

# Howard County, MD Climate Action Plan



April 2010

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# Plan Overview

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For the past 10 years, climate change has been of increasing concern to the citizens and scientists of the world. With an increase in extreme weather events, natural disasters, and declines in Arctic snow cover, greenhouse gases (GHGs) are believed to be the underlying force behind these global occurrences. As a result, climate change legislation and GHG reduction targets are being presented at the national, state, and local levels. As such, Howard County government is developing its position and strategy to minimize the effects of climate change in our community.

In 2007, then newly elected County Executive, Ken Ulman, signed the U.S. Mayor's Climate Protection Agreement and officially declared that Howard County would reduce its carbon footprint to 7% below 1990 levels by 2012 and committed to becoming a more sustainable County. This was and still remains one of his top priorities. Later that year, the County also joined ICLEI – Local Governments for Sustainability and committed to developing a comprehensive GHG emissions inventory of not only County government operations, but also the community as a whole. The inventory would assess overall carbon footprint and include emissions from the following sectors:

- Facilities and Infrastructure (Energy, Refrigerant, and Chemical Use)
- Transportation
- Solid Waste
- Agriculture
- Wastewater Treatment

The GHG analysis completed in 2008 determined that Howard County government owned and controlled operations emitted a total of **340,042 metric tons (mt) of carbon dioxide equivalent (CO<sub>2</sub>-e)**. The largest sources of GHG emissions for the government operations resulted from other indirect emissions – mainly contracted services (38%) with 128,944 mt CO<sub>2</sub>-e, followed by indirect emissions from electricity usage (29%) at 98,756 mt CO<sub>2</sub>-e. Community-based emissions were **4,376,006 mt CO<sub>2</sub>-e**. The largest source of GHG emissions resulted from mobile combustion (49%, 2.15 million mt CO<sub>2</sub>-e) from transportation along the Interstate 95 corridor. Energy based indirect emissions from electricity usage were the second largest contributor of emissions with 38% of the total and 1.67 million mt CO<sub>2</sub>-e, while emissions from direct stationary combustion followed at 13% and 0.55 million mt CO<sub>2</sub>-e. Agricultural emissions were less than 1% of the total community emissions. The analysis concluded that the most emissions were generated due to transportation. Emissions from energy usage in county operations, the public schools system, and the community-at-large were the second largest source of GHGs.

Since taking office, the Ulman Administration has made major strides in a vast number of environmental areas: installing solar arrays and geothermal heating as renewable energy sources, installing LED traffic lights for energy efficiency, purchasing hybrid cars and buses for the County fleet to reduce fuel usage, developing a comprehensive climate action plan for energy efficiency and use reduction, initiating land preservation projects, and achieving solid waste reductions by implementing a County-wide recycling program.

This Climate Action Plan serves to summarize the results of the GHG emissions inventory by sector and source category, present the County's emission reduction goals and targets, document the actions the County has and is currently implementing to reduce emissions, and highlight future actions in an effort to achieve the proposed reduction targets and become a more sustainable community.

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## From the County Executive



*Ken Ulman*  
**Howard County Executive**

In 2007, when I signed the Mayor's Climate Protection Agreement, I acknowledged that this was "the easy part". This Climate Action Plan represents the next step, the much more difficult but achievable process of attaining our goals for reducing our carbon footprint.

The development of the inventory and the action plan was truly a collaborative effort from the many partners inside county government as well as partner agencies such as the Howard County school system and Howard Community College. All should very much be commended both for working so hard to collect data and having the courage to set ambitious targets for themselves to help Howard County collectively reach our ultimate goals.

This action plan also presents the County with a opportunity for true sustainability - for it incorporates all three factors of a triple bottom line into County operations. If we follow the guideposts created here we will clearly help protect and restore our environment, we will improve the quality of life for the people who live and work in Howard County, and we will indeed save the County money.

I am excited to begin acting on this plan and hope the community will join us in these initiatives.

Sincerely,

A handwritten signature in black ink, appearing to read "Ken Ulman".

Ken Ulman, County Executive

# 1.0 Introduction

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## 1.1 Global and Local Impacts of climate change

With the number of extreme weather events tripling in the past 50 years, the global average level of the sea is increasing, and the amount of snow cover declining<sup>1</sup>. Federal, regional, state, and local governments are taking a stance on climate change and the reporting of GHG emissions by industrial companies and municipalities under their governance. These entities agree that the first step to getting a handle on the effects of GHG emissions on climate change is to determine the current contribution of man-made emission sources.

The six major GHGs, carbon dioxide (CO<sub>2</sub>), nitrous oxide (N<sub>2</sub>O), methane (CH<sub>4</sub>), hydrofluorocarbons (HFCs), sulfur hexafluoride (SF<sub>6</sub>), and perfluorocarbons (PFCs), are believed to be the underlying force behind climate change. The increased concentration of GHGs in the atmosphere enhances the absorption and emission of infrared radiation. Excessive amounts of CO<sub>2</sub> cause radiation to remain in the earth's atmosphere trapping heat and consequently heating the earth's surface. There are anthropogenic and natural effects causing the increase in GHGs in the atmosphere. Anthropogenic changes are caused by humans (i.e. combustion of fossil fuels, aerosol emissions, manufacturing operations, etc.) and natural effects those occurring naturally (e.g. volcano eruptions, photosynthesis) as a part of the earth's natural greenhouse effect<sup>2</sup>. While there is no conclusive evidence on which cause is having the most adverse effect on the earth's surface temperature, we can see that there are changes taking place in the environment that should be addressed.

While the impacts of climate change vary from region-to-region and from state-to-state, climate change has the potential to impact natural resources - such as drinking water supply due to decreased amounts of snowfall, drought, and increased demand by growing populations; change precipitation patterns, increase storm water and wastewater treatment flows, agricultural crop development, and increase energy demand. For coastal states, such as Maryland, climate change could contribute to flooding in low-lying coastal areas from sea-level rise due to melting Arctic ice caps from higher temperatures. Climate change could also impact

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<sup>1</sup> Core Writing Team, Pachauri, R.K. and Reisinger, A. (Eds.) *Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report: Climate Change 2007: Synthesis Report*, IPCC, Geneva, Switzerland.

<sup>2</sup> J. T. Houghton, Y. Ding, D.J. Griggs, M. Noguer, P. J. van der Linden and D. Xiaosu (Eds.) *Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report: Climate Change 2001: The Scientific Basis* Cambridge University Press, United Kingdom.

migration habits of birds, sea life, and other mammals pertinent to the maintaining of ecological resources here. Some studies even speculate that higher temperatures and sporadic seasonal weather could increase illness and infectious disease.<sup>3</sup>

In February 2007, the United Nations Intergovernmental Panel on climate change (IPCC) concluded that if annual GHG emissions remain at today's levels, CO<sub>2</sub> concentrations will double by 2050. The IPCC also concluded that "global warming is significantly affecting our planet and is projected to cause severe impacts." As a result, climate change policy has moved to the forefront for policy-makers at all levels of government.

## 1.2 GHG Legislation, Regulation, and Initiatives

Climate change and climate science have been at the forefront of legislators' agendas for the past five years. As summarized by the Pew Center on Global climate change, during the 108th Congress (2003-2004), nearly 100 bills, resolutions, and amendments specifically addressing global climate change were introduced; 106 items were presented during the 109th Congress (2005-2006); and over 288 items in the 110th Congress (2007-2008). Each bill included GHG emission limits, mandatory reporting, reductions in transportation emissions, further development of nuclear power, agricultural sequestration, research and development of climate-friendly technology, and the start of international negotiations.

In early April 2009, the first draft of a climate change bill from the 111th Congress (2009-2010) was introduced by the House Energy and Commerce Committee Chairman Henry Waxman (D-CA) and Energy and Environment Subcommittee Chairman Edward Markey (D-MA). Titled "The American Clean Energy and Security Act (ACESA)", H.R. 2454, the Waxman-Markey bill calls for an economy-wide, greenhouse gas cap-and-trade system, a renewable energy standard, increased energy efficiency requirements, and critical complementary measures. The bill passed in the House in June 2009. In November 2009, the Senate Environment and Public Works Committee, chaired by Sen. Barbara Boxer (D-CA), passed the Clean Energy Jobs and American Power Act (S.1733), which draws many aspects from the ACES Act and establishes a cap-and-trade system. Differences between the Senate and House bills would have to be reconciled, with the final bill passed by both houses, before the bill could be sent to President Obama and signed into law.

On September 22, 2009, the U.S. Environmental Protection Agency (USEPA) released final regulation for the mandatory reporting of GHGs. Code of Federal Regulation 40 Part 98 calls for suppliers of fossil fuels or industrial greenhouse gases, manufacturers of vehicles and engines, and facilities that emit 25,000 metric tons or more of carbon dioxide equivalent (CO<sub>2</sub>-e) per year to submit annual reports to EPA.

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<sup>3</sup> Core Writing Team, Pachauri, R.K. and Reisinger, A. (Eds.) *Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report: Climate Change 2007: Synthesis Report*, IPCC, Geneva, Switzerland.

The main objective of the rule is to collect accurate and comprehensive emissions data to inform future policy decisions. Under the rule industrial and municipal solid waste landfills and agricultural operations that generate methane emissions greater than or equal to the threshold are required to report. Howard County's one active landfill generates CO<sub>2</sub>-e greater than the threshold and will be required to report emissions beginning in 2011 for calendar year 2010. No emission reduction targets have been included in this rule.

In addition to the new mandatory GHG reporting rule, the US EPA issued a finding that CO<sub>2</sub> poses a danger to human health and the environment. If approved by the White House, the finding could bring about regulation to control emissions of CO<sub>2</sub> and other GHGs by treating them as pollutants under the Clean Air Act Amendments.

### 1.3 State Government Initiatives

In April 2007, Governor Martin O'Malley signed the Memorandum of Understanding for the State of Maryland to join the Regional Greenhouse Gas Initiative (RGGI). RGGI is a regional cap-and-trade program designed to initially reduce CO<sub>2</sub> emissions from fossil fuel-fired units serving an electricity generator in eight New England states (also includes Connecticut, Delaware, Maine, New Hampshire, New Jersey, New York, and Vermont). The main objective of the initiative is to achieve a 10% overall reduction in CO<sub>2</sub> emissions below a 2009 baseline by 2019 within the region. In the Model Rule, the document that governs the program, it states that the majority of emission reductions must be "real" - achieved through efficiency or process improvements within the region. Only 3.3% of the emission reductions can be covered with offsets. Allowable offsets include: 1) landfill methane recovery, 2) SF<sub>6</sub> reductions, 3) afforestation activities, 4) fossil fuel energy efficiency, and 5) agricultural methane recovery. While municipalities are not currently required to report under RGGI, Howard County has landfill methane recovery systems at two of its landfills - Alpha Ridge and New Cut, and is progressing with fossil-fuel energy efficiency efforts. The County also has agricultural farms throughout the County that generate methane. While the landfill recovery systems at both of Howard County's landfills do not meet the requirements for offset projects within RGGI, registering these types of projects with other emissions trading programs such as the Chicago Climate Exchange (CCX) could potentially be a means to generate additional revenue from the monetization of GHG emission reduction credits. Members of RGGI report GHG emissions through The Climate Registry (TCR), a nonprofit collaboration among North American states, provinces, territories, and Native Sovereign Nations that sets consistent and transparent standards to calculate, verify and publicly report GHG emissions into a single registry. Although not currently a member, Howard County's inventory was developed using the protocols from and within the reporting guidelines of TCR.

As part of the State of Maryland's involvement in RGGI, in July 2008, regulation was adopted to implement the initiatives requirements. Code of Maryland Air Regulation (COMAR) 26.09 sections 01, 02, and 03 sets forth the requirements for reporting and monitoring GHG emissions, establishes the requirements for the State's CO<sub>2</sub> cap-and-trade program, and outlines the offset projects allowed. Currently, the regulations affect only fossil fuel-fired electricity generating units at specific plants within the State.

The State of Maryland also formed a Commission on climate change. The Commission introduced the first draft of the State's Climate Action Plan in January 2008. The final version was released in August 2008 and details the key findings of several working groups, covering the likely impacts of climate change for Maryland, as well as strategies the state can take both to reduce its GHG emissions and adapt to climate change. The Plan lists a range of short- and long-term GHG reduction goals beginning with a 10 percent reduction below 2006 levels by 2012 extending to a 90 percent reduction by 2050. Forty-two measures are proposed to reduce emissions. Model projections show that full implementation of these measures would achieve approximately a 50 percent reduction in GHG emissions by 2020 with a net economic benefit to the state of about 2 billion dollars. Howard County's reduction goals are aligned to support the State goals and targets.

## 1.4 Local Government Initiatives

On February 16, 2005 (the same day the Kyoto Protocol was ratified by 141 countries) the mayor of Seattle, WA, Mayor Greg Nickels, launched the US Mayors Climate Protection Agreement. This initiative was to advance the goals of the Kyoto Protocol through leadership and action by at least 141 American cities. The cities involved have grown steadily since that day. Currently, more than 900 mayors from all 50 states, Washington, DC, and Puerto Rico have signed the agreement and accepted the challenge to meet or exceed Kyoto Protocol targets for reducing global warming pollution by taking actions in their city operations and in their communities. The mayors are seeking to urge the federal government and state governments to enact policies and programs to meet or beat the target of reducing global warming pollution levels to seven percent below 1990 levels by 2012 and for the U.S. Congress to pass bipartisan GHG reduction legislation that includes 1) clear timetables and emissions limits and 2) a flexible, market-based system of tradable allowances among emitting industries.

