2008

Charlottesville Emissions Baseline Report

Cities for Climate Protection Program

A summary of greenhouse gas and criteria air pollutant emissions for the City of Charlottesville, VA for the baseline year of 2000

Department of Public Works
City of Charlottesville
March 2008

ACKNOWLEDGEMENTS

Charlottesville Citizens Committee on Environmental Sustainability

City of Charlottesville

County of Albemarle

Dominion Virginia Power

ICLEI Mid-Atlantic Region

UVA Department of Energy

UVA Facilities Management Department – Energy and Waste Management

UVA Office of Environmental Health and Safety

Perrin Quarles Associates, Inc.

Rivanna Solid Waste Authority

Thomas Jefferson Planning District Commission

Virginia Department of Transportation

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2007

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2007

CHARLOTTESVILLE COMPREHENSIVE PLAN

In 2006, the City became a signatory to the US Mayors Climate Protection Agreement, and as such agreed to establish an emissions baseline, meet or beat the greenhouse gas (GHG) reduction targets recommended for the U.S. under the Kyoto Protocol (7% below 1990 levels), and urge state and federal governments to enact stronger policies and programs.

A community greenhouse gas emissions baseline is essentially an inventory, or an audit of the activities within the city limits which contribute to the release of greenhouse gases – energy use, transportation, and waste management. By evaluating where our emissions are coming from, a community or municipality is able to see where energy efficiencies or other improvements may be made, through actions in municipal buildings, municipal fleet, or through public education for residents and businesses.

Reducing greenhouse gas emissions directly involves cutting energy use and therefore cutting financial costs. This baseline report contains an overview of the emissions resulting from activities within our community for the baseline year of 2000, for the interim year of 2006, and for a forecasted year, 2020.

Baseline and Interim year data was collected from local utilities, City departments, and agencies such as VDOT and UVA. Forecast data for 2020 is based on national energy projections by the Energy Information Administration.

The data was analyzed using Clean Air and Climate Protection (CACP) software developed on behalf of ICLEI – Local Governments for Sustainability. Typically, greenhouse gas emissions come from the following sources: burning fossil fuels to produce electricity that lights, heats, and ventilates buildings and lights streets; using fossil fuels for heating and operating vehicles, and from waste decomposing in landfills and treatment plants.

The baseline report covers greenhouse gas emissions from carbon dioxide, methane and nitrous oxide. The criteria air pollutants covered herein are carbon monoxide, sulfur oxides, nitrogen oxides, volatile organic compounds, and particulate matter (PM_{10}).

This report also contains an analysis of the criteria air pollutants that are directly resulting from our local energy, transportation and waste practices. With less than 5% of the world's population, the United States produces more than 25% of all global greenhouse gas emissions. Worldwide, cities account for 78 percent of all greenhouse gas emissions (US Mayors).

> *"Embarking on an environmental program sounds like a great idea. But if you're a mayor trying to cut greenhouse gases, where do you begin? How do even know how to measure your current levels? That's where an organization called ICLEI -Local Governments for Sustainability can help."*
>
> **Newsweek, Leadership and the Environment issue, April 16, 2007**

EXECUTIVE SUMMARY

DATA SUMMARY

YEAR	ENERGY USE (MMBTU)	TOTAL ECO$_2$ EMISSIONS (TONS)	PER CAPITA EMISSIONS (METRIC TONS*)
2000	**6,903,433**	**868,952**	**19.7**
2006	**6,706,718**	**910,991**	**20.6**
2020	**8,681,799**	**1,119,049**	**24.5**

**1 metric ton = 2,200 lbs*

1 ton of *e*CO_2 has a volume of 500 m^3, every year Charlottesvillians are responsible for emitting enough *e*CO_2 to fill about 5 hot air balloons each!

In 2000, Charlottesville's eCO$_2$ emissions were a total of 868,952 metric tons, with a city population of 40,099.

Our per capita emissions for our baseline year of 2000 were 19.7 metric tons.

The city population in 2006 was 40,315. Current estimates for residential population in 2020 are that it will remain similar to 2000, with a projected additional 2040 students at UVA.

The per capita figures above are for greenhouse gas equivalents (*e*CO_2), comprising carbon dioxide, methane, and nitrous oxide from energy use in the residential, commercial, and industrial sectors, as well as emissions from waste management, and transportation within the city. *e*CO_2 emissions per capita have risen between 2000 and 2006, and are predicted to continue to rise using national energy projections (to 2020); however, MMBtu (energy used) has actually decreased slightly between 2000 and 2006. This is almost entirely due to a sharp rise in electricity use compared to other fuel types, leading to higher *e*CO_2 emissions in relation to MMBtu.

USA national average estimates of per capita emissions range from between 20 and 24 tons per capita, according to the Energy Information Administration, World Resources Institute, and ICLEI.

Compared nationally, Charlottesville per capita emissions are therefore just below average - but looking further afield, average per capita emissions worldwide include China at 3.9, Great Britain at 9.8, Mexico at 4.3, Australia at 16.5, and Canada at 20 tons per capita.

INTRODUCTION

On February 16, 2005, the day the Kyoto Protocol took effect in the 141 countries that ratified it, Seattle, Washington Mayor Greg Nickels challenged other mayors throughout the United States to join Seattle in taking local action to cut greenhouse gas emissions and reduce global warming.

'We believe that U.S. cities can – and should – act to reduce global warming pollution, both in our own municipal operations and in our communities.

Many of us are already doing so through programs such as energy conservation, urban forest restoration, controlling sprawl and using alternative fuels in our fleets. Not only are we reducing our contributions to global warming pollution, we are investing in more livable cities through cleaner air, creation and preservation of open space and urban forests, and reduced energy costs.'

Mayor Greg Nickels of Seattle, with eight other U.S. mayors, March 2005, in a letter to city mayors nationwide, inviting them to join the efforts to reduce global warming.

The goal of the resulting U.S. Mayors Climate Protection Agreement is that localities pledge to reduce their greenhouse gas emissions to 7% below 1990 levels by 2012 - the same goal the United States would have been required to meet under the Kyoto Protocol.

Initially, the aim of the agreement was to gain the endorsement of 141 cities within a year in order to match the number of countries that ratified the Kyoto Protocol. By May 2007, a little more than two years after the initiative began, over 500 cities had signed on, including the City of Charlottesville. By November 2007 there were more than 710 signatories to the agreement.

In March 2007, the City of Charlottesville joined the International Council for Local Environmental Initiatives (ICLEI) and their Cities for Climate Protection Program. This 5-step program facilitates cities and counties in the calculation - or inventory – of their emissions for a baseline year using specific software supplied by ICLEI. The city then has the ability to set quantifiable and realistic targets for future reductions, before embarking on the challenge of producing a community climate action plan to address climate and air quality issues.

The baseline is an inventory of the major activities within our community that add to our overall greenhouse gas emissions, along with other criteria air pollutants that affect the health of residents and the environment.

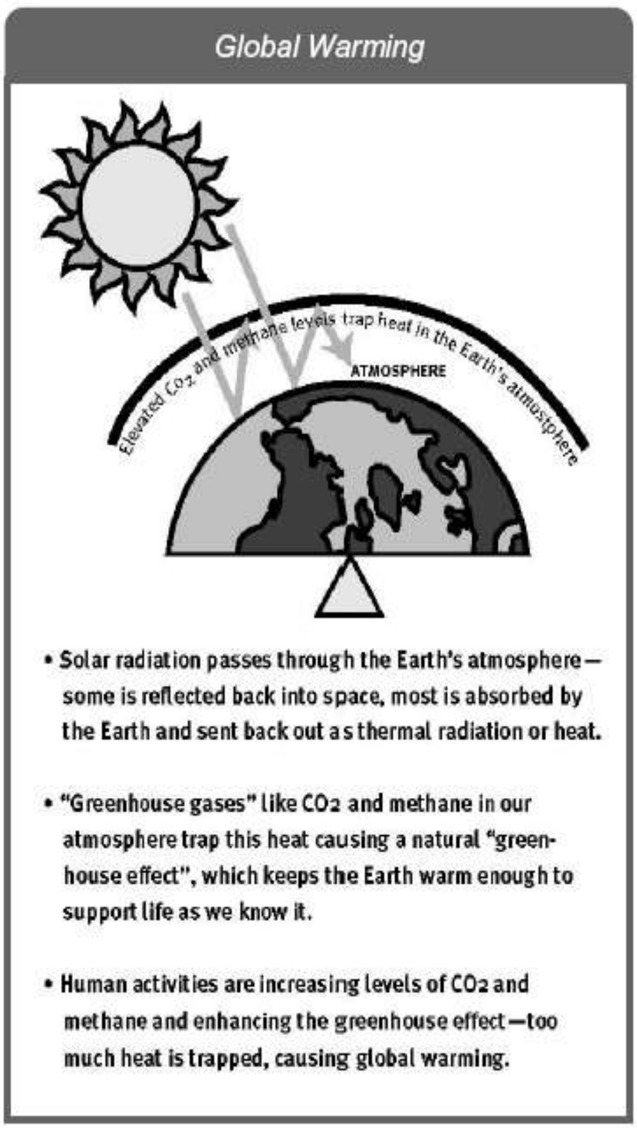
This report contains the results of the emissions inventory and analysis for residential, commercial, industrial, transportation and waste sectors; as well a separate analysis of municipal facilities and operations.

OVERVIEW OF CLIMATE CHANGE

The Earth's atmosphere is made up of many gases, but mostly nitrogen and oxygen. Some of the remaining gases that make up a small constituent of our atmosphere are known as greenhouse gases. Of these gases, carbon dioxide (CO_2) is one, along with water vapor (H_20), nitrous oxide (N_20) and methane (CH_4).

There are also greenhouse gases found within the atmosphere in much smaller amounts than those above, including chemical compounds such as HFCs (hydro fluorocarbons).

All of the greenhouse gases can come from both natural and manmade (anthropogenic) sources, with the exception of some CFCs and HFCs, which are purely anthropogenic and used in aerosols for instance.



Greenhouse gases have the ability to absorb some of the heat from the sun being reflected from the Earth and re-emit it back down towards the surface again, causing the atmosphere to heat. This is the process known as the greenhouse effect, and without it life would be very different on this planet, as the average temperature would be 59°F (33°C) cooler than it is now.

Since around the time of the Industrial Revolution in Western countries, concentrations of carbon dioxide, methane, and nitrous oxide in the atmosphere have all risen dramatically.

Most scientists now agree that human activities are to blame for the majority of these greenhouse gas increases, and this is resulting in anthropogenic global climate change. The more greenhouse gases we add to the atmosphere, the more our planet warms. It is rather like wrapping the planet in a blanket. A series of atmospheric re-adjustments follow. These are largely positive feedbacks that serve to amplify the warming. For example, as more water evaporates from oceans and lakes due to the heat, the extra water vapor in the air causes further warming and further evaporation. Likewise, melting sea ice reduces the amount of sunlight reflected back to space from the reflective surfaces of the poles, leading to more ice melt.

The excess carbon dioxide is, to some extent, re-absorbed by the earth. The ocean is a major 'sink' of CO_2, but this brings with it other problems. The IPCC (Intergovernmental Panel on Climate Change) Working Group II in their 2007 assessment state that the ocean has become more acidic because it has absorbed amounts of anthropogenic carbon dioxide.

Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level.

IPCC 4th Assessment, Working Group I Report, "The Physical Science Basis". Sections 3.2, 4.2, 5.5

The IPCC is an organization established jointly by the United Nations Environment Program and the World Meteorological Organization in 1988 to assess information in the scientific and technical literature related to all significant components of the issue of climate change, and to provide technical analysis of the science of climate change, as well as guidance on the quantification of greenhouse gas emissions.

THE GREENHOUSE GASES

CARBON DIOXIDE (CO_2)

When we burn fossil fuels, in the form of coal for our electricity, or oil as petroleum for our cars, the carbon in the fossilized material that has been locked into the earth for millions of years is released back into the atmosphere in the form of carbon dioxide (CO_2). According to the National Oceanic and Atmospheric Administration (NOAA), in the past 400,000 years, carbon has never been present above 300 parts per million (ppm) in the atmosphere. As of 2007 it is at 380ppm. CO2 remains in the atmosphere for approximately 100 years before it is absorbed by the forests, oceans and other carbon "sinks". The urgency to reduce CO2 levels is to mitigate further compounding effects of the cumulative effect of CO2 in the atmosphere.

METHANE (CH_4)

Methane is a particularly potent greenhouse gas, and is naturally emitted from cattle and from organic matter as it rots in anaerobic conditions. Major emitters of methane into the atmosphere are landfills, wetlands and rice paddies, the production and distribution of natural gas and petroleum, coal production, and incomplete fossil fuel combustion. Increasingly intensive agriculture and an expanding global human population have been the primary causes for the increase in anthropogenic methane.

NITROUS OXIDE (N_2O)

Unlike other nitrogen oxides, nitrous oxide is a major greenhouse gas. Human induced nitrous oxide primarily comes from agricultural fertilizers and sewage treatment, but also from burning fossil fuels in vehicles, the production of nylon and nitric acid, as well as naturally from a wide variety of biological sources in soil and water.

WATER VAPOR (H_2O)

As the air warms, its ability to absorb moisture increases as we see regularly when Charlottesville has days of high humidity. As the oceans and the planet surface warms, more water vapor is evaporated from them - leading to more water vapor in the air and an increased warming effect.

> *Global atmospheric concentrations of carbon dioxide, methane and nitrous oxide have increased markedly as a result of human activities since 1750 and now far exceed pre-industrial values determined from ice cores spanning many thousands of years [...] The global increases in carbon dioxide concentration are due primarily to fossil fuel use and land use change, while those of methane and nitrous oxide are primarily due to agriculture.*
>
> **IPCC 4th Assessment 2007, Working Group I Report "The Physical Science Basis". Sections 2.3, 6.4, 7.3**

FLUOROCARBONS (HFCS)

HFCs are man-made chemicals, many of which have been developed as alternatives to high level ozone-depleting substances for industrial, commercial, and consumer products. However, hydro fluorocarbons are one of the most efficient absorbers of infrared radiation and so are classed as greenhouse gases for this reason. Refrigeration is the main source.

PER FLUOROCARBONS (PFCS)

PFCs are potent man-made greenhouse gases, used in medical applications and electronics. However, the main source is in the manufacture of aluminum products and the purification of aluminum ores.

SULFUR HEXAFLUORIDE (SF_6)

SF_6 is a highly potent greenhouse gas; however its concentration in the atmosphere is considerably smaller than that of CO_2. It is mostly used in electrical equipment.

Criteria Air Pollutants

The issues of global warming and the polluted air that affect cities are closely linked. First, the primary activities that create the emissions that cause these two problems are essentially the same—that is the burning of fossil fuels whether for energy production, industrial processes or powering vehicles. As fossil fuel combustion increases, the emissions that cause global warming and air pollution also increase. Second, hotter urban temperatures intensify air pollution due to the chemical mix that additional heat causes, especially in low level ozone formation. The phenomenon of hotter urban temperatures is frequently referred to as the Urban Heat Island Effect.

Sulfur oxides (SO_x)

Sulfur, which occurs to varying degrees in coal, reacts with oxygen when combusted - and in the atmosphere further reacts to form sulfuric acid, which can fall to Earth as acid rain.

Nitrogen oxides (NO_x)

Nitrogen oxides are formed by combustion engines, and in areas of high motor vehicle traffic, such as in large cities, the amount of nitrogen oxides emitted into the atmosphere can be quite significant. When NO_x and volatile organic compounds (VOCs) react in the presence of sunlight and heat, they form photochemical smog, a significant form of air pollution. Children, the elderly, people with lung diseases such as asthma, and people who work or exercise outside are susceptible to adverse effects of smog such as damage to lung tissue and reduction in lung function. Nitrogen oxides eventually form nitric acid when dissolved in atmospheric moisture, forming a component of acid rain.

Volatile Organic Compounds (VOCs)

Many governments regulate volatile organic compounds, a large group of potentially harmful organic (carbon-containing) chemicals used in industrial processes. The largest sources of VOC emissions from human activity include industrial use of solvents and from vehicle emissions.

Carbon Monoxide (CO)

Carbon monoxide is a colorless, odorless gas produced primarily by the incomplete combustion of fuels. Sources include vehicles, lawn and garden equipment, forest wildfires, and open burning of industrial waste. CO is dangerous to humans and animals even in small concentrations, as it prevents the body's ability to absorb oxygen.

Particulate Matter ($PM_{2.5}$, PM_{10})

Any solid or liquid particles small enough to be carried aloft are termed particulate matter, and many can cause damage to respiratory tissues when inhaled. Dust and soot from industry and emissions from vehicles is a common source. The number following the "PM" refers to the size of particle being tracked.

CLIMATE CHANGE – POTENTIAL IMPACTS

There has been an increase in hurricane intensity in the North Atlantic since the 1970s, and that increase correlates with increases in sea surface temperature. The observed increase in hurricane intensity is larger than climate models predict for the sea surface temperature changes we have experienced. There is no clear trend in the number of hurricanes.

IPCC 4th Assessment 2007, Working Group 1 Climate Change 2007: The Physical Science Basis

COASTS

Glaciers are shrinking in many areas around the world, and as glaciers shrink, a greater proportion of Earth's water enters the liquid phase and becomes available to the oceans and atmosphere. This can lead to a significant increase in sea level.

The United States has over 153,000km (95,000 mi) of coastline and more than 8.8 million km^2 (3.4 million mi^2) of marine waters within its territory. Population densities in these areas are also relatively high; 53% of the US population lives in coastal areas (Brennan, 2005).

Coastal flooding and conversely water shortage in inland areas through drought are probably the biggest imminent threats to USA. Just 3 feet of raised sea level will have flooding impacts on populations and economies of major coastal cities on the Atlantic and Gulf Coasts; Coastal cities & towns, such as those in Florida, Louisiana and New York, will be much more susceptible to damage from tidal surge in storm events (EPA Nov 2007)

The IPCC estimates that the global average sea level will rise between 0.3 and 2.9 feet in this century if current emissions continue. As for specific impacts to Virginia, most notably at this stage is the affect on the Chesapeake Bay area, which is already suffering wetland loss, and coastal erosion. Severe weather events are likely to increase in number and in severity (USC Apr 2007), as warmer waters in the Atlantic and Gulf of Mexico will fuel storm intensity.

'The impact of global warming and climate change can effectively kill us off, make us refugees...'

