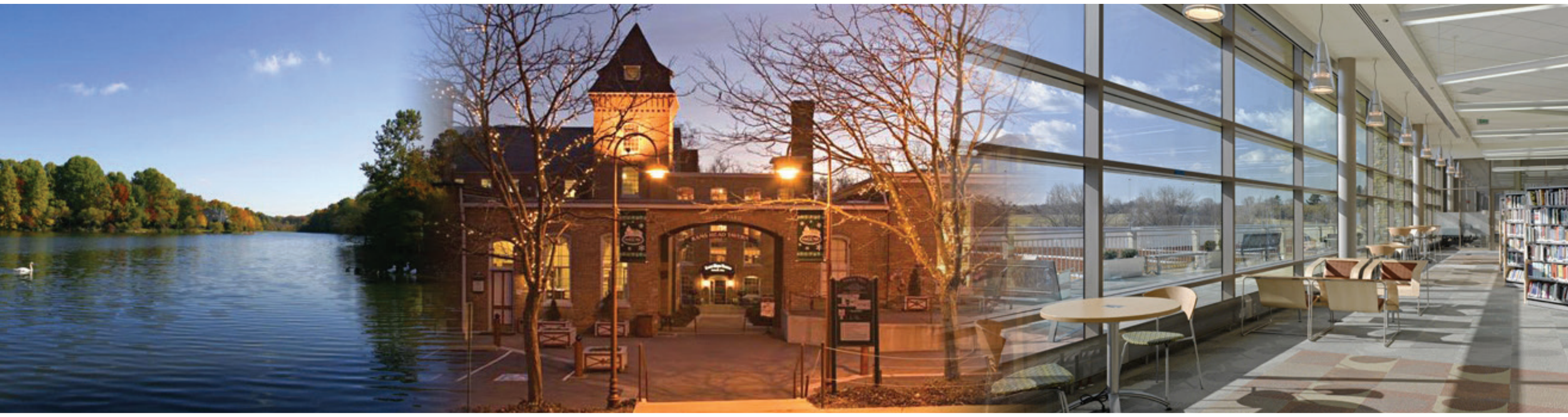
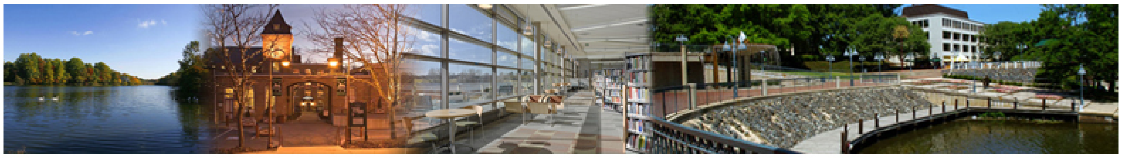


Howard County, Maryland 2015 Climate Action Plan

September 2015



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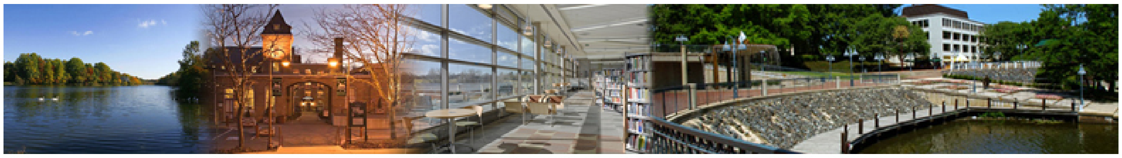

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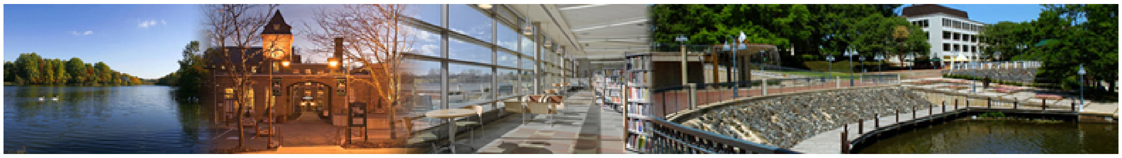
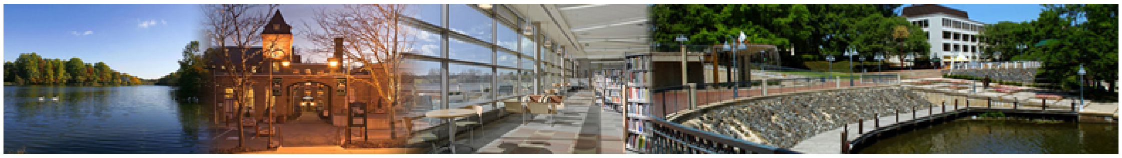


Acronyms and Abbreviations

BOD_5	5-day biological oxygen demand
Btu	British thermal units
CFC	chlorofluorocarbon
CH_4	methane
CO_2	carbon dioxide
CO_2-e	carbon dioxide equivalents
CY	calendar year
eGRID	Emissions and Generation Resource Integrated Database
EPC	Energy Performance Contract
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
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_2O	nitrous oxide
OX	oxidation factor
PFC	perfluorocarbon
scf	standard cubic feet
SF_6	sulfur hexafluoride
TCR	The Climate Registry
USEPA	United States Environmental Protection Agency
VMT	vehicle miles traveled
wk	week
yr	year



SECTION 1

Introduction

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[1]. As a result, federal, regional, and state governments have taken a stance on climate change and are requiring the reporting of greenhouse gas (GHG) emissions by industrial companies and some 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_2), nitrous oxide (N_2O), methane (CH_4), hydrofluorocarbons (HFCs), sulfur hexafluoride (SF_6), 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_2 cause radiation to remain in the earth's atmosphere trapping heat and consequently heating the earth's surface. We understand that there are both anthropogenic changes, those 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) causing the increase in GHGs in the atmosphere[2.] 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; decrease 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 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.[3]

In February 2007, the United Nations Intergovernmental Panel on climate change (IPCC) concluded that if annual GHG emissions remain at today's levels, CO2 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.

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1 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.

2 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.

3 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.

1.2 GHG Legislation, Regulation and Initiatives

1.2.1 Federal

Climate change and climate science have been at the forefront of legislators' agendas for the last decade. As summarized by the Center for Climate and Energy Solutions (formerly 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 more than 235 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. It was not until the 111^{th} Congress (2009-2010) that federal bills would be enacted, the "American Clean Energy and Security (ACES) Act" (H.R. 2454) and the "Clean Energy Jobs and American Power Act" (S.1733). Approximately 263 bills were introduced during the 111^{th} Congress. During the 112^{th} Congress (2011-2012), only 113 climate-specific bills were introduced with nearly as many proposals to block efforts to curb carbon emissions as proposals to strengthen them. As a result, none of the bills proposed were enacted. Nearly 230 bills focusing specifically on climate change were introduced in the 113th Congress (2013-2014). These bills focused on energy, environment, transportation, agriculture and other areas that could have an impact on or be affected by climate change.

Due to a lack of federal comprehensive legislation at the time, in September 2009, the U.S. Environmental Protection Agency (USEPA) finalized the Mandatory GHG Reporting Rule, Code of Federal Regulation 40 Part 98, which requires suppliers of fossil fuels or industrial greenhouse gases, manufacturers of vehicles and engines, and facilities that emit 25,000 metric tons (tonnes) or more of carbon dioxide equivalent (CO_2-e) per year from stationary combustion sources (such as boilers, incinerators, or non-emergency electricity generation equipment) and specified industrial processes to report these emissions annually starting in 2011. 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 also required to report. Currently, the Howard County Alpha Ridge and New Cut landfills report methane (CH_4) and CO_2-e emissions to the USEPA. However, general stationary fuel combustion source emissions are lower than the reporting threshold and not required to be reported.

In recent years, the USEPA has promulgated additional regulations to control emissions of CO_2, which was found to endanger human health and the environment, as well as other GHGs by treating them as pollutants under the Clean Air Act Amendments. Specific regulations include:

1. Greenhouse Gas Tailoring Rule (under Clean Air Act permitting processes) [2010]
2. New Motor Vehicle and Engines GHG Emissions and Fuel Efficiency Standards (2012, 2015)
3. Renewable Fuel Standard (2012)
4. Carbon Pollution Standards for Power Plants (2013, 2014)
5. Landfill Air Pollution Standards (2014)

1.2.2 State

The State formed the Maryland Commission on Climate Change in April 2007 under the direction of Governor Martin O'Malley. The Commission introduced the first draft (interim report) 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 in the areas of energy supply, transportation, agriculture, forestry, and waste were proposed to mitigate GHG 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, which are discussed in detail in Section 1.3, are aligned to support the State goals and targets.

In May 2009, Governor O'Malley signed into law the Greenhouse Gas Emissions Reduction Act of 2009, which contained a GHG emission reduction target for the State of Maryland. The legislation set the reduction target at 25 percent below a 2006 baseline by 2020. In subsequent years, 2009 and 2010, the Commission in collaboration with the Maryland Department of the Environment (MDE) continued to update the Climate Action Plan and submitted a plan for achieving the target. As a whole, emission reduction measures presented for inclusion in the Plan must provide a net economic benefit to the state and a net increase in jobs. The State seeks to reduce emissions by ten percent every five years through 2050, for a total reduction of 80 percent below 2006 levels.

The State of Maryland also has a renewable portfolio standard (RPS) for electric utilities. The RPS requires that 20 percent of the State's electricity supply come from renewable sources by 2022. In addition, two percent of electricity must come from solar power. Sources of energy that count toward the standard include wind, qualifying biomass, CH_4 from the anaerobic decomposition of organic materials in a landfill or wastewater treatment plant, geothermal, the ocean (including energy from waves, tides, currents, and thermal differences), a fuel cell that produces electricity from qualifying biomass or CH_4, and small hydroelectric power plants. Electric utilities not meeting the standard have the option of purchasing renewable energy certificates (RECs) from entities producing renewable energy from the above sources.

1.2.3 Local

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. The primary objective of 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. As of June 2014, more than 1,000 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 and state governments to enact policies and programs in support of meeting or beating a national goal of reducing GHG seven percent below 1990 levels by 2012 and by 80 percent from 1990 levels by 2050.

In 2006, the Howard County Executive, Ken Ulman, became one of the many mayors/county executives that signed on to be part of the U.S. Mayors Climate Protection Agreement. During that year, the County 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. As a member of ICLEI, Howard County generated its first comprehensive GHG emissions inventory using the program's guidance and reported emissions from its operations in 2007.

1.3 GHG Reduction and Energy Efficiency Goals for Howard County

Howard County, Maryland, has long been recognized as a community rich in natural resources and a leader in climate action in an effort to maintain the green qualities it embodies. As a result, the Howard County Commission on Sustainability and the Environment ("Commission") was formed in 2007 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.

In August 2007, the Commission released a report that included a section from the Energy Committee with key GHG emission reduction goals and targets. These goals and targets were aligned with those of the U.S. Mayors Climate Protection Agreement and the State of Maryland and were as follows:

- Reduce GHG emissions to **7 percent** below 2007 levels by 2012;
- Establish a long-range strategy to reduce GHG emissions by 80 percent of 2007 levels by 2050;

The emission reductions would be achieved through targeting several key areas: ***energy use in buildings***, ***transportation***, and ***renewable energy development***, but would also need to support the three key factors of the County's triple bottom line – help protect and restore our environment, improve the quality of life for the people who live and work in our County, and save the County money. Specific measures recommended for implementation in the target 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 with 50 percent of the renewable energy sources generated in Maryland.
- 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.

Transportation Systems

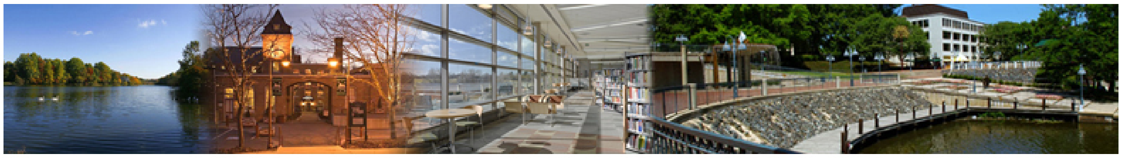
- County government will reduce non-renewable transportation fuel use by 10 percent of 2007 levels by 2010, 25 percent by 2015 and 50 percent by 2020.
- Residential/Commercial/Industrial sectors will reduce non-renewable transportation fuel use 10 percent of 2007 levels by 2010, 20 percent by 2015 and 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 fuel stations.

Renewable Energy Development

- 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 sources by 2020.
- Stimulate economic development and new job creation through investments in alternative fuel resources (e.g. cellulosic ethanol, biodiesel, etc.).

In the spring of 2009, the Energy Task Force released the Sustainability Energy Strategy for Howard County which included recommendations on how to meet these goals. These recommendations covered a variety of programs including outreach, tax incentives, pilot projects, financing, etc.

During calendar years 2008 and 2009, the County developed its 2007 baseline GHG inventory to assess emissions for government operations as well as the community. In June 2010, Howard County published its first Climate Action Plan as a first step in establishing a long-range strategy to reduce GHG emissions through 2050. In addition to detailing the sources and magnitude of GHG emissions for all County departments and operations, the Plan outlined measures for reducing emissions and achieving the Commission and Energy Committee emission reduction goals over a five-year period. This Climate Action Plan serves to document the progress the County has made over the past five years toward the goals as well as detail measures currently being implemented and planned for further GHG reductions over the next 5 to 10 years.



SECTION 2

Greenhouse Gas Emissions Profile

2.1 Greenhouse Gas Emission Sources and Categories

In April 2008, the County developed its 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 the following County government operations were assessed.

- 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)

All six of the Kyoto GHGs – carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoroide (SF_6) - were evaluated for inclusion. However, there were no sources of SF_6 within governmental operations.

Total emissions for the GHG inventory were expressed as carbon dioxide equivalents (CO_2-e). Carbon dioxide equivalents represent the universal unit for comparing emissions of the various GHGs to one unit of CO_2 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_2. To obtain CO_2-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 summarized in **Table 2-1**.

