Attachment B:

Baltimore County Government Agencies Greenhouse Gas Inventory 2006

BALTIMORE COUNTY GOVERNMENT AGENCIES

2006
Greenhouse Gas Inventory and Forecast

PAB Environmental

Table of Contents

Executive Summary……..1

1 Baltimore County Agencies 2006 GHG Inventory…….3

1.1 What is a Greenhouse Gas Inventory……....3

1.2 Establishing an Inventory……..3

1.3 Emissions Summary…….…….5

1.4.1 Sectors, Sources and Scopes……...6

1.4.1 Sectors…….6

1.4.2 Sources……..……..7

1.4.3 Scopes…….…….…….. 8

1.5 Forecast…….....9

1.6 Climate Action Plan…….……10

2 Agencies……14

2.1 General Operations……..14

2.2 Public Schools……..17

2.3 Community College of Baltimore County……...19

2.4 Public Library……..21

2.5 Revenue Authority……...23

4 Reduction Scenarios……25

References

Appendix A – Data Sources and Assumptions

Appendix B – Inventory Methodology

Appendix C – CAPPA Reference Cases

Acknowledgements

List of Tables

Table ES1 Baltimore County Government 2006 GHG Inventory, by Agency …….....2

Table 1 Baltimore County Government 2006 GHG Inventory, by Agency ……..…….6

Table 2 Baltimore County Government 2006 GHG Inventory by Source .....….....7

Table 3 Baltimore County Government 2006 GHG Inventory by Scope …….…....8

Table 4 Baltimore County Public Schools Buildings (kWh)……....10

Table 5 Baltimore County Gen. Operations 2006 GHG Emissions by Sector…….……15

Table 6 Baltimore County Gen. Operations 2006 GHG Emissions by Scope …….……...15

Table 7 Baltimore County Gen. Operations 2006 GHG Emissions by Source ……..….16

Table 8 Baltimore County Public Schools 2005─2008 GHG Emissions by Sector…….18

Table 9 Baltimore County Public Schools 2006 GHG Emissions by Scope ….……..18

Table 10 Baltimore County Public Schools 2006 GHG Emissions by Source ……..….18

Table 11 Community College of Baltimore County 2006 GHG Emissions by Sector…....20

Table 12 Community College of Baltimore County 2006 GHG Emissions by Scope...…..20

Table 13 Community College of Baltimore County 2006 GHG Emissions by Source……20

Table 14 Baltimore County Public Library 2006 GHG Emissions by Sector……..21

Table 15 Baltimore County Public Library 2006 GHG Emissions by Scope ……..21

Table 16 Baltimore County Public Library 2006 GHG Emissions by Source ……....21

Table 17 Baltimore County Revenue Authority 2006 GHG Emissions by Sector……..24

Table 18 Baltimore County Revenue Authority 2006 GHG Emissions by Scope ……..24

Table 19 Baltimore County Revenue Authority 2006 GHG Emissions by Source……..24

Table 20 General Operations Target for Emissions Reduction using CAPPA ……25

Table 21 Government Sectors and Sustainability Network's Reductions Strategies……...26

Table 22 Government Sectors and CAPPA's Reductions Strategies…….…….27

Table 23 CAPPA Strategies and CO_2e Reductions, Implementation Levels and Savings……..28

Table 24 Buildings Sector Reduction Strategies…….…….……30

Table 25 Lighting Sector Reduction Strategies…….……...……31

Table 26 Transportation Sector Reduction Strategies.…….……32

Table 27 Wastewater Sector Reduction Strategy….……32

Table 28 Solid Waste and Recycling Sector Reduction Strategies……..……33

Table 29 Landscaping Sector Reduction Strategies……..……34

List of Figures

Figure ES1 Relative Baltimore County Government to Community GHG Emissions…….2

Figure 1 GHG Emissions by Scope…….…..….4

Figure 2 Agencies Contribution to Baltimore County Government 2006
GHG Emissions …….…….....……6

Figure 3 Total Baltimore County Government 2006 GHG Emissions……...……9

Figure 4 Forecasted GHG Emissions for County Government Agencies ……...10

Figure 5 Forecasted GHG Emissions for General Operations……..16

Key to Symbols

BCPS	Baltimore County Public School
BGE	Baltimore Gas and Electric
CACP	ICLEI's Clean Air Climate Protection Model
CAPPA	Climate and Air Pollution Planning Assistant
CCBC	Community College of Baltimore County
CH_4	Methane
CO_2	Carbon dioxide
EPA	United States Environmental Protection Agency
FTE	Full Time Equivalent
e-GRID	Emissions & Generation Resource Integrated Database
CO_2e	Carbon dioxide equivalent
GHG	Greenhouse Gas
ICLEI	International Council for Local Environmental Initiatives
mT	metric Ton
NG	Natural Gas
PES	Pepco Energy Services
SIT	State Inventory Tool
TCR	The Climate Registry
VMT	Vehicle Miles Traveled
WRI	World Resource Institute
WBCSD	World Business Council for Sustainable Development

Executive Summary

In 2008, the initial Greenhouse Gas Inventories of Baltimore County and County Government General Operations were conducted (Brady and Fath, 2008). Later that year the newly formed Sustainability Network recommended expanding the GHG Inventory to include all County Agencies, to provide a baseline against which to gauge the success of energy reduction measures. This inventory was calculated using ICLEI's Clean Air and Climate Protection (CACP) 2005 model, The Climate Registry's Local Government Operations Protocol, and the Clean Air-Cool Planet model.

The 2006 GHG inventory includes the Public School System, General Operations, the Community College of Baltimore County (CCBC), the Public Library and the Revenue Authority. Emissions are calculated on energy used in buildings, vehicles, streetlights, waste water pumping, employee commute, and from solid waste, fertilizers and refrigerants.

County emissions sources and sinks were estimated for 2006 (base year) using data supplied by each agency and/or energy provider, where applicable. Carbon sequestration and storage information was derived from the Sustainability Network's Protection of Natural Resources Working Group final report (Baltimore County Sustainability Network, Protection of Natural Resources Working Group, 2009).

Gross emissions from activities within County Government Agencies in 2006 are approximately **474,492** metric tons of carbon dioxide equivalent (mT CO_2e). (see Table 1 below). Based on the results of a GHG inventory for all users in Baltimore County (Brady and Fath, 2008), County Government is responsible for approximately 4% of total community emissions. By Sector, the Public School System produces the largest quantity of emissions (44.9%), followed by General Operations (39.5%), the Community College (13.5%), the Public Library (1.4%), and the Revenue Authority (0.6%). By source, electricity is the largest contributor (41.5%), followed by gasoline (32.8%). Scope 2 emissions (indirect) from purchased electricity produced 41.5% of emissions by County agencies, followed by Scope 1 emissions (direct) 35.1%.

Combustion of fossil fuels is a major contributor to County Government GHGs, in sector, scope and source categories, and is a primary focus for the County Sustainability Network's energy reduction measures.

Annual carbon sequestration is estimated at 2.21 metric tons per acre on County owned 4762 acres, totaling approximately 10,524 mT, or 2.2% of gross emissions. Therefore, net emissions for Government Agencies are **463,968** mT CO2e.

While each Baltimore Government Agency has individual initiatives to reduce energy use and cost, the County Executive, in coordination with the Sustainability Network, has proposed that

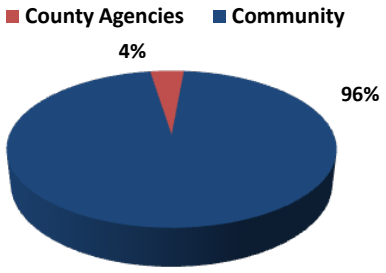
General Operations aim for a 10% reduction of base year GHG emissions. Forecasts were made for 2012 target year 'Business as Usual' (BAU) emissions, **195,768** mT CO_2e, based on 0.6% annual growth rate. If the County General Operations reaches its goal of 10% reduction of base year emissions, then target emissions are estimated to be approximately **169,979** mT or **25,789** mT CO_2e less than BAU emissions. Reduction strategies were run using ICLEI Climate and Air Pollution Planning Assistant to estimate the level of implementation necessary to achieve the target for reduction.

The purpose of this work is four-fold: 1) to identify sources of emissions within the County government agencies; 2) to support analysis that identifies where energy reduction measures will be most productive; 3) to provide a baseline against which to measure success of reduction efforts; 4) to compare with other emission sources, i.e., other jurisdictions.

Table ES1 Baltimore County Government 2006 GHG Inventory by Agency

County Agency	Emissions mT CO2e	Percent of Total
Public Schools	211,556	44.93
General Operations	188,866	39.55
Community College	64,309	13.47
Public Library	6,758	1.42
Revenue Authority	3,003	0.63
Gross emissions	474,492	100.00
Forest sequestration	10,524	
Net Emissions	***463,968***	

Figure ES1 Contributions of Government and Community GHG Emissions within Baltimore County



1 Baltimore County Agencies 2006 GHG Inventory

The Baltimore County Sustainability Network recommended extending the 2006 County General Operations GHG Inventory, completed in 2008 (Brady and Fath), to include all remaining County agencies. The following agencies were included in the base year GHG Inventory: General Operations, the Public School System, the Community College of Baltimore County, the Public Library and the Revenue Authority. The Clean Air and Climate Protection Model was the primary tool used for the inventory, but was supplemented with other models when necessary, such as The Climate Registry's Local Government Operations Protocol, and the Clean Air-Cool Planet model. The 2006 data were used for Base Year analysis, and when additional data were available, an inventory covering a range of years was performed.

1.1 What is a Greenhouse Gas Inventory?

A greenhouse gas inventory is an accounting of gases that are known to have a 'greenhouse' effect, that is, they act to trap heat moving in and out of the earth's atmosphere. A consensus of scientists believe that human activities of the industrial era, such as burning fossil fuels, have altered the amount of these heat trapping gases, and affected the global climate (NAS, 2010).

Policy makers at all levels of government are using the information gained from an emission inventory to develop policies that lead to more energy efficient practices.