Ismail Shafeeu, Minister of Environment, Maldives

Over one third of the world's population currently lives within 10 meters of sea level. The people of Tuvalu (below) in the Pacific Ocean already have to leave their Island because the rising sea is drowning them out.
Hurricane Katrina cannot be put down to rising seas, but it does show how disastrous it is when a city is flooded.

URBAN AREAS

As the population centers of the world, urban and suburban areas have the potential to experience most of the negative impacts of climate change. Urban areas are major consumers of energy and thus major emitters of GHGs. Many urban areas are currently growing both in terms of population and geographic area. As they grow, energy demands for supporting daily activities and public and private infrastructure also increase. Land use and development decisions often cause cities and counties to spread outward, resulting in the urban sprawl that encourages more driving, increasing fossil fuel consumption, and thus more GHG emissions.

Prolonged heat waves, which scientists predict will occur with increasing frequency, hit urban areas hard. The impact of hot weather is intensified by the dark surfaces of pavements and rooftops that cover the typical urban landscape and worsen heat waves, as they absorb and trap additional heat when struck by solar rays and increase already higher temperatures. This heat island effect was a factor in the heat wave experienced by the Chicago area in the summer of 1995, which contributed to the deaths of over 800 people (ICLEI 2008). Increased heat will impact power requirements for air conditioning, water management, and health services.

Changes to the hydrology of a region can also affect local and national agricultural production and thus food supply for cities.

Although very rare, when weather disasters destroy towns and neighborhoods like the floods that hit Kansas in 1998 and South Carolina in 1999, or Hurricane Katrina in 2005, insurance and federal and state disaster funds cannot begin to cover the long term economic, social, and other losses that are felt by the communities that have lost their businesses, homes and schools, or suffered from public health impacts. (ICLEI 2004)

Latest research by the IPCC suggests that we need to achieve an 80% carbon reduction below 1990 levels to enable us to significantly slow global warming, so action at the local level is now critical.

Many millions more people are projected to be flooded every year due to sea-level rise by the 2080s. Those densely-populated and low-lying areas where adaptive capacity is relatively low, and which already face other challenges...are especially at risk. The numbers affected will be the largest in the mega-deltas of Asia and Africa while small islands are especially vulnerable.

IPCC 4th Assessment 2007, Working Group II report, "Impacts, Adaptation and Vulnerability".

INLAND AREAS

50% of the Earth's population has now moved to urban areas, making the global population more of an urban community than ever before. Hardest hit inland areas of the US may continue to be the Southwest - impacts include drought, aquifer water shortage and increased risk of forest fires. Warming in western mountains is projected to cause decreased snowpack, more winter flooding, and reduced summer flows to rivers, exacerbating competition for over-allocated water resources (IPCC 2007 Working Group II)

Some sources cite heavier rainfall to be expected in the Northeast US, although "due to the complexity of global circulation patterns and local weather patterns, an increase in energy in the hydrologic cycle does not necessarily translate into an increase in precipitation in all geographic regions" (EPA 2007).

Temperature increases will mostly be noticeable in winter, with the minimum temperatures rising by an average of 5.4°F (3°C) (NOAA 2007), creating potential impacts for ski tourism in areas of Virginia.

A serious implication of hotter temperatures is the increase in incidences of diseases, such as malaria, dengue fever, and others spread by vectors that are temperature dependent. For example, as areas get hotter, the geographic range of the mosquito may grow larger. Interestingly, in Northern Europe, climate change is initially projected to bring mixed effects, including some benefits such as reduced demand for heating, increased crop yields and increased forest growth. However, as climate change continues, its negative impacts, including more frequent winter floods, endangered ecosystems and increasing ground instability, are likely to outweigh its benefits (IPCC 2007, Working Group II).

'While it may be a bit of a reach to think in terms of "Saving the Planet" from global warming, it's perfectly valid to think about preserving a climate that's sustaining to as many of Earth's residents as possible'

Robert Henson, Guide to Climate Change, 2006

SUMMARY

For most people in the US, climate change may have made little impact so far to daily life. Heating bills may go down but air conditioning bills may go up. It is likely to be the low-lying, poorest countries that are affected first, such as Bangladesh, as their ability to adapt to change is already stretched to the limit. Stresses on agriculture from a changing climate and rising sea level could displace populations as refugees head away from the most affected areas.

CHARLOTTESVILLE PATH TO CLIMATE PROTECTION

> *'Tackling these problems at a global scale is merely the sum of millions of communities addressing the issues locally'*
>
> ***Mohammed Valli Moosa, President, World Conservation Union, March 2006.***

Environmental and Climate Protection Initiatives for local governments can be beneficial on several levels. Beyond the obvious, these initiatives can also help reduce local air pollution, save money through efficiencies, help reduce local air pollution, save money thorough efficiencies, help improve the health of residents, and alleviate local traffic woes through smart transportation development.

The financial benefits of a climate protection program can be seen immediately: lowering emissions = less energy use = less cost. Anticipated cost saving applies to the individual city resident or business who makes energy efficiencies such as switching to CFL bulbs and improving insulation, through to saving money in local government through green buildings, for example the Downtown Transit Station, which utilizes a geo-thermal heating and cooling system, as well as through proactive utility tracking, system upgrades and retrofits, and the implementation of other energy efficiency practices.

City environmental initiatives since 2000 include greening the city fleet through use of hybrids and biofuels, conducting energy audits and retrofits of city schools and municipal buildings, establishing an Environmental Management System (EMS) throughout City departments, developing an urban forest management plan, and promoting public transportation. By signing the US Mayors Climate Protection Agreement in July 2006, the City of Charlottesville became committed to establishing an emissions inventory (a baseline) setting targets, developing and implementing reduction strategies, and tracking progress.

In January 2007, the City launched the Citizens Committee on Environmental Sustainability. Details on committee members and meeting minutes can be found at www.charlottesville.org/greencity . Following recommendations by the committee, and following investigation of climate action planning approaches used by other local governments, the City of Charlottesville joined the International Council for Local Environmental Initiatives (ICLEI) in May 2007 and embarked on the emissions baseline study.

Local city governments can use their influence, their decision making and their purchasing powers in ways that increase energy efficiency and reduce greenhouse gas emissions. By doing so, cities and counties can also improve air quality, reduce pollution and waste, create jobs, save money and enhance the quality of life in their communities. Climate change is a global problem, but local authorities such as the City have plenty of tools to influence local energy usage, in ways that the federal government cannot.

> *Preventing climate change is not the only, or in some cases the primary, reason local governments are acting to reduce greenhouse gas emissions. Many are drawn to the issue because of local economic, environmental, and community needs. Local governments understand that they can benefit from energy efficiency—both economically, through lower energy bills, and socially, through improved air quality and more livable communities.*
>
> **ICLEI, 5-Milestones Guide**

ICLEI – LOCAL GOVERNMENTS FOR SUSTAINABILITY

ICLEI - Virginia Region members:
County of Albemarle
Alexandria
Arlington County
Blacksburg
Charlottesville
Harrisonburg
Norfolk
Roanoke
Roanoke County
Warrenton

The International Committee for Local Environmental Initiatives (ICLEI) was founded in 1990 and is an international association of local governments and national and regional local government organizations that have made a commitment to sustainable development. More than 850 cities, towns, counties, and their associations worldwide comprise ICLEI's membership. ICLEI works with local governments through international performance-based, results-oriented campaigns and programs. ICLEI provides local governments and universities with software tools for calculating greenhouse gas emissions and criteria air pollutants, provides technical aid, software, and information services.

In 2006, Charlottesville signed the US Mayors Climate Protection Agreement, committing the City to undertake emission reductions. In March 2007, Charlottesville joined ICLEI's Cities for Climate Protection (CCP) campaign in order to fulfill the obligations of conducting a greenhouse gas emissions inventory and to begin the challenge of emission reductions.

CITIES FOR CLIMATE PROTECTION

The Cities for Climate Protection™ (CCP) Campaign assists cities to adopt policies and implement quantifiable measures to reduce local greenhouse gas emissions, improve air quality, and enhance urban livability and sustainability. More than 800 local governments currently participate in the CCP, integrating climate change mitigation into their decision-making processes. The campaign is based on an innovative performance framework structured around five milestones that local governments commit to undertake. The milestones allow local governments to understand how municipal decisions affect energy use and how these decisions can be used to mitigate global climate change while improving community quality of life and making financial efficiencies. The CCP methodology is compliant with international standards and provides a simple, standardized way of acting to reduce greenhouse gas emissions and of monitoring, measuring, and reporting performance. (ICLEI 2008)

A vital component of mitigating anthropogenic climate change has to be a drastic reduction of our emissions of CO2, through aggressive energy efficiencies, public transport solutions, effective urban planning, waste management solutions and sustainable procurement policy and practice.

ICLEI 5 Milestones Guide

The majority of anthropogenic greenhouse gas emissions come from the following sources: burning fossil fuels to produce electricity that powers, lights, heats, cools and ventilates buildings, homes, offices, parks, and streets; using fossil fuels for heating and operating vehicles, and from waste decomposing in landfills and sewage treatment plants.

Local governments have a real potential to impact energy use and waste practices within their communities. The day-to-day decisions made by local governments, the facilities they operate, and the services and infrastructure they provide are significant determinants of the energy consumed, fuel used, and waste generated within their communities.

ICLEI provides members with emissions calculation software in order to audit the community emissions. The software is the Clean Air and Climate Protection program (CACP).

The emissions analysis focuses on scope emissions of the three main greenhouse gases - carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). As described on page 10, there are other greenhouse gases, however, these three are the most significant contributors to greenhouse gas emissions in urban areas and are the focus gases tracked by the software.

CO_2, CH_4 and N_20 are aggregated and reported as carbon dioxide equivalent (eCO_2), a commonly used unit that combines greenhouse gases of differing impact on the climate into one weighted unit.

The software provided by ICLEI also calculates volumes of criteria air pollutants being emitted which have an adverse affect on our atmosphere and health. These are nitrogen oxides (NO_x), sulfur oxides (SO_x), Volatile Organic Compounds (VOCs), carbon monoxide (CO) and coarse Particulate Matter (PM_{10}). Including the analysis of these pollutants enables us to study which of our activities are not only causing greenhouse gas emissions, but which activities are adversely affecting air quality and health of the community. The CCP program consists of 5 milestones, as summarized below:

THE 5 MILESTONES

1 Conduct the emissions inventory for the baseline year and an interim year

2 Set a reduction target for both the community and the government (municipal) operations, with a percentage reduction aim and target year

3 Develop a local action plan

4 Implement the measures in the local action plan

5 Monitor progress, continue to track emissions and report results

MILESTONE 1: CONDUCT A BASELINE EMISSIONS INVENTORY

Similar to an energy audit before retrofitting a building, an emission analysis lets you identify what activities in the community are causing greenhouse gas emissions and the quantity each of these activities is contributing.

The inventory comprises an overall community sector, with the ability to enter a local government inventory as a community subset. The local government subset (municipal) incorporates municipal schools, buildings and fleet so that municipal performance on energy efficiency and emissions reductions can be studied in more detail as a contributor to the community total.

MILESTONE 2: SET A TARGET FOR MUNICIPAL AND COMMUNITY GREENHOUSE GAS REDUCTIONS

Latest IPCC research suggests that we need to achieve closer to an 80% reduction below 1990 levels to significantly slow global warming.

Following the baseline report, it is common for municipalities to launch a community Climate Action Team**,** whom take responsibility for managing this and all following steps.

Most jurisdictions have chosen a 10-20 year time frame from the date of the emissions inventory until their forecast, or target year for reduction.

The US Mayors Climate Protection Agreement calls for a 7% reduction from 1990 emissions by 2012, to match the Kyoto agreement. Almost all local governments participating in ICLEI's CCP campaign establish a greenhouse gas emissions reduction target at 15% or higher to be met within their target period (see appendix 2).

MILESTONE 3: ESTABLISH A CLIMATE ACTION PLAN (CAP)

The Climate Action Plan is a description of all actions, policies, programs, and projects that local government will undertake to meet its emission reduction target by the target year. Each action is accompanied with expected *e*CO_2 or pollutant reduction, timeline, financing, assignment of tasks and staff/ department responsibilities. This need not be a long and complex document, but may be included within another document (i.e. Environmental Sustainability Policy, Council Comprehensive Plan) or as a simple stand-alone resolution.

MILESTONE 4: IMPLEMENT THE CLIMATE ACTION PLAN

Implement the programs and monitor progress and success of each. ICLEI recommends updating a basic emissions inventory every 2 - 3 years to check on emission reduction progress and to make sure that new data (i.e. census) and information on new developments within the community are added. The CAP is intentionally voluntary and dynamic - adjustments can be made to keep it on track and for reality checks. This approach is consistent with key components of the City's EMS, which emphasizes review and modification of programs in order to maintain effectiveness and maximize environmental performance based in new opportunities and other influencing factors.

MILESTONE 5: ASSESS, REPORT, MODIFY TO KEEP ON TARGET

Milestone 5 calls for ongoing regular review, progress assessment, public reporting and development until the target year, and beyond.

NATIONAL AND REGIONAL PROGRAMS

CLIMATE REGISTRY

The Climate Registry is a collaboration of over 40 states, provinces and tribes in the United States, Canada, and Mexico who have agreed to develop and manage a common and unified greenhouse gas emissions reporting system. The Climate Registry is designed to support various greenhouse gas emission reporting and reduction policies for its member states, provinces, and tribes and reporting entities, based on data that is accurate, complete, consistent, transparent and verified. The Registry consists of a voluntary entity-wide reporting program as well as the infrastructure to collect and track greenhouse gas data reported to state mandatory and regulatory programs.

The Climate Registry is founded on the GHG Protocol Corporate Accounting and Reporting Standard, a partnership between the World Resources Institute and the World Business Council for Sustainable Development. The Climate Registry is an effort to unify existing U.S. state and regional registries. These include the California Climate Action Registry, the first state-level corporate GHG registry in the U.S. with current participation from 300 reporting companies, and the Eastern Climate Registry, a joint project of several Northeast states. The Climate Registry represents the joint efforts of California and the Northeast, together with states in the Midwest, Western, and Southeast U.S., to create a single unified greenhouse gas emissions registry, supported by states, provinces, and tribes across North America.

The Climate Registry will become operational and accept reported emissions data beginning in early 2008. See www.theclimateregistry.org for more information on The Climate Registry.

Governor's Commission on Climate Change

Governor Timothy M. Kaine established the Commission in December 2007. The commission will prepare a plan for Virginia that identifies ways to reduce greenhouse gas emissions. During the development of the plan, the commission will inventory the amount of and contributors to Virginia's greenhouse gas emissions, including emissions projections through 2025. The commission will also identify what Virginia needs to do to prepare for the likely consequences of climate change, and identify any actions that need to be taken to achieve the 30% greenhouse gas reduction goal, as identified by the Virginia Energy Plan, released in September 2007. The Governor's Commission on Climate Change is expected to issue the report by December 2008.

Notes on ICLEI CACP Software and Emission Coefficient Formulae

The State and Territorial Air Pollution Program Administrators and Association of Local Air Pollution Control Officials (STAPPA/ALAPCO) joined forces in 2005 with ICLEI and with support from the US Environmental Protection Agency to build a software product to help state and local governments. The Clean Air and Climate Protection (CACP) software tracks emissions and reductions of greenhouse gases (carbon dioxide, methane and nitrous oxide) and criteria air pollutants (nitrous oxide, sulfur oxide, carbon monoxide, volatile organic compounds and particulate matter) associated with electricity and fuel use and waste disposal. The software contains thousands of emission factors that are used to calculate emissions based on those used by IPCC, and can be found on the IPCC website.

The IPCC track SP_6, PFCs and HFCs in relation to greenhouse gases. However, these are not specifically tracked within the CACP software. According to ICLEI, it is generally highly unlikely that the majority of municipal operations or even communities will be generating these types of GHGs. However, the software does allow these to be entered in the "other" category if a community has within it a major source.

BASELINE REPORT - METHODOLOGY

Milestone 1 is an audit of activities causing or releasing emissions in the City in a baseline year, and a projection of how much these activities are likely to grow by a nominal target year - with business as usual energy use forecasts.

The baseline inventory helps determine what activities are causing greenhouse gas emissions. Knowing where energy use is highest does not necessarily tell you where greenhouse gas emissions are greatest.

For instance, communities in Washington State use a lot of electricity - which might point to improving building insulation as a measure to decrease greenhouse gas emissions. But because the electricity used mainly comes from hydropower rather than a fossil fuel, the emissions in Washington State are relatively low.

Communities in states such as Arizona, where coal is the main fuel source used to generate electricity, find that a substantial proportion of their greenhouse gas emissions come from electricity use.

ICLEI – 5 Milestones

BASELINE YEAR:

The Kyoto Protocol called for a reduction of emissions by industrialized, and ratifying, countries of an average of 5.3% down from 1990 baseline levels, to be achieved by 2012.

However, it would prove difficult for Charlottesville to collate truly accurate records of community and municipal utility use and other details from 1990, as accurate records are often unavailable this long ago.

Based on the information that was available to the City, the baseline year was set at 2000. This year is long enough ago that it was prior to many of the sustainability measures introduced by the City, but also utility records for this time are still mostly accessible, as are detailed transportation reports from Virginia Department of Transportation. Other communities who have recently started this effort have also selected 2000 as their baseline year. ICLEI supports this approach, given the significantly more accurate data than if 1990 or proxy data were used.

County of Albemarle, who joined ICLEI in fall 2007 and embarked on their baseline in January 2008, also has a baseline year of 2000, which allows for easy comparison of results and for measuring potential joint programs.

INTERIM YEAR:

Data has also been collected for an interim year, 2006, to utilize as a checking tool for 2000 data, and to provide a measure for our emissions growth over the intervening 6 years.

Forecast Year:

Our forecast year is 2020, and projections of business-as-usual growth have been made out to this year, as much as the increase in *e*CO_2 emissions this represents for the municipal sector of the City and the community as a whole.

Future projections to 2025 (the City Council Vision Statement year) can be made in late 2008, once the new rollout of CACP software is available from ICLEI with this capability. It is important to note that the forecast year is only an indication of what direction our emissions are heading, and can be amended as the project continues and as energy use forecasts are amended and updated by federal agencies. Forecast data for projections of increased energy use for this report were taken from the Energy Information Administration 2007 – 2030 National Energy Projections report.