Howard County Executive, Ken Ulman, is one of the many mayors/county executives that have signed on to be part of the US Mayors Climate Protection Agreement. As a result, the County Executive also joined ICLEI – Local Governments for Sustainability, an international association of local governments as well as national and regional local government organizations that have made a commitment to sustainable development. ICLEI provides a platform for local governments to build capacity, share knowledge, and support each other in the

implementation of sustainable development and the reduction of GHGs. ICLEI members generate their GHG emissions inventories using the program's guidance and report emissions from government operations and the community-at-large. Howard County's baseline inventory includes both government and community-based GHG emissions.

## 1.5 Overview of Howard County Initiatives

Howard County is located in central Maryland between Baltimore and Washington, DC. The county occupies a 251-square-mile area and provides governance and services for approximately 280,000 citizens as well as businesses. Although not a coastal community, Howard County is rich in natural resources and agricultural land. Since 2006, the County has been recognized as a leader in climate action in an effort to maintain the green qualities it embodies. As a result, the Commission on the Environment and Sustainability was formed to adopt strong measures, identify greenhouse gas (GHG) emission reduction goals and targets, and develop sustainable climate change strategy and actions to maintain those natural resources.

The Commission released an Energy Report in August 2007 that outlined a Sustainability Energy Strategy for Howard County. Key GHG emission reduction goals and targets were aligned with those of the U.S. Mayors Climate Protection Agreement and the State of Maryland. The GHG reduction goals and targets are as follows:

- Howard County should reduce its GHG emissions to 7% below 1990 levels by 2012;
- Howard County should establish a long-range strategy to reduce its greenhouse gas emissions by 80 percent of 2006 levels by 2050

However, the Committee considered reductions with specific actions for achievement and targets, based on a 2007 baseline (instead of 1990 and 2006) in three key areas: energy use in buildings, transportation, and renewable energy development. 2007 was selected as the base year due to the availability of accurate data. Specific measures recommended for implementation in the County in these areas included the following:

### **Energy Use in Buildings**

- County Government will reduce non-renewable energy use in buildings by 10 percent of 2007 levels by 2010, 15 percent by 2015, and 20 percent by 2020.
- County Government will commit to purchase 5 percent of its electricity from renewable energy sources (including Renewable Energy Credits) by 2010, 10 percent by 2015, and 20 percent by 2020 compared to the 2007 baseline. 50% of these renewable energy sources will be Maryland generated.
- Residential and Commercial Sectors will reduce the use of non-renewable energy use by 5 percent of base year 2007 levels by 2010, 10 percent by 2015, and 15 percent by 2020.

### **Energy Use in Transportation Systems**

- County government will reduce non-renewable transportation fuel use by 10% of 2007 levels by 2010, 25 percent by 2015 and 50 percent by 2020.
- Residential/Commercial/Industrial sectors will reduce non-renewable transportation fuel use 10 percent of 2007 levels by 2010, 20 percent by 2015 and 40 percent by 2020.
- Increase the use of renewable transportation fuels to 10 percent of 2007 levels by 2010, 25 percent by 2015, and 50 percent by 2020.
- The County will establish an alternative fuels strategy and purchasing policy that includes consideration for siting alternative fuels stations.

### **Renewable Energy Generation**

- Identify and develop renewable energy projects (landfill gas/solar energy/wastewater treatment digester gas) within the county to offset 5 percent of County energy use with renewable energy installations by 2020.
- Stimulate economic development and new job creation through investments in alternative fuel resources, e.g., cellulosic ethanol, biodiesel.

The goals and targets detailed in Section 3 and the strategies and actions outlined in Section 4 of this Climate Action Plan are consistent with the Energy Committee Report's initial recommendations outlined in the proceeding paragraphs.

## 2.0 Baseline Greenhouse Gas Emissions Profile

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### 2.1 Emission Sources and Categories

In April 2008, we began developing our first comprehensive county-wide GHG emissions inventory. The inventory included emissions from six key sectors:

1. Energy Use (electricity and fossil fuels)
2. Transportation
3. Solid Waste
4. Wastewater Treatment
5. Refrigerants, and
6. Agriculture

Emissions from County government operations as well as the community-at-large were assessed.

All County government departments were included in the inventory. The following agencies have fiscal control over the emission sectors. For budgeting and operational purposes, Howard County Public Schools and Howard Community College are separate from the Howard County Government.

- Department of Public Works
  - Bureau of Environmental Services
  - Bureau of Utilities
  - Bureau of Facilities
  - Bureau of Highways
- Department of Central Fleet
- Division of Transportation Planning
- Department of Housing
- Department of Parks and Recreation
- Department of Soil Conservation
- Howard Community College (Fleet and Facilities)
- Howard County Public Schools System (Fleet, Facilities, and Operations)

Community emissions were reported in three categories: residential, small commercial and industrial, and large commercial and industrial.

All six of the Kyoto GHGs – carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF<sub>6</sub>) - were evaluated for inclusion. However, Howard County governmental operations and

community activities emitted only five of the six gases. There were no operations within the County that emitted SF<sub>6</sub>.

Total emissions for the GHG inventory are expressed as carbon dioxide equivalents (CO<sub>2</sub>-e). Carbon dioxide equivalents represent the universal unit for comparing emissions of the various GHGs to one unit of CO<sub>2</sub> based upon their global warming potential (GWP) value. GWPs indicate the degree of warming to the atmosphere that would result from the emission of one unit of a given GHG compared to one unit of CO<sub>2</sub>. To obtain CO<sub>2</sub>-e emissions, the mass rate of emissions for each GHG is multiplied by its respective GWP. The GWP values for the six Kyoto GHGs are as follows:

EXHIBIT 2-1  
Greenhouse Gas Global Warming Potentials

| Greenhouse Gas (GHG)                   | Global Warming Potential (GWP)* |
|--|---------------------------------|
| Carbon Dioxide (CO <sub>2</sub> )      | 1                               |
| Methane (CH <sub>4</sub> )             | 21                              |
| Nitrous Oxide (N <sub>2</sub> O)       | 310                             |
| Hydrofluorocarbons (HFCs)              | 1300<br>(for R-134a)            |
| Perfluorocarbons (PFCs)                | varies                          |
| Sulfur Hexafluoride (SF <sub>6</sub> ) | 2600                            |

(\*) Based upon the Second Assessment Report (SAR) of the IPCC

Howard County chose to use the World Resources Institute and World Business Council for Sustainable Development (WRI/WBCSD) *GHG Protocol*, the TCR/ICLEI *Local Governments GHG Protocol*, and the 2006 IPCC *Guidelines for National Greenhouse Gas Inventories* to complete the baseline GHG inventory. The WRI/WBCSD *GHG Protocol* is an internationally recognized document that outlines GHG accounting and reporting guidelines. This protocol is the standard for which the majority of regional, state, and local government protocols and reporting programs are based. The TCR/ICLEI *Local Governments GHG Protocol* was developed as a collaborative effort between the two organizations to give local governments a comprehensive guidance document for completing their inventories outside of the traditional manufacturing/industrial sector. The IPCC *Guidelines* are also internationally recognized for developing national GHG inventories. The U.S. GHG inventory is completed based upon these guidelines. The WRI/WBCSD *GHG Protocol* and IPCC *Guidelines* contain national/country-specific emission factors while the TCR/ICLEI *Local Governments GHG Protocol* contains U.S.-based emission factors. Collectively, all of the protocols were used to assess operations within the Howard County geographical boundary. The GHG inventory included emissions from Scope 1, 2, and 3 sources as identified in the WRI/WBCSD *GHG Protocol*. These scopes are detailed further in the following sections:

### 2.1.1 Scope 1 – Direct Emissions

Direct emissions result from sources, processes, or facilities owned and/or controlled by the County and within community residential and industrial/commercial buildings. The Howard County GHG inventory contains the following source categories for direct emissions:

- Stationary Combustion Emissions – Emissions that are the result of combusting fossil-based fuels using equipment in a fixed location. Such pieces of equipment include boilers, heaters, and generators.
- Mobile Combustion Emissions – Emissions resulting from the combustion of fossil-based fuels in transportation sources both on- and off-road. These sources include passenger vehicles, trucks, heavy equipment, engines for aquatic vessels, and construction and maintenance vehicles.
- Process-Related – Process emissions result from physical or chemical processes and refer to emissions other than those resulting from fuel combustion. For the County, this includes emissions from the Little Patuxent Water Reclamation Plant and the County landfills.
- Fugitive – Fugitives emissions result from unintentional leaks or releases of refrigerants from processes, storage devices, and/or cooling systems.

### 2.1.2 Scope 2 – Indirect Emissions

Indirect emissions result from activities owned and/or controlled by another entity, but are being completed on the County's behalf. For this category only emissions resulting from the use of purchased electricity, steam, and/or hot/chilled water are included.

### 2.1.3 Scope 3 – Other Indirect Emissions

Other indirect emissions include emissions from activities over which Howard County exerts significant control or influence and that occur within Howard County boundaries, but are not owned or controlled by the County. The major source of Scope 3 emissions are contracted services. There are no Scope 3 emissions associated with Community activities.

## 2.2 Howard County Government Baseline 2007 GHG Emissions

In 2007, Howard County government emitted a total of 340,042 metric tons (mt) of CO<sub>2</sub>-e. The largest sources of GHG emissions resulted from other indirect emissions – mainly contracted services (38%) with 128,944 mt CO<sub>2</sub>-e, followed by indirect emissions from electricity usage (29%) at 98,756 mt CO<sub>2</sub>-e. These results are graphically depicted in Figure 2-1.

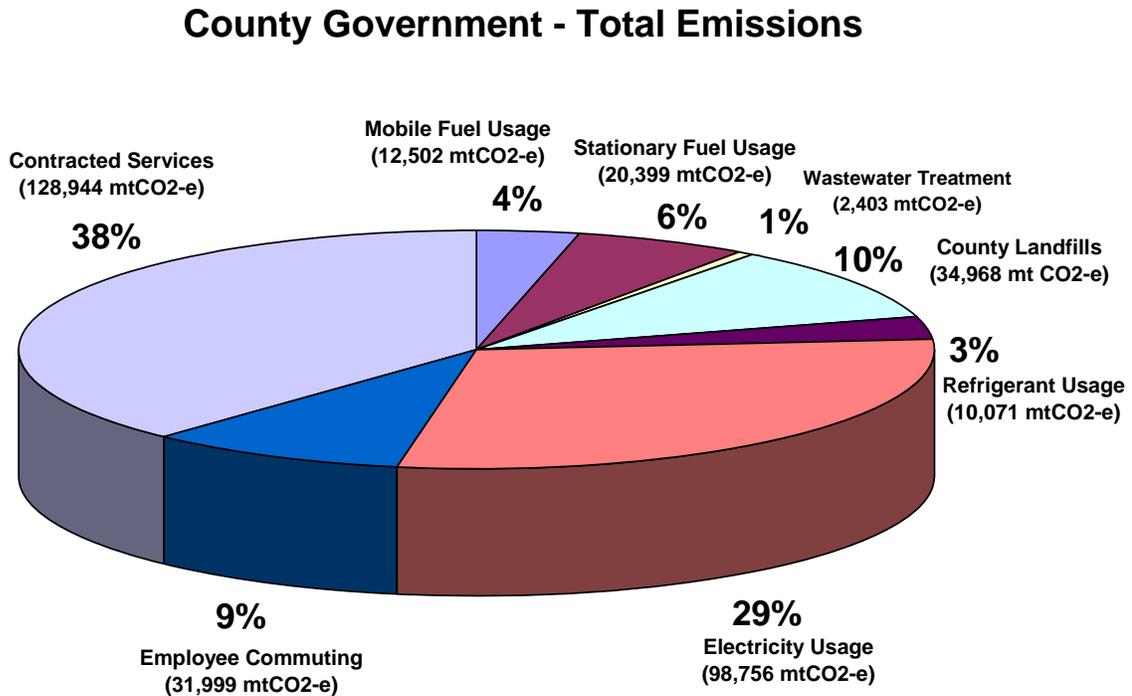
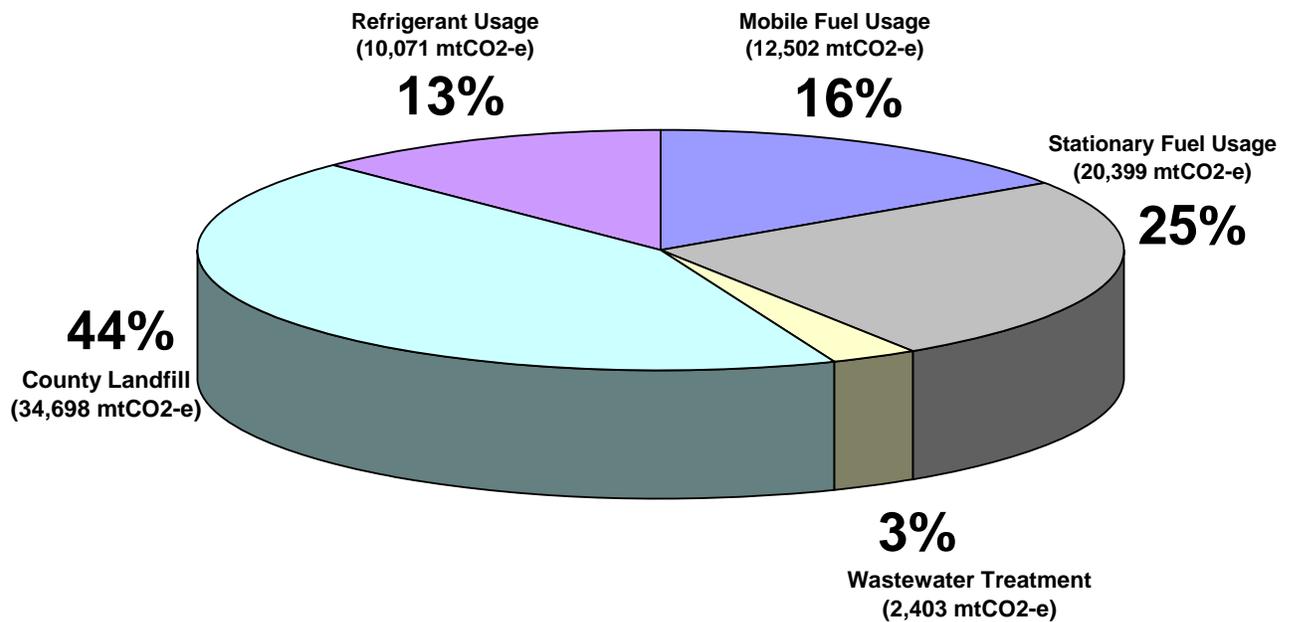