An inventory can help:

- Identify the major sources and trends of greenhouse emissions;
- Establish a baseline for the development of an action plan;
- Track progress of reduction measures;
- Prepare for a carbon constrained future;
- Set goals for reductions.

1.2 Establishing an Inventory

Two key elements in performing this Emissions Inventory are: 1) identify the boundaries, scope and sectors of each agency, and 2) follow guidelines of the International Council for Local Environmental Initiatives (ICLEI), The Climate Registry's (TCR) Local Government Operations Protocol (LGOP), and WRI/WBCSD GHG Protocol Corporate Standard for establishing a complete, consistent and transparent local government operations baseline inventory.

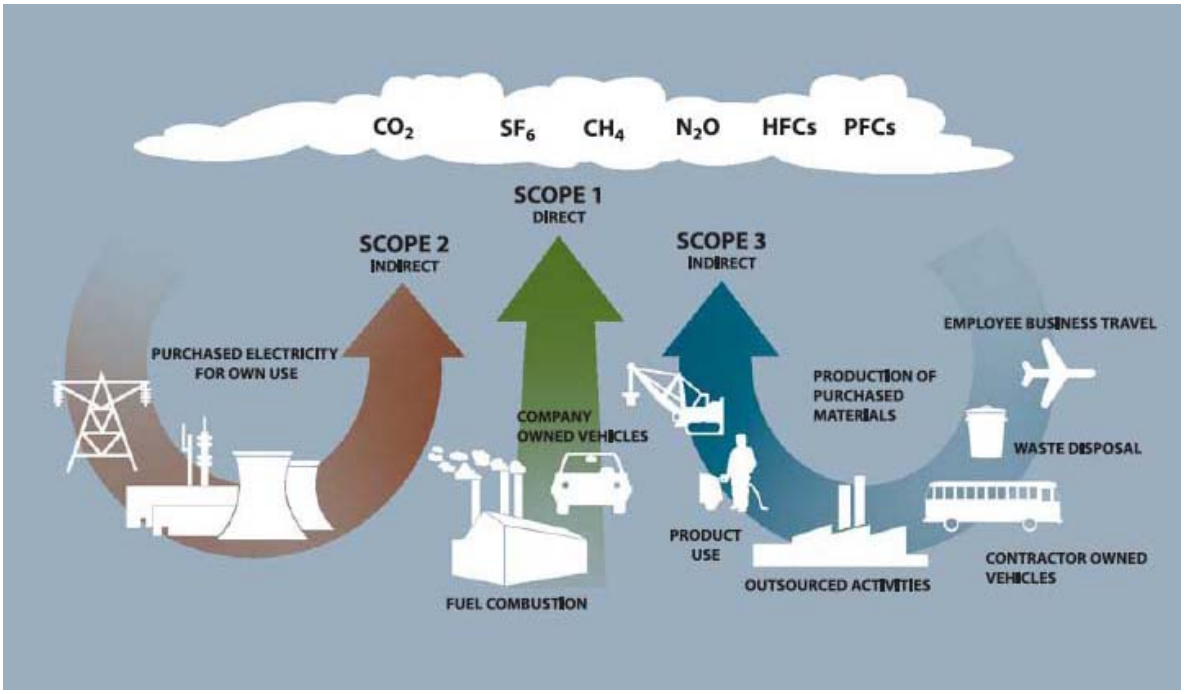
For Baltimore County agencies the operational control approach was used to establish boundaries, as suggested by TCR. This approach represents the emissions sources that local government can influence (LGOP). Consequently, included in the inventory are all facilities over which the local government has full authority to introduce and implement operating policies.

The WRI/WBCSD GHG Protocol Corporate Standard provides guidance for interpreting emissions from fossil fuel use in terms of scope (1, 2, and 3). These are commonly used standards that help account separately for direct and indirect emissions, and influence different types of policies and action plan goals. Scope 1 (direct) emissions occur within the agency's boundaries (e.g. vehicle emissions). Scope 2 (indirect) emissions refer to the consumption of

purchased electricity. Scope 3 (indirect) emissions include all other emission sources related to agency operations, but for which the agency does not have full operational control (e.g. employee commute).

Figure 1 GHG Emissions by Scope

Source: WRI/WBCSD GHG Protocol Corporate Standard (2004)



The sectors used in this inventory to categorize emissions, based on internationally accepted GHG accounting principles, are:

- Buildings and facilities
- Vehicle fleet
- Streetlights and traffic signals
- Transit fleet
- Solid waste facility
- Wastewater pumping
- Other process and fugitive emissions
- Employee's commute

These sectors, common to local governments, best identify opportunities for reductions and communication of results to stakeholders. Greenhouse gases are calculated in the Clean Air Climate Protection's (CACP) government analysis module by entering activity data from each of these sectors. These calculations are based on energy used and waste produced. The County government inventory is a subset of the community inventory and care is taken not to double count emissions.

The CACP model is Windows-based and follows many conventions for calculating emissions at the sub-state level. It allows for the utilization of local emissions factors and for quantification of emission reduction measures. However, its focus is primarily on carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) (and not the other Kyoto gases: sulphur hexafluoride, hydrofluorocarbons, and perfluorocarbons), and aggregates them into a value of metric tons of CO_2 equivalent (mT CO_2e), a commonly used unit that combines greenhouse gases of differing impact on the Earth's climate by weighting them by their global warming potential. A metric ton is 1000 kilograms or 2,206 pounds, about 10% larger than the short ton, 2000 pounds commonly used in the United States.

The current CACP model version does not provide for the accounting of any biogenic sources or sinks of GHGs. Research continues towards a consensus on emission factors for all the land-use sectors such as forests, wetlands and the agricultural sector. However, Baltimore County has demonstrated leadership in inventorying and analyzing its forest cover, and is recognized nationally for its work in this area. The Department of Environmental Protection and the Natural Resource Management and the Sustainability Network have closely examined both the amount of forested acres in the county and on county government-owned land, as well as the amount of carbon stored and sequestered annually in the trees and soil here. Therefore, their values are used in the final calculation of the *net* emissions of GHGs by government agencies.

It should also be noted that the inventory is an end-use, consumption-based accounting system and might not include all emissions that are produced by county government agencies. Efforts were directed most intently towards inventorying the largest sources of emissions, and those that County agencies can help reduce.

2012 was selected as the target year for county government agencies to meet emissions reduction goals, and 'BAU' emissions for 2012 were calculated based on the growth rate of 0.6%, which roughly estimates the growth rate of County General Operations staff over the last several years. A 10% reduction of base year (2006) emissions was set as the target, and goal emissions were calculated. Both the target year in the reduction goal follows the state's lead as outlined in the Maryland Climate Action Plan, 2008.

1.3 Emissions Summary

Gross greenhouse gas emissions for all Baltimore County Agencies in 2006 totaled 474,492 mT CO_2e. These emissions are summarized in Table 2. This accounts for approximately 4% of the total Baltimore County community GHG emissions of 11,567,128 mT CO_2e.To derive net emissions for County agencies, data were taken from the Sustainability Network's Protection of Natural Resources Working Group Report. County government owns approximately 4,762 acres. It is estimated that the forests on county-owned land annually sequester 2.21 mT CO_2e per acre, for a total of 10,542 mT CO_2e, or 2.2% of base year government emissions. Therefore, net emissions are estimated to be 463,968 mT CO_2e**.**

1.4. Sectors, Sources and Scopes

1.4.1 Sectors

Seven sectors were examined in the inventory: buildings, vehicles, streetlights, wastewater pumping, waste, employee commute, and other. Data were gathered on more than 400 buildings, 2,800 vehicles, on approximately 20,000 employees and 115,000 students, and were obtained from agency staff and local utilities.

Baltimore County Public School System was the largest contributor to the government **GHG emissions, with 211,556 mT CO2e (44.9%). County General Operations were second with 188,866 mT (39.5%), followed by the Community College with 64,309 mT (13.5%),** the Public Library with 6,758 mT (1.4%), and the Revenue Authority with 3,003 mT (0.6%).

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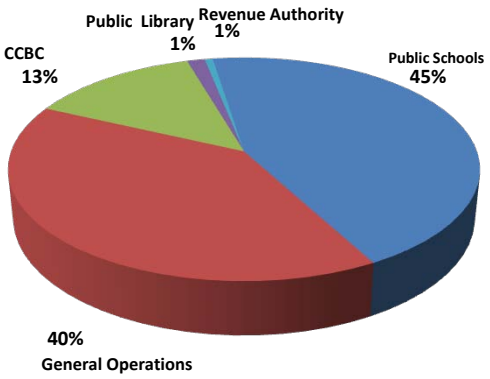
Figure 2 Agencies' Contribution to Baltimore County Government 2006 GHG Inventory



1.4.2 Sources

Almost 90% of the gross emissions resulted from stationary energy consumption in buildings, streetlights, traffic signals, wastewater pumping, and mobile energy consumption such as school

buses, vehicle fleet, and employee commute. The remainder is derived mostly from waste related emissions, followed by fertilizers and refrigerants.

Electricity, used by county government buildings, street lights, pumping stations, etc. is the largest source of emissions (41.5%), followed by gasoline (32.8%) and solid waste (11.0%). Approximately, 341 million kilowatt hours, 8 million therms of natural gas, and 1.1 million gallons of heating oil were consumed. County agencies' vehicles traveled over 40,000,000 miles, of which half were from school buses (11 million) and police vehicles (9 million). Employee commute was conservatively estimated at over 110,000,000 miles.

Eastern Sanitary Landfill emissions were included in the County General Operations inventory, and are generated from 137,924 tons of waste buried in landfill. Landfill gas is both flared and used to generate energy. The County controls flaring of methane gas, while Pepco Energy Services controls the methane-to-energy process. Both of these entities are required to report the amount of carbon dioxide and methane that are generated annually to the state of Maryland. As these values most closely reflect CO_2 and CH_4 production and release into the atmosphere, they are used as the solid waste-related emissions in this inventory.