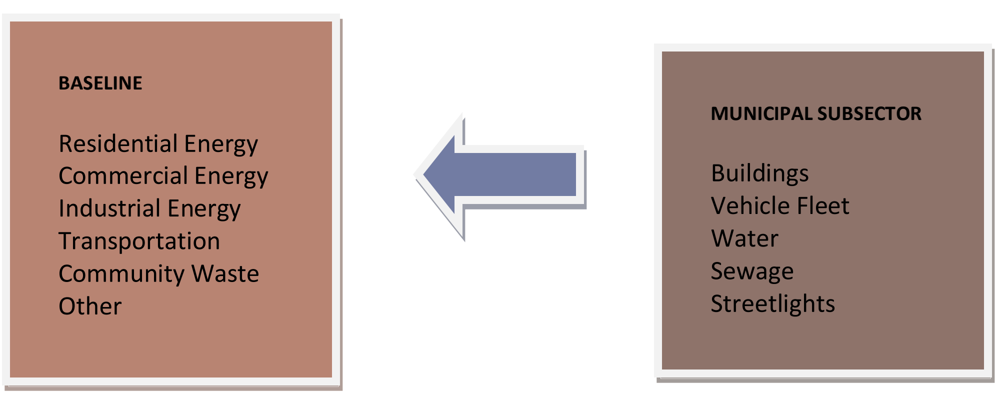
Notes on Data

The CACP software required the following information to produce an emissions baseline:

Energy use for all homes, municipal operations, commerce, and industry within the City limits was required for year 2000 and interim year 2006. To establish the baseline of emissions from transportation in the City, total vehicle miles travelled within City limits in the baseline year (broken down into car class) were required. For emissions from landfills and waste, tons of collected waste in the baseline and interim, plus the tonnages in any landfill sites within the city.

For reasons of future tracking, and to have a clear fence-line, it was agreed with the County of Albemarle that all of UVA, including the area, operations, and activities that falls within the County, would be included under Charlottesville baseline figures, and none of the UVA energy figures would be included within the Albemarle baseline to prevent any double counting. All projected and current population data was taken from the 2000 census.

FIGURE 1: SHOWS SECTORS REPORTED ON IN BASELINE REPORT. MUNICIPAL ENERGY USE FROM MUNICIPAL BUILDINGS IS INTEGRATED INTO THE OVERALL COMMERCIAL SECTOR, ALONG WITH THE UVA BUILDINGS DATA.



Residential, Commercial and Industrial Energy use

Energy use information was obtained from Dominion Virginia Power and City Gas Utilities, and broken into total residential, commercial and industrial consumption based on customer type. This was entered into the respective Residential, Commercial, and Industrial sectors of the CACP software and converted to MMBtu. All UVA energy use (including main heating plant) is recorded within the Commercial sector. Data held by the Dominion Virginia Power included data from UVA buildings within County of Albemarle, along with municipal data including schools as one kWh amount. For reasons of accuracy and future tracking, this Dominion Virginia Power section of data was discarded and detailed energy use information from UVA and City of Charlottesville Public Works, Facilities Maintenance Division was used in place. County of Albemarle is following the same methodology as above.

For forecasting out to 2020, information on projected national trends of energy use was taken from the Energy Information Administration (EIA) and EPA. The forecast year includes initial estimates of the increase in coal use at UVA regarding the upgraded main heat plant opening in 2008.

Transportation

A breakdown of daily vehicle miles traveled within the City area per car class for 2000 and 2006 was taken from the Virginia Department of Transportation figures.

Projections to 2020 are based only on established estimates of vehicle use increases and national fuel use increase estimates by EIA, as the population of Charlottesville is not expected to increase from 2006 figures.

WASTE

Waste figures were compiled using tonnage data from City Public Works, UVA Facilities Management, and commercial companies where they were available. Emissions were calculated using national averages of landfill waste: 38% paper, 13% food waste, 10% plant debris, 4% wood/ textiles and 35% all other waste. No addition to waste figures was made for forecasting to 2020.

MUNICIPAL SUBSECTOR:

Buildings

Information for the energy use within all municipal buildings and schools was acquired from the Charlottesville Public Works Department, Facilities Maintenance Division. Figures for natural gas and electricity were broken down by individual buildings for the baseline where records for 2000 were still available. Breaking the data into individual buildings makes the task of tracking energy efficiencies more accurate in the future.

STREETLIGHTS

Electricity use for streetlights was taken from records of City utility payments, and includes all streetlights within the City including traffic signals. The ownership of lights within the city is a combination of City of Charlottesville and a private utility. Energy use information for this sector was taken from records held by the City of Charlottesville Public Works, Facilities Maintenance Division.

FLEET

A detail of fuel used by the City vehicle fleet was obtained from the Charlottesville Public Works Department, Fleet and Transit Divisions, using fuel usage statistics of gasoline, diesel, biodiesel (B20), and compressed natural gas (CNG) for 2000 and 2006. B20 biodiesel was introduced to the fleet in stages throughout 2006 and 2007, and it is therefore expected that any greenhouse gas and criteria air pollutant reductions resulting from this will become apparent at next inventory.

WASTE/ SEWAGE

The water and sewage treatment works is not under the direct control of the City government, but of the Rivanna Water and Sewer Authority (RWSA). The RWSA energy data is therefore contained within the Commercial subsector fuel usage statistics.

NOTE ON UNITS

Within the CACP software, units of fuel are recorded in kWh, MMBtu, mcf (1000 cubic feet), US gallons, cords, and barrels. For reasons of ease and consistency, units for fuel energy recorded in the following baseline report are provided in MMBtu, all greenhouse gas emissions in metric tons, and all criteria air pollutants in lbs.

Emissions Reduction Target

The baseline serves as a reference against which to measure our emission reduction achievements in terms of tons of greenhouse gas emissions. The target is typically set at a certain percentage below baseline (2000) emissions, i.e. 10 - 20%. There are several issues involved in setting a reduction target. We need enough time to implement the measures in the Climate Action Plan and achieve its reduction goal - but the further out the target year is, the more we might be pledging to reduce.

ICLEI recommends that regardless of the chosen long-term (e.g., 15-20 year) emissions reduction target, it is advisable to establish interim targets for every 2-3 year period.

ICLEI 5 Milestones Guide

EMISSIONS BASELINE REPORT

DATA SUMMARY

YEAR	ENERGY USE (MMBTU)	TOTAL eCO_2 EMISSIONS (TONS)	PER CAPITA EMISSIONS (METRIC TONS*)	PER CAPITA EMISSIONS (METRIC TONS*) BASED ON STUDENT POPULATION AS RESIDENT 0.75 OF YEAR
2000	**6,903,433**	**868,952**	**19.7**	**22.5**
2006	**6,706,718**	**910,991**	**20.6**	**23.9**
2020	**8,681,799**	**1,119,049**	**24.5**	**28.6**

**1 metric ton = 2,200 lbs*

If 1 ton of *e*CO_2 has a volume of 500 m3, then every year Charlottesvillians are responsible for emitting enough *e*CO_2 to fill about 5 hot air balloons each!

In 2000, Charlottesville's eCO_2 emissions were a total 868,952 metric tons, with a population of 40,099. This included a student population of 18,550. Our per capita emissions of eCO_2 in our baseline year were 19.7 metric tons.

The city population in 2006 was 40,315 with a student population of 20,397. Current estimates for residential city population in 2020 are that it will remain unchanged from 2000. Approximately 170 students per annum will be added to student numbers based on Board of Visitors data, leading to a total population of 42,139 in 2000. As the student proportion of this figure is so large, per capita calculations for 2000 and 2006 in the table above have also been made to cover students as residing an average of 75% of the year within the city. This higher number simply allows us to compare our emissions with any other similar communities if required.

As demonstrated in Figure 2, our baseline is set at the 2000 level of just under 900,000 tons and our emissions are forecasted (green line) to continue to climb steadily from 2006 to 2020, despite the predicted lack of population growth within the city. This projected increase in energy use expected to occur under the "business-as-usual" scenario nationally across all sectors, especially coal fueled electricity, and across most fuel types. The increase of our *e*CO_2 emissions contrasted against the drop in MMBtu used is a reflection of the large rise in electricity demand and a drop in other fuel sectors.

USA national average estimates of per capita emissions range from between 20 and 24 tons per capita, according to the Energy Information Administration, World Resources Institute, and ICLEI. Compared nationally, Charlottesville per capita emissions are therefore just below average - but looking further afield, average per capita emissions worldwide include China at 3.9, Great Britain at 9.8, Mexico at 4.3, Australia at 16.5, and Canada at 20 tons per capita.

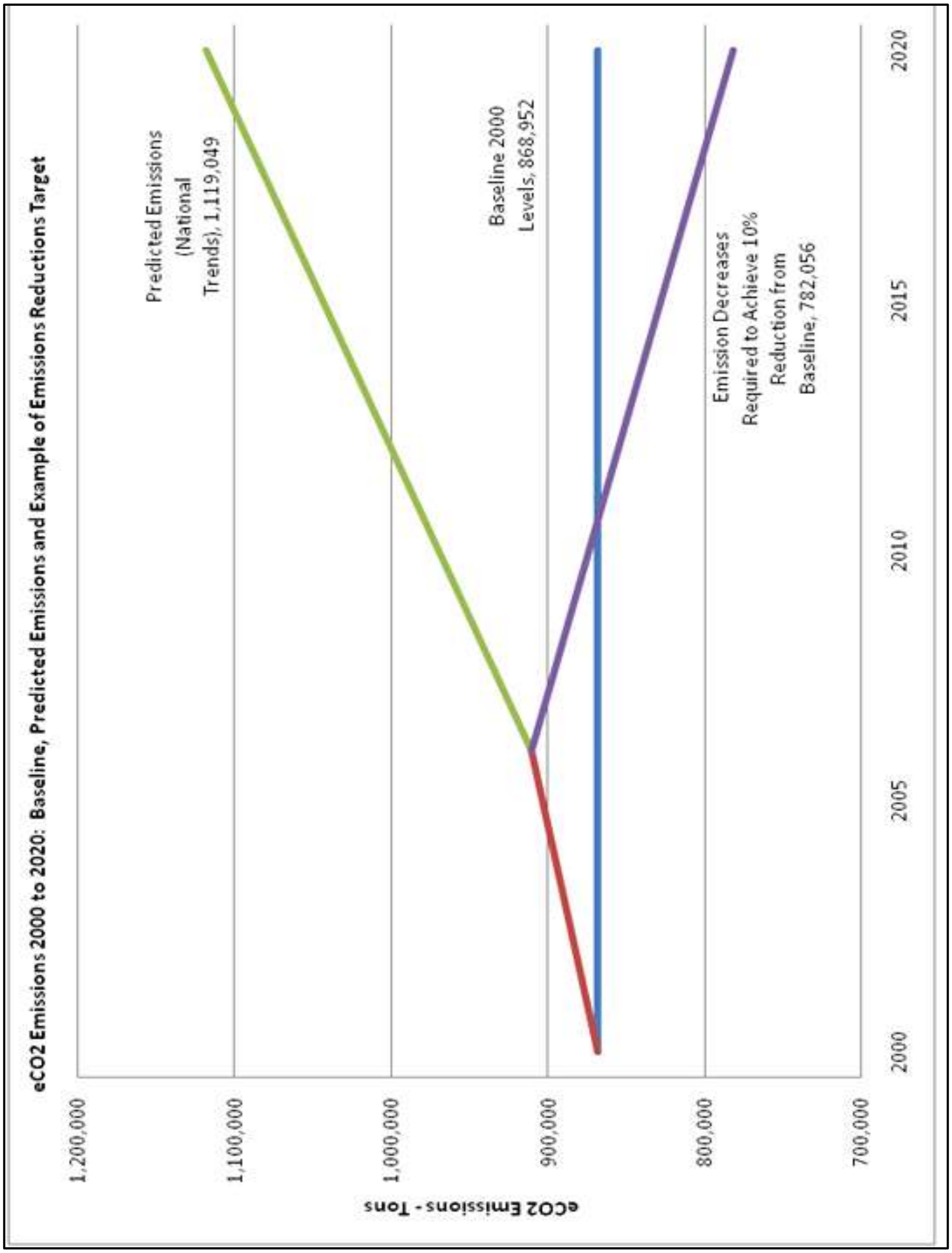


FIGURE 2: **ABOVE. TOTAL ECO$_2$ EMISSIONS FOR CHARLOTTESVILLE. THE BLUE LINE SHOWS OUR EMISSION LEVEL IN 2000, OUR "BASELINE". THE RED LINE SHOWS OUR EMISSION INCREASE BETWEEN 2000 AND 2006. THE GREEN LINE DEMONSTRATES WHERE OUR EMISSIONS ARE PREDICTED TO GO (BASED ON EIA NATONAL ESTIMATES) IF ALLOWED TO CONTINUE UNCHECKED, THE "BUSINESS-AS-USUAL" SCENARIO. THE PURPLE LINE REPRESENTS AN EXAMPLE 10% TARGET FOR REDUCING OUR EMISSIONS BELOW 2000 LEVELS**

The CACP software enables us to "separate out" all government, or municipal, operations, enabling us to report data for municipal operations at a closer level. Local government has additional control over their own practices, policies and procedures and therefore closer control over their future emissions. "Municipal" data referred to in this report includes all City buildings, schools, parks, fleet, and streetlights.

The first part of this report will look at the results from the baseline study, followed by a review of the data from the municipal sector.

Future projections to 2020 are made using "business-as-usual" data. Remember when one electric socket per room was enough? Modern hi-tech gadgets, plasma TVs, bigger homes all contribute to this steady increase in electricity use (Dominion/ EIA). From this visual it is apparent that the longer we postpone cutting emissions, the bigger the challenge it will be not only to reach a 10% reduction below our baseline level, but also to simply return to baseline level emissions.

The forecast projections for 2020 are derived from predicted percentage increases by fuel type, per capita, from 2006 to 2020. Figures are all taken from the EIA 2007-2030 Energy Projections report. Nationally, with business as usual conditions, the EIA estimates an 18% increase in overall energy demand projected to 2030. Using national figures to project local growth is not ideal, as the city will not be experiencing population and industry growth in line with national trends. The forecast will therefore be amended to reflect local trends as they become apparent in regard to transportation and utility use.

Following the current heating plant upgrade in 2008, UVA will be using an increased amount of coal for the main heat plant, with a reduction in natural gas use. Approximately 90% of energy use at the plant will be from coal, which is approximately 50% of total energy use at the university (source: UVA). The projected increase in coal use has only had a moderate impact on projections thus far. The "commercial" sector of the data includes all of UVA, all municipal schools, city buildings, and all commercial enterprises within the city (as billed by utility companies). This will be looked at in further detail in the following section.

FIGURE 3 :**(RIGHT) SOURCES OF GREENHOUSE GAS EMISSIONS FOR THE CHARLOTTESVILLE COMMUNITY. UTILITY RELATED EMISSIONS DATA FROM MUNICIPAL BUILDINGS AND SCHOOLS HAVE BEEN SEPARATED FROM THE COMMERCIAL SECTOR IN THIS FIGURE.**

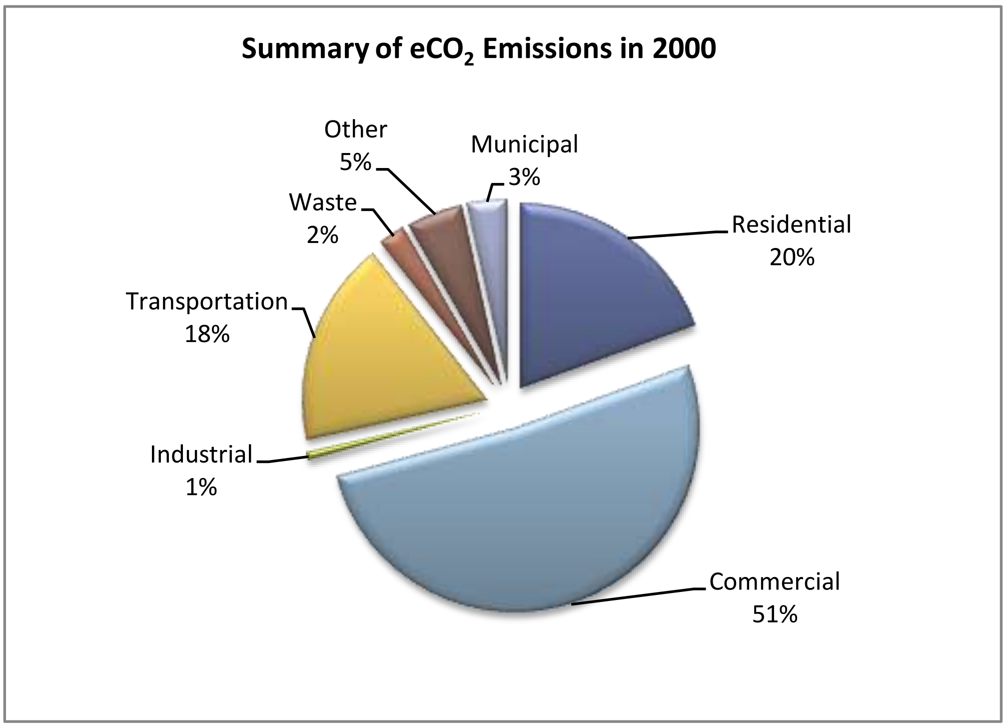


FIGURE 4 **(BELOW) GREENHOUSE GAS EMISSIONS FOR THE COMMUNITY FROM ALL FUEL SOURCES IN TONS OF ECO_2. NOTE THAT THE DISPOSAL OF PLANT DEBRIS IN 2000 ACTED AS A CARBON SINK. THE MAJORITY OF THIS PLANT DEBRIS WAS A RESULT OF THE COLLECTION AND COMPOSTING OF CITY FALL LEAVES - A TOTAL OF 2,000 TONS - IN THE BASELINE YEAR**

