2012

Charlottesville Emissions Report Update

Cities for Climate Protection Program

An update of the 2000 Baseline Report originally published in 2008 with energy consumption and greenhouse gas emissions data and analysis for the years 2009 and 2011

Department of Public Works
City of Charlottesville
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Contents

Credits and Acknowledgements

This report was prepared by the Environmental Sustainability Division of the City of Charlottesville Public Works Department.

Organizations Which Provided Data or Assistance

Albemarle County
Allied Waste Services, a Republic Services Company
Amerigas
City of Charlottesville
Dominion Virginia Power
ICLEI-Local Governments for Sustainability USA
Local Energy Alliance Program (LEAP)
Martha Jefferson Hospital
Rivanna Water and Sewer Authority
University of Virginia
Virginia Department of Transportation
Waste Management Inc.

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EXECUTIVE SUMMARY

The 2011 Charlottesville Emissions Report Update presents a comparison of the energy use, greenhouse gas (GHG) emissions, and criteria air pollutants in 2009 and 2011 to baseline assessment data from 2000 & 2006. The Environmental Sustainability Division of the Charlottesville Public Works Department developed this update following the Recommended Next Steps in the Local Climate Action Planning Process (LCAPP) Steering Committee's report of 2011 (www.charlottesville.org/lcapp) to "Provide regular public updates on progress toward reducing emissions and energy use in internal programs and operations as well as on the results of periodic tracking of community baseline emissions". This report is intended to present data that enables the City to assess current programs and strategies for reducing emissions and to propose goals that both municipal operations and the community as a whole can work towards.

The 2000 & 2006 baseline data from the initial Charlottesville Emissions Baseline Report, published in 2008, have been adjusted to maintain comparability and accuracy of data between inventory years due to the adoption of updated emissions calculations and methodologies in the current calculation software, CACP 2009. The Community Overview section of this report estimates the total energy use and GHG emissions generated by residents, businesses, and other entities in Charlottesville, including the University of Virginia and the City of Charlottesville municipal government activities. Energy use and associated emissions from the City of Charlottesville's municipal operations are described in greater detail in the Municipal Focus section of this report.

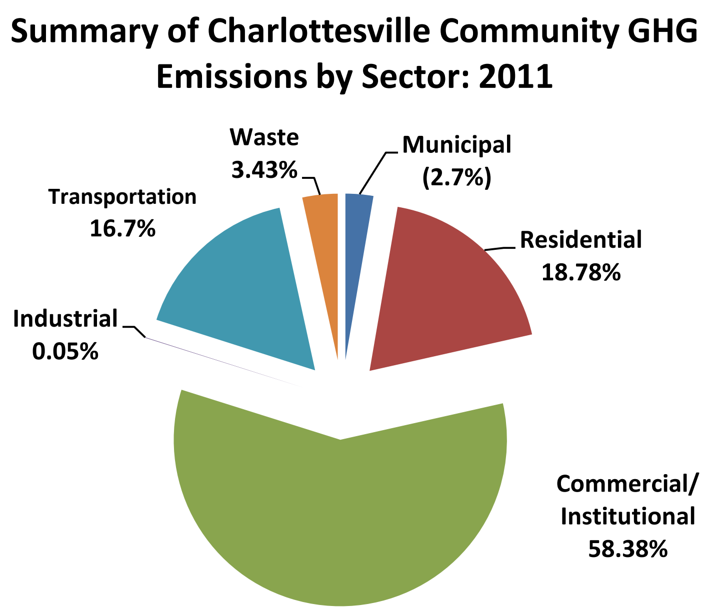


Figure ES1: 2011 Community GHG Emissions Summary

The emissions inventory established that the Charlottesville community as a whole was responsible for 720,870 metric tons of CO_2e emitted in 2011. The three largest sectors that contribute to Charlottesville emissions are the Commercial/Institutional (58.38%, including all of UVa), Residential (18.78%), and Transportation (16.7%) sectors (Figure ES1). Compared to the 2000 baseline, there has been an overall 7% increase in GHG emissions. Individually, the Commercial/Institutional sector experienced an increase of 16%, the Residential sector increased by 15%, and the Transportation sector decreased by 13% (Figure ES2). In both Figure ES1 and Figure ES2, the emissions from the Municipal sector within the Community Overview account for the operation of municipal and public school facilities, streetlights & traffic signals, and fleet vehicles and transit.

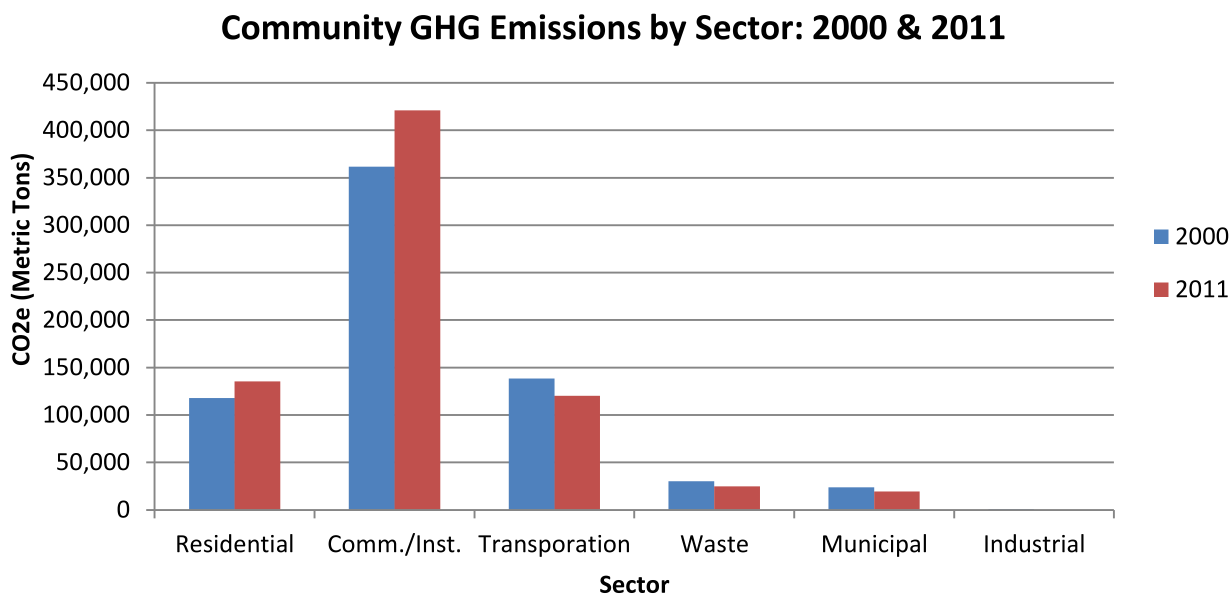


Figure ES2: Community GHG Emissions Baseline Comparison by Sector

As a subset of the total Charlottesville community emissions profile (2.7%), municipal operations have reduced GHG emissions 18% from the baseline.

The Facilities portion of the Municipal sector, which accounts for 59% of the total municipal emissions (Figure ES3), successfully decreased energy consumption by 29.5% from 2000-2011 amidst continued growth of facilities (7.8% increase or 122,020 sq. ft. since 2006) (Figure ES4). These reductions provided significant budgetary impacts in the form of avoided costs ($844,000 in 2011), protection from rising utility prices (an annual average of 8% since 2000), and an emissions decrease of 30%. These results have been achieved through an

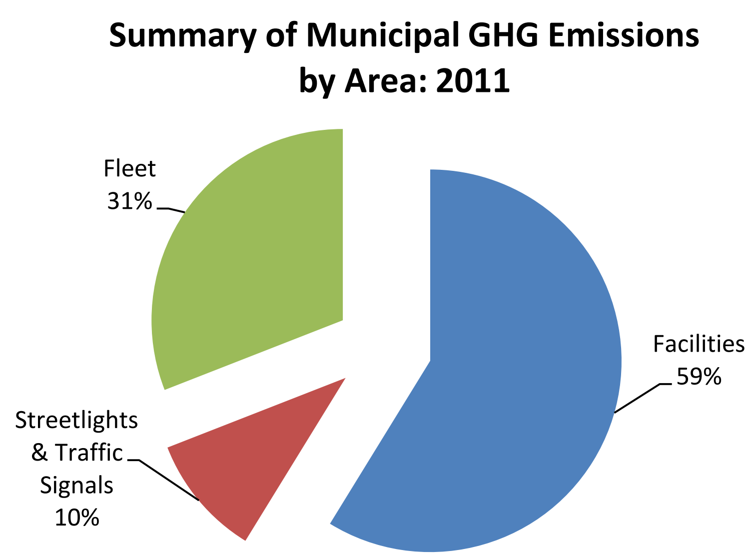


Figure ES3: 2011 Municipal GHG Emissions Summary

effective internal strategy comprised of three principles: (1) Improve the efficiency of existing facilities; (2) Pursue high performance green buildings for all new facilities; (3) Operational adjustments for energy efficiency and conservation.

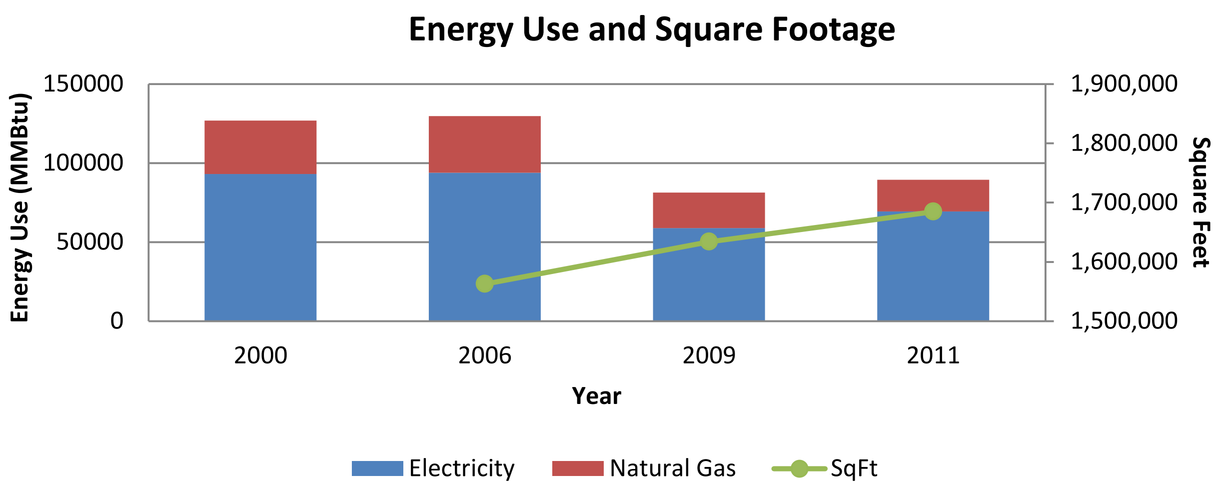


Figure ES4: Municipal Facilities Energy Consumption Comparison

Looking forward, an effective strategy to reducing Charlottesville emissions will need to include continued leadership by example from municipal operations as well as strong participation from residents and commercial and institutional entities. In order to realize future overall emission reductions, efforts directed at reducing increases of emissions in the built environment as well as continued and furthered support for the decrease of emissions from the mobility sector will be needed. The establishment of net average and stretch long-term goals, with periodic reviews, could aid the development and progress of future programs.

1.0 BACKGROUND

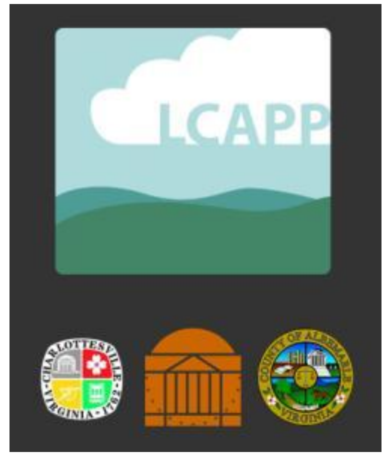
1.1 ICLEI - Local Governments for Sustainability

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, ecomobility, sustainable procurement, sustainable cities, and sustainable water management among others. ICLEI supports its members with tools and resources that strengthen their commitment to sustainability. One of the key tools available to the membership is a software called Clean Air and Climate Protection (CACP) and is used for calculating greenhouse gas emissions and criteria air pollutants. The City of Charlottesville joined ICLEI's Cities for Climate Protection (CCP) Campaign in March of 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. A Five Milestone performance framework is the center of the CCP and was outlined in the 2008 Charlottesville Emissions Baseline Report. In accordance with this process, the City completed a baseline emissions inventory, participated in a climate action planning process, is committed to implementing its programs, and will routinely update the emissions inventory. After five years of effort and the completion of this baseline update, the ICLEI confirmed that Charlottesville has successfully completed the Five Milestones and is moving onto the phase of ongoing monitoring, measuring, and adjustment to meet locally defined goals.

1.2 Charlottesville Emissions Baseline Report

The original emissions baseline report is based on calendar year 2000 and 2006 data and is available on the City's website: www.charlottesville.org/lcapp. The report includes information about climate change and its potential impacts as well as basic information about greenhouse gases and criteria air pollutants. The original baseline report also provides a detailed description of the City's path to a climate protection commitment including the US Mayors Climate Protection Agreement and a description of ICLEI's Cities for Climate Protection program. The baseline emissions inventory was also completed using the CACP emissions calculation software. By establishing a baseline, it is possible to set targets for reducing emissions and energy costs in the future.

1.3 Local Climate Action Planning Process (LCAPP)



Completed in August of 2011, the Local Climate Action Planning Process (LCAPP) Report was presented to Charlottesville City Council on September 6, 2011. The report provides examples of current efforts by the City, County, and University of Virginia (UVa) to reduce energy use and emissions and provided a Five-Part Framework with associated action strategies for the three organizations to consider and pursue. The LCAPP Steering Committee encouraged the City, County, and UVa to take tangible and measureable action consistent with the Recommended Principles and Recommended Next Steps outlined in the report.

1.4 Charlottesville Emissions Report Update

This 2011 Charlottesville Emissions Report Update was completed to meet two important goals – improve the accuracy of the original baseline calculations and provide a current data assessment for comparison. To meet these goals the City utilized the latest emissions accounting software available, CACP 2009, across all inventory years. Throughout this report, when reference is made to data from 2000 (also known as the baseline) or 2006 (the initial interim year), this refers to adjusted data collected and computed in 2012 using CACP 2009 software and not the data previously reported in the original Charlottesville Emissions Baseline Report. The inventory methodology was refined during the development of this report and is reflected in every inventory year.

The 2011 Charlottesville Emissions Report Update demonstrates the City's commitment to routinely report updated measurements of community and municipal GHG gas emissions. Having this information available and inventoried allows City government and community leaders to make informed decisions to continuously improve environmental management practices and become a world-class model of environmental performance and stewardship as envisioned in the City's Environmental Sustainability Policy and City Council's 2025 Vision Statement.

2.0 INVENTORY METHODOLOGY

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). Table 1 demonstrates an example of common emission calculations that use this formula.

Table 1: Basic Greenhouse Gas Emissions Calculations

Activity Data	Emissions Factor	Emissions
Electricity Consumption (kWh)	CO_2 emitted/kWh	CO_2 emitted
Natural Gas Consumption (cubic feet)	CO_2 emitted/therm	CO_2 emitted
Gasoline/Diesel Consumption (gallons)	CO_2 emitted /gallon	CO_2 emitted
Vehicle Miles Traveled	CH_4, N_2O emitted/mile	CH_4, N_20 emitted

This inventory presents GHG emissions in terms of equivalent carbon dioxide units, or CO2e. This standard is based on 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 (CH4) emissions are equal to 21 metric tons of CO2e. See Table 2 for the GWPs of the commonly occurring greenhouse gases.

Table 2: Greenhouse Gases

Greenhouse Gas	Chemical Formula	Global Warming Potential
Carbon Dioxide	CO_2	1
Methane	CH_4	21
Nitrous Oxide	N_2O	310
Hydrofluorocarbons	Various	43-11,700
Perfluorocarbons	Various	6,500-9,000
Sulfur Hexafluoride	SF_6	23,900

The most commonly used unit for reporting CO2e is metric tons. In terms of everyday equivalents 1 metric ton of CO2e is equal to the use of 112 gallons of gas, spending $200 in electricity, or using a light bulb for 3.3 years.