Two additional sources of emissions are included in 'Other' category, refrigerants and fertilizers. First, 450 pounds of non-Freon refrigerants were reported by the Public School, producing 362mT CO_2e. The Community College of Baltimore County reported 7 metric tons of 'fugitive emissions', a standard used to denote refrigerant replacement. It should be noted here that additional amounts of Freon used by the County Agencies were also reported, but it is accepted practice to not include Freon (global warming potential of 1700) and other ozone depleting substances, because according to the Montréal Protocol, an international treaty designed to protect the ozone layer, CFCs and HCFCs, including Freon are being phased out.

Finally, emissions of nitrous oxide were calculated from over 137,000 pounds of fertilizers which the Revenue Authority and Public Schools applied to lawns and golf courses.

Table 2 Baltimore County Government 2006 GHG Inventory by Source

Sources			Emissions mT CO_2e	Percent of Total
	Electricity	290 million kWh	196,880	41.5
	Gasoline	8.4 million gallons	155,412	32.8
	Solid waste	137,924 tons	52,102	11.0
	Natural gas	8.1 million therm	43,048	9.1
	Heating Oil	1.1 million gallons	14,501	3.1
	Diesel	2.8 million gallons	12,075	2.5
	Other		474	0.1
Total			474,492	100.0

1.4.3 Scopes

GHG emissions can be described in terms of scopes. Scope 1(direct) emissions occur within government agencies' organizational boundaries. They are often subdivided into emissions from four separate types of sources: stationary combustion (e.g., heat from a furnace), mobile combustion (e. g., vehicle fleet), process emissions (manufacturing of cement), and fugitive

emissions (e.g., HFCs from refrigeration leaks). Scopes 2 and 3 are indirect emissions that do not occur within the agencies' organizational boundaries. The most common example of Scope 2 indirect emissions is purchased electricity, where emissions are consequence of activities that take place within the County Government's organizational boundaries but the actual emissions occur at sources owned or controlled by another entity outside those boundaries. Scope 3 emissions (e.g., employee commute) include all other indirect emissions not covered in Scope 2.

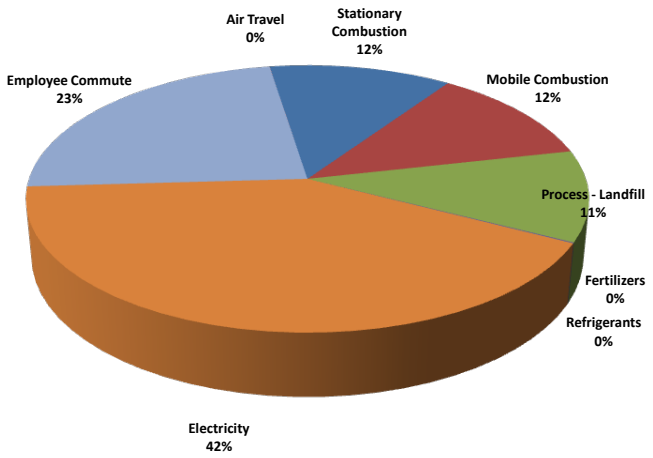
Baltimore County Government GHG emissions, and emissions from individual agencies, are reported in terms of sector and source as previously reported, and also in terms of scope emissions. This is in keeping with updated industry standards for GHG reporting, as found in TCR's Local Government Operations Protocol. This method of reporting clearly identifies emissions over which the local government has direct control and, by means of its policies and activities, will influence in the future. ***For this reason it is suggested that energy reduction measures are directed at activities that fall into Scopes 1 and 2.***

Scope 2 emissions generated by County Government agencies were the largest of the scope categories, with 41.5% of County emissions. Electricity used in County buildings generated 152,704 mT CO_2e (32.2% of total emissions), followed by Wastewater pumping 25,322 mT CO_2e, 5.3% of total. Scope1 emissions were the next largest category (31.5%). Again fossil fuel combustion in buildings (natural gas and oil) generated 57,549 mT CO_2e (12.1%). Vehicle fleet emissions were the second largest in Scope 1 category, generating 56,314 mT CO_2e (11.9% of total emissions). Employee commute emissions, scope 3 emissions, were the second largest overall sector (after electricity used in buildings) generating 111,165 mT CO_2e (23.4% of total emissions). Further analysis into Scope 3 emissions will include additional categories such as up-stream emissions products used by Agencies and VMTs from parents driving children to school.

Table 3 Baltimore County Government 2006 GHG Inventory by Scope

	Emissions mT CO_2e	Percent of Total
Scope 1		**35.1**
Stationary Combustion	57,549	12.1
Mobile Combustion	56,314	11.9
Process - ESL	52,102	11.0
Other	474	0.1
Scope 2		**41.5**
Electricity - Buildings	152,704	32.2
Electricity - Street lights	18,854	4.0
Electricity - Waste Water Pumps	25,322	5.3
Scope 3		**23.4**
Employee Commute	111,165	23.4
Air Travel	8	0.0
Total mT CO2e	**474,492**	**100.0**

Figure 3 Total Baltimore County Government 2006 GHG Emissions



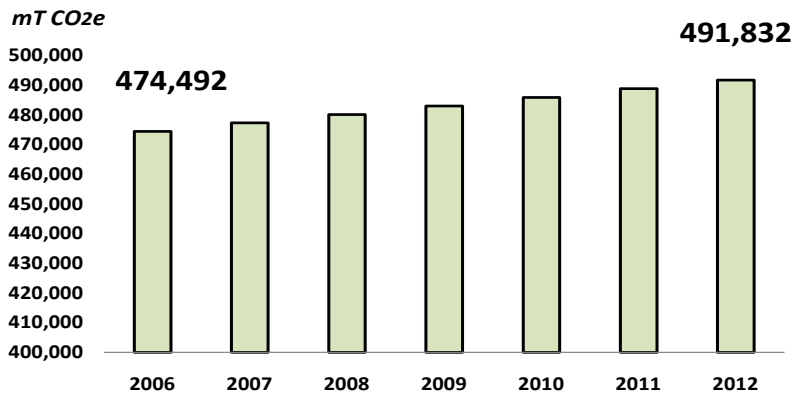
1.5 Forecast

Using the 2006 baseline inventory and an estimated rate of change of emissions, it is possible to forecast the GHG emissions for County Government Agencies from 2007 through 2012. One method for determining the rate of change is to examine growth rates of the immediate past

Since the energy used by a county government agency may be influenced by the number of staff members at that agency, and County General Operations is the second largest contributor to County GHG emissions, an examination of the rate of change of General Operations staff members was conducted.

From 2006 through 2009 annual rates ranged from 0.4% to 1.0%, with an average of approximately 0.6%. This percentage was deemed appropriate as conservative estimation of future change of County Government Agencies' greenhouse gas emissions. At 0.6% annual growth rate, GHG emissions for Baltimore County Government Agencies will increase to **491,832** mT CO_2e by 2012 under 'BAU' conditions.

Figure 4 Forecasted GHG Emissions for County Government Agencies



Baltimore County Public School's annual energy activity was also examined because this agency is the largest energy consumer of all agencies, produces the most GHG emissions; therefore its rate strongly influences the overall county agencies emissions. Specifically, electricity use in buildings was examined. From 2006 to 2008 electricity use in public schools increased from 176,686,966 kWh to 182,662166 kWh, for an average annual change of 1.7%. At first glance this appears to be a reasonable estimate. However, local government historically will grow at a slower rate than the general population, and the expected population growth rate for Baltimore County from 2005 to 2010 is approximately 3.34% for the entire five-year period (US Census 2000). Therefore 1.7% may be an over estimation of annual growth rate.

Table 4 Baltimore County Public School Buildings (kWh)

	2006	2007	2008
kWh	176,686,966	179,810,926	182,662,166
% change		1.8	1.6

1.6 Climate Action Plan

The County Sustainability Network will use these results to develop the County Climate Action Plan (CAP) to guide both the County General Operations and the Community towards a more sustainable, energy efficient future. While the CAP is a relatively new body of work for local government, studies have been conducted on state and local CAPs for plan quality and for effectiveness at GHG reduction. The results of these studies may help guide the County Sustainability Network to develop a quality plan that will be successful in achieving GHG reduction targets.

The first of these studies by Tang et al. (2009) examines 40 recently adopted local climate change action plans in the US and analyzes how well governments recognize the concepts of climate change and prepare for both mitigation and adaptation. It identifies specific factors

influencing the quality of local plans and finally provides policy recommendations to improve planning for climate change at the local level.

The study examined several independent variables such as political will, wealth, population density, energy consumption and vehicle emissions, which would influence the three dependent variables:

- Awareness
- Analysis
- Actions

The results of this analysis showed that all 40 local climate change action plans have identified the important concepts of climate change and GHG emissions, were aware of effects and impacts and set long-term goals and targets for reduction, thus scoring high marks for Awareness.

Next, a majority of plans conducted a detailed emissions inventory and trends' forecasts. However, only 15% of plans had conducted vulnerability assessments to geographically identify populations that are most susceptible to the adverse impact of climate change. Overall, the scores indicate relatively high quality Analysis.

In the Action component where policies, tools and strategies listed by individual plans were examined lower scores suggest that there is room to improve in this area of climate action planning. Potential tools that could be used to enhance quality of the CAP include:

- Financial Tools - GHG reduction fee, carbon tax
- Land Use Policies - disaster-resistant land use and building codes, low impact design for impervious surfaces, control of urban service/growth boundaries
- Energy Strategies - renewable and solar energy, energy efficiency
- Waste Strategies - landfill methane capture, waste and storm water management
- Implementation and Monitoring Strategies - establish implementation priorities, financial commitment, identify roles and responsibilities among sectors and stakeholders, continuously monitor, evaluate and update.

Finally, major findings of the study are:

- Current climate change action plans focus predominantly on the built environment (energy transportation buildings) and pay little attention to the natural environment
- The most significant predictor contributing to higher quality plans is the presence of state mandates
- Longer commuting times, indicative of a sprawling pattern of regional development significantly lower the climate change plan quality

- Local jurisdictions tend to pay more attention to reducing climate change impacts rather than preparing for the consequences.