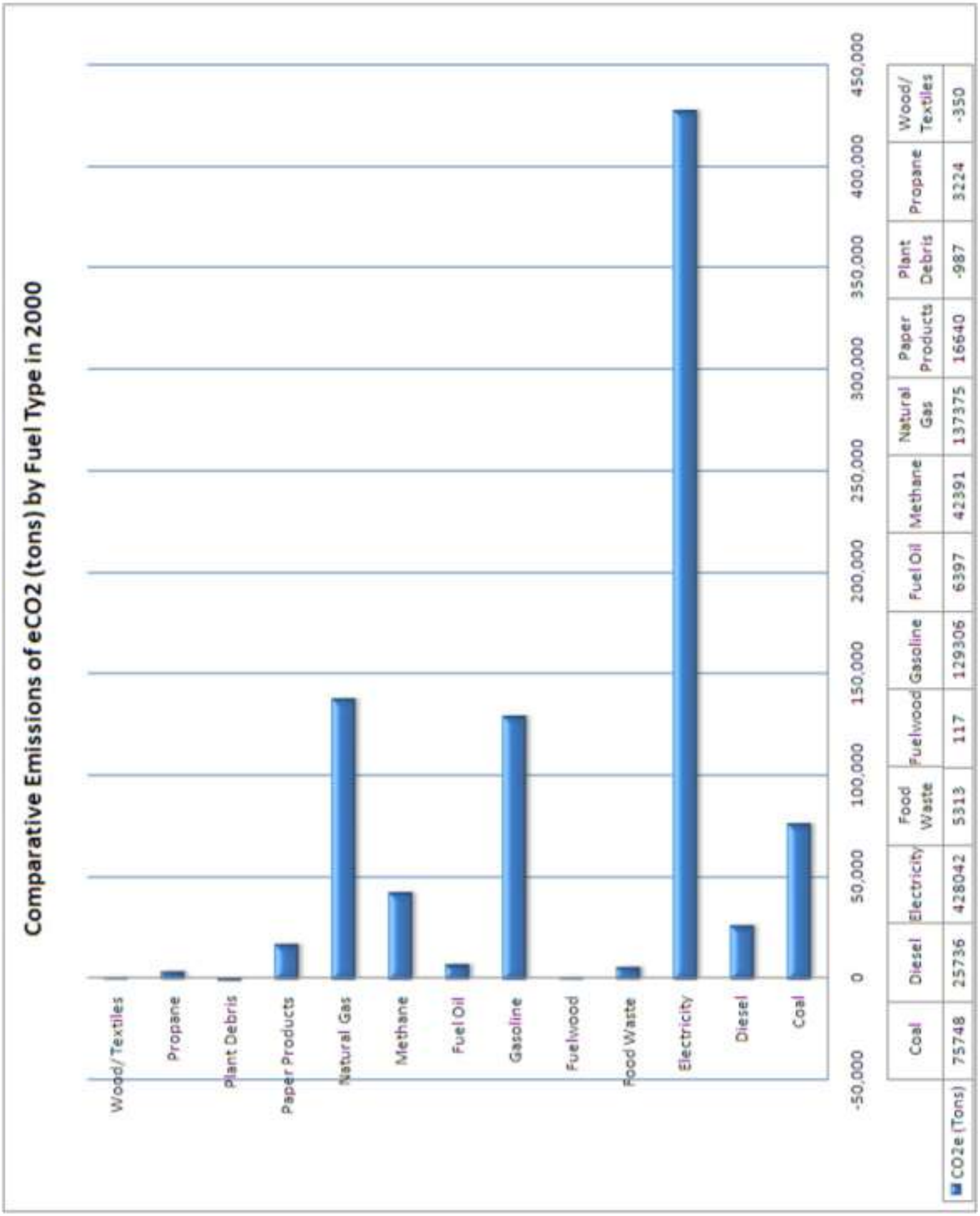
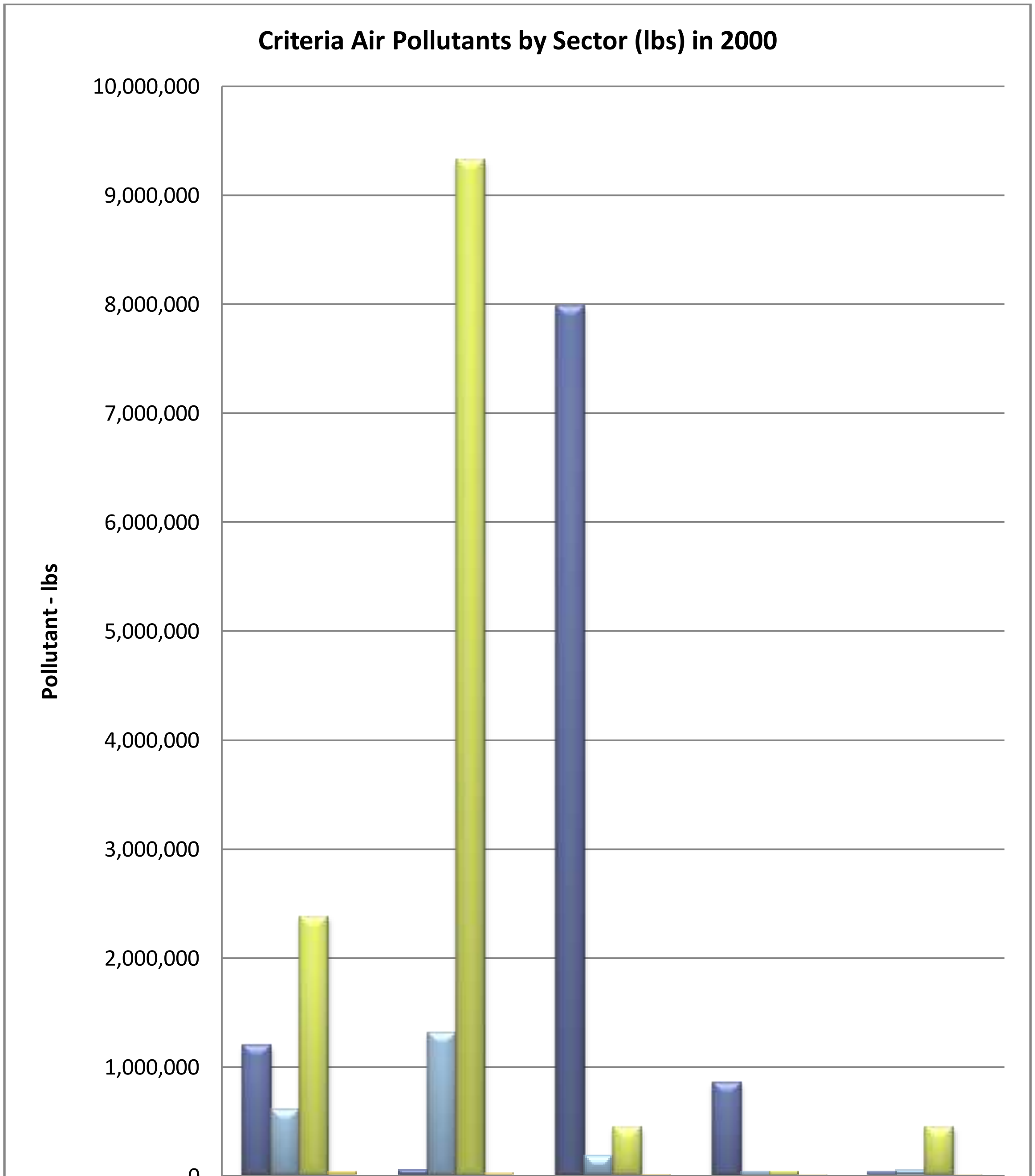


FIGURE 5 **(BELOW): SUMMARY OF CRITERIA AIR POLLUTANTS FROM ENERGY USE IN CHARLOTTESVILLE, 2000. THE SOX SPIKE IN THE COMMERCIAL SECTOR IS MOSTLY AS A RESULT OF THE COAL USED IN THE UVA MAIN HEAT PLANT. THE CO SPIKE IN THE TRANSPORTATION SECTOR IS THE DIRECT CARBON MONOXIDE EMISSIONS FROM FUEL COMBUSTION IN VEHICLES.**

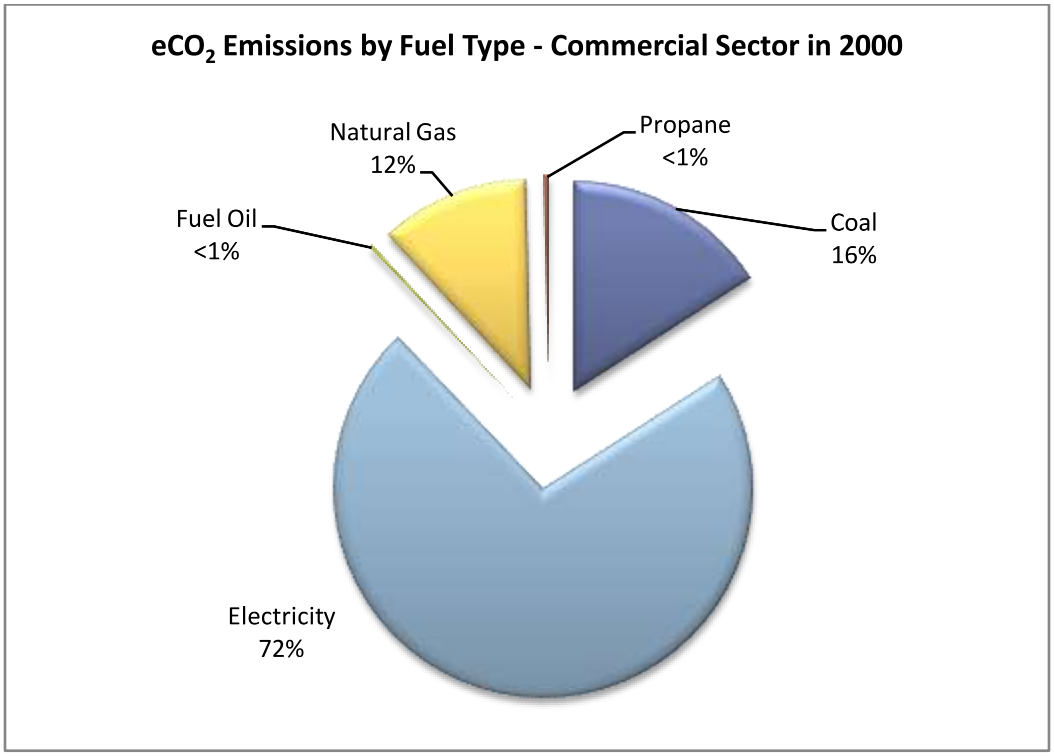


	NOx	SOx	CO	VOC	PM10
Transportation	1192387	54719	7987208	856827	38282
Residential	602327	1310978	187465	34567	43104
Commercial	2380286	9321440	441312	37708	450176
Industrial	30429	16348	8500	1501	1091

COMMERCIAL SECTOR

The Commercial sector is the largest source of energy use and eCO_2 emissions in our community.

FIGURE 6: **BELOW. THIS DIAGRAM SHOWS THE PERCENTAGE BREAKDOWN OF ECO_2 EMISSIONS FROM FUELS USED IN THE COMMERCIAL SECTOR IN 2000. COMMERCIAL SECTOR INCLUDES ALL OF UVA, ALL MUNICIPAL BUILDINGS, AND COMPANIES IN THE CITY BILLED AS COMMERCIAL.**



> In March 2001, the then Secretary of Energy, Mr. Spencer Abraham, delivered a speech in which he predicted that electricity demand in the US 'will increase 45% over the next 25 years'.

Commercial gas customers who purchased natural gas from the City Gas Utility represented 39% of the total gas use in the city, where commercial gas customers made up about 19% of total users. According to the EIA 2007 - 2030 Projection report, the yearly increase in the national commercial energy use is projected to be 0.4% annually.

In the commercial sector, Charlottesville has seen a sharp rise in the use of electricity from 2000 to 2006. This rise of 20.5% (source: Dominion) fits with general projections for energy demand nationally. According to the EIA, this rise is due primarily as a result of rising electricity use as the US moves increasingly to a service economy. Commercial energy use is projected to increase in the future, by a total of 19% from 2005 to 2030, as the transition to a service economy continues and energy prices even out from current levels. This, however, is a business as usual forecast, and does not take into consideration the adoption of energy efficient technologies in either energy production or in energy consumption trends.

UVA contributes 62% of the emissions from the commercial sector, which makes up 54% of city-wide emissions (including utilities from municipal buildings and schools). UVA contributes 35% to community emissions overall. This figure includes all buildings, heating and cooling plants, and a share of overall community transportation (this percentage does not include waste figures)

FIGURE 7 (BELOW) COMMERCIAL SECTOR WITH UVA CONTRIBUTION SPLIT OUT. THE REMAINING COMMERCIAL SECTOR INCLUDES MUNICIPAL BUILDINGS AND SCHOOLS, AND COMMERCIAL ENTITIES WITHIN THE CITY.

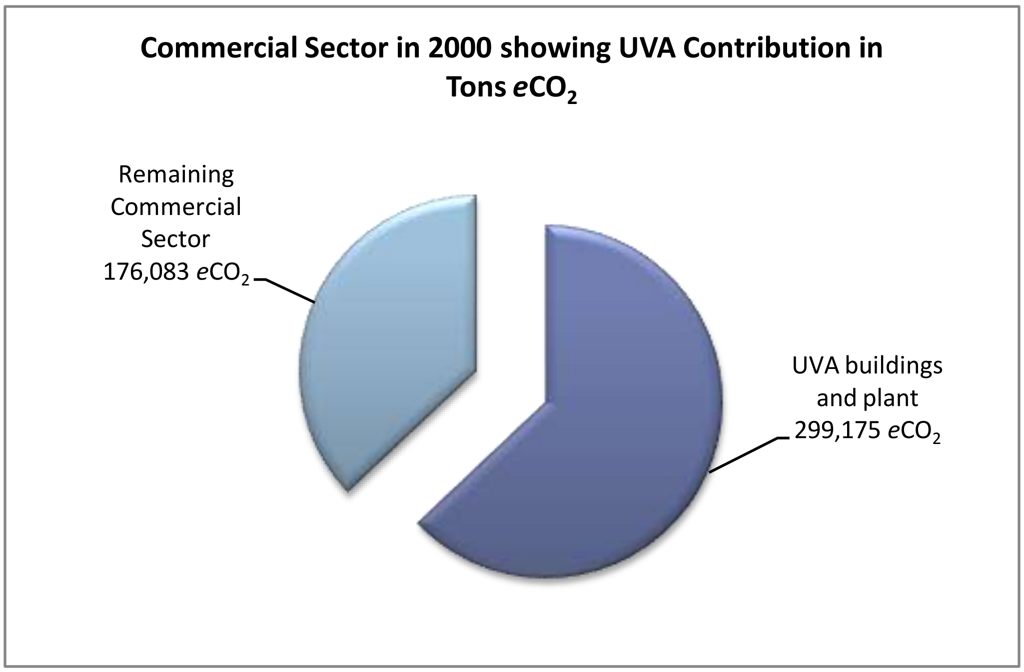
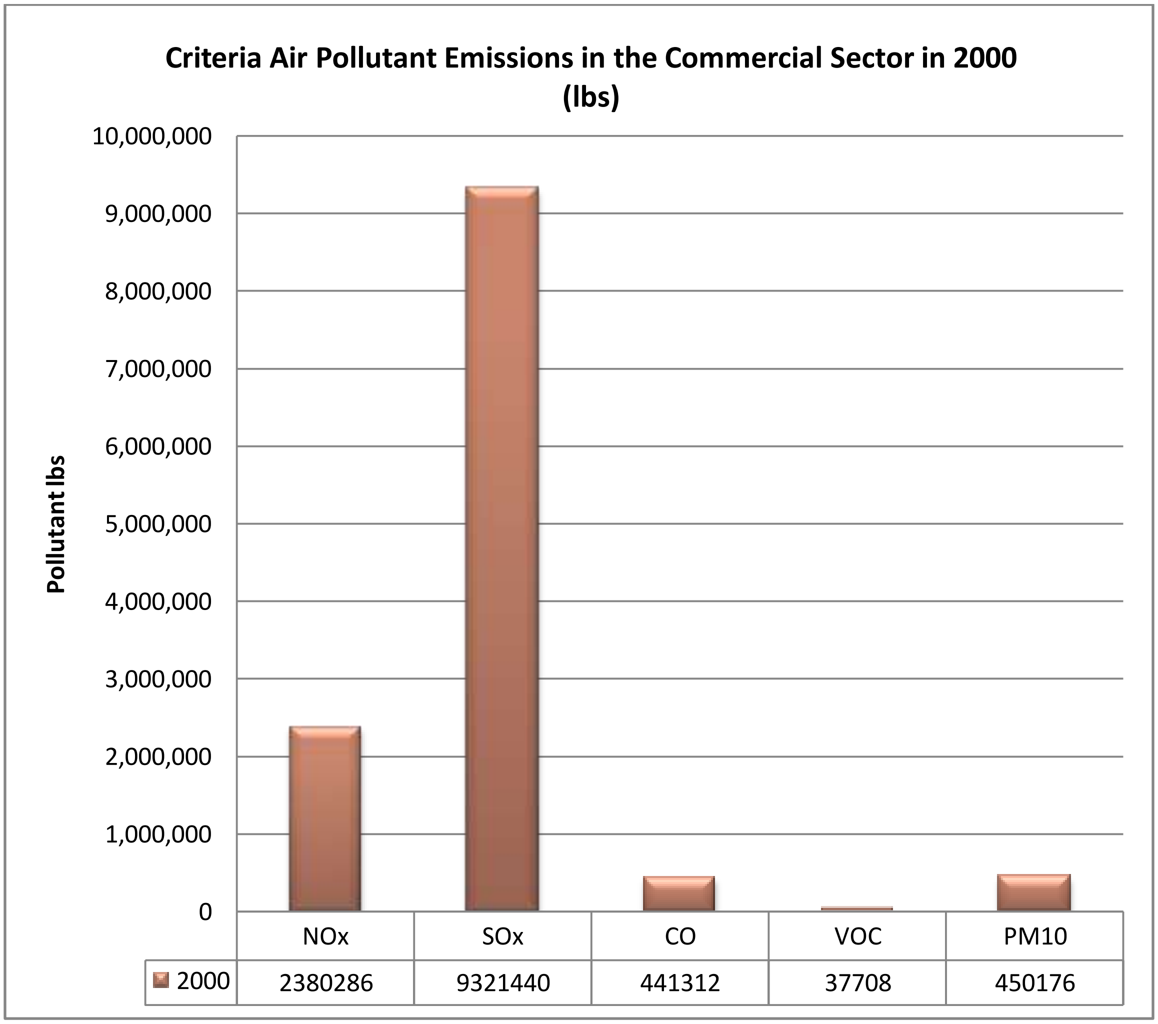


FIGURE 8: **BELOW, SHOWS THE PERCENTAGE BREAKDOWN OF CRITERIA AIR POLLUTANTS FROM ENERGY USE WITHIN THE COMMERCIAL SECTOR IN 2000**



With reference to the above figure, the elevated level of SO_x is from the relatively high electricity use within the commercial sector as compared to the residential and industrial sectors, and from the use of coal within the UVA main heat plant.