FIGURE 2-1  
County Government Baseline 2007 GHG Inventory Includes Scope 1, 2, and 3 Emissions

A review of only direct, Scope 1, emissions resulting from County government operations looks wholly different from the overall inventory. For direct emissions, shown in Figure 2-2, the largest sources were fugitive emissions of methane at the County landfills at 44% (34,968 mt CO<sub>2</sub>-e) of the total, followed by stationary combustion emissions at 25% (20,399 mt CO<sub>2</sub>-e). The credits for the destruction of methane in the landfill recovery and flare systems are not included in this category.

## County Government - Direct Emissions



**FIGURE 2-2**  
County Government Direct (Scope 1) GHG Emissions Distribution by Source Category

Other indirect emissions, Scope 3, which includes employee commuting and contracted services, represented 47% of the total inventory. When looking only at other indirect emissions (as shown in Figure 2-3), the emissions from the disposal of solid waste in landfills outside of the County was 67% of the total with 109,121 mt CO<sub>2</sub>-e. The second largest category was employee commuting emissions (20%), 31,999 mt CO<sub>2</sub>-e, followed by emissions from contracted school buses (7%), 11,415 mt CO<sub>2</sub>-e.

## County Government - Other Indirect Emissions

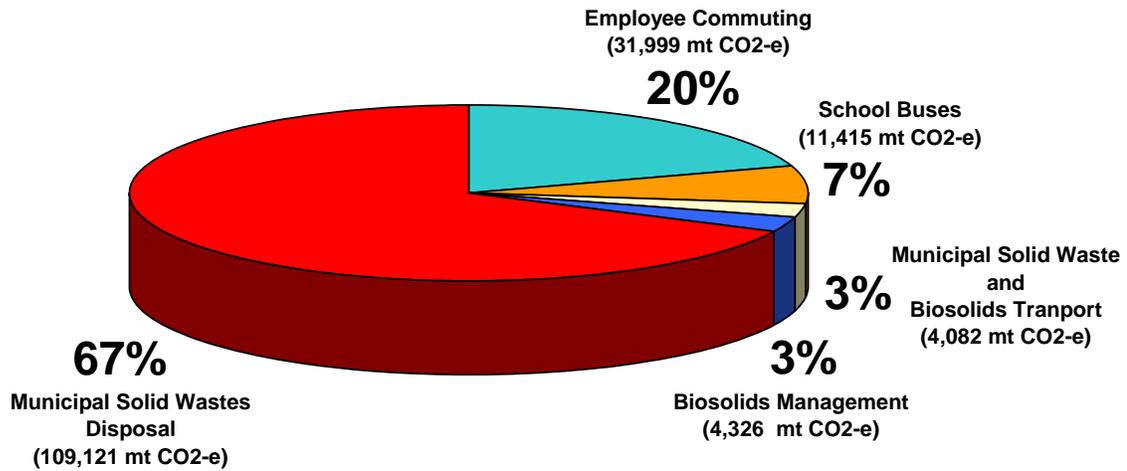


FIGURE 2-3  
County Government Other Indirect (Scope 3) GHG Emissions Distribution by Source Category

A summary of the emissions totals is detailed below in Exhibit 2-2:

EXHIBIT 2-2  
Howard County Government Emissions by Source Category

| Emissions Category   | Emissions (metric tons CO <sub>2</sub> -e) | Percentage of Total or Source Category |
|--|--|--|
| <b>Direct Emissions</b>  | <b>80,343</b>                              | <b>24%</b>                             |
| Mobile Combustion  | 12,502                                     | 16%                                    |
| Stationary Combustion  | 20,399                                     | 25%                                    |
| Process - Wastewater Treatment   | 2,403                                      | 3%                                     |
| Process - County Landfills   | 34,968                                     | 44%                                    |
| Refrigerant Usage  | 10,071                                     | 13%                                    |
| <b>Indirect Emissions</b>  | <b>98,756</b>                              | <b>29%</b>                             |
| Electricity Usage  | 98,756                                     | 100%                                   |
| <b>Other Indirect Emissions</b>  | <b>160,943</b>                             | <b>47%</b>                             |
| Employee Commuting   | 31,999                                     | 20%                                    |
| Contracted Services - School Buses   | 11,415                                     | 7%                                     |
| Contracted Services - Municipal Solid Waste Collection and Biosolids Transport | 4,082                                      | 3%                                     |
| Biosolids Land Application   | 4,326                                      | 3%                                     |
| Contracted Services - Municipal Solid Waste Disposal (External Landfill)       | 109,121                                    | 66%                                    |
| <b>Total Emissions</b>   | <b>340,042</b>                             |  |

NOTE: The destruction of methane gas recovered from the landfill is not included in the stationary combustion total.

Further analysis of the County-wide GHG emissions inventory is broken out by source category in the sections that follow.

## 2.3 County Government Energy Usage

The use of fossil-fuel derived energy represents a large source of GHG emissions within County government operations. Energy is also a primary focus for emission reductions and the use of renewable or alternative energy sources. Fossil fuels used by the County Government operations include natural gas, fuel oil, diesel, and propane in stationary combustion sources. Electricity generated from fossil fuel sources is also included in this section.

### 2.3.1 Combustion of Fossil Fuels

During the base year (2007) Howard County government operations utilized a total of 3.38 million therms of natural gas, 163,834 gallons of fuel oil, 10,691 gallons of propane, and 14,547 gallons of diesel resulting in GHG emissions of 20,399 metric tons of CO<sub>2</sub>-e. The Howard County Public School System used the largest amount of the natural gas in boilers, comfort heating systems, school cafeterias, and laboratory facilities. Howard Community College was the second largest user of natural gas, for similar sources. County government buildings used the least amount of natural gas, but the most fuel oil, diesel, and propane. A summary of fossil fuel usage by County government entity and the resulting GHG emissions is included in Exhibit 2-3. The GHG emissions resulting from the stationary combustion of fossil fuels is shown in Figure 2-4.

EXHIBIT 2-3  
Summary of Fossil Fuel Usage and Emissions by County Government Entity

| Entity               | Natural Gas<br>(therms) | Fuel Oil<br>(gallons) | Propane<br>(gallons) | Diesel<br>(gallons) | Emissions<br>(metric tons CO <sub>2</sub> -e) |
|----------------------|-------------------------|-----------------------|----------------------|---------------------|---|
| Community College    | 430,780                 | 30,613                | 0                    | 0                   | 2,672   |
| Govt. Buildings      | 292,722                 | 93,397                | 7,723                | 13,515              | 2,751   |
| Public School System | 2,654,290               | 39,824                | 2,968                | 1,032               | 14,977  |
| <b>Total</b>         | <b>3,377,792</b>        | <b>163,834</b>        | <b>10,691</b>        | <b>14,547</b>       | <b>20,399</b>                                 |

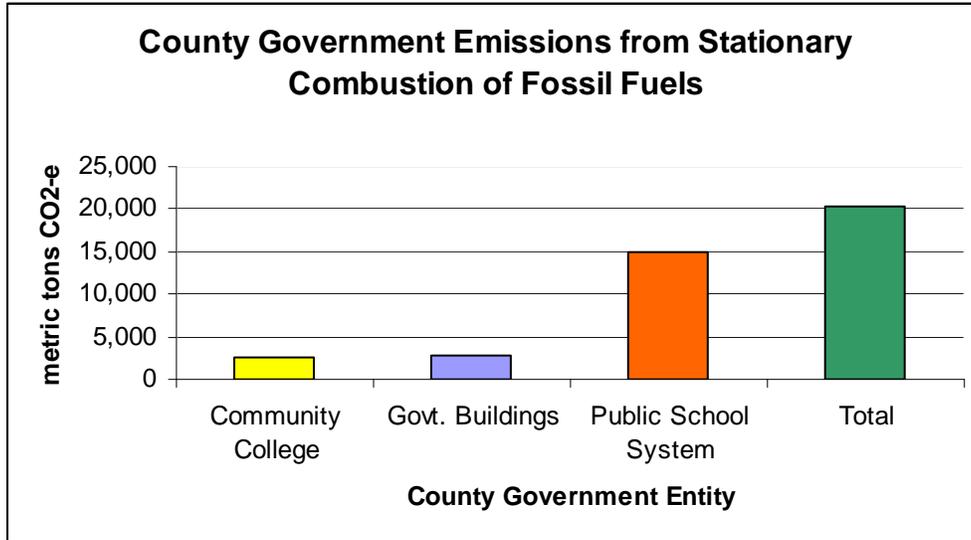


FIGURE 2-4  
Stationary Combustion Source GHG Emissions by County Entity

As indicated by the usage summary, natural gas is often the preferred fuel over the other fossil fuels due to cost and the fact that GHG emissions are lowered during combustion. Natural gas is an efficient and clean burning fuel.

### 2.3.2 Electricity Usage

Purchased electricity usage made up the entirety of the indirect (Scope 2) emissions category as Howard County does not purchase steam or hot/chilled water. The largest user of electricity in calendar year 2007, as shown in Figure 2-5, was the Howard County Public School System using a total of 96.3 million kilowatt hours (kWh) of purchased electricity. The second largest user was the Little Patuxent Water Reclamation Plant and pumping stations using a total of 45.2 million kWh. County government buildings were the third largest electricity users at 35 million kWh. The three entities released GHGs in the amounts 48,155; 22,594; and 17,497 metric tons of CO<sub>2</sub>-e, respectively. These results are consistent with the total number of elementary, middle, and high schools within the County, the large amounts of energy needed to operate a water reclamation plant in order to meet water quality standards, and the size and number of County government buildings (includes maintenance shops, fire stations, office space, and operational facilities).

Normalizing the emissions by total square footage for the buildings shows a similar result. Per square foot emissions associated with electricity usage shows that the public school system uses more electricity per square foot than County government. Howard County Public Schools emitted 12.122 mt CO<sub>2</sub>-e per square foot; County government buildings were second with 0.0137 mt CO<sub>2</sub>-e per square foot; and the Community College had 0.0109 mt CO<sub>2</sub>-e per square foot.

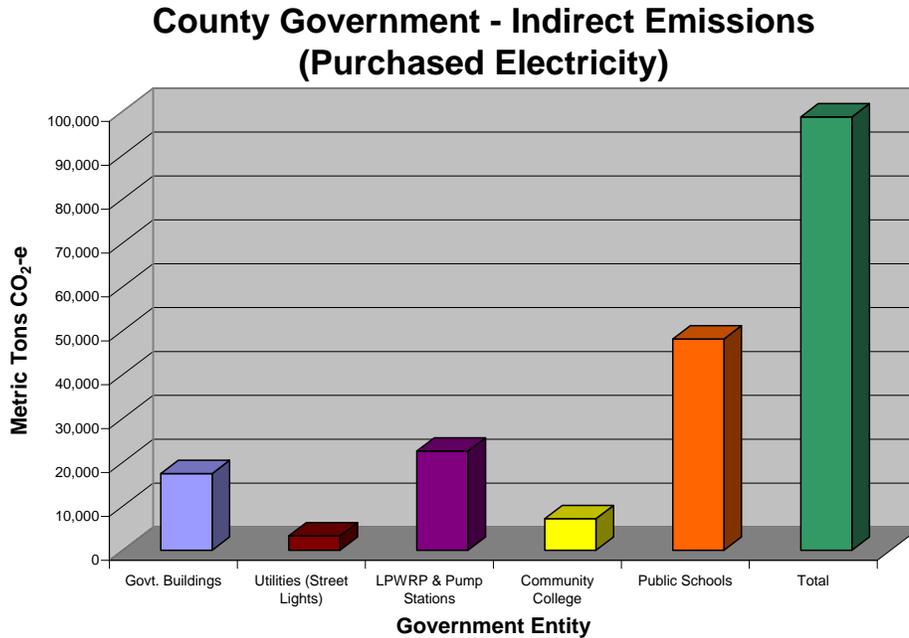


FIGURE 2-5  
County Government Indirect Emissions Distribution by Government Entity

A summary of electricity usage, total building square footage, associated GHG emissions, and normalized emissions are detailed in Exhibit 2-4 below by government entity.