In the second study Drummond (2010) evaluated whether state-level CAP's have actually been successful in reducing greenhouse gas emissions, and assessed which specific climate action plan characteristics and policy recommendations are closely associated with actual reductions. He found that in the 30 state plans examined common characteristics were:

- an inventory of GHG emissions for base year
- a forecast of future emissions
- a target for GHG reductions for one or more future years
- a set of policy recommendations for different sectors including residential commercial industry and transportation.

Other plans included expected impacts of climate change, economic costs of policy actions and potential funding sources for climate related government expenditures.

He does make note of the challenges in analyzing this first generation of climate action plans and policies and the difficulty in separating out their effect from other state energy plans, state sustainability plans and development/growth plans. He also lists major policy variables and major dependent variables and the direct and indirect effects of policy implementation. For example, indirectly, the planning process itself can produce outcomes especially if the public and stakeholders are included in that process, quoting Altshuler (1965) who argued that "planning is more important than any plan". Further, he points out the value of government leading by example, speaking specifically to a new building policy that requires Leadership in Energy and Environmental Design certification (LEED), which could increase awareness of the benefits of energy-saving and thereby lower construction costs for LEED certified buildings. He states that the lead-by-example effect is not minor, adding that the EPA produced a 300 page guide intended to help government take advantage of the phenomenon (EPA State Clean Energy and Climate Program, 2009).

His final results show that states with climate action plans in place reduced per capita emissions by about 0.5 metric tons compared to states without plans, holding all other variables constant. He points out that, since1990, states with higher percentages of population in compact areas have been substantially more successful at reducing emissions than states with higher percentages of the population in sprawled suburbia in the areas. Further, he notes that the significant variables are those that represent plan attributes or policies that require or encourage building efficiency in residential and commercial sectors, smart growth, LEED policies, alternate fuels, strict vehicle standards and bio-fuels. Insignificant variables include green building policies, vehicle efficiency and policies favoring public transit. Finally, he points out that while this study did not include all sectors of the economy, it provides an early look at the challenging work ahead to achieve significant GHG reductions for the second generation of climate action plans.

The results of these two studies may provide additional guidance to the County Sustainability Network as they move forward in the process of developing a CAP for the County. Many of the details described in both studies have already been incorporated in the CAP development:

- base year GHG inventory is completed
- forecasts emissions in target years are estimated
- goals for reductions are set
- set of policy recommendations has been submitted
- an accounting of sustainable actions already implemented has been submitted.

Further, many of the tools suggested by Tang are currently utilized in the County:

- landfill methane capture
- storm water management upgrades
- urban growth boundaries
- attention paid to the contribution of the natural environment.

It is therefore likely that Baltimore County is well-positioned to reach its targets for emissions reductions in the near future. County government has a long and documented history of leading by example especially in environment and growth areas. Even in the absence of a strict Maryland mandate, environmental professionals and county staff working together on the Sustainability Network, can develop a Climate Action Plan of GHG emissions reducing policies that will guide government and community towards a sustainable and energy-efficient future.

2 Agencies

2.1 General Operations

A Greenhouse Gas Inventory for Baltimore County General Operations was originally conducted on energy use and waste data from 2006 (Brady and Fath 2008). That report is updated here to include the current inventory of all County Government Agencies.

Seven sectors were included in the inventory of general operations: buildings, vehicle fleet, streetlights/traffic signals, waste, wastewater pumping, employee commute and other. Included in the inventory are data for fossil fuel use in over 100 buildings, 1500 fleet vehicles, wastewater pumping stations that pumped more than 40 billion gallons of water, annual employee commute miles for over 8000 staff members, and 40,000 streetlights and traffic signals. All of these are included in the organizational boundary of general operations.

General Operations generated **188,866** $mTCO_2e$, or 39.5% of total Government Agencies' emissions.

Additional data were collected to supplement the previous inventory in three areas: vehicle fleet, wastewater pumping stations, and solid waste. In the original inventory data were available for on-road County owned vehicles, such as police and fire vehicles, pickups trucks, and passenger cars and vans. Recently, additional data were obtained on fuel use by heavy equipment such as dump trucks used by Department of Public Works. Data for heavy equipment is not tracked by vehicle miles traveled, as is the case with on-road vehicles, but by the amount of gas and diesel consumed. In 2006 it is estimated that these vehicles consumed 32,000 gallons of gasoline and almost 900,000 gallons of diesel, producing an additional 9,140 $mTCO_2e$. From 2002 to 2007 emissions from heavy equipment ranged from almost 8,000 $mTCO_2e$ to more than 9,500 $mTCO_2e$. This brings total emissions from County government vehicle fleet to 28,139 $mTCO_2e$.

Further investigation was made into energy use by the wastewater pumping station. Data from the local utility supplier, BGE, was supplemented by additional data from Public Works staff members. This allowed for a more accurate estimation of energy used in the sector than the previous estimation based on energy costs only. A total of 43.8 million kWh were used to pump over 40 billion gallons of wastewater, generating 25,322 $mTCO_2e$ in 2006.

Finally, data on the amount of carbon dioxide and methane that are generated as a result of solid waste deposited in the Eastern Sanitary Landfill were obtained. ESL is the only operating sanitary landfill in Baltimore County, owned and operated by County government. In 2006, 137,924 tons was deposited at the landfill. In the same year an agreement was reached between County Government and Pepco Energy Services (PES) to utilize methane gas produced at the landfill as a source of renewable energy. In addition to the methane that PES uses, Baltimore County Department of Solid Waste Management flares the remaining methane. Both the County and PES are required to report the amounts of criteria air pollutants, carbon dioxide and methane that are produced annually to Maryland Department of the Environment. In 2006 it is estimated that 52,102 mTCO2e were produced at ESL as a result of the solid waste deposited and the activities of County Government and PES. Actual reported values obtained from Maryland Department of the Environment are 2007 figures, and estimates for 2006 were derived by comparing amounts of solid waste deposited in 2006 to those deposited in 2007. This sector

generates the greatest amount of GHG emissions for Baltimore County General Operations (27%). It is noted that, in order to prevent double counting of emissions from solid waste, the previously reported value of 572 mTCO2e is still attributed by General Operations staff, but is not included in the ESL emissions.

Table 5 Baltimore County General Operations 2006 GHG Emissions by Sector

Sector	GEN OPS mT CO2e	Percent of Total
Buildings	39,629	21.0
Vehicles	28,139	14.9
Solid waste	52,102	27.6
Emp commute	24,820	13.1
Streetlights	18,854	10.0
Wastewater	25,322	13.4
Total mT CO 2 e	**188,866**	**100.0**

Table 6 Baltimore County General Operations 2006 GHG Emissions by Scope

	GEN OPS mT CO2e	Percent of Total
Scope 1		**46.8**
Stationary Combustion	8,112	4.3
Mobile Combustion	28,139	14.9
Process - Landfill	52,102	27.6
Scope 2		**40.1**
Electricity - Buildings	31,517	16.7
Electricity - Streetlights	18,854	10.0
Electricity - Wastewater Pumps	25,322	13.4
Scope 3		**13.1**
Employee Commute	24,820	13.1
Total mT CO2e	**188,866**	**100**

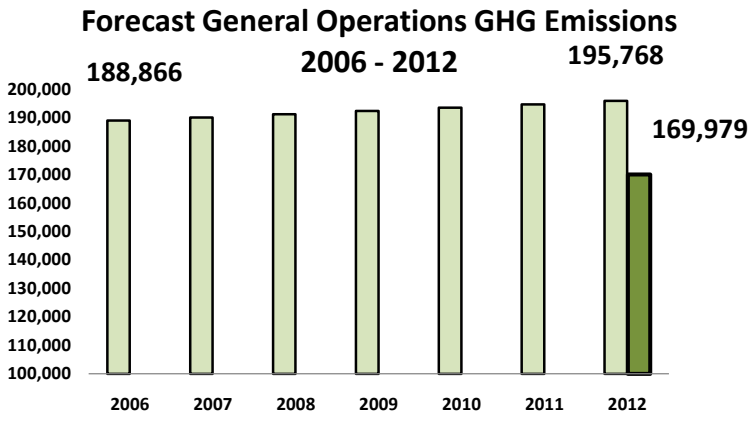
Table 7 Baltimore County General Operations GHG 2006 Emissions by Source

Sources	Emissions mT CO2e	Percent of Total
Electricity	75,693	40.1
Gasoline	42,698	22.6
Solid waste	52,102	27.6
Natural gas	2,872	1.5
Heating Oil	5,240	2.8
Diesel	10,261	5.4
Total mTCO 2 e	**188,866**	**100**

Since the County Sustainability Network will be using the information from the General Operations GHG emissions inventory to focus reduction measures, an estimation of 2012 GHG emissions was determined using the rate of change of General Operations staff members (0.6%), as was used when making estimations of 2012 GHG emissions for all County Agencies.

Baltimore County General Operations GHG emissions are estimated to rise to **195,768** mT CO_2e by target year 2012. If General Operations is to meet its goal of 10% reduction of 2006 base year emissions, they must limit emissions in 2012 to **169,979** mT CO_2e by reducing GHG emissions **25,789** mT CO_2e.

Figure 5 Forecasted GHG Emissions for General Operations



2.2 Public Schools

The Baltimore County Public School System (BCPS) ranks among the top 26 largest school systems in the United States. The school system reflects diversity in the student population of almost 105,000 students in grades pre-K through 12. These students are served by over 8,800 teachers and more than 15,000 volunteers, making the public school one of the largest employers in the region.

The BCPS operates over 170 schools, centers and programs. The School Board passes the annual budget of over $1 billion, and dedicates almost $20 million to renovation work on the school infrastructure. The annual energy budget is $30 million.

Public school managers and engineers have initiated system wide programs to identify the buildings that have the maximum potential for improvements in energy efficiency. Further, they have established programs for energy conservation in schools including outreach and staff education.

Five sectors are included in the public school inventory: buildings, vehicle fleet, employee commute, refrigerants and fertilizers. These include 166 buildings and over 1,300 vehicles. Waste produced by staff and students at public schools was calculated but not included in the inventory because all emissions at ESL are included. Therefore, 2990 $mTCO_2e$ waste sector emissions are reported here for informational purposes only.

