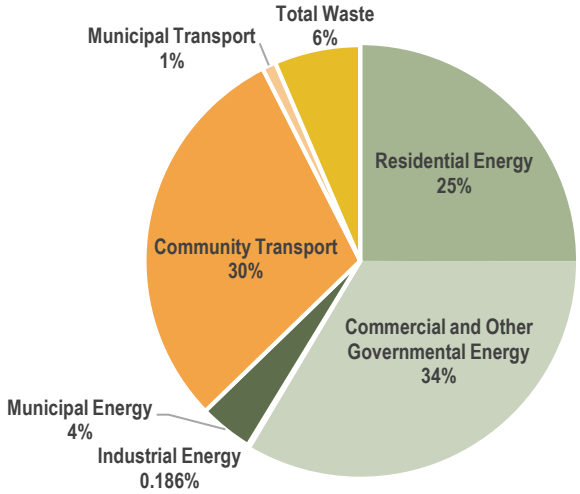
2016 Total Emissions	$MTCO_2e$
Total Stationary Energy	236,855.30
Residential	107,857.26
Commercial	97,907.25
Industrial	6.50
Other Governmental	20,641.58
Municipal	10,442.72
Total Transportation	102,274.33
Community	96,238.02
Municipal	6,036.31
Total Waste	22,997.92
Total Wastewater	64.75
TOTAL	**362,192**

2011



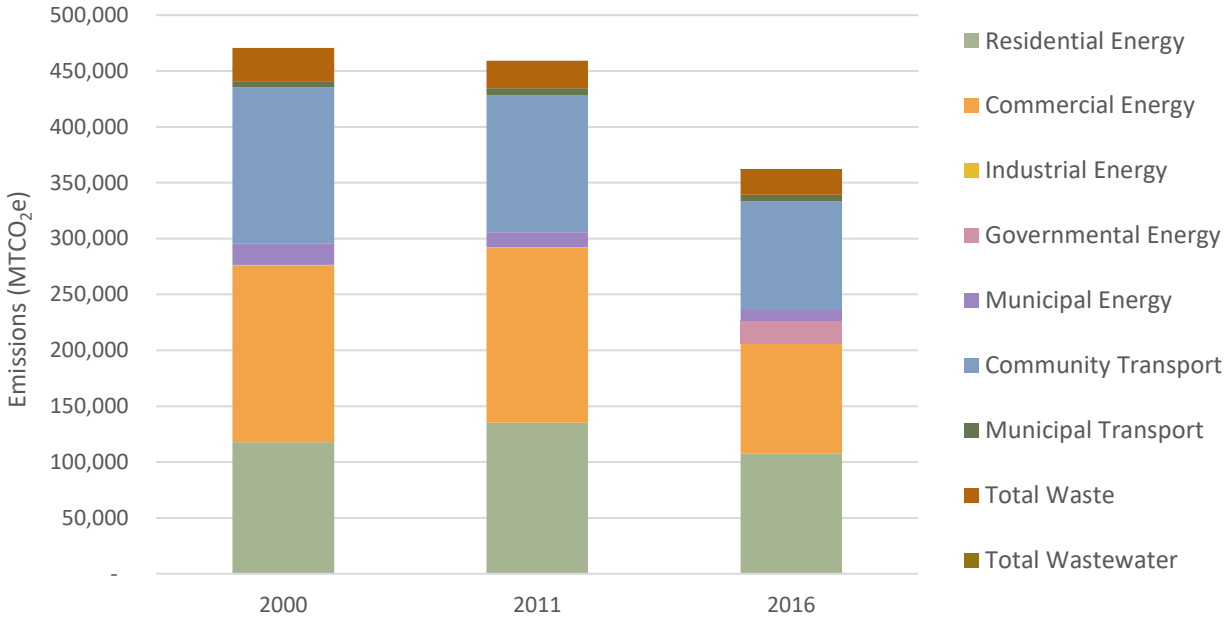
2011 Total Emissions	$MTCO_2e$
Total Stationary Energy	305,780.17
Residential	135,405.00
Commercial & Other Governmental	156,572.17
Industrial	372.00
Municipal	13,431.00
Total Transportation	128,835.00
Community	122,821.00
Municipal	6,014.00
Total Waste	24,694.00
Total Wastewater	N/A
TOTAL	**459,309**