EXHIBIT 2-4  
Summary of Electricity Usage and Emissions by County Government Entity

| Entity                    | kWh Used           | Total Square Footage | Emissions (metric tons CO <sub>2</sub> -e) | Normalized Emissions (metric tons CO <sub>2</sub> -e/sq. ft) |
|---------------------------|--------------------|----------------------|--|--|
| Utilities (Street Lights) | 6,582,917          | NA                   | 3,292                                      | NA   |
| Community College         | 14,434,226         | 662,261              | 7,218                                      | 0.0109   |
| Govt. Buildings           | 34,992,339         | 1,276,810            | 17,497                                     | 0.0137   |
| LPWRP & Pump Stations     | 45,186,000         | NA                   | 22,594                                     | NA   |
| Public Schools            | 96,304,895         | 7,944,861            | 48,155                                     | 12.122   |
| <b>Total</b>              | <b>197,500,377</b> | <b>9,883,932</b>     | <b>98,756</b>                              |  |

## 2.4 County Government Transportation Emissions

For the baseline GHG emission inventory, we considered transportation from County fleet, employee commuting, and contracted transport services. The County fleet included vehicles from all County agencies including but not limited to the police, fire department, rescue, sheriff, highway, public schools, parks and recreation, utilities, facilities, community college, etc.

Emissions from employee commuting for full- and part-time government staff and public school teachers were also included. In addition, emissions from contracted transport services essential to the operation of the County, such as trash collection and disposal, school buses, and wastewater treatment bio-solids transport were also quantified and included in the inventory.

### 2.4.1 County Government

County fleet mobile emissions made up 14% of the total direct (Scope 1) emissions category. The County government utilized a total of 1.34 million gallons of fuel in 2007 resulting in emissions of 12,502 metric tons of CO<sub>2</sub>-e. The largest user of gasoline and diesel fuel was the County government fleet. Howard County Public Schools used the second largest amount of gasoline. Figure 2-6 shows the emissions by County entity.

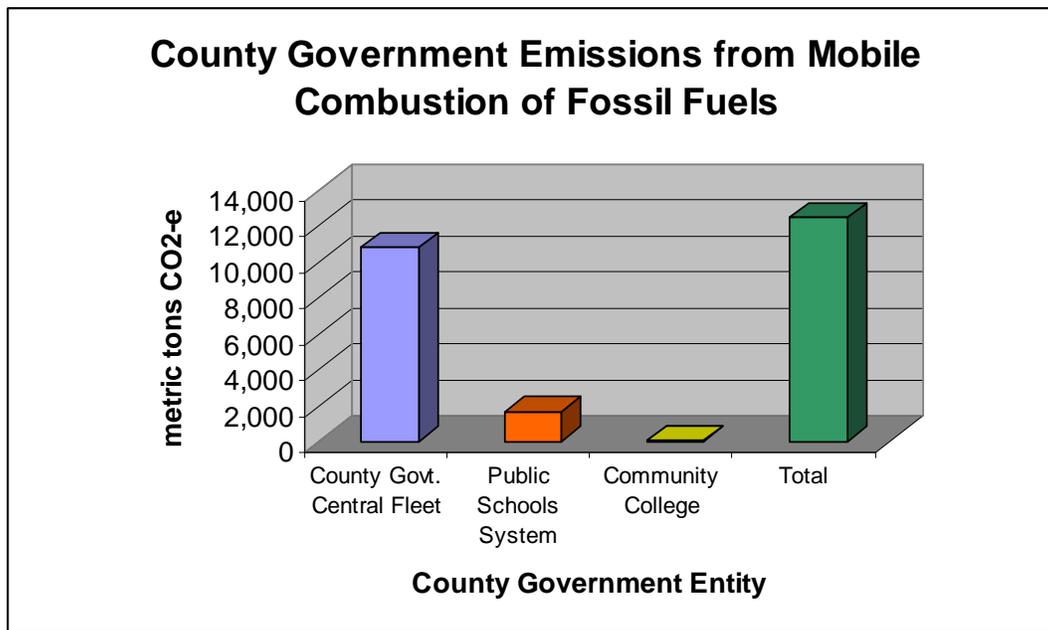


FIGURE 2-6  
Mobile Combustion Sources GHG Emissions by County Entity

A summary of the total gallons of fuel used by County government entity as well as the associated GHG emissions are included in Exhibit 2-5.

EXHIBIT 2-5  
Summary of Mobile Fuel Usage and Emissions by Entity and Fuel Type

| Entity                              | Fuel Type | Total Usage (gallons) | Emissions (metric tons CO <sub>2</sub> -e) |
|-------------------------------------|-----------|-----------------------|--|
| Howard County Central Fleet         | Diesel    | 423,609               | 4,319                                      |
| Howard County Central Fleet         | Gasoline  | 729,522               | 6,482                                      |
| Howard County Public Schools System | Gasoline  | 183,648               | 1,653                                      |
| Howard Community College            | Gasoline  | 5,185                 | 47   |
| <b>Total</b>                        |           | <b>1,341,965</b>      | <b>12,502</b>                              |

NOTE: Central Fleet is responsible for all fuel purchases for government mobile sources.

## 2.4.2 Employee Commuting and Contracted Transport Services

Employees commuting to work from inside and outside of the County and contracted transport services made up approximately 31% of the County’s total other indirect emissions (Scope 3). County employees and teachers traveled a total of 72.4 million miles to and from work while contractors traveled 1.81 million vehicle miles on behalf of the County. These entities emitted a total of 32,000 (21%) and 15,497 (10%) metric tons of CO<sub>2</sub>-e, respectively.

Total vehicle miles traveled by employees and contractors and the associated GHG emissions are included in Exhibit 2-6.

EXHIBIT 2-6  
Summary of Vehicle Miles Traveled and Emissions by Entity and Fuel Type

| Entity                                  | Fuel Type | Total Miles Traveled | Emissions (metric tons CO <sub>2</sub> -e) |
|---|-----------|----------------------|--|
| Employees Commuting                     | Gasoline  | 72,423,185           | 31,999                                     |
| Biosolids Transport                     | Diesel    | 140,000              | 384  |
| School Buses                            | Diesel    | 149,774              | 11,415                                     |
| Trash Collection and Disposal Transport | Diesel    | 1,520,104            | 3,698                                      |
| <b>Total</b>                            |           | <b>74,253,063</b>    | <b>47,469</b>                              |

Figure 2-7 depicts the GHG emissions associated with vehicle miles traveled per employee or contracted transport service.

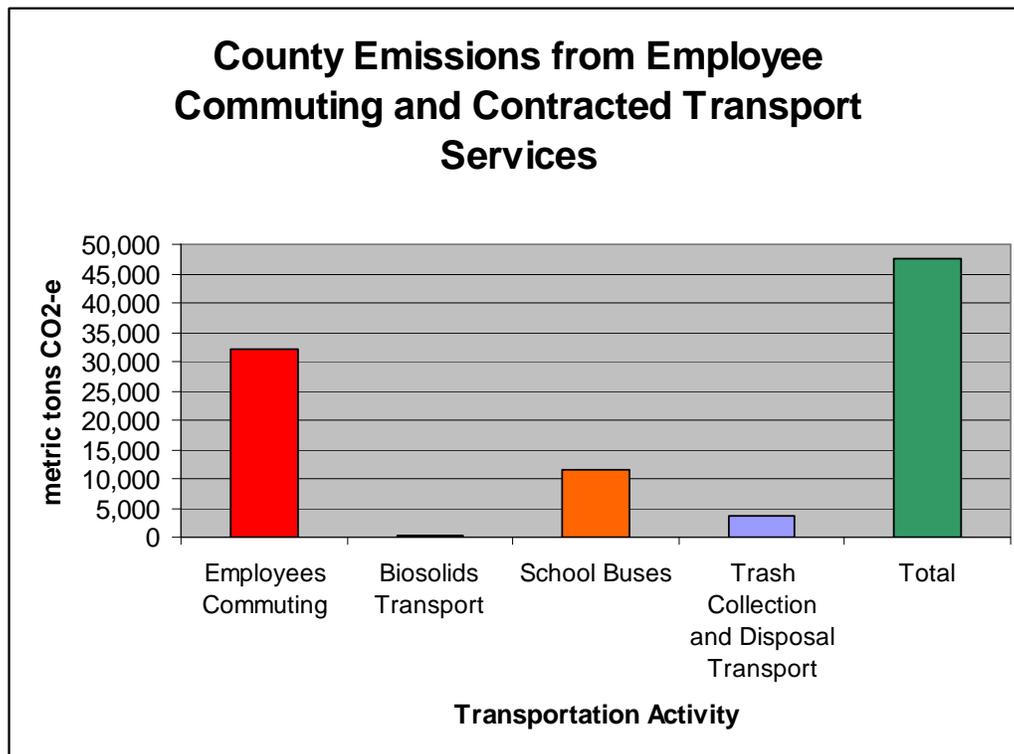


FIGURE 2-7  
Employee Commuting and Contracted Transport GHG Emissions

## 2.5 County Landfill Operations and Solid Waste Export Emissions

Because the majority of Howard County’s municipal solid waste is transported to a landfill outside of the County’s geographical boundaries, we quantified emissions from solid waste disposal at the County’s two active landfills, Alpha Ridge and New Cut, and a landfill in Virginia.

GHG emissions at the County landfills result from the degrading of waste in the landfill, fugitive emissions from the landfill cap/cover and the combustion of landfill gas in a flare after recovery. In 2007, these direct (Scope 1) emissions from the County-owned and operated landfills accounted for 44% of total direct emissions. Emissions at the external landfill made up 67% of total other indirect (Scope 3) emissions. A summary of the landfill gas recovered and flared, solid waste tonnage disposed in 2007, and the associated GHG emissions is shown in Exhibit 2-7.

EXHIBIT 2-7  
Landfill Gas Flared and Solid Waste Disposal Tonnage and Emissions by Entity

| Landfill             | Total Amount of Gas Recovered and Flared (scf/yr) | Fugitive Emissions (metric tons CO <sub>2</sub> -e) |
|----------------------|---|---|
| Alpha Ridge Landfill | 282,247,200                                       | 24,145  |
| New Cut Landfill     | 80,942,400  | 8,945   |
| <b>Total</b>         | <b>363,189,600</b>                                | <b>33,091</b>                                       |

| Entity                              | Total Solid Waste Exported (tons) | Emissions (metric tons CO <sub>2</sub> -e) |
|-------------------------------------|-----------------------------------|--|
| Government Buildings and Operations | 1,516                             | 1,430                                      |
| Community College                   | 2,518                             | 2,374                                      |
| Public Schools System               | 4,010                             | 3,781                                      |
| Community                           | 107,685                           | 101,536                                    |
| <b>Total</b>                        | <b>115,729</b>                    | <b>109,121</b>                             |

Emissions resulting from solid waste disposal outside of the County by entity are graphically presented in Figure 2-8.

