Maryland's Plan to Reduce Greenhouse Gas Emissions,

December 31, 2011

A plan to reduce GHG emissions and produce a net economic benefit to Maryland's economy.

A presentation by the

State of Maryland
Department of the
ENVIRONMENT

Reducing GHG Emissions 25% by 2020.

ACKNOWLEDGEMENTS

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- The University of Maryland Center for Environmental Science
- The University of Maryland Center for Integrated Environmental Research
- The Regional Studies Institute at Towson University
- The Northeast States for Coordinate Air Use Management
- Science Applications International Corporation
- Maryland Colleges and Universities
- Thompson Creek Windows
- Progressive Insurance
- Constellation Energy
- The Maryland Historical Trust

Lead Agency: **MDE-ARMA Air Quality Planning Program**

The MDE is the agency responsible for preparing and submitting this stakeholder draft of the 2012 Greenhouse Gas Emissions Reduction Act of 2009 (GGRA) plan. The MDE Air and Radiation Management Administration's Air Quality Planning Program compiled this Plan.

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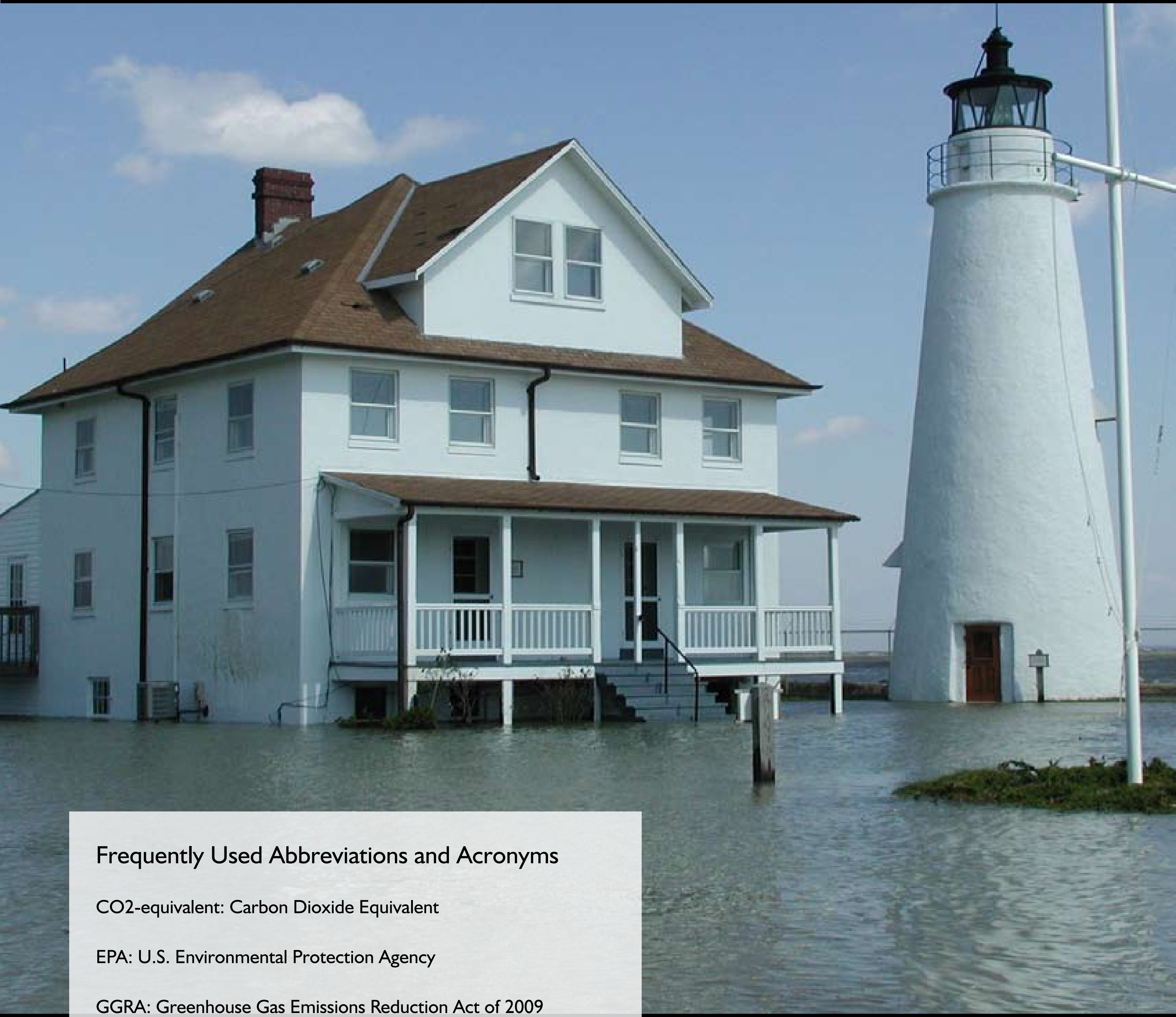
Photo courtesy of Maryland Historical Trust, September 2003. "Flooding caused by Hurricane Isabel. This is the Cove Point Lighthouse in Calvert County which is listed on the National Register of Historic Places. For more information on the Cove Point Lighthouse, go to http://mht.maryland.gov/NR/NRDetail.aspx?HDID=149."



Frequently Used Abbreviations and Acronyms

CO2-equivalent: Carbon Dioxide Equivalent

EPA: U.S. Environmental Protection Agency

GGRA: Greenhouse Gas Emissions Reduction Act of 2009

GHG: Greenhouse Gas

MDE: Maryland Department of the Environment

RGGI: Regional Greenhouse Gas Initiative

Executive Summary

Introduction

In 2009, Maryland Governor Martin O'Malley and the Maryland General Assembly passed the Greenhouse Gas Emission Reduction Act of 2009 (GGRA). The law requires the State to develop and implement a Plan (the GGRA Plan or the Plan) to reduce greenhouse gas (GHG) emissions 25 percent from a 2006 baseline by 2020. The GGRA Plan must have a positive impact on job creation and contribute to Maryland's economic recovery.

This draft of the GGRA Plan fulfills the law's requirement for the Maryland Department of the Environment (MDE) to submit a draft of the GGRA Plan to the Governor and General Assembly by the end of 2011. The final GGRA Plan is due in December of 2012. During the interim period, MDE will solicit public comment on the Plan through a series of public workshops. MDE is encouraging public comment on the Plan as a whole, on the 65 control measures that comprise the Plan and on any new ideas that members of the general public may have.

The Bottom Line

This draft Plan puts the State on track to achieve the 25 percent GHG reduction required by the law while also creating jobs and improving Maryland's economy. The Plan also will help with other environmental priorities, including restoration of the Chesapeake Bay, improving air quality and other critical energy and national security issues.

Communicating Risk: Visualizing Impacts

Why should Maryland care?

Maryland is among the states most vulnerable to climate change. With the fourth longest tidal coastline (behind only Florida, California and Louisiana), Maryland is the third state most vulnerable to sea level rise – one of the major consequences of climate change. Rising sea levels, along with increased storm intensity could have devastating and far reaching environmental and economic impacts on the Chesapeake Bay ecosystem and the quality of life Marylanders currently enjoy.

Maryland's sizeable farming community could suffer costly losses during extreme droughts and heat waves. Marylanders everywhere will face an increased risk of floods and significant property damage as a result of heavier precipitation and other extreme weather events.

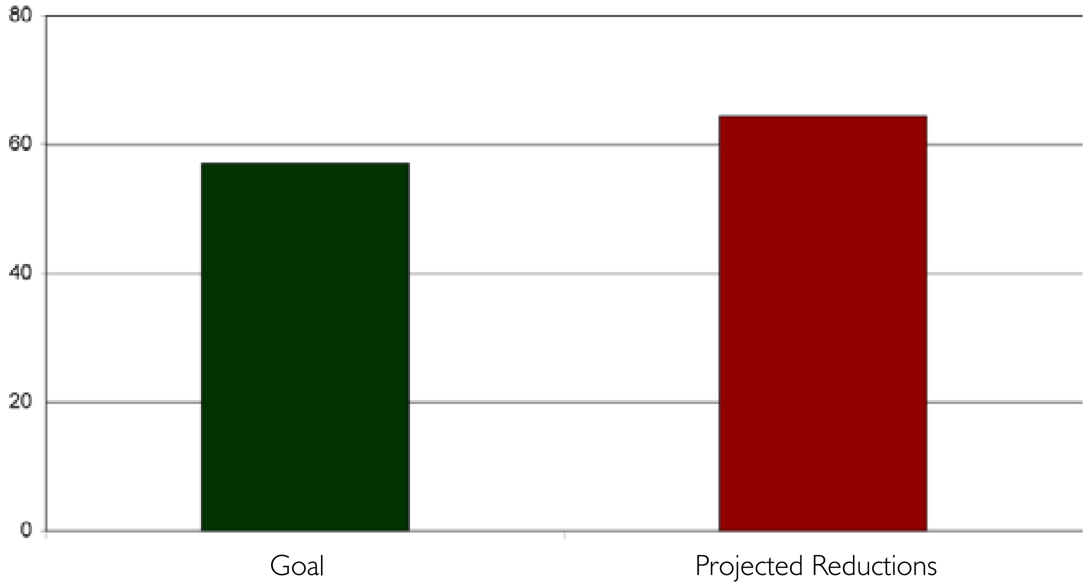
A meaningful national climate program is vitally important. Through the adoption and implementation of a robust State climate action plan, Maryland can lead the nation by example. This draft proposed Plan to reduce State-wide GHG emissions 25% by 2020 demonstrates that the most severe impacts of climate change can be avoided through the implementation of multiple strategies, that will at the same time, contribute to the growth of green jobs and economic recovery.

A Multi-Pollutant Plan: Reductions in Emissions of Other Pollutants

Full implementation of this draft GGRA Plan puts Maryland squarely on track to achieve the required 25% reduction in GHG emissions by 2020.

Figure ES-1 shows that the 65 strategies in the Plan are expected to achieve a GHG emissions reduction that is just slightly greater than the required 25% reduction.

Figure ES-1
GHG Emission Reductions From the Draft GGRA Plan



There are, however, important environmental and public health co-benefits associated with implementation of the Plan. Many of the strategies that comprise the Plan also will contribute to restoration of the Chesapeake Bay, improved air quality and visibility through reductions in ground level ozone and fine particulate matter, and reductions in mercury emissions.

Maryland faces very tough challenges in meeting our Chesapeake Bay cleanup goals and recently adopted new health-based ambient air quality standards for ground level ozone, nitrogen dioxide and sulfur dioxide. A new, tougher air quality standard for fine particulate matter is also expected in 2012. Maryland's lakes and public impoundments are subject to fish consumption advisories for mercury from deposition of mercury emissions. Finally, Maryland must reduce regional haze levels to comply with the Clean Air Act. The GGRA Plan will help the State in all of these efforts.

Photo courtesy of Salisbury University.

This version of the 2012 GGRA Plan is the first phase of a three-phase planning process that uses a "multi-pollutant" planning approach to analyze and select the control programs that comprise the Plan. This approach focuses on getting the "biggest bang for the buck" – that is, maximizing multi-pollutant co-benefits.

The three key plans that will serve as Phases 1, 2 and 3 of MDE's multi-pollutant planning process are as follows:

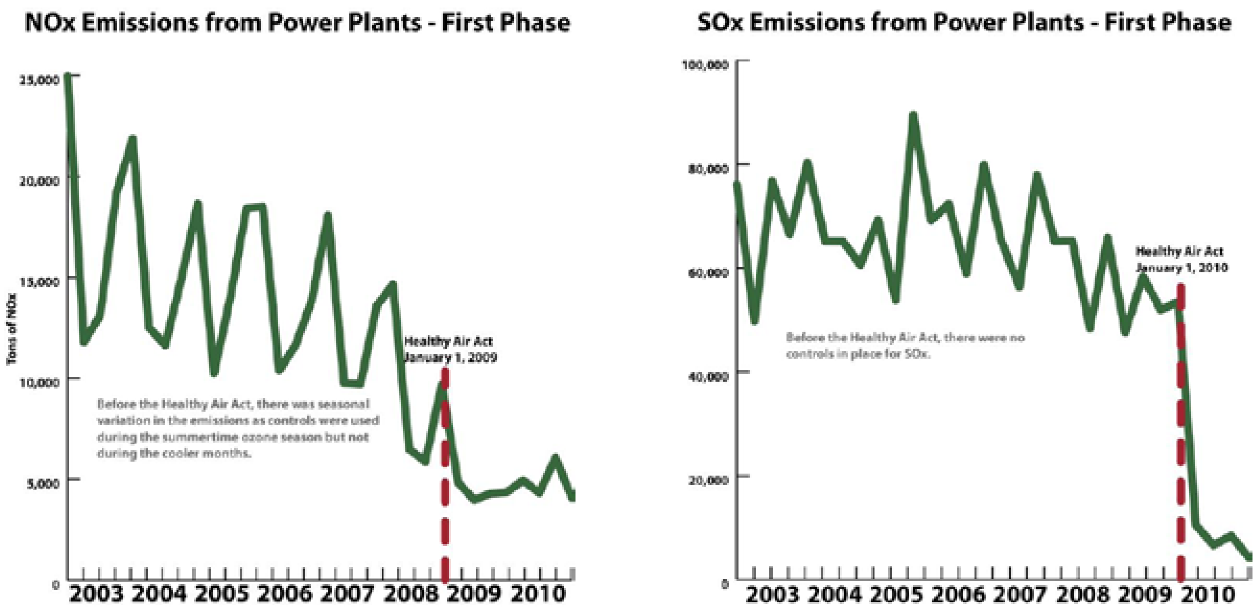
- Phase 1 – the GGRA Plan due in December of 2012;
- Phase 2 – the State Implementation Plan required to implement the new federal ozone standard; and
- Phase 3 – the State Implementation Plan to implement the "soon to be" revised federal fine particle standard.

Maryland has adopted several, high profile multi-pollutant control programs over the past five years. These include:

- The Maryland Healthy Air Act of 2006
- The Maryland Clean Cars Act of 2007
- The EmPOWER Maryland Act of 2008

As an example of a multi-pollutant control program, the Maryland Healthy Air Act not only requires GHG reductions from the power plant sector (through the RGGI program), but it also requires a dramatic reduction in emissions of nitrogen oxides, sulfur dioxide and mercury. Figure ES-2 shows the significant reductions that have already been achieved by the Healthy Air Act. A second phase of reductions is required in the 2012 to 2013 time frame.

Figure ES- 2
Healthy Air Act Reductions from Power Plants



Helping with Economic Recovery and Job Creation

Preliminary economic impact analyses of the programs that comprise the draft GGRA Plan indicate that implementation of the strategies will result in a substantial net benefit to Maryland's economy and creation of tens of thousands of new jobs. Significant additional economic impact analyses are underway and will be included in the final 2012 GGRA Plan.

This preliminary analysis, conducted by Towson University's Regional Economic Studies Institute (RESI), estimates that the Plan, when fully implemented, will result in annual benefits that include the creation of approximately 36,000 jobs, $6.1 billion in additional economic output, and $2.1 billion in additional wages.

A Work in Progress

With the final plan due at the end of this year, some of the technical analysis to support the GGRA Plan is still under development. The University of Maryland's Center for Integrated Environmental Research and Towson University's RESI continue to refine the economic impact analysis.

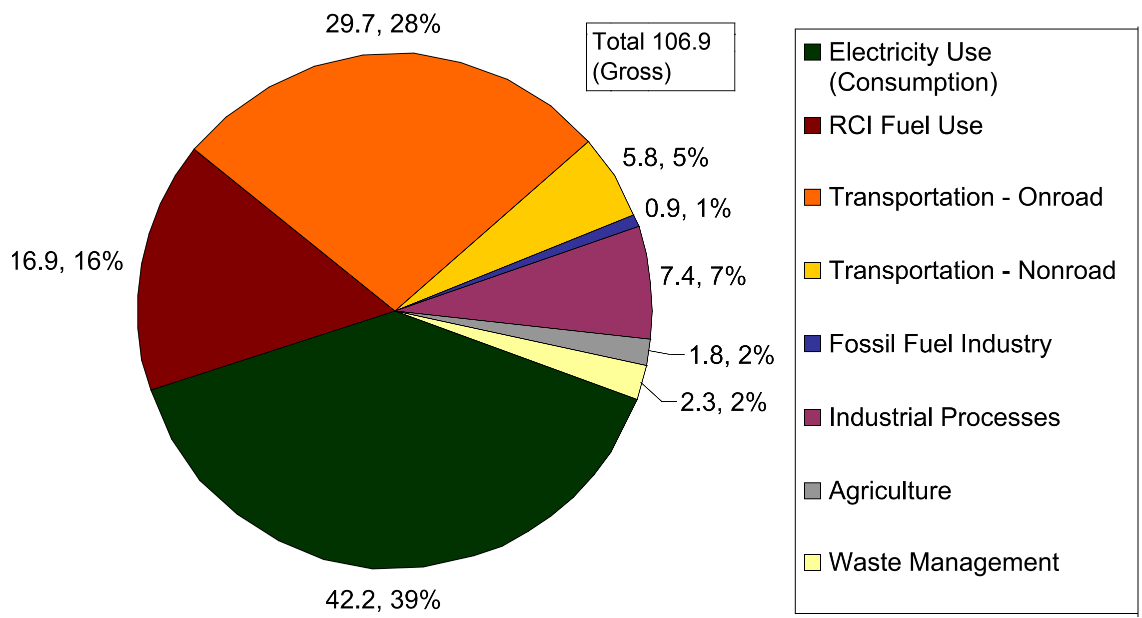
The Northeast States for Coordinated Air Use Management (NESCAUM) is performing multi-pollutant analyses to quantify the environmental co-benefits and the net monetized benefits of the Plan when compared to its costs. State agencies also are refining earlier work on projected emissions reductions and economic impacts.

The Programs

The draft GGRA Plan includes 65 programs being implemented by 11 State agencies. Many of the programs already are required by various State laws that were adopted between 2006 and 2011. Examples of such programs include the Regional Greenhouse Gas Initiative (RGGI) which was required by the 2006 Healthy Air Act, the Maryland Clean Cars Program adopted in 2007 and the EmPOWER Maryland and Renewable Portfolio Standards (RPS) programs from 2008. More than 25 laws were enacted between 2006 and 2010 that directly or indirectly support the GGRA.

Figure ES-3 depicts our "starting point," known as the "baseline GHG inventory" from which we measure reductions in GHG emissions. In this case, the law established 2006 as our baseline.

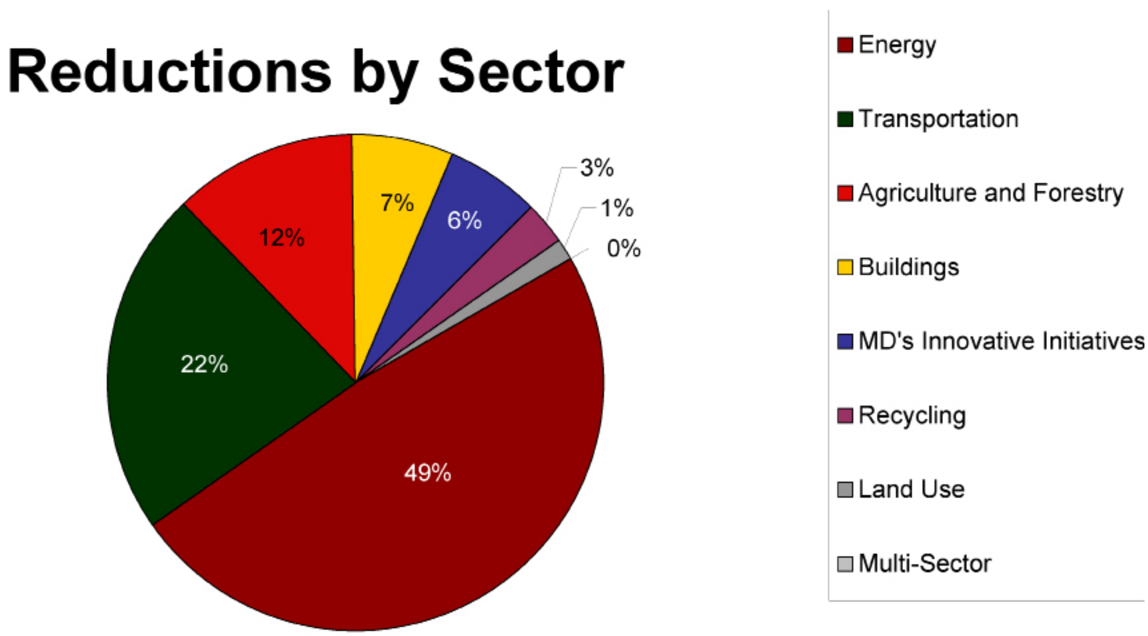
Figure ES-3
The 2006 "Baseline" GHG Inventory



The 2006 emissions inventory is dominated by emissions from the energy (electricity use and residential, commercial and industrial fuel use) and transportation sectors.

The programs in the draft Plan are organized by key sectors of the economy. Figure ES-4 shows how the reductions in the draft Plan break out by sector.

Figure ES-4
GHG Reductions in the GGRA Plan by Sector



The majority of the reductions in the draft Plan also come from the energy and transportation sectors.

Eleven State agencies are implementing at least one program in the draft Plan. Figures ES-5 through ES-9 identify the agency responsible for implementing each of the 65 programs.

MDE Programs

MDE is responsible for implementation of 19 of the 65 programs in the Plan. High profile MDE initiatives include the Regional Greenhouse Gas Initiative (RGGI) and the Maryland Clean Cars Program. RGGI, a nine state partnership, is the country's first successful GHG cap-and-trade program for power plants. The Maryland Clean Cars Program ensures that vehicles sold in Maryland meet the toughest possible GHG emissions limits provided for in law. Figure ES-5 lists all of the MDE programs.

Figure ES-5
MDE Programs

Regional Greenhouse Gas Initiative
Maryland Clean Cars Program
National Fuel Efficiency & Emissions Standards for Medium- and Heavy- Duty Trucks
Clean Fuel Standard
Recycling & Source Reduction
GHG Early Voluntary Reductions
GHG New Source Performance Standard
Title V Permits for GHG Sources
The Transportation and Climate Initiative
Leadership-By-Example: Local Government
Leadership-By-Example: Federal Government
Leadership-By-Example: Maryland Colleges and Universities
GHG Emissions Inventory Development
Program Analysis, Goals and Overall Implementation
Outreach and Public Education
GHG Emissions Reductions from Imported Power
Boiler Maximum Achievable Control Technology (MACT)
GHG Prevention of Significant Deterioration Permitting Program
Energy Efficiency in the Power Sector: General

MDOT Programs

MDOT is responsible for 14 of the Plan's programs (Figure ES-6). These initiatives include efforts to advance cleaner technologies, such as the Electric Vehicle program and other public transportation initiatives designed to reduce the number of conventional fueled vehicles on the road.

Many of the transportation programs become stronger over time as older vehicles are replaced by newer, cleaner vehicles. Consequently, significant additional GHG reductions will be generated by these strategies between 2020 and 2050.

Figure ES-6
MDOT Programs

Public Transportation Initiatives
Initiatives to Double Transit Ridership by 2020
Intercity Transportation Initiatives
Bike and Pedestrian Initiatives
Pricing Initiatives
Transportation Technology Initiatives
Electric Vehicle Initiatives
Low Emitting Vehicle Initiatives
Evaluate the GHG Emissions Impacts from Major New Projects and Plans
Airport Initiatives
Port Initiatives
Freight and Freight Rail Strategies
Federal Renewable Fuels Standard
Corporate Average Fuel Economy Standards: Model Years 2008-2011

MEA Programs

MEA is responsible for implementing nine of the programs in the draft Plan (Figure ES-7). The majority of the MEA programs are part of two major initiatives: the EmPOWER Maryland energy efficiency and conservation effort, and the Renewable Portfolio Standard (RPS) program designed to promote development of renewable energy.

Both the EmPOWER Maryland effort and the RPS program are based upon Maryland laws adopted in 2007, 2008 and 2009.

Figure ES-7
MEA Programs

EmPOWER: Energy Efficiency in the Residential Sector
Promoting Hybrid and Electric Vehicles
EmPOWER: Energy Efficiency in the Commercial and Industrial Sectors
EmPOWER: Energy Efficiency: Appliances and Other Products
EmPOWER: Utility Responsibility
The Maryland Renewable Energy Portfolio Standard Program
Incentives and Grant Programs to Support Renewable Energy
Offshore Wind Initiatives to Support Renewable Energy
Combined Heat and Power

DNR Programs

DNR is responsible for implementing seven of the programs in the draft Plan (Figure ES-8). DNR's programs encourage sustainably managed natural resources which can maximize carbon sequestration and reduce GHGs from the atmosphere. Increasing the acreage and enhancing the condition of forests, wetlands and urban trees is a critical component of mitigating climate change in the State.