GHG emissions for Baltimore County Public Schools are 211,556 $mTCO_2e$, 43% of County Government GHG emissions, with the Building sector contributing 146,630 $mTCO_2e$, (69.3%), followed by emissions from Employee Commute sector 38,316 $mTCO_2e$ (18.1%). Scope 2 emissions were the highest (48.2%), followed by Scope 1 (33.7%). Electricity used in buildings was the largest source (48.2%), followed by gasoline (29.8%). Electricity clearly demonstrated the greatest influence on emissions of the public school system, causing the Building Sector, Scope 2 and the electricity source category to dominate emissions. In 2006, the Public Schools used over 176 million kWh, at a cost of over $14 million. Additional energy used by public schools contributed significantly to emissions. Natural gas and heating oil contributed 21% to Scope 1 direct emissions, and cost over $12 million. The Public School fleet consists of buses trucks, and cars, accumulates 16,000,000 VMTs, and in 2006, emitted 26,247 $mTCO_2e$, or 12% of the Public School GHG's.

Total GHG emissions grew almost 4% from 2005 to 2008, for an increase of over 8,300 $mTCO_2e$.

Table 8 Baltimore County Public Schools 2005-2008 GHG Emissions by Sectors

	mTCO2e			
Sectors	**2005**	**2006**	**2007**	**2008**
Buildings	145,233	146,630	147,410	148,684
Vehicles	25,406	26,247	27,647	29,082
Refrigerants	362	362	362	362
Fertilizers	1	1	1	1
Emp Commute	37,962	38,316	38,841	39,144
Total	**208,964**	**211,556**	**214,261**	**217,273**

Table 9 Baltimore County Public Schools 2006 GHG Emissions by Scope

	Public Schools mTCO2e	**Percent of Total**
Scope 1		**33.7**
Stationary Combustion	44,595	21.1
Mobile Combustion	26,247	12.4
Other	363	0.2
Scope 2		**48.2**
Electricity - Buildings	102,035	48.2
Scope 3		**18.1**
Employee Commute	38,316	18.1
Total mT CO2e	**211,556**	**100**

Table 10 Baltimore County Public Schools 2006 GHG Emissions by Source

	Emissions	**Percent of**
Sources	**mT CO2e**	**Total**
Electricity	102,035	48.2
Gasoline	63,128	29.8
Natural gas	35,334	16.7
Heating Oil	9,261	4.4
Diesel	1,435	0.7
Other	363	0.2
Total mTCO 2 e	211,556	100.0

2.3 Community College of Baltimore County

The Community College of Baltimore County (CCBC), formed in 1998 by combining the Community Colleges from Essex, Catonsville and Dundalk, has over 50 buildings on three campuses, and offers over 100 associate degree programs to its 13,000 FTE students.

In April 2008, the Community College joined 23 other Maryland College and Universities, and became one of 682 signatories to the American College and University Presidents Climate Commitment. As such, they have made a commitment to become a sustainable community college by identifying energy consumption patterns and opportunities for reduction, with the ultimate goal of achieving climate neutrality and producing graduates that will be climate leaders in the community.

A requirement of the agreement is to complete a GHG inventory and this was completed for 2008 using the Clean Air Cool Planet model, widely used by other signatories. The results of this inventory are included in the County Government Agencies' inventory, although as noted, using the model designed for higher education institutions. It is not an uncommon practice to employ a variety of models when conducting a GHG inventory, as seen in the 2008 Maryland GHG inventory, as long as it is clearly indicated what tools are used and how they are used.

GHG emissions for CCBC (reported at the Association for the Advancement of Sustainability in Higher Education website) are 64,309 $mTCO_2e$, 13.5% of County Government GHG emissions Unlike other County agencies, where buildings are responsible for the largest percent of emissions, at CCBC commuting miles dominated the GHGs emitted (71.79%), followed distantly by buildings (27.51%). As a result, Scope 3 (71.8%) and the gasoline source emissions (72.43%) lead the profile of the community college's emissions, followed distantly by Scope 2 and electricity source emissions, each 20.7%.

Table 11 Community College of Baltimore County 2006 GHG Emissions by Sector

Sectors	Emissions mT CO_2e	Percent of Total
Buildings	17,690	27.51
Vehicles	438	0.68
Refrigerants	7	0.01
Emp Commute	46,166	71.79
Air Travel	8	0.01
Total mTCO 2 e	**64,309**	**100.00**

Table 12 Community College of Baltimore County 2006 GHG Emissions by Scope

	CCBC mTCO2e	Percent of Total
Scope 1		**7.5**
Staionary Combustion	4,349	6.8
Mobile Combustion	438	0.7
Other	7	0.0
Scope 2		**20.7**
Electricity - Buildings	13,341	20.7
Scope 3		**71.8**
Employee Commute	46,166	71.8
Air Travel	8	0.0
Total mT CO2e	**64,309**	**100.0**

Table 13 Community College of Baltimore County 2006 GHG Emissions by Source

Sources	Emissions mT CO_2e	Percent of Total
Electricity	13,341	20.75
Gasoline	46,577	72.43
Natural gas	1,770	2.75
Heating Oil	2,566	3.99
Diesel	27	0.04
Other	28	0.04
Total mT CO2e	64,309	100.0

2.4 Public Library

The Baltimore County Public Library includes 17 libraries, 476 full-time employees, 20 vehicles, and an operating budget of over $42 million. As a result of activities conducted in the Library facilities in 2006, a total of 6,758 $mTCO_2e$ were generated, or 1.4% of County Government Agencies GHG emissions.

As with most other County agencies, the Building sector generated the highest percent (60.3%) of GHG emissions, followed by emissions from employee commute (21.2%). Scope 2 indirect emissions are the highest (53.1%), followed by Scope 1 direct (25.8%). Electricity is the largest of the source emissions (53.1%), followed by gasoline (34.9%).

Emissions from solid waste produced at County Libraries are estimated that 33 $mTCO_2e$, but reported for informational purposes only. Since emissions from all solid waste generated in the county are it is included in the General Operations GHG inventory, it is considered double counting to include waste related emissions in the individual agency's inventory.

Data were supplied on the number of pounds of refrigerants injected into cooling systems in the county libraries in 2000 - 2008. In 2006, 478 pounds of Freon were added to cooling systems at county library buildings, which generated almost 370 $mTCO_2e$. As previously stated, these emissions are not included in the inventory because of the Montréal agreement but are noted for informational purposes only.

Table 14 Baltimore County Public Library 2006 GHG Emissions by Sector

Sectors	Emissions mT CO_2e	Percent of Total
Buildings	4,074	60.28
Vehicles	1,256	18.59
Emp Commute	1,428	21.13
Total mTCO 2 e	**6,758**	**100.00**

Table 15 Baltimore County Public Library 2006 GHG Emissions by Scope

	Public Library mTCO2e	Percent of Total
Scope 1		**25.8**
Stationary Combustion	485	7.2
Mobile Combustion	1,256	18.6
Scope 2		**53.1**
Electricity - Buildings	3,589	53.1
Scope 3		**21.1**
Employee Commute	1,428	21.1
Total mT CO2e	**6,758**	**100.0**

Table 16 Baltimore County Public Library 2006 GHG Emissions by Source

Sources	Emissions mT CO_2e	Percent of Total
Electricity	3,589	53.1
Gasoline	2,356	34.9
Natural gas	485	7.2
Diesel	328	4.9
Total mTCO 2 e	6,758	100.0

2.5 Revenue Authority

The Baltimore County Revenue Authority was established in 1955 for the purpose of constructing*, improving, equipping, furnishing, maintaining, acquiring, and operating* projects wholly for the benefit of County residents. It is a self-supporting agency governed by five Board Members.

Revenue Authority consists of three major businesses: Parking (which includes parking garages, surface lots and on-street parking spaces); Golf (which includes five courses and driving ranges throughout the County); and Recreational Facilities (Reisterstown Sports Complex).

As a result of activities conducted at the Revenue Authority facilities in 2006, a total of 3,003 $mTCO_2e$ were generated, or 0.6% of County Government Agencies GHG emissions.

As with most other County agencies, the Building Sector generated the highest percent (74.3%) of GHG emissions, but in this case parking garages are included as buildings. Next highest emissions are from employee commute (21.2%). Scope 2 indirect emissions are the highest (53.1%), followed by Scope 1 direct (25.8%). Electricity is the largest of the source emissions (53.1%), followed by gasoline (34.9%).

Emissions from solid waste produced at the Revenue Authority were estimated at 10 $mTCO_2e$, but reported for informational purposes only. Since emissions from all solid waste generated in the county were included in the General Operations GHG inventory, it is considered double counting to include waste related emissions in the individual agency's inventory.

Data were supplied on the number of pounds of fertilizers applied to County golf courses. It is estimated that 137,000 pounds of fertilizer applied to lawns and golf courses produced 104 $mT\ CO_2e$, or 3.5% of revenue Authority GHG Emissions.

Table 17 Baltimore County Revenue Authority 2006 GHG Emissions by Sector

Sectors	Emissions mT CO_2e	Percent of Total
Buildings	2,230	74.26
Vehicles	234	7.79
Fertilizers	104	3.46
Emp Commute	435	14.49
Total mTCO 2 e	**3,003**	**100.00**

Table 18 Baltimore County Revenue Authority 2006 GHG Emissions by Scope

	Revenue Authority mTCO_2e	Percent of Total
Scope 1		**11.6**
Stationary Combustion	8	0.3
Mobile Combustion	234	7.8
Other	104	3.5
Scope 2		**73.9**
Electricity - Buildings	2,222	73.9
Scope 3		**14.5**
Employee Commute	435	14.5
Total mT CO2e	**3,003**	**100.0**

Table 19 Baltimore County Revenue Authority 2006 GHG Emissions by Source

Sources	Emissions mT CO_2e	Percent of Total
Electricity	2,222	74.0
Gasoline	626	20.8
Natural gas	8	0.3
Diesel	43	1.4
Other	104	3.46
Total mT CO2e	3,003	100.0

4 Reduction Scenarios

4.1 Climate and Air Pollution Climate Assistant

The International Council for Local Environmental Initiatives has developed a tool to help US local governments explore and analyze potential climate and air pollution emissions reduction opportunities. The Climate and Air Pollution Planning Assistant (CAPPA) provides a starting point for two major tasks: determining an emissions reduction target that is achievable and selecting strategies to include in a climate action plan (CAPPA User Guide). This tool allows users to compare reductions from a wide variety of measures, and helps to identify those most likely to be successful based on local priorities and constraints.