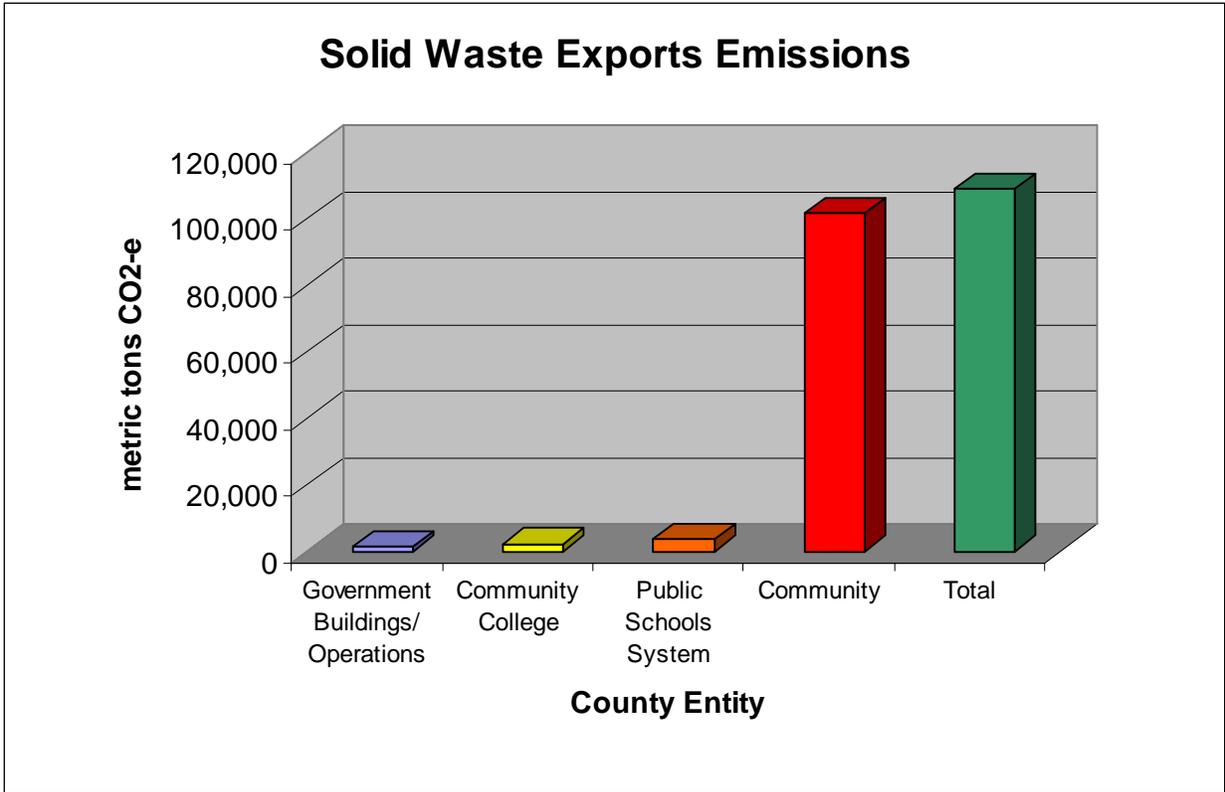


FIGURE 2-8  
County Solid Waste Exports GHG Emissions by Entity

## 2.6 County Water Reclamation and Treatment Plants Emissions

The Little Patuxent Water Reclamation Plant treats 16-19 million gallons per day (MGD) of wastewater and storm water collected in sewers throughout the County. In the future, this plant will be expanding its operations to treat wastewater from a nearby manufacturing facility. There are also four smaller wastewater treatment (package) plants operated at Howard County public schools, one of which also treats water from a surrounding neighborhood. The treatment of these waters causes emissions of GHGs.

Total emissions for the five plants were 2,186 mt CO<sub>2</sub>-e in 2007 and represented 2% of total direct (Scope 1) emissions. The biosolids generated from these processes are also processed and transported by a contractor to a third party vendor for land application. The land application of the biosolids emitted 4,326 mt CO<sub>2</sub>-e and represented 3% of the total other indirect emissions. Exhibits 2-8 and 2-9 detail the amount of wastewater treated, tons of biosolids transported for land application, and the corresponding amount of GHGs emitted from each source.

EXHIBIT 2-8

Amount of Wastewater Treated and Emissions by Facility

| Facility                                | Amount of Water Treated<br>(gallons/year) | Emissions<br>(metric tons CO <sub>2</sub> -e) |
|---|---|---|
| Little Patuxent Water Reclamation Plant | 6,825,500,000                             | 2,371   |
| Bushy Park                              | 17,012,650                                | 12  |
| Dayton Oaks                             | 931,845                                   | 7   |
| Marriotts Ridge                         | 1,825,000                                 | 7   |
| Glenelg                                 | 1,825,000                                 | 7   |
| <b>Total</b>                            | <b>6,847,094,495</b>                      | <b>2,403</b>                                  |

EXHIBIT 2-9

Amount of Biosolids Land Applied and Emissions

| Facility                                | Amount of Biosolids<br>Land Applied (tons) | Emissions<br>(metric tons CO <sub>2</sub> -e) |
|---|--|---|
| Little Patuxent Water Reclamation Plant | 12,088                                     | 4,326   |

## 2.7 County Government Refrigerant-Based Emissions

Refrigerant-based emissions were also assessed for County government operations. These fugitive emissions resulted from unintentional leaks of coolant from cooling systems in government buildings, schools, and fleet vehicles. Total refrigerant-based emissions were 10,071 mt CO<sub>2</sub>-e in 2007. These emissions accounted for approximately 11% of total direct emissions. Exhibit 2-10 details the amount of refrigerant added to building and vehicle cooling systems throughout the year and the emissions resulting from the fugitive leaks. The majority of the refrigerant-based emissions were the result of cooling systems in the County's public schools.

EXHIBIT 2-10

Summary of Refrigerant Usage and Emissions by Entity

| Entity                      | Refrigerant Charged<br>to Systems (pounds) | Emissions<br>(metric tons CO <sub>2</sub> -e) |
|-----------------------------|--|---|
| Public Schools System       | 16,678                                     | 9,873   |
| Department of Central Fleet | 336  | 198   |
| <b>Total</b>                | <b>17,014</b>                              | <b>10,071</b>                                 |

## 2.8 Howard County Community-Based 2007 Baseline GHG Emissions

In 2007, the community-based emissions for Howard County were **4,376,006 mt CO<sub>2</sub>-e**. The largest source of GHG emissions resulted from direct (Scope 1) emissions – mainly

mobile combustion (49%, 2.15 million mt CO<sub>2</sub>-e) from transportation along the Interstate 95 corridor. Energy based indirect (Scope 2) emissions from electricity usage were the second largest contributor of emissions with 38% of the total and 1.67 million mt CO<sub>2</sub>-e, while emissions from direct stationary combustion followed at 13% and 0.55 million mt CO<sub>2</sub>-e. Agricultural emissions were less than 1% of the total community emissions. These results are graphically depicted in Figure 2-9.

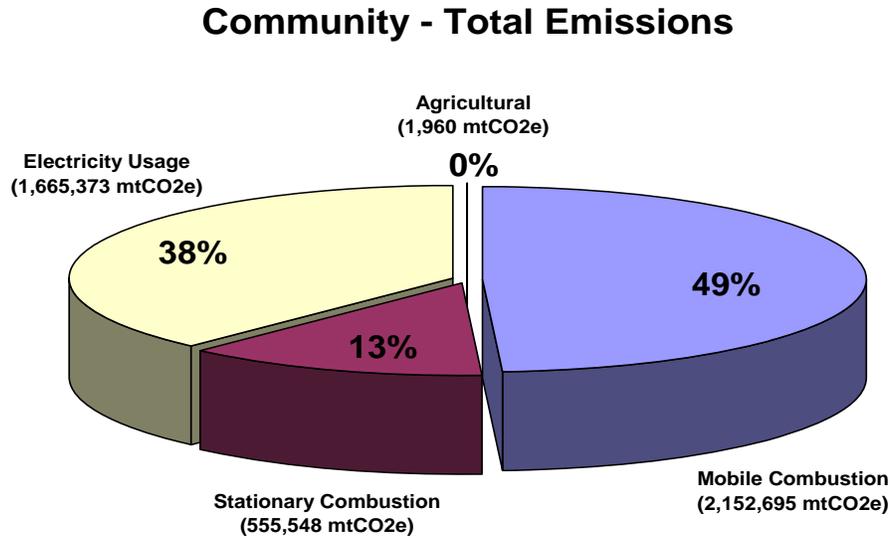


FIGURE 2-9  
Community Baseline GHG Inventory Distribution by Sectors

A summary of the emissions totals is detailed below in Exhibit 2-11:

EXHIBIT 2-11  
Community Emissions by Source Category

| Emissions Category        | Emissions (metric tons CO <sub>2</sub> -e) | Percentage of Total or Source Category |
|---------------------------|--|--|
| <b>Direct Emissions</b>   | <b>2,710,203</b>                           | <b>62%</b>                             |
| Mobile Combustion         | 2,152,695                                  | 49%                                    |
| Stationary Combustion     | 555,548                                    | 13%                                    |
| Agricultural              | 1,960                                      | <1%                                    |
| <b>Indirect Emissions</b> | <b>1,666,373</b>                           | <b>38%</b>                             |
| Electricity Usage         | 1,666,373                                  | 100%                                   |
| <b>Total Emissions</b>    | <b>4,376,576</b>                           |  |

Further analysis of the Community-based GHG emissions inventory is broken out by sector in the sections that follow.

## 2.9 Community Energy Usage

As with County government operations, fossil-fuel derived energy represents a large source of GHG emissions within the Community. Howard County evaluated the use of natural gas, propane, fuel oil, and purchased electricity usage. While fuel oil and propane usage from stationary combustion sources in the Community are included in the GHG emissions inventory, their usage and corresponding emissions are not as significant as those resulting from natural gas and purchased electricity usage.

### 2.9.1 Stationary Combustion of Fossil Fuels

During the base year (2007) the Community utilized a total of 68.7 million therms of natural gas, 6.6 million gallons of propane, and 13.8 million gallons of fuel oil resulting in GHG emissions of 555,548 mt CO<sub>2</sub>-e. The residents of Howard County used the natural gas in comfort heating systems. Small commercial & industrial users accounted for the second largest use of natural gas. Large commercial & industrial accounts used the least amount of natural gas. A summary of natural gas usage by Community entity and the resulting GHG emissions is included in Exhibit 2-12.

EXHIBIT 2-12

Summary of Fossil Fuel Usage and Emissions by Community Entity

| Entity                        | Natural Gas (therms) | Propane (gallons) | Fuel Oil (gallons) | Emissions (metric tons CO <sub>2</sub> -e) |
|-------------------------------|----------------------|-------------------|--------------------|--|
| Residential                   | 35,897,330           | 6,597,500         | 13,811,250         | 375,860                                    |
| Small Industrial & Commercial | 27,676,300           | NA                | NA                 | 151,644                                    |
| Large Industrial & Commercial | 5,118,380            | NA                | NA                 | 28,045                                     |
| <b>Total</b>                  | <b>68,692,010</b>    | <b>6,597,500</b>  | <b>13,811,250</b>  | <b>555,548</b>                             |

Figure 2-10 shows the Community-based GHG emissions resulting from combustion of fossil fuels.

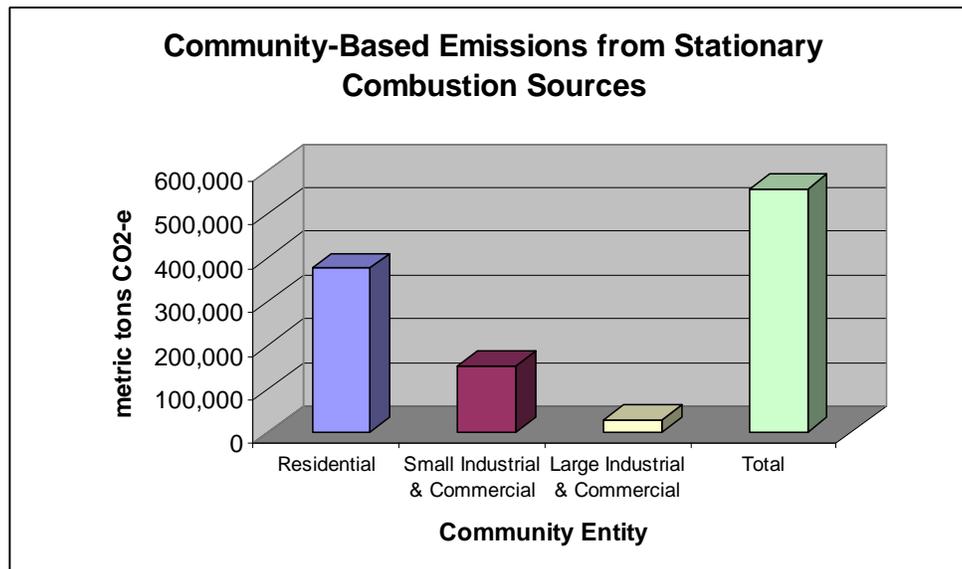


Figure 2-10

Community-Based Stationary Combustion Source GHG Emissions

## 2.9.2 Electricity Usage

The largest user of electricity and biggest emitter of Scope 2 indirect emissions in calendar year 2007, as shown in Figure 2-10, was Howard County residents using a total of 1.53 billion kWh of purchased electricity. The second largest user was small commercial & industrial operations using a total of 1.39 billion kWh. Large commercial & industrial accounts were the third largest electricity users at 416 million kWh. The total amount of GHGs emitted as a result of this usage was 1.67 million mt CO<sub>2</sub>-e. These results are consistent with the total number of residential (single-family homes) communities, the large number of small businesses, and the relatively low number of large industrial facilities within the County.