Photo by R Fizer, 2010. Charter boats at Chesapeake Beach MD impacted by flooding from nor'easter.

Figure ES-8
DNR Programs

Managing Forests to Capture Carbon
Creating Ecosystems Markets to Encourage GHG Emissions Reductions
Increasing Urban Trees to Capture Carbon
Creating and Protecting Wetlands and Waterway Borders to Capture Carbon
Geological Opportunities to Store Carbon
Planting Forests in Maryland
Expanded Use of Forests and Feedstocks for Energy Production

Other Agency Programs

The Maryland Department of General Services (DGS), Maryland Department of Housing and Community Development (DHCD), Maryland Department of Planning (MDP), Maryland Department of Agriculture (MDA), Maryland Insurance Agency (MIA), Maryland Department of Business and Economic Development (DBED), and Maryland Department of Health and Mental Hygiene (DHMH) developed 16 of the 65 GHG reduction programs (Figure ES-9). These GHG reduction programs focus primarily on reducing GHG emissions from the residential, commercial, and industrial buildings, transportation and land use sectors.

Figure ES-9
Other Agency Programs

Program	Lead Agency
State of Maryland Initiative to Lead by Example	DGS
State of Maryland Carbon and Footprint Initiatives	DGS
Green Buildings	DGS
Main Street Initiatives	DHCD
Building and Trade Codes in Maryland	DHCD
Energy Efficiency for Affordable Housing	DHCD
Reducing GHG Emissions from the Transportation Sector through Land Use and Location Efficiency	MDP
Transportation GHG Targets for Local Governments a nd Metropolitan Planning Organizations	MDP
Funding Mechanisms for Smart Growth	MDP
GHG Benefits from Priority Funding Areas and Other Growth Boundaries	MDP
Conservation of Ag Land for GHG Benefits	MDA
Buy Local for GHG Benefits	MDA
Nutrient Trading for GHG Benefits	MDA
Pay-As-You-Drive® Insurance in Maryland	MIA
Job Creation and Economic Development Initiatives	DBED
Public Health Initiatives Related to Climate Change	DHMH

Maryland's 2008 Climate Action Plan

On April 20, 2007, Governor O'Malley signed an executive order establishing the Maryland Commission on Climate Change, which issued its Climate Action Plan for the State in August 2008. The Climate Action Plan includes 42 recommendations for reducing GHG and 19 recommendations for adapting to climate change in Maryland as well as an exploration into the science behind all facets of climate change in Maryland.

The report is available on the Maryland Department of the Environment's website at: http://www.mde.state.md.us/programs/Air/ClimateChange/Pages/Air/climatechange/legislation/index.aspx

Next Steps – Getting to the Final GGRA Plan

The final GGRA Plan is due in December of 2012. Issuance of this draft GGRA Plan commences the beginning of a comprehensive public review and comment process.

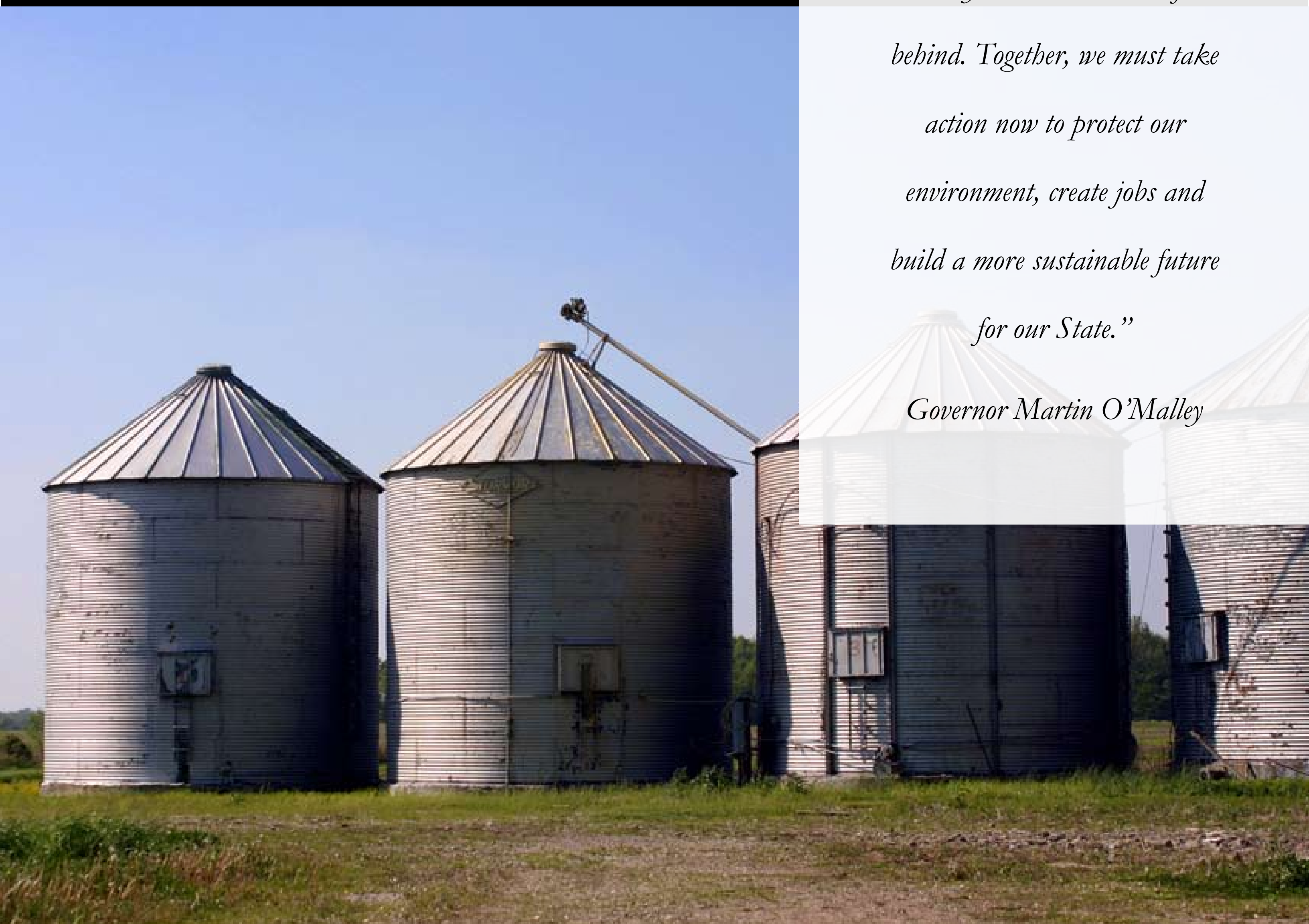
MDE will be providing briefings on the Plan to appropriate Committees of the Maryland General Assembly and also begin a series of State-wide workshops on the draft Plan in Spring of 2012.

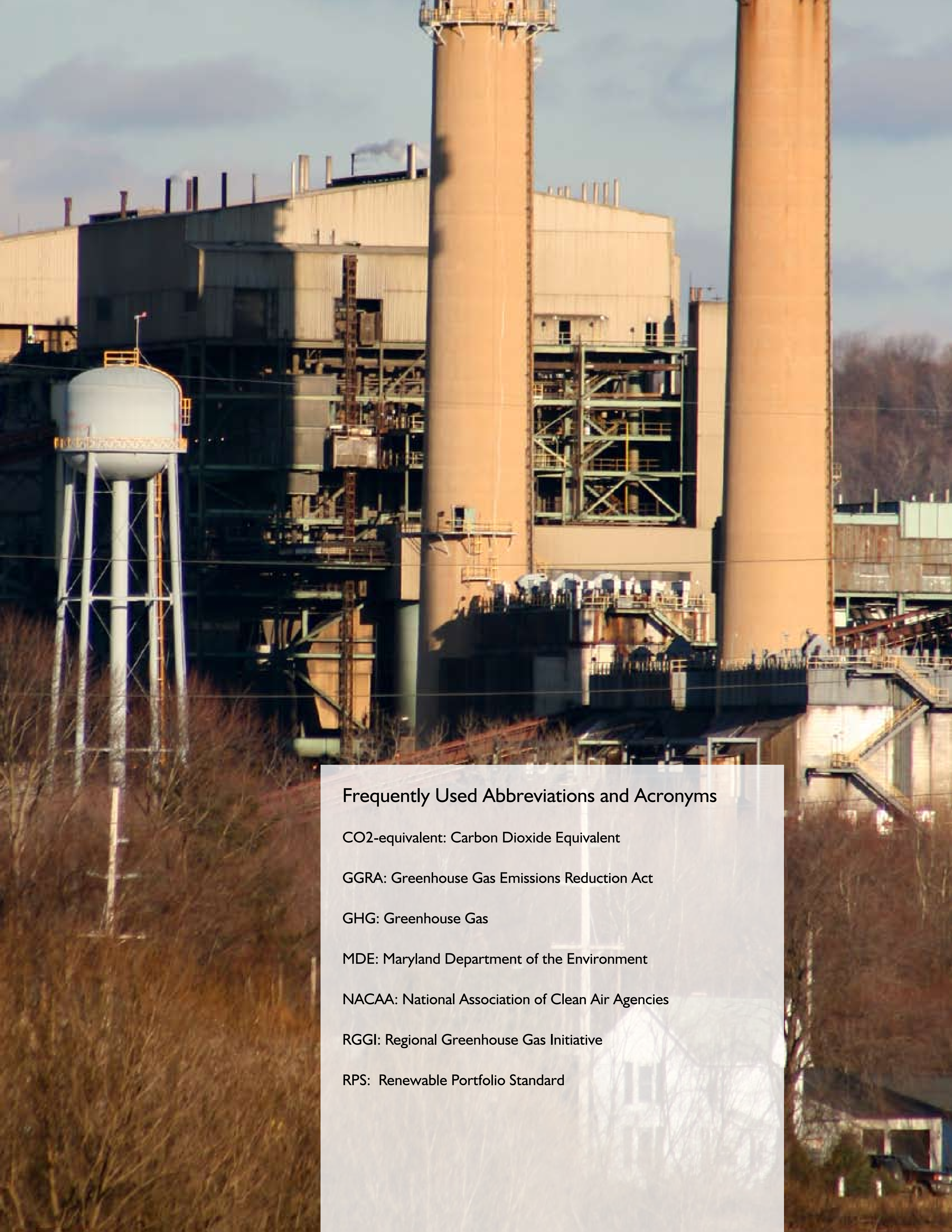
MDE and the other State agencies involved in developing and implementing the GGRA Plan are continuing to refine their analyses of the projected emission reductions and economic benefits associated with the Plan.

This document should be viewed as a work in progress. Many improvements to the Plan are expected between now and the end of 2012, when the final plan is due to the Governor and General Assembly. They will be incorporated into the final version of the Plan.

"For our prosperity, for our current and future generations, we must commit to reducing greenhouse gas emissions. Maryland will not be left behind. Together, we must take action now to protect our environment, create jobs and build a more sustainable future for our State."

Governor Martin O'Malley





Frequently Used Abbreviations and Acronyms

CO2-equivalent: Carbon Dioxide Equivalent

GGRA: Greenhouse Gas Emissions Reduction Act

GHG: Greenhouse Gas

MDE: Maryland Department of the Environment

NACAA: National Association of Clean Air Agencies

RGGI: Regional Greenhouse Gas Initiative

RPS: Renewable Portfolio Standard

Chapter

1 Background

Not Your Grandfather's Air Pollution

Greenhouse gases (GHG) are not like other air pollutants. GHGs are so named because they are heat retaining gases and they are fairly abundant in the atmosphere. Ozone, fine particles and other air pollutants are found in very small amounts and undergo chemical changes in the atmosphere so that harmful levels typically dissipate after a few hours, days or weeks. GHGs, on the other hand, accumulate in the atmosphere and stay there for a very long time. A pound of carbon dioxide emitted today by driving a car or using electricity generated by burning fossil fuels, such as coal, will still be in the atmosphere decades to hundreds of years from now. It is this persistence in the atmosphere coupled with their heat retaining properties that create the problem. It does not matter if the GHG is emitted in Maryland, China, or elsewhere – the climate impact is the same.

Why is the world's climate changing?

Key Points:

Maryland's climate has been variable but stable for several thousand years.

Maryland's climate warmed after the peak of the last Ice Age and has been relatively stable for the past 6,000 years. Around these long-term average conditions there have, of course, been variations in temperature and precipitation due to ocean current cycles, solar activity, and volcanic activity.

Atmospheric concentrations of greenhouse gases have dramatically increased.

Certain gases that trap the sun's energy from radiating back into space have increased since pre-industrial times. Carbon dioxide concentrations exceed those experienced over at least the last 650,000 years. Average global temperature and sea level began to increase rapidly during the 20th century.

Global warming is unequivocal.

The Intergovernmental Panel on Climate Change found the evidence for the warming of the Earth to be "unequivocal." The IPCC concluded that most of the observed temperature increase since the middle of the 20th century is very likely due to the observed increase in GHGs.

Why Should Maryland Care?

Climate change resulting from the accumulation of GHGs will affect Maryland in a variety of ways. More obvious impacts could include continued sea level rise; an increased risk for extreme events such as drought, storms, flooding, and forest fires; more heat-related stress; the spread of existing or new vector-born disease; and increased erosion and inundation of low-lying areas along the State's shoreline and coast. In many cases, Maryland is already experiencing these problems to some degree, today. Climate change raises the stakes in managing these problems by changing the frequency, intensity, extent, and magnitude of these problems.

The Chesapeake Bay region's geography and geology make the State one of the three most vulnerable areas of the country to changes resulting from sea level rise. Health risks to Maryland's citizens, including heat-related stress and cardiovascular mortality and morbidity, respiratory illness, altered infectious disease patterns (both vector-borne and water-borne diseases), impacts to water supply and quality, and direct or mental harm from extreme storm events and flooding, are all possible. Maryland's large agriculture also will be affected, as many of the stressors farms already face are likely to intensify or become less predictable, such as drought frequency, winter flooding, pests and disease, and ozone levels.

What Happens When GHGs Accumulate?

Simply stated, the accumulation of GHGs in the atmosphere traps heat from the sun and warms the planet. As synthesized by the Intergovernmental Panel on Climate Change, when GHG concentrations in the atmosphere – expressed as carbon dioxide equivalent (CO2-equivalent) – reach 445 to 490 parts per million, it will increase the annual mean temperature of the earth's surface 2 - 2.4°C (3.6 - 4.3°F) above pre-industrial levels.

The scientific evidence assembled by the international community and Maryland's best scientists indicates that temperature increases above this level are very likely to result in dangerous consequences in terms of food production, biodiversity, and initiation of uncontrollable and unpredictable changes in the earth's climate system, such as rapid melting of polar ice caps and changes in the ocean circulation that regulate the planet's climate. GHG concentrations have to be held in the range of 445 to 490 parts per million CO2-equivalent to avoid this level of global warming.

Just this year, in May of 2011, the National Academy of Sciences' National Research Council released a new report confirming the mounting scientific evidence pointing to human-caused emissions of GHGs as the most likely cause of the noticeable increase in strange climate and weather across the world over the past few years. The report concludes that the most efficient way to accelerate emissions reductions is through a coordinated national response. Maryland has seen extremely hot summers, wet falls, tornadoes and severe flooding in both 2010 and 2011.

So What's the Rush?

To stabilize GHGs at or below this level requires substantial early action because atmospheric concentrations are approaching the 445 to 490 parts per million range quickly. The international scientific community predicts these ranges may have been breached already. Global annual man-made GHG emissions have grown by 70% between 1970 and 2004.

What are GHGs:

Gases that trap heat in the atmosphere are often called GHGs. Some GHGs, such as carbon dioxide, occur naturally and are emitted to the atmosphere through natural processes and human activities. Other GHGs (e.g., fluorinated gases) are created and emitted solely through human activities. The principal GHGs that enter the atmosphere because of human activities are:

A number of wetland bird species such as the American bittern, common loon, and sora are projected to decline as a result of climate-driven changes including degradation of inland wetlands (due to summer drought and winter or spring flooding) and loss or degradation of coastal wetlands (due to rising sea levels). Overall, significant change is projected for many of the Northeast's most colorful species, such as certain wood warblers; most beautiful singers, including the hermit thrush and veery; and iconic species, such as the Baltimore oriole, goldfinch, and common loon. Although many of the negatively affected species may persist in more northerly Canadian habitats, this will be cold comfort to bird enthusiasts in the U.S. Northeast.

Source: http://www.climatechoices.org/assets/documents/climatechoices/confronting-climate-change-in-the-u-s-northeast.pdf p.52

- **Carbon Dioxide:** Carbon dioxide enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement). Carbon dioxide also is removed from the atmosphere (or "sequestered") when it is absorbed by plants as part of the biological carbon cycle.
- **Methane:** Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills.
- **Nitrous Oxide:** Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste.
- **Fluorinated Gases:** Hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are synthetic, powerful greenhouse gases that are emitted from a variety of industrial processes. These gases are typically emitted in smaller quantities, but because they are potent GHGs, they are sometimes referred to as High Global Warming Potential gases.

What is CO2-equivalent?

A scale has been developed to allow the comparison of all the GHGs on an equivalent level. Carbon dioxide was selected as the compound to which all others would be equated since carbon dioxide is by far the most prevalent GHG and has been identified as having the Global Warming Potential of 1. The goals, inventory and reductions in this plan are expressed as carbon dioxide equivalents or CO2-equivalent based in the conversions to CO2-equivalent below.

Maryland has used the established Intergovernmental Panel on Climate Change global warming potential's for the GHG pollutants.

Figure 1-1
GHG Global Warming Potentials

GHG Pollutant	Global Warming Potential
Carbon Dioxide	1
Methane	21
Nitrous Oxide	310
Sulfur Hexafluoride	23,900
Perfluorocarbons	9,200
Hydro Chlorofluorocarbons	11,700

The rate of increase of carbon dioxide levels has grown as more developing countries become industrialized and the use of fossil fuel for transportation and electricity production has grown. Levels of methane and carbon dioxide now exceed the natural ranges from the last 650,000 years, which, for carbon dioxide, varied between 180 and 300 parts per million. Over the past century, GHG levels rapidly increased well out of this range, and are now around 390 parts per million. Atmospheric nitrous oxide far exceeds pre-industrial levels.

Considering that GHGs remain in the atmosphere for a long time, global reductions in emissions by 50 to 85% below 2000 levels would be required by 2050 in order to reach the 445 to 490 parts per million level of stabilization. Developed countries such as the U.S. are responsible for the majority of the GHG emissions and have much higher emissions on a per capita basis than developing nations, so they would have to achieve reductions on the high side of this range in order to achieve this result.

Consequently, wide-spread concern over climate change has lead to action from many different organizations including governments. Governments, at both the national and state level, and political partnerships such as the European Union, have adopted policies and goals intended to reduce GHG emissions on both a voluntary and mandatory level. These actions range from adopting GHG reduction legislation to implementing clean energy policies and promoting energy efficiency, renewable energy alternatives, and conservation.

This version of the 2012 Greenhouse Gas Emissions Reduction Act (GGRA) Plan fulfills the mandate to, by 2011, propose a plan that achieves a 25% Statewide reduction in GHG emissions by 2020, while also spurring job creation and helping improve the economy. The final plan is due in December of 2012. The GGRA also requires a report in 2015 that, amongst other things, requires MDE to provide a recommendation on what the State's longer term reduction target should be. In 2008, the Maryland Commission on Climate Change, appointed by Governor O'Malley, recommended that Maryland consider a 2050 goal as high as a 90% reduction from 2006 levels.

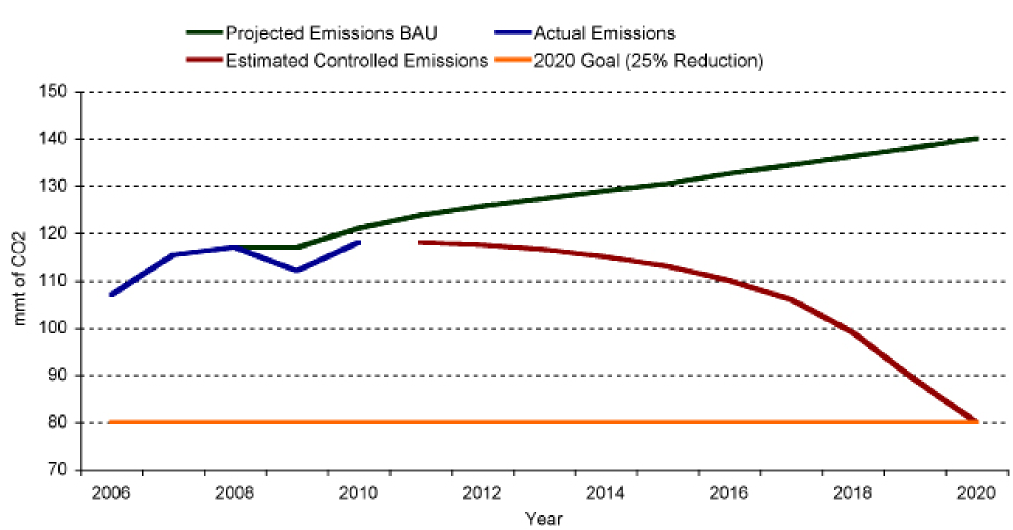
This plan spurs reductions in GHGs through incentives that increase energy efficiency using existing technologies, and identifies ways to transition to new energy sources and stimulate further technology development. This requirement, like those of the European Union and leadership states in the U.S., is based on the scientific conclusions of the Intergovernmental Panel on Climate Change regarding the level and pace of reductions that industrialized societies will need to achieve in order to keep global concentrations of GHGs below the 445 parts per million lower limit.

The plan also shows that the measures to reduce GHG emissions can spur the creation of new jobs and help improve the economy.

More Is Needed

Although Maryland has taken important first steps, more GHG reduction programs are needed to stabilize emissions (Figure 1-2). The green line on the figure shows Maryland's GHG emissions if they remained unchecked and continued to grow absent any climate programs. The blue line shows how recent actions have altered emissions, and the red line projects how the reductions from the programs in the proposed plan will meet the 25% reduction target by 2020.

Figure 1-2
Projected Unregulated Growth of Maryland Greenhouse Gas Emissions through 2020 Compared to GGRA 2020 Goal
(in million metric tons of carbon dioxide equivalent)



This version of the 2012 GGRA Plan identifies 65 programs that, if implemented successfully, will reduce GHG emissions below the 25% reduction goal for 2020 at a net savings to Maryland citizens, businesses and the State's overall economy. Maryland has already made significant progress in enacting programs that will dramatically reduce GHG emissions. The Maryland Clean Cars Program, the Regional Greenhouse Gas Initiative (RGGI), EmPOWER Maryland and the Renewable Energy Portfolio Standard (RPS), in addition to recent legislation aimed at GHGs, get Maryland about 70% of the way to the 2020 goal.