TABLE 2-1
Greenhouse Gas Global Warming Potentials
Howard County Climate Action Plan

Greenhouse Gas (GHG)	CO_2	CH_4	N_2O	HFC	PFC	SF_6
Global Warming Potential (GWP)[1]	1	21	310	1300[2]	varies	2600

(1) Based upon the Second Assessment Report (SAR) of the IPCC
(2) Represents the GWP of R-134a, the most commonly used HFC in Howard County.

The County used the TCR/ICLEI *Local Governments GHG Protocol* to complete the 2007 baseline GHG inventory. The TCR/ICLEI *Local Governments GHG Protocol* was developed as a collaborative effort between The Climate Registry and ICLEI-Local Governments for Sustainability to give local governments a comprehensive guidance document for completing their inventories outside of the traditional manufacturing/industrial sector. The IPCC *Guidelines* are internationally recognized for developing national GHG inventories. The U.S. GHG inventory is completed based upon these guidelines. The 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 TCR/ICLEI *Local Governments GHG Protocol*. These scopes are summarized in the sections that follow.

2.1.1 Scope 1 – Direct Emissions

Direct emissions result from sources, processes, or facilities owned and/or controlled by the County. 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 directly controlled by the County. The major source of Scope 3 emissions are contracted services.

2.2 Greenhouse Gas Emissions Profile Comparison for Calendar Years 2007 and 2012

For calendar year 2012, the County developed its annual GHG emissions inventories for all County government operations. As with the inventory completed in April 2008, the inventory quantified GHG emissions that resulted from stationary and mobile fuel use, wastewater treatment and landfill operations, energy use, and other contracted services. The main purpose of developing the 2012 inventory was to compare total emissions between the two years to determine if the short-term emission reduction goals had been met.

For the baseline year of 2007, Howard County government operations emitted a total of ***324,546*** metric tons (tonne) CO_2e emissions. In 2012, overall GHG emissions decreased to ***285,635*** metric tons CO_2e due to reductions in stationary fuel use, wastewater treatment process upgrades, refrigerant phase out, and energy efficiency measures. As such, total emissions decreased **12 percent** over the 5-year period – exceeding the County goal of **7 percent**. A graphical representation of the annual GHG emission totals for 2007 and 2012 by scope is presented in **Figure 2-1**. A summary of emissions totals by scope are presented in **Table 2-2**.

FIGURE 2-1
Comparison of Howard County 2007 and 2012 Total GHG Emissions

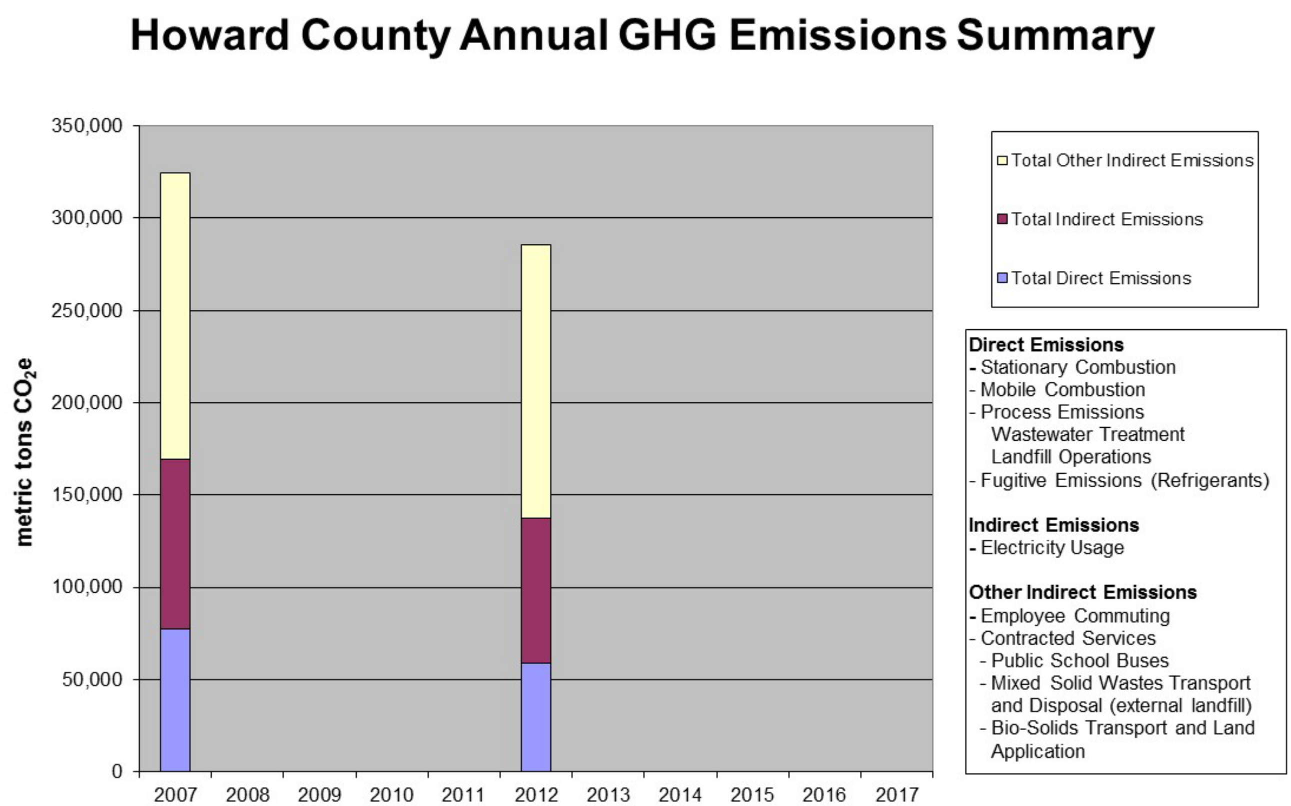


TABLE 2-2
Summary of Total GHG Emissions by Scope Category and Year
Howard County Climate Action Plan

Source	2007	2012
Direct Emissions – Scope 1 (tonnes CO_2e)	77,645	59,200
Indirect Emissions – Scope 2 (tonnes CO_2e)	91,597	78,464
Optional Emissions – Scope 3 (tonnes CO_2e)	155,304	147,971
Total GHG Emissions (tonnes CO_2e)	**324,546**	**285,635**
Increase/Decrease from the Baseline Year (2007)	---	-12%

Annual comparisons of each emissions category are detailed in the sections that follow.

2.2.1 Direct Emissions - Stationary Combustion Sources

Stationary source emissions result from combustion of fossil fuels in equipment such as boilers, heaters, generators, pumps, and flares in a fixed location. Howard County operates boilers and heaters within the Howard County Public School System, the Howard Community College, County administration buildings, and other County operations. The majority of the boilers and heaters use natural gas as a fuel source while some use fuel oil and propane. Diesel and fuel oil are used in emergency generators as well as in back-up pumps.

Although, both fuel oil use and propane use were up, there has been an overall 10 percent reduction in GHG emissions from stationary combustion sources between the baseline year of CY2007 and CY2012 as a result of a 17 percent decrease in diesel fuel use in generators and a 13 percent reduction in natural gas use in County Government and Howard County Public School System buildings. **Table 2-3** summarizes the annual use of each fuel by type and the associated GHG emissions.

TABLE 2-3
Stationary Source Fuel Usage and GHG Emissions by Year
Howard County Climate Action Plan

Fuel Type	2007	2012
Howard County Public School System	2,654,290	2,172,326
Howard Community College	430,780	487,100
Howard County Bureau of Facilities	292,722	293,889
Total Natural Gas Usage (therms):	**3,377,792**	**2,953,315**
Howard County Public School System	1,032	900
Howard County Bureau of Facilities	4,849	2,725
Howard County Bureau of Utilities	8,666	9,386
Total Diesel Usage (gallons):	**14,547**	**13,011**
Howard County Public School System	39,824	46,400
Howard Community College	30,613	40,691
Howard County Bureau of Facilities	93,397	83,310
Total Fuel Oil Usage (gal):	**163,834**	**170,401**
Howard County Public School System	2,968	4,721
Howard County Bureau of Facilities	7,729	47,587
Total Propane Usage (gal):	**10,697**	**52,308**
Total Stationary Source Emissions (tonnes CO_2e)	**20,399**	**18,374**
Increase/Decrease from the Baseline Year (2007)	--	-10%

2.2.2 Direct Emissions - Mobile Combustion Sources

Mobile source emissions result from the combustion of fossil fuels in on- and off-road vehicles. For Howard County, these sources include owned and/or leased fleet passenger cars and trucks, utility vehicles, heavy equipment, and other material handling equipment.

Although the Howard County Public School System fleet decreased its gasoline usage by 8 percent in 2012 compared to 2007, overall County mobile source emissions were significantly higher than the baseline year due to an increase in the number of fleet vehicles within the County Government and at the Howard Community College. Total diesel usage increased by 38 percent and gasoline use increased by 25 percent in 2012. Overall, mobile source emissions increased 29 percent compared to 2007. A summary of annual fuel usage by entity and type with related GHG emissions are listed in **Table 2-4**.

TABLE 2-4
Mobile Source Fuel Usage and GHG Emissions by Year
Howard County Climate Action Plan

Entity	2007	2012
Howard County Public School System	-----	58,810
Howard Community College	-----	1,160
Howard Department of Central Administration Fleet	423,609	523,305
Total Diesel Usage (gallons):	**423,609**	**583,275**
Howard County Public School System	183,648	110,097
Howard Community College	5,185	8,086
Howard Department of Central Administration Fleet	729,522	1,025,837
Total Gasoline Usage (gallons):	**918,355**	**1,144,020**
Total Mobile Source Emissions (tonnes CO_2e)	**12,502**	**16,055**
Increase/Decrease from the Baseline Year (2007)	--	28%

2.2.3 Direct Emissions - Wastewater Treatment Process Emissions

Process emissions result from physical or chemical processes at the Little Patuxent Water Reclamation Plant (LPWRP) and five (5) package plants located at schools throughout Howard County. The LPWRP emits GHGs generated from the organic matter and nutrients being processed through the plant. The CO_2 emissions resulting from the decomposition of organic matter in the wastewater treatment process are considered biogenic emissions. Biogenic emissions of CO_2 are those releases of CO_2 that are non-manmade/produced and are not included in the inventory and process emissions totals. Nitrous oxide (N_2O) is released from primary treatment operations in the aeration basins, in the nutrient removal process, and upon discharge of plant effluent to a surface water body. In addition, there are also emissions of CO_2 that result from the chemical reaction caused by adding methanol to enhance the nitrogen-removal process. These CO_2 emissions are not biogenic and are included in the inventory total. The sum of these emissions make up the process emissions category of the GHG emissions inventory and are expressed in CO_2-e.

While the total annual average flow treated at the LPWRP was approximately the same in 2007 compared to 2012, the flow from the package plants increased slightly due to the addition of a new treatment system. Process-related emissions of N_2O have decreased 7 percent, as a result of the completion of Enhanced Nitrogen Removal (ENR) upgrades at the facility. The ENR upgrades reduce the amount of nitrogen in the plant effluent and thus, the N_2O emissions associated with the discharge to surface water. However, because of the addition of methanol to the ENR process, CO_2 emissions are now produced as part of the process. As a result, total process emissions have increased by 40 percent in 2012 compared to 2007. **Table 2-5** summarizes the annual process parameters for the wastewater treatment operations and the overall process-related GHG emissions for each calendar year.

TABLE 2-5
Annual Average Wastewater Treatment Parameters and GHG Emissions by Year
Howard County Climate Action Plan

Parameter	2007	2012
Annual Population Served	275,000	301,000
Total Treated Flow (million gallons/yr)	6,847	6,908
Average Influent BOD_5 Conc. for LPWRP (mg/L)	179	179

TABLE 2-5
Annual Average Wastewater Treatment Parameters and GHG Emissions by Year
Howard County Climate Action Plan

Parameter	2007	2012
Average Effluent Total Nitrogen Conc. for LPWRP (mg/L)	4.6	2.6
Average Influent BOD_5 Conc. for Package Plants (mg/L)	11	34
Average Effluent Total Nitrogen Conc. for Package Plants (mg/L)	7	5
Total CO_2 Process Emissions (tonnes CO_2e)	0	428
Total N_2O Process Emissions (tonnes CO_2e)	918	855
Total Wastewater Process Emissions (tonnes CO_2e)	**918**	**1,284**
Increase/Decrease from the Baseline Year (2007)	--	40%

2.2.4 Direct Emissions - Landfill Emissions

While the Howard County New Cut Landfill is closed to receiving municipal solid wastes (MSW), the Alpha Ridge Landfill still buries a minimal amount of waste. The landfills are still actively producing landfill gas (LFG) that is recovered at both sites. GHG process emissions at the County landfills result from the degrading of wastes in the landfills. Fugitive emissions of methane are released from the landfill cap/cover. Treated emissions are released from the combustion of LFG in a flare and its use in a turbine that produces electricity.

In 2012, less LFG was recovered and combusted than in 2007 due to the diminishing supply of gas being generated by the decomposing organics within the landfill. A new turbine was also installed at the Alpha Ridge landfill in the third quarter of 2012. The turbine uses LFG as a fuel source to produce electricity. The electricity is transmitted to the grid within Howard County for distribution. The turbine's combustion efficiency is the same as the flare previously used to combust the LFG recovered in 2007. An overall reduction in GHG emissions of 31 percent was achieved in 2012 compared to 2007. **Table 2-6** summarizes the total annual landfill gas recovered and combusted at the Howard County landfills.