2.1 Clean Air and Climate Protection 2009 (CACP 2009) Software

ICLEI developed the Clean Air and Climate Protection 2009 (CACP 2009) software package in partnership with the National Association of Clean Air Agencies (NACAA) and the U.S. Environmental Protection Agency (EPA). CACP 2009 is designed for compatibility with the Local Government Operations Protocol 2008 (LGOP). CACP 2009 replaced the original 2003 CACP software used to complete the 2008 Charlottesville Emissions Baseline Report. To establish an accurate and equivalent assessment of GHG emissions amongst all inventory years, baseline activity data from 2000 and 2006 along with 2009 and 2011 was entered into CACP 2009. Figure 1 briefly describes the differences in CACP 2009 compared to the original CACP software. These updates along with modified activity data collection methods produced both adjusted baseline activity data and GHG emissions amounts.

Electricity — **Municipal Facilities, Streetlights & Traffic Signals, Residential, & Commercial**

- Electricity emission factors changed to EPA eGrid - a new division of regions with factors that reflect the current generation mix for a paticular year

Natural Gas & Other Fuels — **Municipal Facilities, Residential, Commercial, Industrial**

- Natural gas emission factors changed based on improved data available for the software
- Emission factors also changed for propane, fuel oil, and firewood

Gasoline, Diesel, CNG — **Municipal Fleet and Transit, Community Transportation**

- Fuel emission factors updated
- Motorcycles now have their own set of emission factors and are categorized as Off-Road Gasoline- Recreational
- Model Year considered in emission calculations. Used Alt-Method Model Year for all inventories which uses a selection model years based on the inventory year.

Solid Waste Management — **Municipal Generated and Community**

- New waste share percentages applied based on latest protocol suggestion
- CACP 2009 no longer includes on-site sequestriation factors for waste

Figure 1: Overview of Updates to CACP Software

The CACP software is a sophisticated and useful tool, however, calculating emissions from energy use with precision is difficult. Calculating GHG emissions depends upon numerous assumptions, and it is limited by the quantity and quality of available data. With this in mind, it is useful to think of any specific number generated by the CACP 2009 software as an accurate approximation, rather than an exact value.

2.2 Data Collection

The emissions calculating software, CACP 2009, used for this report is only as good as the activity data collected and used in the calculation based methodology. This data came from a variety of sources. In some cases, access to the data has improved since the original baseline was conducted.

2.2.1 Community Data Collection Methods

For this updated inventory, the scope of the community emissions was expanded to include energy consumption associated with the management of potable water and wastewater by the community. This addition to the 2009 and 2011 GHG emission inventory follows the latest recommendation from ICLEI's new Community Protocol published October 2012. The protocol defines a minimum set of five basic emissions generating activities that must be included in all protocol-compliant GHG emissions inventory reports:

1) Use of Electricity by the Community

2) Use of Fuel in Residential and Commercial Stationary Combustion Equipment

3) On-Road Passenger and Freight Motor Vehicle Travel

4) Use of Energy in Potable Water and Wastewater Treatment and Distribution

5) Generation of Solid Waste by the Community

Figure 2 is an overview of the type and source of activity data collected for the inventory:

Electricity

- Residential, Commercial, Federal , County, and Industrial within City boundaries provided by Dominion (annual kWh)
- UVa provided annual kWh (including use outside City boundaries)
- Municipal data from Municipal Inventory

Natural Gas

- Residential, Commercial, Government, and Industrial provide by City Utility Billing Office (annual cubic feet)
- UVa provided natural gas data (including use outside City boundaries)

Misc. Fuels

- Modified methodology used to calculate propane, fuel oil, and firewood fuel consumption for the residential community: Calculated average energy use per household based on natural gas utility data for inventory year and then multiplied this amount by number of households using each particular fuel.

Transportation

- Used VDOT Report: Daily Vehicle Miles Traveled (VMT) by "City of Charlottesville" and "Vehicle Class." Entered this data into CACP Transport Assistant which distributes VMT across fuel type, vehicle type, and model year
- Within the Municipal Focus section, activity data collected for Fleet emissions from total annual fuel useage

Potable Water & Wastewater Treatment

- Rivanna Water & Sewer Authority provided utility data (electricity and natural gas)
- Calculated City proportion based on City/County customer split

Solid Waste

- Tons of waste landfilled data collected from City of Charlottesville Public Service (City Curbside MSW (contract), Large Item Collection), Martha Jefferson Hospital , University of Virginia, and other local haulers that provide commercial, multi-family, and residential service
- Waste from municipal opearations included in the Community-Wide total. In addition, 2011 municipal-only waste data available in the Municipal Focus section.

Figure 2: Overview of Activity Data Collected

2.2.2 Municipal Data Collection Methods

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 two 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. However, since municipal waste data was only available for 2011 the emissions were not accounted for separately in the Municipal sector of the Community-Wide GHG emissions total instead they are included in the Waste sector as part of the Waste emissions total.

One substantive change in methodology was applied to the Streetlight & Traffic Signal area. In the original baseline inventory, the amount of electricity used (kWh) had to be estimated since this data was not tracked separately. However, the City has since been tracking this utility data independently and therefore was able to provide accurate totals for 2009 and 2011. Having this recent data allowed for back-casting to the baseline year based on the known efficiency improvements made to City traffic signals since 2000.

3.0 COMMUNITY OVERVIEW

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. This inventory also incorporates the emissions associated with the entirety of the University of Virginia (UVa) main grounds despite the fact that these facilities are not located wholly within the City of Charlottesville. This approach was selected to be consistent with the initial baseline data and in consideration of the institution's significant role in the community as well as the unknown schedule regarding a future community emissions reporting by Albemarle County.

3.1 Charlottesville GHG Emissions Summary

In 2011, Charlottesville's GHG emissions totaled 720,870 metric tons of CO_2e. This amount is a sum of six separate community sectors:

- Residential
- Commercial/Institutional
- Industrial
- Transportation
- Municipal
- Community-generated Waste

Total 2011 Charlottesville GHG emissions are 7% higher (720,870 MT CO_2e) from the 2000 baseline emission levels of 673,050 MT CO_2e (Table 3). It should be noted, however, that the 2009 values were 9.1% above the baseline levels, and the data indicates a small decrease since that time. *Commercial/Institutional* is the largest contributing sector accounting for 58.38% of the total community GHG emissions. This sector includes all commercial entities, state & federal government buildings within the city, the University of Virginia (including the main grounds portion of UVA physically outside of but adjacent to the City limits), and water & wastewater treatment services provided to City residents and businesses. The second largest source is the *Residential* sector, contributing 18.78% of the total community GHG emissions. The third largest sector is *Transportation*, contributing 16.7% of the total community GHG emissions. Lastly, 2.7% of the community emissions are associated with the *Municipal* sector (accounting for the use of energy for the facilities, streetlights, and traffic signals owned and operated by the municipal government and emissions from fleet and transit vehicles) and are presented in a dedicated section of this report. (Figure 3)

According to the 2010 Census, Charlottesville's population is 43,475. This is an 8.4% increase from the population reported in the 2000 Census (Table 3). A portion of this growth can be attributed to the expanding student population at the University of Virginia, which increased 13.7% since 2000, although it is unknown what proportion of the UVa population is represented in the census data as part of Charlottesville's population. Based on the census data, the per capita CO_2e emissions has slightly decreased from 16.8 metric tons in 2000 to 16.6 metric tons in 2011 (Table 3).

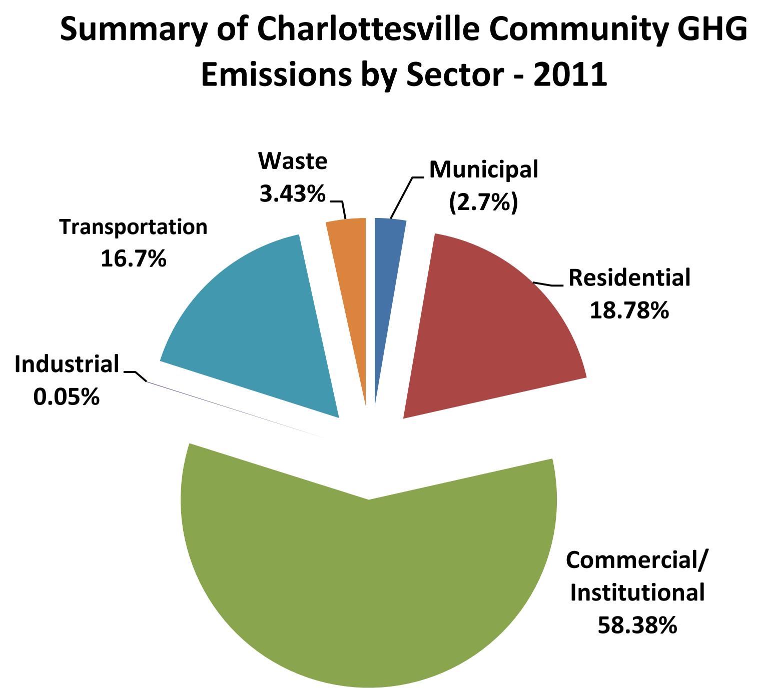


Figure 3: 2011 Charlottesville Community GHG Emissions by Sector

Table 3: Total Energy Use, Emissions, Population and Per Capita Inventory Comparison

Year	Energy Use (MMBtu)	CO_2e Emissions (metric tons)	Population	Per Capita CO_2e Emissions (metric tons)
2000*	6,714,098	673,050	40,099	16.8
2006*	7,243,603	715,799	40,745	17.6
2009	7,387,352	734,561	41,228	17.8
2011	7,264,102	720,870	43,475	16.6
**totals adjusted since publication of original Baseline Report*				

Compared to the baseline, both the *Commercial/Institutional* and the *Residential* sectors have increased their levels of emissions since 2000. The *Commercial/Institutional* sector has experienced the largest growth with emissions levels of 420,845 metric tons of CO_2e in 2011, a 16% increase from 2000 levels (Figure 4). The emissions from the *Residential* sector have increased by 15% (Figure 4).

The remaining sectors have all decreased their emissions as compared to the baseline (Figure 4). Notably, in the *Transportation* sector, emissions were 18,398 metric tons CO_2e less in 2011, a 13% decrease. Similarly, the emissions associated with the management of solid waste are down 19% from the baseline, and there is an 18% overall reduction in emissions associated with municipal operations.

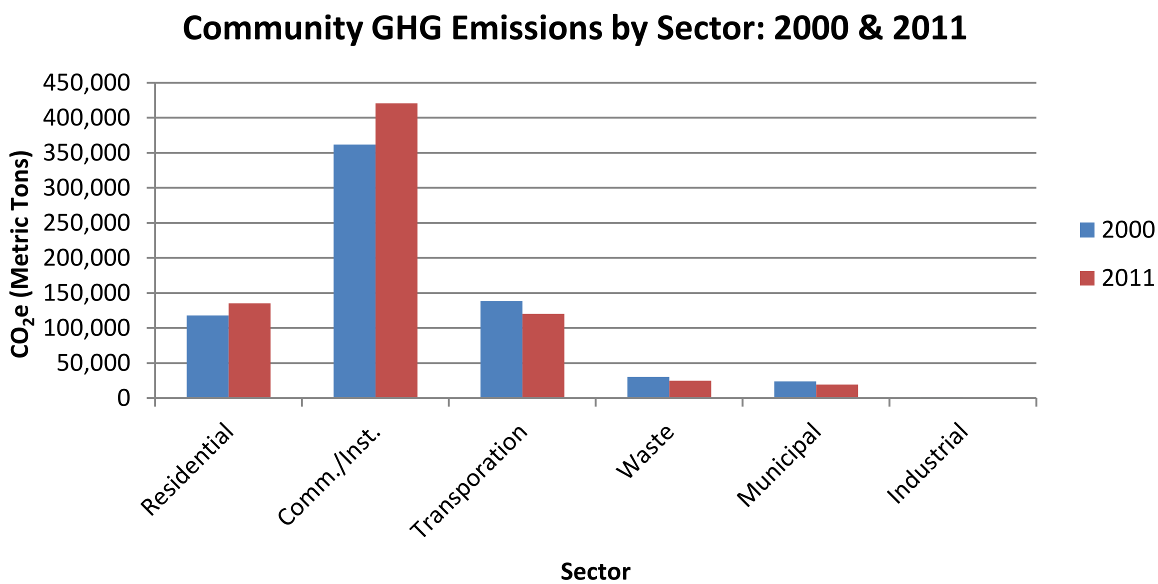


Figure 4: GHG Community Emissions by Sector: 2000 & 2011

Electricity and natural gas are the most widely used fuel types in the community and therefore the largest contributors of GHG emissions, 55.5% and 16.7% respectively, of the community GHG total emissions (Figure 5). Electricity is provided by Dominion Virginia Power from eleven major power stations, which use a combination of oil, coal, water, and nuclear energy to generate electricity throughout the system. Within the *Residential* and *Commercial/Institutional* sectors a small proportion of emissions are associated with the use of fuel oil and propane primarily used for space heating. Lastly, the use of coal makes up the remainder of the community emissions - 8.8% - and is entirely associated with the operations at the University of Virginia. Compared to the baseline, consumption of electricity, natural gas, and coal, and their associated GHG emissions, all increased in the community.

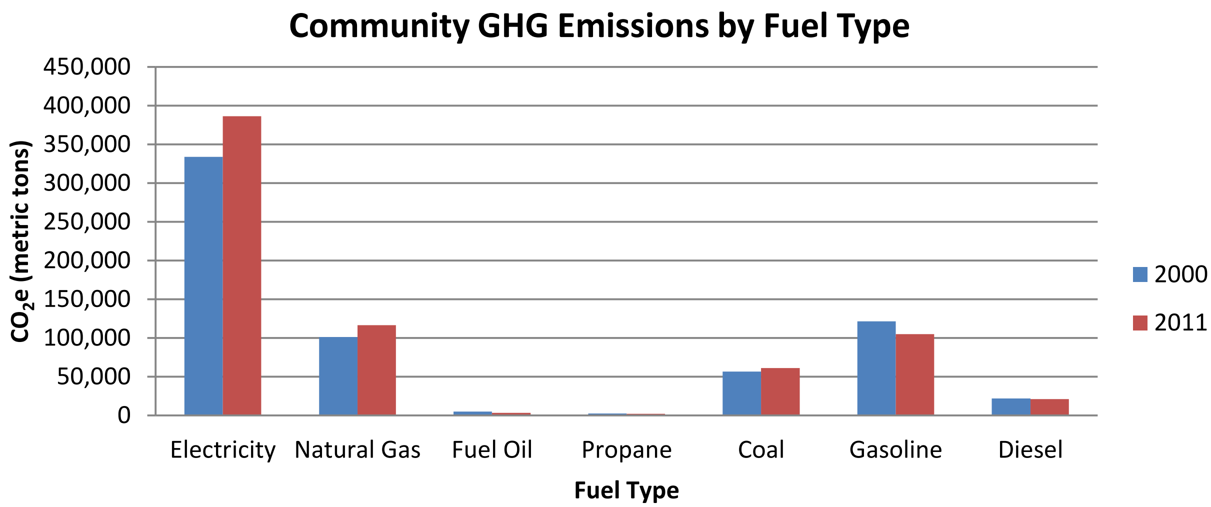


Figure 5: Community GHG Emissions by Fuel Type in 2000 and 2011

3.2 Residential

As shown in Table 4, Charlottesville's *Residential* sector is linked to an estimated 135,404 metric tons of CO_2e in 2011. This estimate was calculated using 2011 electricity and natural gas consumption data provided by City of Charlottesville Gas Utility, Dominion Virginia Power, and calculated estimates of use of other fuel types, propane, fuel oil, and wood. Data on residential equipment usage, such as lawnmowers or on-site electricity generation, is not included in this inventory. GHG emissions associated with residential transportation and residential waste generation are included separately in the *Transportation* and *Waste* sector emissions totals. Per household emissions can be a useful metric for measuring progress in reducing greenhouse gases and for comparing one's emissions with neighboring cities and against regional and national averages. In Charlottesville, households are responsible for an annual amount of 7.6 metric tons of CO_2e on average – an almost 1 metric ton increase from the baseline (Table. 4).