Steps in the right direction

The Healthy Air Act

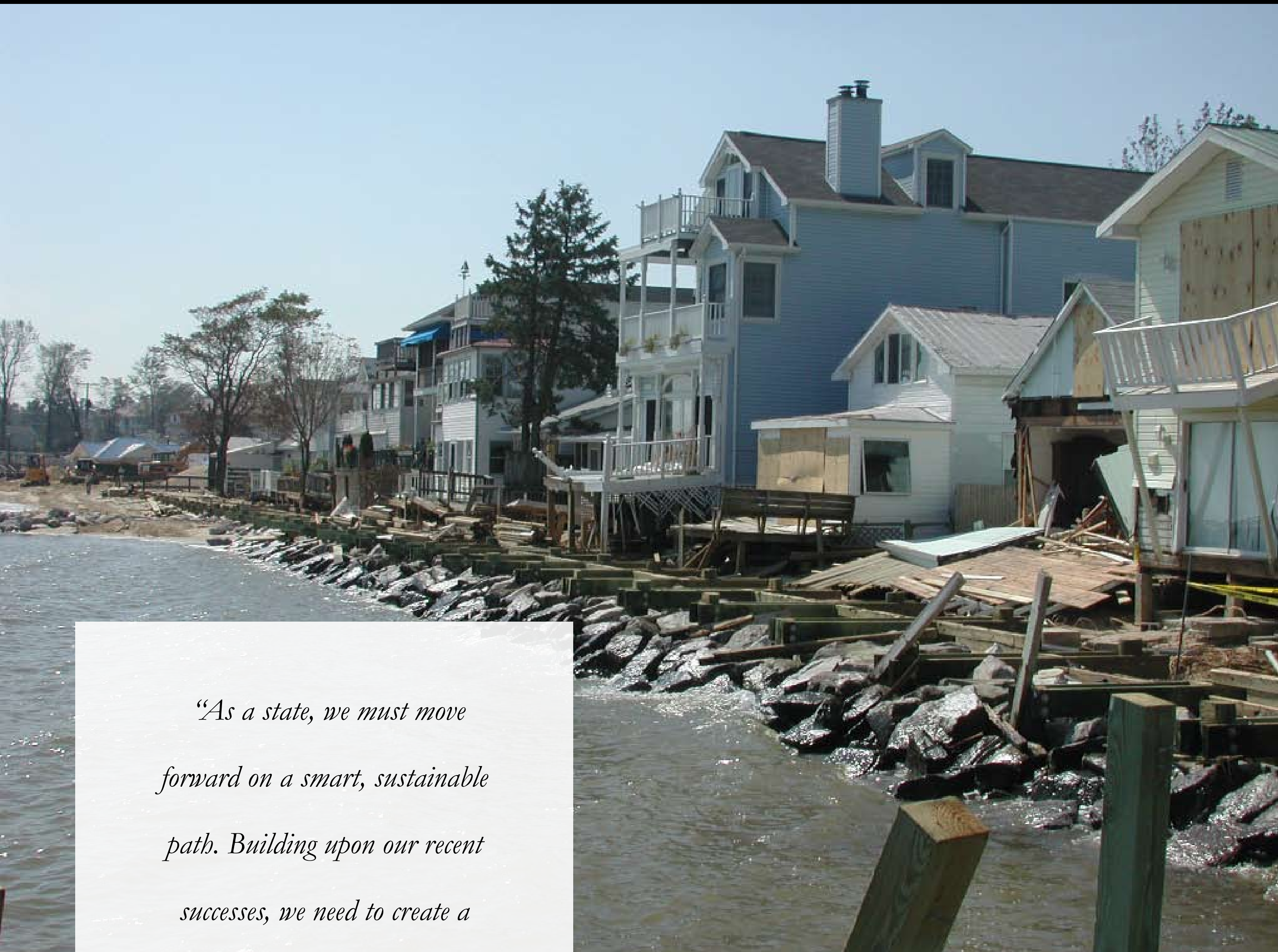
Adopted as Maryland law in 2006, the Healthy Air Act included a provision for the State to join RGGI, a groundbreaking cap and trade program designed to reduce carbon dioxide emissions from power plants in participating states in the Northeast and Mid-Atlantic. Maryland's participation in RGGI is expected to reduce carbon dioxide emissions by up to approximately 17.71 million tons by 2020. The Healthy Air Act also reduces pollutants that degrade the Chesapeake Bay and Maryland's air quality. Sources that emit pollution, like Constellation Energy, created new Maryland jobs to implement the Healthy Air Act.

The Maryland Clean Cars Act

Sponsored by Governor O'Malley and adopted in 2007, this law required Maryland to implement the California Clean Cars Program which requires the most stringent emissions standards for light duty cars and trucks allowed by law. The Maryland Clean Cars Program began with vehicle model year 2011. Total expected reductions, when combined with other related transportation programs, could be up to approximately 9.48 million tons by 2020. The program also will reduce cancer-causing pollutants by 2,100 tons per year and nitrogen pollution by 1,500 tons per year by 2027. By 2030, nitrogen oxide emissions are expected to be reduced by 7.1 tons per day. This program covers new cars and trucks and the benefits, although initially small, will increase steadily over time. The Clean Cars Act also helps the Chesapeake Bay water quality and air quality. When fully implemented, it is projected to annually contribute $11,230,937 to the State's gross domestic product.

EmPOWER Maryland

Launched by Governor Martin O'Malley in July 2007 and codified by the General Assembly in its 2008 session, this program is designed to reduce per capita electricity use



"As a state, we must move forward on a smart, sustainable path. Building upon our recent successes, we need to create a foundation for both our future and our children's future. We have to make tough decisions, governing through green initiatives and living our own lives as examples."

Governor Martin O'Malley,
January 2011

Photo courtesy of the Maryland Historical Trust, September 2003. "This is an assessment photo of damage caused by Hurricane Isabel. North Beach, Calvert County, Maryland. High water penetrated several blocks into the town flooding many historic residences and commercial structures, but it was houses along Atlantic Avenue that were hardest hit. It is clear that the historic character of the beachfront of North Beach will be lost."

NACAA's Primer on Climate Change Science provides a summary of the most important information on climate change science in one document. The primer explains the greenhouse effect, the major GHGs and their sources, the differences and similarities between GHGs and conventional air pollutants, and it documents the scientific consensus that the planet is warming and that this warming is from man-made causes.

Available: http://www.4cleanair.org/Documents/NACAAClimateSciencePrimerpost.pdf by Maryland consumers 15% by 2015. This could reduce GHG emissions by about 7.27 million tons in 2020. As part of the EmPOWER Maryland legislation, Maryland's five utilities offer many programs to save ratepayers money resulting from reduced electricity consumption. These programs include lighting and appliance rebates for homeowners, home energy audits, commercial lighting rebates, and energy efficiency services for industrial facilities. The Maryland Energy Administration also offers a variety of programs that encourage energy efficiency improvements as part of EmPOWER Maryland.

Greenhouse Gas Emissions Reduction Act

Another State sponsored legislative initiative, adopted as a Maryland law in 2009, with broad support from the General Assembly and stakeholders, the GGRA requires MDE to work in cooperation with State agencies to develop a 2012 the GGRA Plan to achieve a 25% reduction in GHGs from a 2006 baseline by 2020 that creates jobs and improves the economy. This reduction will require approximately 57 million metric tons of reduction, no small task, making Maryland's law one of the most aggressive currently adopted by states.

Now is the best time to start!

Policy decisions regarding climate change made today have a larger influence on the future than most people realize. To stay below the 445 parts per million CO2-equivalent lower limit, we must eliminate growth in the amount of GHGs emitted, as well as make a significant reduction in the amount of GHGs we emit. GHGs persist in the atmosphere for a long time accumulating quite rapidly. Think of it this way: a program that keeps a ton of GHGs out of the atmosphere today is worth more than the same program started five years from now, because five years of GHG accumulation will be avoided if started today. Here are two example scenarios:

1. **"Business-as-Usual" Scenario:** Under this scenario, business-as-usual activities allow GHGs to accumulate. Like compounding interest on an unpaid credit card debt, GHG will accumulate (the needed emission reductions grow larger every year) until a point is reached where we can no longer make payments because the reduction measures are vastly harder, or impossible, and too expensive, to achieve the goal by 2020, or any other year. The ability to level off the growth in GHGs and reduce emissions to stay within the 445 to 490 parts per million CO2-equivalent range may be possible now, but if we delay and try to compress the time frame for these reductions, we may not be able to succeed.

2. "Early Action" Scenario: Under this scenario, the timing and pace of GHG accumulation is metered by implementing early and significant GHG reduction programs now, and phasing in medium and long-term programs on an aggressive "ramp up" schedule. In so doing, continued rapid GHG accumulations – the compounding interest – is avoided and Maryland begins stabilizing and reducing emissions. This puts the State on a sustainable path to its 2020 goal through controlling growth in GHG emissions and transitioning into a clean energy economy. Even programs that won't yield reductions in the early years must be launched now in order to ramp up to their full effectiveness within the needed time frame.

Shrinking Our Footprint Will Grow Maryland's Economy

Maryland's GGRA recognizes that human activities such as sprawl and coastal development and the burning of fossil fuels contribute to the causes and consequences of climate change. The GGRA mandates Maryland to reduce its State-wide GHG emissions 25% from a 2006 baseline by 2020. Reducing emissions is not enough; the GGRA requires that reductions be done in a way that has a positive effect on the State's economy and job creation and does not have a direct negative impact on manufacturing jobs.

This version of the 2012 GGRA Plan identifies a suite of cost-effective GHG reduction programs which, if fully implemented, will benefit Maryland consumers, businesses and the State's economy as a whole. The Regional Economic Studies Institute recently estimated that by implementing these policies, Maryland could see as much as a $6.1 billion increase in the State gross domestic product by 2020. The impact and benefit of our climate policies will depend on how and when they are implemented (the sooner the better).

Energy Efficiency – The Low Hanging Fruit

Energy efficiency is the fastest and least expensive approach available to reduce GHG emissions. According to the EPA-DOE National Action Plan for Energy Efficiency, energy efficiency will not only help to address GHG emissions, but actions in this area also can lower energy bills, help stabilize energy prices, enhance electric and natural gas system reliability thereby reducing the need for new generation sources, and reduce harmful air pollutants. In fact, some states with well-designed energy efficiency programs are saving enough energy at an average cost of building a new electric power plant to avoid the need for a new power plant.

Maryland research suggests even greater savings for the State. A 2006 study funded by the Maryland Department of Business and Economic Development and the Maryland Energy Administration, and carried out by the Baltimore-based International Center for Sustainable Development, found that energy efficiency can reduce energy costs to homeowners, businesses, institutions and government by 60 to 70%, which is a great savings over adding the cost of building new generating capacity in Maryland.

As noted earlier, Maryland has launched important energy efficiency programs such as EmPOWER Maryland and RGGI, which have started yielding GHG emission reductions. This version of the 2012 GGRA Plan includes many energy efficiency programs that will yield additional early, significant and cost-effective GHG reductions.

Growing Clean Energy Industries and Green Collar Jobs

Maryland can position itself as a national leader in developing clean energy industries and growing an indigenous green collar work force. The 2006 International Center for Sustainable Development study found that by developing clean energy industries, Maryland could create between 144,000 and 326,000 jobs in the State over the next 20 years, contributing $5.7 billion in wages and salaries to Maryland citizens, boosting State and local tax revenues by $973 million and increasing gross State product by $16 billion. It noted that Maryland's existing capacity to capture energy efficiency savings suffered from a lack of businesses that deliver energy efficiency services, such as energy service companies and home weatherization contractors. The International Center for Sustainable Development study found that although a number of states are investing aggressively in the clean energy industry, valued at $50 billion a year worldwide and growing at the rate of 30% a year, Maryland was lagging behind in this sector and missing out on huge economic development and job growth potential. Since 2006, Maryland has been pushing very hard to tap into this win-win opportunity.

In 2011, the Regional Economic Studies Institute estimated that, by addressing climate change, Maryland could create between 12,900 and 60,800 new jobs in the State by 2020 with wage increases between $4.2 billion and $6.2 billion. With investments in energy efficiency since 2009 through the EmPOWER Maryland program, Maryland has moved ahead with other states to create green jobs and businesses. Examples of Maryland's robust business and job opportunities abound.

They include: designing and constructing green buildings; retrofitting older buildings with energy efficient appliances and technologies; expanding and maintaining public transit systems; designing, constructing, and operating windmills, biomass generators, and solar collectors; and research and development in a wide array of new practices and technologies.

Shrinking Energy Costs

In addition to paying lower monthly utility bills through energy savings from RGGI, EmPOWER Maryland and other programs implemented prior to the draft 2012 GGRA Plan, Maryland consumers will be able to offset higher prices at the gas pump through the Maryland Clean Cars program, which encourages fuel-efficient and low emissions vehicles. Other programs also lower energy use in the transportation sector such as transit-oriented development designed to reduce vehicle miles traveled.

States Provide Leadership for a Difficult Challenge

Maryland began developing and implementing climate programs as early as 2006, and the programs usually had a dual purpose. The Healthy Air Act and the Maryland Clean Cars programs reduce air pollution as well as GHG emissions. EmPOWER Maryland and the RPS were focused on reducing electricity demand to provide an adequate electricity supply during peak demand and avoid the need for new power plants and thus reduce electricity costs. These programs also provide substantial GHG emissions reductions. In the face of growing concerns over the pace of climate change and the lack of federal leadership, Maryland and other states assumed a leadership role in developing programs to reduce GHG emissions. Leadership by Maryland and other select states on climate issues encourages states that are "on the fence" about climate change to seriously consider making the hard policy decisions to reduce GHG emissions.

Most states are not equipped to provide all of their energy needs. Attempts to move toward cleaner fuels and renewable energy are often inconsistent and would benefit from a uniform national policy.

Since 2006, Maryland's work on the front lines to develop climate programs has also pushed the federal government to acknowledge the need for uniform national climate policy. Federal movement on national climate policy, which seemed imminent in 2009, has been relegated to a much lower priority. In the meantime, the nation is relying upon states, like Maryland, California and New York to apply pressure for more work on national climate policy (Figure 1-3). The transition to a clean energy economy is a very difficult task and will require time to develop these alternative options. From commuters driving the beltways, to heating homes and businesses, and to buying locally made products, Marylanders rely heavily on fossil fuels which have been shown to contribute to the devastating effects of climate change. The option simply to stop fossil fuel use without alternative options is unrealistic.

WHAT WE DO IN MARYLAND MATTERS IN MARYLAND

Maryland Is Small – Why Should We Care?

Small Geography, Big Footprint

Although Maryland is a small state, it is responsible for nearly as many GHG emissions as Sweden and Norway combined. Maryland's gross emissions have increased by about 18% between 1990 and 2005, a faster rate of growth than the U.S. as a whole (16% between 1990 and 2005). Per capita GHG emissions by Maryland citizens also grew between 1990 and 2005, during a period when per capita emissions for the U.S. as a whole decreased. Relative to its size, Maryland has a big and growing carbon footprint. As a GHG "Bigfoot," it is incumbent on the State to take leadership responsibility to shrink both its State-wide and per capita GHG emissions.

Local Actions Yield Local Benefits

In addition to stimulating economic development and creating jobs, GHG reduction programs will result in other local benefits for Maryland citizens. For example, policies in place to reduce GHG emissions also will reduce air and water pollution in Maryland.

The Maryland Department of Natural Resources' Urban Tree Canopy project represents an effective strategy for local communities to reduce GHGs because trees sequester carbon dioxide from the atmosphere as well as cool nearby buildings, reducing the need for air conditioning and lowering the demand for mid-day electricity. By contributing to lower summertime temperatures at street level, trees also improve ambient air quality. The lower temperatures slow the formation of ground-level ozone. The Marylanders Plant Trees program has resulted in approximately 54,000 trees planted to date.

Fiqure 1-3
States with Law Requiring GHG Reductions

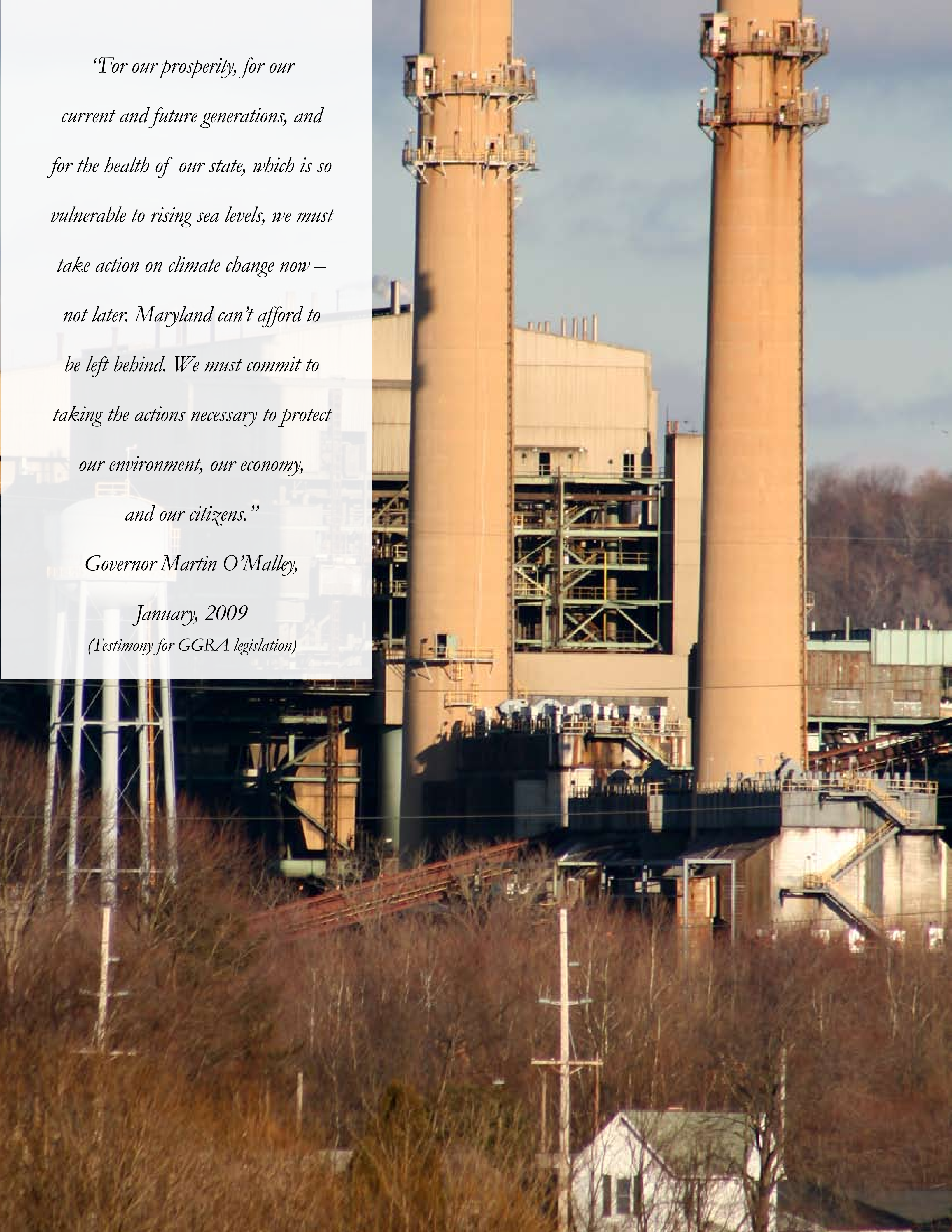
State	Year of Legislation	GHG Reduction Goal(s)
Arkansas	2007	By 2020: 20% below 2000 levels. By 2025: 35% below 2000 levels. By 2035: 50% below 2000 levels.
California	2006	By 2020: 1990 levels.
Connecticut	2008	By 2020: 10% below 1990 levels. By 2050: 80% below 2001 levels.
Hawaii	2007	By 2020: 1990 levels.
Maine	2003	By 2020: 10% below 1990.
Maryland	2009	By 2020: 25% below 2006 levels.
Massachusetts	2008	By 2020: 10% below 1990 levels.
Minnesota	2007	By 2015: 15% below 2005 levels. By 2025: 30% below 2005 levels. By 2050: 80% below 2005 levels.
New Jersey	2007	By 2020: 1990 levels. By 2050: 80% below 2006 levels.
Oregon	2009	By 2020: 10% below 1990. By 2050: 75% below 1990.
Vermont	2007	By 2012: 25% below 1990 levels. By 2028: 50% below 1990 levels.
Washington	2008	By 2020: 1990 levels. By 2035: 25% below 1990 levels. By 2050: 50% below 1990 levels.

"For our prosperity, for our current and future generations, and for the health of our state, which is so vulnerable to rising sea levels, we must take action on climate change now – not later. Maryland can't afford to be left behind. We must commit to taking the actions necessary to protect our environment, our economy, and our citizens."

Governor Martin O'Malley,

January, 2009

(Testimony for GGRA legislation)



Other synergies abound. Managing forests for enhanced carbon sequestration from the atmosphere also promotes forest health, biodiversity and water quality and reduces soil erosion. Transit-oriented development programs not only reduce GHGs by reducing vehicle miles traveled by cars, these projects also reduce air pollution, highway congestion and lost productivity, as well as public expenditures for roads, sewers and water infrastructures and school bus transportation driven by sprawl development. Agricultural nutrient trading programs promote soil carbon sequestration and protect the Chesapeake Bay watershed by reducing nitrogen and phosphorus loads from fertilizer run-off through a market-driven, public marketplace. Maryland's water-based livelihoods, cultural heritage and unique quality of life derive from the Chesapeake Bay and its many tributaries.

Maryland's exceptional vulnerability to sea level rise poses a unique leadership responsibility on Marylanders to reduce State and personal GHG footprints. We have a tremendous amount to lose. We also have a tremendous amount to gain.

State Leadership Is Pushing Federal Action

It is true that acting alone, Maryland cannot reduce the world's GHGs by much. But together with more than the dozen other states that have adopted GHG reduction laws and have implemented climate plans, the cumulative impact will be significant. These efforts are forcing the federal government to continue considering comprehensive climate change and clean energy policy, a vitally needed step toward achieving reductions globally.

Climate Programs in Maryland are GGRA-great!!!

On October 1, 2009, Maryland's GGRA became law. It recognizes that human activities such as sprawl and the burning of fossil fuels contribute to the causes and consequences of climate change. The GGRA requires Maryland to reduce its State-wide GHG emissions 25% from a 2006 baseline by 2020. Reducing emissions is not enough; the GGRA requires that reductions be done in a way that has a positive effect on the State's economy and the creation of new jobs, while also protecting existing jobs.

Goodpaster Hall - St. Mary's College, St. Mary's County

Photo courtesy of St. Mary's College

Green Initiatives at St. Mary's College of Maryland

At St. Mary's, sustainability is deeply rooted in the college mission and campus culture. In recent years, the College has worked to translate this commitment to the environment to its campus infrastructure. Goodpaster Hall was selected as one of two sites for a state-funded pilot program in high performance building construction. Opened in 2008, Goodpaster Hall earned a LEED Silver rating and has achieved 30%-40% energy savings compared to an average building of its size. Subsequent construction projects: Glendening Hall and the Muldoon River Center also have been built to LEED standards, and the new Anne Arundel hall is anticipated to achieve LEED Gold.

The College also has worked to reduce the environmental impact of the campus' energy usage, reducing its carbon footprint by more than 4,600 tonnes of CO2-equivalent each year through the implementation of an energy performance contract and the installation of a 37-well geothermal heat pump system. St. Mary's students have been extremely supportive of campus environmental initiatives. In addition to providing half of the funding for the geothermal heat pump system, students have voted twice to raise their student fees in order to finance the purchase of renewable energy credits to offset 100% of campus electricity consumption (2007), and to fund the Green St. Mary's Revolving Fund (2010).

The following summarizes the requirements of the GGRA:

- By 2011, MDE must develop a State-wide GHG emissions inventory, a "business-as-usual" emissions projection for 2020, and a proposed GHG emission reduction plan for public review and comment;

- By 2012, Maryland must adopt a final GHG emissions reduction plan that includes regulations and other control initiatives that, when fully implemented, will achieve the requirements of the law. The plan must ensure:
  - A minimum reduction in GHG emissions of 25%, from a 2006 baseline, by 2020
  - A net increase in jobs and a net economic benefit
  - Opportunities for new green jobs in energy and low carbon technology fields
  - No adverse impact on the reliability and affordability of electricity and fuel supplies
  - Deferral of regulations of Maryland's manufacturing sector until after a 2016 legislative review unless required by federal law or as part of a pre-2009 regional program like RGGI.

- By 2015, MDE must provide the Governor and General Assembly with:
  - An independent study of the manufacturing sector
  - An assessment of the progress toward:
    - achieving the 25% emissions reduction,
    - benefits to the State's economy
    - job creation
    - other benefits to public health, and the environment,
    - the need for further reductions, and
    - the status of any federal GHG reduction program;

- In 2016, the legislature will review the progress report, the report on economic impacts on manufacturing sector, the requirements of a federal program, and other information and determine whether to continue, adjust, or eliminate the requirement to achieve a 25% reduction by 2020.

Conclusion

Sea level rise and severe drought from climate change could have a devastating a nd costly impact on Maryland's economy. Reducing the State's GHG emissions is a critical step to avoid the price of fighting against Mother Nature.

Based on this preliminary plan, it is possible for Maryland to reduce State-wide GHG emissions by 25% by 2020 through a diverse suite of multi-sector climate programs. The plan also shows that these programs could be implemented in a way that benefits Maryland's economy, creates jobs, contributes to the health of the Chesapeake Bay and improves air quality.

Stakeholder input to the Maryland General Assembly is vital to help them with their decision-making. MDE will be holding a series of "across-the-State" public meetings on the proposed GGRA plan in the spring and summer of 2012. Please provide written comment on this plan to Brian Hug, Deputy Program Manager, (bhug@mde.state.md.us) in the Air Quality Planning Program.

Frequently Used Abbreviations and Acronyms

GGRA: Greenhouse Gas Emissions Reduction Act

GHG: Greenhouse Gas

Governor O'Malley's Strategic Policy Goals:

Goal Number 11: Reduce Maryland's GHG Emissions by 25 percent by 2020

Understanding the need for immediate action to help in mitigating the State's impact on climate change, the O'Malley-Brown Administration has established the Maryland Climate Change Commission, sponsored the 2009 Greenhouse Gas Emissions Reduction Act, and developed a plan to reduce greenhouse gas emissions in Maryland by 25 percent by 2020.

http://www.statestat.maryland.gov/GDUgreenhouse.asp

Chapter

2 Update on Climate Change Science

This chapter is based upon material provided by the University of Maryland Center for Environmental Sciences

Since the enactment of the Greenhouse Gas Emission Reduction Act of 2009 (GGRA), the science of climate change has made steady advances that, in aggregate, increase certainty regarding human-caused global climate change and demonstrate significant changes that are already taking place. This chapter provides a very general overview of key advances in understanding and the implications for Maryland. A more detailed report called *Global Warming in the Free State: Comprehensive Assessment of Climate Change Impacts in Maryland*, prepared by the Maryland Commission on Climate Change, is available at http://www.umces.edu/sites/default/files/pdfs/global_warming_free_state_report.pdf.