TABLE 2-6
Landfill Gas Recovered and Combusted and GHG Emissions by Year
Howard County Climate Action Plan

Landfill	2007	2012
Alpha Ridge Landfill	537	350
New Cut Landfill	154	103
Total LFG Emitted, Recovered and Flared/Combusted (scfm)	691	453
Total Landfill Emissions (tonnes CO_2e)	**33,755**	**23,362**
Increase/Decrease from the Baseline Year (2007)	---	-31%

2.2.5 Direct Emissions - Fugitive Emissions

Fugitive emissions result from unintentional leaks or releases from processes, storage devices, systems, etc. For Howard County, fugitive emissions result from the use of hydrofluorocarbons (HFCs) in HVAC and vehicle cooling systems. Non-reportable hydrochlorofluorocarbon (HCFCs) and chlorofluorocarbons (CFCs) emissions were also quantified for informational purposes due to their use in these systems. Because HCFCs and CFCs are reported under the Montreal Protocol for the reduction and elimination of ozone depleting substances (ODS), they are not included in the GHG inventory.

Fugitive emissions were significantly lower in 2012 compared to 2007 due to the complete phase out of an HFC, R-134a, in the Howard County Public School System cooling units – a reduction of approximately 17,000 pounds of refrigerant. Refrigerants used to recharge fleet vehicle cooling systems were reduced by nearly 50 percent in 2012 compared to 2007. Overall, refrigerant-related emissions have been nearly eliminated (reduced by 99 percent). **Table 2-7** summarizes the total refrigerant charged to cooling equipment and vehicle cooling systems by year and entity with the associated GHG emissions.

TABLE 2-7
Refrigerant (R-134a) Usage and GHG Emissions by Calendar Year
Howard County Climate Action Plan

Entity	2007	2012
Howard County Public School	16,678	0
Howard County Fleet	336	171
Howard County Bureau of Facilities	0	60
Total Refrigerant Charged to Equipment (lbs)	17,014	231
Total Fugitive Emissions (tonnes CO_2e)	**10,071**	**125**
Increase/Decrease from the Baseline Year (2007)	---	-99%

2.2.6 Indirect Emissions – Electricity Use

For the Howard County inventory, only indirect emissions from purchased electricity are included. Total entity-wide electricity use for 2012 was greatly reduced compared to 2012 due to the implementation of energy efficiency measures within the Howard County Public School System and County Government buildings under the Energy Performance Contract (EPC) Phase I project. While some entities' electricity usage increased due to organic growth (e.g. construction of new buildings, process upgrades, etc.), overall indirect emissions were reduced by 14 percent compared to the base year. For the 2012 inventory, the new eGrid emission factors (released in 2014) for sub-region RFC East were used to determine emissions. These factors reflect the generation of more renewable energy in the sub-region; hence, further decreasing indirect emissions. A summary of annual electricity usage for each entity and the associated GHG emissions are shown in **Table 2-8**.

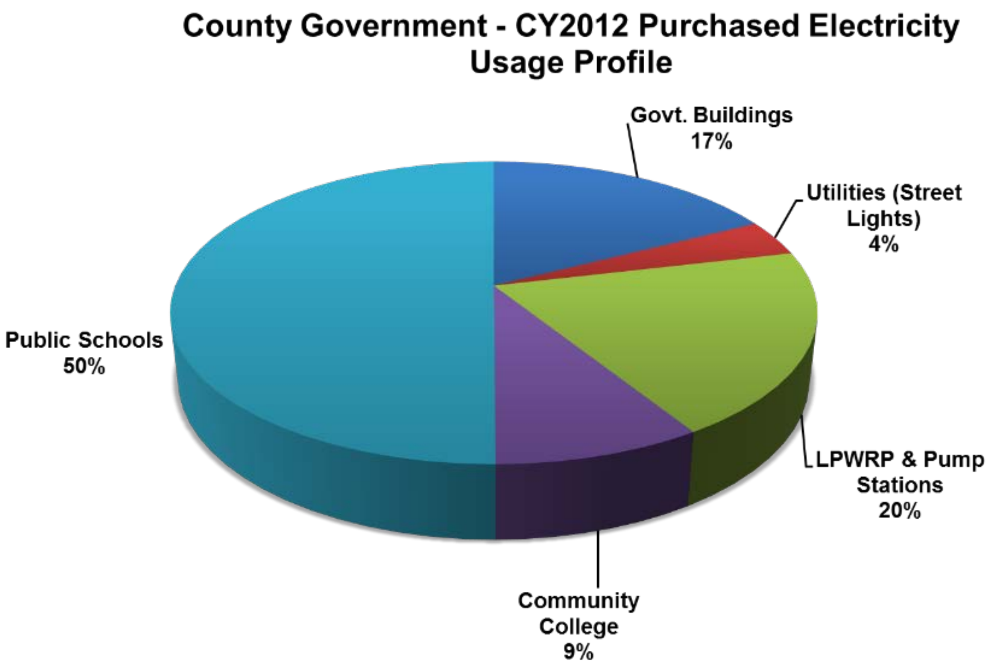
TABLE 2-8
Purchased Electricity Use and GHG Emissions by Government Entity and Calendar Year
Howard County Climate Action Plan

Entity	2007	2012
Howard County Public Schools	96,305	86,020
Bureau of Utilities (Wastewater Treatment and Water Distribution)	30,870	33,970
Bureau of Facilities (Government Buildings)	34,992	29,925
Howard Community College	14,434	15,190
Bureau of Highways (Street Lights and Traffic Signals)	6,583	6,669
Total Annual Electricity Use (MWh)	183,184	171,773

Entity	2007	2012
Total Indirect Emissions (tonnes CO_2e)	**91,597**	**78,464**
Increase/Decrease from the Baseline Year (2007)	---	-14%

As in the 2007 inventory, the Howard County Public School System used the most electricity at 50 percent while the LPWRP and County Government buildings rank second and third with allocations of 20 and 17 percent, respectively. **Figure 2-2** shows the allocations of electricity by County entity.

FIGURE 2-2
Howard County 2012 Electricity Usage Allocation



2.2.7 Other Indirect Emissions (Scope 3)

For Howard County, sources of Scope 3 emissions are mobile source emissions from employee commuting, and contracted services (e.g. mixed solid wastes transport and disposal, treatment plant solids transport, and pupil transport). Process and fugitive emissions from MSW disposed in external landfills outside of the County and the land application of biosolids on agricultural lands within the County are also included as other indirect emissions.

2.2.7.1 Employee Commuting

Emissions resulting from employee commuting to and from work in Howard County increased by 6 percent in 2012 compared to 2007 as the number of County Government and Howard County Public School System employees increased nearly 12 percent between the two years. **Table 2-9** lists the total number of employees, the miles traveled by employees in personal vehicles, and the associated GHG emissions.

TABLE 2-9
Employee Travel Mileage and GHG Emissions by Calendar Year
Howard County Climate Action Plan

Parameters	2007	2012
Total Number of County Government Employees	3100	3900
Total Number of Howard County Public School Employees	7677	8084

Parameters	2007	2012
Total Miles Traveled (million miles)	72.4	76.5
Total Employee Commuting Emissions (tonnes CO2e)	**31,999**	**33,794**
Increase/Decrease from the Baseline Year (2007)	---	6%

2.2.7.2 Contracted Services – Pupil Transport on School Buses

Mobile emissions associated with contracted services include the use of contracted school buses for transporting students to and from schools within the Howard County Public School System. In 2012, the number of miles traveled by contracted school buses and the associated diesel fuel use emissions increased due to a 5 percent increase in the number of students enrolled in the County compared to 2007.

2.2.7.3 Contracted Services – Biosolids Transport

The total miles traveled by contractors to transport biosolids generated at the LPWRP increased by 45,000 miles in 2012 compared to 2007. This increase in trips is attributed to the increase in the amount of biosolids requiring transport off-site due to the ENR process upgrades.

2.2.7.4 Contracted Services – Municipal Solid Waste Transport

Howard County facilities and residents generate MSW which is collected and disposed at a landfill outside of the County. The wastes are collected at curbside and transported for disposal to a landfill in Virginia. In 2012, the amount of MSW disposed was less than the amount disposed in 2007. However, the miles traveled remained the same as the number of trips to collect and dispose of the waste are independent of the amount of waste collected.

Table 2-10 details the total miles traveled for the transportation of students to Howard County Public Schools, biosolids for land application, and MSW to external landfills and the corresponding GHG emissions. Overall emissions for this source category increased by 3 percent in 2012 compared to 2007.

TABLE 2-10
Contracted Services Transport Annual Mileage, Fuel Use, and GHG Emissions by Year
Howard County Climate Action Plan

Category	2007	2012
HCPSS Contracted School Buses (gallons of diesel)	654,463	675,840
Biosolids Transport (miles traveled)	140,000	185,000
Mixed Solid Waste Transport (miles traveled)	1,520,104	1,520,104
Total Optional Mobile Source Emissions (tonnes CO_2e)	**10,733**	**11,074**
Increase/Decrease from the Baseline Year (2007)	---	**3%**

2.2.7.5 Contracted Services – Biosolids Management

When the biosolids resulting from the wastewater treatment process are land-applied on agricultural lands, GHG emissions of N_2O are released into the environment. Carbon dioxide, CO_2, is also sequestered in the soil as a result of the land application of bio-solids. This CO_2 is considered biogenic and is not included in the overall inventory. In 2012, the amount of biosolids produced increased due to the ENR process upgrades. As a result, the amount of biosolids being land-applied and the associated GHG emissions increased by 11 percent compared to 2007.

2.2.7.6 Contracted Services – Municipal Solid Waste Disposal

Howard County facilities and the County-at-large generate MSW which is collected and disposed at a landfill outside of the County. Landfill disposal of MSW results in GHG emissions due to methane gas released at the landfill. The process-related emissions resulting from the disposal of this waste are included as other indirect emissions within the inventory as they occur outside of the Howard County physical and organizational boundary. In 2012, the amount of MSW disposed was approximately 10 percent less than the amount disposed in 2007 as recycling programs were fully implemented.

Overall emissions in this category were reduced by 8 percent compared to 2007. **Table 2-11** details the total amount of bio-solids land applied, MSW disposed, and the associated GHG emissions.

TABLE 2-11
Contracted Services Process and Fugitive GHG Emissions by Year
Howard County Climate Action Plan

Emissions Category	2007	2012
Biosolids Land-Applied (tons - wet basis)	32,144	35,645
Mixed Solid Waste Landfilled (tons)	115,729	105,407
Total Optional Process and Fugitive Emissions (tonnes CO_2e)	**112,572**	**103,216**
Increase/Decrease from the Baseline Year (2007)	---	**-8%**

2.3 Summary of Year-over-Year Emissions

As shown in **Figures 2-3** and **2-4**, the total emissions profile for Howard County has not varied significantly between 2007 and 2012. Emissions related to Contracted Services continue to make up the majority of the inventory at 40 percent in 2012 compared with 38 percent in 2007. Emissions related to electricity usage and employee commuting rank second and third with 28 percent and 12 percent of the total in 2012 compared to 28 percent and 10 percent in 2007, respectively. County landfill and fugitive refrigerant emissions were significantly lower in 2012 with emissions decreasing their overall percentages from 11 percent and 3 percent in 2007, to 8 percent and less than 1 percent in 2012.

FIGURE 2-3
Howard County 2007 Total GHG Emissions Profile

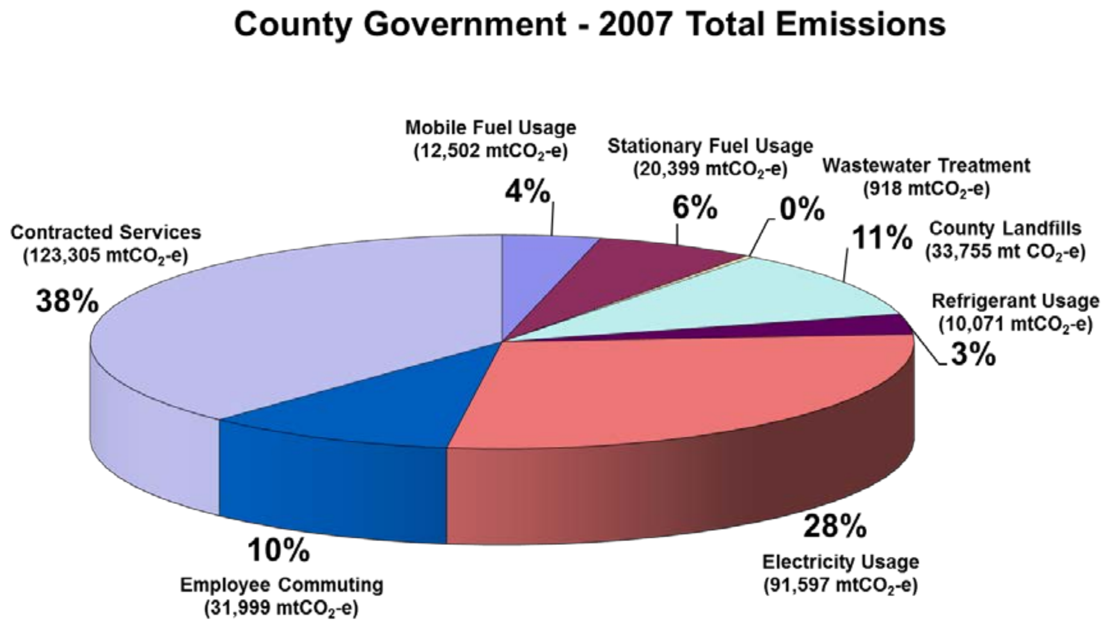
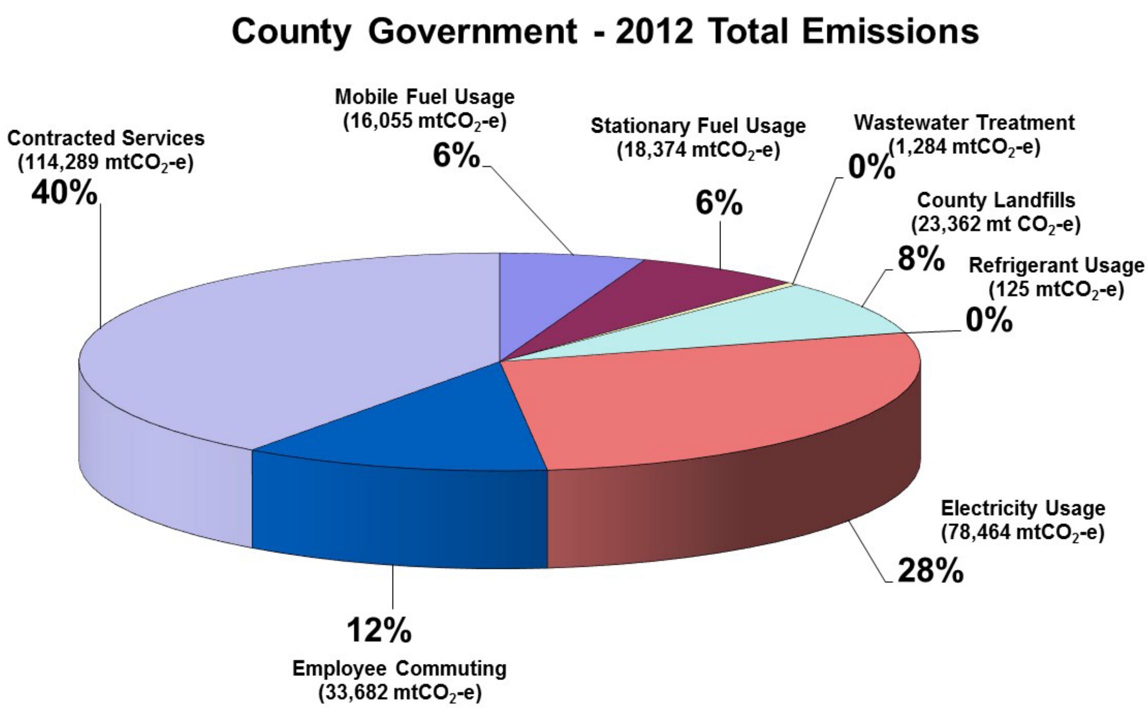
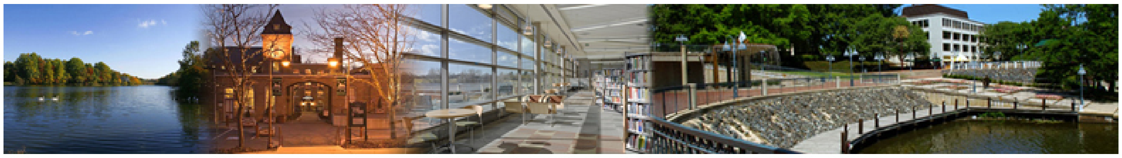