CAPPA allows users to enter specific information from their GHG inventory and view possible outcomes for different emissions reduction measures. It includes a library of more than 110 reduction strategies for local governments, based on real-world data from US communities as well as expert sources. This tool provides to local governments a **high-level view** of reduction strategies in the early stages of creating a climate action plan. As jurisdictions move from planning towards implementation, it is recommended that they seek additional methods to refine the estimates of the impact of each reduction scenario.

Table 20 General Operations Target for Emissions Reduction using CAPPA

General Operations GHG Inventory Base Year	2006
General Operations GHG Inventory Target Year	2012
	CO2e (metric tons)
General Operations Base Year Emissions	188,866
Target Year Forecasted Emissions	195,768
Annual Emissions Reductions Achieved Since Base Year	0
Adjusted Target Year Forecasted Emissions	195,768
General Operations Reduction Target (% below base year)	10%
Remaining General Operations Emissions Reduction Goals	25,789

CAPPA contains more than 110 reduction measures for designing a climate action plan to reduce greenhouse gases. The goal for using this tool is to determine if the 10% reduction target set by the county can be met by implementing the measures outlined in the Sustainability Network working groups' reports. The following table lists the government operations' sectors that were examined because of their contribution to greenhouse gas production, and some of the reduction strategies suggested by the network:

Table 21 Government Sectors and Sustainability Network's Reduction Strategies

Buildings	▪ Implement LEED for existing buildings ▪ Promote and incentivize renewable energy generation ▪ Pilot green roofs ▪ Increase renewable energy portfolio ▪ Provide training to staff to understand and implement energy saving techniques ▪ Develop department 'Energy Champions'
Lighting	▪ Develop lighting strategy
Transportation	▪ Maximize efficiency in operations of all County fleets ▪ Optimize routing ▪ Develop and implement flex scheduling and telecommuting ▪ Encourage bicycling and walking ▪ Right size the entire County fleet ▪ Actively promote Commuter Choice Maryland ▪ Promote the 'Green Your Ride' County carpooling program ▪ Identify and enhance walkable older communities
Waste water system	▪ Assess wastewater pumping operations efficiency.
Solid Waste/ Recycling	▪ Recycle
Landscaping	▪ Utilize artificial turf at county parks and recreation centers ▪ Adopt and implement a 'no net loss' forest policy ▪ Develop and implement conservation landscaping measures

The following CAPPA strategies were selected for developing a climate action plan based on the above listed Sustainability Network recommendations:

Table 22 Government Sectors and CAPPA Reduction Strategies

Buildings	▪ Employee commitment to initiative ▪ Purchase green electricity ▪ Energy efficiency retrofits of existing facilities ▪ Energy efficient computers ▪ Reflective roofing ▪ Green roofs ▪ High efficiency water heaters ▪ Energy efficient copiers ▪ Energy efficient computer monitors ▪ Use solar hot water ▪ Energy efficient refrigerators
Lighting	▪ Reduce hours street lights are on ▪ Lights out at night policy ▪ Energy efficient exit signs ▪ Lighting occupancy sensors ▪ LED holiday lights
Transportation	▪ Limit idling of heavy duty vehicles ▪ Police on bicycles ▪ Initiate car share ▪ Promote telecommuting ▪ Increase bus ridership ▪ Promote carpooling and vanpooling ▪ Hybrid vehicles ▪ Use smaller fleet vehicles ▪ Electric vehicles for parking enforcement ▪ Reduce municipal fleet mileage ▪ Limit idling of light duty vehicles ▪ Bicycling paths and facilities
Waste water system	▪ Waste Water system efficiency
Solid Waste/ Recycling	▪ Establish/expand recycling program
Landscaping	▪ Forest sequestration ▪ Low maintenance landscaping ▪ Plant trees to shade buildings ▪ Irrigation control sensors

The CAPPA tool utilizes examples of real life scenarios for each of strategies (see Appendix C). Implementation levels are adjusted to reach the goal of 25,789 mT CO_2e in reductions.

Table 23 CAPPA Strategies and CO_2e Reductions

	Measure	CO2e (metric tons)
Buildings	Purchase Green Electricity	4,274
	Employee Commitment to Initiative	1,981
	Energy Efficiency Retrofits of Existing Facilities	523
	Energy Efficient Computers	219
	Reflective Roofing	131
	Green Roofs	95
	High Efficiency Water Heaters	45
	Energy Efficient Copiers	41
	Energy Efficient Computer Monitors	33
	Use Solar Hot Water	19
	Energy Efficient Refrigerators	13
Lighting	Reduce Hours Street Lights Are on Each Day	3,017
	Lights Out at Night Policy	1,309
	Energy Efficient Exit Signs	148
	Lighting Occupancy Sensors	131
	LED Holiday Lights	1
Transportation	Limit Idling of Heavy Duty Vehicles (trucks)	1,144
	Police on Bicycles	354
	Initiate a Carshare	173
	Promote Telecommuting	172
	Increase Bus Ridership	146
	Promote Carpooling and Vanpooling	124
	Hybrid Vehicles	99
	Use Smaller Fleet Vehicles	92
	Electric Vehicles for Parking Enforcement	85
	Reduce Municipal Fleet Milage	72
	Limit Idling of Light Duty Vehicles	30
	Bicycling Paths and Facilities	1
WaterSystem	Water System Efficiency	1,012
Waste	Establish/Expand Recycling Programs	142
Landscape	Forest Sequestration	10,524
	Low-Maintenance Landscaping	660
	Plant Trees to Shade Buildings	223
	Irrigation Control Sensors	65
	Total	27,098
	Goal	25,789
	% Reduction Toward Goal	105

It must be noted that the CAPPA tool provides only a high level look at emission reduction strategies for creating a climate action plan, using information provided by local governments, combined with national and regional emissions factors. It is recommended that users further analyze and refine estimates of the impact of each measure.

It is also noted that the implementation levels described in the scenarios do not reflect real life implementation in Baltimore County government facilities and operations, but rather provide a starting point for estimating potential for success in reducing General Operations GHG emissions based on the recommendations of the Sustainability Network. Applying actual levels of implementation will improve the model's output, and provide a better guide for further action.

The reduction scenarios generally fall into two categories: energy efficiency or energy conservation. ICLEI suggests that reduction efforts be focused initially towards energy efficient technologies and systems such as computers and printers. Following that, the next step is to modify behaviors to make further gains in emission reductions. The reduction strategies outlined by the Sustainability Network also fall along these two lines, for optimal alignment with the CAPPA reduction measures. Two examples from the transportation sector illustrate the different focal points: update the school bus fleet and optimize routing. The first of these addresses energy efficiency in the school bus fleet, and the second strategy illustrates energy conservation by route optimization.

Modeling 35 reduction strategies for Baltimore County General Operations based on recommendations by the Sustainability Network revealed that the target goal for reductions (25,789 mT CO_2e) is achievable. Further an estimation of incremental cost, the additional cost for technologies and systems that have a higher energy efficiency rating, was made by CAPPA, and totals approximately $7 million. An estimate of annual savings from the decrease in energy used at facilities and operations after measures are implemented will be $2.3 million, for a simple payback period of just over three years. Below each sector is discussed individually.

4.1.1 Buildings

More than 100 county buildings were included in General Operations GHG inventory and energy used in these buildings produced almost 40,000 mT CO_2e in 2006. The Sustainability Network recognized that in order to reach the county target for reduction energy use in building must be examined. Both the operations workgroup and the built environment workgroup selected strategies that address energy efficiency in county facilities, including LEED certification for building and accreditation for county personnel. Many of the recommendations are in fact already underway or under consideration for implementation.

Using the CAPPA tool, 11 reduction strategies based on systems and equipment used in buildings were examined, for a total of 7374 mT CO_2e reductions and over $700,000 in annual electricity costs savings. Purchasing Green electricity will provide the largest reduction, over 4200 mT CO_2e. This will be realized because the Maryland Renewable Portfolio Standard requires that utility companies generate additional clean energy, 9% by 2012. This reduction is considered a low hanging fruit since it costs nothing to implement. Other strategies, such as

purchasing energy efficient computers, copiers and monitors carry an incremental cost with them, an additional cost for the energy efficient technology. CAPPA makes estimates of the incremental costs as well as annual savings in energy costs which yield approximate payback periods.

An estimate was made of GHG emissions reductions that could be made by employees' commitment to this initiative. EPA estimates that between 5 and 15% of energy used in buildings can be reduced by modifying the behavior of the occupants of the building, for example by shutting off lights when leaving a room or turning off computers and printers at the end of the night. It was estimated that a 3% reduction of the electricity used in county buildings could be made by engaging all County staff in this initiative.

Further GHG reductions were estimated by energy retrofits of existing facilities using CAPPA. Estimates were based on 500,000 ft² of retrofit of facility windows, water heaters, HVAC systems, etc. This strategy included an incremental cost $750,000 and an estimated $323,000 annual savings in energy costs as a result of the retrofits. Retrofitting County buildings is currently underway, and actual level will improve estimates made here.

It should be pointed out that as the County realizes annual savings from implemented measures, consideration must be given to the rebound effect (Jevon's Paradox), spending the additional available funds in ways that generate their own emissions, thereby decreasing the overall effect of the original efforts.

The table below lists all building related reduction measures, the amount of CO_2e reduction, the degree of implementation, as well as incremental cost estimates and annual savings.