2000



2000 Total Emissions	$MTCO_2e$
Total Stationary Energy	295,296.93
Residential	117,796.00
Commercial & Other Governmental	157,702.93
Industrial	874.00
Municipal	18,924.00
Total Transportation	144,938.00
Community	140,118.00
Municipal	4,820.00
Total Waste	30,349.00
Total Wastewater	N/A
TOTAL	**470,584**

Community-Wide Emissions by Sector



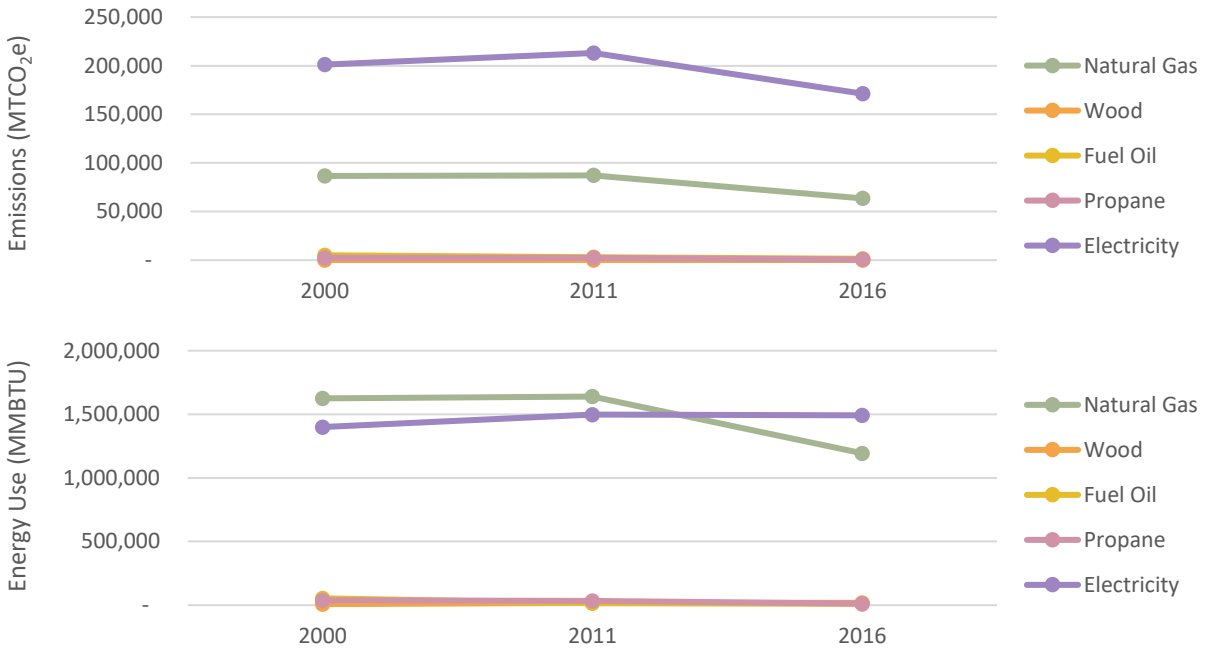
Community-Wide Emission Inventory Comparisons

	Total Emissions	Change from Baseline Inventory 2000	Change from Previous Inventory 2011
2016	362,192 $MTCO_2e$	23% reduction	21% reduction
2011	459,309 $MTCO_2e$	2% reduction	
2000	470,584 $MTCO_2e$		

Sector: Stationary Energy

Stationary Energy Emissions and Consumption – by Subsector

Stationary Energy Emissions and Consumption – by Fuel Type



Sector: Stationary Energy

Stationary Energy Emissions and Consumption – by Subsector

Stationary Emission Totals	Unit	2000	2011	2016
Residential Energy	MTCO2e	117,796	135,405	107,857
Commercial Energy	MTCO2e	157,703	156,572	97,907
Industrial Energy	MTCO2e	874	372	6
Governmental Energy	MTCO2e	-	-	20,642
Municipal Energy	MTCO2e	18,924	13,431	10,443
Total Energy Emissions	MTCO2e	295,296.93	305,780.17	236,855.30