FIGURE 2-4
Howard County 2012 Total GHG Emissions Profile





SECTION 3

GHG Emission Reductions Progress

3.1 Emission Reduction Projects Implemented from 2007 to 2012

Since the release of the first Climate Action Plan in 2010, the County has made major strides in completing the actions presented in the plan in order to meet its U.S. Mayor's Climate Protection Agreement goal of reducing the County's carbon footprint 7 percent below 2007 levels by 2012 and an overall mission of becoming a more sustainable county. To achieve the goal, the County implemented numerous projects that included the following:

- Installation of solar arrays on County and public school buildings
- Construction of LEED-certified buildings
- Implementation of geothermal heating in a public school building
- Replacement and retrofit of older equipment
- Completion of treatment process upgrades
- Switching of fuels and use of alternative fuels
- Completion of lighting upgrades and on-demand control installation
- Installation of light emitting diode (LED) traffic signals
- Completion of energy audits and facility assessments
- Completion of heating/cooling equipment and control upgrades
- Purchase of hybrid vehicles and buses for the County fleet
- Implementation of fleet vehicle take home policy
- Purchase and use of electric vehicles at college campus
- Implementation of County-wide recycling programs

As a result of implementing these measures, the County reduced its carbon footprint **12 percent** below 2007 levels by 2012. Specifically, significant reductions resulted from the following:

- Implementation of EPC Phase I project. Energy conservation measures (ECMs) were completed at seven Howard County Buildings - Detention Center, Scaggsville Public Safety Complex, East Columbia Library, Central Library, Recreation & Parks HDQTRS, Dorsey Building, and the Gateway Buildings. Specific measures undertaken at each site included: upgrading lighting and controls, upgrading heating and cooling systems and controls, equipment replacement and retrofits, vending machine optimization, weather-proofing, and building envelope upgrades. These energy efficiency improvements in Bureau of Facilities buildings and lighting upgrades at Howard County Public School System buildings led to a 13 percent reduction in natural gas usage and a 14 percent reduction in electricity usage.

- Effluent discharge related GHG emissions decreased 7 percent, as a result of the completion of ENR upgrades at the LPWRP.

- The combined effect of diminishing flows of landfill gas and increased collection efficiencies of the recovery systems at the Alpha Ridge and New Cut Landfills resulted in a 29 percent decrease in landfill process emissions.

- An upgrade of Howard County Public School System cooling systems lead to the complete removal of GHG-emitting refrigerants used to annually recharge older equipment. The use of more environmentally-friendly substitutes equated to a 99 percent reduction in fugitive GHG-related emissions.

- The diversion of nearly 10,300 tons of municipal solid waste (MSW) from external landfills through increased recycling efforts, contributed to a 10 percent reduction in emissions associated with disposal.

Another goal established by the Energy Committee of the Commission on the Environment and Sustainability was 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 with 50 percent of the renewable energy sources generated in Maryland***. To meet this goal, the County purchases approximately 10 percent green power as part of an energy cooperative agreement from generation sources within the State of Maryland. Since 2010, the County has purchased approximately 32,000,000 kilowatt hours (kWh) of green power annually as part of a five year agreement. **Table 3-1** summarizes the green power purchases and shows the County has exceeded the 2010 and 2015 renewable energy purchase targets of 5 and 10 percent, respectively.

TABLE 3-1
Summary of Green Power Purchases
Howard County Climate Action Plan

Entity	kWh
Howard County Government	59,935,436
Howard County Public Schools	83,338,944
Howard County Community College	16,604,420
Total Green Power to be Purchased:	**159,878,800**
Total Green Power to be Purchased Annually:	**31,975,760**
Percentage of 2007 Baseline Electricity Use*:	**17%**

*Total electricity usage for 2007 was 183,184,377 kWh.

3.2 Emission Reduction Projects Implemented 2012 – 2014

While the County has made significant progress in the five years since the baseline emissions inventory was completed, additional projects and measures must be identified and implemented year-after-year for continual reductions in fuel and energy use and to meet the goal of ***identifying and developing renewable energy projects within the County to offset 5 percent of County energy use with renewable energy sources by 2020***. To accomplish this goal and long-term GHG emission reduction targets, the County has completed projects that include green buildings, landfill gas to energy, solar power generation, composting, and EPC projects. A short description of the projects completed and/or being implemented are included below.

- Howard County Housing – The Commission has completed construction and renovations on several multi-unit complexes and housing developments – Burgess Mill Station, Monarch Mills, The Cottages at Greenwood, Morning Park Senior Housing, and Orchard Crossing Townhomes - that represent nearly 600 single-family homes and multi-family housing units. Each complex utilized sustainable solutions during construction and for end-use. Sustainable initiatives employed included the installation of Energy Star-rated appliances, windows, and light fixtures; installation of water efficient plumbing fixtures and appliances; development of green roofs, native vegetation landscaping, and bio-retention ponds; air-sealing of leak points; and the installation of high efficiency heating/cooling systems. These initiatives serve to reduce energy use in the units and County operations (e.g. wastewater treatment and collection).

- Little Patuxent Water Reclamation Plant Aeration Efficiency Project – This project installed more efficient blowers at the aeration basin which is estimated to reduce electricity usage 5 to 10 percent annually at the plant.

- Alpha Ridge Landfill - Landfill Gas-to-Energy Project – A 1 MW system which uses recovered landfill gas and a turbine to produce electricity was installed at the Alpha Ridge landfill. The system produces 7,000 – 8,000 MWh of electricity annually depending on the flow and methane content of the gas recovered. The electricity produced is equal to 4.4 percent of the total 2007 baseline electricity use of 183,184,377 kWh. The electricity is transmitted to the grid for use in the region.

- Landfill Gas Recovery System Improvements – Currently, landfill gas recovered at the Alpha Ridge Landfill (ARL) is being used to generate electricity that is sent to the grid. While the New Cut Landfill recovers only one third of the landfill gas as the ARL, collection efficiency improvements of each landfill's gas recovery system will reduce GHG emissions resulting from fugitive emissions from the landfill cap. The improvements serve to increase efficiency seven percent at Alpha Ridge (68% to 75%) and five percent at New Cut (65% to 70%).
- Howard County Pilot Composting Facility - A 0.75 acre site at Alpha Ridge Landfill was developed for the composting of yard trim and food scraps. The project was commissioned in March 2013 and offsets approximately 600 tons of food wastes from being shipped to external landfills, reduces fuel used for transport of MSW, and produces HoCoGro Compost which is available for purchase.
- Little Patuxent Water Reclamation Plant Solar Energy Project – In 3Q 2014, solar photovoltaic (PV) panels were installed on several rooftops and open areas at the LPWRP. The 217 KW system should produce approximately 273,000 kWh (273 MWh) of renewable energy annually to offset electricity use at the plant. The power produced by the PV panels represents nearly 1 percent of the total 2007 baseline electricity use of 183,184,377 kWh, and supports the renewable energy production target.
- Energy Efficiency Improvements – Howard County has identified for implementation several large scale energy efficiency projects. The continuation of over-arching envelope improvements (e.g. weather-proofing, equipment and lighting replacements, automated controls, air-sealing, etc.) within all County-owned and maintained buildings will continue to reduce energy use (e.g. electricity, natural gas, and other fossil-fuels) each year – 13 percent reduction in natural gas usage and a 14 percent reduction in electricity usage.

Table 3-2 summarizes the projects completed in Howard County to achieve additional emission reductions over the next five to ten years as well as their impact on the overall carbon footprint.

TABLE 3-2
Current Emission Reduction Projects 2012 - 2014
Howard County Climate Action Plan

Strategy Name	Description	Annual GHG Impact	Year of Implementation	Lifetime of Project[a]
Alpha Ridge Landfill LFG-to-Energy project	1 MW system producing 7,000 – 8,000 MWh of renewable energy annually	-5,700 tonnes CO_2-e	3Q 2012	10 years
Landfill Gas Collection System Improvements	Improves the collection of LFG at New Cut Landfill through increased system run hours; reduces fugitive emissions from the landfill cap	-1,100 tonnes CO_2-e	3Q 2012	10 years
Pilot Composting Facility	Diverts ~3,000 tons of waste from external landfills over 5 years	-2,800 tonnes CO_2-e	1Q 2013	5 years
LPWRP Aeration Efficiency	1,400 MWh reduction in electricity use	-640 tonnes CO_2-e	3Q 2013	10 years
LPWRP Solar PV System	217 kW system producing 273 MWh of renewable energy annually	-200 tonnes CO_2-e	3Q 2014	20 years
EPC Phase I	Continuation of energy efficiency measures to maintain reduction of 85,000 therms and 15,350 MWh annually	-470 tonnes CO_2-e -7,000 tonnes CO_2-e	1Q 2012	20 years

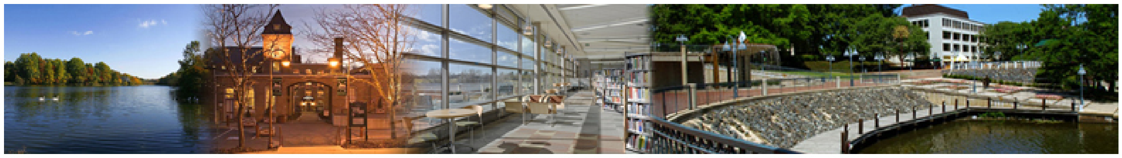
[a] Lifetime of project is an estimate

3.3 Summary of Progress

As detailed in Section 1.3, the Energy Committee of the Commission on the Environment and Sustainability established key GHG emission reduction goals and targets aligned with those of the U.S. Mayors Climate Protection Agreement and the State of Maryland Climate Action Plan. Through the implementation of an array of sustainability and energy strategies and actions, the County has achieved and/or exceeded their energy use and renewable energy targets through 2010 and in some instances 2015. Over the next three years, the County will strive to further reduce energy use, increase its renewable energy portfolio, and focus on achieving the 2015 transportation system goals and targets. **Table 3-3** summarizes the County's current status on the 2007 Energy Report strategies.

TABLE 3-3
Sustainability Goals Progress Report
Howard County Climate Action Plan

Measure	Goal	Status		
		Achieved	Not Achieved	In-progress
Overall				
Reduce overall GHG emissions	7% below 2007 levels by 2012	√		
Establish a long-range strategy to reduce GHG emissions by 80 percent of 2007 levels by 2050;				√
Energy Use in Buildings				
Reduce non-renewable energy use in buildings [compared to 2007 baseline]	10 percent by 2010	√		
	15 percent by 2015	√		
	20 percent by 2020			√
Purchase electricity from renewable energy sources (including Renewable Energy Credits) with 50 percent of the renewable energy sources generated in Maryland [compared to 2007 baseline]	5 percent by 2010	√		
	10 percent by 2015	√		
	20 percent by 2020			√
Reduce the use of non-renewable energy in Residential and Commercial Sectors [compared to 2007 baseline]	5 percent by 2010	√		
	10 percent by 2015			√
	15 percent by 2020.			√
Renewable Energy Development				
Identify and develop renewable energy projects (landfill gas/solar energy/wastewater treatment digester gas) within the County	Offset 5 percent of County energy use with renewable energy sources by 2020	√		
Stimulate economic development and new job creation through investments in alternative fuel resources (e.g. cellulosic ethanol, biodiesel, etc.)				√
Transportation Systems				
Reduce non-renewable transportation fuel use [compared to 2007 baseline]	10 percent by 2010		√	
	25 percent by 2015			√
	50 percent by 2020			√
Reduce non-renewable transportation fuel use in the Residential/Commercial/Industrial sectors [compared to 2007 baseline]	10 percent by 2010		√	
	20 percent by 2015			√
	40 percent by 2020			√
Increase the use of renewable transportation fuels [compared to 2007 baseline]	10 percent by 2010		√	
	25 percent by 2015			√
	50 percent by 2020			√
Establish an alternative fuels strategy and purchasing policy that includes consideration for siting alternative fuel stations.				√



SECTION 4

Long-Range Strategy for the Reduction of GHG Emissions

4.1 Future Projects and Additional Strategies for Achieving Long Term Emission Reductions (2015-2030)

Although Howard County has implemented several large scale projects for the achievement of energy efficiency, renewable energy production, and emission reduction goals, additional capital projects and strategies will be required to maintain and achieve long-term reductions.