Compared to the baseline measurements, energy use and GHG emissions have increased from 2000 with *Residential* emissions up 15% (Table 4). It is important to note the energy use data and the resulting emissions data in this report were not weather normalized. Record breaking winter and summer weather conditions during these inventory years influenced energy consumption related to heating and cooling demands. Population growth (8.4%), increased number of housing units (187 units) and residential square footage (18%), and higher median household incomes (36%) are a few additional factors that have changed over the course of the inventory years and which also play a role in energy use. The total energy use in the *Residential* sector grew 13.5% growth since 2000, including an increase in the share of the energy consumption from electricity to 44% (5% change) while the proportion from natural gas decreased by 2% to 52% (Figure 6).

Table 4: Charlottesville 2011 Greenhouse Gas Emissions per Household

Year	Number of Occupied Housing Units	Total Residential GHG Emissions (metric tons CO_2e)	Residential GHG Emissions/Household (metric tons CO_2e)
2000	17,591	117,796	6.7
2011	17,778	135,404	7.6

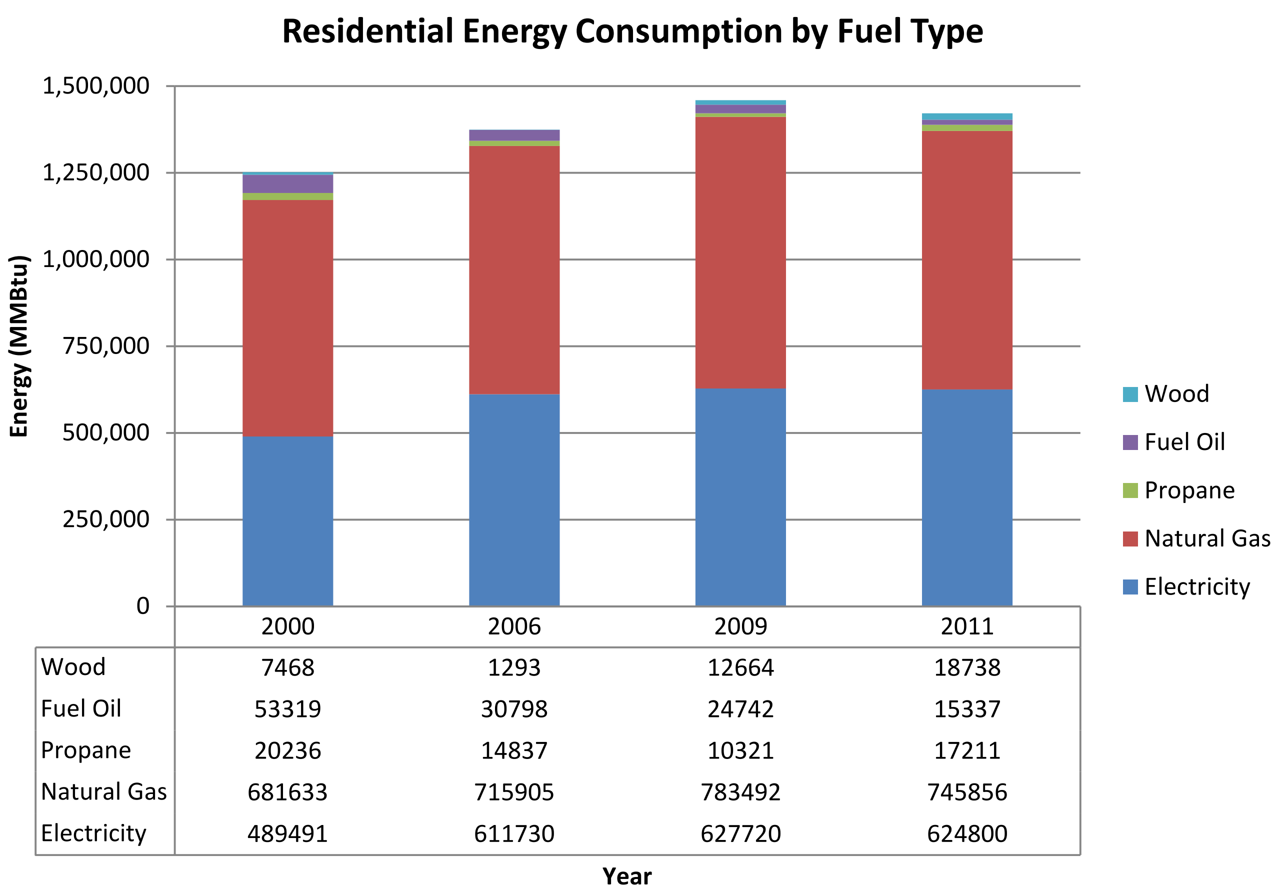
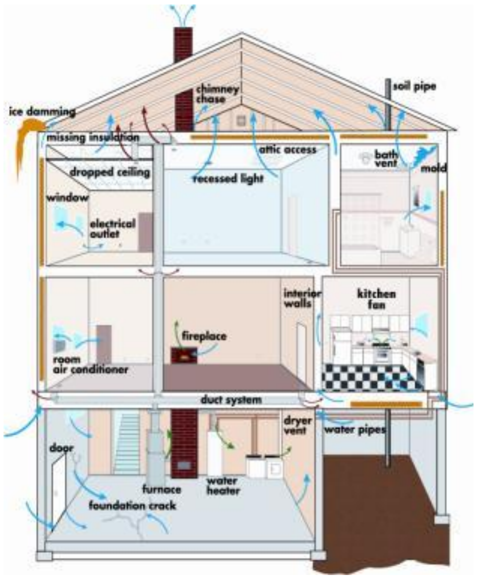


Figure 6: Energy Consumption by Fuel Type in Residential Sector



In addition to the factors mentioned above, national trends in residential energy over the past three decades indicate that the share of energy use by consumer electronics and appliances is on the rise accounting for 31% of total energy use in homes, according to the most recent Residential Energy Consumption Survey (RECS) completed by the U.S. Energy Information Administration (EIA) in 2009[1]. The survey also finds the average household has 2.5 televisions and 45% of homes have at least one television with a screen size of 37 inches or larger. As of 2009, 79% of homes had a DVD player, and 43% had a DVR. There was also an increase in personal computing products with 75% of households with a CPU and 35% with at least two. As homeowners continue to increase significantly the type and number of home electronics, they may find their household energy use increasing. Heating and cooling of residential space including water heating account for the remainder of the total energy use in homes, at approximately 69%.[1] Considering the aging housing stock in Charlottesville, where approximately 85% of total housing units were built before 1970, when full insulation of new homes was not standard practice, there is great opportunity to educate and assist homeowners in methods to improve the efficiency, comfort, and air quality of their homes. There has been an important evolution in understanding buildings and energy efficiency that takes into consideration building materials, the building envelope, and the efficiency rating of heating and cooling influences of climate and occupants. A building science approach – viewing buildings as a system of inter-related parts – has given rise to the energy assessment or energy audit as a means to evaluate building efficiency problems and opportunities. The great strides in the efficiency of heating and cooling equipment, appliances, insulation methods, and window technology can reduce consumption sufficiently that utility bill savings recoup the cost for the improvements.

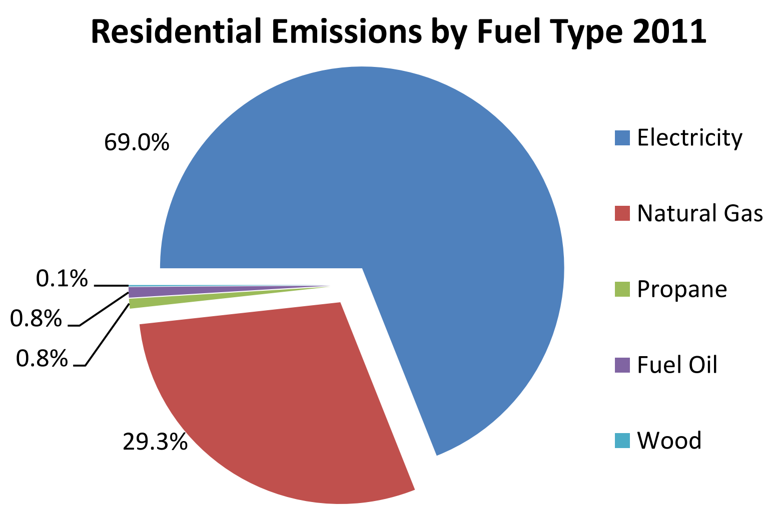


Figure 7: Residential GHG Emissions by Fuel Type, 2011

For our community, Figure 7 illustrates the breakdown of residential GHG emissions by fuel type. Nearly 69% of residential GHG emissions were generated through electricity provided by Dominion Virginia Power. Approximately 29% of residential GHG emissions were associated with the use of natural gas. Natural gas is typically used in residences as a fuel for home heating, water heating and cooking. (Figure 7)

3.3 Commercial and Institutional

The *Commercial/Institutional* subsector is an assorted mix of building types and energy demands. The inventory includes hospitals, higher education facilities, offices, houses of worship, lodging, and retail's big box stores, strip malls, grocery stores, fast food, and restaurants. Nationwide, the two largest energy-using areas are offices and retail spaces.[2] For all types of commercial buildings, especially larger buildings, lighting is responsible for ¼ of the energy use and heating and cooling combined account for an additional quarter.[3] As a whole, energy consumption in the commercial/institutional sector increased 19.9% from the baseline with the largest growth in energy use from fuel oil (87%), followed by natural gas (23%), and electricity (22%). (Figure 8)

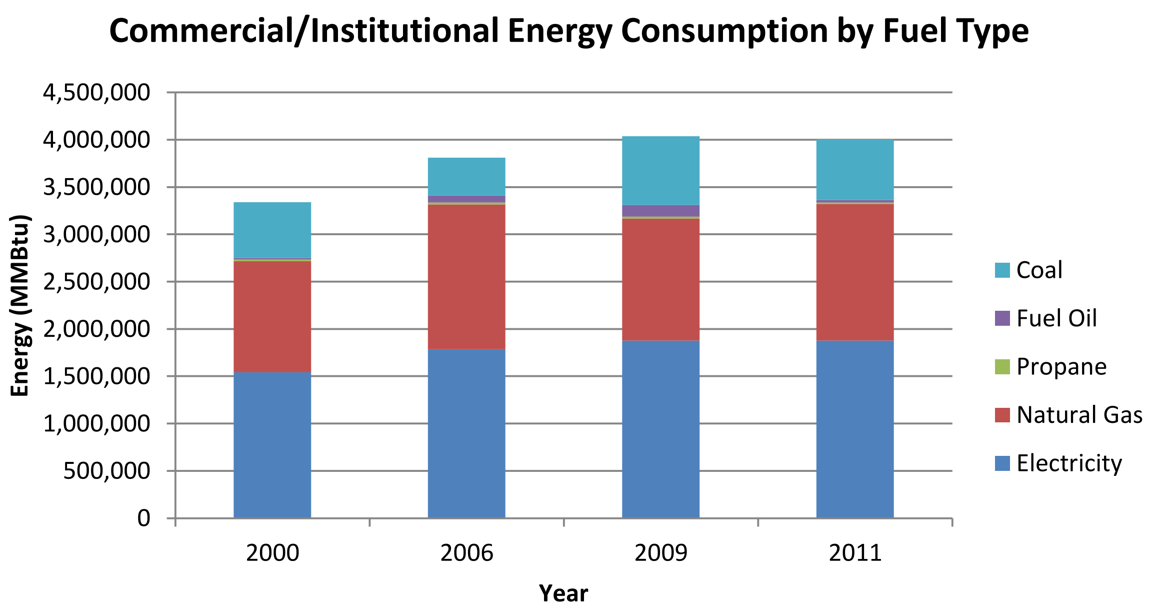


Figure 8: Energy Consumption by Fuel Type in Commercial/Institutional Sector

The GHG emissions associated with the *Commercial/Institutional* sector increased by 16% from the 2000 baseline measurements. When considered separately, the commercial sector experienced a less than 1% increase in GHG emissions from the baseline, and the institutional sector (which is representative solely of UVa) showed a 28% increase (Figure 9). Rising energy demand is associated with the expansion of UVa facilities and growth of the student population.

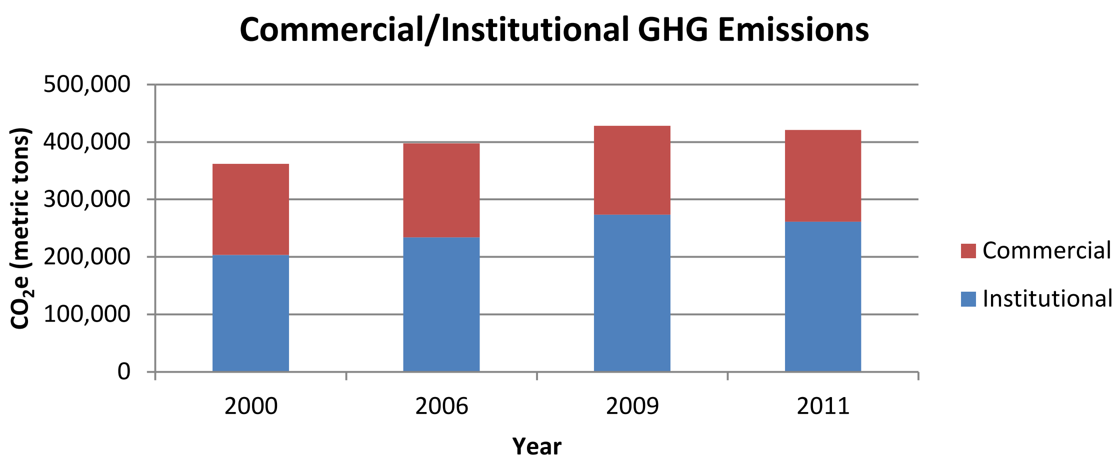


Figure 9: Commercial/Institutional GHG Emission Totals

3.4 Transportation

Emissions associated with the *Transportation* sector were calculated using vehicle miles traveled (VMT) data within the City limits. This data is available online through the Virginia Department of Transportation. Since this activity data accounts for all vehicles traveling on City streets, calculated fleet emissions from the municipal focus inventory were subtracted from the community total and discussed later in detail. 2011 GHG emissions linked to the *Transportation* sector totaled 16.7 % (120,111 metric tons CO_2e), a 13% decrease from 2000 levels. Emissions from gasoline powered vehicles show the greatest reductions with a 13.5% decrease from the baseline (Figure 10). Using "Journey to Work" data from the latest Census information available, the percentage of workers using public transportation (8.3%) and carpooling (10.6%) in Charlottesville have both increased slightly from 5.1% and 9.7% respectively since 2000.

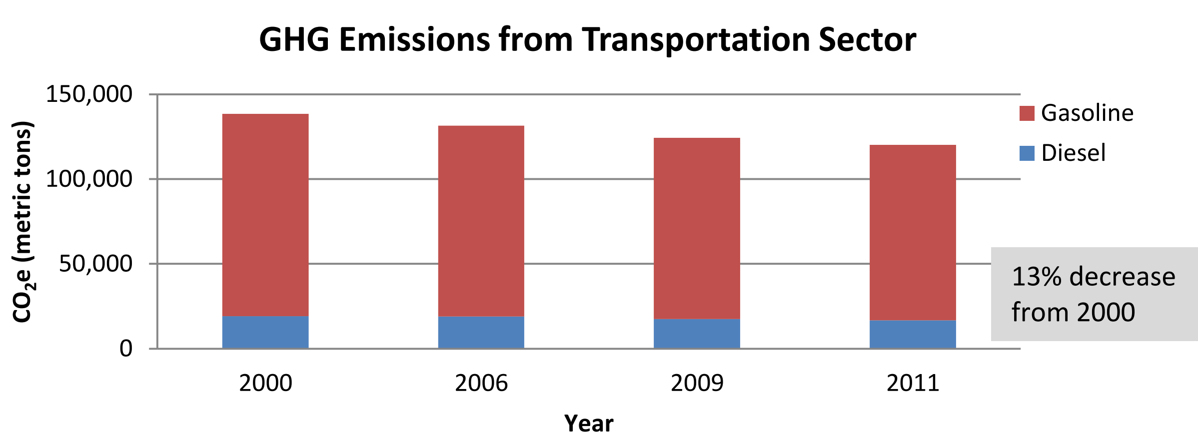


Figure 10: Transportation Section GHG Emissions

3.5 Waste

Emissions associated with the disposal of municipal solid waste (MSW), commonly known as household trash, were calculated based on the total tons of waste generated and collected during a given year within the boundaries of the City – regardless of the location of the landfill. In 2011, Charlottesville – community and municipal – generated 34,334 tons of MSW. A private company, contracted by the City of Charlottesville, collects the majority of the community's waste. This volume includes waste from the residential, commercial (downtown businesses), and municipal (city government buildings and schools) sectors. The remaining commercial, industrial, and multi-family properties receive waste collection services from other private vendors.