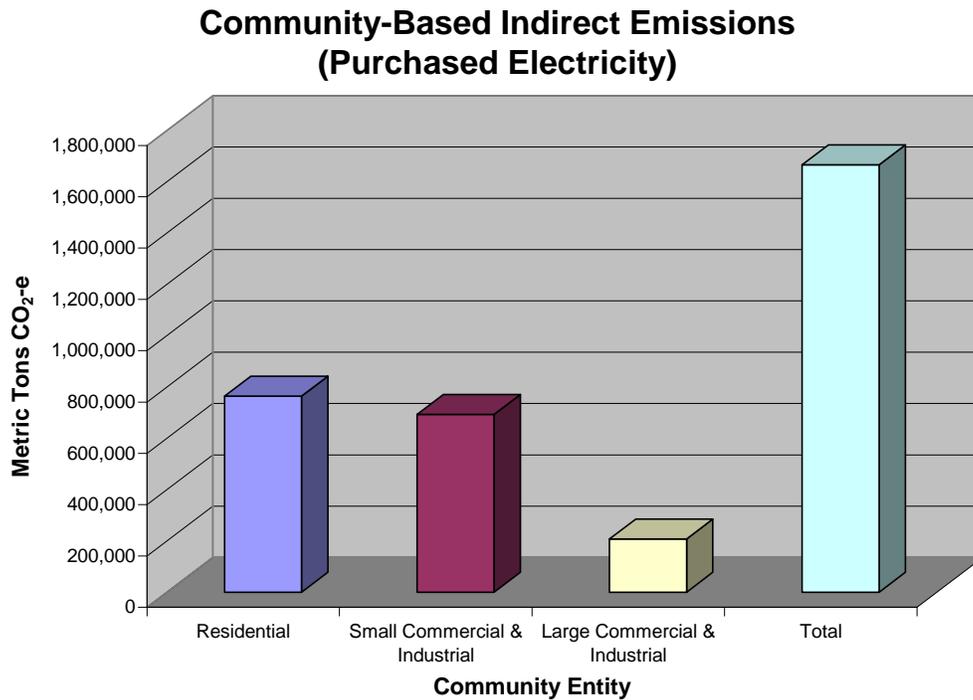


FIGURE 2-10  
County Government Indirect Emissions Distribution by Government Entity

A summary of electricity usage and the associated GHG emissions is detailed in Exhibit 2-13 by Community entity.

EXHIBIT 2-13  
Summary of Electricity Usage and Emissions by Community Entity

| Entity                        | kWh Used             | Emissions<br>(metric tons CO <sub>2</sub> -e) |
|-------------------------------|----------------------|---|
| Residential                   | 1,530,707,000        | 764,758                                       |
| Small Commercial & Industrial | 1,388,028,000        | 693,474                                       |
| Large Commercial & Industrial | 416,609,000          | 208,142                                       |
| <b>Total</b>                  | <b>3,335,344,000</b> | <b>1,666,374</b>                              |

Based on this data and the associated GHG emissions, the focus for emission reductions in the Community should also be on energy efficiency, energy use reduction, and renewable energy sources.

## 2.10 Community Transportation Emissions

The major source of mobile combustion emissions in the Community is transportation activities taking place on the Interstate 95 corridor that runs through Howard County. Local traffic on the urban and rural roads in the County is the other source of GHG emissions. Using regional transportation models, the total number of vehicle miles traveled in and through Howard County annually was determined for several vehicle types - automobiles/motorcycles, light duty trucks, heavy duty trucks, and buses.

Light duty trucks traveled the most vehicle miles (1.93 billion) in 2007 emitting 1.01 million mt CO<sub>2</sub>-e. Automobile/motorcycle traffic was second with 1.6 billion miles (602,586 mt CO<sub>2</sub>-e), followed by heavy duty trucks with 371 million miles (470,083 mt CO<sub>2</sub>-e). Mobile combustion emissions make up 79% of Community direct emissions. A summary of Community transportation mileage and associated emissions is included in Exhibit 2-14.

EXHIBIT 2-14  
Summary of Vehicle Miles Traveled and Emissions by Vehicle Type

| Entity                  | Fuel Type       | Total Miles Traveled | Emissions (metric tons CO <sub>2</sub> -e) |
|-------------------------|-----------------|----------------------|--|
| Automobiles/Motorcycles | Gasoline/Diesel | 1,596,372,230        | 602,586                                    |
| Light Duty Trucks       | Gasoline/Diesel | 1,931,801,915        | 1,011,494                                  |
| Heavy Duty Trucks       | Diesel          | 371,573,833          | 470,083                                    |
| Buses                   | Diesel          | 33,238,518           | 68,531                                     |
| <b>Total</b>            |                 | <b>3,932,986,495</b> | <b>2,152,695</b>                           |

It should be noted that mobile source emissions associated with County-government employees commuting to and from work are also included with the Community total above. For these two sources, emissions have been overestimated due to the fact that the regional transportation models used to estimate emissions includes the employee commute mileage, also.

A graphical representation of the GHG emissions resulting from vehicle miles traveled by mobile source type is shown in Figure 2-11 below:

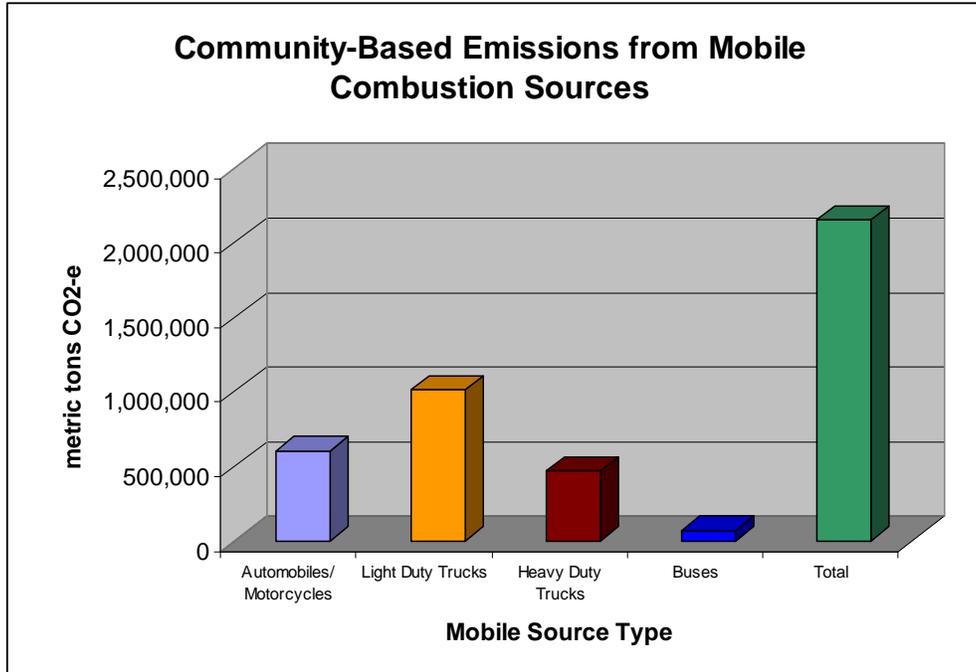


FIGURE 2-12  
Mobile Combustion Source GHG Emissions by Source Type

## 2.11 Community Refrigerant-Based Emissions

Refrigerant-based emissions from the Community were not evaluated as part of the GHG emissions inventory. Based upon the magnitude of the Community direct stationary and mobile emissions, as well as the indirect emissions from use of purchased electricity, fugitive refrigerant emissions are assumed to be de minimus (<1% of the total emissions).

## 2.12 Agricultural Emissions

Because Howard County is such a green County, there are a number of farms and livestock farms located in the geographical boundary. Howard County has pasture land that is home to cows. Emissions resulting from the manure management activities at these farms resulted in emissions of 1,960 mt CO<sub>2</sub>-e in 2007. These emissions were also less than 1% of the total emissions.



Howard County's green acreage is home to several dairy farms.

## 3.0 Emission Reductions Identification and Recommendations

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After determining the GHG emissions for each source category, the largest users of fossil fuels, electricity, and refrigerants were evaluated to identify potential sources for emission reductions. The largest users of fossil fuels and electricity are also generally the largest emitters of greenhouse gases. Targeting the largest users and emitters will allow the recommendations to achieve greater reductions throughout the specified period.

### 3.1 County Government Operations

#### 3.1.1 Stationary Combustion

The fossil fuel that was utilized the most within County government operations was natural gas. Natural gas usage within the public schools was over 2 million therms in 2007 and constituted the largest usage. The County's office buildings were the second largest users with less than a half million therms. The County's office buildings were the largest users of fuel oil with the Public School System's usage of fuel oil coming in second. Total uses of propane and diesel and their corresponding emissions were significantly lower than natural gas and fuel oil.

Because the usage of natural gas in the public schools is so high, this is the fundamental area that will be focused on for usage and emission reductions. The boilers and heating, ventilation, and air conditioning (HVAC) systems within the school district should be evaluated.

Recommendations for reducing the usage of natural gas and other fossil fuels that are combusted in stationary sources include the following:

- Energy Audits - audits could potentially identify pieces of equipment that are operating outside of their design limits and/or are in need of replacement due to age or wear
- Evaluation of alternative fuels or fuel switching options
- Replacement/retrofit of older equipment (e.g. heaters, hot water heaters, heat pumps, etc.)
- Installation of automatic thermostats

#### 3.1.2 Mobile Combustion

Based on the vehicle miles traveled data, employees commuting to the County offices and Public School System used the most fuel and emitted the greatest amount of GHG

emissions in 2007. However, because these usages and emissions were estimated based on the number of employees, their home locations, and national average fuel economy data, the County may consider a more rigorous method for evaluating this category to obtain a more accurate measure of fuel usage and mileage. A survey could be presented to employees to better understand their driving habits (i.e. carpooling, use of mass transit, use of fleet vehicles, biking, etc.) and obtain actual vehicle and fuel type data. Once a more thorough evaluation has been completed, the County could then review mileage reduction options.

Recommendations for decreasing vehicle miles traveled by employees include:

- Evaluation of incentives for carpooling and ride-sharing
- Development of bike trails leading to major business parks
- Addition of bus routes to major business parks
- Tele-working options
- Consideration of compressed work weeks

As the second largest consumers of gasoline, the County government fleet vehicles present an area for potential fuel usage and emission reductions. Emission reduction options for the fleet vehicles to be considered include:

- Purchase and use of additional hybrid vehicles
- Use of bio-fuels
- Optimization of service vehicle routes and areas of operation
- Reductions in fleet vehicle usage for non-business related activities

The largest user of diesel fuel was the contracted school buses that transport students to and from school. Potential emission reductions for this source could be realized through:

- Trip planning to reduce vehicle miles traveled and redundant routes
- Use of buses with electricity plug-in capacity for idling periods
- Use of bio-fuels
- Use of buses with more efficient diesel engines

### 3.1.3 Process Emissions

There is a considerable amount of methane being generated at the landfills. A portion of this methane is currently being flared while some escapes the recovery system as fugitive emissions. This recovered methane could potentially be used as a renewable energy source to produce electricity and/or cleaned and used as a fuel similar to natural gas from a supply pipeline. This new source of electricity could be used to offset grid-supplied electricity at the landfills; hence reducing GHG emissions from electricity use and fugitive emissions of methane.

Reductions in the amount of solid waste collected and disposed will not only reduce GHG emissions, but will reduce the amount of fuel that is used to transport the solid

waste for disposal. The amount of solid waste sent to landfills can also be reduced by increasing the amount of materials that are recycled.

The Little Patuxent Water Reclamation Plant (LPWRP) also holds potential for producing a renewable energy source. Digesters have been installed at the plant for processing wastewater and solids from a dairy products manufacturing plant. Recovering digester gas has the same offset potential as recovered landfill gas due to the high methane content of the gas. This recovered gas could also be used for the production of electricity and/or cleaned and sold for use as a fuel similar to natural gas supplied from a pipeline.

While emissions for the LPWRP were low, GHG reductions can still be realized by reducing water usage and the amount of storm water run-off from impervious surfaces within the County that have to be treated at the treatment plants.

### 3.1.4 Refrigerant-Based Emissions

The amount of refrigerant charged to cooling systems within the Public School System is significant. This indicates that the cooling systems are leaking coolant at a high rate. Fleet vehicles were also recharged with coolant on a regular basis. As with the school district heating systems, these cooling units should be considered for the following:

- Energy audits
- Upgrades, repairs, and/or replacement due to age, wear, or inefficiency
- Evaluate the use of substitutions for existing coolants (HFCs) with environmentally-friendly blends or products with lower GWP values

### 3.1.5 Electricity Usage

The top three largest users of electricity are the Public School System, LPWRP, and County government buildings, respectively. The public schools and government buildings should consider the following to evaluate reductions in electricity usage:

- Energy audits – audits may identify options to help reduce electricity consumption
- Energy conservation measures
  - automatic shut-down of HVAC systems
  - establishing of thermostat set-points and set backs
  - installation of sensors for shutting of lights in unoccupied spaces
  - power down of personal computers
- Lighting audits – audits that determine to what extent interior lighting has been upgraded to energy efficient lighting
- Evaluate the feasibility of solar energy
- Vending machine energy and efficiency review
- Weatherizing of older buildings

The LPWRP is the second largest user of electricity. As mentioned in Section 3.1.3, the County could benefit from the use of recovered digester gas to generate electricity to offset the heavy usage of the plant and the water/sewer pumping stations that supply the water to be treated.