4.1.1 Future Projects

Howard County has evaluated two major capital projects for implementation in the short term. These projects were included in the long-range goal evaluation as they have not been implemented. Brief descriptions of the projects are included in the sections that follow.

4.1.1.1 EPC Phase II

The County has identified 70 additional buildings in which ECMs will be completed. As with Phase I, the buildings will have the following measures implemented: upgrades to lighting and controls, electrical system improvements, upgrading to heating/cooling systems and controls, equipment replacement and retrofits, vending machine optimization, water conservation measures, weather-proofing, and building envelope upgrades. It is estimated the implementation of the ECMs will result in a 34 percent reduction in energy costs and usage.

4.1.1.2 Solids Treatment Process Improvements

The County will be implementing improvements to the solids treatment process at the LPWRP in the near future (expected by 2018). Solids process improvements include new anaerobic digestion facilities to stabilize the primary and waste activated solids and a new drying facility to produce Class A biosolids. Biogas produced by the anaerobic digestion system will be beneficially used to meet a portion of the annual anaerobic digestion and biosolids drying heat demand offsetting the use of natural gas in the process dryers. The additional processing of biosolids will reduce the amount hauled off-site and land-applied. An increase in electricity and natural usage is expected to operate the new process equipment.

4.1.1.3 Landfill Gas Capture Improvements

The County is designing an incremental expansion to its landfill gas collection system. The system will increase the percentage of the active landfill cell that is controlled by a methane extraction system, reducing further the fugitive methane emissions that are released at the Alpha Ridge Landfill.

4.1.2 Additional Strategies

For long-term goal evaluation purposes, additional strategies have been identified in the areas of stationary and mobile fuel usage reductions, energy efficiency, and operational improvements. These strategies were developed and evaluated to determine the potential emission reductions that could be achieved if they were implemented.

4.1.2.1 Fossil-Fuel Switching

While natural gas usage has been reduced significantly within County buildings and Howard County Public School System buildings, some high emission fossil-fuels such as diesel and fuel oil are still used within operations. The switching of these fuels with lower emission and/or bio-fuels such as natural gas, propane, or bio-diesel could further reduce emissions. This strategy serves to switch the two fuel oil boilers within the HCPSS and several boilers within the Bureau of Facilities to natural gas.

4.1.2.2 Fleet Optimization

As the largest consumers of gasoline and diesel fuel, the County government fleet vehicles and Howard County Public School System contracted school buses present an area for potential fuel usage and emission reductions. Emission reduction options for fleet vehicles and contracted school buses could include the use of bio- and alternative fuels; optimization of vehicle routes, areas of operation, and use (i.e. aligning vehicles with service requirements, trip planning, etc.); and reductions in fleet vehicle usage for non-business related activities. The purpose of this strategy is to identify, evaluate, and implement options for reducing vehicle fuel usage.

4.1.2.3 2 MW Solar PV

With the success of the solar PV project implemented at the LPWRP, this strategy consists of siting and constructing an additional 2 MW solar PV project within the County. This strategy would further reduce GHG emissions associated with electricity usage and increase the amount of renewable energy generated.

4.1.2.4 Municipal Solid Waste Diversion

By diverting an additional 10 percent (9,700 tons) of the MSW generated in the County to the Composting Facility at the Alpha Ridge Landfill, significant emission reductions would be realized at external landfills accepting the waste as well as reductions in fuel use for hauling MSW outside of the County.

4.1.2.5 Mainstream Anammox

This strategy involves evaluating the biological nitrogen removal processes at the LPWRP to develop new process operating strategies that would reduce the oxygen requirement and also, potentially, the supplemental carbon demand for the process. By reducing the oxygen requirement, the amount of electricity used to operate the aeration basin blowers will also be reduced; hence, reducing GHG emissions as the majority of energy used at an aerobic wastewater treatment plants is due to aeration.

4.1.2.6 Anaerobic Codigestion (Option 1)

In addition to the solids process improvements, anaerobic codigestion of biosolids with high strength waste such as fats, oils and grease (FOG) in the anaerobic digesters would increase the amount of digester gas produced. The additional recovered digester gas, with high methane content, could be used as a fuel source to further offset the use of natural gas for solids drying.

4.1.2.7 Cogeneration (Option 2)

Cogeneration (combined heat and power) using digester gas produced from the anaerobic digesters brought online as part of the solids process improvements would allow for the production of electricity on-site and offset the purchase of grid electricity used to power the LPWRP. Heat recovered from the cogeneration system could also be used to partially meet the solids drying heat demand or other heat demand such as building heating during winter. Since the digester gas would be diverted to electricity production in this strategy, additional natural gas would be required to meet the dryer heat demand when compared with the near term strategy (see Solids Treatment Process Improvements) of utilizing all of the digester gas for solids drying. This strategy would support the County's long-term goal of identifying and developing renewable energy projects within the County.

4.1.2.8 Anaerobic Codigestion and Cogeneration (Option 3)

Codigestion and cogeneration (combined heat and power) collectively at the LPWRP could help reduce the use of grid electricity by using the recovered digester gas for the production of electricity on-site. The recovered heat from the cogeneration system could also be used to partially meet the solids drying facility heat demand and provide heat to other facilities. The beneficial use of heat would offset natural gas use. This strategy would also support the County's long-term goal of Identifying and developing renewable energy projects within the County.

4.1.2.9 Bio-CNG Production and Codigestion (Option 4)

A final option for use of biogas produced from anaerobic codigestion is the production of bio-CNG (compressed natural gas). Its use could offset gasoline and diesel fuel use in County vehicles. In addition, this strategy would support the County's goals of increasing the use of renewable fuels and developing alternative fuels within the County. If this strategy is adopted, it would exclude the implementation of the cogeneration strategy as the recovered digester gas would be utilized for bio-CNG production. Supplemental natural gas would be required to operate the solids drying facility.

Table 4-1 summarizes the planned future projects and additional strategies, their potential emission reduction impacts on the Howard County carbon footprint, estimated capital costs, and forecasted costs savings.

TABLE 4-1
Summary of Future Projects and Additional Emission Reduction Strategies
Howard County Climate Action Plan

Strategy Name	Strategy Description	Metric	Net Annual GHG Impact	Estimated Capital Costs	Estimated Annual Cost Savings	Year of Implementation
Fuel Switching						
HCPSS Fuel Oil to Natural Gas	Convert fuel oil boilers at Old Bushy Park and Glenwood Middle schools to natural gas (requires 24,800 and 37,700 therms NG, respectively).	-18,400 gal. -28,000 gal.	-130 tonnes CO_2e	$25,000	$89,800	2016
Bureau of Facilities Fuel Oil to Natural Gas	Convert fuel oil boilers to natural gas (requires 112,200 therms NG)	-83,300 gal.	-240 tonnes CO_2e	$10,000	$161,300	2016
Fleet Optimization						
Gasoline usage reduction	Assumes a 20% reduction in fuel use through optimization of fleet assets that utilize gasoline over 5 year period (5% annually).	-260,000 gal.	-2,330 tonnes CO_2e	$0	$715,000	2016
Diesel fuel usage reduction	Assumes a 20% reduction in fuel use through optimization of fleet assets that utilize diesel fuel over 5 year period (5% annually).	-120,000 gal.	-1,230 tonnes CO_2e	$0	$420,000	2016
Energy Improvements						
EPC Phase II	Estimated 34% reduction in energy use and costs	-82,540 therms -6,950 MWh	-3,630 tonnes CO_2e	$13,000,000	$890,000	2016
2 MW Solar PV Project	2 MW system producing 2,600 MWh of renewable energy annually	-2,600 MWh	-1,850 tonnes CO_2e	$3,000,000	$182,000	2020
Landfill Emission Reductions						
Municipal Solid Wastes (MSW) Diversion	Divert 10% of current MSW stream to enhanced composting facility instead of landfill	-9,700 tons MSW	-9,150 tonnes CO_2e	$0	$0	2016
Alpha Ridge Landfill Gas Extraction System Improvements	Improve the collection efficiency of the ARL LFG recovery system to reduce fugitive emissions from the landfill cap (assumes 7 percent increase in efficiency – 68% to 75%)	140 scfm methane	-4,750 tonnes CO_2-e	<$1,000	$0	2016

TABLE 4-1
Summary of Future Projects and Additional Emission Reduction Strategies
Howard County Climate Action Plan

Strategy Name	Strategy Description	Metric	Net Annual GHG Impact	Estimated Capital Costs	Estimated Cost Savings	Year of Implementation
LPWRP Process Enhancements						
LPWRP Solids Treatment Process Improvements	Implementation of anaerobic digesters at the LPWRP will produce digester gas. The additional processing of biosolids will reduce the amount hauled off-site and land-applied.	326,670 therms 3,770 MWh -14,620 wet tons -75,870 miles traveled	1,730 tonnes CO_2e	$100,000,000+	------	2018
Mainstream Anammox	This strategy involves evaluating the biological nitrogen removal processes at the LPWRP to develop new process operating strategies that would reduce the oxygen requirement and the supplemental carbon demand for the process.	-3,950 MWh	-1,800 tonnes CO_2-e	$3,000,000	$276,650	2018
Anaerobic Codigestion (Option 1)	Codigestion of biosolids with FOG waste in the digesters would increase the amount of digester gas produced. Using the biogas as a fuel source would offset the use of natural gas in the process dryers and provide additional biogas for beneficial use.	-765,436 therms	-4,250 tonnes CO_2e	$3,000,000	$315,450	2020
Cogeneration (Option 2)	Cogeneration (combined heat and power) uses digester gas to produce electricity onsite which would offset the purchase of grid electricity. The recovered heat from the system could also be used to partially meet the biosolids drying heat demand.	-8,840 MWh	-4,040 tonnes CO_2e	$3,900,000	$619,000	2020
Anaerobic Codigestion and Cogeneration (Option 3)*	The increase in digester gas production due to codigestion together with cogeneration would help reduce both purchased electricity and natural gas use at the LPWRP.	-102,060 therms -16,500 MWh	-8,100 tonnes CO_2e	$10,300,000	$1,205,000	2020
Bio-CNG Production and Codigestion (Option 4)	This strategy converts digester gas to bio-CNG (compressed natural gas) for use as vehicle fuel. Using bio-CNG as vehicle fuel would help reduce the use of gasoline and/or diesel as vehicle fuel.	-337,320 gal gasoline	-2,960 tonnes CO_2e	$7,500,000	$843,300	2020

(*) Option 3 is used in the long term emission reduction evaluation in Section 4.2 as it provides the greatest net GHG emission reduction of the four additional options proposed at the LPWRP.

More detailed descriptions of these additional strategies along with their respective GHG emission reductions, capital costs, and cost savings analyses are included in **Appendix A**.

4.2 Evaluation of Long Range GHG Emission Reduction Goals and Targets

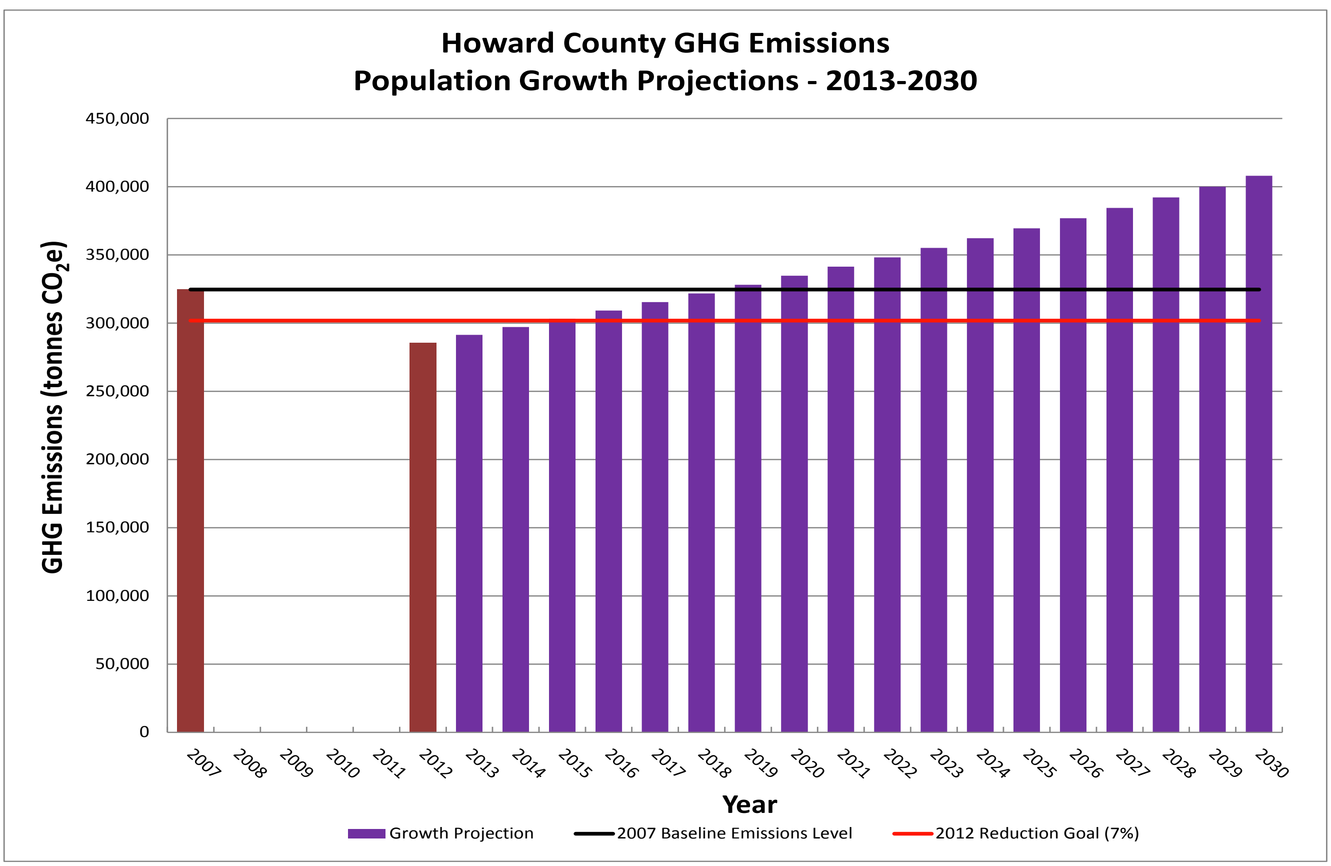
Because the County has implemented and identified short- and long-term projects for the achievement of their sustainability goals, the next step in establishing a long-range strategy was to determine if reducing GHG emissions by 80 percent of 2007 levels by 2050 is an achievable goal based upon the overall GHG impact the identified strategies and projects would have on future emissions. A three step approach was used to evaluate future emissions and the impact of these projects on the overall emissions profile.