Since the 2000 baseline report was written, the City is now able to estimate its municipal waste production and has measured the amount of waste it produced in 2011.We are unable, however, to backcast an estimate of waste production to the baseline year of 2000. As such, to remain consistent with the baseline, municipal waste is included in the *Waste* sector instead of the *Municipal* sector in this *Community Overview* section. A more detailed look at the municipal waste can be found later in this report under the *Municipal Focus* section.

As noted above in Figure 1, the *Waste* sector constituted 3.43 % of total 2011 Charlottesville emissions. Emissions from the *Waste* sector are an estimate of methane generation from the anaerobic decomposition of organic wastes (such as paper, food scraps, plant debris, wood, etc.) that are deposited in a landfill. As such, waste generated in Charlottesville is associated with the production of 24,693 metric tons of CO_2e. Through the increased participation in the recycling services provided by the City and other options for MSW diversion from landfills available in the community, the amount of landfilled waste decreased by 5% as compared to the 2000 baseline, equal to a reduction of 5,656 metric tons of CO_2e and 593,687 lbs. of methane (Table 5).

Table 5: Waste Generated in Charlottesville & Emissions

	Waste Generated (tons)	CH_4 (lbs.)	CO_2e (metric tons)
2000	36,181	3,186,055	30,349
2006	38,158	2,930,014	27,910
2009	34,835	2,651,787	25,259
2011	34,334	2,592,368	24,693

3.6 Municipal

Emissions associated with Municipal Operations are from four main areas: Facilities, Streetlights & Traffic Signals, Fleet (including both Public Transit and Pupil Transportation), and Waste. When the 2000 Baseline was written, municipal waste was tracked and reported in combination with all other community produced waste. Since the 2000 Baseline, municipal waste has begun to be tracked separately, however, to remain consistent, this report represents municipal waste within the waste sector of the **Community Overview** (providing comparisons between the 2000 and 2011 inventories), and later discusses it separately in the **Municipal Focus** section.

The emissions associated with municipal operations (Facilities, Streetlights & Traffic Signals, and Fleet) are a small percentage of the total community inventory (2.7%). Overall, emissions associated with municipal operations are down by 18% from the baseline. The largest contributor within the municipal inventory is from the facilities area. Since 2000, there has been a shift in emissions with proportionally less coming from Facilities and Streetlights & Traffic Signals coupled with an increase in emissions from Fleet, largely due to an expanding the Public Transit service.

It is important to track municipal operations because they reflect progress towards goals made by the community and embodied in the *Green City Vision 2025*, and can provide examples of effective emissions reduction strategies that could be applied throughout the community.

Further discussion of the municipal sector can be found in the **Municipal Focus** section on page 38.

4.0 GHG Emissions and LCAPP

The Local Climate Action Planning Process (LCAPP) Report, recognizing the close association between greenhouse gas (GHG) emissions and energy use, offered a Five-Part Framework for our Community Energy Profile as a format to organize and approach energy use and GHG emissions in the community (Figure 11). The Framework considers energy in relation to five areas: the built environment, mobility, sourcing, materials, and the landscape. The sectors associated with GHG emissions, as discussed within this report, can be considered to align with three of the Framework's five areas: the built environment, mobility, and materials (Figure 12).

Figure 11: Transportation Section GHG Emissions

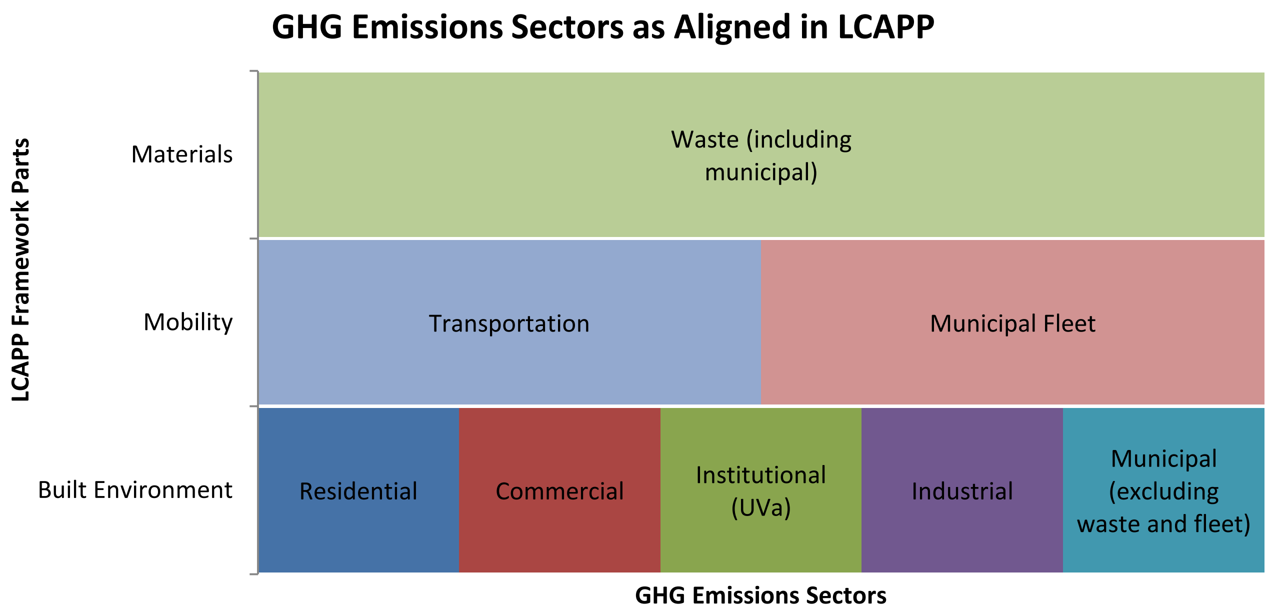


Figure 12: GHG Emissions Sectors as Aligned in LCAPP

GHG emissions were calculated and organized by data gathered in the built environment, transportation, and materials sectors. As an overall average, community GHG emissions increased 7% from the baseline. Emissions from the Built Environment increased by 14% while the Mobility and Materials sectors, which measure GHG emissions from vehicles traveling on City streets and municipal solid waste deposited in landfills, both present lower emissions than the 2000 baseline measurements (Figure 13).

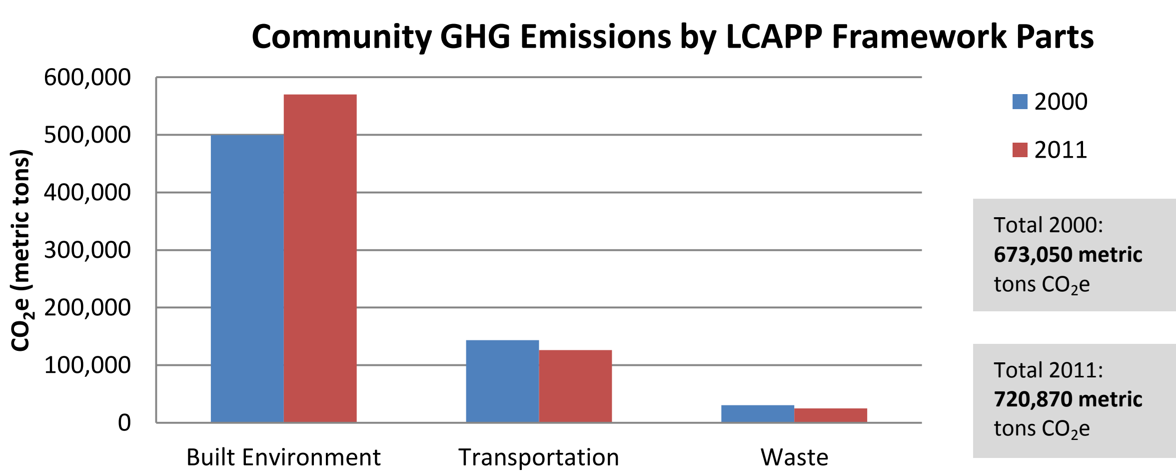


Figure 13: Community GHG Emissions by LCAPP Framework Parts

The following sections consider each of the *Framework*'s five parts and discuss efforts, successes, and influences within them.

4.1 Energy & the Built Environment

On average, buildings account for 40% of all energy use in the U.S. and consume more energy than either transportation or industrial sectors. The built environment is the largest component of the Charlottesville community energy profile and is responsible for over 75% of the total 2011 Community GHG emissions at 570,051 metric tons CO_2e. This large sector includes residential, commercial, institutional, governmental, and industrial buildings and operations. The GHG emissions from the commercial and residential areas of the built environment together account for 52% of the total emissions. While 46% of the total built environment emissions are associated with UVa (Figure 14).

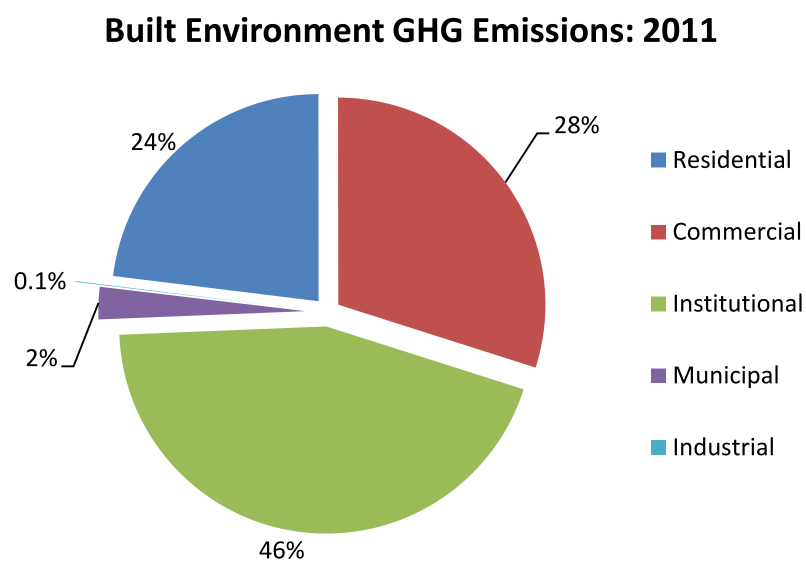


Figure 14: Built Environment GHG Emissions: 2011

The built environment is vital to the strength of our local economy and vibrancy of our City. This area of the community receives a lot of attention from citizens because of the increasing interest in saving money on utilities as well as feeling comfortable in their homes and at work. From homeowners and renters to business owners and property managers, many in the community continue to express interest in saving energy and water for both the bottom line and for the goal of sustainability. Following the action strategies of the LCAPP Report, the community should continue with and create programs and resources that "Reduce energy demand in existing buildings, Increase energy efficiency performance of new buildings, and Incentivize and enable building to green building standards and practices.

leap
local energy alliance program

One of the most significant initiatives launched in the Charlottesville area in 2009 that focused on the subject of energy efficiency in the built environment is The Local Energy Alliance Program (LEAP). LEAP is a community-based nonprofit serving Albemarle, Fluvanna, Greene, Louisa and Nelson Counties and the City of Charlottesville. Leveraging and bundling existing incentives from all levels of government and local utilities, LEAP provides local residents and property owners with a one-stop shop for information on options, service providers, and financial assistance for residential and commercial energy efficiency retrofits that create more comfortable, healthy, and affordable homes and buildings.

LEAP's mission is to lead the effort in our local community to conserve water and energy in buildings to promote cost savings, job creation, local economic development, and environmental stewardship. A key component to the City's strategy to address energy efficiency opportunities in the community is through supporting and utilizing LEAP's expanding programs and services to achieve energy improvements. The City has previously contracted with LEAP to conduct home energy assessments/improvements for income-qualifying residents through a locally-funded initiative. The City recognized the opportunity to increase support for energy efficiency improvements in the residential sectors by designating its 2009 federal Energy Efficiency and Conservation Block Grant (EECBG) funds for specific initiatives linked to this opportunity. To date, 180 energy audit rebates have been issued and an interest-rate buy down program for an energy efficiency retrofit loan program offered by the UVA Community Credit Union has been established. The impact of works performed with the EECBG funds along with several other substantial grants, can be measured as energy savings of nearly 7 million kWh annually, an amount of emissions reduced equivalent to the annual GHG from 959 passenger vehicles. It is anticipated that this strategic infusion of funding support to raise awareness, accessibility, and affordability of energy efficiency improvements will contribute to the ongoing success of LEAP and achieve energy saving and GHG emissions goals of the community.

The basic services for homeowners that are facilitated by LEAP include testing the efficiency of the home, providing tailored improvement recommendations, and the coordination of energy efficiency upgrades with pre-qualified LEAP Contractors based on the improvements the homeowner decides to pursue. In addition to the recent round of energy savings incentives from LEAP, a one-time 50% Energy Efficient Building Tax Rate can be obtained by owners of qualifying buildings. The City also offers homeowners rebates on WaterSense toilets, programmable thermostats, gas water heaters, rain barrels, and, for a limited time, home energy reviews. Additional information on incentives for local residents and property owners including rebates, financing and financial assistance, workshops, and more can be obtained from LEAP (www.leap-va.org). The most recent initiative to promote residential energy efficiency is the Energize! 250 campaign for City homeowners. This effort, in the spirit of the City's 250th anniversary celebrations, strives to get 250 homeowners to get discounted home energy reviews in 250 days and collectively achieve 10% energy use reduction.

On the commercial side, one widely known measure of building energy performance used by the Charlottesville local government and other commercial buildings in this community is the U.S. Environmental Protection Agency's (EPA's) ENERGY STAR certification. These certified buildings meet strict energy performance standards set by EPA, use on average 35% less energy, are less expensive to operate, and have lower fewer greenhouse gas emissions than similar buildings nationwide. EPA provides a free online tool called ENERGY STAR Portfolio Manager to help measure the energy use of commercial buildings, compare building with other, similar facilities, and strategies for energy management and improvements. ENERGY STAR provides the tools necessary to assist property owners in benchmarking their building's energy use allowing them to make more informed decisions and potentially reduce energy use and demand. In addition to municipal and city school buildings discussed later in the *Municipal Focus* section that have achieved the certification, two grocery stores, one lodging facility, and three offices in Charlottesville that are Energy Star certified.

Launched in 2011, the Charlottesville Area Better Business Challenge, a collaborative effort of the City, County, UVa, LEAP and Better World Betty, created a friendly competition among commercial businesses challenging them to incorporate sustainable practices into their operations and space. This competition provided suggestions on a variety of action items (many of which were no or low cost), hosted free workshops and events, and created awareness of example businesses efforts. The informational website for the Challenge also served as a "go-to" resource for the community covering the topics scored in the competition: energy use, water use, waste reduction, transportation options, purchasing and leadership.

CHARLOTTESVILLE AREA
BETTER BUSINESS CHALLENGE

Another widely accepted certification for green building standards and practices is the Leadership in Energy and Environmental Design (LEED) rating system, developed by the U.S. Green Buildings Council (USGBC). This program recognizes the whole building approach to sustainability in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection, and indoor environmental quality. In Charlottesville, there are 24 certified buildings including the Boys and Girls Club of Charlottesville, the Downtown Transit Station, and UVA's Physical

and Life Sciences Research Building to name a few. The City of Charlottesville and the University of Virginia have existing green building policies committing all future new construction projects meet LEED standards. This leadership provides increased awareness of the advantages of these high performing buildings and promotes the use of particular strategies in private projects.

Members of the community are particularly interested in low and no cost measures to reduce energy use. The City/LEAP partnership continues to be an effective strategy to provide information and opportunities for both homeowners and business owners to reduce energy consumption and save money.

4.2 Energy & Mobility

There are a variety of transit services and commuter friendly programs available in Charlottesville that help reduce vehicles on the road and provide alternatives to single occupancy travel. Public transit provided by Charlottesville Area Transit (CAT) offers service on seventeen routes. In 2009, CAT - for the first time ever - had more than two million passengers board its buses in a single year, an 18% increase in boarding's over the previous year. The CAT Free Trolley is a signature route that helps alleviate vehicle traffic and transportation-related GHG emissions in the City by servicing the following activity centers; University of Virginia, UVA Medical Center, Scott Stadium, The Corner, Downtown Transit Station and downtown Charlottesville.