In late 2009, the media were atwitter with news of "Climategate," with the unauthorized release of emails suggesting that climate scientists had conspired to mislead the public about the recent warming of earth's climate. This led to several formal investigations by the British government, the National Oceanic and Atmospheric Administration, and universities employing the implicated scientists. Every one of these investigations concluded that there was no evidence that scientists had manipulated their research and the Inspector General for the U.S. Department of Commerce noted that nothing in the e-mails conflicted with the scientific consensus that "global warming is happening and that it is induced by human activity."

As if to accentuate the confusion caused by this controversy and the time lost as a result of the failure to come to binding agreements on greenhouse gas emission reductions in meetings of the United Nations Framework Convention on Climate

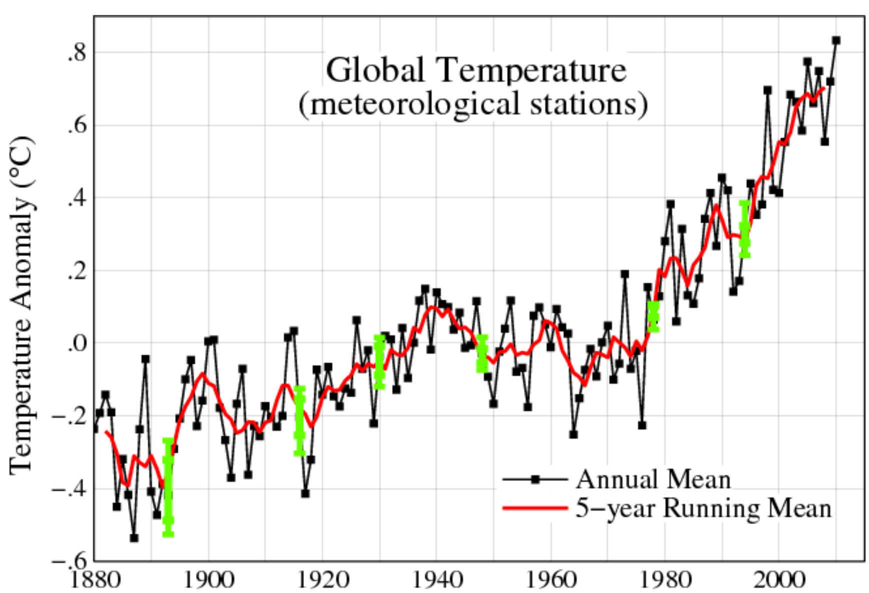
The GGRA defines a greenhouse gas as one of the following:

- Carbon dioxide (CO2)
- Methane (CH4)
- Nitrous oxide (N2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulfur hexafluoride (SF6)

Change in Copenhagen in December of 2009 and December of 2010, the year 2010 proved to be the warmest year on record in terms of global average air temperature.

If air temperatures continue to rise through this century, global warming could lead to deadly temperatures for humans based on reasonable worst-case scenarios for global warming accompanied with high humidity . This suggests that the pressing need to reduce greenhouse gas (GHG) emissions will finally be understood and accepted by society as temperatures become more unbearable. But, there is a lag time in the climate system, so will this realization come in time?

Figure 2-1
Global average air temperature by year expressed as the anomaly (difference) from the 1951-1980 average.



Source: *http://data.giss.nasa.gov/gistemp/graphs/*

Meanwhile, scientists are beginning to document changes in the earth's critical biological systems as the planet warms. Long-term records suggest a decline in the concentration of phytoplankton in the most of the world's oceans commensurate with their warming . Phytoplankton provide the base of the food chains that support the ocean's fisheries. A reduction in phytoplankton production also would mean a reduced capacity of the oceans to remove carbon dioxide from the atmosphere.

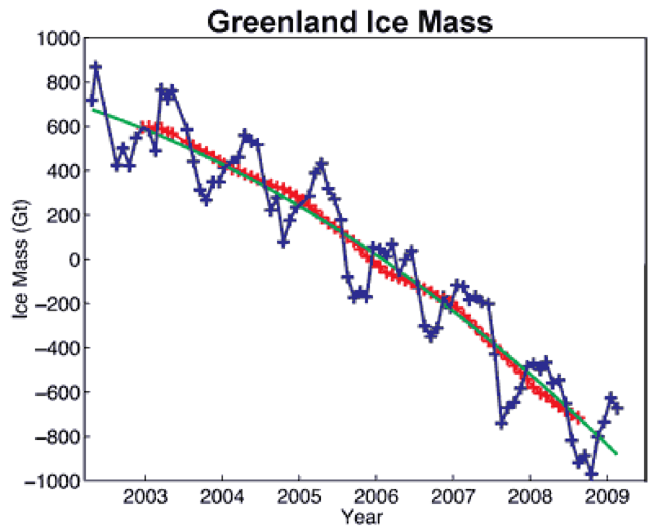
On land, there is evidence that soils are emitting more carbon dioxide as a result of more rapid decomposition of soil organic matter as temperatures have increased over the past 20 years . This is an example of a positive feedback loop that exacerbates the buildup of GHGs and accelerates climate change. Also on land, available evidence indicates that recent warming has increased atmospheric moisture demand and likely altered circulation pattern, both contributing to droughts in Africa, Southern Europe and Asia. Climate models project increasing aridity in many parts of the world, including the western and southern U.S. This would provide serious challenges to agriculture to meet the food requirements for the growing world population.

The largest changes in the earth's climate are being witnessed in the polar and high latitude regions, where atmospheric and oceanic temperatures have warmed most and the spatial extent of sea ice cover—or, even more so, sea ice thickness—has rapidly declined to levels not anticipated for decades. Although seemingly far removed, polar warming has great significance for Maryland as well as for polar bears and penguins. The future course of sea-level along our statestate's shores will largely be determined by how rapidly ice sheets sitting on the land masses of Greenland and Antarctica melt . Based on our recent capabilities to observe changes in the thickness of these ice sheets by satellite measurements of gravity it now is clear that both Greenland and West Antarctica are losing ice mass at an accelerating rate. This has led many scientists to increase their estimates of how much sea-level rise we will see during the 21st century to levels three times those forecast in 2007 by the Intergovernmental Panel on Climate Change and to or beyond the outer limit of those levels (2 to 4 feet) used in Maryland's 2008 Climate Action Plan's climate change impacts assessment .

The warming of the polar regions is very likely to produce several other positive feedbacks that accelerate global warming. The loss of ice cover, presently more evident in and around the Arctic Ocean than in the Southern Ocean around Antarctica, means that more of the sun's heat is captured by dark ocean waters rather than reflected back to space by ice. Large supplies of methane, which has a 21 times greater greenhouse effect than carbon dioxide on a molecule-by-molecule basis, are likely to be released into the atmosphere from Arctic soils and continental shelf sediments.

The year 2010 was legendary for its very extreme weather events. These started with Snowpocalypse and Snowmageddon blizzards in December 2009 and February 2010, and continued with the 1000-year floods in Tennessee in May, heat waves throughout the summer in the Northern Hemisphere, the Russian drought and wildfires in July 2010, the Pakistani floods from late July through August, record-breaking rainfall in Maryland in September that same year, and an unusually cold and snowy end of the year in Great Britain and parts of Europe. Although skeptics pointed to the blizzards as evidence that the world is not warming, each of these extreme events, although not linked definitively, are consistent with the scientific expectations of global warming . More droughts result from hotter and more persistent high pressure systems that dry out the land. More deluges, whether they are in a liquid or crystallized form of precipitation, are to be expected as hotter air and warmer oceans result in more evaporation

Figure 2-2
The rate of decline in the mass of ice on Greenland, as determined from satellite gravity measurements, is accelerating.

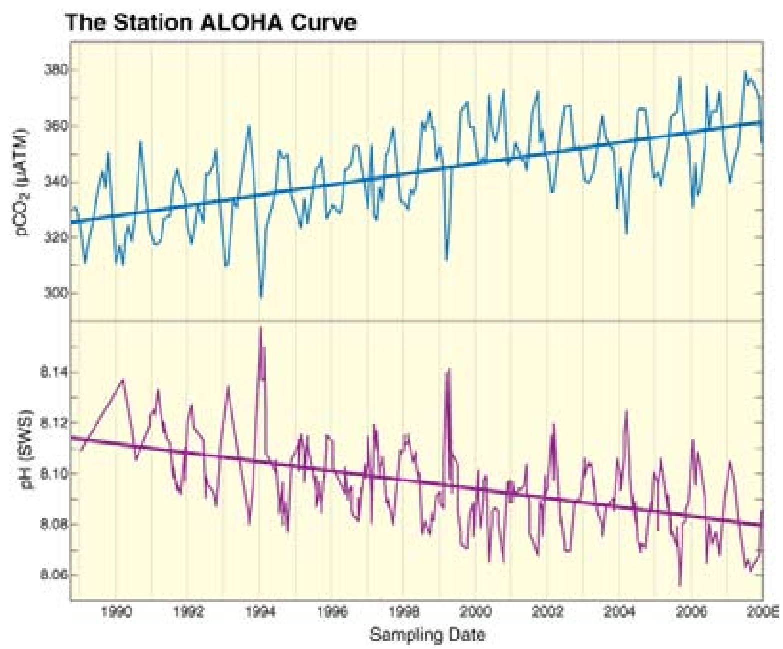


Source: http://data.giss.nasa.gov/gistemp/graphs/

from land and water surfaces. Scientists have recently demonstrated that climate disruptions related to the build-up of GHGs have contributed to the observed intensification of heavy precipitation events in New Hampshire. These findings underscore the need to take into account the frequency and magnitude of such extreme events as Maryland plans its strategies to adapt to its changing climate.

Another manifestation of the increased carbon dioxide concentrations in the atmosphere that has received substantial recent attention is ocean acidification. Although not strictly, a "climate" change, it has the same root cause. As carbon dioxide concentrations in the atmosphere increase, more carbon dioxide is absorbed in ocean surface waters, which results in lowering their pH, a measure of whether a solution is a base (greater than 7) or an acid (less than 7). The average pH of ocean surface waters has decreased from 8.2 to less than 8.1 since the beginning of industrial revolution and an additional 0.2-0.3 drop is likely by the end of the century even if we stabilize atmospheric carbon dioxide concentrations . While this might not seem like much, the pH scale is logarithmic and reductions of pH of this amount have been shown to limit the ability of organisms, such as oysters and corals, to build shells and skeletons of calcium carbonate.

Figure 2-3
The decline in pH of surface waters in the Pacific Ocean off Hawaii is directly related to the increase in the atmospheric concentration of carbon dioxide (pCO2).



Source: Center for Microbial Oceanography, University of Hawaii.

Ocean acidification presents not just a challenge for the life of the open ocean and for coral reefs, but also for coastal regions such as the Chesapeake Bay. Scientists working at the University of Maryland Center for Environmental Science examined Bay water quality data collected over 23 years and found that average pH significantly declined in the waters of the lower Bay to below 8.0, a trend consistent with that observed in the open ocean. While pH in lower salinity waters, including tributaries that once supported large oyster populations, has not declined, current average conditions in some of these tributaries correspond to values found in the laboratory to reduce or eliminate the ability of juvenile oysters to form new shell.

Salisbury University

The Princeton Review and the U.S. Green Building Council have named Salisbury University one of the nation's 286 most environmentally responsible colleges, including the campus in the inaugural Guide to Green Colleges and citing its "long history of environmentalism." The campus has incorporated sustainability into curricula across a wide range of disciplines: Chesapeake Bay author Tom Horton teaches environmental studies, while biology and business faculty, and their students, study forest growth locally and in the Amazon. Two students were among only 30 in the nation to earn prestigious $42,700 fellowships and summer internships from the U.S. Environmental Protection Agency.

Committed to sustainable design, SU is pursuing LEED Gold certification from the U.S. Green Building Council for the new Franklin P. Perdue School of Business building and five housing renovation projects. The Teacher Education and Technology Center was the Eastern Shore's first LEED certified new construction project, earning Silver status. Recently renovated Manokin Hall is SU's first geothermal facility, providing a significant savings in heating and cooling costs. Among its residents are first-year students on a "Green Floor" Living Learning Community dedicated to sustainable living and studies. Annually, SU partners with the Newton Marasco Foundation to present the Green Earth Book Awards, the nation's first prize honoring environmental stewardship in children's literature.

This brief review of recent findings concerning global climate change does not do justice to the massive amount of research findings that are being published by scientists every week. The good news is that we are improving our understanding of the phenomenon of climate change, its repercussions and its likely course. The bad news is that the substantial preponderance of the new science indicates that significant climate change is more certain, will occur sooner than previously thought, and will result in largely negative consequences for the wellbeing of humans and their planet’s critical living systems.

Several Marylanders participated in the National Academies study, America’s Climate Choices, which produced thoughtful and informative reports on advancing the science, limiting the magnitude and adapting to the impacts of climate change, as well as informing an effective response to climate change. The findings and recommendations of these reports resonate well with the efforts of the State of Maryland as it moves ahead with the GGRA Plan to do its part to limit the magnitude of global climate change and adapt to its impacts based on sound scientific understanding.

Global Warming Potential

- Measures how much a given mass of a GHG is estimated to contribute to global warming over a specific period of time
- Depends on the ability of the GHG to trap heat in the form of infrared radiation and the amount of the GHG removed from the atmosphere over a given number of years.
- Based on a relative scale which compares all GHGs to the same mass of carbon dioxide
- Carbon dioxide has a global warming potential equal to 1

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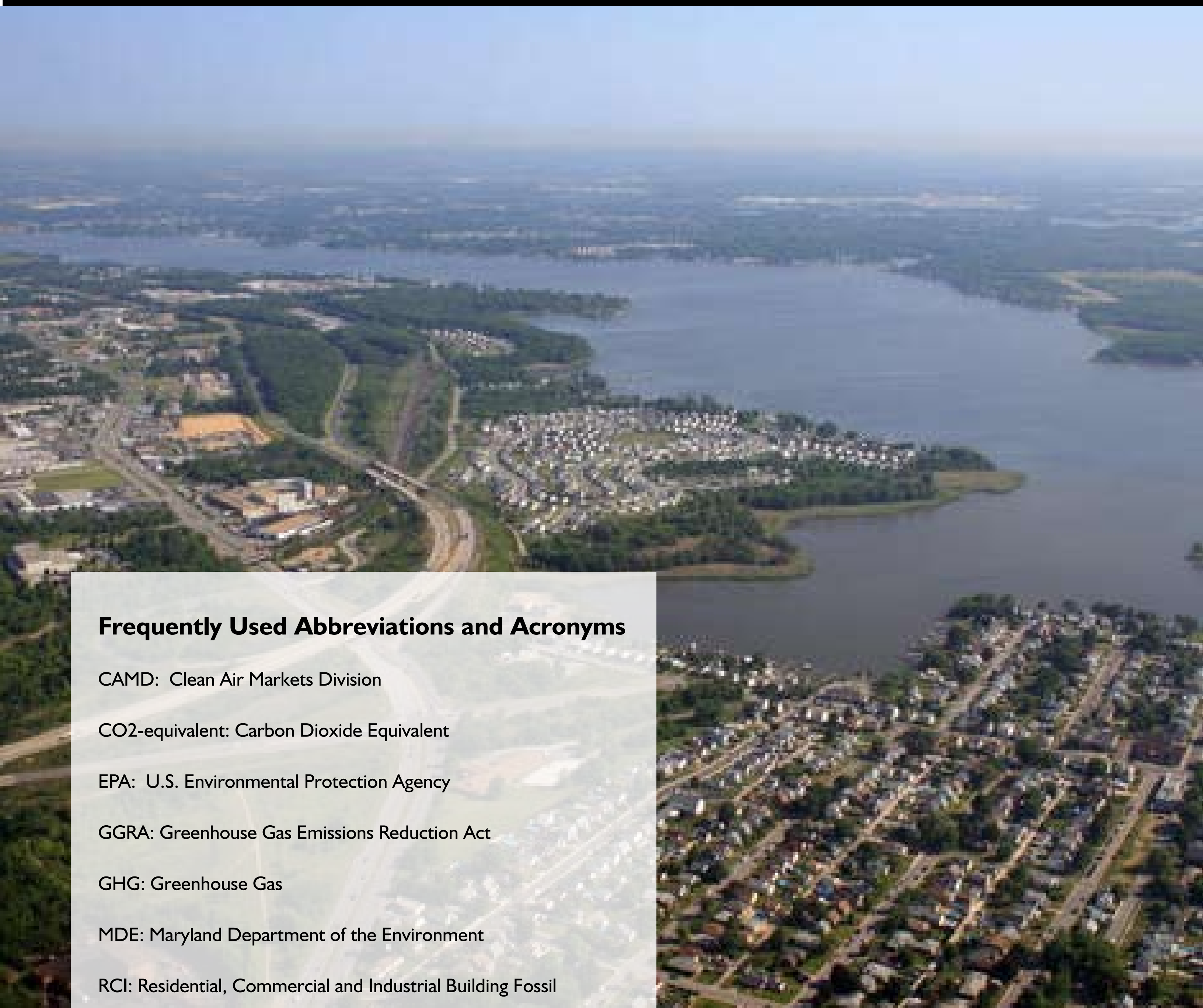
http://americasclimatechoices.org/

"We figured that if you could use data collection and mapping technology to improve law enforcement, there's no reason why you could not use it to improve the other things that government does."

Governor Martin O'Malley,
April 2007



Frequently Used Abbreviations and Acronyms

CAMD: Clean Air Markets Division

CO2-equivalent: Carbon Dioxide Equivalent

EPA: U.S. Environmental Protection Agency

GGRA: Greenhouse Gas Emissions Reduction Act

GHG: Greenhouse Gas

MDE: Maryland Department of the Environment

RCI: Residential, Commercial and Industrial Building Fossil Fuel Combustion

Source: IAN Image Library (www.ian.umces.edu/imagelibrary/)

Chapter 3 Inventory and Forecast

The Inventory and Forecast Process Overview

The Greenhouse Gas Emissions Reduction Act (GGRA) requires the 2012 GGRA Plan to achieve a 25 percent reduction in greenhouse gases (GHG) by the year 2020. GGRA specifically requires the development of a baseline inventory for 2006. This inventory was developed based on the six categories of heat retaining gases: carbon dioxide, methane, nitrous oxide, sulfur hexafluoride, hydrofluorocarbons and perfluorocarbon. Collectively, these gases are referred to as CO2-equivalent. The 25 percent reduction is subtracted from the baseline to create a target level of emissions for 2020.

To calculate the reductions needed to achieve the target, a projected inventory for the year 2020 was developed to estimate emissions possible due to growth from business-as-usual activities. The growth emissions added to the emissions needed to achieve the 25 percent reduction are the total emission reductions needed for success of the 2012 GGRA Plan. The emissions estimates, assumptions, and methodologies are explained further in this chapter and the full report, which was made available in June of 2011, and is located at: http://www.mde.state.md.us/programs/Air/ClimateChange/Pages/GreenhouseGasInventory.aspx.

Emissions inventories are the foundation of air quality decisions; it is essential the data be as accurate as possible. Inventory quality is critical since the inventory assists decision makers in defining realistic regulations and reduction strategies.

GHG Emissions Reporting Requirements in Maryland

Federal regulations established under EPA's Acid Rain program require large sources of air pollutants to report carbon dioxide emissions data quarterly to EPA's Clean Air Markets Division (CAMD) public access database. These sources are mainly electric generating units. The data reported is obtained through direct measurement of carbon dioxide emissions by monitors located in the exhaust stacks of the sources. These instruments collect data continuously. In the absence of a monitoring system, sources calculate the amount of carbon dioxide using an accepted methodology and then report this into CAMD. These regulations include standards for monitoring, recordkeeping, and reporting.

More recently, EPA promulgated 40 Code of Federal Regulations Part 98, called the Mandatory GHG Reporting Rule. This regulation requires affected sources to report GHG emissions data directly to EPA. The affected sources are any source expected to emit more than 25,000 tons of GHG emissions annually. EPA will then disseminate the information to the states. 2010 was the first year affected by these requirements and, as yet, no data is available from EPA. Accurate GHG data will assist on a national level in determining the relative emissions of specific industries, the variability in GHG emissions from industrial processes and unit emissions across each source category, and factors that influence GHG emission rates.

In the fall of 2007, the Maryland Department of the Environment (MDE) requested Maryland industrial sources to include GHG emissions reporting along with annual reporting of other criteria air pollutants. For calendar year 2007, about one half of Maryland's registered sites, 267, reported a cumulative total of 46.5 million tons of CO2-equivalent. For calendar year 2008, 324 Maryland sites reported a cumulative total of 44.3 million tons of CO2-equivalent. For calendar year 2009, 351 Maryland sites reported a cumulative total of 37.0 million tons of CO2-equivalent.

As part of the Maryland CO2 Budget Trading Program, which began in 2009, electric generating units greater than 25 megawatts in Maryland are required to report carbon dioxide emissions into EPA's CAMD database. For the most part, the same sources are reporting emissions under the Maryland CO2 Budget Trading Program as report under the federal Acid Rain Program.

These data from these programs provide a basis for emissions estimates for several categories of sources in the inventory.

The GGRA Inventory and Forecast

Emissions inventories are essential to developing environmental policies. The quality of a state-specific inventory is vital to the process if Maryland expects to set and achieve realistic pollution reduction goals. A baseline GHG inventory will pinpoint the business sectors that contribute to Maryland's GHG emissions, identifying where priorities should be placed in the development of climate policies. It also is necessary to determine what Maryland's future GHG emissions will be through the use of a forecast and modeling. Since GHG emissions may increase in the future, Maryland can take advantage of any cost-effective opportunities for early GHG reductions that may exist.

An initial inventory was developed for the 2008 Climate Action Plan by the Center for Climate Strategies, which provided necessary technical support for policy discussion at the time. This inventory was a "top-down" inventory that provided a broad-brush 2006 GHG inventory and a 2020 emissions forecast for Maryland. To further refine any GHG emissions reduction strategies, however, a more state-specific "bottom-up" GHG inventory is necessary. Such an inventory and forecast is what MDE has developed for GGRA.

The Maryland General Assembly passed the GGRA, which is codified in Maryland Annotated Codes, Title 2, Subtitle 1203. The GGRA specifically mandated the MDE to prepare and publish an updated inventory of State-wide GHG emissions for calendar year 2006 and develop a projected "business-as-usual" inventory for calendar year 2020 on or before June 1, 2011. This GGRA requirement was met and can be found at: http://www.mde.state.md.us/programs/Air/ClimateChange/Pages/GreenhouseGasInventory.aspx. The GGRA also requires an updated inventory every three years. These periodic inventories are the primary tool that MDE will use to track emission reduction progress.

The GGRA identified 2006 as the base year for Maryland's process and as the year for the first compliance-quality inventory. Since Maryland GHG data existed for 2006, using 2006 as the base year for Maryland's GHG inventory made sense from a resource perspective. Many states and other jurisdictions have used 1990 as their starting point, while others chose later years like 2000 or 2005. Using an earlier year, such as 1990, does not always sufficiently communicate the magnitude of the challenges of achieving reductions. In Maryland, a 25 percent reduction from 2006 levels by 2020 goal is nearly the same as meeting 1990 levels by 2020. That means the target level of emissions for 2020 under the GGRA is very similar to 1990 GHG emissions levels in Maryland. The difference between the two numbers is small. On the other hand, population and economic growth between 1990 and 2006 was robust and is expected to continue through 2020. This growth represents a large number and must be offset to reach the 1990 goal, yet the need to offset growth in order to be successful in reaching an emissions target is often overlooked. So a more current year, 2006, with more recent data and better inventory methodologies was selected as the base year.

Steps to Conducting a GHG Inventory

To comply with this mandate, MDE prepared a report that estimates the State-wide emissions of GHGs for calendar year 2006 and a "business–as-usual" projected inventory for calendar year 2020. The report and the emissions inventory is divided into seven major business sectors that contribute to GHGs emissions in Maryland and can be found in its entirety on the MDE web page.

The seven major business sectors are:
- Electricity use and supply
- Residential, commercial and industrial buildings fossil fuel combustion (RCI)
- Transportation
- Industrial processes
- Fossil fuel industry, including fugitive emissions from GHGs released from leakage
- Waste management
- Agriculture

The inventory also includes a forestry and land use category for carbon sequestration.

Maryland's man-made GHG emissions and sinks for carbon storage were estimated for the base year 2006 using a set of generally accepted principles and guidelines for state GHG emissions, relying to the extent possible on Maryland-specific input data. The projections are based on the application of appropriate growth factors to the base year GHG emission inventory. Growth factors associated with the emissions projections are described in detail in the report. The projected inventories were based on a business-as-usual forecast as required in GGRA, therefore, to the extent possible, no control or reduction programs were taken into consideration in the estimation.