4.2.1 Future GHG Emissions due to Population Growth

The first step in determining future GHG emissions for the County was to use population growth data and current emissions levels to project future energy use and operational throughput. Based upon actual growth between calendar years 2007 and 2012, emissions were projected out to 2030 using an average of two percent annual growth. For the purposes of this evaluation, it was assumed all County operations in the future would operate as they do today; hence, the annual increase in overall GHG emissions would be directly proportional to the increase in population. Further, the evaluation also assumed that all other aspects of County operations (e.g. personnel, fleet vehicles, etc.) would increase in the same proportion.

Figure 4-1 shows the effect of population growth on future GHG emissions. The evaluation indicates that in the absence of reduction strategies in calendar year 2016 potential emissions due to population growth will be approximately 310,000 tonnes CO_2e and begin to exceed the 7 percent reduction goal level. In 2019, emissions would be around 328,000 tonnes CO_2e which is slightly above the 2007 baseline level of 324,546 tonnes CO_2e. By 2030, the projected GHG emissions will have increased to nearly 408,000 tonnes CO_2e, 26 percent **above** 2007 levels.

FIGURE 4-1
Projected Future Emissions due to Population Growth

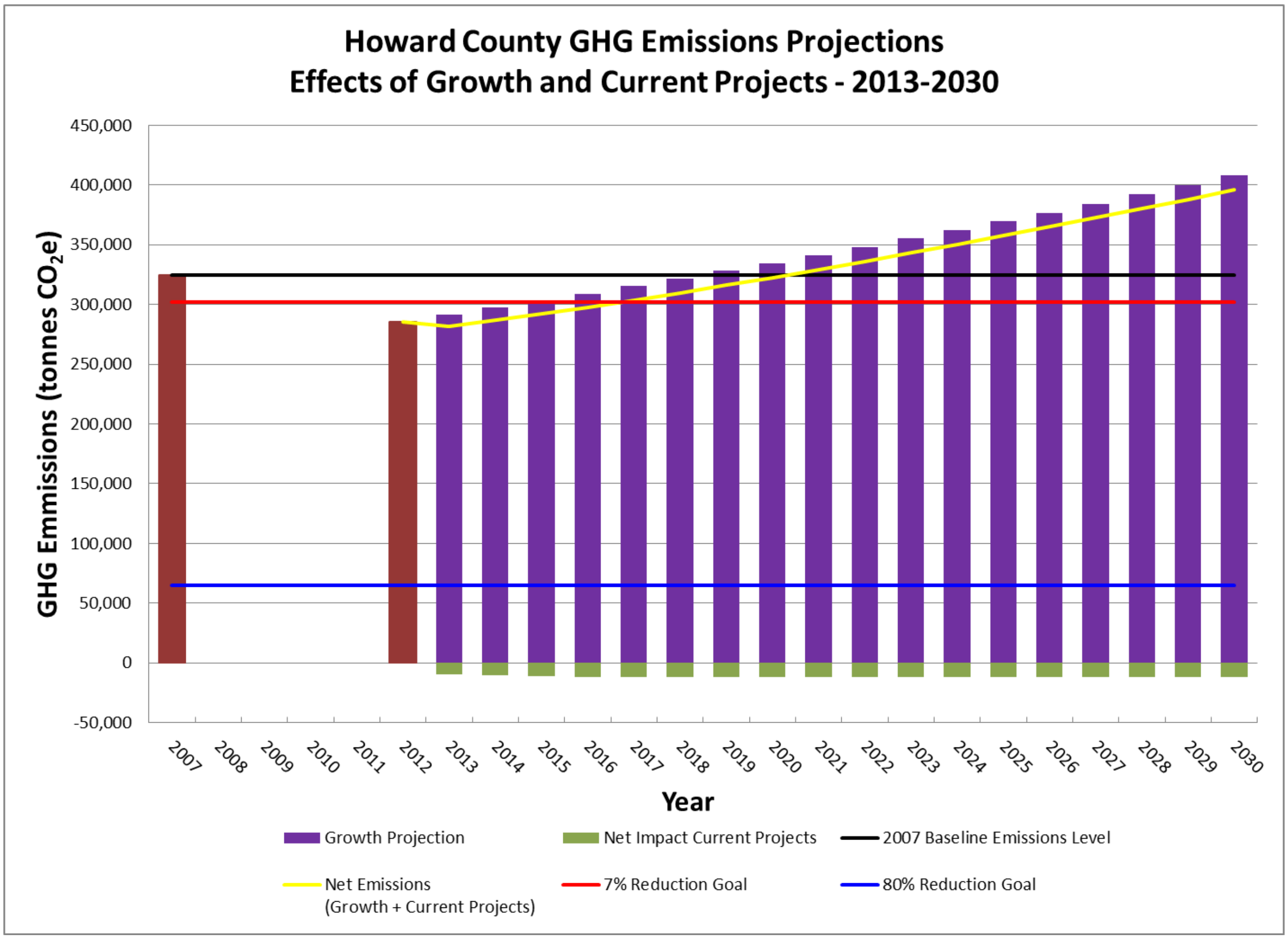


4.2.2 Future GHG Emissions with Currently Implemented Projects

The next step in developing the projection of future GHG emissions for the County was to evaluate the impact of the currently implemented energy and operational efficiency projects detailed in Section 3.2. The metrics data collected for each major project and future energy use data was used in the estimation of GHG emissions as summarized in **Table 3-2**.

Figure 4-2 shows the cumulative effect of growth and a reduction in GHG emissions due to projects currently implemented and maintained over a 17 year period. The projects account for a total reduction on average of 12,000 tonnes CO_2e from 2013 through 2030. In 2013, estimated GHG emissions would be approximately 281,600 tonnes CO_2e with a reduction of 13 percent below 2007 levels. However, over the next 8 years, the emissions due to growth overtake the emission reductions and emissions increase to an estimated 329,300 tonnes CO_2e in 2021, 2 percent above the 2007 baseline.

FIGURE 4-2
Projected Future Emissions due to Implemented Projects

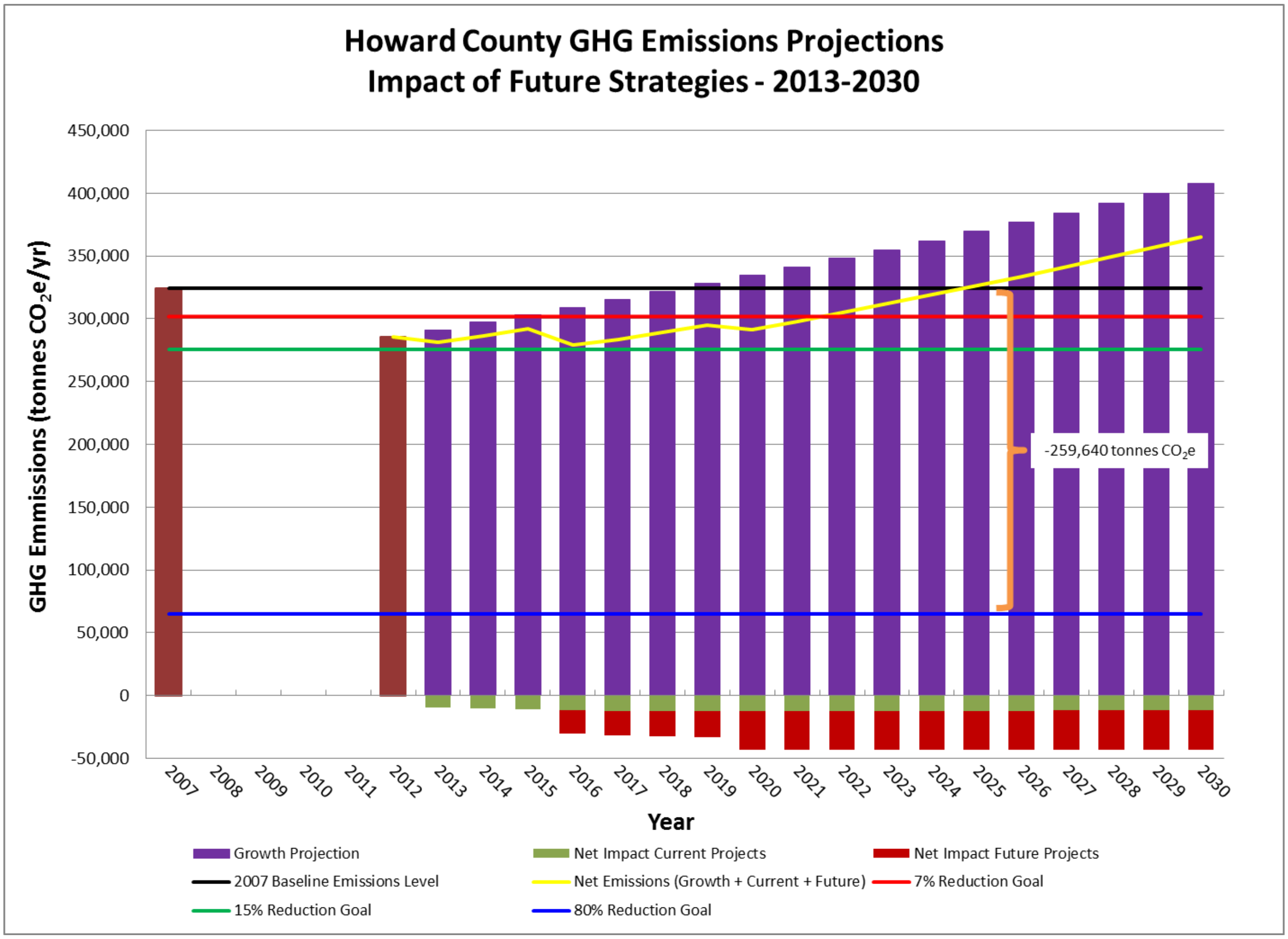


4.2.3 Future GHG Emissions with Future Projects and Additional Strategies

The final step in the evaluation process was to determine if the projected GHG emissions due to population growth along with the implementation of the current projects, future projects, and additional strategies would achieve the long-range goal of reducing total GHG emissions by 80 percent of 2007 levels by 2050. The County's emissions would have to be reduced by nearly 260,000 tonnes CO_2e from the baseline in order to meet the goal.

Figure 4-3 illustrates the total impact of the current projects, future projects, additional strategies, and LPWRP Process Enhancement Option #3 through 2030. The figure shows that through 2016 GHG emissions are projected to be on average 15 percent **below** 2007 levels.

FIGURE 4-3
Projected Future Emissions due to Future Projects and Additional Strategies



Significant reductions in projected emissions are realized in 2016 and 2020 when large scale emission reductions projects are brought online and/or fully implemented. However, after 2020, emissions due to growth begin to overtake the emission reductions and net emissions rise slightly above the 2007 baseline level in calendar year 2025. Based upon the estimations, an 80 percent reduction in GHG emissions by 2050 cannot be achieved through implementation of the current and future projects. A summary of the projected emissions profile due to the implementation of the current projects, future projects, and additional strategies is included in **Table 4-2**.