Two other public transit agencies, University Transit Service (UTS) and JAUNT Paratransit Service, have major presences in the Charlottesville area. UTS is the transit service UVA provides to its students, faculty, and staff. JAUNT is a regional public transportation system providing demand response service to the citizens of Charlottesville and five surrounding counties in Central Virginia. They also provide additional services including human service agency transportation, rural demand response service, and commuter route service.

Carpooling is another means of reducing vehicles on the road in the City of Charlottesville and is a popular option for many employees who commute to Charlottesville from surrounding cities. RideShare, is a program of the Thomas Jefferson Planning District Commission in cooperation with the Central Shenandoah Planning District Commission, working to assist commuters. This program offers free carpool and "SchoolPool" matching, a guaranteed ride home program for use in emergencies to alleviate carpool apprehension, vanpool coordination, and other employer

services. More information is available at, http://www.rideshareinfo.org. The Department of Parking and Transportation at UVa has implemented a Cavpool program (www.virginia.edu/parking/TDM) to reward carpools with discounted permit rates, free Occasional Parking Permits for those days when members need to drive separately, and a special Zipcar bonus. UVa also has a free online ride matching service contracted with Zimride. Additional information on both programs is available at http://www.virginia.edu/parking/TDM/.

Charlottesville, a Bronze Level Bicycle Friendly Community since 2003, achieved the Silver Level of honor in 2012 as recognized by the League of American Bicyclists. The Bicycle Friendly Community Program awards recognition to communities that actively support bicycling by providing safe accommodation for cycling and encouraging people to bike for transportation and recreation. In addition, the Charlottesville-Albemarle Metropolitan Planning Organization released a new Cville Bike mApp, a free bike route mapping application for iPhone and Android phones, to collect data from users that will be used to help inform long range transportation planning. The Cville Bike mApp project received national recognition from the American Planning Association with a feature article in its December 2012 *Planning* magazine.[4]

4.3 Energy & Materials

Source reduction, recycling, re-using, and composting are all methods available in the community to minimize waste and thus reducing GHG emissions. By focusing at the beginning of the waste stream, purchasing decisions can be made to limit the amount of material that has to be disposed and the amount of resources it required to create them. The local government operations of the City of Charlottesville have implemented several Environmentally Preferable Purchasing practices specifying the use of products ranging from office paper to building materials with a high-recycled content, to materials that can be recycled, are durable and long-lasting. Additionally, the City's Board of Architectural Review supports "adaptive reuse of a historic building or living in a pre-owned home" and "locally obtained building materials, rapidly renewable or recycled materials, non-toxic materials and finishes, and wood certified by the Forest Stewardship Council".

Charlottesville offers a very popular curbside recycling program for residents and many commercial businesses along Main Street and on the Downtown Mall. Annually, this program collects around 3,500 tons of recyclables (up 69% from 2000). The City's Public Works Department collects leaves annually to be composted and offers a pick-up service for brush and other large debris that are turned into mulch. These services accounted for over

4,000 tons of material being diverted from the landfill in 2009 and 2011 combined. In addition, approximately 6 tons of appliances, furniture and other bulk items are picked up and recycled annually. Another recycling option for members of the community is drop-off recycling centers located, McIntire Road Recycling Center and Ivy Materials Utilization Center, facilities operated by the Rivanna Solid Waste Authority (RSWA). RSWA also provides bi-annual Household Hazardous Waste Days, Vegetative Waste Mulching, and an Encore Shop for the collection and sale of reusable items.

The University of Virginia (UVa), included in the community waste & emissions measurement, contributes approximately 21% of the total waste generated. UVa is continually improving their procedures for recycling, composting, and waste reduction. On average, UVa recycles 43% of its MSW and overall diverts approximately 72% of all discarded tonnage from being landfilled including chemicals, tires, oil, batteries, electronics, and lamps/ballasts. For a more detailed look into the variety of recycling and waste diversion programs and initiatives at UVa, refer to the 2011 University of Virginia Sustainability Assessment, http://www.virginia.edu/architectoffice/pdf/2011_UVA_SustainabilityAssessment.pdf.

4.4 Energy Sourcing

Energy savings is only a portion of the road towards sustainability in our community. As expressed in the *Five-Part Framework* of our Community Energy Profile of the LCAPP Report, energy sourcing is also a valuable component of an emissions reduction strategy. Per the *Five-Part Framework,* the strategies associated with energy sourcing include promoting wider awareness and adoption of cleaner sources of electrical energy, energy for heating/cooling systems, and hybrid, electric and biodiesel vehicles. Cleaner sources of energy are available through renewable sources such as solar, wind, water (hydropower), biomass, and geothermal. These forms of renewable energy account for 9% of the total U.S. Energy Consumption. When renewable sources are used there is less demand for fossil fuels, which are exhaustible and directly emit greenhouse gases.

4.4.1 Alternative Energy Sourcing for Buildings

Local examples of solar projects include a 108kW Solar PV system on the roof of the Charlottesville High School (CHS). This system provides approximately 8% of the total CHS power demand and will save an estimated $1M over 25 years. Recently, a Single Room Occupancy building operated by the Virginia Supportive Housing was constructed and includes a 36 kW roof top solar array designed to provide 20% of the buildings required electricity. Also in 2012, a commercial business, Main Street Arena, installed a 68 kW solar PV system on the roof of their ice skating and entertainment building. Another technology that is becoming more prevalent in both residential and commercial properties is solar hot water heaters, a very cost effective and sustainable way to provide hot water to the home. In addition to federal and state incentives the City of Charlottesville offers a solar energy tax exemption on solar energy equipment, facilities, and devices.

Since 2007, geothermal technology for heating and cooling was incorporated into the design and construction of three new City of Charlottesville facilities: The Downtown Transit Station, Smith Aquatic Center, and the Charlottesville Area Transit Base. This type of heating and cooling system takes advantage of the relatively constant temperature of the Earth's surface and reduces the energy needed to heat or cool a building.

4.4.2 Alternative Energy Sourcing for Transportation

Over the last decade, the adoption of hybrid electric vehicles in the community has been popular. Charlottesville ranked 7th in the list of metropolitan areas where hybrids are most popular according to hybridcars.com online article *November 2008 Hybrid Market Dashboard Summary*.[3] Popularity is measured by the number of new hybrids per 1,000 households with Charlottesville scoring 4.875. Hybrid vehicles are designed to achieve improved fuel economy as well as produce fewer emissions than conventional vehicles. Hybrid electric vehicles are widely used in the City fleet and, recently, Yellow Cab of Charlottesville announced that it is in the process of purchasing 30 new hybrid electric vehicles to use in the community. Charlottesville is also currently involved with a research and development project in partnership with the U.S. Department of Energy that will demonstrate the viability of all-electric vehicles and the benefits of fast charging technology in several municipal applications. The advantages of all-electric vehicles include decreased greenhouse gas emissions and reduced demand for fossil fuels. The scope of this project includes overall engineering and planning, construction of two electric vehicle dual Level 2 and DC Fast Charge stations, addition of three electric Nissan Leaf vehicles to the Fleet, and an engineering study.

4.5 Energy & the Landscape

The final component of the LCAPP Five-Part Framework pertains to role of the landscape in the community with respect to energy use and carbon sequestration. Landscaping for energy efficiency by planting trees to shade homes and businesses can reduce heating and cooling costs. Forests in a community potentially contribute 1 to 5% of emission reductions through absorption of $CO2$ and storage of carbon in the tree trunks, branches, foliage, roots and soils. Additional benefits of the forest canopy include improved air and water quality, diverse wildlife habitat, reduced urban heat island effect, and decreased flooding. In general, planning, decision-making,

• • •

Charlottesville's tree canopy coverage is estimated at 47%

Charlottesville earns The Arbor Day Foundation Tree City USA recognition since 2007 and awarded "growth award" in 2010

• • •

and implementation of future actions in Charlottesville should recognize the importance of maintaining, expanding, and managing a healthy tree canopy for multiple goals.

Guided by its 2009 Urban Forest Management Plan, the City continues to focus on the quality of the canopy by replacing invasive species with natives and properly maintaining and managing the current canopy. The Meadow Creek Stream Restoration project, completed in 2012, involves stream restoration along a 9,000 linear foot corridor as well as enhancement preservation of the forested buffer and wetlands and permanent conservation of the 72 acre area.

5.0 CRITERIA AIR POLLUTANTS

Criteria air pollutants are a set of air pollutants common in all areas of the United States and are regulated by the Clean Air Act. This act requires EPA to set National Ambient Air Quality Standards for the following six criteria air pollutants: ozone, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxide, and lead. These pollutants not only are harmful to human health and the environment but also can cause property damage through the formation of acid rain. Of the six pollutants, particulate matter and ground-level ozone are linked to widespread health threats including asthma, heart disease, altered lung function, and lung cancer. In Virginia, ground-level ozone is recognized as the most problematic pollutant and various areas have reported noncompliance with the standards mentioned above. Characteristics of ozone make it possible to be transported long distances by wind; high transport amounts arriving from the mid-west are being tracked by the Virginia Department of Environmental Quality.

Ground-level Ozone

Created by chemical reactions between NOx and volatile organic compounds (VOC)

Levels increase on hot sunny days

Transported long distances by wind

The CACP accounting tool calculates and inventories the following criteria air pollutants using energy and fuel use data: nitrogen oxides (NOx), carbon monoxide (CO), sulfur oxides (SOx), volatile organic compounds (VOC), and particulate matter (PM_{10}). In Charlottesville during 2011, total criteria air pollutants were largely the associated with gasoline combustion and use of fossil fuels for electricity demand from the built environment, 35.0% and 35.7 %, respectively (Figure 15). Coal used for energy production at the UVa Main Heat Plant contributes 22.1% of the total criteria air pollutants in Charlottesville. Air pollutants linked to municipal operates are largely a result of fossil fuel based electricity consumption.

In Virginia, criteria air pollutants are following a downward trend. For example, Virginia has significantly reduced the number of days when the ozone standard was exceeded, from 509 days per 3-year average between 1998 and 2000 to an average 72 days between 2008 and 20105. Criteria air pollutants calculated by the CACP software were greater in 2000 from community activities compared to 2011 amounts, with a total reduction of 5.9% (Figure 16).

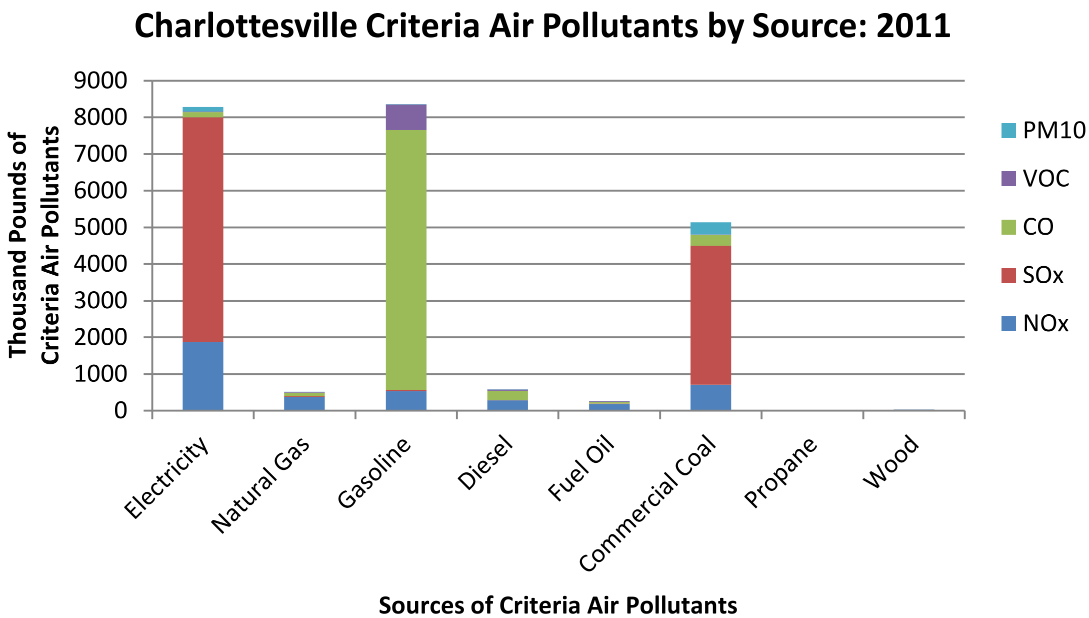


Figure 15: Community Criteria Air Pollutants by Source: 2011

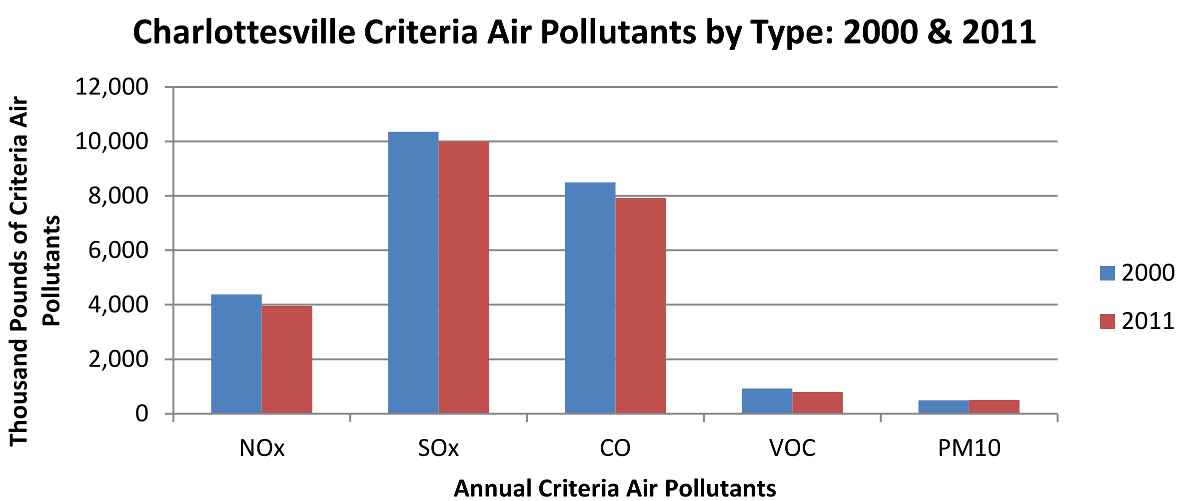


Figure 16: Community Criteria Air Pollutants by Type: 2000 & 2011

6.0 MUNICIPAL FOCUS

The government operations emissions inventory is a subset of the community emissions inventory; for example, data on commercial energy use by the community includes energy consumed by municipal buildings, streetlights & traffic signals, and community vehicle-miles-traveled estimates include miles driven by municipal fleet vehicles. By analyzing emissions in this manner, Charlottesville's local government is enabled to understand its own impact within the community and lead by example to reduce its impact on the environment. Although the emissions associated with municipal operations are a small percentage of the total community inventory (2.7%), they are important to track because they provide an opportunity to identify effective emissions reduction strategies that can be applied throughout the community.

6.1 GHG Emissions Summary

Within the operational boundaries of Charlottesville's local government, the three main areas in which GHG emissions are measured: Facilities, Streetlights & Traffic Signals, and Fleet (including both Public Transit and Pupil Transportation). The largest contributor within the municipal inventory is from the facilities area with City-owned facilities responsible for 59% of the total municipal emissions (Figure 17). The remaining municipal emissions are the result of electricity use associated with the operation of streetlights and traffic signals and fuel use associated with the vehicle and transit fleet. Since 2000, there has been a shift in emissions with proportionally less coming from Facilities and Streetlights & Traffic Signals coupled with an increase in emissions from Fleet (Figure 18).