Stationary Energy Totals	Unit	2000	2011	2016
Residential Energy	MMBTU	1,252,147	1,421,942	1,284,611
Commercial Energy	MMBTU	1,679,267	1,621,691	1,049,935
Industrial Energy	MMBTU	15,719	7,002	57
Governmental Energy	MMBTU	34,908	52,832	284,928
Municipal Energy	MMBTU	143,716	102,743	107,692
Total Energy	MMBTU	3,125,756.80	3,206,210.59	2,727,223.27

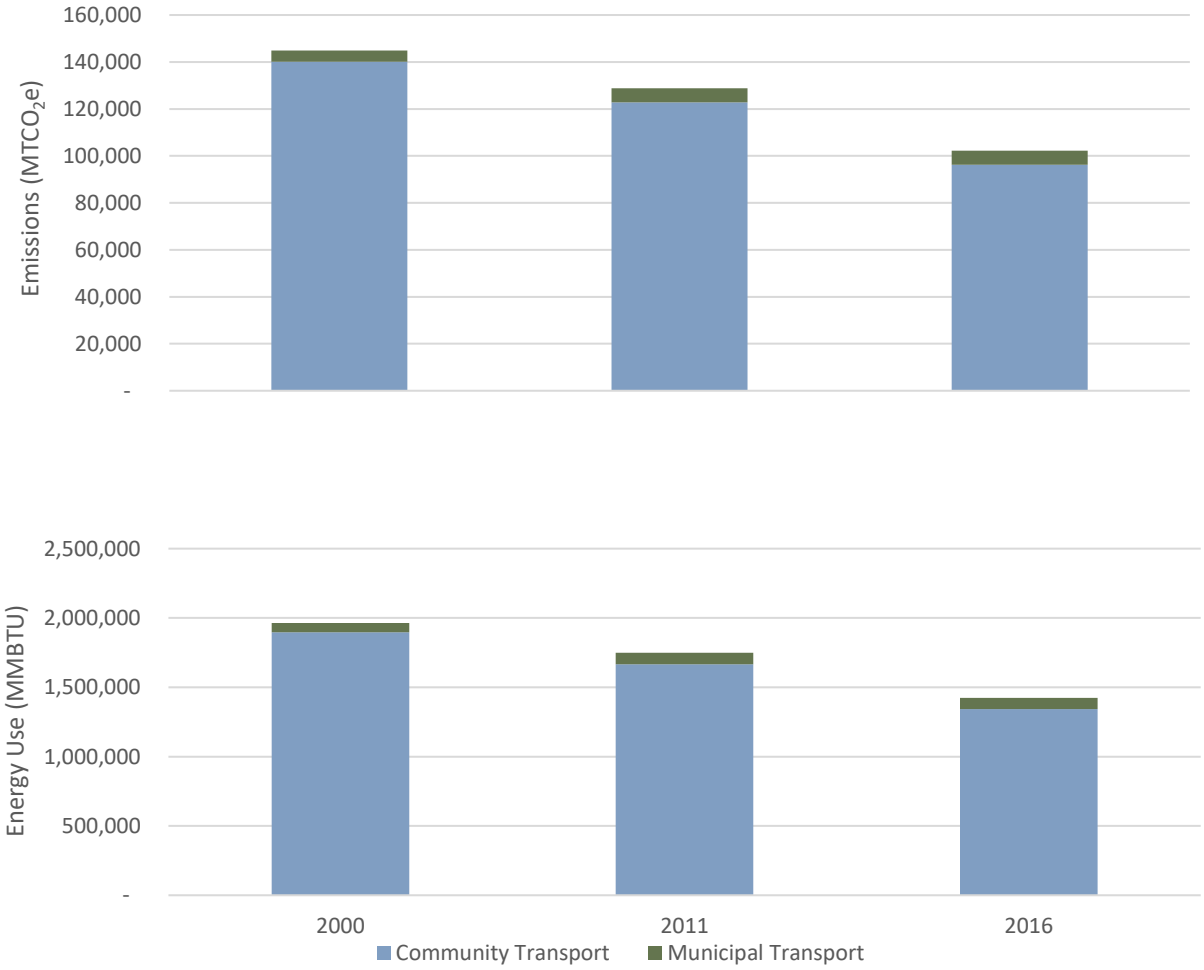
Stationary Energy Emissions and Consumption – by Fuel Type