MDE has already received comments on the business-as-usual projection and projections made by other groups. Projections made by other groups, like the Maryland Public Service Commission, the U.S. Department of Energy, and the U.S. Energy Information Administration., are not 2006-based business-as-usual projections. They already include policies like RGGI and EmPOWER Maryland in their projections. Under the GGRA programs like RGGI and EmPOWER Maryland are reduction programs that count toward the 25 percent reduction requirement. The projection required by the GGRA allows these programs to be creditable reductions.

The inventory and forecast cover the six types of gases included in the U.S. Greenhouse Gas Inventory: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. A scale has been developed to allow the comparison of all the GHGs on an equivalent level. Carbon dioxide was selected as the compound to which all others would be equated since carbon dioxide is by far the most prevalent GHG and has been identified as having the Global Warming Potential of 1. The goals, inventory and reductions in this plan are expressed as CO2-equivalents based on the conversions.

Maryland has used the established Intergovernmental Panel on Climate Change global warming potential's for the GHG pollutants.

Figure 3-1 Global Warming Potentials of GGRA Gases

GHG Pollutant	Global Warming Potential
Carbon Dioxide	1
Methane	21
Nitrous Oxide	310
Sulfur Hexafluoride	23,900
Perfluorocarbons	9,200
Hydro Chlorofluorocarbons	11,700

Figures 3-2 and 3-3 provide a graphic representation of the relative proportions of the major sectors of the GHG inventory for the 2006 base year and the 2020 projection year respectively. Figure 3-4 provides a summary of the base year and projection year GHG emissions for Maryland for the years 2006, 2010, 2015, and 2020. Activities in Maryland accounted for approximately 106.9 million metric tons of gross CO2-equivalent emissions (consumption basis) in 2006, an amount equal to about 1.5 percent of total U.S. gross GHG emissions (7,054.2 million metric tons of CO2-equivalent).

Emission Summaries

Figure 3-2
Baseline 2006 CO2-equivalent Emissions by Activity
(in million metric tons of CO2-equivalent, percentage)

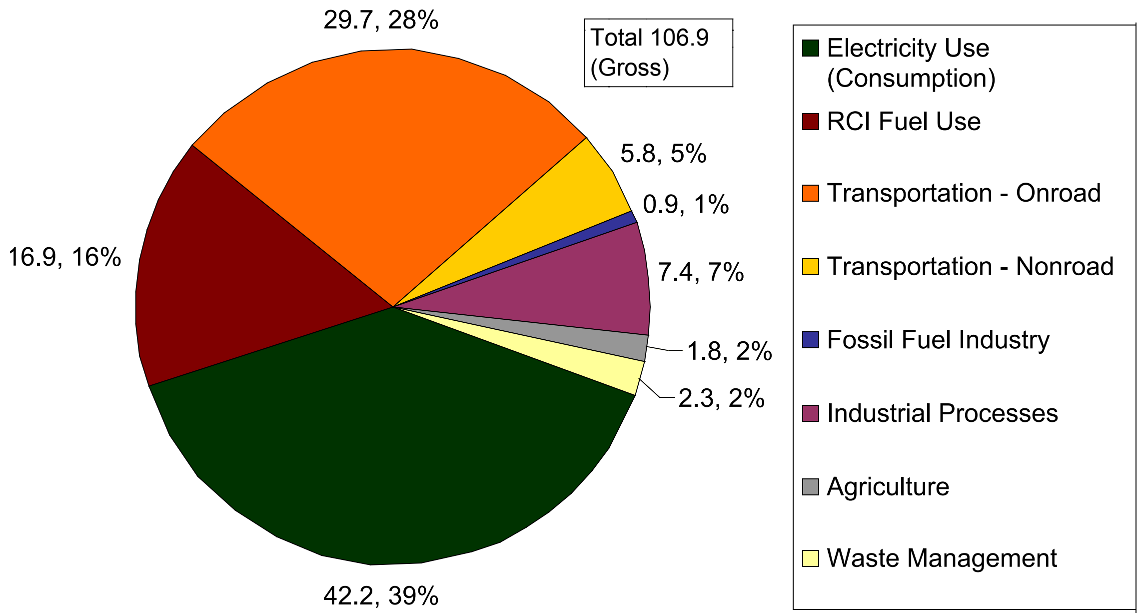


Figure 3-3
Projected "Business-As-Usual" CO2-equivalent Emissions by Activity (2020)
(in million metric tons of CO2-equivalent, percentage)

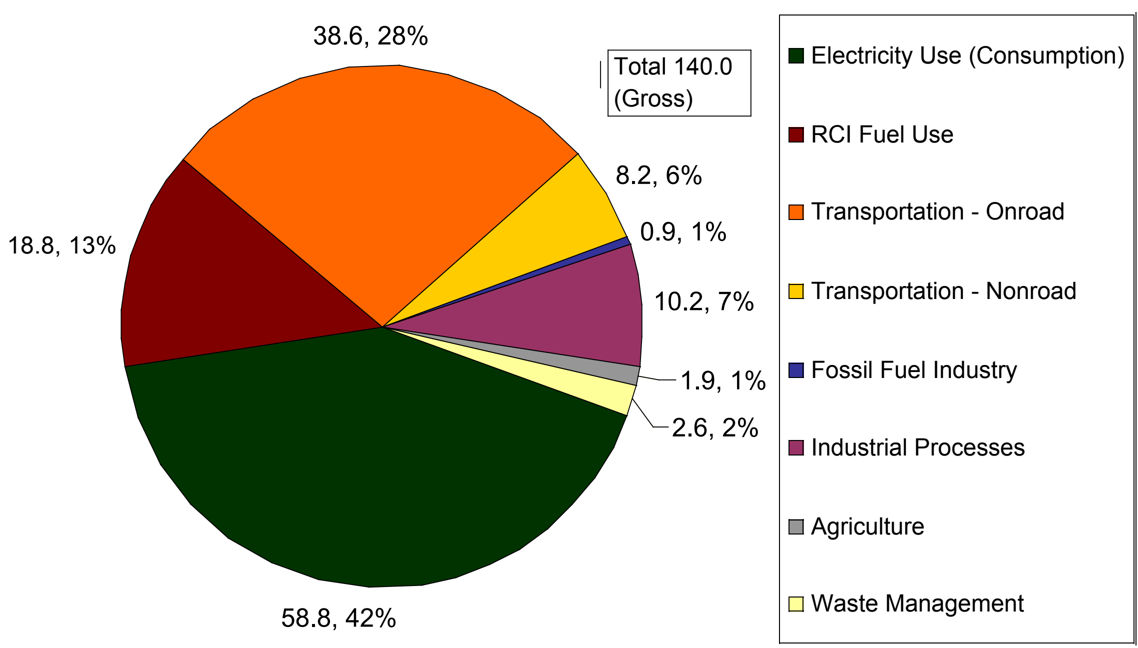


Figure 3-4
Maryland 2006 Base Year and Projected 2020 GHG Emissions, by Sector

MMtCo2e	2006	2010	2015	2020	Explanatory Notes for Projections
Energy Use (CO2, CH4, N2O)	**95.46**	**108.64**	**116.90**	**125.34**	
Electricity Use (Consumption)b	**42.18**	**51.92**	**55.28**	**58.79**	Population growth
Electricity Production (in-state)	32.16	41.21	42.46	42.88	Output Optimization.
Coal	28.28	33.79	33.79	33.79	Output Optimization.
Natural Gas	3.65	6.78	8.03	8.45	Output Optimization.
Oil	0.24	0.64	0.64	0.64	Output Optimization.
Wood	0.00	0.00	0.00	0.00	Population growth
MSW/LFG	0.00	0.00	0.00	0.00	Population growth
Net Imported Electricity	10.01	10.72	12.82	15.92	Population growth
Residential/Commercial/Industrial (RCI) Fuel Use	**16.87**	**17.24**	**18.07**	**18.84**	
Coal	3.00	3.17	3.68	4.20	Household growth
Natural Gas & LPG	9.21	9.42	9.72	10.00	Household growth
Petroleum	4.58	4.57	4.57	4.56	Household growth
Wood	0.09	0.09	0.09	0.09	Household growth
Transportation	**35.47**	**38.66**	**42.68**	**46.78**	
Onroad Gasoline	23.76	25.75	28.23	30.71	MOVES Modeling
Nonroad Gasoline	1.04	1.05	1.06	1.06	Various
Onroad Diesel	5.91	6.47	7.18	7.88	MOVES Modeling
Nonroad Diesel	1.50	1.60	1.73	1.85	Various
Rail	0.24	0.25	0.27	0.30	EPA RIA
Marine Vessels (Gas & Oil)	1.00	1.21	1.48	1.75	EPA RIA
Lubricants, Natural Gas, and LPG	0.30	0.34	0.40	0.47	Industrial Employment.
Jet Fuel and Aviation Gasoline	1.72	1.98	2.34	2.76	Aircraft Operations

"For the first time, we will begin collecting data from the largest facilities in this country, ones that account for approximately 85 percent of the total U.S. emissions. The American public, and industry itself, will finally gain critically important knowledge and with this information we can determine how best to reduce those emissions."

EPA Administrator, Lisa P. Jackson.

MMtCo2e	2006	2010	2015	2020	Explanatory Notes for Projections
Fossil Fuel Industry	**0.94**	**0.82**	**0.87**	**0.92**	
Natural Gas Industry	0.81	0.69	0.74	0.79	Industrial Employment.
Oil Industry	0.00	0.00	0.00	0.00	Industrial Employment.
Coal Mining	0.13	0.13	0.13	0.13	Production growth
Industrial Processes	7.44	8.21	9.21	10.24	
Cement Manufacture	1.48	1.57	1.83	2.09	Production growth
Limestone and Dolomite	0.11	0.15	0.18	0.21	Production growth
Soda Ash	0.05	0.05	0.05	0.05	Production growth
Iron and Steel	3.60	3.65	3.75	3.85	Production growth
ODS Substitutes	1.97	2.65	3.35	4.04	Population growth
Electricity Transmission and Dist.	0.23	0.14	0.05	0.00	Population growth
Semiconductor Manufacturing	0.00	0.00	0.00	0.00	Industrial Employment.
Ammonia and Urea Production	0.00	0.00	0.00	0.00	Industrial Employment.
Aluminum Production	0.00	0.00	0.00	0.00	Industrial Employment.
Agriculture	1.77	1.85	1.79	1.86	
Enteric Fermentation	0.42	0.44	0.42	0.51	Population growth
Manure Management	0.32	0.32	0.30	0.29	Population growth
Agricultural Soils	1.02	1.08	1.06	1.05	Population growth
Agricultural Burning	0.01	0.01	0.01	0.01	Population growth
Urea Fertilizer Usage	0.01	0.01	0.01	0.01	No Growth
Waste Management	2.26	2.34	2.48	2.60	
Waste Combustion	1.29	1.34	1.42	1.49	Population growth
Landfills	0.39	0.40	0.43	0.45	Population growth
Wastewater Management	0.54	0.56	0.59	0.62	Population growth
Residential Open Burning	0.03	0.03	0.04	0.04	Household growth

MMtCo2e	2006	2010	2015	2020	Explanatory Notes for Projections
Gross Emissions (Consumption Basis, Excludes Sinks)	106.93	121.05	130.38	140.05	
Increase gross emissions relative to 2006					
Emissions Sinks	-11.79	-11.75	-11.75	-11.75	
Forested Landscape	-10.45	-10.45	-10.45	-10.45	
Urban Forestry and Land Use	-1.33	-1.33	-1.33	-1.33	
Agricultural Soils (Cultivation Practices)	-0.05	-0.05	-0.05	-0.05	
Forest Fires	0.04	0.04	0.04	0.04	
Net Emissions (Consumptions Basis)	95.14	109.29	118.63	128.30	
(Including forestry, land use, and agric sinks)					
Increase net emissions relative to 2006		14.87%	24.68%	34.85%	

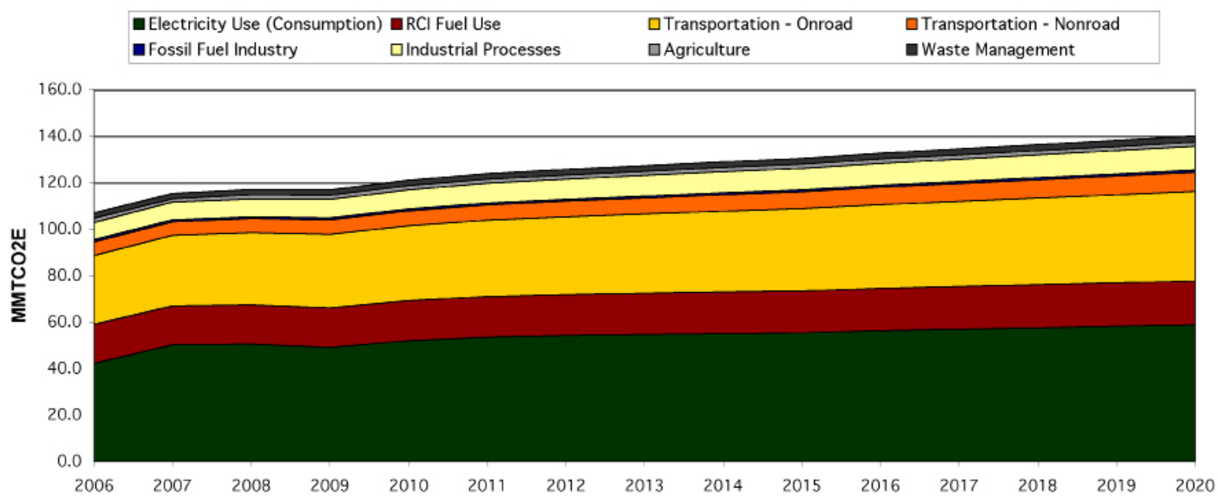
Estimates of carbon sinks within Maryland's forests, including urban forests and land use changes, also have been included in this report. Current estimates indicated that about 11.8 million metric tons of CO2-equivalent were stored in Maryland forest biomass and agricultural soils in 2006. This leads to net emissions of 95.1 million metric tons of CO2-equivalent in Maryland in 2006.

There are three principal sources of GHG emission in Maryland in 2006: electricity consumption, transportation, and RCI fossil fuel use. Electricity consumption accounted for 41 percent of gross GHG emissions, transportation for 32 percent and RCI fuel use accounted for 16 percent.

As shown numerically in Figure 3-5, under the reference case projections, Maryland's gross GHG emissions continue to grow and are projected to climb to about 140 million metric tons of CO2-equivalent by 2020. This is approximately 31 percent above 2006 levels. Maryland's electricity consumption sector is projected to be the largest contributor to future GHG emissions growth in Maryland, followed by the transportation sector and RCI fossil fuel use.

Some data gaps exist in this analysis, particularly for the reference case projections. Key refinements include review and revision of key emissions drivers that will be major determinants of Maryland's future GHG emissions (such as the growth rate assumptions for electricity generation and consumption, transportation fuel use, and RCI fuel use). The full report provides the detailed methods, data sources, and assumptions for each GHG sector. Also included are descriptions of significant uncertainties in emission estimates or methods, and suggested next steps for refinement of the inventory.

Figure 3-5
Maryland Gross GHG Emissions by Sector 2006-2020: Base Year and Projected



Source Catagories

The full inventory and forecast report describes the inventory procedures MDE used to compile the 2006 base year emissions inventory of the GHG pollutants: carbon dioxide, methane, nitrous oxides, sulfur hexafluoride, chlorofluorocarbons and hydro chlorofluorocarbons. The emission sources are divided into the following eight source categories:

- Electricity Supply
- Residential, Commercial, and Industrial Buildings (RCI) Fuel Combustion
- Transportation Energy Use
- Industrial Processes
- Fossil Fuel Production Industry
- Agriculture
- Waste Management
- Forestry and Land Use

The inventory procedures have been calculated on a State-wide basis and have not been allocated to the county level unless otherwise stated. Brief descriptions of each emission source category are presented in the following paragraphs.

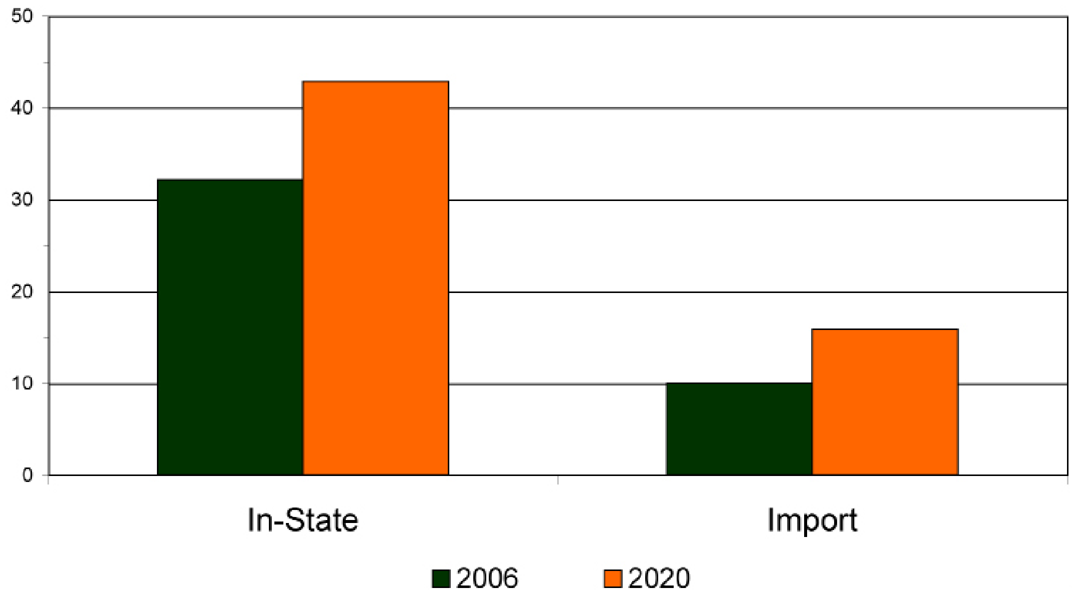
Electricity Supply

The electricity supply sector accounts for GHG emissions occurring as a result of the combustion of fossil fuel at electricity-generating facilities located both in and outside of the State. Carbon dioxide represented more than 99.5 percent of total sector emissions, with methane and nitrous oxide CO2-equivalent emissions comprising the balance.

Maryland is a net importer of electricity, meaning that the State consumes more electricity than is produced here. For this analysis, it was assumed that all power generated in Maryland was consumed in Maryland, and that remaining electricity demand was met by imported power. Sales associated with imported power accounted for 28 percent of the electricity consumed in Maryland in 2006. GHG emissions from electricity produced in-state are dominated by the combustion of coal, followed by emissions from the use of oil and natural gas. As shown previously in Figure 3.2, electricity consumption accounted for about 39 percent of Maryland's gross GHG emissions in 2006 (about 42 million metric tons of CO2-equivalent), which was higher than the national average share of emissions from electricity consumption (34 percent).

In 2006, emissions associated with Maryland's electricity consumption (42 million metric tons of CO2-equivalent) were about 10 million metric tons of CO2-equivalent higher than those associated with electricity production (32.0 million metric tons of CO2-equivalent). The higher level for consumption-based emissions reflects GHG emissions associated with net imports of electricity to meet Maryland's electricity demand. Projections of electricity sales for 2006 through 2020 indicate that Maryland will remain a net importer of electricity (Figure 3-6). The 2020 "business-as-usual" forecast assumes that in-state production-based emissions will increase by about 10 million metric tons of CO2-equivalent. In addition, consumption-based emissions associated with electricity consumed in-state will increase by about 6 million metric tons of CO2-equivalent.

Figure 3-6
2006 Baseline vs. Projected 2020 "Business-As-Usual" for Electricity Consumption by both In-State and Import
(in million metric tons CO2-equivalent)



The consumption-based approach better reflects GHG emissions and emissions reductions occurring in Maryland, particularly with respect to electricity use and energy efficiency improvements. This is particularly useful for policy-making.

RCI Fuel Combustion

This section discusses emissions associated with direct fossil fuel used in the residential, commercial and the industrial buildings sector to provide space and process heating.

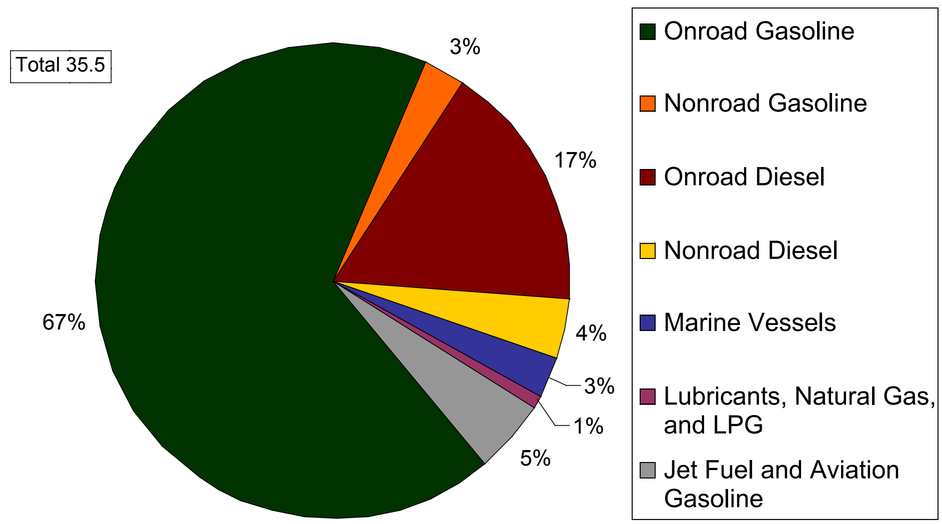
Transportation Energy Use

Emissions estimated for this business sector are the result of the combustion of fossil-fuel primarily for transportation purposes. Sources include:

- Cars
- Light-duty trucks
- Vans
- Buses
- Other diesel vehicles

The majority of CO2-equivalent emissions in the transportation sector relate to onroad gasoline, with onroad diesel accounting for a significant percentage. This is illustrated in Figures 3-7 and 3-8 for 2006 baseline and projected 2020 Business-as-usual, respectively.

Figure 3-7
2006 Baseline Transportation Emissions by Sector
(in million metric tons CO2-equivalent)



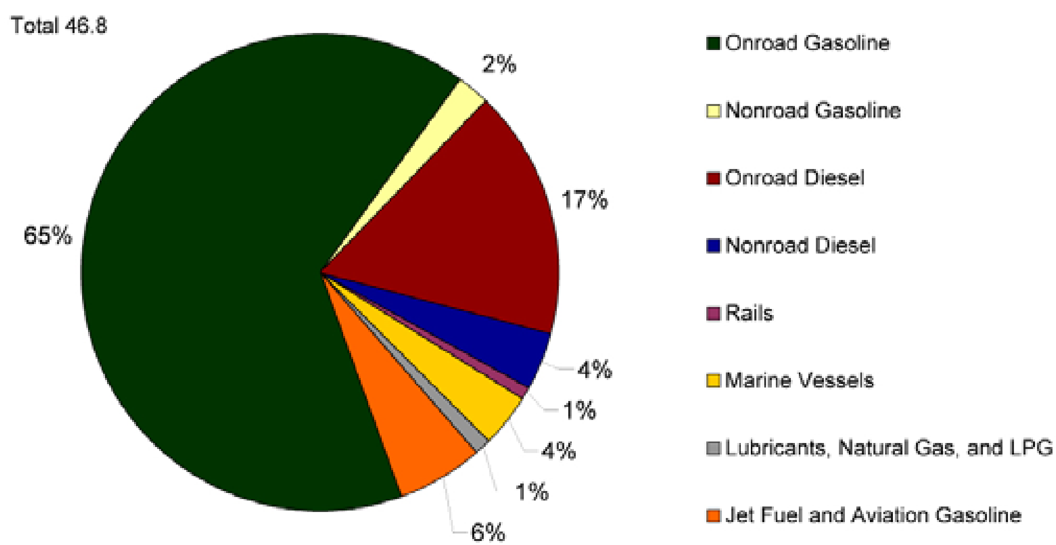
Other modes of transportation, such as airplanes, trains and commercial marine vessels are included under the general category of nonroad mobile sources. It is often difficult identifying the actual end-use for nonroad gasoline and diesel fuels (other than marine use). Natural gas and liquified petroleum gas used as transportation fuel are easily broken out. Also, jet fuel and aviation gasoline are discrete products that are treated as a separate sector. For illustrative purposes, Figures 3-7 and 3-8 provide a visual breakout of nonroad fuel uses.