Table 24 Building Sector Reduction Strategies

Building Measure	CO2e (metric tons)	Degree of Implementation (2006-2012)	Incremental Cost	Annual Savings $
Employee Commitment to Initiative	1,981	5% reduction in Building kWh	25,000	329,000
Purchase Green Electricity	1,638	6% increase in RPS	0	0
Energy Efficiency Retrofits of Existing Facilities	523	500,000 ft²	750,000	323,480
Energy Efficient Computers	219	2,000	0	32,000
Reflective Roofing	131	250,000 ft²	62,500	20,000
Green Roofs	95	250,000 ft²	62,500	9,000
High Efficiency Water Heaters	45	50	50,000	8,238
Energy Efficient Copiers	41	100	1,200	6,010
Energy Efficient Computer Monitors	33	2,000	0	4,880
Use Solar Hot Water	19	2,000 gal/day	120,000	3,629
Energy Efficient Refrigerators	13	50	1,500	2,292

4.1.2 Lighting

The lighting sector addresses both interior and exterior lighting issues. The tool provides at least five strategies that could be used to develop a lighting strategy as suggested by the operations workgroup of the Sustainability Network. The five measures combined for total reduction potential of 4,606 mT CO_2e of emissions and $670,000 annual savings from electricity costs. The County has taken steps towards energy efficiency in their exterior lighting, updating

technologies in both street lights and traffic signals. The first measure examined in the lighting sector falls into the energy conservation category, by calling for a reduction in the number of hours that street lights are left on each day. A two-hour reduction for over 40,000 street lights could result in savings of 1,500 mT CO_2e and annual savings in energy costs of over $220,000. The next strategy, lights out at night, if implemented in 1,000,000 ft.² of interior building would cost nothing to implement, reduce emissions by over 1,300 mT CO_2e, and save the county almost $200,000 in energy costs per year. The final strategies that were examined in the lighting sector focused on energy efficient exit signs, holiday lighting and installing occupancy sensors.

Table 25 Lighting Sector Reduction Strategies

Lighting Measure	CO2e (metric tons)	Degree of Implementation (2006-2012)	Incremental Cost	Annual Savings $
Reduce Hours Street Lights Are on	3,017	2 hrs, 40k lights	0	221,000
Lights Out at Night Policy	1,309	1,000,000 ft²	0	191,800
Energy Efficient Exit Signs	148	1,000	57,000	21,700
Lighting Occupancy Sensors	131	100,000 ft²	6,000	19,180
LED Holiday Lights	1	100 strings	200	120

4.1.3 Transportation

GHG emissions generated by the General Operations' transportation sector total over 53,600 mT CO_2e, and therefore it is important to look for ways to reduce admissions from the sector. Emissions arise from County trucks, vans, police vehicles as well as heavy equipment. Also included are the employees' commuting emissions. A total of 12 reduction measures were examined in the transportation sector, which combined for 2,280 mT CO_2e reduction in GHG emissions, and over $600,000 in fuel cost savings.

Two reduction strategies that were modeled by CAPPA pertain to limiting idling of county vehicles. The first strategy alone, which examines the reduction potential of limiting idling of heavy-duty vehicles, if implemented, can reduce emissions by more than 1100 mT CO_2e. This is a significant reduction for the county because no additional costs are needed to implement a 'no idling' policy but clearly fuel costs and GHG emissions can be reduced. The second strategy, pertaining to light duty vehicles, shows that some reductions can also be acquired from including smaller vehicles in the implementation.

Three reduction strategies are directed at reducing emissions related to employees commuting. Together emission reductions will total over 400 mT CO_2e. Reductions from employee commute must be addressed if the County is to meet its target for reduction, as these emissions make up 13% of total county GHG emissions. The County has started to address these emissions. Baltimore County currently has a Green Your Ride program in place. This program provides benefits to county employees by reducing the cost of parking at city garages. Baltimore County as part of the Baltimore Metro Council, is also focused on transportation issues in the region, working with Maryland Transportation Authority to increase mass transit ridership.

Emissions reduction strategies addressed fuel economy issues such as converting part of the fleet to smaller vehicles, bicycles and hybrids. A reduction of almost 300 mT CO_2e can potentially be realized if these strategies are implemented, which are currently under consideration by the County Vehicle Operations department.

Finally, route optimization reductions reveal a potential for over 70 mT CO_2e. This technology is also under consideration, and actual benefits gained could be used as input for this scenario, improving the accuracy of the reduction from this measure.

Table 26 Transportation Sector Reduction Strategies

Transportation Measure	CO2e (metric tons)	Degree of Implementation (2006-2012)	Incremental Cost	Annual Savings $
Limit Idling of Heavy Duty Vehicles (trucks)	1,144	500 trucks	0	334,800
Initiate a Carshare	173	100 cars	0	48,000
Promote Telecommuting	172	1000 employees	0	0
Increase Bus Ridership	146	200 employees	0	0
Police on Bicycles	142	20 bicycles	20,000	136,000
Promote Carpooling and Vanpooling	124	500 employees	75,000	0
Hybrid Vehicles	99	30	76,000	27,680
Use Smaller Fleet Vehicles	92	50 cars	0	25,800
Electric Vehicles for Parking Enforcement	85	15 vehicles	0	23,900
Reduce Municipal Fleet Milage	72	150,000 miles	0	20,100
Limit Idling of Light Duty Vehicles	30	500 vehicles	0	8,400
Bicycling Paths and Facilities	1	50 employees	500,000	0

4.1.4 Wastewater System

Baltimore Counties' 120 wastewater pumping stations generate over 25,000mT CO_2e at a cost of over $2.5 million annually. However this reduction strategy, improving wastewater pump efficiency, provided some challenges to analyze, because of current technologies employed and costs for improvement and replacement. The example used by the tool describes a municipality in New York that conducted a study of replacement of five wastewater pumps. For the County, an estimate of $200,000 per pump was made as the incremental cost, and four pumps per year between 2006 and 2012, or a total of 24 pumps. If a 20% increase in efficiency was gained by each of these pumps, then the total of approximately 4% reduction in energy and emissions will be realized. Estimations of reductions from this sector will be improved by actual degree of implementation.

Table 27 Wastewater Sector Reduction Strategy

Wastewater System Measure	CO2e (metric tons)	Degree of Implementation (2006-2012)	Incremental Cost	Annual Savings $
Wastewater System Efficiency	1,012	4 pumps/yr	4,800,000	220,000

4.1.5 Solid Waste Recycling

GHG emissions from solid waste buried at Eastern Sanitary Landfill reach over 52,000 mT CO_2e annually, and the county's recycling program has been effective in reducing these emissions for over 20 years. Data from the recent success of the single stream recycling initiative that was implemented this year were entered into the CAPPA tool to estimate reductions. Since the beginning of this year an increase of approximately 20,000 tons (greater than 30%) of residential recyclables has been realized. It is estimated in CAPPA that by 2012 a dditional gains will be achieved and that over 140 mT CO_2e of emission reductions will be achieved from this initiative. Data on incremental costs were not estimated for this strategy and actual data for implementation will improve results.

Table 28 Solid Waste and Recycling Sector Reduction Strategies

Solid Waste Recycling Measure	CO2e (metric tons)	Degree of Implementation (2006-2012)	Incremental Cost	Annual Savings $
Establish/Expand Recycling Programs	142	> 30% increase in recycling	0	0

4.1.6 Landscaping

Four strategies were modeled in the landscaping sector for potential to help the county achieve its target for emission reductions. The first, forest sequestration, was taken from County Sustainability Network Protection of Natural Resource Working Group's final report. It is estimated that forests on 4700 acres of County owned land sequester approximately 2.2 mT CO_2e annually, or a total of 10,524 mT CO_2e. This is significant as it offers tremendous reduction in GHG emissions at no a dditional cost to the County, and brings to light the importance of saving and protecting current forests as well as implementing policies of aforestation and reforestation.

Other strategies examined in this sector include low-maintenance landscaping which primarily involves planting native plants and reducing lawn mowing for emission reduction potential of 660 mT CO_2e annually and reduced fuel costs of over $90,000. Strategy of planning trees near county buildings to offer shade that reduces the need for summer air-conditioning was modeled, but it is acknowledged that trees planted now will not offer full potential savings until trees mature in 20 or more years. At that time 223 mT CO_2e and $40,000 will be saved annually. Finally irrigation control sensors are estimated to save the county 65 mT CO_2e and $84,000 per year at an incremental cost of $10,000. The Baltimore County Advisory Commission for Environmental Quality has completed a Conservation Landscaping report which provides specific recommendations for maintenance of county properties (http://www.baltimorecountymd.gov/Agencies/ceq/currentprojects.html#landscaping).

Table 29 Landscaping Sector Reduction Strategies

Landscaping Measure	CO2e (metric tons)	Degree of Implementation (2006-2012)	Incremental Cost	Annual Savings $
Forest Sequestration	10,524	2.21 mt CO2e/acre, 4.7k acres	0	0
Low-Maintenance Landscaping	660	500 acres of affected lawn	0	91,000
Plant Trees to Shade Buildings	223	2000 trees	400,000	40,000
Irrigation Control Sensors	65	200 acres of affected lawn	10,000	84,000

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Appendix A

Data Sources and Uncertainties

Data used in the GHG inventory were supplied by county staff members and public utilities, and include electricity, gas, and heating oil used in buildings, gasoline and diesel fuel used in County fleet, and waste buried at Eastern Sanitary Landfill. When actual data were not available estimates were made using most reliable data available.

Some data gaps exist in this analysis, primarily in Scope 3 emissions, which include a diverse range of activities, including employee commute and air travel. Data on Scope1 refrigerants were not available for all agencies. When they were available they contributed less than 1% to total emissions, and as a result are considered de *minimus* emissions, but this gap should be filled over time. Guidance for data gathering and calculations will continue to come down from federal agencies, and these existing gaps may be lessened, if not completely eliminated.

General Operation:

1) Buildings, **Streetlights, Waste Water** For three sectors, Buildings, Streetlights and Waste Water, data on energy usage were supplied by Baltimore County Department of Public Works, Property Management and BGE. Indicators for each sector such as the amount of office space in square feet in government buildings, the number of streetlights, and the volume of output of wastewater were included whenever possible.