Stationary Emission Totals	Unit	2000	2011	2016
Natural Gas	MTCO2e	86,437	87,136	63,485
Wood	MTCO2e	59	149	106
Fuel Oil	MTCO2e	5,017	3,107	1,390
Propane	MTCO2e	2,440	2,253	635
Electricity	MTCO2e	201,344	213,135	171,240
Coal	MTCO2e	-	-	-
Stationary Emission Totals	MTCO2e	295,296.93	305,780.17	236,855.30

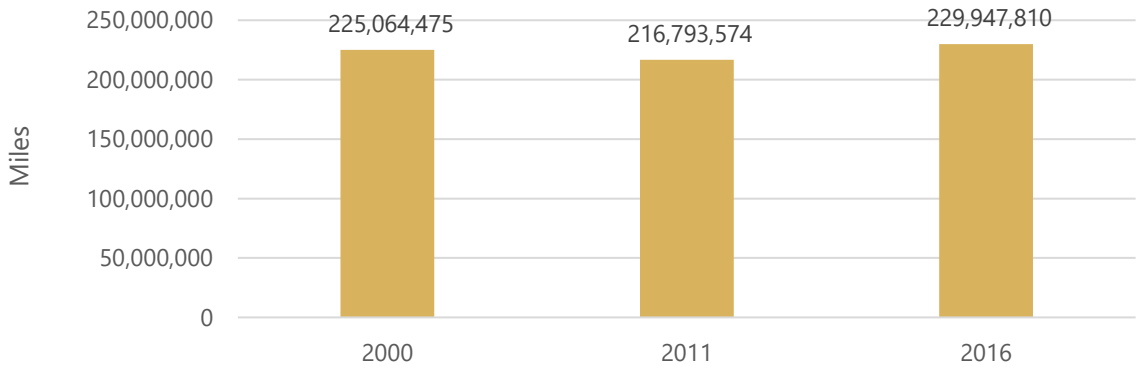
Stationary Energy Totals	Unit	2000	2011	2016
Natural Gas	MMBTU	1,626,486	1,639,549	1,193,890
Wood	MMBTU	7,468	18,738	18,669
Fuel Oil	MMBTU	53,375	15,578	10,231
Propane	MMBTU	38,337	34,412	11,560
Electricity	MMBTU	1,400,090	1,497,934	1,492,873
Coal	MMBTU	-	-	-
Total Energy	MMBTU	3,125,757	3,206,211	2,727,223

Sector: Transportation

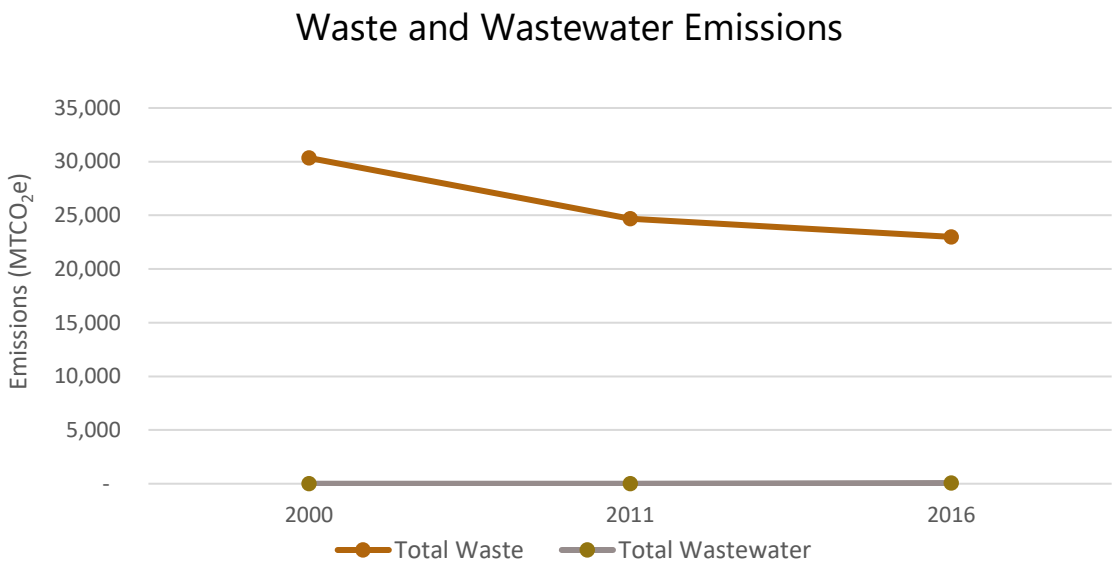
Transportation Emissions and Energy – by Subsector