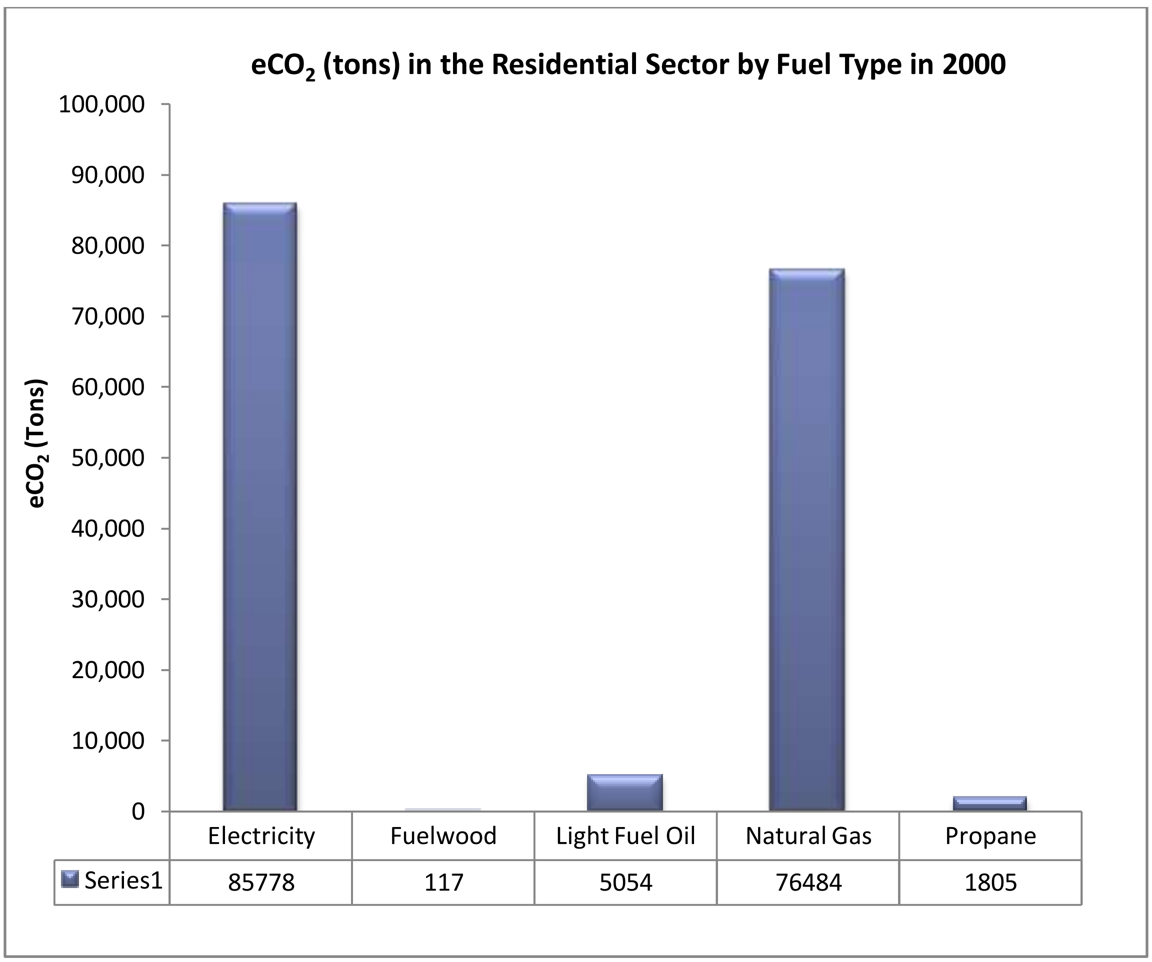
Residential Sector

The Commercial sector as a whole is the largest source of our emissions, over half. This sector contains all of UVA buildings, municipal buildings and schools and commercial entities within the city, so it represents a large portion of our community in itself. However, it is apparent that the impact of energy used in residential buildings also has a dramatic effect on the greenhouse gas emissions to our community. 20% of all of our emissions come from residential buildings.

This is not necessarily through the burning of fossil fuels directly within the home, or from emissions being directly released from properties. These emissions figures reflect the overall greenhouse gas emissions from energy use within those homes, and the sources of that energy, mostly electricity and natural gas.

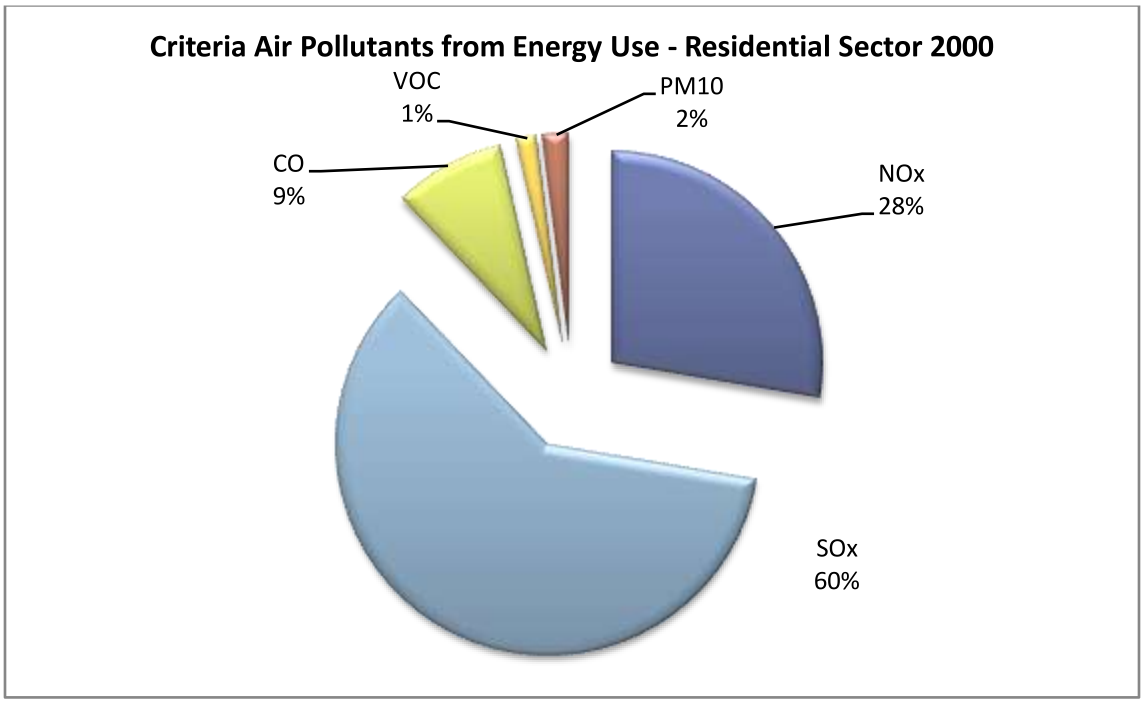
For instance, as can be seen in Figure 4, the majority of the overall *e*CO_2 emissions in our community are coming from the electricity we use. Much of the electricity supplied to our homes is obtained through the burning of fossil fuels at power stations here in Virginia; the release of *e*CO_2 at the power station is what is reflected in the emissions here.

FIGURE 9 – **GREENHOUSE GAS EMISSIONS (ECO_2) BY FUEL TYPE IN THE RESIDENTIAL SECTOR.**



Reducing emissions in the residential sector is generally a win-win situation. By making homes more energy efficient, not only are there less greenhouse gas emissions, but the occupants can also save substantial amounts on their utility bills. This is especially important, as the EIA predicts in their 2007-2030 Projection Report with a business as usual scenario continuing per capita increases in residential electricity consumption are expected to average 1.3 percent per year from 2007 to 2030. This will occur as more electric devices and larger television sets with digital capability continue to penetrate residential markets, along with other new technologies including plug-in hybrid vehicles.

FIGURE 10: **CRITERIA AIR POLLUTANTS IN THE RESIDENTIAL SECTOR, IN LBS.**



With reference to Figure 6, carbon monoxide (CO) is the product of the partial combustion of carbon compounds, when lighting natural gas on appliances for instance and eventually oxidizes to CO_2 in the atmosphere. CO is toxic, as it prevents oxygen uptake in the bloodstream in moderate doses, which is why gas appliances should be checked regularly, and adequate fresh air flow is necessary.

Coal and petroleum often contain amounts of sulfur, and their combustion causes the release of sulfur dioxide (SO2) at source. The general term SO_x refers to many Sulfur oxides, but Sulfur dioxide tends to be of most significant environmental concern. This important gas is the main product from the combustion of sulfur compounds.

SO_2 is naturally produced in the atmosphere by volcanoes and in various industrial processes. Since coal and petroleum often contain sulfur compounds, their combustion generates sulfur dioxide. Further oxidation of SO_2, usually in the presence of a catalyst such as NO_2, forms H_2SO_4, and thus acid rain. The EPA's Acid Rain Program helped contribute towards a 33% decrease in SO_2 emissions between 1983 and 2002. This improvement resulted from "flue gas desulfurization", a technology that enables SO_2 to be chemically bound in power plants burning sulfur-containing coal or oil. Essentially, lime is reacted with

SO_2 to ultimately become gypsum. A lot of SO_2 is now captured at the source within power plants. Despite this, SO_2 is the dominant pollutant in this sector. This is due to the majority of the power supplied by our electrical utility originating from the combustion of coal.

PM_{10}, small particulate matter, causes pollution in the atmosphere in the form of tiny aerosols. The biggest natural sources of PM are dust, volcanoes, and forest fires. Sea spray is also a large source of particles though most of these fall back to the ocean close to where they were emitted. The biggest human sources of particles are combustion sources, mainly the burning of fuels in internal combustion engines in vehicles and power plants, and wind-blown dust from construction sites and other land areas where the water or vegetation has been removed. PM_{10} refers to particulate matter of 10 micrometers in diameter.

It is important to remember that while greenhouse gas emissions within this report are in tons, these pollutants are in lbs. So in the instance of SO_x, in the residential sector 1,368,623 lbs of SO_x are produced in the baseline year by residential fuel - this is compared to 168,609 tons of eCO_2 for the residential fuel sector over the same period.

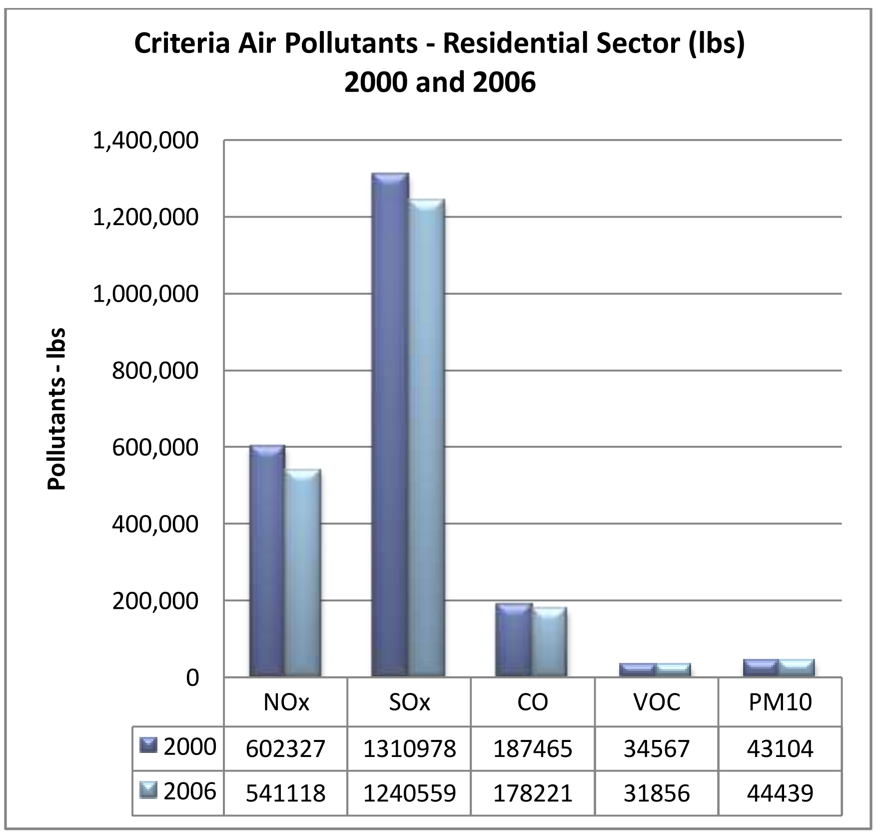


FIGURE 11: **ABOVE. COMPARISON OF CRITERIA AIR POLLUTANTS IN THE RESIDENTIAL SECTOR 2000 TO 2006. WE CAN SEE FROM THIS HOW CLEANER TECHNOLOGIES HAVE HELPED TO REDUCE POLLUTANTS (WITH EXCEPTION OF PM_{10}) IN THE RESIDENTIAL ENERGY SECTOR SINCE 2000.**

75% of all electricity used to power home electronics is consumed while the products are turned off or on standby. This waste of money and energy can be avoided by unplugging the appliance or using a power strip with switch to cut all power to the appliance when not in use.

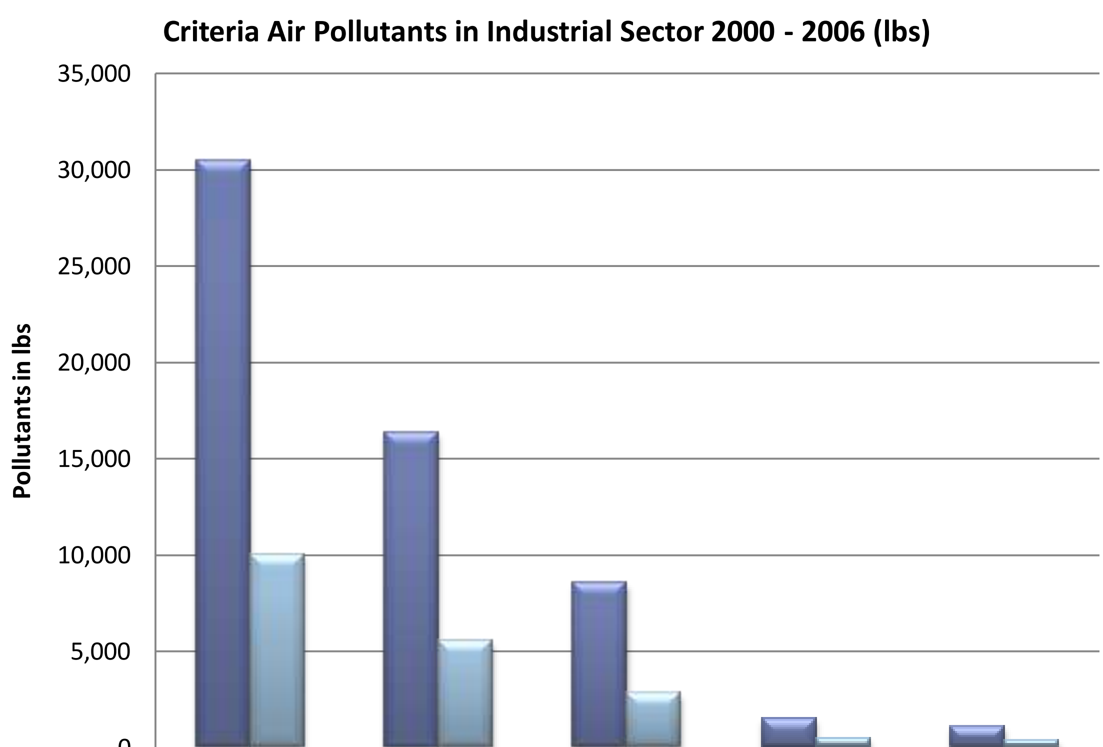
An old 60 Watt incandescent bulb is the equivalent of a CFL of between 15 - 19 Watts. The CFL bulb would save 850 lbs of carbon dioxide in its lifetime compared to the old style bulb, and could lead to savings of up to $68 for the householder.

Industrial Sector

Industrial sector emissions in both 2000 and 2006 are small when compared to the commercial and residential sectors. Industrial customers contributed only 1% of all emissions, and this sector has declined by nearly 20% in MMBtu and *e*CO_2 emissions by 17.5% between the years of 2000 and 2006. Natural gas is the dominant source of power in this sector, with 97.8% of emissions coming from gas use, a total of 6,273 *e*CO_2 tons in 2000. Natural gas has also seen a reduction of eCO_2 of 17%, and a drop in energy use of 17,223 MMBtu between 2000 and 2006.

The reduction in emissions from 2000 and 2006 has been 1,126 tons of *e*CO_2. Dominion Virginia Power reports a reduction in electrical demand between 2000 and 2006 in this sector of 307 MMBtu. There are a few explanations for this. The closure of a large textile factory that was located within the city has had some impact, and this was the explanation put forward by the Dominion Virginia Power. However, there may be other factors, for instance the possible moving of some industrial registered entities into the commercial sectors during the past 6 years. The Dominion Virginia Power no longer had access to this detailed information.