Nonroad mobile sources are motorized vehicles and equipment not normally operated on public roadways. These include:

- Lawn and garden equipments
- Agricultural or farm equipment
- Logging equipment

- Industrial equipment
- Construction equipment
- Airport service equipment
- Recreational land vehicles or equipment
- Recreational marine equipment
- Locomotives
- Commercial aviation
- Air taxis
- General aviation
- Military aviation
- Commercial Marine Vessels

Figure 3-8
2020 Projected "Business-As-Usual" Transportation Emissions by Sector
(in million metric tons CO2-equivalent)



As shown previously in Figure 3-2, the transportation sector accounted for about 33% of Maryland's gross GHG emissions in 2006 (about 36 million metric tons of CO2-equivalent), which was higher than the national average share of emissions from transportation fuel consumption (27%).

Atlantic States Offshore Wind Development Progress:

- **Delaware:** The 450 megawatt (MW) offshore wind farm to be located 13 miles off the coast, as proposed by NRG Bluewater Wind, is finalized and currently undergoing permitting and environmental verification.
- **Georgia:** Georgia Tech and Southern Company jointly completed an offshore wind feasibility study and are considering a 10 MW demonstration project to be built near Tybee Island.
- **Maine:** Maine has created a phased-in approach to floating offshore wind. It is starting with a proposed test model off Monhegan Island in 2012, a 25 megawatt pilot by 2016, and a commercial-scale wind farm with a capacity of up to 1,000 megawatts by 2020.
- **Maryland:** Governor O'Malley introduced the Maryland Offshore Wind Energy Act of 2011, which requires the development of 400 to 600 MW of offshore wind capacity, approximately ten nautical miles off of Maryland's coast. This would require the installation of between 80 and 200 wind turbines, depending on project scope and turbine capacity. Chapter 9 discusses current legislative activity on this issue.
- **Massachusetts:** State goal of developing 2,000 MW of wind power capacity by 2020. Cape Wind Project of 130 turbines to cover 25 miles of Nantucket Sound approved in 2010.
- **New Jersey:** Fishermen's Energy of Cape May is expecting to begin construction of a 25 MW wind farm 2.5 miles off the coast of Atlantic City in the summer of 2012. Deepwater Wind and Public Service Enterprise Group are collaborating to build a 1,000 MW capacity wind farm 20 miles east of Avalon NJ.
- **New York:** Utilities and the state considering a 350-MW wind farm off the Long Island Coast, expandable to a 700 MW target. Deepwater Wind has proposed a 200 turbine wind farm estimated to be 1,000 MW of capacity dubbed Hudson Canyon located 30 miles South of Long Island.
- **North Carolina:** Duke Energy and the University of North Carolina are collaborating to study and help enable large-scale offshore wind development on the ocean side of the North Carolina coast.
- **Rhode Island:** The Deepwater Wind Energy Center is planned as the nation's first 1,000 MW offshore regional energy center; a 200 turbine project located in southern Rhode Island Sound with most turbines located more than 20 miles from the mainland. Another project planned is the demonstration-scale Block Island Wind Farm, which will be located about three miles off of the southeastern coast of Block Island; a 30 MW offshore wind farm expected to be in operation in 2013 or 2014.
- **South Carolina:** Joined with North Carolina to explore ways to accelerate offshore wind partnerships and received a grant from the Department of Energy to analyze permitting and transmission issues.
- **Virginia:** The Virginia Offshore Wind Development Authority was created by 2010 legislation and currently meeting to discuss development of offshore wind power and collecting environmental data.

For 2006, onroad gasoline vehicles accounted for about 67% of transportation GHG emissions. Onroad diesel vehicles accounted for another 17% of emissions, and air travel for roughly 5%. Marine vessels, rail, and other sources, such as natural gas- and liquefied petroleum gas-fueled vehicles used in transport applications, accounted for the remaining 11% of transportation emissions.

Industrial Processes

Emissions estimated in the industrial sector account for process-related GHG emission resulting from the four main industrial processes that occurs in the State:

(1) Carbon dioxide emissions from cement production, soda ash, dolomite and lime/limestone consumption;

(2) Carbon dioxide emissions from iron and steel production;

(3) Sulfur hexafluoride emissions from electric power transmission and distribution system transformer use

(4) Hydrofluorocarbon and perfluorocarbon emissions resulting from the consumption of substitutes for ozone-depleting substances used in cooling and refrigeration equipment.

As illustrated below in Figure 3-9, industrial process CO2-equivalent emissions are estimated to increase in the projected 2020 business-as-usual forecast, although not uniformly across sectors. Several sectors have values that are not visible based on the scale of the chart, but the GHG emissions are calculated and do change between the 2006 baseline and 2020 business-as-usual forecast.

Carbon Sequestration

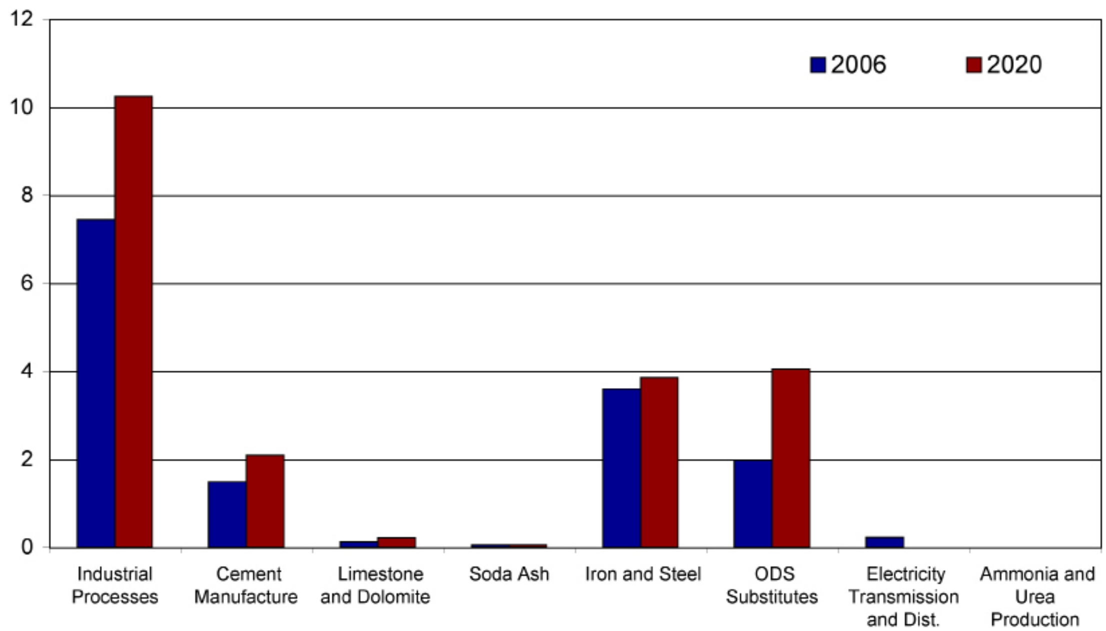
Carbon sequestration is the process through which plant life removes carbon dioxide from the atmosphere and stores it in biomass. Over the course of a year, plants remove and release carbon dioxide and net sequestration results if the rate of removal is higher than the rate of release. Young, fast-growing trees in particular will remove more carbon dioxide from the atmosphere than they will release. Agricultural and forestry practices can enhance the rate of carbon sequestration, or cause net emissions, depending on the overall balance.

The term "sink" is a broader term used to describe agricultural and forestry lands or other processes that absorb or sequester carbon dioxide, and other chemical processes that remove other greenhouse gases from the atmosphere (e.g., methane).

All land areas such as farms, grasslands and forests can be sources or sinks of carbon dioxide, depending on the particular agricultural and forestry practices on these lands. In the US, forests and other types of lands have been significant sinks since 1990, due in large part to forest and soil management practices. Nationally, carbon sequestration offset or removed 13% of total GHG emissions in 2006. The largest share came from forest growth, increasing forest area and an increase in the amount of carbon stored in durable wood products. The rate of carbon sequestration has decreased since 1990, particularly in forests.

Source: http://www.epa.gov/statelocalclimate/local/activities/ghg-inventory.html

Figure 3-9
Industrial Processes: 2006 Baseline vs. 2020 "Business-As-Usual" Total and by Type
(in million metric tons CO2-equivalent)

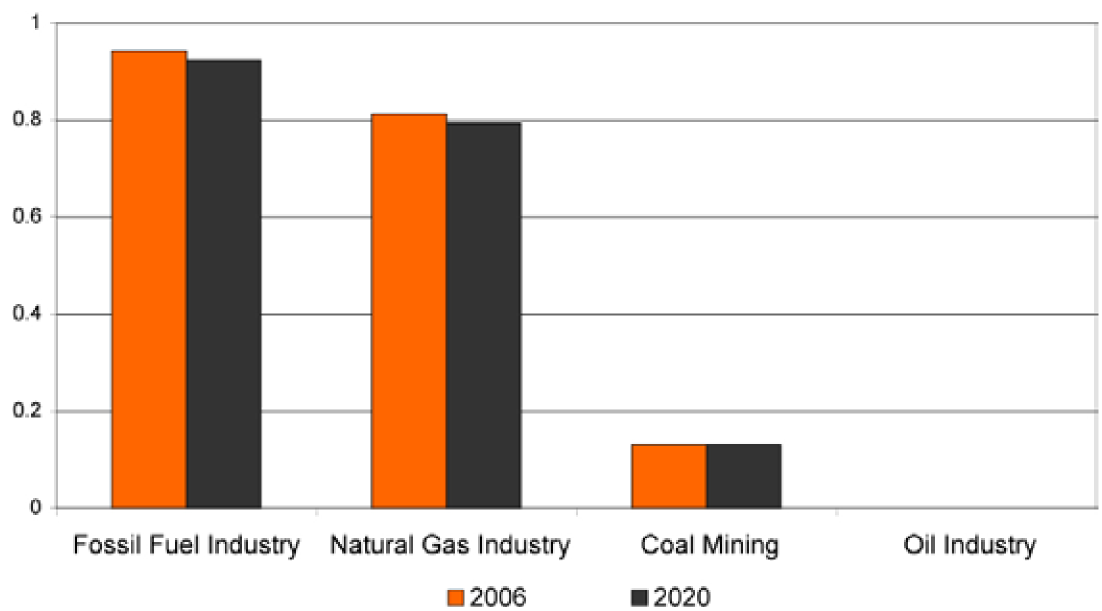


Fossil Fuel Production Industry

This section reports GHG emissions that are released during the production, processing, transmission, and distribution of fossil fuels (primarily natural gas and coal) in the State. Methane emissions released via leakage and venting from oil and gas fields, processing facilities and natural gas pipelines, and fugitive methane emissions during coal mining, are estimated in this section, as well as carbon dioxide emissions associated with the combustion of natural gas in compressor engines.

Fossil fuel production emissions are projected to drop in the 2020 business-as-usual forecast, this is attributable to a decrease in emissions in the natural gas industry (Figure 3-10). Coal mining emissions are expected to remain constant between the 2006 baseline and the 2020 business-as-usual forecast.

Figure 3-10
Fossil Fuel Production: 2006 Baseline vs. 2020
"Business-As-Usual" Total and by Type
(in million metric tons CO2-equivalent)



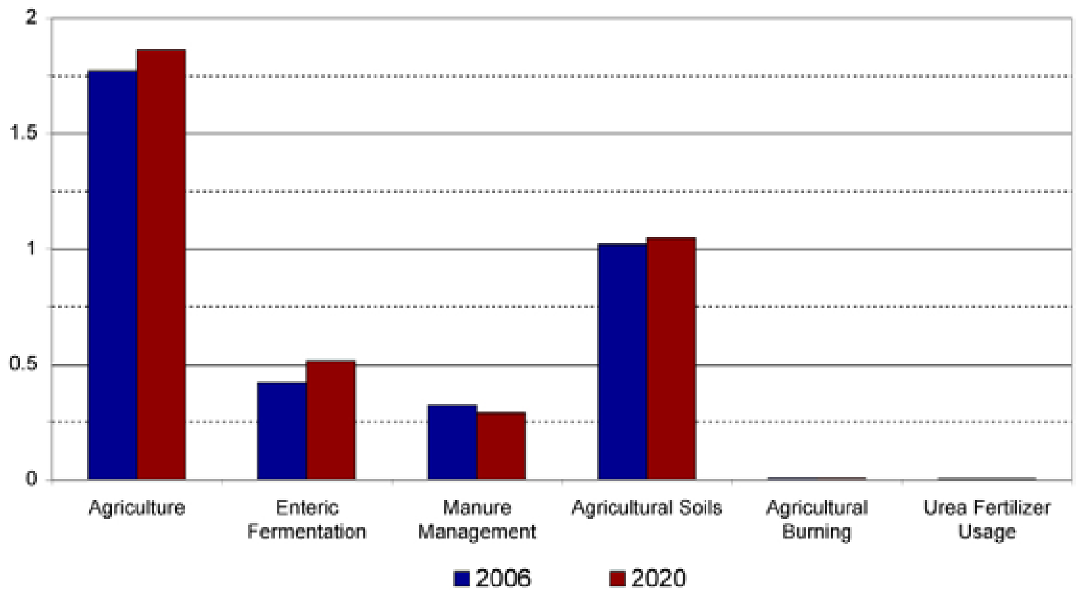
Agriculture

The emissions estimated in this section refer to non-energy generating methane and nitrous oxide emissions from enteric fermentation, manure management, and agricultural soils. Emissions and sinks of carbon in agricultural soils also are estimated in this section. Energy emissions, such as combustion of fossil fuels in agricultural equipment, are not included in this section, but are already accounted for under the RCI and nonroad transportation sectors.

Agriculture CO2-equivalent emissions are projected to increase from the 2006 baseline (Figure 3-11). The growth is different by type of emission source, some going down and some going up at different rates. Enteric Fermentation shows the largest percentage of growth.

This version of the inventory does not include any specific estimates of increases or decreases in GHG emissions associated with Marcellus Shale activity in Maryland. There is a large amount of research and analysis currently underway on this issue and MDE will consider this information for future versions of the inventory.

Figure 3-11
Agriculture: 2006 Baseline vs. 2020 "Business-As-Usual"
Total and by Type
(in million metric tons CO2-equivalent)



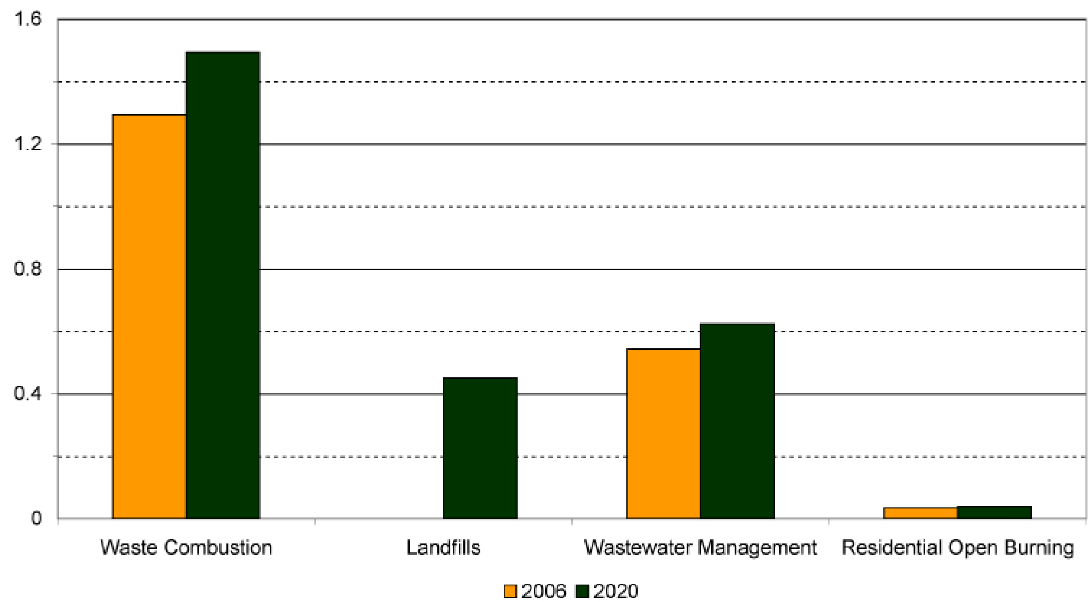
Waste Management

GHG emissions from Maryland's waste management practices were estimated in this section, emissions were estimated from the three main classes of waste management in Maryland:

1. Solid waste management - mainly in the form of methane emissions from municipal and industrial solid waste landfills (including methane that is flared or captured for energy production);
2. Wastewater management - including methane and nitrous oxide from municipal and industrial wastewater treatment facilities;
3. Methane and nitrous oxide from municipal solid waste incinerations.

Waste CO2-equivalent emissions are projected to increase from the 2006 baseline (Figure 3-12). Waste combustion (also known as incineration) is currently the greatest contributor to these emissions and is projected to remain that way for the foreseeable future.

Figure 3-12
Waste: 2006 Baseline vs. 2020 "Business-As-Usual" by Type
(in million metric tons CO2-equivalent)



Forestry and Land Use

This section provides an assessment of the net GHG flux resulting from land uses, land-use changes, and forest management activities in Maryland. The balance between the emission and uptake of GHGs is known as GHG flux. The GHG emissions estimated in this section include carbon dioxide emissions from urea fertilizer use, methane and nitrous oxide emissions from wildfires and prescribed forest burns, and nitrous oxide emissions from synthetic fertilizers application to settlement soils. Carbon sequestration pathways estimated in this section include:

- above and below ground biomass
- dead wood and forest litters
- landfilled yard trimmings and food scraps
- harvested wood product
- wood products in landfills
- urban trees.

Net forestry emissions remain basically constant from the 2006 baseline to the forecasted 2020 business-as-usual.

2020 Goal: How much do we need to reduce?

To calculate a specific 2020 emission reduction goal for Maryland, two key pieces of information are needed: the 2006 State-wide GHG emissions baseline and the 2020 State-wide business-as-usual forecast. Both pieces of data are needed, since the total GHG reduction needs to include both the amount below the 2006 baseline and the anticipated growth of GHGs in the absence of any climate programs. The growth is the difference between the 2020 business-as-usual forecast and the 2006 baseline. This is the same methodology that MDE uses for reduction efforts for criteria pollutants, such as precursors of ozone.

Maryland's 2006 baseline GHG emissions are confirmed at 95.14 million metric tons of CO2-equivalent. So, a 25% reduction from this would mean a reduction of 23.785 million metric tons of CO2-equivalent. Another way to think about this is that the GGRA climate strategies should lead Maryland down to a 2020 actual State-wide emission of 71.355 million metric tons of CO2-equivalent (95.14 minus 23.785).

Maryland's 2020 business-as-usual GHG emissions forecast is 128.30 million metric tons of CO2-equivalent. This represents a 34.9% increase over the 2006 actual baseline. Note, this forecast does not include any measures to reduce GHG emissions that were put in place after 2006. The difference between the 2020 business-as-usual forecast and the 2006 baseline represents the possible "growth" between these years, assuming no climate programs are created. This is the second piece of the GHG emissions goal that is needed.

The 2020 GHG reduction target is **56.94** million metric tons of CO2-equivalent. This target is calculated by subtracting where we need to be in 2020 (71.36 million metric tons of CO2-equivalent) from the 2020 business-as-usual forecast (128.30 million metric tons of CO2-equivalent).


THE COLONY
WELCOME TO OCEAN CITY'S ORIGINAL
FLASHBACK
OLD TIME PHOTOS
FAMILY, GROUP, & CHILDREN'S PORTRAITS • READY IN MINUTES
LAST STOP
BEACHWEAR
LAST STOP
BEACHWEAR
BODY PIERCING
HENNA TATTOO
FOOD
DRINK
TIKI BUNCHE
7.99
2 FOR 15

Elevating Ocean City as Sea-Level Rises

Logistically, the easiest time to elevate low land is when it is still vacant, or during a co-ordinated rebuilding. Low parts of Ocean City's bay side were elevated during the initial construction. As sea level rises, the town of Ocean City has started thinking about how it might ultimately elevate.

Ocean City's relatively high bay sides make it much less vulnerable to inundation by spring tides than other barrier islands. Still, some streets are below the 10-year flood plain, and as sea level rises, flooding will become increasingly frequent.

However, the town cannot elevate the lowest streets without considering the implications for adjacent properties. A town ordinance requires property owners to maintain a 2-percent grade so that yards drain into the street. The town construes this rule as imposing a reciprocal responsibility on the town itself to not elevate roadways above the level where yards can drain, even if the road is low enough to flood during minor tidal surges. Thus, the lowest lot in a given area dictates how high the street can be.

As sea level rises, failure by a single property owner to elevate could prevent the town from elevating its streets, unless it changes this rule. Yet public health reasons require drainage, to prevent standing water in which mosquitoes breed. Therefore, the town has an interest in ensuring that all property owners gradually elevate their yards so that the streets can be elevated as the sea rises without causing public health problems.

The Town of Ocean City (2003) has developed draft rules that would require that, during any significant construction, yards be elevated enough to drain during a 10-year storm surge for the life of the project, considering projections of future sea-level rise. The draft rules also state that Ocean City's policy is for all land to gradually be elevated as the sea rises.

Source: http://www.epa.gov/climatechange/effects/coastal/pdfs/ccsp_app1.pdf p.214

Reference Page

The following resources were utilized in the writing of this chapter.

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http://www.michie.com/maryland/lpExt.dll?f=templates&eMail=Y&fn=main-h.htm&cp=mdcode/dea9.

Boucher, O., et al. "Radiative Forcing of Climate Change." Chapter 6 in *Climate Change* 2001: The Scientific Basis. Contribution of Working Group 1 of the Intergovernmental Panel on Climate Change Cambridge University Press. Cambridge, United Kingdom. Available at: http://www.grida.no/climate/ipcc_tar/wg1/212.htm.
Excluding GHG emissions removed due to forestry and other land uses.

The national emissions used for these comparisons based on 2006 emissions from *Inventory of US Greenhouse Gas Emissions and Sinks: 1990–2006*, April 15, 2008, US EPA # 430-R-08-005, http://www.epa.gov/climatechange/emissions/usinventoryreport.html.
(Note that electricity sector emission reductions attributable to the RGGI are not included in the reference case emissions inventory.)

Frequently Used Abbreviations and Acronyms

GHG: Greenhouse Gas

Chapter 4

Climate Change and the Cost of Inaction in Maryland: A 2011 Review

This chapter is based upon material provided by the University of Maryland's Center for Integrative Environmental Research

Executive Summary

This chapter provides an update to a prior report from the Center for Integrative Environmental Research on the costs associated with not implementing policies in Maryland to combat the impacts of climate change, which was included as chapter three in the 2008 Maryland Climate Action Plan. An estimation of these costs is important to guide investment and policy making for two key reasons. First, all too often, the cost of action, such as paying for energy efficiency in homes or investing in renewable energy sources, can be easily calculated and may suggest that programs to cut emissions of greenhouse gases (GHGs), including increased availability of mass transit and use of smart-growth policies, are too costly, given the other needs of society, such as affordable housing, educating children and improving healthcare. Yet, not acting to prevent the impacts of climate change has its costs, which must also enter the decision process. It is the cost of inaction upon which this chapter focuses. The costs of action must be compared to the costs of inaction before policy-makers can make informed decisions.

Second, acknowledging and avoiding the costs of inaction will have clear local and regional benefits. Without recognizing the benefits of climate action, decision-makers may be misled by the notion that stabilizing or reversing global climate change is a futile exercise for local jurisdictions that can only impose costs on their citizens, their economy and their environment. In reality, understanding the impacts of climate variability and change on a region's economy, society and environment is an important precondition for determining the viability and profitability of investments in economy, society and environment, be it through investments in institutions, infrastructure or the preservation of natural systems.

Key Findings

In this chapter, new information is presented to substantiate the findings for the costs of inaction provided in the 2008 Climate Action Plan. None of the issues presented in the 2008 report as important to the State of Maryland have declined in their importance, though many have become more pronounced. At least the following six factors may have contributed to the rise in potential cost of inaction and add to the urgency of addressing climate change:

1. **Research on climate impacts and response options has progressed significantly in the last few years.** New data and better models confirm that past predictions of global climate change impacts were on the conservative side for both severity and cost. Data confirms that the average temperature of the Chesapeake Bay has warmed by 2°F over the past half-century, which is consistent with observed increases in air temperatures. By mid-century, under a business-as-usual scenario, additional atmospheric warming will surpass 3ºF, and the number of days with temperatures exceeding 90ºF is expected to triple to 90 days per year. By 2050, there are expected to be 25 to 35 summer days with temperatures exceeding 100ºF.

2. **GHG emissions have grown more rapidly than assumed, Arctic sea ice has retreated faster than models indicated, and satellite measurements have shown a recent increase in the rate of sea-level rise.** Average global land and ocean surface temperatures in 2010 tied 2005 as the warmest on record. The acceleration of atmospheric warming, changes in the frequency and severity of extreme weather events, and the rate of sea level rise have all been faster than previously anticipated. Extreme weather events, including the Texas drought, the lower Mississippi River flood, devastating tornadoes, and forest fires, have broken records, reminding us of the increased risks from both extreme precipitation and extended periods of drought forecast for Maryland.