Transportation Activity Data – Vehicle Miles Traveled (Source: VDOT)



Sector: Waste and Wastewater



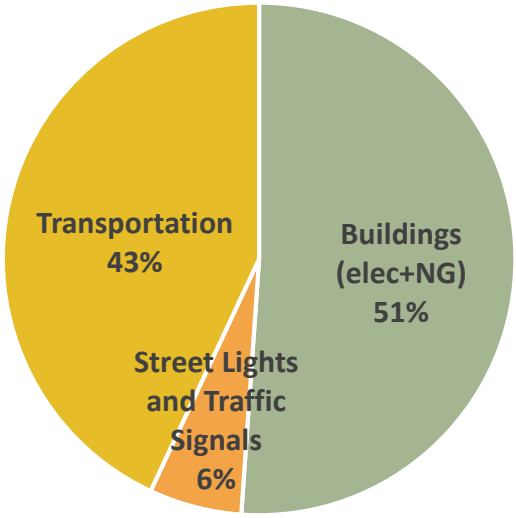
Wastewater Activity Data

(Note: added in the 2016 inventory per GPC protocols, estimated calculation)

	Unit	2016
Methane Flare	Million Cubic Feet	3.6
Methane Used Boiler/CoGeneration	Million Cubic Feet	28.4
Methane CoGeneration Only	Million Cubic Feet	11.3
Total	Million Cubic Feet	32.0

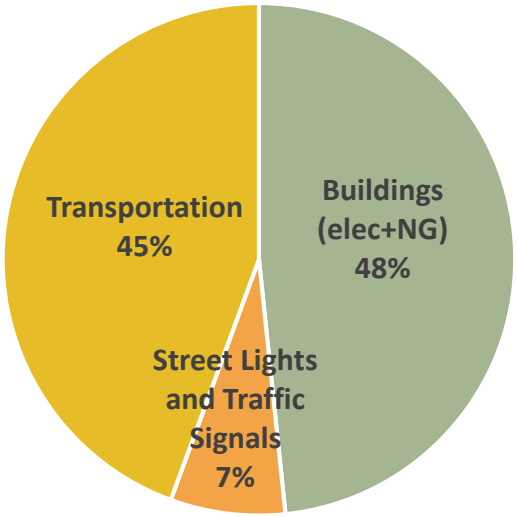
Municipal Emissions Data

2016



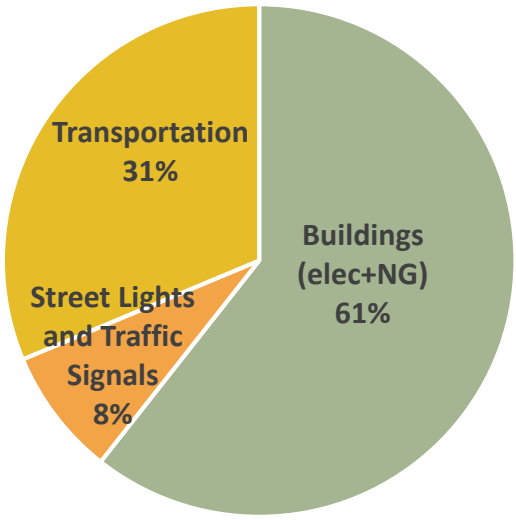
2016 Emissions	MTCO2e
Buildings (electricity & natural gas)	9,174
Street Lights & Traffic Signals	1,268
Transportation	6,036
TOTAL	**16,479**