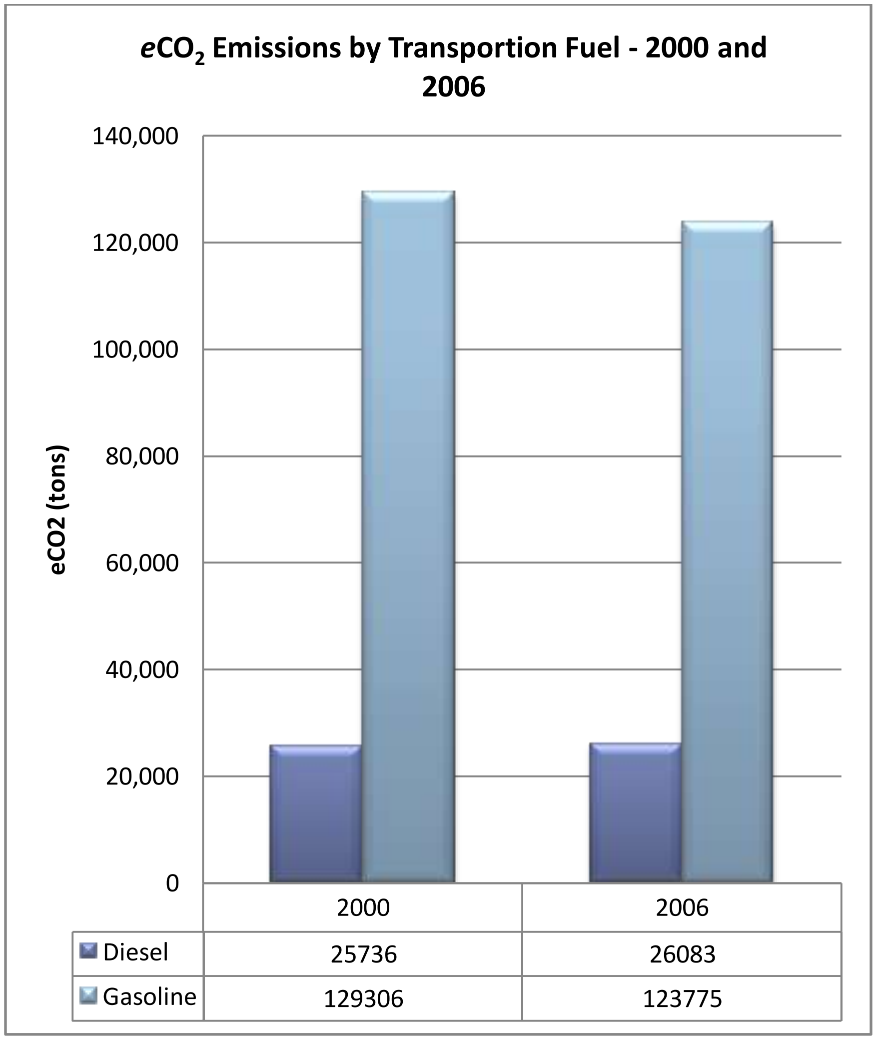
FIGURE 12 **BELOW: THE REDUCTION IN CRITERIA AIR POLLUTANTS WITHIN THE INDUSTRIAL SECTOR BETWEEN THE YEARS OF 2000 AND 2006. EXPLAINED THROUGH MAJOR SHRINKAGE OF THE CHARLOTTESVILLE INDUSTRIAL SECTOR, AND CLEANER ENERGY TECHNOLOGIES.**



	NOx	SOx	CO	VOC	PM10
2000	30429	16348	8500	1501	1091
2006	10035	5497	2796	493	363

Transportation Sector

FIGURE 13 **(BELOW) SHOWS THE BREAKDOWN OF ECO_2 EMISSIONS FOR THE TRANSPORTATION SECTOR BY FUEL TYPE, COMPARING 2000 AND 2006.**

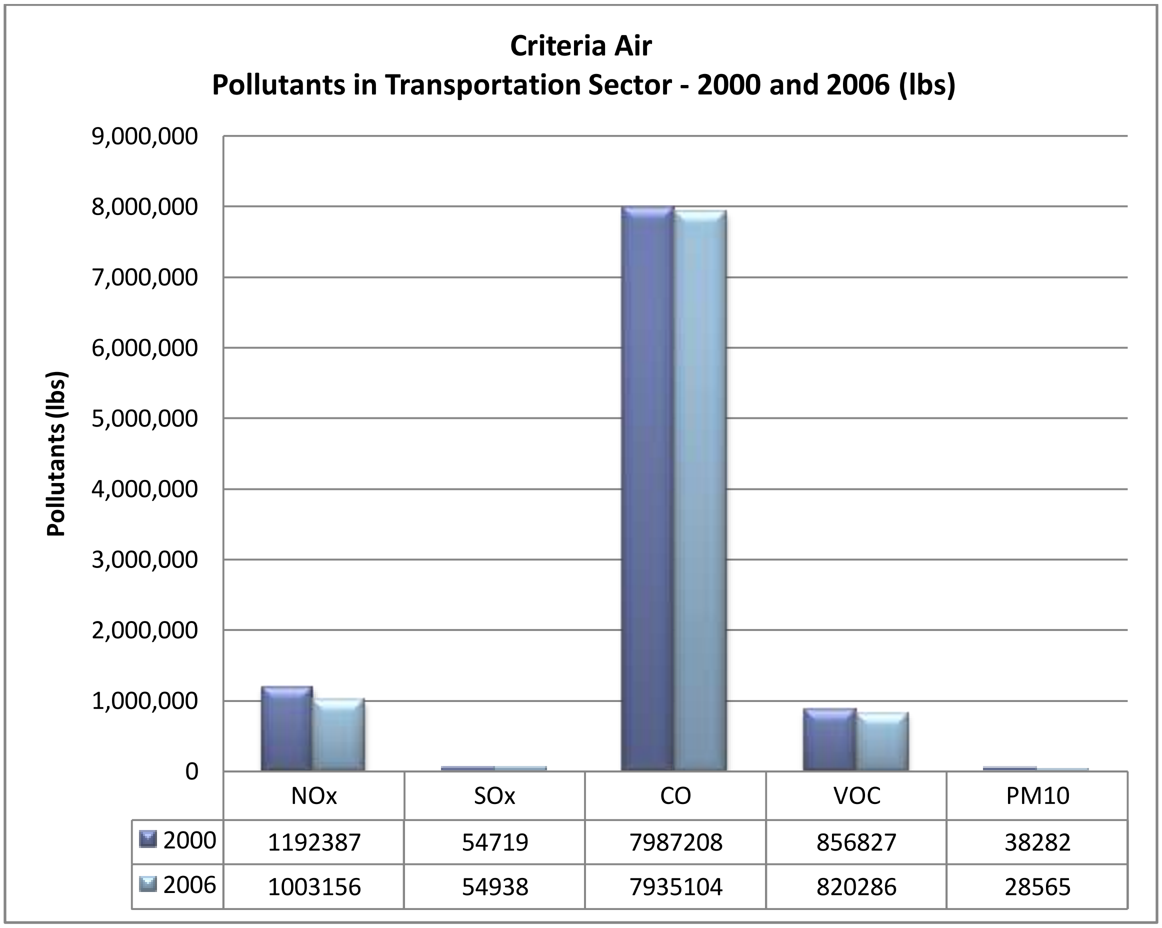


Not surprisingly, gasoline makes up the largest contributor to emissions from the traffic traveling around and through the city. However, the total emissions from vehicles (18% of total) are still less than the total emissions from the residential sector. Charlottesville is only 10 square miles, and these figures will only include those roads within the city boundaries, and will not include the major trunk roads within County of Albemarle. It is expected that these transportation figures will be reflected within the Albemarle baseline study. Interestingly, *e*CO_2 emissions from gasoline have reduced by 4% in the period 2000 – 2006, with a reduction of 3.5% MMBtu, and diesel emissions have risen by 1% during the same period, although this is in line with an increase of energy from diesel of 1.3%.

According to the Worldwatch Institute, American food travels an average of 1,500 to 2,500 miles from farm to table. Coffee from Sumatra travels 10,200 miles to Charlottesville, Cheese from France 3,930 miles, and carrots from California, 2,270 miles.

Many of the foods that we consume are not indigenous to the USA. Some food researchers argue that energy and resources are actually saved when buying food from the region of the world where it naturally grows best, not where it has to be grown with the use of additional water, chemical fertilizers, and transportation energy expenditure, often referred to as "food miles".

FIGURE 15: **(BELOW) SHOWS THE BREAKDOWN OF CRITERIA AIR POLLUTANTS WITHIN THE TRANSPORTATION SECTOR FROM 2000 TO 2006.**



	NOx	SOx	CO	VOC	PM10
2000	1192387	54719	7987208	856827	38282
2006	1003156	54938	7935104	820286	28565

The effects of inhaling particulate matter include asthma, lung cancer, and cardiovascular issues. The size of the particle is a main determinant of where in the respiratory tract the particle will come to rest when inhaled. Larger particles are generally filtered in the nose and throat and do not cause problems, but particulate matter smaller than about 10 micrometers, referred to as PM10, can settle in the bronchi and lungs and cause health problems. The 10 micrometer size has been agreed upon for monitoring of airborne particulate matter by most regulatory agencies.

Journal of the American Medical Association 287: 1132-1141

According to the National Biodiesel Board, there is a 78% reduction in eCO_2 emissions between regular diesel and biodiesel, however, the use of biofuel does not cut all greenhouse gases, notably N_20, and CH_4, although it does cut the emission of some criteria air pollutants, such as CO, VOC, and PM_{10}. For example a particular vehicle running on 100% diesel can emit 1.23 grams/mile of VOC, whereas biodiesel in the same vehicle will emit 0.4 grams/mile.

New fuel additives in gasoline, ultra-low sulfur diesel and diesel engine improvements are contributing to lowering the emission of sulfur oxide gases into the atmosphere, which can act as an acid in rain, and lower particulate emissions. In the United States and Europe, particulate emissions (PM_{10}) from vehicles are expected to continue to decline over the next decade, through increased usage of cleaner technologies.

WASTE SECTOR

In 2006, 11.7% of all waste in the US was plastic – that equates to 29.5 million tons.

Recycling paper slows the harvesting of trees, which are essential to processing carbon in the atmosphere.

In addition to energy use, another large source of greenhouse gas emissions in many communities is the waste sector. Waste materials greenhouse gas emissions come from two sources—the emissions from the upstream processes needed to mine the raw material and manufacture it into a new product, and the methane released as the organic portions of the wasted materials decompose in landfill sites.

Local governments have a substantial impact on the energy use and waste practices within a community. These figures are based on the tonnages of waste collected through the City's residential curbside recycling program, large item collections, fall leaf collections, waste collected from commercial properties by commercial companies, and UVA waste figures.

The total tonnages were divided into categories of waste streams that have varying effects on emissions – in this case 38% paper products, 13% food waste, 10% plant matter, 4% wood or textile, and 35% other. These national averages are supplied by ICLEI.

It is interesting to see, if we go on the national averages, how much tonnage of food waste is being sent to landfills. Also, there is an opportunity for recycling additional paper items. If there was a composting scheme in the city, food waste could be reduced as a proportion of tonnage based on the success of the scheme.

The resource management decisions of a community influence the extraction and manufacturing decisions made upstream and beyond the community's borders. For every ton of material destroyed by incinerators and landfills, many more tons of raw materials must be mined, extracted, and processed to make new products to take its place. Virgin raw materials industries are among the world's largest consumers of energy and the energy sector is the single largest contributor to greenhouse gases. Community decisions concerning resource management directly affect the flow of materials upstream and the larger inventory of GHG emissions.

Eco-cycle, Boulder, CO

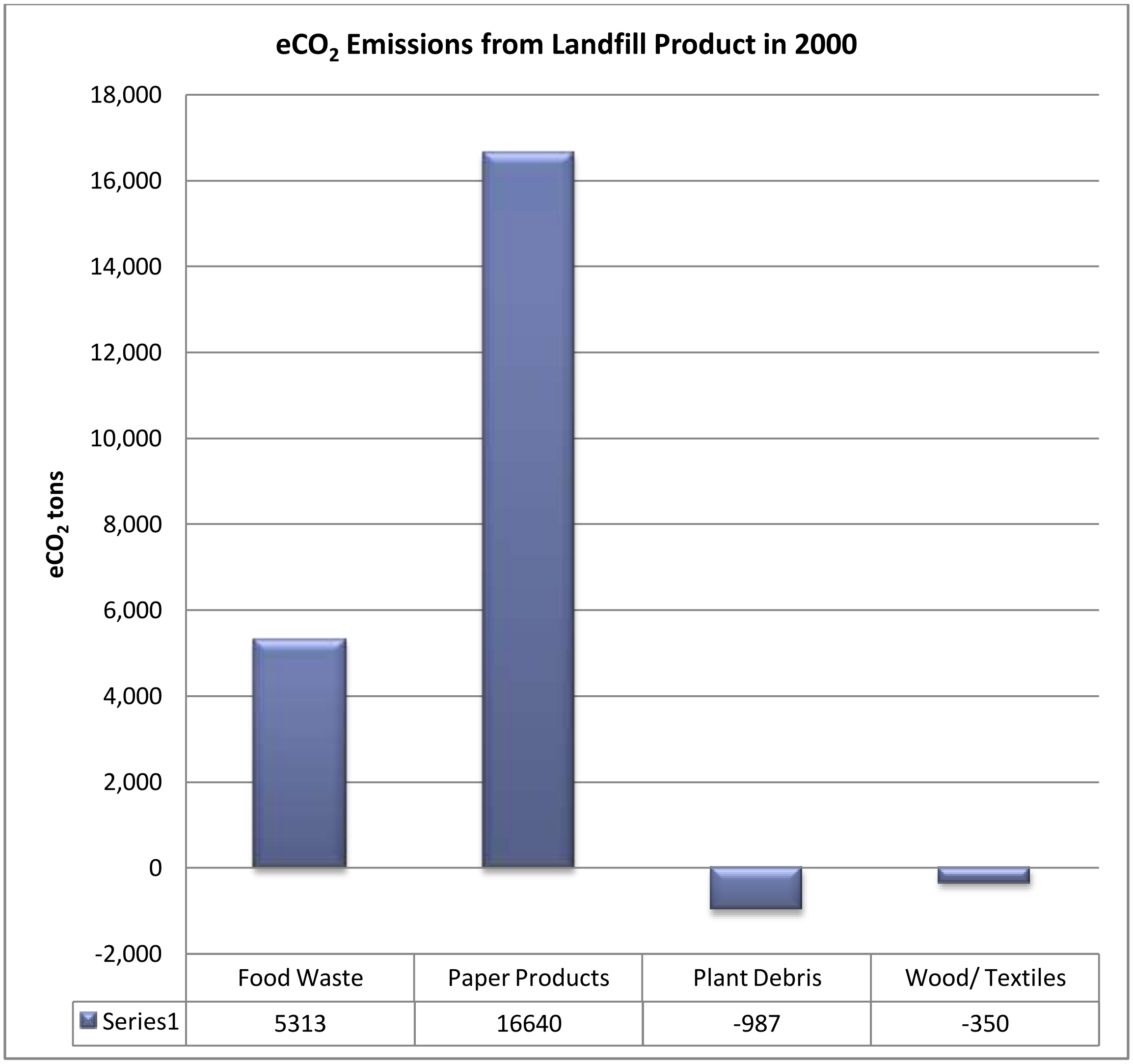


FIGURE 16 **(ABOVE): ECO$_2$ EMISSIONS FROM WASTE SENT TO LANDFILL IN 2000. THE VEGETATIVE AND WOOD DEBRIS ACT AS A CARBON "SINK", AS THEIR ABILITY TO REDUCE ECO2 OUTWEIGHS THEIR DECOMPOSITION RELATED METHANE EMISSIONS.**

OTHER

By far the most important non-CO_2 greenhouse gas is methane CH4, the number one source of methane worldwide is animal agriculture.

This sector refers to any particular large emitter of greenhouse gases that has not already been accounted for in the other sectors of the community. The most common use for this sector would be for agricultural communities who need to calculate ruminator (livestock-related) methane, for instance. In this sector, we have methane emissions that will gradually decline year on year as a result from the closed Old Ivy Landfill. In 2000, this accounted for 42,391 tons of *e*CO_2 – 4.9% of the overall community figure. The software takes into account waste tonnage when a landfill is sealed ("waste in place"), and any methane-flaring or methane use, then automatically reduces these community emissions year on year into the interim and forecasting years. As a result, *e*CO_2 from landfill in 2006 from "waste-in-place" was 31,404 tons, or 3.5% of the overall figure.

Greenhouse gas emissions reductions are achieved by diverting material from landfills by recycling, providing waste wood as feedstock for biomass energy generation, and composting organic materials and producing mulch for soil application.

For example, recycling reduces the demand for raw or virgin materials while re-manufacturing with recycled materials generally reduces overall energy use. Recycling also results in increased carbon sequestration by forests since fewer trees need to be harvested for wood and paper products.

The soil application of composted or mulched organics increases the soil's ability to store carbon, and reduces the need for fertilizers and herbicides, thereby the energy required for their manufacture is reduced, irrigation requirements are also reduced as well as the energy required delivering to deliver the irrigation water.

[One of the largest]… contributors of greenhouse gas emissions from agriculture is nitrous oxide from fertilizer (over 300 times more potent than carbon dioxide), the need for which is reduced through compost use. Other benefits of compost application are erosion control, soil structural improvements, and decreased eutrophication of water bodies from fertilizers, although these benefits do not represent reductions in GHG emissions.

Rick Moore, Edgar & Associates

Municipal Subsector

In looking at our baseline emissions data in more detail, we can parse out the total municipal emissions and analyze these separately. This is a valuable exercise as local government has the greatest control over its own operations and facilities. As a portion total of the overall Charlottesville emissions, emissions from municipal buildings, schools, and street lighting account for just over 3% of the total. Municipal fleet figures are contained within the Transportation sector.