2)Vehicle Fleet The information on VMTs from County fleet was supplied by the County's Vehicle Operations Manager and emissions were estimated using default fuel efficiencies for each vehicle type (see Appendix A for additional details on default values and emissions factors). Heavy equipment and lawn mowing equipment were not included.

3) Employee Commute In the Employee Commute Sector emissions were estimated from the amount of energy used during travel to and from work by County Government employees based on a survey of Department of Environmental Protection and Resource Management (DEPRM) staff (82 replies out of 110 staff members). Employee commute was added to capture the total emissions for which county operations are responsible, and to calculate the benefits of employee commute trip reductions measures. The sector has the same inputs as the Vehicle Fleet Sector, VMT.

4)Waste Emissions from waste shipped to the County Eastern Sanitary Landfill from County General Operations was derived from the annual report of Baltimore County Solid Waste Management and PEPCO Energy Service to Maryland Department of the Environment.

5)Other The Other Sector is used to enter the absolute amount of greenhouse gases (HFCs, PFCs) emitted from government activities that are not included in any specific sector. Emissions from heavy equipment, derived from data provided by County's Vehicle Operations Manager, were calculated using The Climate Registry's Local Government Operations Protocol and entered into this sector.

Public Schools:

1) Buildings, Vehicle Fleet, **Waste** Data on energy use in Baltimore County Public Schools, and fuel used by the school vehicles, including buses, trucks, and mowing equipment, as well as the amount of solid waste generated, were provided by Merrill Plait, Assistant Administrator of Physical Facilities , and Pete Dixit, Energy Manager. Emissions related to waste were estimated using the same calculations as were used for General Operations' employee generated waste, and are included for informational purposes only because all emissions related to solid waste buried at Eastern Sanitary Landfill are included in emissions generated by General Operations, and to include the here again would be double counting.

2) Employee Commute Estimates of emissions generated from employee commute were made using results of the survey conducted for Baltimore County DEPRM and used to calculate employee commute emissions for General Operations' employees. This was approximated to be 3 mT CO_2e per employee.

3)Other Data on refrigerants and fertilizers used in public school facilities were provided by Energy Manager Pete Dixit.

Community College of Baltimore County:

1) Buildings, **Vehicle Fleet**, **Employee Commute**, **Waste, Refrigerants, Air Travel** No data were gathered for calculating emissions from the community colleges, because the results of the GHG inventory conducted by the college were included in the inventory of all county agencies. These results are available on the AASHE website.

Public Library:

1) Buildings, **Vehicle Fleet** Data on energy use by Baltimore County Public Library, and fuel used by the library vehicles, including trucks, van and book mobiles, were provided by Jen Evans, Administrative Assistant, and Pam Kryglik, Facilities Services Administrative Assistant.

2) Employee Commute Estimates of emissions generated from employee commute were made using results of the survey conducted for Baltimore County DEPRM and used to calculate employee commute emissions for General Operations' employees. This was approximated to be 3 mT CO_2e per employee.

3)Waste Emissions related to waste were estimated using the same calculations as were used for General Operations' employee generated waste, and are included for informational purposes only because all emissions related to solid waste buried at Eastern Sanitary Landfill are included in emissions generated by General Operations, and to include the here again would be double counting.

Revenue Authority:

1) Buildings, **Vehicle Fleet, Fertilizers** Data on energy use by Baltimore County Revenue Authority, fuel used by the vehicles, including trucks, van and mowing equipment, and applied fertilizers, were provided by Wayne Mixdorf, Director of Parking.

2) Employee Commute Estimates of emissions generated from employee commute were made using results of the survey conducted for Baltimore County DEPRM and used to calculate employee commute emissions for General Operations' employees. This was approximated to be 3 mT CO_2e per employee.

3)Waste Emissions related to waste were estimated using the same calculations as were used for General Operations' employee generated waste, and are included for informational purposes only because all emissions related to solid waste buried at Eastern Sanitary Landfill are included in emissions generated by General Operations, and to include the here again would be double counting.

Appendix B

Inventory Methodology

Clean Air and Climate Protection 2005

The software used in this study is *Clean Air and Climate Protection* by Torrie Smith Associates. It was designed for the International Council for Local Environmental Initiatives (ICLEI) and National Association of Clean Air Agencies (N ACAA) to support local governments as they develop strategies to combat global warming and air pollution. It is intended to track emissions and reductions of greenhouse gases. This tool can create an emissions inventory for the community as a whole and for the government's internal operations, quantify the effect of existing and proposed emissions reduction measures, predict future emissions levels and set reduction targets and track progress towards meeting those goals. The software contains emission factors that are used to calculate emissions based on simple fuel and energy use, and waste disposal data. It is recommended by t he USEPA for use by l ocal jurisdictions.

It should be noted that the inventory is an end-use accounting system, consumption based, and might not include all emissions that occur here. For example, emissions from electricity usage i ncluded in the inventory are based on kW h consumed here, not necessarily produced here, and may in fact be released at power plants not located within the county. This way a jurisdiction can account for emissions resulting from its consumption patterns and consequently be in a better position to design effective tactics to alter or reduce these emissions.

The Baltimore County inventory considers CO_2, CH_4 and N_2O emissions, and aggregates them into a value of metric tons of CO_2 equivalent, a commonly used unit that combines greenhouse gases of differing impact on the Earth's climate by weighting them by their warming potential.

GHG	100 Year GWP
CO_2	1
CH_4	23
N_2O	296
IPCC Third Assesment Report 2001	

The Baltimore County Government 2006 GHG Inventory is a subset of the Community inventory. Care was taken not to double count emissions.

CACP Software organizes the analysis Of Government Agencies into seven sectors – Buildings, Vehicle Fleet, Employee Commute, Streetlights, Waste Water, Solid Waste and Other.

[To be completed]

Climate and Air Pollution Planning Assistant

This tool is designed to help local governments analyze emission reduction opportunities it allows users to enter their own specific emissions information from their greenhouse gas inventory as well as local utility emission factors, and then to view the potential outcomes for various emission reduction strategies. It provides a wide variety of emission reduction strategies allowing local governments to model benefits from reduction measures applied to all sectors and scopes of government activities.

However CAPPA is intended as a high-level view of reduction measures and suggests that all results be analyzed and considered by us er governments before adoption in the final climate action plan. Further it is recommended that user seek additional tools and methodologies to refine their individual estimates of each measure.

The first step in getting started using the CAPPA tool is to provide information from local GHG inventory of emissions from base year and potential emissions from target year, as well as goals for reduction in target year. These were provided using results from the General Operations inventory.

The next step is to complete the Measure Benefits Ratings, which are the six key decision criteria which the tool uses to determine level of importance to local government.

[To be completed]

Appendix C

	Measure	Reference
Buildings	Purchase Green Electricity	www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=MD0
	Employee Commitment to Initiative	www.ccbcmd.edu/media/sustainability/sustainability_report_2010.
	Energy Efficiency Retrofits of Existing Facilities	www.ci.berkeley.ca.us/ContentDisplay.aspx?id=20068
	Energy Efficient Computers	www.dallascityhall.com/business_development/index.html
	Reflective Roofing	www.energystar.gov/ia/partners/manuf_res/JeffersonHouston_ne
	Green Roofs	www.hclib.org/pub/images/agencyhpart/py_friends_fall09.pdf
	High Efficiency Water Heaters	www.aceee.org/consumer/water-heating
	Energy Efficient Copiers	www.lacity.org/ead
	Energy Efficient Computer Monitors	www.honolulu.gov/refs/cclpol/99-225.htm
	Use Solar Hot Water	ww.chicagosolarpartnership.org/index.php?src=gendocs&link=Be
	Energy Efficient Refrigerators	fypower.com/bpg/case_study.html?b=institutional&c=Pasadena%
Lighting	Reduce Hours Street Lights Are on Each Day	www.rpi.edu/dept/lrc/nystreet/how-to-planners.pdf
	Lights Out at Night Policy	greenguardian.com/EPPG/10_6.asp#Success
	Energy Efficient Exit Signs	www.energync.net/resources/docs/pubs/exitsigns.pdf
	Lighting Occupancy Sensors	www.naco.org/cffiles/ggi/green_counties/documents/Ramsey%2C
	LED Holiday Lights	usatoday.com/news/nation/2007-11-20-led-lights_N.htm
Transportation	Limit Idling of Heavy Duty Vehicles (trucks)	www.epa.gov/smartway/documents/420b06004.pdf
	Police on Bicycles	www.policebikes.com/
	Initiate a Carshare	www.citycarshare.org
	Promote Telecommuting	ww.teleworkarizona.com/mainfiles/visitor/voverview.htm
	Increase Bus Ridership	www.dpi.wa.gov.au/travelsmart/14958.asp
	Promote Carpooling and Vanpooling	www.metro.net/riding_metro/commute_services/rideshare_basics
	Hybrid Vehicles	www.sonoma-county.org/
	Use Smaller Fleet Vehicles	www.greenfleets.org/Denver.html
	Electric Vehicles for Parking Enforcement	www.bizjournals.com/eastbay/stories/2007/04/09/story6.html
	Reduce Municipal Fleet Milage	www.phillycarshare.org
	Limit Idling of Light Duty Vehicles	www.epa.gov/smartway/documents/420b06004.pdf
	Bicycling Paths and Facilities	www.bicyclinginfo.org/case_studies/
WaterSystem	Water System Efficiency	www.nyserda.org/programs/Technical_Assistance/Success/RCSe
Waste	Establish/Expand Recycling Programs	www.epa.gov/osw/conserve/tools/localgov/index.htm
Landscape	Forest Sequestration	BC Sustainability Network Report of the Protection of Natural Res
	Low-Maintenance Landscaping	www.cleanaircounts.org/Resource%20Package/A%20Book/lands
	Plant Trees to Shade Buildings	www.chattanooga.gov/Public_Works/70_TakeRootChattanooga.h
	Irrigation Control Sensors	www.cleanaircounts.org/Resource Package/A Book/landscaping/

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