## 3.2 Community-Based Energy Usage

### 3.2.1 Stationary Combustion

The largest users of natural gas were residential customers. In second place were small commercial/industrial entities. Fuel/Heating oil use was also high amongst residential customers. Viable options for reducing natural gas usage on the residential side include:

- Home energy assessments
- Weatherization of homes
- Establishment of set points for hot-water heaters
- Replacement/retrofit of older equipment (e.g. heaters, hot water heaters, heat pumps, etc.)
- Purchase of Energy Star® appliances or alternative equipment
- Installation of automatic thermostats

These measures could potentially reduce fuel consumption as well as GHG emissions.

### 3.2.2 Mobile Combustion

Because mobile fuel usage, as a result of vehicle miles traveled, is a significant portion of the Community inventory, the County will focus emission reductions in this sector around the following:

- Promoting the use of alternative fuels
- Promoting the use of bike trails
- Establish more bus routes
- Encourage walking

### 3.2.3 Electricity Usage

The largest users of electricity in the community were also residential customers. The second largest users were small commercial/industrial entities. Several energy saving measures could be undertaken at relatively low costs, such as:

- Weather-proofing
- Lighting replacement
- HVAC system optimizations (in order to reduce electricity usage)

Lower electricity usage will result in a reduction of GHG emissions and in costs savings for residents and commercial/industrial entities.

In addition to the measures recommended for each source category, the County will undertake overarching education and outreach activities to promote energy efficiency, awareness of renewable energy technologies and water conservation measures, as well as the distribution of information via community meetings, mail outs, leaflets, pamphlets, bill enclosures, etc. to County government staff, Public School System teachers and students, Community College teachers and students, residents, and businesses-at-large.

# 4.0 Emissions Reduction Goals and Targets

## 4.1 County-Wide GHG Reduction Goals and Targets

The Howard County Energy Commission’s report has set the following County-wide goal and target date:

- Howard County should reduce its GHG emissions to 7% below 2007 levels by 2012;

How will Howard County achieve this overarching goal? First we evaluated where we were in 1990, where we are now, and where we must be in the goal year (2012). Based upon Howard County’s population growth estimates from the U.S. Census Bureau and the County’s Master Plan for Water and Sewer, the County’s population was nearly 190,000 in 1990 and will increase to approximately 289,000 residents in 2010 and 313,000 in 2020. By normalizing the baseline emissions using the current population of the County, we used the same linear progression to back-calculate emissions for 1990 and interpolate the emissions through 2050. Figure 3-1 depicts the 1990 baseline, business as usual GHG emissions over time, the 2012 emissions target (7% below 2007), the estimated emissions over time with implementation of reduction strategies, and the 2050 emissions target (20% below 2007).

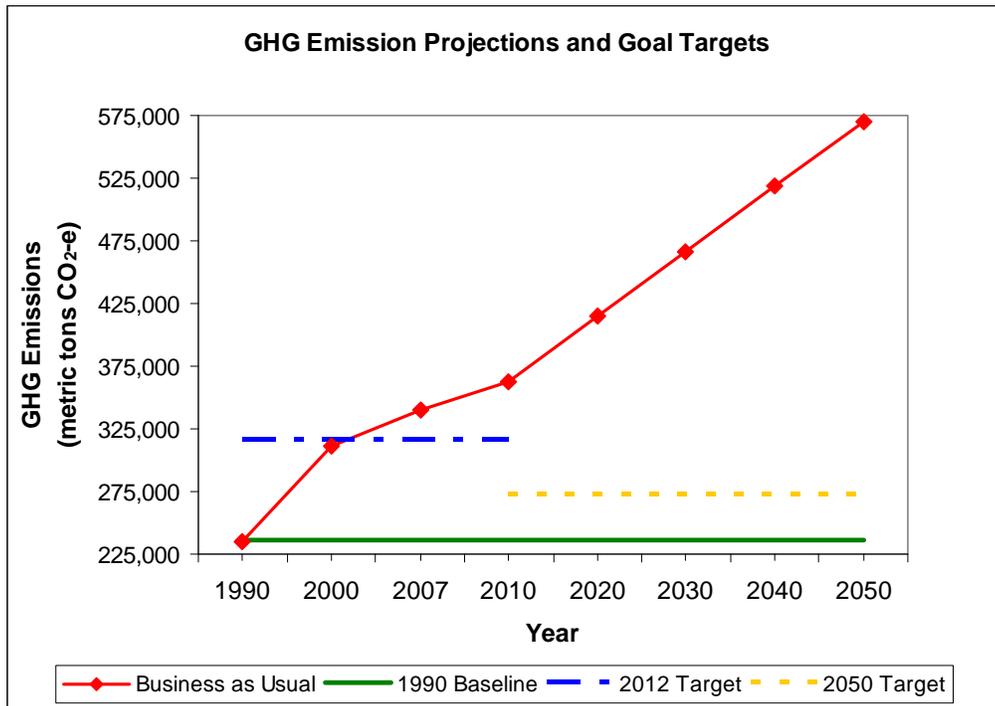


FIGURE 3-1  
Howard County GHG Emissions Projections and Reductions over Time

In order to maintain population growth targets, yet still reduce GHG emissions, challenging reduction goals and targets will have to be established across all sectors of County government and the Community-at-large. The following sections outline the proposed reduction goals and targets by County entity.

## **4.2 GHG Reduction Goals and Targets by Entity**

The following goals and targets have been proposed by the County government departments and bureaus to meet the goals established by the Energy Commission as well as those committed to as part of Howard County GHG initiatives.

### **4.2.1 Bureau of Facilities**

The Bureau of Facilities will seek to reduce total natural gas usage by 10% over a 5 year period (2008-2012) using 2007 as a baseline. This decrease in natural gas usage results in a 1% decrease in GHG emissions by 2012.

Facilities also proposes to reduce purchased electricity usage in County government buildings by 10% over a 5 year period (2008-2012) compared to a 2007 baseline. Facilities will aim to reduce GHG emissions by 0.5 - 1% during that time.

### **4.2.2 Department of Central Fleet**

The Fleet Department will strive to achieve a 25% reduction in fuel usage (gasoline and diesel) by 2012 compared to a 2007 baseline. This reduction will result in approximately a 12% reduction in Fleet GHG emissions.

### **4.2.3 Department of Highways**

The Department of Highways is responsible for the maintenance and operation of Howard County's street lights, park lights, and traffic signals. This Department pledges to reduce its electricity usage by 1% by 2012.

### **4.2.4 Bureau of Utilities**

The Bureau of Utilities operates the Little Patuxent Water Reclamation Plant. While the plant is expanding and the population is increasing, the department seeks to maintain current emission levels through 2012.

### **4.2.5 Bureau of Environmental Services**

The Bureau of Environmental Services which is responsible for the operation of the County's landfills proposes to reduce fugitive emissions from the Alpha Ridge Landfill by 15-17% below 2007 levels by 2012.

The Bureau also proposes to reduce fugitive methane emissions at the New Cut Landfill by 2% from 2007 levels by 2012.

#### **4.2.6 Howard Community College**

Howard Community College proposes to be climate neutral within 10 years (by 2017). The Office of Sustainability is implementing strategy and actions to reduce and/or offset the entirety of the College's 2007 Scope 1 and 2 GHG emissions (approximately 10,500 mt CO<sub>2</sub>-e).

In an effort to get the faculty and student body involved in achieving this goal, additional goals may be set on an intensity basis (e.g. emissions/full-time equivalent; emissions per square foot, etc.).

#### **4.2.7 Howard County Public School System (HCPSS)**

The HCPSS proposes to reduce electricity consumption 3% on a weather adjusted basis by 2012 compared to the 2007 baseline.

The HCPSS also proposes to reduce diesel consumption from school buses by 1% by 2011 compared to the 2007 baseline.

#### **4.2.8 Community-at-Large**

Based on the Energy Committee recommendations the following goals have been established for the Howard County Community-at-large.

- Residential and Commercial Sectors will reduce the use of non-renewable energy use by 5 percent by 2010, 10 percent by 2015, and 15 percent by 2020.
- Residential/Commercial/Industrial sectors will reduce non-renewable transportation fuel use 10 percent by 2010, 20 percent by 2015 and 40 percent by 2020.

If each department or bureau within County Government as well as the Community as a whole works aggressively to achieve its proposed reduction in fossil fuel and purchased electricity usage, we will exceed our overall GHG emissions reduction target (14% compared to 7%) by the goal year of 2012.

## 5.0 Emission Reduction Actions

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In order to achieve the emission reduction goals set forth in Section 3, we will build upon strategies and actions we are currently implementing and are planning for in the future. A summary of these actions are included in the sections that follow.

### 5.1 Past and Current Actions

Through the work of the Howard County Commission on the Environment and Sustainability, we are ensuring that sustainability will always be a priority in Howard County. One of the first steps to demonstrate the County's commitment to sustainability has been in the establishment of an Office of Environmental Sustainability, which aims to protect and enhance natural resources and the quality of life in the community.

By taking steps now to improve Howard County's community environment, we can generate dramatic impacts in the future. Our green building policies embody this belief. Examples of Howard County's green building policies include: requiring new buildings to be built to green standards and extending tax credits for solar and geothermal energy. These standards will require most new publicly-funded buildings larger than 10,000 square feet to attain a LEED Silver rating and most new private buildings larger than 50,000 square feet to attain a LEED Certified rating.



A residential home using solar panels is one method of reducing electricity consumption.

The County also offers property tax credits for green buildings that exceed Howard County LEED certification requirements and property tax credit for an energy conservation device that receives a LEED credit and is used in a LEED certified structure.

A specific example of how Howard County is implementing green building policies can be seen in the establishment of the Robinson Nature Center Foundation. The Robinson Nature Center will be the first nature center owned and operated by the County Government. The Center will be the state's second LEED Platinum building. Building construction is underway currently. Another example is the installation of 24 new solar photovoltaic (PV) panels on the rooftop of our East Columbia Branch Library. The system is expected to generate approximately 500 kWh a month.

We have also created a voluntary green neighborhood policy that will encourage residential developers to build more sustainable communities.

Other success stories include initiating the transformation of the County's fleet of vehicles to hybrids. We now have more hybrid vehicles in our County fleet than any other jurisdiction in the state, including hybrid buses for Howard transit, which also means considerable savings on fuel costs. We anticipate the hybrid buses will reduce fuel consumption by about 35% and reduce maintenance and repair costs by 30% to 50% compared to similar diesel buses.



LED traffic lights use 80 - 90% less electricity and have a longer life than regular traffic signals that use incandescent bulbs.

Additionally, we have converted all of the traffic lights on County roads to LED (light emitting diode) lights. LED lights use dramatically less energy than do incandescent lights. Based on the first year after the conversion of all 85 intersection signals, the lights are using 60% less energy.

We are also making significant efforts to protect and preserve our natural resources. In 2007, we announced a partnership to promote preservation easements on parcels of less than 50 acres. This program fights "bad infill" across the County by protecting small tracts of land from future development by encouraging land owners to place land into preservation easements. Since inception over 150 acres of land is being preserved. Additionally, we have established a partnership with the state to have prisoners at the Patuxent Institute grow 1,000 saplings on prison land in Jessup. In three years, prisoners will transplant those 1,000 trees to county parks, and the total cost to the county for this venture was purchasing saplings for a grand total of --- 350 dollars.

In 1985, we installed a landfill gas (LFG) recovery system and flare at the New Cut Landfill. This was a voluntary action by the County. The system pulls the LFG from under the landfill cover/cap and reduces fugitive emissions of methane (CH<sub>4</sub>) and carbon dioxide (CO<sub>2</sub>), two greenhouse gases. Due to the effectiveness of the LFG recovery system at the New Cut Landfill, in 1999, we installed an LFG recovery system and flare at the Alpha Ridge Landfill. This action was also voluntary and reduces fugitive emissions of methane. It is estimated the two systems destroy approximately 248 million cubic feet of landfill gas, which is approximately 50% methane, a year that would have otherwise been emitted to the atmosphere.

We have also received a large financial grant from the Maryland Department of the Environment to dramatically improve the water quality in the Little Patuxent River and the Chesapeake Bay. Howard County is receiving \$35.5 million from the state

for improvements and upgrades to the Little Patuxent Water Reclamation Plant, expected to cost almost \$100 million.

Through the Energy Efficiency Block Grant, the Department of Recreation and Parks is completing a complete overhaul of the park ball field lights at Cedar Lane Park which represent one of the largest contributors to the Recreation and Parks energy budget.

Additionally the will be installing high efficiency lighting throughout the park in all indoor and outdoor non-field lighting.



Aeration basins at the Little Patuxent Water Reclamation Plant are a source of nitrous oxide (N<sub>2</sub>O), a potent GHG.

Our County is also engaged in making government run more efficiently by looking for opportunities for government to improve how it runs. For example, we have implemented a new online job application system that has reduced paper usage by 40,000 sheets annually.

Additionally, we have instituted a policy that reduced the number of take-home cars (used by county employees who are “on call” and/or for employees who are routinely called back to work for emergencies) by 60 percent, resulting in an annual savings of \$700,000.

Efforts to “green” our County are also demonstrated through the establishment of a green business council as a means of attracting more businesses and enhancing this industry in our local economy.