TABLE 4-2
Summary of Projected Emissions and Reductions 2007-2030
Howard County Climate Action Plan

Year	Projected Emissions	Total Estimated Emission Reductions	Net Emissions	Percent Increase/Decrease from Baseline Year
2007	324,546			
2012	285,635	(38,911)*		-12%
2013	291,348	(9,768)	281,580	-13%
2014	297,175	(10,528)	286,647	-12%
2015	303,118	(11,093)	292,025	-10%
2016	309,181	(30,235)	278,945	-14%
2017	315,364	(31,492)	283,872	-13%
2018	321,671	(32,255)	289,417	-11%
2019	328,105	(32,852)	295,253	-9%

TABLE 4-2
Summary of Projected Emissions and Reductions 2007-2030
Howard County Climate Action Plan

Year	Projected Emissions	Total Estimated Emission Reductions	Net Emissions	Percent Increase/Decrease from Baseline Year
2020	334,667	(43,398)	291,269	-10%
2021	341,360	(43,331)	298,029	-8%
2022	348,187	(43,267)	304,921	-6%
2023	355,151	(43,204)	311,947	-4%
2024	362,254	(43,144)	319,110	-2%
2025	369,499	(43,086)	326,414	1%
2026	376,889	(43,029)	333,860	3%
2027	384,427	(42,975)	341,452	5%
2028	392,116	(42,923)	349,193	8%
2029	399,958	(42,873)	357,085	10%
2030	407,957	(42,825)	365,133	13%

(*) Actual emission reductions achieved in calendar year 2012

4.3 Summary of Short and Long Term Emission Reduction Goals and Targets

Based upon the evaluation of future emissions, the impacts of population growth, and the implementation of current projects (short-term), future projects (mid-term), and the additional strategies (long-term), Howard County would not achieve the current long-term emission reduction target of reducing GHG emissions by 80 reduction of 2007 levels by 2050 using current technologies and through the implementation of the identified strategies. However, a mid-term goal and target of maintaining emissions at 2012 levels - approximately 15 percent below 2007 levels - through 2020 is achievable. This goal aligns with the projected reductions associated with the short-term projects currently implemented and long-term projects identified for implementation through calendar year 2020. The mid-term goal allows progress toward meeting the long-term goal of reducing emissions by ten percent every five years through 2050.

As previously stated, emission reduction measures presented for inclusion in the long range plan must provide a net economic benefit to the County and a net increase in jobs. It is expected that additional emission reductions will be achieved and jobs created through the development of alternative and bio-fuels generation and distribution facilities within the County. Emissions reductions could also be achieved through the use of cleaner burning fossil fuels and the purchase of more fuel efficient vehicles with engines designed to meet more stringent air quality standards over the next 5 years. As new technologies become available, the County will evaluate their economic feasibility for use in government operations as well as their GHG emission impacts.

Appendix A
Long Term Emission Reduction Strategies

Fuel Switching

Strategy Description	The strategy serves to convert fuel oil boilers at Old Bushy Park, Glenwood Middle School, and several buildings in the Bureau of Facilities to a natural gas supply. Natural gas is a cheaper, cleaner burning fossil-fuel and its use would reduce Scope 1 emissions as well as energy costs.	
GHG Reduction Benefit	Net reduction for the fuel conversions is approximately 360 tonnes CO_2e	
Capital Cost (estimate)	It is expected that minimal piping would be required to switch to a natural gas supply for the boilers and heaters. The cost estimate would be less than $50,000.	
Economic Benefit	The boilers currently use approximately 129,700 gallons of fuel oil annually. A total of 174,700 therms of natural gas would be required to supply the same heat output. Using an average rate of $3.35 per gallon for fuel oil and $1.05 per therm for natural gas, a net annual savings of $251,100 can be realized for converting the boilers/heaters to natural gas.	
Implementation Steps and Schedule	**Activities**	**Timeframe**
	Assessment of boilers to determine suitability for fuel switching, availability of natural gas at respective locations, and piping modifications	2015
	Installation of piping, if necessary	2016
Keys to Success	• Availability of natural gas connections	
Performance Indicators	• Reduction in stationary source GHG emissions • Annual costs savings ($ per year)	

Fleet Optimization

Strategy Description	In order to meet the goals for reductions in use of non-renewable transportation fuels, Howard County should evaluate the current use of fleet vehicles and optimize vehicle use. In the first phase of this strategy, the County would complete a “Fleet Optimization Study” to evaluate current vehicle routes, areas of operation, miles traveled, and business use. In addition, the study would review the policy around the use of fleet vehicles for non-business related activities as well as the take home policy. The objective of the study is to determine if the best vehicles are being used for the job. An example of using the best vehicle for a particular job would be to use a more fuel-efficient compact car to transport one to two people to a meeting instead of using a less fuel-efficient truck, van, or SUV; hence, better utilizing the extensive fleet of hybrid vehicles already part of the County fleet. The study would also evaluate routine trips for completing County business. The study would perform a point-to-point analysis of trips made by County personnel to determine the primary transportation requirements of frequent fleet vehicle users. The study can provide information regarding peak travel times and frequent destinations, which show the most efficient uses for vehicles.
GHG Reduction Benefit	It is assumed approximately 20 percent of the current use of mobile fuels would be reduced – approximately 260,000 gallons of gasoline and 120,000 gallons of diesel over a 5 year period (~5 percent annually). The total emission reductions would be 2,300 tonnes of CO_2e for gasoline and 1,230 tonnes of CO_2e for diesel fuel use.
Capital Cost (estimate)	There are no capital costs associated with the implementation of this strategy as no infrastructure is required to right-size the fleet. However, if the Fleet Optimization Study is not completed in-house, an estimated $75,000 should be allotted for completion of the study by an external entity.
Economic Benefit	With an average price of $2.75 per gallon for gasoline and $3.50 per gallon for diesel, an annual savings of $715,000 and $420,000 could be realized, respectively, due to fuel use reductions.
Implementation Steps and Schedule	**Activities** — **Timeframe** Complete Fleet Optimization Study — 2015 Implement the Study recommendations — 2016
Keys to Success	• Buy-in for key stakeholders (drivers of fleet vehicles) • Successful implementation of policy changes • Maintaining the hybrid fleet
Performance Indicators	• Gallons of fuel, diesel and gasoline, reduced annually • Therms reduced annually • Annual costs savings ($ per year)

Energy Efficiency – EPC Phase II

Strategy Description	This second phase of the EPC project will install upgrades and make facility improvements in over ***70 sites*** County wide, while generating energy and cost savings. Implementation will provide the following multiple Energy Conservation Measures (ECMs): • New lighting and controls • New boilers and RTU's • Electrical system upgrades • HVAC system and controls upgrades • New transformers and motors • Water Conservation • Building Envelope Upgrades • Solar PV system An annual savings of 82,542 therms of natural gas and 6,945,589 kWh (6,950 MWh) of electricity is expected upon implementation.
GHG Reduction Benefit	It is expected that Scope 1 emissions will be reduced by 453 tonnes CO_2e due to natural gas savings. Scope 2 emissions would be reduced by 3,173 tonnes CO_2e due to electricity use reductions.
Capital Cost (estimate)	$13,000,000
Economic Benefit	$890,000 annual cost savings from 34 percent reduction in energy costs (e.g. natural gas, electricity, and water)
Implementation Steps and Schedule	**Activities** — **Timeframe** Installation of Equipment — 2015 Full operation of all equipment upgrades — 2016
Keys to Success	• Availability of equipment • Equipment operating as designed at full peak
Performance Indicators	• MWh/kWh reduced annually • Therms reduced annually • Annual costs savings ($ per year)

Renewable Energy – 2 MW Solar PV Installation

Strategy Description	This strategy consists of siting and installing one additional 2 MW solar PV installation in addition to the installation currently implemented at the LPWRP. The system would produce approximately 2,600 MWh of electricity annually (at 15% efficiency).	
GHG Reduction Benefit	It is estimated that the electricity generated by the additional solar PV installation will offset Scope 2 emissions by 1,200 tonnes of CO_2e per year through 2035.	
Capital Cost (estimate)	Based upon the capital costs to install the 217 kW solar PV panels at the LPWRP, it is estimated the cost for a 2 MW system would be approximately $3,000,000	
Economic Benefit	Assuming 7 cents ($0.07) per kWh as the cost for grid electricity, the solar PV system could realize approximately $182,000 per year in electricity cost savings.	
Implementation Steps and Schedule	**Activities**	**Timeframe**
	Completing a feasibility study to site the additional solar capacity	2015
	Design and construction of the solar installations	2020
Keys to Success	• Finding adequate locations for the solar PVs • Availability of tax rebates or other incentives	
Performance Indicators	• MWh of renewable energy generated per year • Cost savings ($ per year)	

Landfill Emission Reductions

Strategy Description	This strategy serves to divert 10 percent of the current residential and commercial municipal solid waste generated within Howard County to the enhanced Composting Facility located at the Alpha Ridge Landfill. Approximately, 100 households are currently sending food wastes to the pilot facility. Expansion of the pilot system would allow more waste to be diverted from landfills outside of the County and reduce the associated GHG emissions of methane.	
GHG Reduction Benefit	An estimated 9,100 tonnes CO_2e can be reduced at an external landfill due to the high GWP of methane	
Capital Cost (estimate)	There are no capital costs associated with this strategy as the composting facility already exists. It is assumed the same trucks that currently collect the food waste for the pilot composting facility would collect the additional tonnage.	
Economic Benefit	Because the number of trips to collect and dispose of MSW are independent of the amount of waste collected curbside, there is no estimated economic benefit associated with this strategy.	
Implementation Steps and Schedule	**Activities**	**Timeframe**
	Identify the source of MSW and food scraps to be diverted	2015
	Implement the collection process and divert MSW to the composting facility	2016
Keys to Success	• Minimizing the impact of MSW diversion on the current collection route • Identifying a sufficient number of households to participate	
Performance Indicators	• Tons of MSW diverted • Cubic feet of LFG reduced • Tonnes of CO_2e reduced	

LPWRP Process Enhancements – Mainstream Anammox

Strategy Description	This strategy involves evaluating the biological nitrogen removal processes at the LPWRP to develop new process operating strategies that would reduce the oxygen requirement and also, potentially, the supplemental carbon demand for the process. New research into the nitrogen removal process has resulted in several possible approaches for optimizing the efficiency of the process. These include: • Nitrification/Denitrification: This process seeks to eliminate the creation of nitrate in the process by suppressing the growth of nitrite-oxidizing bacteria (NOBs). This can be achieved by operating at low dissolved oxygen (DO) concentrations or by implementing a process that rapidly switches air on/off in the bioreactors. • Mainstream Deammonification: This process uses the NOB suppression described above and also the Anammox micro-organisms which can further shorten the metabolic process by using nitrite to oxidize ammonia. If the digester project is implemented, including treatment of digested sludge dewatering recycle stream using deammonification, then implementation of mainstream deammonification would be relatively easy as the facility would have a ready supply of Annamox bacteria on site. Implementing these processes would likely require installing additional instrumentation in the facility and possibly a hydrocyclone system for the WAS to help waste the NOBs and also to improve the ability of the activated sludge to settle.
GHG Reduction Benefit	This evaluation estimated that the electricity used to meet the aeration requirement at the facility would be reduced by 20 percent, 3,950 MWH. This would translate into a reduction of the Scope 2 emissions by approximately 1800 tonnes CO_2e annually. In addition, the methanol requirement will be reduced by 50 percent (assuming some methanol would still be added for polishing).
Capital Cost (estimate)	$3,000,000 – for additional equipment, piping and instrumentation.
Economic Benefit	Assuming 7 cents ($0.07) per kWh as the cost for grid electricity, implementation of this strategy will result in annual savings of approximately $276,650.
Implementation Steps and Schedule	**Activities** — **Timeframe** Evaluate existing WWTP process, including modeling activities to determine optimal approach. — 2015 Procure and perform engineering design — 2016 Procure necessary improvement projects and/or equipment — 2017 Construction and Startup — 2018
Keys to Success	• Adequate treatment options to implement Nitrification/Denitrification • Proper instrumentation selection, performance and maintenance
Performance Indicators	• Air used (average scfm per day) • Energy saved (kWh per MG treated) • Cost savings ($ per year)

LPWRP Process Enhancements – Biosolids Processing Facilities Improvements (Anaerobic Digestion)

Strategy Description	Bio-solids produced at the Little Patuxent Water Reclamation Plant (LPWRP) are currently lime stabilized and trucked offsite for land application. The current bio-solids treatment and disposal practice results in the generation of GHG emissions. The majority of the emissions are attributed to Scope 3 emissions from the transport of stabilized solids to the land application site. In the near future, a new anaerobic digestion process is proposed for installation at the LPWRP and the digester gas produced would be used beneficially on-site. Based on consultant experience at other facilities, it is assumed that the anaerobic digestion process will reduce the volume of solids requiring treatment and management post anaerobic digestion. The recovered digester gas will be used to provide heat to the digesters, and operate the proposed downstream solids drying system. Because the quantity of digester gas produced will not be adequate to meet the dryer heat demand, natural gas will be required as a supplement. It is expected there would also be an increase in purchased electricity use to operate the digesters and ancillary equipment. Implementation of solids treatment process improvements as described in the *DRAFT Preliminary Engineering Report* dated October 2014.
GHG Reduction Benefit	Anaerobic digesters will increase annual natural gas use by approximately 326,670 therms and electricity usage 3,770 MWh resulting in an increase of 1,720 and 1,790 tonnes CO_2e in Scope 1 and 2 GHG emissions, respectively. Conversely, anaerobic digestion will reduce the amount of biosolids required to be transported for land application by 14,620 tons annually reducing transport by 75, 870 miles and Scope 3 GHG emissions by 1,780 tonnes CO_2e. Implementation of the solids treatment process improvements will result in a net increase in GHG emissions of 1,730 tonnes CO_2e from the LPWRP.
Capital Cost (estimate)	$62,331,000 [per the *DRAFT Preliminary Engineering Report* dated October 2014]
Economic Benefit	The beneficial use of digester gas and a reduction in the tons of biosolids requiring transport will reduce the costs associated with each. However, the additional costs of supplemental natural gas and grid electricity that will be required to operate the anaerobic digesters are more significant.
Implementation Steps and Schedule	**Activities:** Solids treatment process improvements including anaerobic digestion system becomes operational — **Timeframe:** 2018
Keys to Success	• Consistent reduction in biosolids hauling and land-application. • Stable long term digestion operation at the LPWRP. • Maximized year round beneficial use of digester gas.
Performance Indicators	• Digester gas produced (cubic feet) per pound of dry solids digested. • Additional thermal energy produced (million BTU) per pound of dry solids digested.