3. **Frequently, the relationship between climate change and associated impacts is non-linear.** Small increases in the rate at which the climate changes can have disproportionately large and far-reaching implications for the economy, society and environment. For example, as the rate of freshwater flow into the Chesapeake Bay increases, which is driven by precipitation events and snowmelt, the amount of erosion and thus sediment deposition in the Bay will increase at a faster rate. As an illustration, the first 1,000 cubic feet of water flow may result in 2 pounds of sediment added to the Bay; as water flow increases to 2,000 cubic feet, the sediment addition might be 6 pounds, more than a simple doubling.

4. **A growing economy and population mean that ever more assets are at risk.** Since in Maryland most of the growth in both economic activity and population has occurred along the coast and in urban areas, the costs of inaction have risen. By the end of the century, an estimated 6.1% of Maryland's 3,190 miles of coastline will be vulnerable to inundation from a 3.3-foot increase in sea-level. With two feet of additional sea-level rise, 550 square miles of land could also be inundated at high tide, including the homes of over 60,000 people and 66 miles of roads. Maryland's coastal zone encompasses two-thirds of the State's land area and is home to almost 70% of its residents.

5. **Interdependencies among social, economic and environmental changes can ripple through the economy to magnify climate impacts.** Since 1973, the amount of developed land area in Maryland has grown by 135% at the expense of other types of land use such as agriculture and forests. The loss of agricultural and forested land can exacerbate the effect of climate change on water availability from aquifers because, as the share of developed land area increases, storm water runoff increases and water is unable to enter and recharge aquifers. In contrast, permeable surfaces such as forest and farmland allow water to infiltrate the soil and recharge aquifers. As another example of ripple effects, increased urbanization can worsen extreme heat in cities, thus requiring more air conditioning during peak heat events, which further drives energy consumption and GHG emissions.

6. **The absence of a globally binding climate accord and of national energy and climate legislation that reduces GHG emissions mean that the planet will continue to experience increases in emissions of GHGs, and thus increases in temperatures, sea level rise and in the frequency and severity of extreme weather events.**

Findings by Sector

This chapter highlights important new developments in climate science and the anticipated impact of climate change on the State of Maryland. These climate impacts serve to illustrate costs of inaction central to the welfare of Maryland's citizenry in five sectors – (1) coastal land and ecosystems, (2) tourism, (3) agriculture, (4) public health and (5) energy.

1. **Coastal Lands, Infrastructures and Ecosystems**. Maryland's coastal counties, including all of those adjacent to the Chesapeake Bay and the Atlantic Ocean, are home to a significant share of the State's population. Many parts of its infrastructure, from roads, airports, ports, and water treatment facilities, to commercial and residential buildings, are located here as well. Sea level rise and more frequent and intense weather events will pose an increasing risk to ensuring reliable and sustained infrastructure services. For example, the trade, transportation, and utilities sector alone accounted for $42 billion, or 14%, of the gross domestic product in Maryland in 2010. Increasingly frequent and severe weather events will not only disrupt supply chains and jeopardize businesses, but also require expansion of emergency services and thus divert economic resources.

   Existing storm water and transportation infrastructures are generally designed based on historic precipitation patterns and do not account for future climatic trends. As a result, key dimensions of major infrastructure investments, such as bridge height, pipe diameters, and storm water retention facilities, may be significantly under-designed to accommodate more precipitation, particularly for intermediate term peak events. One consequence of under-designed storm water infrastructure is that peak floods may be more frequent and severe than in the past.

   The Maryland Commission on Climate Change's Scientific and Technical Working Group projected 2.7-3.4 feet (.82 meters to 1.04 meters) of relative sea level rise by the end of the century (Figure 8 in Appendix F). The 2008 Climate Action Plan shows that the southern half of the Eastern Shore (Dorchester and Somerset Counties) is rich in low-lying areas at-risk from sea level rise. These areas have many acres of ecologically diverse tidal wetlands, marshes, and farmland that could be swallowed by waves. Already, 13 islands in the bay are submerged and 400,000 acres on the Eastern Shore are projected to join them.

Using geographic information system tools, the vulnerability of Maryland residential areas to a relative sea level rise of 3.3 feet (1 meter) was evaluated. Storm surge and high tide were not considered in the analysis. The analysis shows that 67.3 square miles of Maryland residential area would be inundated and Figure 4-1 gives the top 20 places affected by the percentage of their area that is at risk. These are shown by absolute area at risk and proportion of the place area at risk, respectively, from a 3.3-foot sea level rise.

2. **Tourism.** In 2009, tourism in Maryland generated roughly $13.7 billion in spending, which resulted in $1.6 billion in tax revenue, directly supported 134,677 full-time equivalency jobs and provided $3.8 billion in salaries and wages. Every year, 27 to 30 million visitors come to Maryland and each visitor stays an average of 1.6 days and spends $250 per trip.

   Since much of Maryland's tourism is heavily dependent on short-term summer trips made by people from nearby destinations, and since such trips are not usually booked months in advance, the state's tourism industry is sensitive to extreme summer weather conditions. By mid-century, the number of days with temperatures exceeding 90ºF is expected to increase threefold. Heat waves will be more frequent and longer lasting, making Baltimore and other Maryland cities less pleasant to visit. While summer revenues could be compensated by increased travel during the "off season," businesses will be adversely impacted by increasing volatility in tourism and an atmosphere of economic uncertainty driven by weather events. Assuming a linear relationship, if the tourist sector shrank by just 5% due to rising temperatures and more frequent and longer lasting heat waves, then this would translate to a loss of $685 million annually and approximately 6700 jobs.

   In addition, tourism can be affected by threats to the physical environment. Increasing beach erosion as well as the frequency of major storms will most likely raise the cost of maintaining Maryland's shoreline or make it a less attractive tourist destination. It is estimated that beaches will move inland at a rate 50 to 100 times faster than the rate of sea level elevation and that the cost of replenishing the coastline after a 20-inch rise in sea level would be between $35 and $200 million. In addition, beach replenishment creates its own negative externalities including high ecological costs. Dredged material buries beach plants and animals, and is detrimental to the existing ecosystem because the material used to replenish beaches is often unsuitable for the reintroduction of the same species, or of any species.

3. **Agriculture.** Roughly one-third of Maryland's six million acres is farmland

Figure 4-1
Top twenty Maryland places (U.S. Census Populated Places)
by percentage area at risk from 3.3 ft (1 m) relative sea level rise.

	Area (square miles)	Sea level rise risk area (square miles)	Percentage at risk
Frenchtown-Rumbly	4.18	3.88	92.73%
Dames Quarter	12.70	11.24	88.47%
Deal Island	3.29	2.32	70.53%
Smith Island	6.92	4.02	58.08%
Fairmount	15.33	8.53	55.66%
Church Creek	0.31	0.17	53.89%
Chance	1.77	0.83	47.16%
Crisfield	1.69	0.69	40.93%
Potomac Heights	1.37	0.48	35.38%
Kent Narrows	2.25	0.72	32.05%
Chesapeake City	0.61	0.19	30.74%
Highland Beach	0.08	0.02	30.47%
Golden Beach	3.44	1.03	29.99%
Oxford	0.72	0.21	29.65%
Ocean City	4.62	1.34	28.94%
Tilghman Island	2.85	0.82	28.65%
West Ocean City	4.32	1.11	25.76%
Mount Vernon	15.01	3.82	25.47%
Stevensville	6.17	1.44	23.28%
Deale	4.31	0.98	22.82%

1 Elevation less than one meter

and agriculture plays a central role in the State's economy. In 2007, the market value of agricultural products sold by Maryland farms was $1.8 billion. Of this value, $629 million (34%) was in the form of crop sales and $1.2 billion (66%) in livestock. Of the latter, 75% ($903 million, 49% of the total) was for poultry and eggs alone.

It is because of the significance of Maryland's agricultural sector to the economy as a whole that consideration of climate impacts is particularly important. Most segments of the Maryland agriculture industry face increasing costs resulting from climate variability. As mentioned above, poultry production is responsible for a large portion of the industry's revenue. The majority of production is located on the Eastern Shore, the area of the State most at risk of inundation from a rise in sea level. Also, rising summer temperatures and more frequent and longer-lasting heat waves could cause animals to grow more slowly, or even die from heat stress. Chickens and turkeys are primarily raised in enclosures, so warmer temperatures will require more energy for building cooling and ventilation. Finally, changing climatic conditions may increase the prevalence of pathogens that in turn increase the cost of disease prevention or decrease production.

The production of crops such as corn, soy and wheat also will face a variety of challenges. Those that seem most likely include increased irrigation needs, a higher risk of flooding, changes in crop yield due to rising temperatures, new pests and increased precipitation variability. Although a moderate rise in average temperatures and higher carbon dioxide levels can lengthen the growing season and stimulate crop growth, the negative impacts of climate change are expected to outweigh these benefits. Even where positive impacts are expected in the short term, optimal growing conditions will be surpassed towards the end of this century.

Additionally, more frequent and intense rainfall can overwhelm nutrient runoff management systems and require investments by farmers and local communities to reduce the negative impacts to water systems caused by nutrient runoff. For example, farmers may need to more actively monitor soil nutrients and moisture to ensure optimal growing conditions. Furthermore, downstream impacts on streams, rivers and the Chesapeake Bay will be exacerbated by increased nutrient runoff. It may become increasingly difficult for Maryland localities and the State to comply with federal water quality regulations (e.g., Total Maximum Daily Loads), something that will require Maryland to adopt more aggressive and costly water protection measures to achieve and remain in compliance.
Increased climate variability means that farmers will have to be prepared for a

wider range of climatic conditions. This could mean compromising crop yield with disease and weather resilience, or risk crop failure (CCSP, 2008). It also means more intense crop management with increasing equipment costs, which could be problematic for the many small-scale farmers in Maryland.

4. **Public Health.** Rising temperatures and an increase in precipitation variability is liable to influence air quality, heat stress and vector-borne diseases across Maryland. Additionally, the risk of water contamination, such as harmful algal blooms, will increase due to changes in temperature and precipitation patterns. As summer days grow hotter due to the effects of climate change, Baltimore and other Maryland cities should be prepared to deal with higher rates of heat-related health effects. Furthermore, large changes in day-to-day temperatures can be expected to happen more frequently, which will have an adverse impact on mortality.

   Impacts of climate change on human health will depend on a number of factors, including an individual's sensitivity and exposure level to a given threat, as well as his or her capacity to cope and adapt. This, in turn, is partially a function of socioeconomic factors. Socially and economically disenfranchised individuals – such as the elderly, the disabled and the poor – are the most vulnerable. As a consequence, there may be considerable environmental justice implications to take into account.

5. **Energy.** Climate changes will influence energy demand. Higher winter temperatures will reduce heating needs, and as a consequence, lower demand for heating fuels. However, summer cooling requirements, typically met by electricity, will increase with more frequent and extreme heat events. Even if total annual electricity consumption in the State remains relatively constant, more extreme heat events are likely to lead to higher peak electricity demand during the summer months, thereby necessitating an increased investment in electricity generation capacity and transmission with those costs being transferred to customers.

   Energy resource production and transmission/delivery systems along the Gulf

Coast and the East Coast are vulnerable to sea level rise and extreme weather events. A hurricane landfall in the Gulf Coast region, where such storms occur more frequently than in the Mid-Atlantic, poses a substantial risk to Maryland due to the oil and gas interconnections between the two regions. Locally, snowstorms and hurricanes damage power lines and disrupt the delivery of fuel oil. Heating fuels are expected to be in less demand as winter temperatures increase. The net impact on natural gas, which serves as both a peak electricity fuel and a primary heating fuel, is uncertain. While less natural gas will be consumed to meet heating requirements, more natural gas is likely to be consumed to meet electricity demand during extreme heat events in the summer. Climate change also will impact renewable electricity sources such as bio-fuels, solar and wind. The warming of the planet is expected to mean greater variability in wind resources and direct solar radiation, which has substantial implications for the planning, siting, and financing of wind farms and solar power generators.

Approach

Appendix F contains a detailed discussion of the study methodology provided by the Center for Integrative Environmental Research. Section 3 of Appendix F provides an overview of new developments in global climate change science since the 2008 Maryland Climate Action Plan, followed by a review of expected climate changes in Maryland in Section 4. Section 5 assesses how the regional climate projections play out along Maryland's urban and rural coastal zones, where vulnerability is expected to be especially high. Sections 6, 7, 8 and 9 focus on tourism, agriculture, public health and energy sectors, respectively. Appendix F closes with a summary of the most important findings and lessons learned.

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"Climate change is happening now and it's happening in our own backyards and it affects the kinds of things people care about."

– Jane Lubchenco, NOAA Administrator

Photo taken 9/25/2003 by MHT staff. This is an assessment photo of damage caused by Hurricane Isabel. Deal, Anne Arundel County, Maryland.

Deale: Several historic resources were destroyed by massive waves breaking over the point. An 1860 center passage house lost its front porch and front wall, which caused a total collapse of the second story framing. A boat building shop, where the owner's uncle built over 300 boats, was smashed into pieces by pounding waves; equipment and hand tools from the shop were strewn about the site. An oyster house also was completely destroyed. A recently renovated bungalow was damaged beyond repair; waves and wind lifted it off its foundations and dropped it eight feet away.

Frequently Used Abbreviations and Acronyms

EPA: U.S. Environmental Protection Agency

GGRA: Greenhouse Gas Emissions Reduction Act

GHG: Greenhouse Gas

MDE: Maryland Department of the Environment

NE-MARKAL: Northeast version of the Market Allocation model

REMI: Regional Economic Models, Inc.

Chapter

5 A Multi-Pollutant Planning Approach

The Northeast States for Coordinated Air Use Management (NESCAUM) contributed to this chapter.

The GGRA and Environmental Planning in Maryland

The 2012 Greenhouse Gas Emissions Reduction Act (GGRA) Plan is part of a larger environmental planning effort in Maryland. It is the first of three key pollution reduction plans that the Maryland Department of the Environment (MDE) will be releasing over the next few years that use a "multi-pollutant" planning approach for selecting and analyzing the control programs that make up these plans. The 2012 GGRA Plan will not only help reduce emissions of greenhouse gases (GHG), but also will help Maryland meet its mandates to: (1) further clean up the Chesapeake Bay; (2) meet new National Ambient Air Quality Standards for ground-level ozone, fine particles, sulfur dioxide, and nitrogen dioxide; and (3) meet federal and State requirements to further reduce regional haze as well as mercury and other air toxics.

Three key pollution reduction plans are the primary end products of MDE's multi-pollutant planning process. They will be developed as follows:

- Phase 1: Developing the GGRA Plan which must be adopted in December 2012
- Phase 2: Developing the State Implementation Plan that is required by the federal Clean Air Act to implement the new ozone standard (which was revised in August 2011). This State Implementation Plan will be due in 2013 or 2014.
- Phase 3: Developing the State Implementation Plan that will be required by the federal Clean Air Act to meet the revised fine particle standard (expected in 2012), and will be due in 2013 or 2014.

In addition to these key plans, there are several other environmental planning efforts that will benefit from the multi-pollutant planning process established for the 2012 GGRA Plan, such as regional haze, and mercury and other air toxics. The 2012 GGRA Plan also is expected to help the State with economic recovery and to help create new green jobs.

Linkages between Greenhouse Gases and Air Pollution

There are some critical linkages between GHGs and other air pollutants. First, studies have indicated that climate change, if unaddressed, could result in increased ozone and fine particulate levels. Second, many strategies that are designed to lower GHG emissions, such energy efficiency programs, may also reduce emissions of nitrogen oxides, sulfur dioxide, mercury, other toxic metals, diesel, and black carbon. Third, some strategies that are designed to lower GHG emissions may result in increases in ozone-forming emissions, such as volatile organic compounds. It makes a lot of sense to work on climate, energy, criteria pollutant, and toxics issues together, not only to maximize benefits but to also ensure that any adverse effects are minimized.

A multi-pollutant assessment approach can be an excellent way to work simultaneously to address several of these goals and concerns. Multi-pollutant planning is a term that can mean different things to different people. The next section describes how Maryland defines multi-pollutant planning.

The Multi-Pollutant Approach

Historically, Maryland's air pollution problems have been addressed on a pollutant-by-pollutant basis. Each pollutant, or pollutant category, of concern has required its own discrete planning effort. As today's environmental and public health challenges become more complex, states are recognizing the importance of moving to a more integrated, multi-pollutant, economy-wide approach. Maryland began its movement into an integrated approach with Maryland's 2006 Healthy Air Act, a four pollutant law. It set standards for three pollutants, nitrogen oxides, sulfur dioxide, and mercury. Additionally, it required Maryland to participate in a GHG reduction program. This approach was extremely successful and very cost effective. The controls for nitrogen oxides and sulfur dioxide also lead to reductions in mercury so that, in some cases, mercury –specific technologies were not necessary. This success has lead to a plan to continue a more in-depth approach to multi-pollutant planning that not only considers cost effectiveness to the source but a broad spectrum of benefits from both an overall economic and public health perspective as well as energy implications.

A comprehensive multi-pollutant planning approach looks at multiple air quality goals concurrently and assesses potential control approaches and their environmental, public health, energy, and economic impacts together. It will help Maryland address multiple pollution problems in a more strategic, cost-effective and resource-efficient manner.

For years, major businesses have pushed for a more integrated, multi-pollutant approach for pollution controls. Through this multi-pollutant planning process, MDE's Air and Radiation Management Administration hopes to better integrate across environmental problems and design common sense, integrated, cost-effective solutions that will not only maximize environmental protection, but also significantly reduce the cost to regulated sources.

While the concept of multi-pollutant planning sounds simple, implementing a multi-pollutant planning approach is complex, cutting-edge, and pioneering work. Only a handful of states have been proactively engaging in multi-pollutant activities, and the U.S. Environmental Protection Agency (EPA) has only recently begun exploring how to assist states in such efforts. Maryland has been a leader, working with other Northeast states such as New York, the Northeast States for Coordinated Air Use Management (NESCAUM), and EPA on multi-pollutant planning.

A multi-pollutant approach can help educate the State's decision makers on how various policies may interact, be effective and yield benefits. A multi-pollutant approach that makes sense for Maryland is one that integrates climate, air quality, and energy goals. It can also conduct health and economic assessments in addition to traditional air quality assessments. Maryland's view of multi-pollutant planning is that it:

- Address multiple pollutants, including carbon dioxide, sulfur dioxide, nitrogen oxides, and mercury;
- Highlight tradeoffs and co-benefits of various policy options;
- Analyze the environmental, public health, economic, and energy implications of various potential control strategies;
- Allow for multi-sector analyses.

The multi-pollutant approach will enable simultaneous policy and economic analyses consistent with requirements of the GGRA. It also will help Maryland integrate GHG mitigation and future air quality planning for ozone, fine particles, and regional haze into a consolidated analytical and policy framework.

The Co-Pollutants and Co-Benefits from Reducing Them

Air pollution affects not only the quality of the air, but also the land and the water. Since what goes up must come down, pollutants released into the air will eventually make their way down to the earth's surface.

Almost all of the control strategies selected to reduce GHG emissions in the proposed GGRA Plan also reduce emissions of other pollutants of concern. These pollutants include nitrogen oxides, sulfur dioxide, ozone, fine particles, and mercury and other air toxics. This section describes the non-GHG co-pollutants and benefits associated with reducing them.

Nitrogen Oxides

Nitrogen oxides are important pollutants to reduce, since they contribute significantly to Maryland's primary air quality problems: ground level ozone (a lung irritant), fine particles (associated with lung and pulmonary public health problems), and nitrogen dioxide (adversely affects the respiratory system). They also contribute to Maryland's water quality problems in the Chesapeake Bay and elsewhere. While most people associate Chesapeake Bay problems with run-off water from the surrounding land, it is important to note that approximately one-third of the Chesapeake Bay's nitrogen pollution problem is due to airborne nitrogen.

Nitrogen oxides are primarily a product of incomplete combustion emitted from power plants, and many types of motor vehicle engines used on and off highways, that burn fossil fuels. Nitrogen oxides are a major contributor in the creation of ground level ozone. Ozone is formed on hot summer days, when nitrogen oxide emissions combine with emissions of volatile organic compounds and sunlight to photochemically produce ozone. Emissions of nitrogen oxides also play a key role in contributing to Maryland's problems with fine particle pollution.

Sulfur Dioxide

Achieving reductions in sulfur dioxide is also important to public health and the environment. Sulfur dioxide is the primary pollutant contributing to unhealthy fine particle levels in Maryland. Sulfur dioxide emissions mostly come from fossil fuel combustion at power plants and other industrial facilities, as well as from the burning of high-sulfur fuel in off-road vehicles, such as locomotives and large ships. Due to adverse respiratory effects associated with exposure to sulfur dioxide, EPA established and recently revised the National Ambient Air Quality Standards for sulfur dioxide. It also is the primary pollutant linked to acid rain, as well as the main contributor to reduced visibility across the country. The Regional Haze requirements of the federal Clean Air Act are designed to address the visibility issues.

Fine Particles

Significant public health benefits can be created by reducing emissions of sulfur dioxide and nitrogen oxides, which lead to lower levels of fine particles in the air Marylanders breathe. The size of particles is directly linked to their potential for causing health problems. Fine particles less than 2.5 microns in diameter pose the greatest risk because they can lodge deep into the lungs and some particles may pass into the bloodstream. Therefore, exposure to such particles can affect both lungs and heart. Particulate pollution exposure is linked to increased risk of respiratory symptoms, such as irritation of the airways, coughing, or difficulty breathing; decreased lung function; aggravated asthma; onset of chronic bronchitis; irregular heartbeat; nonfatal heart attacks; and premature death in people with heart or lung disease. Another concern with fine particles is that their adverse impacts occur year-round versus the seasonal nature of ozone impacts.

Environmental effects of particulate pollution include reduced visibility, environmental damage, and aesthetic damage. Fine particles are the major cause of haze in many national parks and wilderness areas. Particles can be carried over long distances by wind and then settle on ground or water, causing more acidic lakes and streams, changed nutrient balance in coastal waters and large river basins, depletion of nutrients in soil, damage to sensitive forests and farm crops, and affects on the diversity of ecosystems. Particle pollution can stain and damage stone and other materials, including culturally important objects such as statues and monuments.

Ozone

Reducing nitrogen oxide emissions leads to lowered ozone levels, and the associated public health benefits are significant. Ozone is a highly reactive gas that reacts strongly with living tissues as well as many man-made substances. Volatile organic compounds assist in forming ozone; volatile organic compounds are emitted from a variety of products, such as gasoline, paints and building materials. Ninety percent of the ozone breathed into the lungs is never exhaled, since ozone molecules react with lung tissue to cause several health consequences.

Too much ozone in the air can be harmful to people who work or exercise outdoors regularly, anyone with respiratory difficulties, and especially to children. The most common symptom is pain when taking a deep breath. Exposure to ozone can result in long- and short-term effects in healthy individuals as well as those who are already sensitive to air pollution, such as children, asthmatics and the elderly.

Long-term ozone effects may include reduced lung function, scarring of lung tissue, and even premature death. Research suggests that repeated exposure to ozone may cause damage to lung tissue, thereby reducing lung function. According to EPA, "Long-term exposures to ozone can cause repeated inflammation of the lung, impairment of lung defense mechanisms, and irreversible changes in lung structure, which could lead to premature aging of the lungs and/or chronic respiratory illnesses such as emphysema and chronic bronchitis."

Children are at greater risk for ozone-related respiratory problems because their lungs are still developing, they breathe more rapidly, and they play outside during the afternoons, when ozone is at its highest levels. Children also inhale more air, hence more pollution, per pound of body weight than do adults. Additionally, people suffering from lung disease have even more trouble breathing when air is polluted with high levels of ozone. Prolonged exposure, even to relatively low levels of ozone, can even significantly reduce a healthy adult's lung function.

Short-term ozone effects among healthy populations include impaired lung function and reduced ability to perform physical exercise. For example, healthy young people developed significant reduction of lung function, additional coughing and breathing pains, and enhanced airway reactivity to irritants when exposed to ozone at concentrations between 80-120 parts per billion for 6.6 to 7.0 hours while moderately exercising.

Ozone poses a threat to the health of natural ecosystems. Scientific evidence suggests that air pollution weakens the immune systems of many types of vegetation and can cause significant crop damage. In addition, rain and snow wash air pollution deposited on vegetation and architectural surfaces into the streams and rivers of the region and finally into the Chesapeake Bay.