Emissions by Source

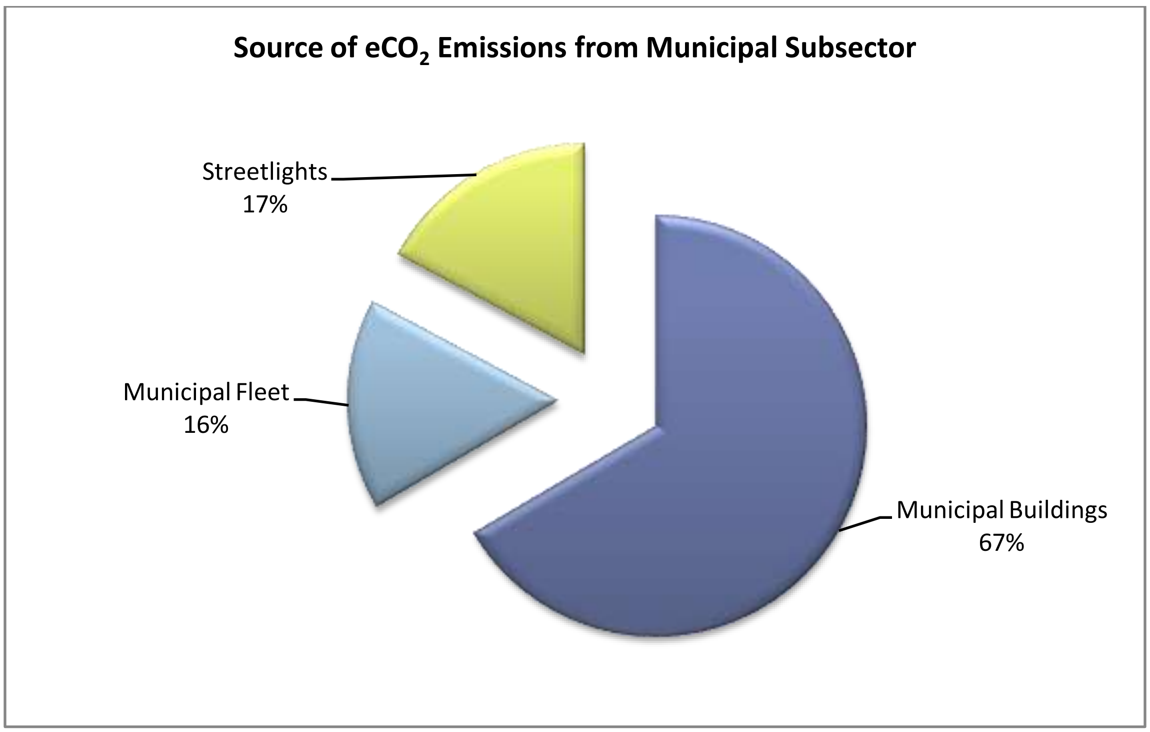
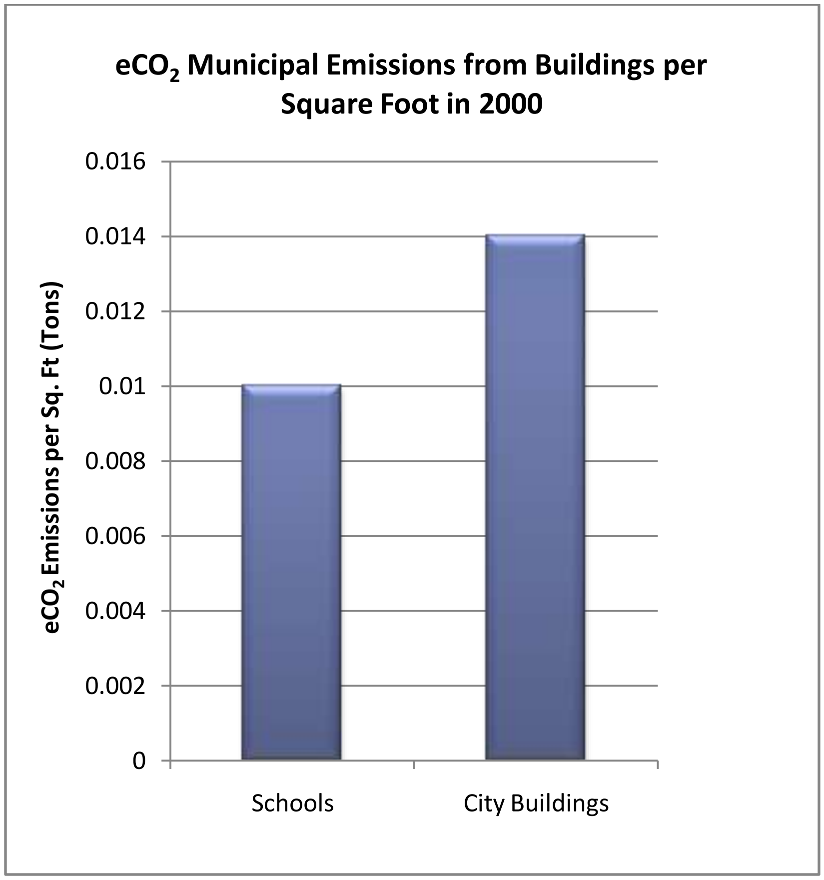


FIGURE 17 **(ABOVE) ECO_2 EMISSIONS FROM MUNICIPAL SECTOR**

Not surprisingly, municipal buildings dominate this sector in *e*CO_2 emission contributions. This includes all City buildings and City Schools, and the energy use they represent. Surprisingly, perhaps, the streetlights (all lights, including all traffic lights) are responsible for more emissions than the municipal vehicle fleet, including buses. While this may be surprising at first glance, the fleet emissions have different effects, mostly in the quantity of criteria air pollutants that they emit.

ICLEI helped local governments reduce their greenhouse gas emissions by 23 million tons in 2005 alone. This translates into about $600 million in annual cumulative savings, largely on energy expenditures.

FIGURE 18 **(BELOW) OVERALL BREAKDOWN OF ECO$_2$ EMISSIONS IN 2000 FROM MUNICIPAL BUILDINGS AND SCHOOLS PER SQUARE FOOT. THIS GRAPHIC DEMOSTRATES THAT SCHOOLS ARE GENERALLY MORE ENERGY EFFICIENT PER SQUARE FOOT THAN CITY BUILDINGS.**

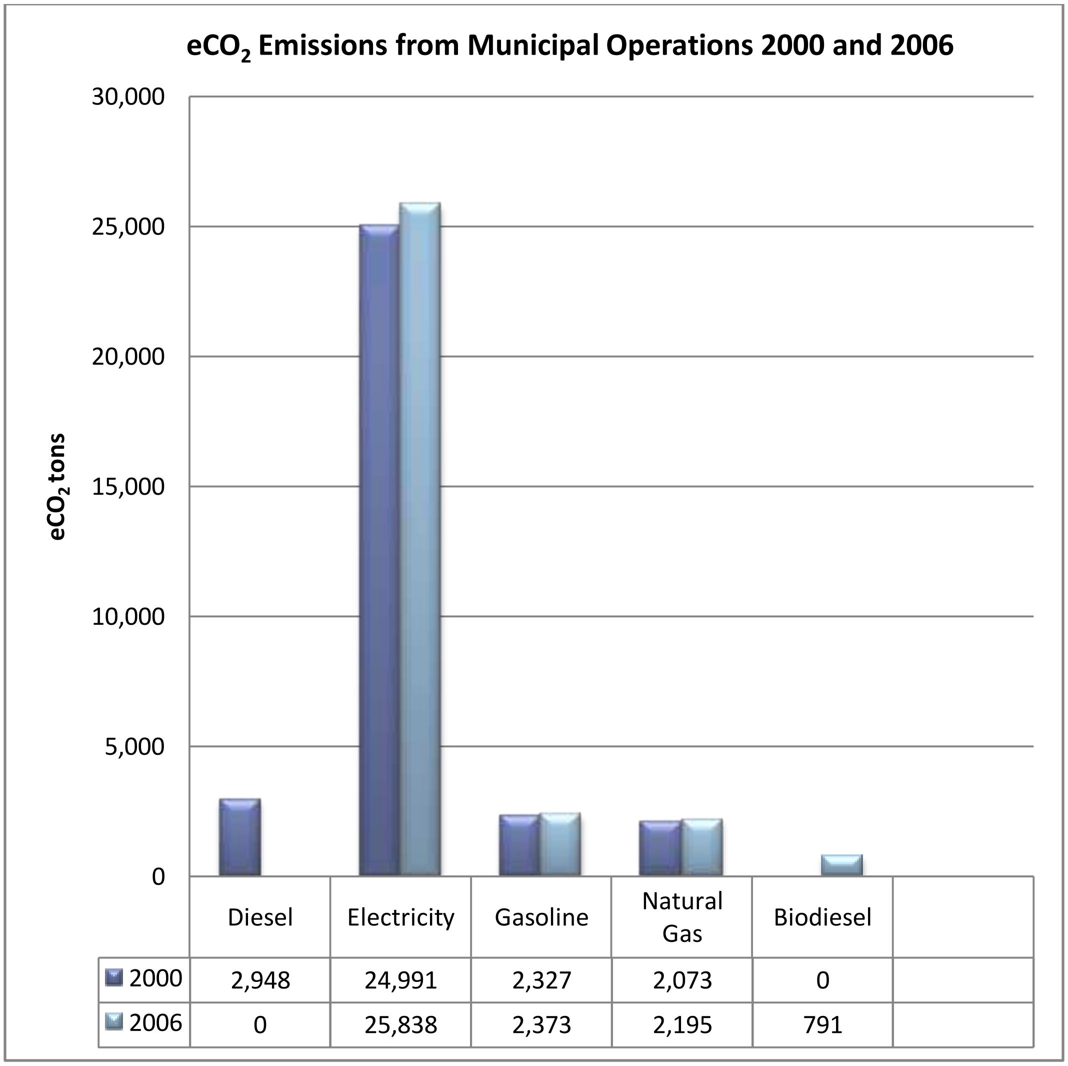


Municipal City buildings currently cover 870,264 square feet and all schools cover 901,273 sq ft. Municipal buildings, including City Hall, emitted a total of 12,387 tons of eCO_2 in the baseline year, while City schools emitted a total of 9,132 tons of eCO_2.

Many initiatives, such as the School Energy Program, building retrofits, and various other efficiencies are already in place and have been put into effect since the baseline year. The impact of emission reductions on each of these initiatives will start becoming apparent on the emission reduction target in the coming year and beyond, as most were begun during 2006.

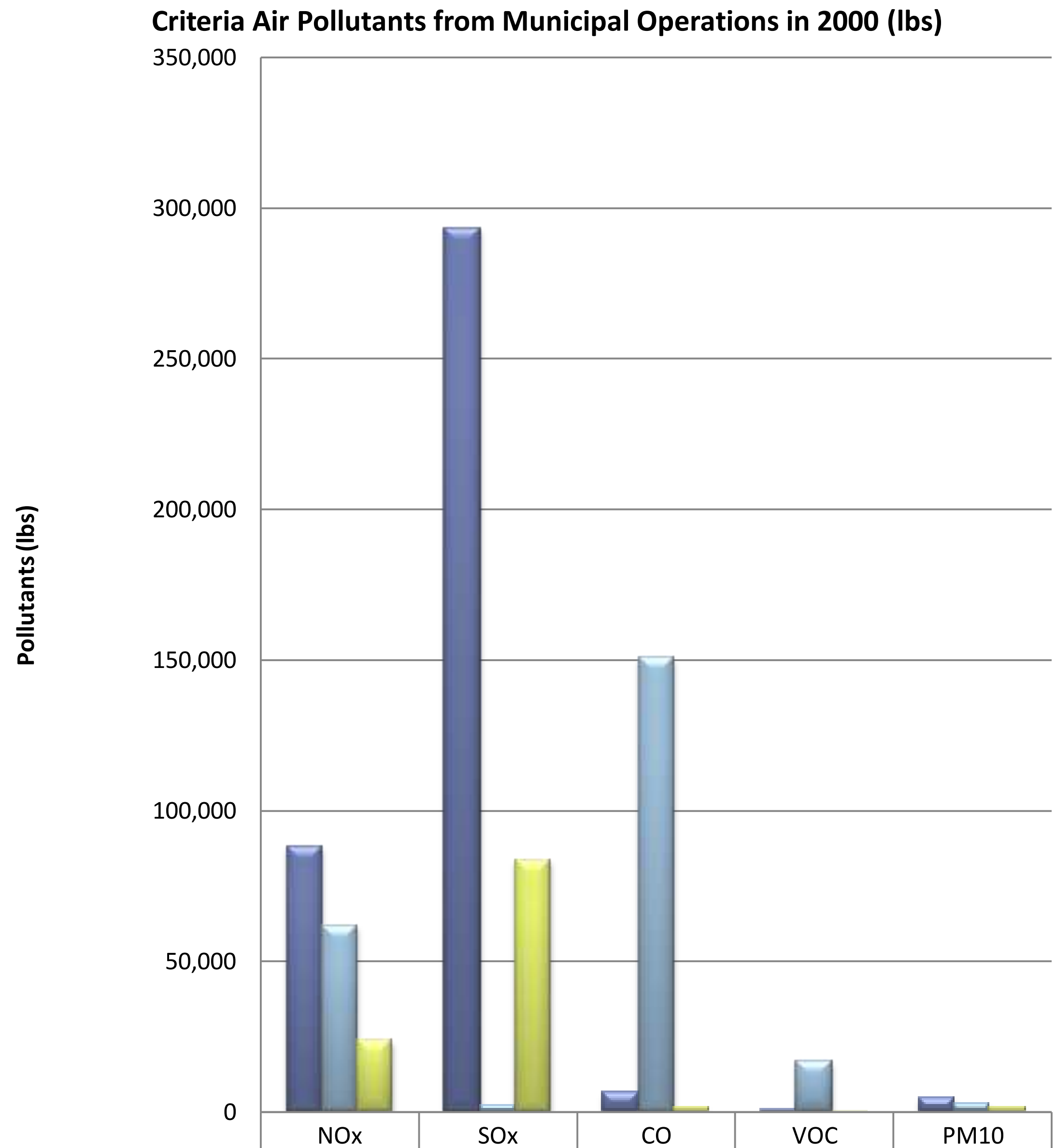
Likewise, for the municipal vehicle fleet, the introduction of biodiesel during the mid and latter part of 2006, the use of CNG, and the introduction of hybrids will become apparent when comparing 2008 data to 2000, especially in terms of vehicle emissions of criteria air pollutants. Biodiesel can help to reduce CO, VOC, and PM_{10} – although has little impact on quantities of N_20, or CH_4 released per gallon.

Regarding electricity, a substantial reduction in municipal emissions will be achieved by replacing traffic signals with energy efficient LED technology, an effort to be pursued in 2008. Although looking at the bigger community-wide picture, streetlights (including traffic signals) contribute 5,546 tons of eCO_2 – less than 1% of the total for Charlottesville.



	Diesel	Electricity	Gasoline	Natural Gas	Biodiesel
2000	2,948	24,991	2,327	2,073	0
2006	0	25,838	2,373	2,195	791

FIGURE 19 **(ABOVE): COMPARISON OF EMISSIONS FROM FUEL USE IN MUNICIPAL OPERATIONS, 2000 AND 2006. THIS GRAPHIC INCLUDES ALL MUNCIPAL BUILDINGS, SCHOOLS, FLEET, TRANSIT, AND STREETLIGHTS.**

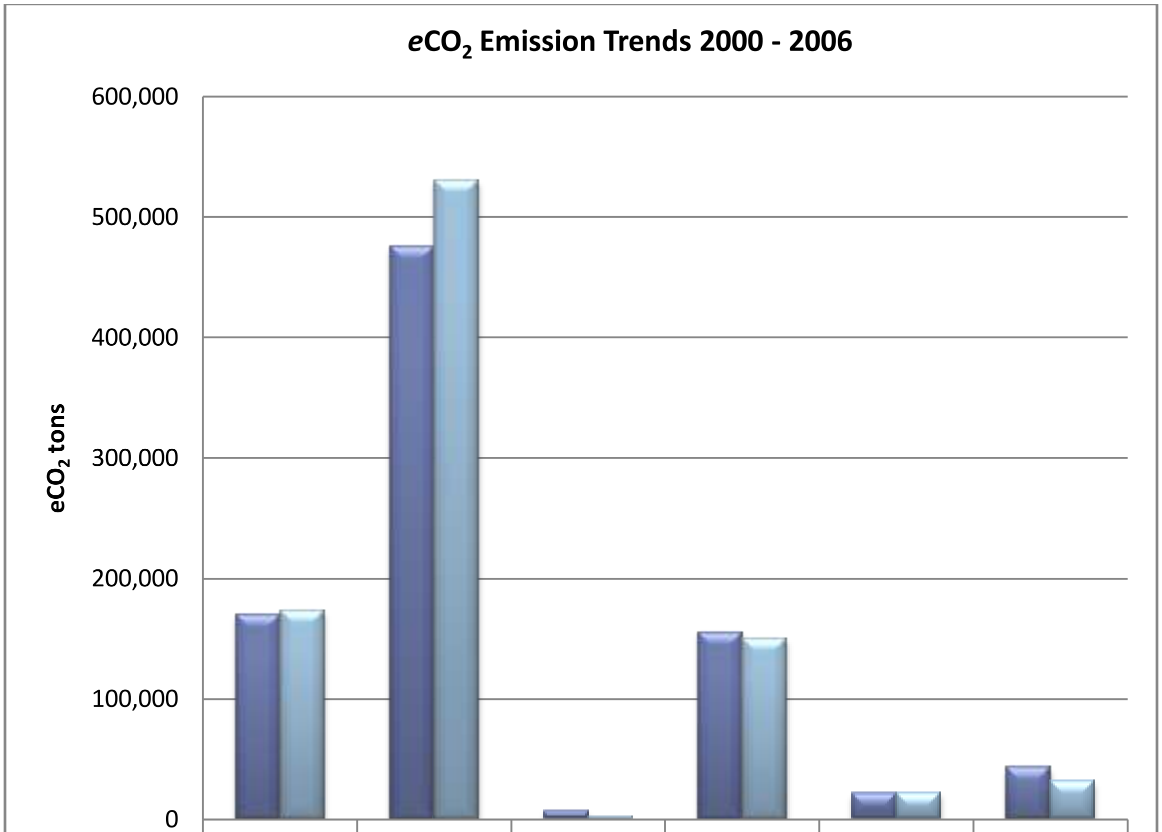


	NOx	SOx	CO	VOC	PM10
Municipal Buildings	88082	293456	6378	871	4839
Municipal Fleet	61931	2286	150469	16715	2750
Streetlights	23515	83636	1404	160	1331

FIGURE 20 **(ABOVE): IMPACTS THAT MUNICIPAL OPERATIONS HAVE ON AIR QUALITY ISSUES AND CRITERIA AIR POLLUTANT EMISSIONS. IT IS CLEAR FROM THIS DIAGRAM THE LARGE AMOUNT OF CO FROM VEHICLES, AND THE HIGH EMISSIONS OF SO_X FROM ENERGY – IN BUILDINGS AND STREETLIGHTS. ALSO APPARENT IS THE RELATIVELY HIGH VOC EMISSIONS FROM TRANSPORTATION WHEN COMPARED TO VOC EMISSIONS FROM ELECTRICITY OR NATURAL GAS SOURCES.**

TRENDS 2000 – 2006

Looking at the baseline and community as a whole, the figure below demonstrates where emissions have risen and fallen in Charlottesville over the period of 2000 to 2006.



	Residential	Commercial	Industrial	Transport	Waste	Other
2000	169235	475258	6409	155042	20616	42391
2006	172296	530386	2131	149857	21765	31404

FIGURE 21 **(ABOVE): ECO_2 EMISSION TRENDS 2000 AND 2006. RESIDENTIAL EMISSIONS AND WASTE EMISSIONS HAVE RISEN OVERALL, DESPITE LACK OF POPULATION GROWTH. LIKEWISE, COMMERCIAL EMISSIONS HAVE INCREASED. TRANSPORTATION EMISSIONS WITHIN THE CITY HAVE REDUCED. THE "OTHER" SECTOR REFERS TO EMISSIONS FROM "WASTE IN PLACE" IN IVY LANDFILL AND WILL CONTINUE TO REDUCE IN COMING YEARS.**

Electricity consumption has increased considerably in the city since 2000 overall, matching national trends. Nationally, changes in natural gas and liquid fuels consumption in the residential sector over the past 20 years have been less dramatic, and this also is reflected in our data.