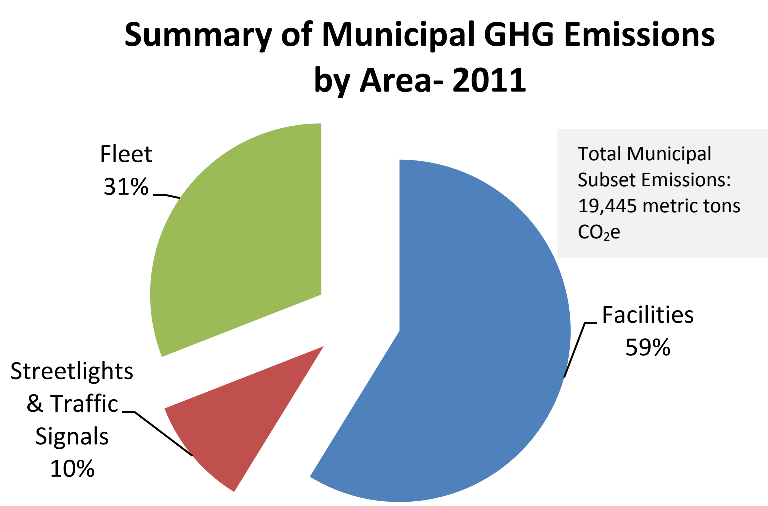


Figure 17: 2011 Summary of Greenhouse Gas Emissions Associated with Municipal Operations

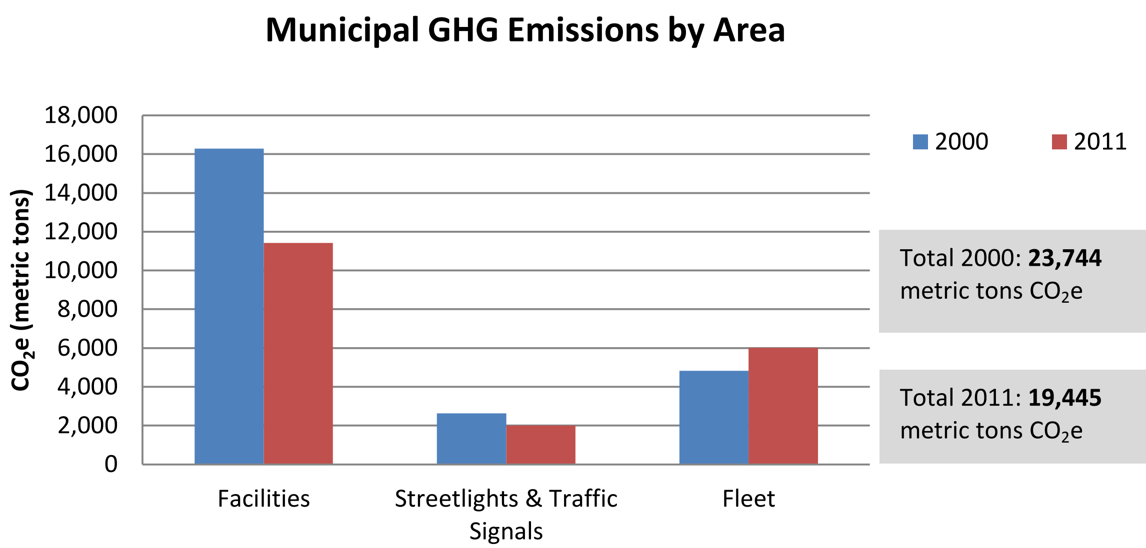


Figure 18: Municipal GHG Emissions by Area: 2000 & 2011

Overall, emissions associated with municipal operations are down by 18% from the baseline. The City has successfully decreased emissions associated with the use of electricity, natural gas, and gasoline (Figure 19). An increase in emissions associated with diesel is observed, largely due to demand associated with an expanding Public Transit operation (Figure 19).

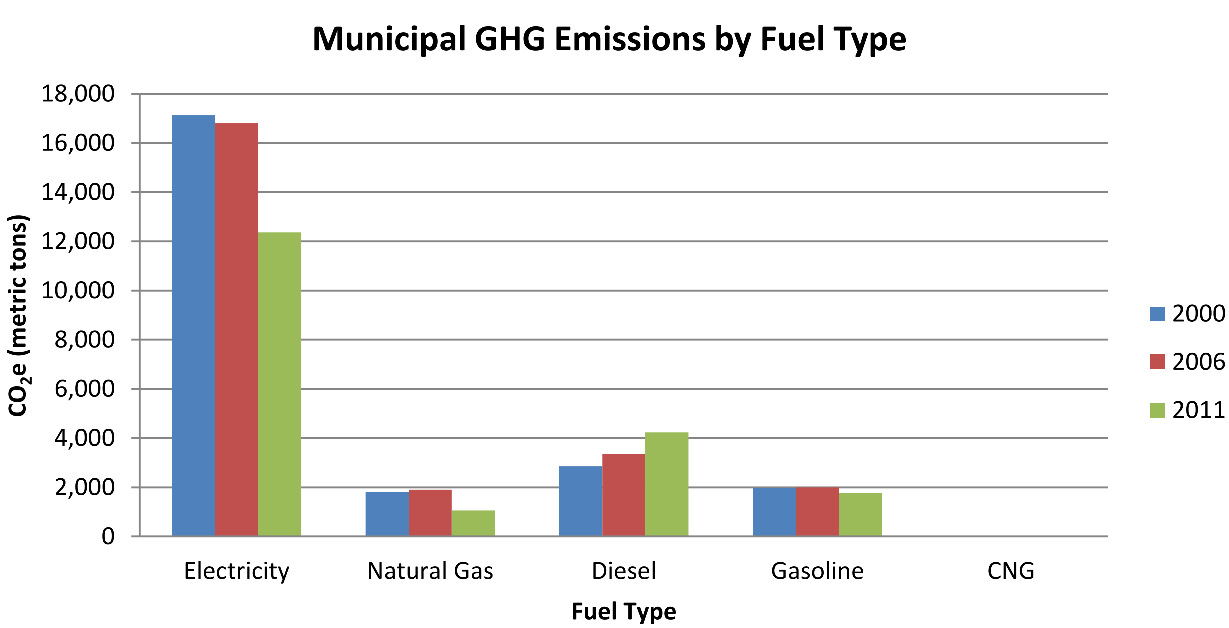


Figure 19: Municipal GHG Emissions by Fuel Type: 2000, 2006, 2011

6.2 Facilities

The scope of Facilities measured for this inventory encompasses 39 city-owned buildings, 9 city schools, as well as the buildings and outdoor lighting at 29 parks, pools, and other recreational facilities. Consumption of electricity and natural gas, the major energy sources used by these facilities, is totaled for each year allowing for the calculation of associated GHG emissions.

The utility data referenced in this inventory is tracked in a centralized database and is monitored in an ongoing manner at a detailed building-by-building level. As of 2007, the City has also utilized the EPA Energy Star Portfolio Manager tool for its larger facilities, which provides the ability to track and assess energy and water consumption within individual buildings and across a complete building portfolio. This tool also provides the ability to benchmark buildings relative to weather-normalized past performance, verify the progress of improvement projects, and determine a building's Energy Star rating.

Benchmark: a standard against which something can be measured or assessed

6.2.1 Energy, Cost, & Emissions

The City of Charlottesville and Charlottesville City Schools have reduced electricity and natural gas consumption in their buildings through building improvements, energy efficiency measures, occupant education, and the consistent monitoring of utility data. Compared to the 2000 baseline, in 2011, the City used 37,464 less MMBtu of energy associated with Facilities, a 29.5% reduction (Figure 20). This decrease in energy use is further notable considering that since 2006 the total square footage of the City's building stock increased 7.8% or an additional 122,020 sq. ft.

Reducing energy use in the City's facilities saves the City on monthly utility costs and reduces the City's vulnerability to rising energy prices. For instance, rising energy prices locally have increased at an annual average of 8% since 2000. In 2011, the City spent $185,144 less on electricity and natural gas utility costs than in 2000. Considering the higher utility rates in 2011 compared to 2000, the total avoided cost of $844,042 takes into account the potential for utility bills in 2011 if the City had continued to consume the same amount of energy as in 2000. (Figure 21)

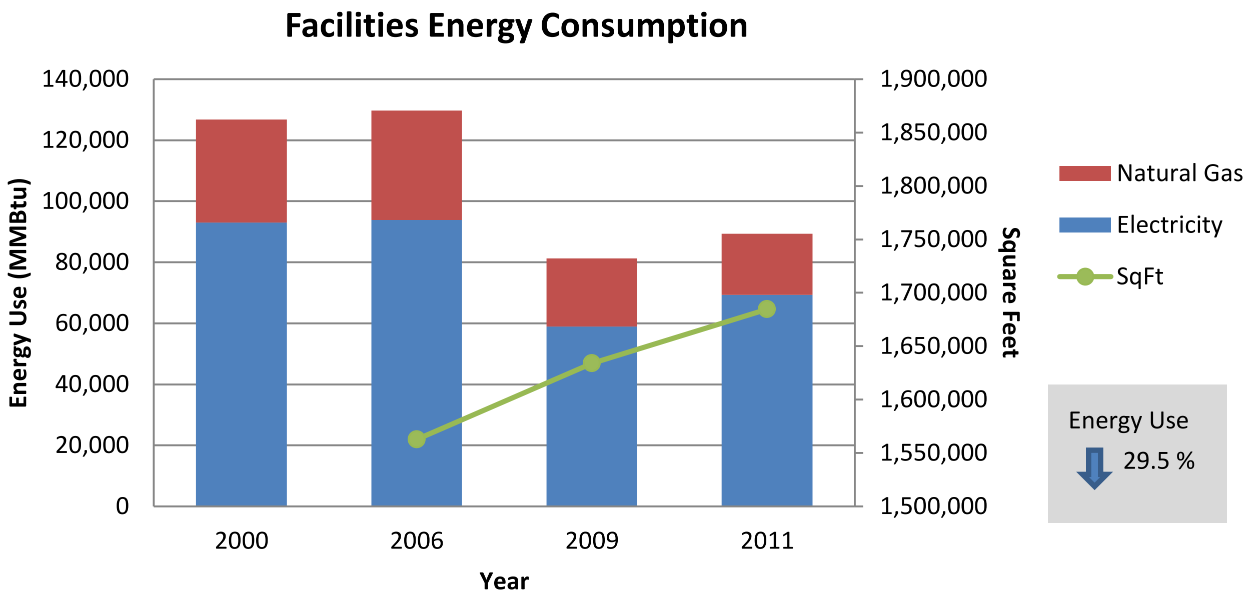


Figure 20: Electricity and Natural Gas Consumption in Facilities Area

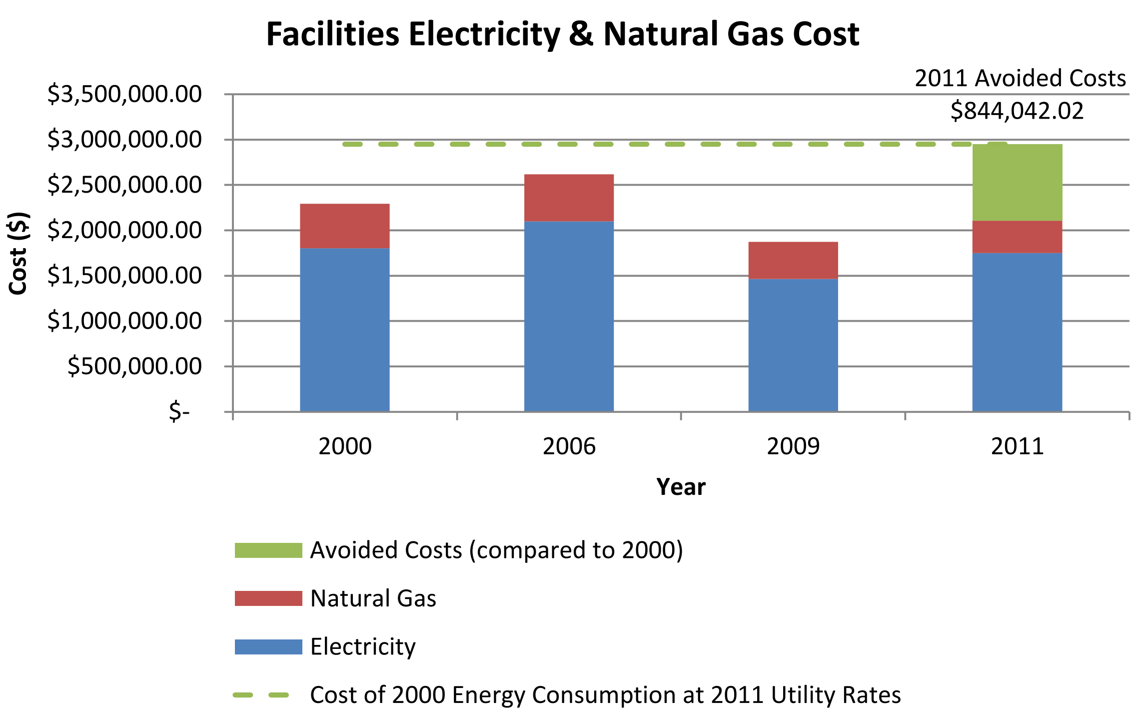


Figure 21: Total and Avoided Utility Cost in Facilities Area: 2000, 2006, 2009, 2011

The 2011 inventory update presents a significant reduction in GHG emissions from the baseline. In 2011, the City emitted 4,861 less metric tons of CO_2e associated with electricity and natural gas use in the *Facilities* area compared to the baseline. Individually, CO_2e emissions from electricity are down 28% and 41% for natural gas (Figure 22). Together, the emissions associated with electricity and natural gas use in the City facilities are 29.8% less than the GHG emissions associated with *Facilities* in 2000.

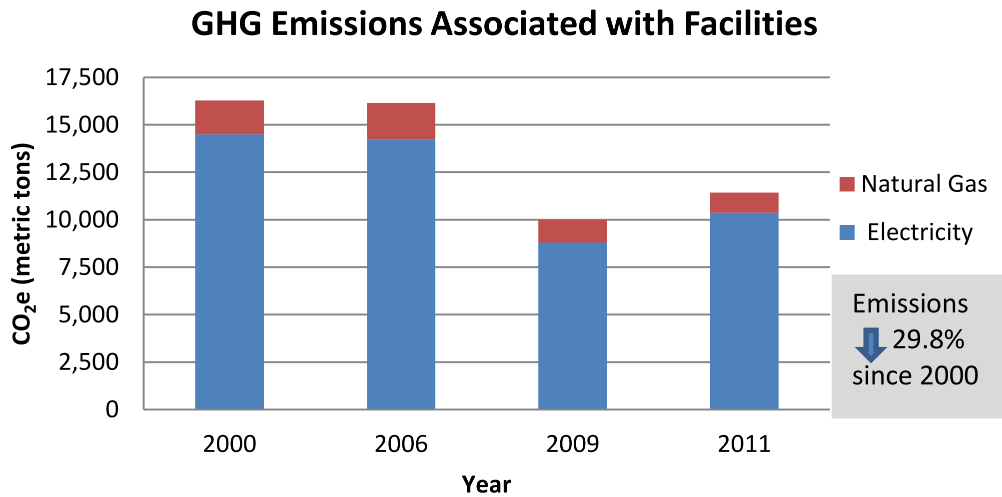


Figure 22: Facilities GHG Emissions: 2000, 2006, 2009, 2011

6.2.2 Highlights

Reductions in energy use, cost, and emissions compared to the baseline are reflective of three major efforts of the City improving the efficiency of existing facilities, pursuing high performance green buildings for all new facilities, and operational adjustments.

LEED Facility - Under Construction
Fontaine Fire Station
(spring, 2013)

Thin film rooftop PV system

Geothermal well system

Tubular daylighting

20,000 gallon rainwater harvesting system used for vehicle washing & other non-potable usage

The first piece of the City's efforts is improvements made to existing facilities. In 2008, a $1.8M Energy Performance Contract was used to identify, assess, and make improvements in 31 city buildings. Energy efficiency improvements implemented include upgrades of over 8,000 lighting and water fixtures, the addition of 1,700 occupancy sensors, and the installation of a solar thermal system to supplement the hot water supply at the Central Fire Station. The Bypass Fire Station also received infrastructure improvements including a high efficiency furnace and air conditioning upgrade and the addition of insulation resulting in a 34% decrease in energy use for that specific building.

As mentioned before, an increasingly common industry standard for tracking and comparing a building's utility improvement and performance is EPA's Energy Star certification program. As of November 2012, seven City schools have achieved Energy Star certification and, on average, had individually reduced their energy use by 11.75 % since 2007. Another example is City Hall Annex. With an Energy Star score of 81 out of 100, City Hall Annex had successfully reduced its energy consumption by 30%. Contributing buildings improvements included boiler and air handler replacement as well as upgrades to the building automation system. The City Hall Complex received improvements as well, including replacement of the roof the incorporation of a green roof component, better insulation, and replacement of windows.