2011

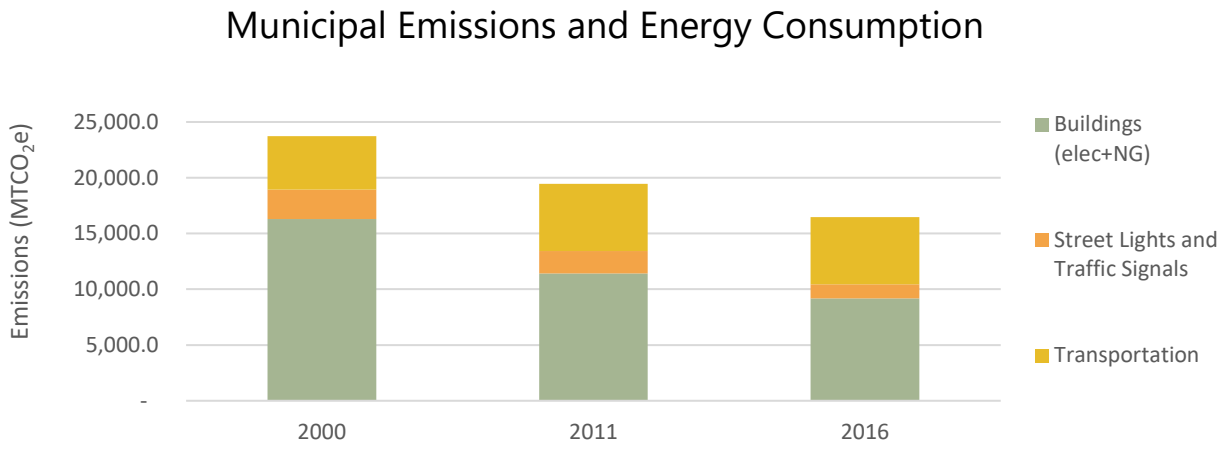


2011 Emissions	MTCO2e
Buildings (electricity & natural gas)	11,430
Street Lights & Traffic Signals	2,001
Transportation	6,014
TOTAL	**19,445**

2000



2000 Emissions	MTCO2e
Buildings (electricity & natural gas)	16,291
Street Lights & Traffic Signals	2,633
Transportation	4,820
TOTAL	**23,744**



Municipal Emissions	Unit	2000	2011	2016
Buildings (elec+NG)	MTCO2e	16,291.0	11,430.0	9,174.4
Street Lights and Traffic Signals	MTCO2e	2,633.0	2,001.0	1,268.3
Transportation	MTCO2e	4,820.0	6,014.0	6,036.3
Total	MTCO2e	23,744.00	19,445.00	16,479.03

Municipal Energy	Unit	2000	2011	2016
Buildings (elec+NG)	MMBTU	126,819.0	89,355.0	96,635.1
Street Lights and Traffic Signals	MMBTU	16,897.0	13,388.0	11,057.2
Transportation	MMBTU	65,487.0	82,074.0	81,370.8
Total	MMBTU	209,203.00	184,817.00	189,063.07

Further Information

Tables and charts offering a deeper dive into the 2016 GHG Inventory are available as supplemental documents. An interactive data visualization format is also being pursued to provide the data for community members to access and analyze if they so wish.

Questions about this document and the 2016 Greenhouse Gas Inventory can be directed to:

City of Charlottesville
Department of Public Works
Environmental Sustainability Division
Climate Protection Program

305 4th St, NW
Charlottesville, VA 22903

energy@charlottesville.org
434-970-3506

Website Resources:

Emission Inventories: www.charlottesville.org/emissions

Climate Protection Program: www.charlottesville.org/cpp