Moving forward, residential natural gas consumption is predicted by the EIA to experience annual growth averaging 0.4% from 2005 to 2030, and a slight decrease is projected for liquid fuels use. With relatively few new homes within the city using oil furnaces, the economic growth cases do not have as much effect on residential liquid fuels use as they do on electricity, which is predicted to increase by 1.3% annually for the residential and 2% for commercial sectors.

Data – Assumptions

Residential, Commercial and Industrial Sectors

Electric data: Dominion Virginia Power no longer holds detailed information on each sector for 2000. Therefore the Dominion data from 2001 was used and extrapolated back to 2000 through using population growth and by normalizing electrical growth in Charlottesville between 2001 and 2006.

Data held by the Dominion Virginia Power included data from UVA buildings within County of Albemarle, along with municipal data including schools as one kWh amount. For reasons of accuracy and future tracking, this Dominion Virginia Power section of data was discarded and detailed energy use information from UVA and City Facilities Management was used in place. County of Albemarle is following the same methodology as above.

Other fuel use for homes, businesses, UVA, and industry within the city limits for the baseline and interim years was obtained from gas and electric utilities, UVA, City Gas Utility, ICLEI, and some private companies where information was available.

To overcome the barrier of some information being incomplete or unavailable for 2000 or unavailable, ICLEI provided strong estimates on household and state-level fuel consumption for the Northeast and Mid-Atlantic. These average amounts were derived from taking state level energy consumption data, and dividing it by the 2000 census data on the number of households in the State that are heating with the identified fuel. This number then gives the average usage per household that is heating with the fuel in question. This number is then multiplied by the 2000 data on the number of households in Charlottesville that are heating with that particular fuel. Data for state level energy was obtained from: http://www.eia.doe.gov/emeu/states/_seds.html. All census data obtained from census unless otherwise noted.

Transportation sector

The data required was annual vehicle miles traveled within the city, broken into vehicle class. Information and help gathering this information was obtained from the Thomas Jefferson Planning District Commission (TJPDC), Virginia Department of Environmental Quality (VDEQ), and Virginia Department of Transportation (VDOT) Office of Air Data Analysis and Planning. UVA fleet data was discounted due to double counting with above vehicle miles travelled by vehicle class, meaning UVA fleet were already included.

Trains and planes for Charlottesville are not counted in this sector. Rail and air transportation emissions are captured at the hub, or originating station.

WASTE SECTOR

Ivy landfill is included within these figures, so that emissions from previous community waste can be counted. Ivy will not be included in Albemarle calculations.

Charlottesville specific data for 2000 and 2006 was unavailable from one private company; therefore an educated estimate was made by a waste management professional.

MUNICIPAL DATA

The recently introduced SAP system makes detailed information prior to 2006 hard to obtain, therefore each set of data was extracted manually by the Facilities Maintenance Division. Total energy usages have been used. Detailed information on each building is not available in detail for 2000. Going forward, detailed information on energy use within each municipal building and school can be broken out for more detailed assessment on emissions reductions per building or building type.

Fuel use for municipal fleet was obtained from City Yard and Avon fuel depots, broken down into vehicle type. Additional fuel use from the Parks and Recreation Department and the Fire Department has been added for fuels stored on site.

The Next Step – Milestone 2

Building a Climate Action Team

A Charlottesville Climate Action Team needs to be able to set measurable, ambitious, yet ultimately achievable goals to reduce our emissions from the baseline figures contained herein over time. Ideally this group will have representation from all stakeholders, and climate and energy experts. Many communities set a different reduction goal for their municipal operations and the community, with a larger goal for reduction for the municipal sector, as local governments has more influence over their own operations. For a table of reduction targets by other communities and regions please see appendix.

This team must also have the potential to be a springboard to proactive planning for future climate change and the mitigation of inevitable climate change effects within the community. A new ICLEI program is underway, working towards helping municipalities with this latter goal of mitigation planning, and examples from cities currently undergoing pilot programs will be available in late 2008.

There are many examples of Climate Action Teams, or Green Teams, in looking at other communities. Most dedicated committees consist of a diverse group. In the case of Charlottesville, an example of representatives could include:

- City staff: fleet, waste management, gas utility, planning, finance, environment, schools & facilities, elected officials
- General public and other interested parties
- Local environmental groups
- Electricity representation from Dominion Virginia Power
- Water utility representation from RWSA
- Representatives from major local industry and commercial establishments
- UVA Facilities Management, Fleet, Architecture, Waste Management
- Local media
- County of Albemarle - officials, and other interested parties

ICLEI USA, in partnership with the Clinton Foundation and Microsoft, is developing an internet-based software tool for local governments to accurately calculate their greenhouse gas emissions, track progress and support global comparative analysis between local government users.

The new software builds upon ICLEI's earlier software including the widely used Clean Air Climate Protection (CACP) software and the multinational Harmonized Emissions Analysis Tool (HEAT).

By combining the Local Government Greenhouse Gas Protocol and software efforts, ICLEI along with our partners will establish a global standard accounting framework and common software platform so cities can share data on emissions and measures designed to reduce emissions.

The software will be released in 2008 to the ICLEI network and C40, a group of the world's largest cities committed to tackling climate change.

POTENTIAL FOR COMBINED PROGRAM FOR CHARLOTTESVILLE - ALBEMARLE

County of Albemarle has also joined the ICLEI Climate Protection Program and is embarking on its own emissions baseline program. The City and County are already working closely together on this.

Combining the results would give a much truer picture of our community emissions and would allow for big picture planning - with wider community input.

By combining our emissions data in the future, we would allow for clearer results tracking and a more accurate and honest representation of the growth and development of the community as a whole. This perhaps represents the opportunity to demonstrate broader thinking across boundaries - a small-scale representation of what is required in combating climate change.

A similar combined program has worked with great success for the Cities of St Paul and Minnesota.

GLOSSARY

Baseline - A hypothetical scenario for what GHG emissions would have been in the absence of a greenhouse gas reduction project or project activity typically determined by a base year.

Base Year – The emissions level against which to measure or change over time, comprised of the annual emissions by activities within the boundaries of the analysis for a selected year.

Biofuel – A fuel derived from a biological (as opposed to fossil) source (i.e. vegetable oil, wood, straw, etc).

Blended fuels – Any fuel made from a mix of different fuels. Most often refers to a mix of a fossil fuel with a renewable bio-fuel. For example:

- Ethanol blend – Ethanol, or ethyl alcohol, combined with regular gasoline
- Biodiesel (B20) – A mix of 80% petroleum diesel with 20% diesel derived from vegetable oil
- Methanol Diesel – A combination of methanol blended with petroleum diesel fuel

British thermal unit (Btu) – A measure of energy content defined as the quantity of heat required to raise the temperature of one pound of water by one degree Fahrenheit at about 39.2 degrees Fahrenheit.

Carbon Dioxide (CO_2) – The most common GHG, consisting of a single carbon atom and two oxygen atoms. CO_2 is released by respiration, the burning of fossil fuels, and is removed from the atmosphere by photosynthesis in green plants.

Carbon Dioxide Concentration - The atmospheric carbon dioxide concentration, at 353 ppmv in 1990, is about 25% greater than the pre-industrial (1750-1800) value of about 280 ppmv, and higher than at any time in at least the last 160,000 years. Carbon dioxide is currently rising at about 1.8 ppmv (0.5%) per year due to anthropogenic emissions.

Carbon Dioxide equivalents – See "eCO_2"

Chlorofluorocarbons (CFCs) - Compounds of carbon containing both chlorine and fluorine. They are non-poisonous and inert at ordinary temperatures and easily liquefiable under pressure, which make them excellent refrigerants, solvents, foam-makers and for use in aerosol sprays. Chlorofluorocarbons (CFCs) do not occur naturally. The use of CFCs is strictly regulated.

CO_2 (*e*CO_2 - Carbon Dioxide Equivalents) – A common unit for combining emissions of greenhouse gases with different levels of impact on climate change. It is a measure of the impact that each gas has on climate change and is expressed in terms of the potency of carbon dioxide. For carbon dioxide itself, emissions in tons of CO_2 and tons of CO_2e are the same, whereas for nitrous oxide and methane, stronger greenhouse gases, one ton of emissions are equal to 310 tons and 21 tons of CO_2e respectively.

Coefficients – See "Emission Factors"

Emission Factors / Coefficients – A unique value for determining the amount of a GHG emitted for a given quantity of fossil fuel consumed. These factors are expressed in terms of the ratio of emissions of a particular pollutant (e.g. carbon dioxide) to the quantity of the fuel used (e.g. kilograms of coal). For example, when burned, 1 ton of coal = 2.071 tons of CO_2.

Forecast Year – Any future year in which predictions are made about emission levels based on growth multipliers applied to the base year.

Fugitive Emissions – The unintended emissions of GHGs from the transmission, processing, or transportation of fossil fuels or other materials (e.g. coolant leaks in HVAC systems or natural gas line leaks).

Greenhouse Effect - The effect of heat retention in the lower atmosphere.

Greenhouse Gases (GHG) – Gases which reduce the amount of earth's radiation that escapes to space, with consequent warming of the lower atmosphere and the earth's surface.

Hydro fluorocarbons (HFCs) – GHGs used primarily as a refrigerant, comprising a class of gases containing hydrogen, fluorine, and carbon.

Indirect Emissions – Emissions that occur because of a local government's actions, but are produced by sources owned or controlled by another entity. For example, the purchase of electricity that was generated by emission-producing fuel outside of the jurisdiction's boundaries.

Intergovernmental Panel on Climate Change (IPCC) – An organization established jointly by the United Nations Environment Program and the World Meteorological Organization in 1988 to assess information in the scientific and technical literature related to all significant components of the issue of climate change, and providing technical analysis of the science of climate change as well as guidance on the quantification of GHG emissions.

Interim Year – Any year for which an emissions inventory is completed that falls between the base year and the target year. Completing an emissions inventory for an interim year is useful in determining a jurisdiction's progress towards meeting their emission reduction goals.

Inventory – The quantification of all emissions within the jurisdiction's boundaries during a particular year.

Kilowatt Hour (KWh) – The electrical energy unit of measure equal to one thousand watts of power supplied to, or taken from, an electric circuit steadily for one hour. (A Watt is the unit of electrical power equal to one ampere under a pressure of one volt, or 1/746 horsepower.)

Local Action Plan – includes the emissions analysis, Emissions Reduction Target, Emissions Reduction Strategy, and Emissions Reduction Implementation Strategy.

Methane (CH_4) – A GHG resulting from the anaerobic decomposition of vegetative materials in wetlands, urban landfills, and rice paddies, the production and distribution of natural gas and petroleum, coal production, and incomplete fossil fuel combustion. The principle constituent of natural gas, methane is a single carbon atom linked to four hydrogen atoms.

Methane Recovery Factor – A measurement of the percentage of methane produced that is being captured at a landfill. For example, a landfill that is capped, lined, and has a methane extraction system may not allow any methane to escape. In this case the Methane Recovery Factor would be 100.

Metric Ton – Common international measurement for the quantity of GHG emissions, equivalent to 1000 kilograms, about 2,204.6 pounds or 1.1 short tons.

Nitrous Oxide (N_2O) – A potent greenhouse gas produced in relatively small quantities. It is composed of a two nitrogen atoms and a single oxygen atom and is typically generated as a result of soil cultivation practices, particularly the use of commercial and organic fertilizers, fossil fuel combustion, nitric acid production, and biomass burning.

Per fluorocarbons (PFCs) – A GHG consisting of a class of gases containing carbon and fluorine. Originally introduced as alternatives to ozone depleting substances they are typically emitted as by-products of industrial and manufacturing processes.

Sectors – Within CACP, records are organized into sectors that contain similar activities or emissions sources. The sectors for the community module includes: Residential, Commercial, Industrial, Transportation, Waste, and other. The sectors in the municipal module include: Buildings, Vehicle Fleet, Employee Commute, Streetlights, Sewage, Waste, and Other

Sulfur Hexafluoride (SF_6) – a GHG consisting of a single sulfur atom and six fluoride atoms. Primarily used in electrical transmission and distribution systems.

Target Year – The year by which the emissions reduction target should be achieved. See also "Forecast Year."

United Nations Framework Convention on Climate Change (UNFCCC) – An international environmental treaty produced at the United Nations Conference on Environment and Development in Rio de Janeiro in 1992. The UNFCCC provides an overall framework for international efforts to mitigate climate change. The Kyoto Protocol is an update to the UNFCCC.

VMT - Calculation of daily vehicle miles travelled in an area, based on vehicle class counts on major byways carried out by Virginia Department of Transportation.

APPENDICES

1. The UN Framework Convention on Climate Change

The UNFCCC sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. It recognizes that the climate system is a shared resource whose stability can be affected by industrial and other emissions of carbon dioxide and other greenhouse gases. The Convention entered into force on 21 March 1994 and enjoys near universal membership, with 191 countries having ratified. Under the Convention, governments gather and share information on greenhouse gas emissions, national policies and best practices; launch national strategies for addressing greenhouse gas emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries; cooperate in preparing for adaptation to the impacts of climate change.

The UNFCCC requires signatory nations to report emissions of the following greenhouse gases:

- CO_2 - Carbon dioxide
- CH_4 - Methane
- N_2O - Nitrous oxide
- PFCs - Per fluorocarbons
- HFCs - Hydro fluorocarbons
- SF_6- Sulfur hexafluoride

ICLEI recognizes that activities leading to the emission of some gases are beyond the influence of local government and are more appropriately accounted for by national governments.

2. Table of emission reduction targets by other organizations, regions and communities

Entity	Specific CO2 Reduction Target	Example of Activities
St Paul, MI	20% less than 1988 by 2005	
Sonoma County, CA	25% less than 1990 by 2015	
Seattle, WA	8% less than 1990 in 2005 (need update)	Climate protection fund provides $15k annually for wide variety of projects aimed at helping residents develop community driven approaches to addressing global warming. www.seattle.gov/neighborhoods/nmf/projectawards
San Francisco,CA	20% less than 1990 by 2012	
Fort Collins, CO	30% less by 2020	
Denver, CO	10% below 1990 by 2011	
Overland Park, KS	Stabilize emissions over time	

New York, NY	30% by 2030	
London, England	60% by 2025	Green500 Business Assistance Program: Carbon mentoring, publicity and assessments.
Bristol, England	15% less by 2010	
Neath Port Talbot, Wales	6% less by 2010	
Belfast, N Ireland	15% less by 2010	
Vancouver, Canada	33% by 2020; 80% by 2050	Carbon neutrality for all buildings by 2030
Glasgow, Scotland	60% by 2050	
Cape Town, S Africa	10% by 2010	Reduce local authority electric use by 5% by 2010; 80% renewable energy for the City by 2050
Wal-Mart	20% in all stores within 7 years	Reduce packaging 5% by 2015; Reduce solid waste 25% in 3 years; double transport efficiency in 10 years. Overall aim: 100% renewable and zero waste.

State Level Efforts			
Region	**Specific CO2 Reduction Target**	**Description of Activities**	**Participating States**
Massachusetts	Reduce to 1990 levels by 2010; 10% less by 2020		
New Hampshire	Start reducing by 2010; 10% less by 2020		
Kentucky	Reduce to 1990 levels by 2020	Will achieve this only if maximum effect policies are introduced	

Regional Efforts			
Region	**Specific CO2 Reduction Target**	**Description of Activities**	**Participating States**
New England Governors: Climate Change Action Plan (NEG-ECP)	1990 greenhouse gas emission levels by 2010 and 10% below 1990 levels by 2020.	The NEG-ECP developed a regional Climate Change Action Plan	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont
Regional	10% below 1990 by	RGGI is an effort by Northeastern and	Connecticut, Delaware, Maine, Maryland

Greenhouse Gas Initiative (RGGI)	2020	Mid-Atlantic states to reduce carbon dioxide emissions through a cap and trade program. Phase I (2009-2015) will stabilize emissions at 121.3 million short tons of CO_2 (this is a little above 2000-2004 levels). Phase II (2015-2020) will reduce emissions by 10% below Phase 1 levels (roughly equivalent to 1990 levels).	(2007), New Hampshire, New Jersey, New York, and Vermont. (Pennsylvania and Rhode Island are observers; Massachusetts participated in the design)
The Climate Registry		The Climate Registry is a multi-state and tribe effort to develop a GHG Registry that will measure, track, verify and publicly report GHG emissions accurately, transparently and consistently across borders and industry sectors. The Climate Registry will support voluntary, market-based and regulatory GHG emissions reporting programs and will start accepting data in Jan. 2008.	Arizona, California, Colorado, Connecticut, Delaware, Florida, Hawaii, Illinois, Kansas, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, New Hampshire, New Jersey, New Mexico, New York, North Carolina, Ohio, Oregon, Pennsylvania, Rhode Island, South Carolina, Utah, Vermont, Washington, Wisconsin, and Wyoming.
Southwest Climate Change Initiative		Launched on February 28, 2006, the Southwest Climate Change Initiative (SCCI) creates ways for the two states to collaborate on climate change and emission reduction strategies.	Arizona New Mexico
"Powering the Plains" Initiative		Powering the Plains brings together stakeholders to address climate issues surrounding energy and agriculture while adding value to the region's economy and mitigating the risk of climate change and other environmental concerns.	Iowa, Minnesota, North Dakota, South Dakota, Wisconsin
West Coast Governors' Global Warming Initiative		An effort between the Governors of Washington, Oregon, and California to reduce GHG emissions from their respective states.	California, Oregon, and Washington
Western Governors Association Clean and Diversified Energy Initiative		Participating states agreed to examine the feasibility of: Developing 30,000 Megawatts of clean and diverse energy by 2015. Increasing energy efficiency 20 percent by 2020. Providing adequate transmission to meet the region's needs through 2030.	Alaska, Arizona, California, Colorado, Hawaii, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Texas, Utah, Washington, and Wyoming
Western Regional Climate Action Initiative		The Governors of 5 western states established the Western Regional Climate Action Initiative on Feb. 26, 2007, committing to establish an overall regional goal to reduce GHG emissions within 6 months, develop a	Arizona, California, New Mexico, Oregon, Washington

		design for a regional market-based multi-sector mechanism within 18 months to achieve the regional goal, and participate in a multi-state GHG registry.	
CRED – East England	60% reduction by 2025	Collaboration of universities, councils, city, businesses, hospitals and individuals. Partnered with University of North Carolina	Norfolk, Norwich, East Anglia Region (UK)