County Executive Ken Ulman stands with Alan Wilcom from the Recycling Division during the rollout of recycling bins at Howard Community College.

We have been diligently working with residents to increase the amount of recycling. Recycling carts and bins were given to approximately 175,000 residents and have already led to approximately an 11 percent reduction in trash headed for landfills and approximately a 23 percent increase in recycling. Through a combination of single stream recycling and the new carts and bins, the County generated 1.6 million dollars last year on recycling, which is a 73% increase over the year before.

We have accomplished a great deal and continue to build upon our efforts with actions such as the following:

- Addition of an energy manager in the Office of Sustainability. The key responsibility of the energy manager would be to identify opportunities for such

savings as a result of energy initiatives and to assist in carrying these initiatives forward. AN energy manager was hired in the spring of 2010 using funds from the Energy Efficiency Block Grant.

- Allocation of the \$600,000 in interest from the forest conservation fund for existing or new non-forest tree programs (e.g., stream relief program, tree preservation, tree plantings in community, schools). Recently we ran a program to give away 2,010 trees to residents around the County. The program was very successful, in fact all 2,010 trees were taken within 48 hours.

## 5.2 Planned Future Actions

We are also planning for the future. While we continue to grow as a County, we will have to continually look for innovative ways to reduce or carbon footprint and maintain our natural resources. As such, most of the County departments and bureaus have already begun to brainstorm strategies to further reduce the amount of non-renewable energy and fossil fuel used in government operations. Summaries of these planned initiatives are detailed in the sections that follow.

### 5.2.1 Howard County Public School System (HCPSS)

Most of the boilers in the HCPSS have been switched to natural gas (a cleaner burning fuel) from fuel oil. However, there may be a few boilers remaining that will require replacement, retrofit, or optimization. These observations and strategies were implemented due to nearly 80 percent of the schools in the system having an energy management plan in place.

Several relatively easy measures such as installing switch timers and energy saving light bulbs have already been implemented at various schools. More schools are looking to follow this example due to the energy savings.

Ten of 73 schools within HCPSS have been certified 'Green' by Maryland Association of Environment and Outdoor Education (MAEOE). The overall goal of energy consciousness was embedded in each of the school's Gifted and Talented program. It is an HCPSS goal to have all schools certified as 'Green' by MAEOE in the future.

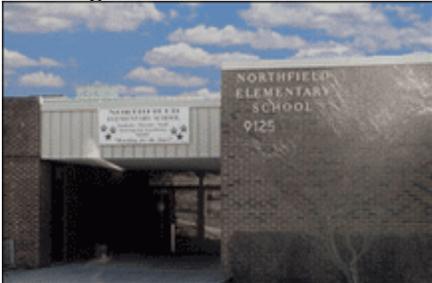
The School Board is also consolidating landscaping duties by turning over lawn mowing duties to the County's Department of Parks and Recreation at several schools in an effort to reduce fuel usage.



Vending machines in the public schools were noted as one area where more energy efficient machines could be installed to reduce electricity usage during down time. The use of Vendor Miser™ machines as been tested and evaluated at several schools. Whether they will be installed in the future will depend on the results of the evaluations.

The School Board also offers a shared savings program that returns some savings back to individual schools for participating in a load curtailment program during peak demand hours. Load curtailment would allow the schools to use diesel generators for electricity production during peak loading with the electric utility paying for the fuel.

Northfield Elementary school recently installed a geothermal system for heating and cooling.

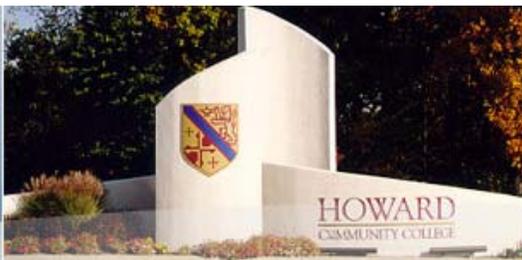


HCPSS also seeks to further reduce electricity usage by installing energy management systems at 5 schools, occupancy sensors in 211 portable classroom units, and system wide shutdown of all computers (~25,000) via network controls.

## 5.2.2 Public School Bus System

The HCPSS Department of Pupil Transport will look to achieve not only cost savings but also reductions in fossil fuel usage by efficiently routing buses to reduce overlaps and unnecessary routes.

Additionally, HCPSS has a no idling policy for buses and a procedure is in place to minimize idling. Some idling would be unavoidable, but bus drivers are trained to avoid unnecessary idling. In the future, the County is considering providing electric plug-in ports at the schools for buses awaiting student pick-up.



## 5.2.3 Howard Community College (HCC)

HCC is working on a customized carpooling website ([www.zipride.com](http://www.zipride.com)) to match up employees and students that drive long distances to the college. The College hopes this will reduce the amount of vehicular traffic

flowing to and from the school each day.

HCC also increased its recyclables to trash ratio to 30% this year. Sending less waste to landfills will reduce fuel costs for transport and emissions from the landfill.

The College is already using electric service vehicles on campus in lieu of fossil-fuel powered equipment and is promoting biking on campus as well as to campus. These measures along with more frequent Howard transit buses going to and from the campus from various locations in Howard County will also contribute to reductions in GHG emissions from mobile source emissions.

HCC is also evaluating the use of load curtailment to reduce electricity consumption during peak hours at the larger buildings and facilities/operations/maintenance areas. Load curtailment would allow the physical plant to use diesel generators for electricity production during peak loading with the electric utility paying for the fuel.

HCC is also switching to motion sensors for non-business hour power-downs. The sensors would turn off electricity when the building is not occupied.

#### 5.2.4 Howard County Department of Central Fleet

The Fleet department hopes to achieve GHG emission reductions by replacing older vehicles with hybrids and clean diesel/biofuel vehicles. A good example of benefits from converting a vehicle to hybrid form will be a tree cutting truck, which needs to idle to provide power to the boom and basket. In this situation, a hybrid vehicle would run on battery power, not fuel, during that time. Hybrid vehicles are estimated to use 50% less gas than regular vehicles.



One of the County's Hybrid fleet vehicles is placed on display for residential viewing.

The County purchased several hybrid buses.

These buses will also reduce the amount of total fossil fuel used during operation.

The Energy Efficiency Block Grant is being used to purchase a diesel hybrid truck for use by bureaus and divisions that need large hauling and towing capacity.

In addition, Fleet is evaluating the use of "GenSets" to generate power to utility/maintenance equipment during call outs. The units will allow the utility vehicle's engine to be shut off instead of idling to provide power for tools and/or comfort heating/cooling.

Finally, the County is installing electric vehicle plug-in stations at the renovated County headquarters in Ellicott City and applying for grant funding to place more throughout County facilities.

## 5.2.5 Howard County Government Department of Public Works - Bureau of Facilities

The Bureau of Facilities currently has provisions to turn the temperature down during non-business hours in the summer. As a result of the energy savings from this action, Facilities is evaluating the need to expand its use of motion sensors to allow automatic turn on/off of lights in rooms and common areas that are not occupied.

Facilities is currently implementing a program to provide energy efficient and uniform light bulbs and fixtures in all government buildings. This will result in a reduction in light bulb inventories the department has to maintain and allow less efficient bulbs to be replaced.



Weather-proofing of existing buildings is also being considered as a means to increase energy efficiency (e.g. decrease the usage of natural gas and electricity for comfort heating and cooling). The Bureau is also evaluating the use of Vendor Miser™ machines within government buildings. The machines shut down at the end of the business day and automatically start up in the morning – eliminating electricity usage during non-business hours.

## 5.2.6 Howard County Government Department of Public Works - Bureau of Utilities

The new expansion of the Little Patuxent Water Reclamation Plant (LPWRP) will reduce nitrogen and phosphorus in the effluent discharge in accordance with new nutrient cap regulations. The new expansion will also include the use of anaerobic digesters for processing solids received from a dairy product manufacturing facility. While the digesters will generate and emit methane, a recovery system and flare has been installed for flaring (methane gas destruction); hence minimizing GHG emissions from the process.



The Bureau also proposes to install high efficiency motors at the plant in order to reduce electricity usage. This will be in conjunction with the Bureau's efforts to undertake an asset management study to evaluate long-term energy management issues. The study will set up a preventative maintenance schedule for equipment which will in turn assist with the replacement or repair of older or malfunctioning equipment.

The LPWRP is evaluating the use of load curtailment to reduce the amount of electricity used during peak hours. Load curtailment would allow the plant to use diesel generators for electricity production during peak loading with the electric utility paying for the fuel.

### 5.2.7 Howard County Government Department of Public Works - Bureau of Environmental Services

The Bureau of Environmental Services plans to improve the collection efficiency of the voluntarily installed landfill gas (LFG) recovery units at the Alpha Ridge and New Cut Landfills by 50-60%. These improvements will increase the total amount of LFG recovered allowing a portion of the recovered methane to be used to produce electricity to power buildings on site (e.g. leachate pumping station) and sell most of the electricity back to the grid.

The landfills are also evaluating the use of load curtailment to reduce the amount of electricity used during peak hours for buildings and auxiliary equipment. Load curtailment would allow the landfills to use diesel generators for electricity production during peak loading with the electric utility paying for the fuel.

Through the Energy Efficiency Block Grant Alfa Ridge Landfill will have forced draft heaters installed to heat the maintenance area and a electric pickup truck for hauling and moving around the landfill.

The Bureau is considering adding the use of bio-fuels in waste hauling/collection contracts for waste collection vendors. This will serve to reduce GHG emissions associated with mobile combustion of fossil fuels during transport.

The Bureau will also make operational improvements at the New Cut Landfill that will improve the collection efficiency of the landfill gas recovery system and ultimately reduce fugitive emissions of methane.

The Bureau will continue to restore streams and retrofit ponds to improve water quality. In addition, the Bureau will maintain recycling and stream outreach activities at schools and community events as well as increase marketing activities around maintaining green environments.

### 5.2.8 Community



As a County, we will strive to educate and include our residents, local businesses, and manufacturers in the development and implementation of climate change strategy, actions, and workable solution for their homes.

One such mechanism is the annual GreenFest. The GreenFest gives residents an opportunity to speak with vendors on a variety of sustainable solutions that can be

implemented at homes or at small businesses, view “green” products, become familiar with sustainable services, and receive information on energy efficient equipment or renewable energy devices (e.g. solar panels, refrigerators, geothermal water heaters, etc.).

County residents may also want to take advantage of energy audits and incentives offered by Baltimore Gas and Electric (BGE) for more efficient use of electricity.

Energy audits can provide residents and businesses alike with valuable tips on weather-proofing, sealing, and operating heating/cooling systems to reduce energy consumption.



Through the Energy Efficiency Block Grant, the County will provide over 1,000 comprehensive energy audits to Howard County residents.

A Howard County resident speaks with a vendor during the GreenFest.

While no one entity will be able to solve the climate change phenomena or reduce our carbon footprint, we can all work together to achieve our energy efficiency, renewable energy development, and natural resource preservation goals. As a community, we can maintain the “green” community we have built and pass it along to our children and grandchildren.

## Abbreviations and Acronyms

|                    |   |
|--------------------|---|
| BGE                | Baltimore Gas & Electric                                  |
| BOD <sub>5</sub>   | 5-day biological oxygen demand                            |
| Btu                | British thermal units                                     |
| CCX                | Chicago Climate Exchange                                  |
| CFC                | chlorofluorocarbon  |
| CH <sub>4</sub>    | methane   |
| CO <sub>2</sub>    | carbon dioxide  |
| CO <sub>2</sub> -e | carbon dioxide equivalents                                |
| CY                 | calendar year   |
| DPW                | Department of Public Works                                |
| eGRID              | Emissions and Generation Resource Integrated Database     |
| g                  | gram  |
| gal                | gallon  |
| GHG                | greenhouse gas  |
| GWP                | global warming potential                                  |
| HCFC               | hydrochlorofluorocarbon                                   |
| HFC                | hydrofluorocarbon   |
| ICLEI              | International Council for Local Environmental Initiatives |
| IMP                | Inventory Management Plan                                 |
| IPCC               | Intergovernmental Panel on climate change                 |
| kg                 | kilogram  |
| kWh                | kilowatt-hour   |
| L/gal              | liters per gallon   |
| lb                 | pound   |
| LFG                | landfill gas  |
| mg                 | milligrams  |
| mg/L               | milligrams per liter                                      |
| mi                 | mile  |

|                  |  |
|------------------|--|
| MMBtu            | million British thermal units                      |
| mpg              | miles per gallon                                   |
| MW               | molecular weight                                   |
| MWh              | megawatt-hour                                      |
| N <sub>2</sub> O | nitrous oxide                                      |
| OX               | oxidation factor                                   |
| PFC              | perfluorocarbon                                    |
| PT               | part-time  |
| scf              | standard cubic feet                                |
| SF <sub>6</sub>  | sulfur hexafluoride                                |
| TCR              | The Climate Registry                               |
| USEPA            | United States Environmental Protection Agency      |
| VMT              | vehicle miles traveled                             |
| WBCSD            | World Business Council for Sustainable Development |
| wk               | week   |
| WRI              | World Resource Institute                           |
| yr               | year   |