LPWRP Process Enhancements – Anaerobic Codigestion (Option 1)

Strategy Description	The increased GHG emissions resulting from the anaerobic digestion process can be reduced through codigestion of wastewater solids with high strength wastes such as fats, oils and grease (FOG). The reduction is realized due to enhanced digester gas production which would offset the supplemental natural gas required to operate the dryers at the LPWRP. Diversion of nearly 18,000 gallons of FOG from an external landfill would also reduce GHG emissions. The environmental and economic benefits presented below are based on Calendar Year 2035 annual average loading conditions as described in the *DRAFT Preliminary Engineering Report* dated October 2014.	
GHG Reduction Benefit	The increase in digester gas production due to codigestion would offset the entirety of the natural gas required to operate the process dryers at the LPWRP. Approximately 765,440 therms of natural gas could be generated and reduce corresponding Scope 1 emissions by nearly 4,250 tonnes CO_2e. It is assumed that the additional digester gas produced would be used year round in the process and in other plant areas (e.g space heating, etc.).	
Capital Cost (estimate)	Implementation of codigestion will require a new FOG Receiving and Processing Facility. The FOG storage and processing equipment is assumed to be indoors, and shall consist of storage tanks, pumps, piping, valves and corresponding electrical and instrumentation equipment. It is assumed that the Facility will be equipped with an odor control system. The budgetary planning level cost estimate for the Facility is approximately $3,000,000. The capital cost estimate is a Level V cost estimate as defined by the Association for the Advancement of Cost Engineering.	
Economic Benefit	Implementation of this strategy can result in revenue of approximately $495,400 per year as a result of assessing a tipping fees for accepting FOG – based upon 7.5 cents ($0.075) per gallon of FOG waste received. Assuming $4/mmBTU as the cost of natural gas, cost savings of approximately $315,450 per year could be realized due to reduction in natural gas use.	
Implementation Steps and Schedule	**Activities**	**Timeframe**
	New anaerobic digestion system becomes operational	2018
	Implementation of this strategy and the corresponding benefits realized	2020
Keys to Success	• A long term comprehensive FOG Receiving Program to obtain the necessary quantity of solids to make the strategy environmentally and economically viable. • Stable long term codigestion operation at the WRP. • Maximize beneficial year round use of additional digester gas.	
Performance Indicators	• Additional digester gas produced (cubic feet) per pound of dry solids (FOG) co-digested. • Additional thermal energy produced (million BTU) per pound of dry solids (FOG) co-digested. • Annual revenue ($/year) in tipping fees for accepting FOG. • Annual savings ($/year) due to reduced natural gas use.	

LPWRP Process Enhancements – Cogeneration (Option 2)

<table>
<tr><td rowspan="1">Strategy Description</td><td colspan="2">Another strategy to reduce GHG emissions from the anaerobic digestion process is to use the digester gas for cogeneration (i.e. combined heat and electricity generation). Electricity generated on-site would be used to offset electricity purchased from the grid. It is assumed that heat recovered from the cogeneration system is used beneficially year round.
The environmental and economic benefits presented below are based on Calendar Year 2035 annual average loading conditions.</td></tr>
<tr><td>GHG Reduction Benefit</td><td colspan="2">Cogeneration at the LPWRP would reduce purchased grid electricity and corresponding Scope 2 GHG emissions. Approximately, 8,840 MWh of grid electricity would be offset and nearly 4,040 tonnes CO_2e emissions reduced.</td></tr>
<tr><td>Capital Cost (estimate)</td><td colspan="2">Implementation of the cogeneration strategy will require installation of energy recovery systems. Internal combustion engines (ICEs) coupled with electric generators are assumed as energy recovery systems for the analysis. The budgetary planning level cost estimate for the Facility is approximately $3,900,000. The capital cost estimate is a Level V cost estimate as defined by the Association for the Advancement of Cost Engineering.</td></tr>
<tr><td>Economic Benefit</td><td colspan="2">The economic benefits of this strategy are savings associated with reduced purchase of grid electricity and natural gas. Assuming 7 cents ($0.07) per kWh as cost for grid electricity, a cogeneration system can help realize approximately $619,000 per year in electricity cost savings.</td></tr>
<tr><td rowspan="3">Implementation Steps and Schedule</td><td>Activities</td><td>Timeframe</td></tr>
<tr><td>New anaerobic digestion system becomes operational</td><td>2018</td></tr>
<tr><td>Implementation of this strategy and the corresponding benefits realized</td><td>2020</td></tr>
<tr><td>Keys to Success</td><td colspan="2">• Maximize beneficial year round use of electricity and heat recovered from the cogeneration system.</td></tr>
<tr><td>Performance Indicators</td><td colspan="2">• Annual on-site electricity production (kWh/year)
• Annual on-site recovery and beneficial use of heat from the cogeneration system (mmBTU/year)
• Annual savings ($/year) due to reduction in grid electricity purchase.</td></tr>
</table>

LPWRP Process Enhancements – Anaerobic Codigestion and Cogeneration (Option 3)

Strategy Description	The digester gas produced and recovered from the anaerobic digesters will be used to provide heat to the proposed downstream solids drying system. Because the quantity of digester gas produced will not be adequate to meet the total drying facility heat demand, natural gas will be required as a supplement. However, increased digester gas production can be realized by implementing codigestion of wastewater solids with high strength waste such as fats, oils and grease (FOG). Diversion of nearly 18,000 gallons of FOG from an external landfill would also reduce GHG emissions. In addition, electricity produced on-site through cogeneration would reduce Scope 2 GHG emissions associated with utilization of grid electricity, and the heat recovered from the cogeneration system would offset Scope 1 GHG emissions associated with natural gas use for solids drying, building heating, and other purposes. The environmental and economic benefits presented below are based on Calendar Year 2035 annual average loading conditions as described in the *DRAFT Preliminary Engineering Report* dated October 2014.
GHG Reduction Benefit	The increase in digester gas production due to codigestion together with cogeneration would reduce purchased grid electricity use by approximately 16,500 MWh and offset natural gas use by 102,060 therms. Codigestion and cogeneration collectively at the WRP can help offset up to approximately 8,100 tonnes CO_2e emissions. It is assumed that heat recovered from the cogeneration system is used beneficially year round.
Capital Cost (estimate)	Implementation of codigestion will require a new FOG Receiving and Processing Facility. The FOG storage and processing equipment is assumed to be indoors, and shall consist of storage tanks, pumps, piping, valves and corresponding electrical and instrumentation equipment. It is assumed that the Facility will be equipped with an odor control system. The budgetary planning level cost estimate for the Facility is approximately $3,000,000. Implementation of the cogeneration strategy will require installation of energy recovery systems. Internal combustion engines (ICEs) coupled with electric generators are assumed as energy recovery systems for the analysis. The budgetary planning level cost estimate for the Cogeneration Facility is approximately $7,300,000. The total capital cost for implementation of a combined codigestion and cogeneration strategy is estimated to be $10,300,000. The capital cost estimate is a Level V cost estimate as defined by the Association for the Advancement of Cost Engineering.
Economic Benefit	The economic benefits of this strategy are savings associated with reduced purchase of grid electricity and natural gas, and revenue from tipping fees for accepting FOG. Assuming 7 cents ($0.07) per kWh as cost for grid electricity, a cogeneration system can help realize approximately $1,155,500 per year in electricity cost savings. Assuming $4/mmBTU as cost of natural gas, heat recovered from the cogeneration system can help realize approximately $50,000 per year in natural gas cost savings. The total savings associated with reduced use of fossil fuel based utilities (natural gas and grid electricity) is estimated to be $1,205,000. Implementation of this strategy will also result in revenue of approximately $495,400 per year in tipping fees for accepting FOG. The revenue is estimated assuming 7.5 cents ($0.075) per gallon of FOG waste received.
Implementation Steps and Schedule	**Activities** — **Timeframe** New anaerobic digestion system becomes operational — 2018 Implementation of this strategy and the corresponding benefits realized — 2020
Keys to Success	• A long term comprehensive FOG Receiving Program to obtain the necessary quantity of FOG to make the strategy environmentally and economically viable. • Stable long term codigestion operation at the WRP. • Maximize beneficial year round use of electricity and heat recovered from the cogeneration system.
Performance Indicators	• Additional digester gas produced (cubic feet) per pound of dry solids (FOG) codigested. • Annual revenue ($/year) in tipping fees for accepting FOG. • Annual on-site electricity production (kWh/year) and beneficial use of heat from the cogeneration system (mmBTU/year) • Annual savings ($/year) due to reduced natural gas and grid electricity purchases.

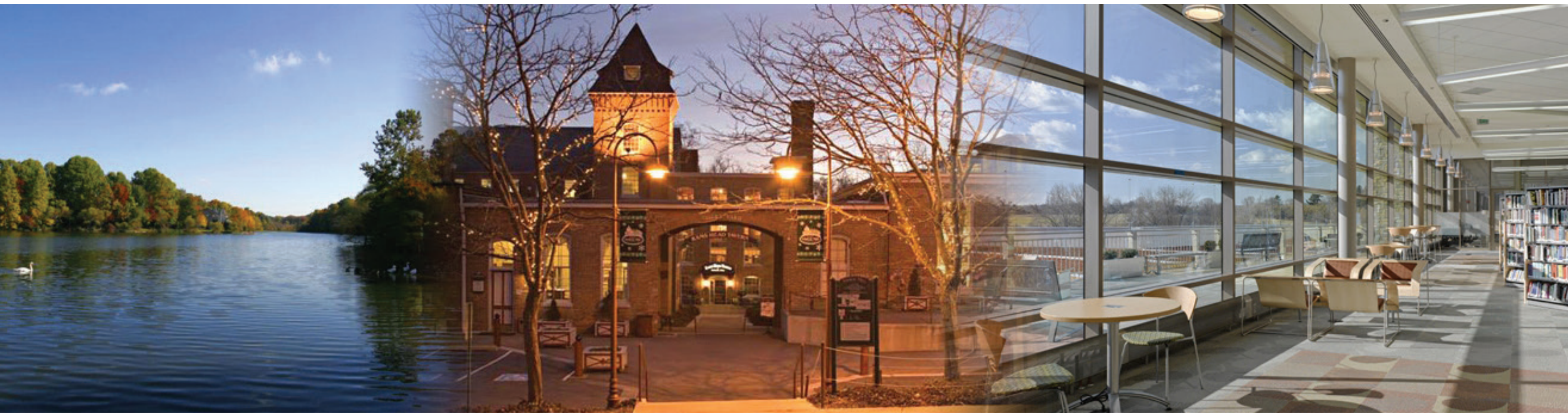
LPWRP Process Enhancements – Bio-CNG Production and Codigestion (Option 4)

<table>
<tr><td>Strategy Description</td><td colspan="2">The additional GHG emissions resulting from the anaerobic digestion process can be reduced by converting digester gas to bio-CNG (compressed natural gas) and using it as vehicle fuel. Using bio-CNG as vehicle fuel would reduce gasoline and diesel use as well as the corresponding Scope 1 GHG emissions. The quantity of bio-CNG produced could be increased by implementing codigestion of wastewater solids and FOG.

The environmental and economic benefits presented below are based on Calendar Year 2035 annual average loading conditions.</td></tr>
<tr><td>GHG Reduction Benefit</td><td colspan="2">Using bio-CNG as vehicle fuel would reduce the use of gasoline and diesel as vehicle fuel and help meet the County goal of developing alternative fuels. It is estimated 337,320 gallons of gasoline or 289,100 gallons of diesel could be offset through the use of the CNG produced. Up to 2,960 tonnes CO_2e emissions associated with gasoline or diesel vehicle fuel use would be reduced.</td></tr>
<tr><td>Capital Cost (estimate)</td><td colspan="2">Producing bio-CNG will require conditioning of digester gas. The conditioning system will help reduce moisture and pollutants such as hydrogen sulfide and siloxanes in digester gas to permissible levels. It will also help remove carbon dioxide to produce fuel grade bio-CNG. The bio-CNG will be stored on-site. Fueling stations will be required to facilitate fueling of vehicles with bio-CNG. The budgetary planning level cost estimate for the bio-CNG production, storage and fueling facility with codigestion is approximately $7,500,000 respectively. The capital cost estimate is a Level V cost estimate as defined by the Association for the Advancement of Cost Engineering.

The fuel storage and injection system of the vehicles will require modification to facilitate use of bio-CNG as fuel. The capital cost of modifying the vehicle’s fuel storage and injection system is not considered at this time.</td></tr>
<tr><td>Economic Benefit</td><td colspan="2">The economic benefit of this strategy is savings associated with reduced purchase of gasoline and/or diesel. Assuming an average cost of $2.50 per gallon of vehicle fuel, a bio-CNG system could save the County $843,300 annually.

Additional revenue due to the sale of green attributes of bio-CNG in the forms of Renewable Identification Numbers (RINs) can also be realized. Bio-CNG when used as vehicle fuel is approved as a “cellulosic” renewable fuel to meet the Renewable Fuel Standard (RFS). The RFS was established under the Energy Policy Act of 2005, and modified through the subsequent Energy Independence and Security Act of 2007.</td></tr>
<tr><td rowspan="3">Implementation Steps and Schedule</td><td>Activities</td><td>Timeframe</td></tr>
<tr><td>New anaerobic digestion system becomes operational</td><td>2018</td></tr>
<tr><td>Implementation of this strategy and the corresponding benefits realized</td><td>2020</td></tr>
<tr><td>Keys to Success</td><td colspan="2">• Producing fuel grade bio-CNG through stable anaerobic digestion operations.
• A long term comprehensive FOG Receiving Program to obtain the necessary quantity of solids to increase bio-CNG production (if codigestion considered).
• Stable long term codigestion operation at the WRP (if codigestion considered).</td></tr>
<tr><td>Performance Indicators</td><td colspan="2">• Additional digester gas produced (cubic feet) per pound of dry solids (FOG) codigested (if codigestion considered)
• Additional energy (mmBTU) per pound of dry solids (FOG) codigested (if codigestion considered).
• Annual savings ($/year) due to reduced vehicle fuel (gasoline or diesel) use.</td></tr>
</table>



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