The City's commitment to green buildings was formalized in 2008 through the adoption of a Green Building Policy applicable to major new municipal buildings and renovations, with the USGBC Leadership in Energy and Environmental Design (LEED) as the relevant standard. In 2007, the City opened the Downtown Transit Station, the first LEED gold-certified municipal building in Virginia. Designed with increased efficiency as a primary goal, the Downtown Transit Station uses geothermal cooling and heating, continuous electrical and mechanical monitoring and control, cooler reflective roof material, and insulated window glass. The LEED Gold- certified Charlottesville Area Transit Operations and Maintenance Facility was completed in 2010, and the LEED Platinum-certified Smith Aquatic & Fitness Center opened in 2011. These three new facilities account for an additional 80,000 SF of high performance design and integration of some of the latest technologies (e.g., integrated geothermal heating and cooling technologies, solar thermal systems, and passive ventilation).

6.3 Streetlights & Traffic Signals

The City of Charlottesville is responsible for lighting in the public right-of-way, which includes the operation and maintenance of 4,145 streetlights and ornamental lights plus 72 traffic signalized intersections. The majority of the energy consumed (94%) in this area is used to power streetlights. These lights vary from the standard Dominion-owned streetlights (3,808) to the City-owned ornamental lights (337) located throughout the City. Traffic signals are the other key component of this area of the inventory and are closely monitored by the Public Works Department.

6.3.1 Energy, Cost, & Emissions

The City has been successful in reducing energy use and thereby decreasing GHG emissions and cost associated with street lighting and traffic signals since 2000. The latest 2011 utility data shows a 20.8% reduction in electricity (Figure 23) and a 24% decrease in GHG emissions during this same period (Figure 24). The 2011 annual expenditure for streetlight and traffic signal electricity is approximately $166,000 less than in 2000 - a 21% reduction in cost.

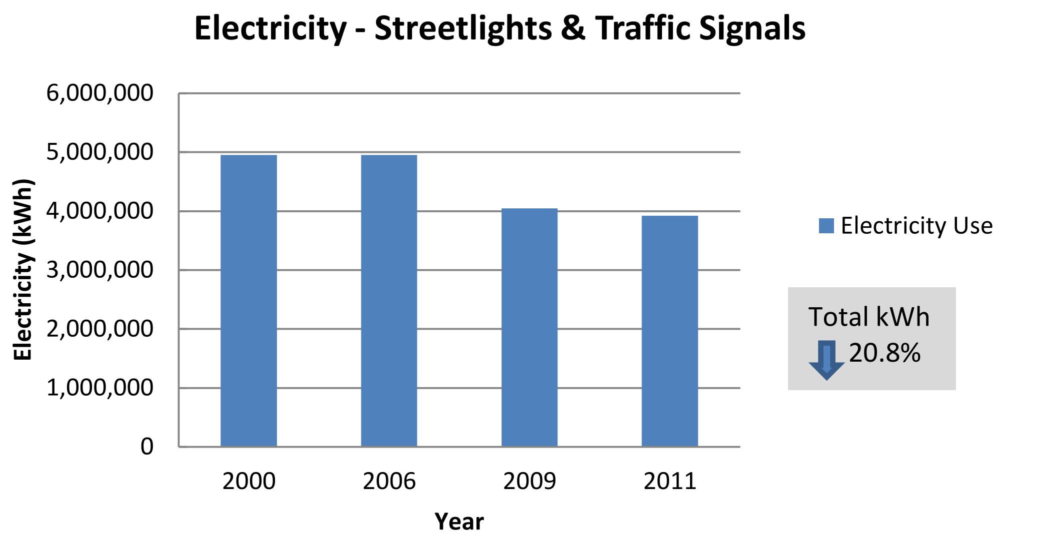


Figure 23: Streetlights and Traffic Signals Electricity Consumption: 2000, 2006, 2009, 2011

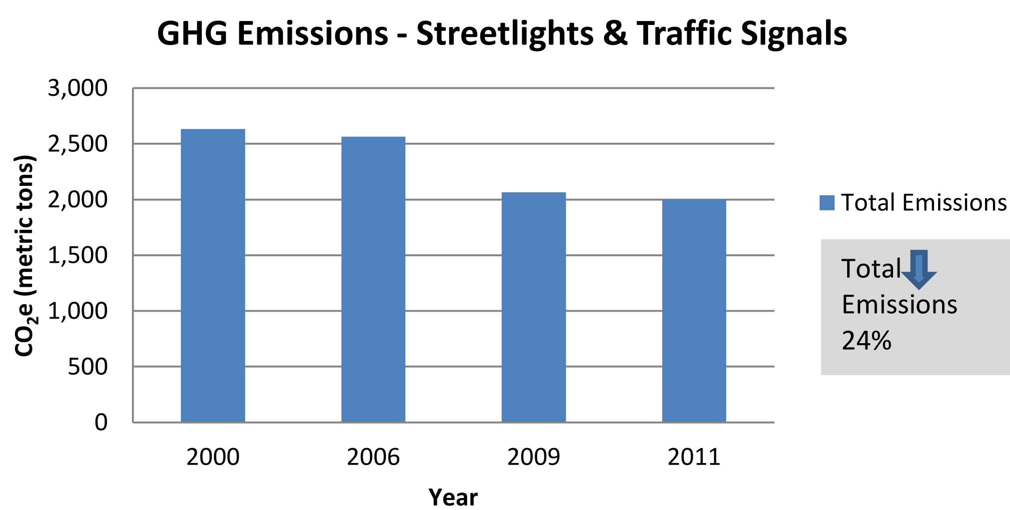


Figure 24: Streetlights and Traffic Signals GHG Emissions: 2000, 2006, 2009, 2011

6.3.2 Highlights

The key efficiency improvement made since the emissions baseline inventory to the streetlight and traffic signal area of the municipal focus is the transition to light-emitting diode (LED) technology. LEDs are known for providing a lower maintenance and energy efficient alternative to high intensity discharge (HID) lighting commonly used for outdoor lighting. While some conversions to LED traffic signal lights had previously been done, the majority of traffic signal lights (approximately 500 lights at 48 signalized intersections) were converted in 2008 from standard incandescent technology to energy efficient LEDs. This conversion to LED included a projected 80% reduction in energy demand per intersection. As of 2011, 53% of the ornamental City lights now utilize LEDs in their fixtures. Going forward, the City is committed to using more efficient LED light sources when upgrading fixtures or adding lights to new areas including, most recently, at the new Jefferson Park Avenue Bridge streetlights. The City is limited to improving efficiency of City-owned lights and does not have control over the efficiency of the Dominion owned streetlights. Dominion has partnered with the City of Charlottesville to pilot LEDs in their double-streetlamps, which traditionally use mercury vapor lamps, on McIntire Street.

6.4 Vehicle Fleet & Transit Fleet

The City's fleet is comprised of a variety of vehicles including passenger vehicles, light and heavy duty trucks, pupil transportation buses and public transit vehicles, as well as on-road and off-road maintenance vehicles. As of 2012, there are 681 units in the fleet, including 36 school buses and 34 transit buses. As recommended by the protocol used for this recent inventory, emissions were calculated based on fuel consumption by vehicle type (passenger car, light truck, heavy duty, off-road) and fuel type. The majority of the fuel consumed is either gasoline or diesel. A small amount of CNG is currently used in the City's fleet as well.

6.4.1 Energy & Emissions

From the data summarized below, the overall trends seen between the 2000 baseline and 2011 are an overall decrease in gasoline use coupled with an increase in diesel fuel use. Since the baseline, however, *Fleet* has decreased CO_2e emissions associated with gasoline by 10%. The largest reduction in gasoline consumption is between the interim year 2009 and 2011 where the City fleet used 13,556 less gallons of gasoline (Figure 25).

The 2011 inventory reveals a 48% increase in CO_2e emissions from diesel fuel within the municipal fleet since the baseline year (Figure 26). The Transit portion of *Fleet* is the biggest user of diesel and has, over the past 10 years, been expanding to meet the public transportation needs and expectations of the community and to support tourism. For example, since September 2000, the City has provided a free trolley service between the downtown mall and the University of Virginia. To meet the demands of over two million passengers and growing, five new bus routes were introduced and Sunday service was offered on the Trolley and Route 7 in 2008.

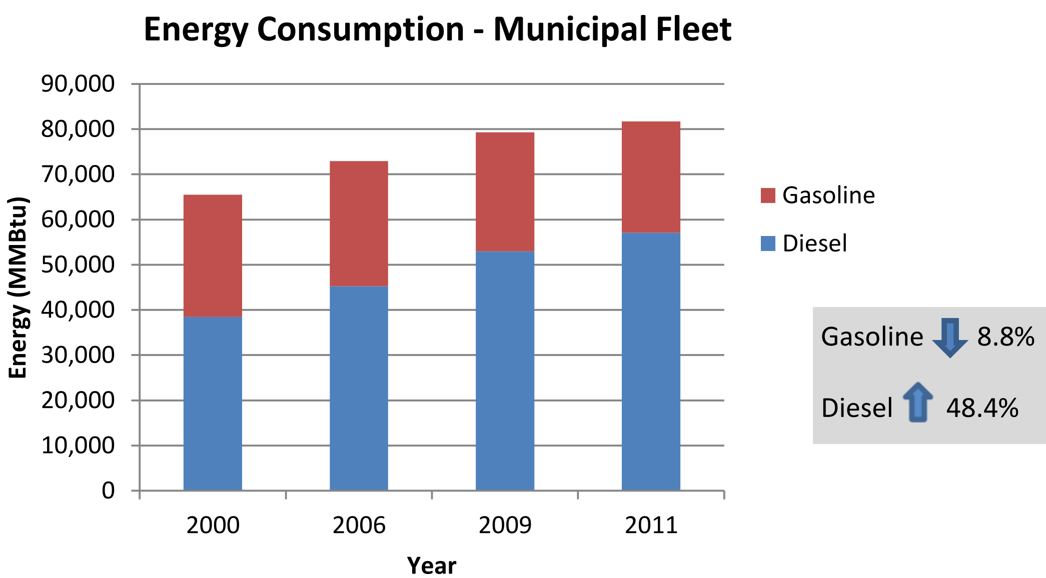


Figure 25: Fleet Energy Use (Gasoline & Diesel): 2000, 2006, 2009, 2011

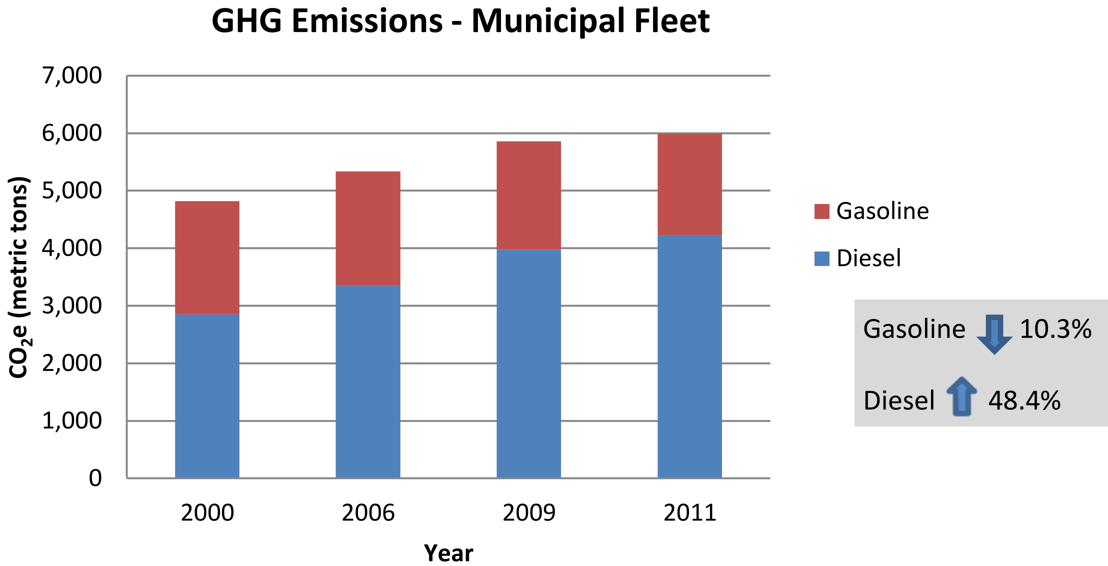


Figure 26: Fleet GHG Emissions (2000, 2006, 2009, 2011)

6.4.2 Highlights

Since 2003, there has been an ongoing fleet transition ("greening of the fleet") that now incorporates 43 hybrid vehicles representing 18% of the total number of passenger vehicles in the fleet. In addition, the fleet includes ten hybrid-electric buses, two pupil transit buses and one passenger vehicle that use compressed natural gas, thirty bi/flex-fuel vehicles, four low-speed all-electric work trucks, and electric golf carts. Starting in 2012, the City has also introduced 3 all-electric passenger vehicles into the fleet.

In addition to the ongoing fleet transition to more fuel efficient and cost effective vehicles, the City has in place the following procedures and policies to increase fuel economy, lower cost, and simultaneously decrease emissions associated with fleet operations:

- Utilization studies
- National standards of equipment replacement routine
- Passenger fleet vehicles preventive maintenance program
- 2007 Anti-idling Policy

6.5 Government-Generated Waste

In an attempt to better manage and reduce emissions from the waste sector, the municipal focus of the inventory has begun to collect data on the amount of waste generated and collected as the result of municipal operations. In 2011, approximately 311 metric tons CO_2e were associated with the management of municipal waste. The municipal waste data collected and used to calculate emissions includes city schools, city buildings, parks and other public spaces. To be consistent with the previous inventories including the baseline, the emissions are incorporated into the community-wide total emissions from waste generation. The City will continue to track independently the emissions from government-generated waste for comparison in subsequent GHG emission inventories and hopes to see a reduction in GHG emissions associated with municipal waste achieved through continuing to offer recycling and waste reduction options within its operations.

7.0 LOOKING AHEAD

Municipal and community GHG emissions are associated with advances in air quality and public health, reductions in energy consumption, increases in energy efficiency, and support of economic development goals for the area. Their measurement reflects how successfully the City and community are meeting these goals. While this report looks back to the baseline and reflects our experiences to date, it also looks forward by informing appropriate next steps, goals, and actions. To this extent, relevant predicted emissions and goals external to Charlottesville provide deeper context for consideration.

7.1 U.S. Energy Information Administration (EIA) Annual Energy Outlook 2013

The U.S. Energy Information Administration (EIA) Annual Energy Outlook 2013 forecasts a 0.1% annual average growth rate from 2011 to 2040 in total U.S. energy-related CO_2 emissions.[6] Regionally in the South Atlantic, the EIA predicts a 0.3% annual growth in GHG emissions through 2040. By applying EIA's regional growth rate, Charlottesville's GHG emissions levels are projected to increase to over 770,000 metric tons CO_2e by 2035 (Figure 27).

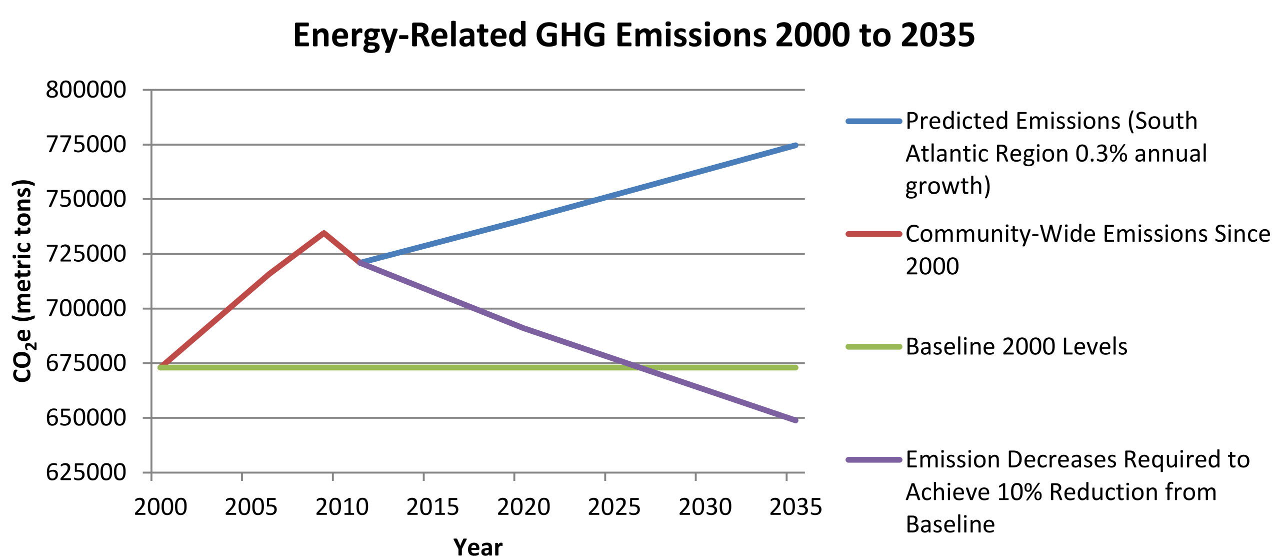


Figure 27: Energy-Related GHG Emissions in Charlottesville including current and predicted trends

7.2 The Emissions Gap Report 2012 by the United Nations Environment Programme (UNEP)

In November 2012, the United Nations Environment Programme released *The Emissions Gap Report 2012*[7]. A synthesis report compiled by 55 scientists from 20 countries, the report was intended to inform negotiations at the UN Climate Change Conference (COP18) and was written in the context of GHG)levels reaching a record high in 2011[8]. The report compares the current levels of GHGs, projected rates of emissions growth, pledges governments have made to reduce emissions by 2020, and the level of GHG needed to prevent temperatures from rising above 2 degrees Celsius in this century. 2^{o}C is the level established that beyond which irreversible damage to the environment could occur.

The report determined that global GHG emissions have risen 20% since 2000 based on 2010 data and estimated the level of global emissions consistent with the 2^{o}C target for 2020, 2030, and 2050. It found that a 14% decrease in global GHG emissions from the 2012 global level is needed to meet the 2020 target; a 27% reduction by 2030; and a 41% reduction by 2050. These equate to a range of 1.3% to 2% annual reductions.

The report concluded that while current emissions reductions pledges would be insufficient, technical means and policy tools are available to bridge the gap. Reductions associated with power generation and transportation were identified as well as several relatively inexpensive actions including higher performance standards for vehicles and appliances and maintaining forests. Many of the strategies beneficial to climate protection were also recognized as able to satisfy a great variety of other local and national priorities.

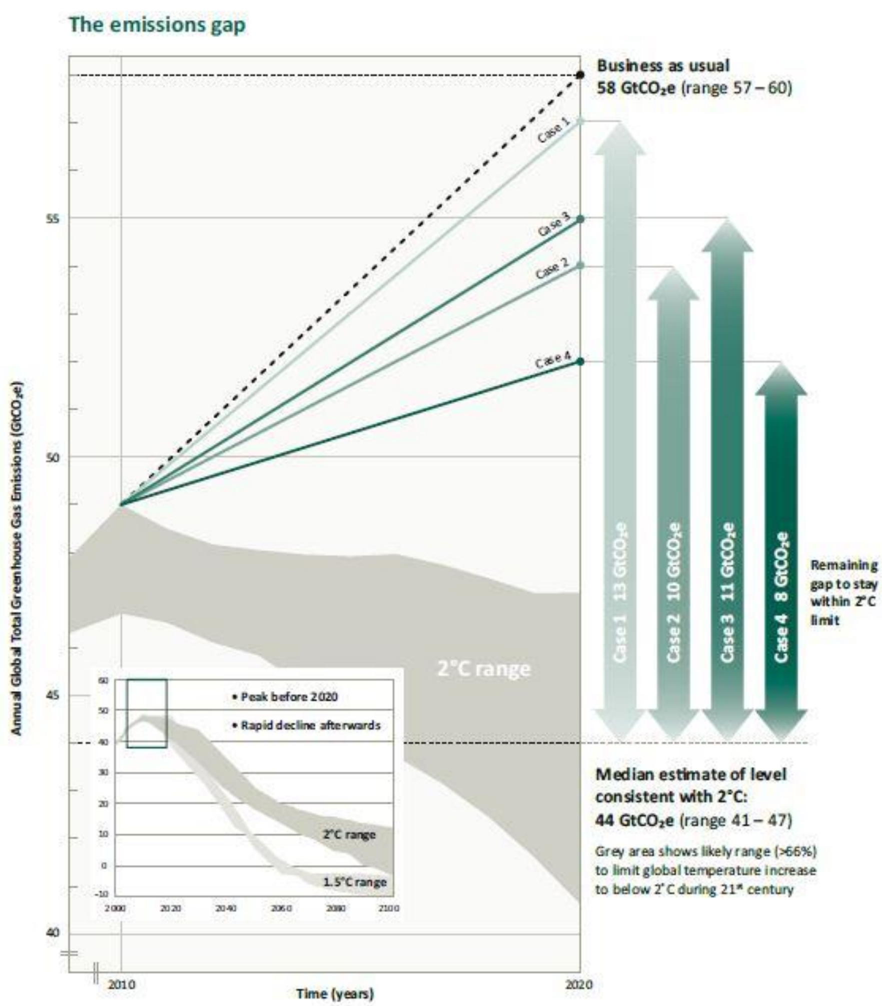


Figure 28: The Emissions Gap Report 2012 Predicted GHG Levels

7.3 Performance Goals and Trends

When the baseline report was written, many organizations and governments were beginning to track their associated GHG emissions for the first time, and it was common to use a '10% reduction from the baseline by 2035' to provide context and a trend line from which to track and gauge progress. In 2012, extensive research on emissions levels and global impact has been developed and can provide a more varied field of context in which to view local emissions. For example, starting in 2013 community-wide:

- Maintaining current levels of associated GHG emissions through 2035 would equate to a reduction of emissions by 0.2% annually to compensate for the growth predicted by EIA.
- Returning to the 2000 baseline emissions levels by 2035 would equate to a reduction of 0.3% annually from 2011 levels.
- Reducing emissions levels to a 10% reduction from the baseline by 2035 would equate to a reduction of 0.7% annually from 2011 levels.
- Paralleling the global reduction levels defined in the UNEP *Emissions Gap 2012* report would equate to:
    - a 14% reduction by 2020 (equivalent to approximately 1.8% of 2011 levels per year)
    - a 27% reduction by 2030 (equivalent to approximately 1.5% of 2011 levels per year)
    - a 41% reduction by 2050 (equivalent to approximately 1.0% of 2011 levels per year)

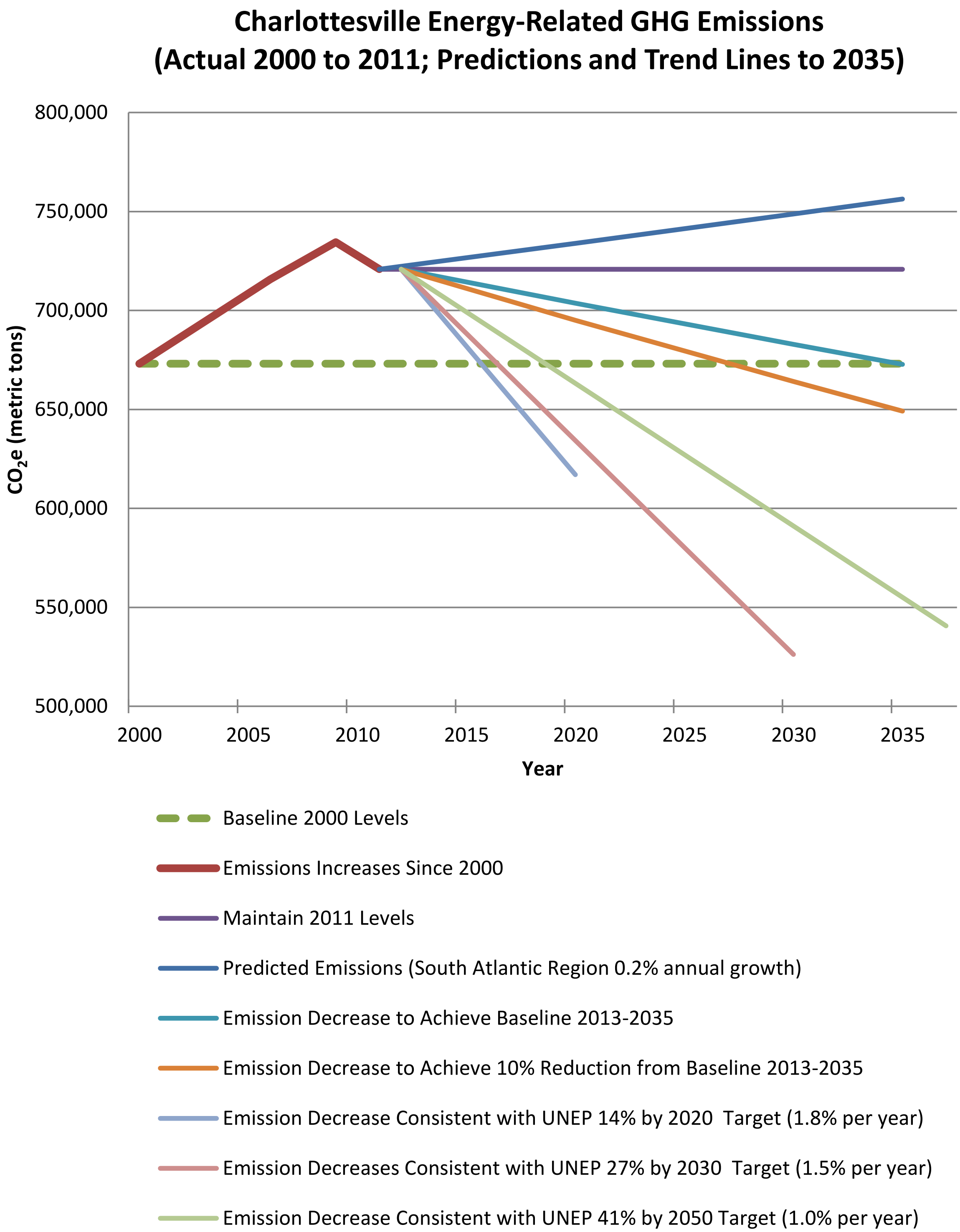


Figure 29: Projected Emissions Increases and Goal Trend Lines

CONCLUSION

The City of Charlottesville, in support of its Environmental Sustainability Policy and City Council's 2025 Green City Vision, has been implementing strategies to reduce GHGs and has been tracking the impacts. As documented in this report, the upward trend in GHG emissions over the past decade is being observed both nationally and regionally. In order to address this rising trend, reduce expenditures, and reflect local commitments, the community and its leaders should continue to identify, pursue, and evaluate actions aimed at achieving measurable emissions reductions.

The next step in reducing emissions includes setting GHG reduction targets community-wide and within municipal operations. Charlottesville is a vibrant and popular city that has experienced growth and expansion over the past decade and has the potential for increased residential growth and commercial expansion. The City and the community are well equipped to make decisions and take action when faced with the rising energy prices, increasing regulations, and limited resources predicted for the next generation. By studying GHG emissions and establishing a challenging yet feasible target, the City of Charlottesville can guide its efforts and demonstrate its goal to do its part towards addressing GHG emissions.

Based on the experiences to date, it would be appropriate to consider an initial community-wide goal to prevent further increases in emissions through increased efficiency and awareness. Following that, it would be appropriate to consider a secondary, stretch goal using developing technologies, energy reduction strategies, and community initiatives to decrease overall emissions to 10% of the baseline 2000 levels by 2035. Continuing the momentum of municipal government GHG emissions reductions to date (18% over 11 years, or 1.6% per year), it would be appropriate for the City to aim for an average of 1% emissions reductions per year from 2011 levels through 2050, with a stretch goal of attaining more than 1% per year through 2020. Both the community-wide and municipal operations goals should be reviewed periodically every 5 years and adjusted as appropriate based on experiences, conditions, and advances in technologies and successes.

Working to meet this average of 1% annual reduction target the City will be supporting two parts of the 2025 City Council Vision:. This includes delivering quality services to citizens that ensure safe neighborhoods, strong schools, and a clean environment along with being a green city with clean air and water, an emphasis on recycling and waste reduction, and energy efficient buildings and homes. Although not limited to the following, the strategies to reach this target include additional retrofitting of existing buildings, increase renewable energy sourcing, improving fuel efficiency in the fleet, and increasing employee awareness on energy saving habits to follow at work. The City's development of strategies and initiatives within the operations of local government that reduce GHG emissions, energy consumption, and cost provides examples for the community and creates the potential for extending resources to interested residents and business owners.

With the latest GHG emissions data collected, Charlottesville is positioned to pursue municipal and community targets. The City intends to build on actions, involve stakeholders, and continue to be a leader in energy efficiency in the community. In adopting the following parts, the community and the local government can expect success in meeting the targets above; selecting and prioritizing effective emissions reduction measures; periodically updating inventories; and reviewing goals every 5 years with the ability to adjust targets.

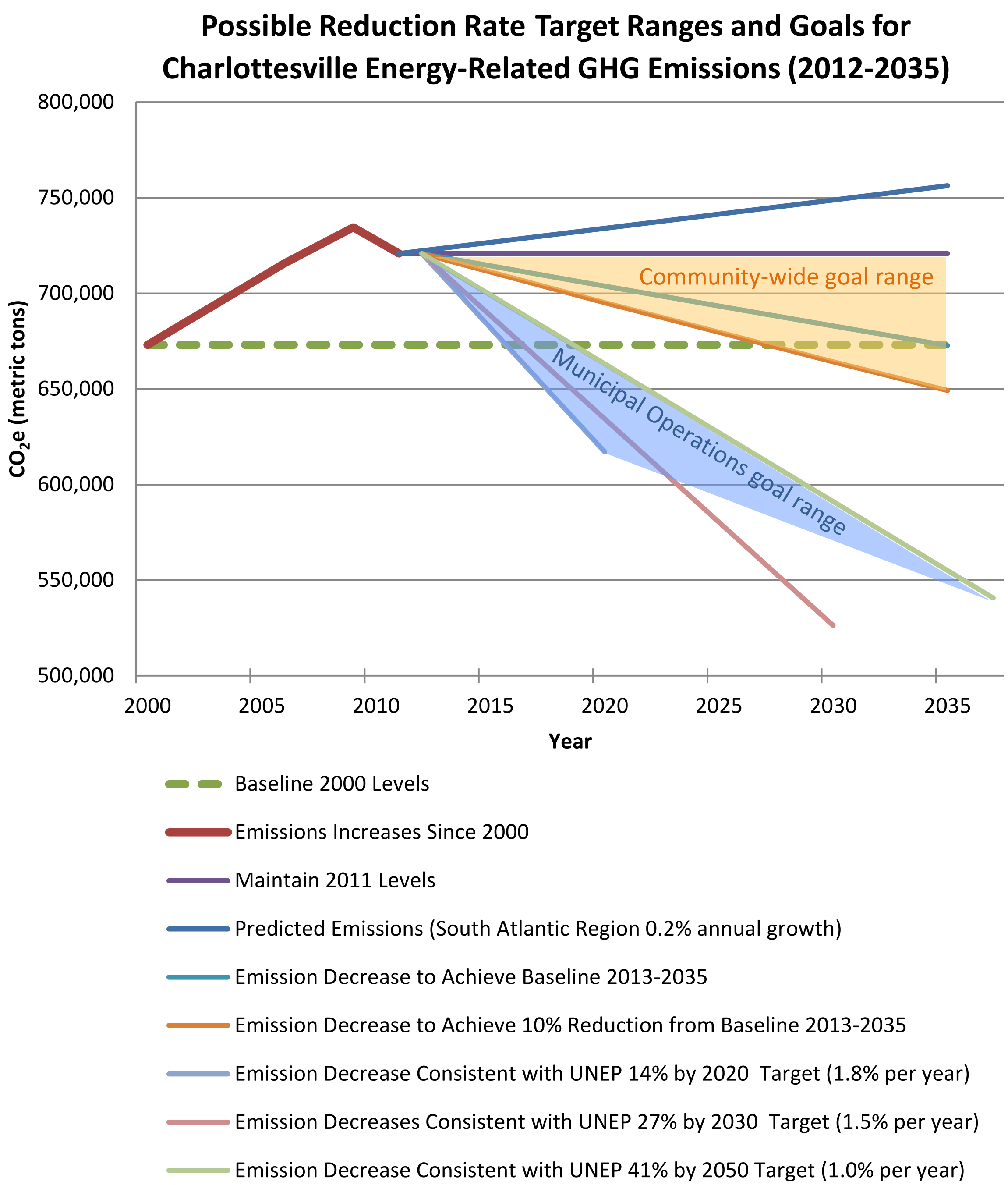


Figure 30: Possible Target Goal Ranges for Charlottesville

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