Mercury and Other Air Toxics

Airborne chemical contaminants such as mercury can also affect the Chesapeake Bay. Mercury is a potent air toxic that can cause serious adverse neurological effects, as well as harm the brain, heart, kidneys, lungs, and immune system. It is a naturally occurring element found in rocks, including coal. When coal is burned at power plants, mercury is released into the environment. It can then be deposited into Maryland's waters by falling to the ground as acidic rain, snow, or fog and by attaching to dust or smoke. Airborne mercury emissions are the primary contributor to the State's ongoing problems with mercury in water bodies as well as the resultant mercury advisories for fish.

Further reducing risk of exposure to other air toxics, such as benzene and acetaldehyde, is also critical for protecting public health. Levels of these toxic emissions, which typically come from cars and other mobile sources, have significantly declined in Maryland with the implementation of the clean fuels, advanced technology vehicles and inspection and maintenance programs. Opportunities should be explored to further reduce these pollutants.

Chesapeake Bay Benefits

One of the primary goals of Maryland's effort to reduce GHG emissions is to begin addressing sea-level rise, which could have a dramatic impact on the living resources of and around the Chesapeake Bay. Chapters 2 and 4 of this version of the 2012 GGRA Plan provide additional information on the impacts of sea-level rise in Maryland.

In addition to addressing sea-level rise, the 2012 GGRA Plan could yield co-benefits that assist in Maryland's efforts to further reduce pollution entering the Chesapeake Bay. One co-benefit is achieved by adopting strategies that reduce nitrogen oxide emissions which lead to excess nitrogen pollution in the Chesapeake Bay. Nitrogen is a type of nutrient contributing to the Chesapeake Bay's poor water quality. While nitrogen is needed for plant growth, human activities, such as driving cars and applying fertilizers, contribute more nitrogen than is healthy for the Chesapeake Bay watershed.

According to the Chesapeake Bay Program, most of the nitrogen comes from:

- Airborne emissions from vehicles, power plants, industries, and other sources (33 percent);
- Chemical fertilizers applied to agricultural and urban and suburban lands, such as lawns and golf courses (26%);
- Treated wastewater discharged from industrial facilities and municipal wastewater treatment plants (19%);

- Manure from agricultural lands (18%);
- Septic systems that treat household wastewater and discharge nutrients into groundwater (4%);
- Soil, animal waste, plant material and the atmosphere, all of which naturally contain nitrogen.

Excess nitrogen fuels the growth of algae, creating dense algae blooms on the surface of the water that rob the Chesapeake Bay's aquatic life of sunlight and dissolved oxygen. "Leftover" algae that are not consumed by algae-eating organisms eventually die and sink to the bottom. There, they are decomposed by bacteria in a process that leaves bottom waters with little or no dissolved oxygen that crabs and other bottom-dwelling species need to survive.

Algae also can grow directly on the grasses' leaves, further reducing the amount of sunlight they receive. Without sunlight, bay grasses cannot grow and provide critical food and habitat for blue crabs, waterfowl and juvenile fish.

Impacts on Public Health

In the 2011 "State of the Air" report for Maryland, the American Lung Association reported that there are 4,972,252 people living in Maryland's ozone nonattainment areas, of whom 1,179,596 were under 18 years old and 600,352 were 65 years or older. Of these, there were

- 345,344 adult asthmatics and 140,794 child asthmatics;
- 164,878 residents with chronic bronchitis; and
- 80,337 residents with emphysema.

Given that multiple pollutants and a variety of sources cause Maryland's pollution problems, it is critical to implement a multi-pollutant approach. The 2012 GGRA Plan provides an opportunity to start this process.

Cornerstone Multi-pollutant Programs in Maryland

Maryland has made considerable progress in improving the region's air quality for the criteria pollutants. Throughout the 1990's, Maryland, on average, experienced half the number of bad air quality days when the ozone levels exceeded EPA national standard than were seen in the 1980's. The summers of 2003 and 2004 were the cleanest on record since Maryland began measuring ozone air pollution. Numerous pollution controls within Maryland as well as some significant pollution controls occurring on a national level have had a major affect upon Maryland's air quality with respect to ozone.

The Maryland Healthy Air Act

The Maryland Healthy Air Act (Annotated Code of Maryland Environment Title 2 Ambient Air Quality Control Subtitle 10 Health Air Act Sections 2-1001 - 2-1005) was developed with the purpose of reducing emissions of nitrogen oxides, sulfur dioxide, and mercury from the largest coal-burning electricity generating sector (power plants). The State's Healthy Air Act is one of the toughest power plant emission laws on the East Coast.

The law was designed to bring Maryland into attainment with the National Ambient Air Quality Standards for ozone and fine particulate matter while also reducing mercury emissions and deposition of nitrogen to the Chesapeake Bay and other waters. The Healthy Air Act also required that Maryland become involved in the Regional Greenhouse Gas Initiative which is aimed at reducing GHG emissions from electricity generation. The Regional Greenhouse Gas Initiative is discussed in more detail in Chapter 6.

MDE was charged with implementing the Healthy Air Act through regulations. These regulations, which became effective on July 16, 2007, constitute the most sweeping air pollution emission reduction measures in Maryland's history.

Over 95% of the air pollution emitted from Maryland's power plants came from the largest and oldest coal burning plants. The emission reductions from the Healthy Air Act occur in two phases. The first phase required reductions in the 2009/2010 timeframe. The law was designed to reduce nitrogen oxide emissions by almost 70%, sulfur dioxide emissions by 80% and mercury emissions by 80 percent from a 2002 emissions baseline. The second phase of emission controls will occur in the 2012/2013 timeframe. When fully implemented, the Healthy Air Act will reduce nitrogen oxide emissions by approximately 75%, sulfur dioxide emissions by approximately 85%, and mercury emissions by 90% from 2002 levels. Figures 5-1 and 5-2 illustrate the dramatic emission reductions from the 2009/2010 phase of the Healthy Air Act.

Figure 5- 1
Quarterly emissions trend of nitrogen oxides (NOX) between 2003 and 2011

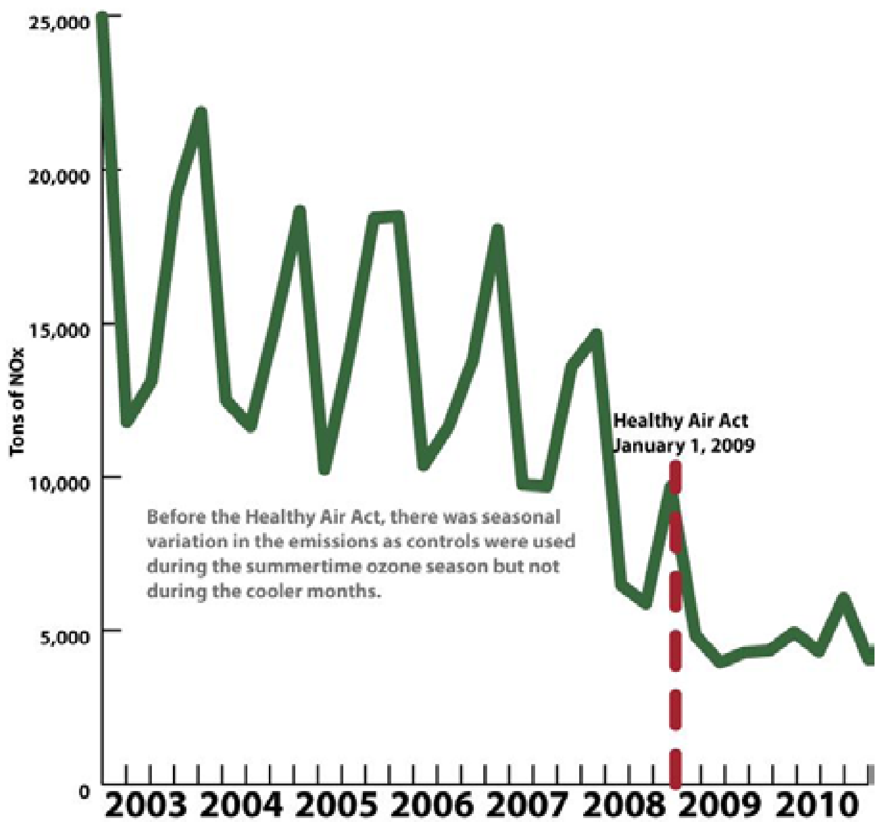
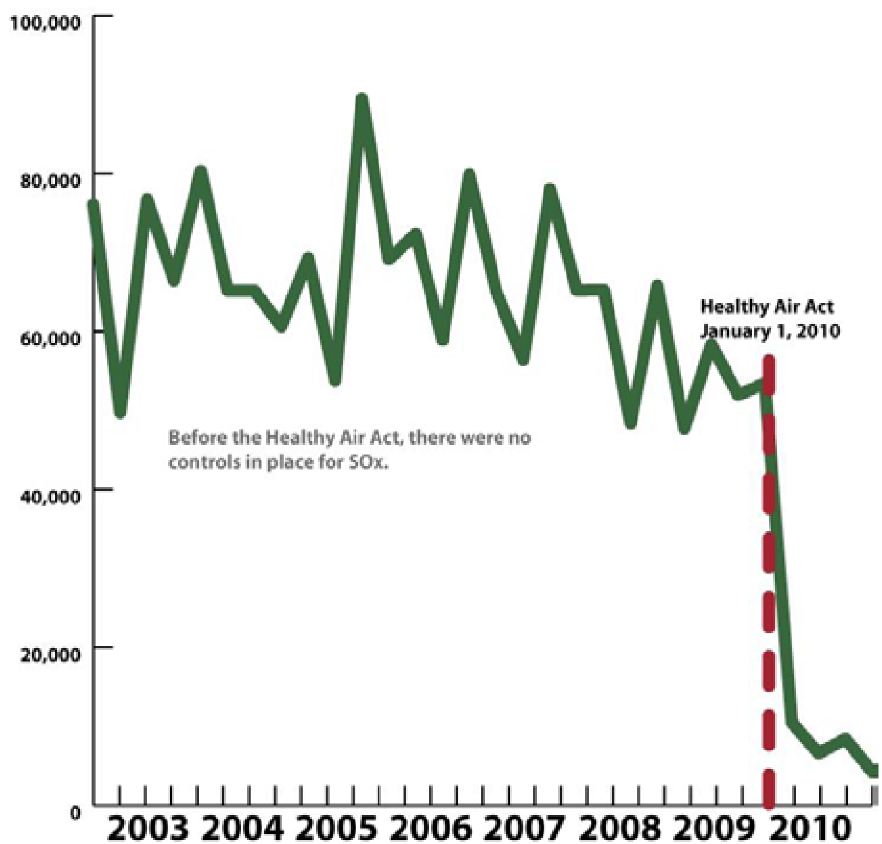


Figure 5- 2
Quarterly emissions trend of sulfur dioxide (SO2) between 2003 and 2011



In addition to tackling the State's ozone problem, the Healthy Air Act protects the Chesapeake Bay by reducing nitrogen and mercury pollution from the air. In 2010, emission monitoring showed the mercury emissions from HAA sources had been reduced by 93%. It also helps to improve visibility throughout scenic areas in Maryland and other states.

The Maryland Clean Cars Program

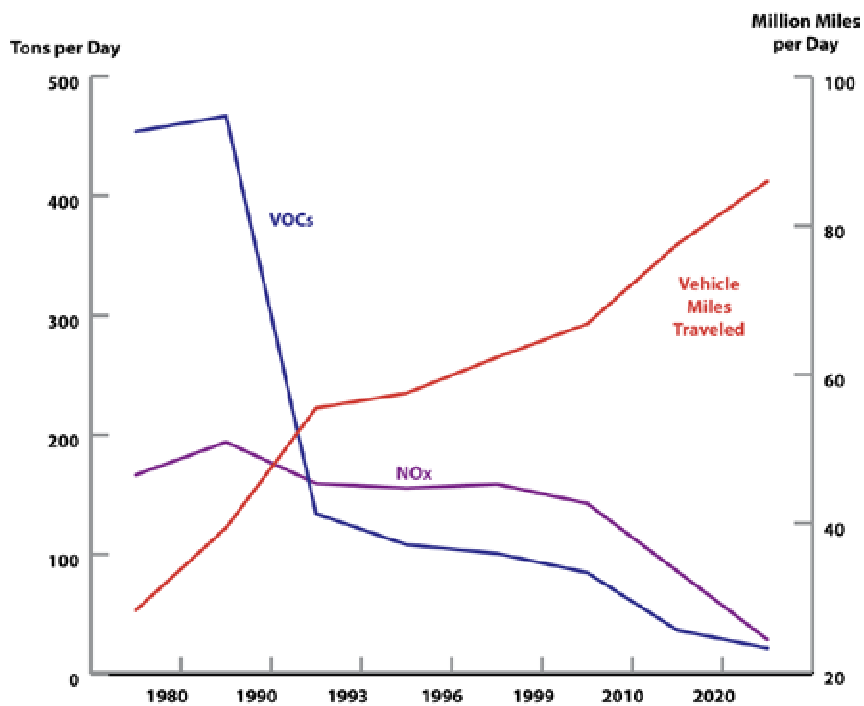
In 2006, Maryland adopted the Clean Cars Act. This law requires that the cleanest cars allowed by law must be sold in Maryland, starting with model year 2011 vehicles. The law requires all vehicles sold in Maryland to comply with stringent emission standards, which reduce emissions of four key pollutants: GHGs, nitrogen oxides, volatile organic carbon, and air toxics.

The Maryland Clean Cars Program helps Maryland in four important ways. First, it is a key part of the State's plan to combat climate change. Second, it helps move the State closer to meeting federal health-based standards for ozone and fine particles. Third, it reduces emissions of air toxics like benzene. Fourth, by reducing nitrogen emissions and toxics, it supports efforts to protect the Chesapeake Bay.

When fully implemented, the Maryland Clean Car Program is estimated to reduce GHG emissions by 7.8 million tons per year and air toxics by 80.2 tons per year. The carbon dioxide reductions provided by this program are the equivalent to removing one 1,200 megawatt coal burning power plant from the State. In addition, the Maryland Clean Car Program will reduce the emissions of nitrogen oxides and volatile organic carbon by 5.18 tons per day and 3.55 tons per day, respectively. The Maryland Clean Cars Program is further discussed in Chapter 6.

Figure 5-3 shows the dramatic emission reductions of nitrogen oxides and volatile organic carbon from mobile sources already achieved, and anticipated to be achieved, in Maryland.

Figure 5- 3
Emissions trends for vehicle related nitrogen oxides (NOX) and volatile organic compounds demonstrating sharp reductions in overall emissions while total vehicle miles travelled significantly increases.



EmPOWER Maryland

In 2007, Maryland launched EmPOWER Maryland as an executive initiative, setting a goal for the State government to reduce its electricity consumption by 15% by 2015. The initiative called on State government to increase energy efficiency in its operations through improved facility operations and purchasing practices and established accountability through energy data reporting into StateStat, the Maryland statistics-based government management process.

The EmPOWER Maryland goal was broadened and codified in the EmPOWER Maryland Energy Efficiency Act of 2008. The law established a State-wide goal of reducing per capita electricity consumption and per capita peak demand by 15% from a 2007 baseline by the end of 2015. These reductions are being achieved through a number of programs, such as utilities implementing energy efficiency programs targeted to consumers and demand-side management. The utilities' initial program plans and periodic updates must be submitted to the Maryland Public Service Commission for review and approval, following advisory review by the Maryland Energy Administration.

Although the primary purpose of the EmPOWER Maryland Program is to reduce energy consumption, the initiative will also significantly reduce emissions of GHGs, nitrogen oxides and sulfur dioxide from the energy generation sector, primarily power plants. EmPOWER Maryland is discussed in more detail in Chapter 6.

The Multi-Pollutant Policy Analysis Framework

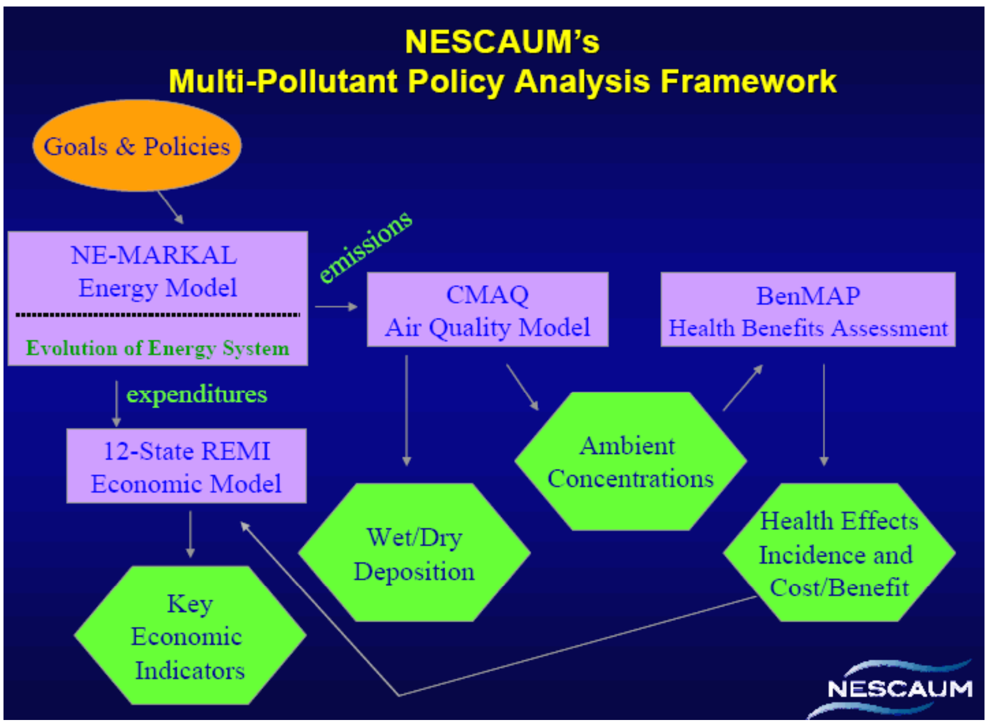
As discussed previously, the non-GHG co-pollutants described above are strongly linked to energy infrastructure in many sectors of the economy. In order to maximize human resource savings, multi-pollutant planning tools are needed that can simultaneously examine policies across pollutants, sectors, and programs. To assist states in implementing a multi-pollutant planning approach, NESCAUM developed a Multi-pollutant Policy Analysis Framework, shown in Figure 5-4. The Multi-pollutant Policy Analysis Framework brings together and uses a series of assessment models, tools, and databases that are linked in order to conduct multi-pollutant analysis. These include:

1. NE-MARKAL, a Northeast version of the Market Allocation model, an energy model that is widely used in Europe;
2. Regional Economic Models, Inc. (REMI), which evaluates the effects of policies on the economies of local regions;

3. EPA's Community Multi-scale Air Quality (CMAQ) model, which assesses future air quality changes for a set of policies;
4. EPA's Environmental Benefits Mapping and Analysis program, which estimates health impacts and associated economic values resulting from changes in ambient air pollution.

These models, through the Multi-pollutant Policy Analysis Framework, can evaluate potential strategies to simultaneously address air quality, Bay and climate goals in Maryland.

Figure 5- 4
NESCAUM's Multi-Pollutant Policy Analysis Framework.



The centerpiece of the framework is the NE-MARKAL model, an energy model that can calculate least-cost combinations of energy technologies to achieve a prescribed pollution reduction goal. The model covers 11 states plus the District of Columbia, and characterizes electricity generation, transportation, and the industrial, residential and commercial building sectors over a 30- to 50-year time horizon.

The Multi-pollutant Policy Analysis Framework models provide a range of outputs. In addition to assessing the potential emissions reductions of several different pollutants of concern for a given policy, it allows the user to input the emissions reductions data from NE-MARKAL into other models that, in turn, can provide output data on potential air quality and health benefits. NE-MARKAL can also link to REMI, the regional economic model, which can estimate useful economic metrics such as gross state product, jobs, and household disposable income. This level of linked analyses and data has not been traditionally available to air quality planners.

The Multi-pollutant Policy Analysis Framework models can help policymakers evaluate relative importance of various policies over others by assessing cross-sector impacts, such as how transportation programs could affect power plant emissions.. It also provides data on technology for modeled policies, such as how many and what type of electric vehicles would be needed to achieve a certain emissions reduction goal. This type of specific information on program characteristics can be very helpful to Maryland in designing future regulatory programs.

MDE has worked with NESCAUM over the past few years on multi-pollutant assessment exercises to become familiar with the Multi-pollutant Policy Analysis Framework tools. An earlier phase included conducting a calibration of the NE-MARKAL model so that the model behaves in a manner that replicates standard assumptions about energy and air emissions trends in Maryland. This work was conducted in collaboration with the Maryland Public Service Commission, the Maryland Energy Administration, and the Maryland Department of Natural Resources' Power Plant Research Project.

MDE has initiated this pioneering work with the GGRA goals as its primary focus, and is also keeping the other pollutants in mind. Specifically, MDE could use the Multi-pollutant Policy Analysis Framework to conduct "weight-of-evidence" analyses for the 2012 GGRA plan over the course of the next few years. In later phases, the Multi-pollutant Policy Analysis Framework could also be used when MDE commences work on the Ozone and Fine Particle State Implementation Plan. The full initial report on the role of NE-MARKAL in Maryland's multi-pollutant planning approach can be found in Appendix D.

On-Going Analyses to Support The Final GGRA Plan

By the end of 2012, Maryland expects to have significant additional analyses completed that demonstrate the multi-pollutant benefits of the GGRA Plan. These analyses will include:

- Initial quantification of benefits to other environmental priorities like the Chesapeake Bay and the ozone and fine particle air quality standards.
- Preliminary estimates of the reduced premature mortality, respiratory illness and other consequences associated with reducing air pollution through the multi-pollutant planning process
- Preliminary cost-benefit analyses of the multi-pollutant plan

New York Approches to Multi-Pollutant Planning

Maryland's approach to multi-pollutant planning is consistent with efforts in New York. The New York Department of Environmental Conservation is employing the Multi-pollutant Policy Analysis Framework in the development of New York's Air Quality Management Plan and in its efforts to reduce GHG emissions. The New York state agency reviewed pending Clean Air Act requirements, state and regional environmental goals and targets, and major New York energy efficiency and renewable energy policy initiatives affecting emissions. The targets include New York's State Implementation Plan requirements for attaining the ozone and particulate matter standards; climate action plans; regional haze reasonable progress goals; and critical loads for sensitive ecosystems for mercury and acid deposition. Emission reduction targets have been identified that will be used as indicators for a broad range of air quality goals.

Maryland and New York are using the multi-pollutant analytical framework to assess impacts of similar policies, including:

- Reducing per capita energy consumption
- Increasing use of renewable energy
- Increasing the number of hybrid and dedicated electric vehicles in the on-road fleet
- Increasing the use of EnergyStar appliances in commercial and residential buildings

In additon to using the NE-MARKAL model, New York and Maryland are planning additional modeling efforts to assess regional economic impacts and human health benefits.


COLOR
KINETICS

Summary

The multi-pollutant approach, including the Multi-pollutant Policy Analysis Framework analyses, examines multi-pollutant benefits and tradeoffs through data and data analysis. It provides illustrative results of the relative importance of various modeled pollution control strategies. The Multi-pollutant Policy Analysis Framework is a pioneering tool, providing linked analyses and data that are not generally available to air quality planners through their typical state planning efforts. Moreover, a multi-pollutant provides: (1) specific information on program characteristics from the NE-MARKAL technology evolution analyses that can be used directly in future air program planning analyses, as well as in regulation development and implementation; and (2) the capability to more easily identify influences and interactions of an individual strategy with the other strategies in the suite of strategies that are modeled.

Working from a combined energy, environmental, and economic platform will be very useful in examining and choosing a set a strategies that can assist Maryland in meeting not only the GGRA goals, but also Maryland's Chesapeake Bay protection and air quality goals while also minimizing the cost of pollution controls at affected sources.

Planning for Sea-Level Rise in Baltimore

Only 3.2 percent of the City of Baltimore's 210 sq km (81 sq mi) of land is currently within the coastal floodplain. This land, however, includes popular tourist destinations such as Inner Harbor and the Fells Point Historic District, as well as industrial areas, some of which are being redeveloped into mixed use developments with residential, commercial, and retail land uses. The map below depicts the areas that the city expects to be flooded by category 1, 2, 3, and 4 hurricanes, which roughly correspond to water levels of 1.8 m (6 ft), 3.0 m (10 ft), 4.2 m (14 ft), and 5.5 m (18 ft) above North Amercan Vertical Datum (NAVD88). Approximately 250 homes are vulnerable to a category 1, while 700 homes could be flooded by a category 2 hurricane (Baltimore, 2006). As Hurricane Isabel passed in September 2003, water levels in Baltimore Harbor generally reached approximately 2.4 m (8 ft) above NAVD, flooding streets and basements, but resulting in only 16 flood insurance claims (Baltimore, 2006).

Inundation Zone for Baltimore Harbor under category 1,2,3, and 4 hurricanes.

The city's All Hazards Plan explicitly includes rising sea level as one of the factors to be considered in land-use and infrastructure planning. The All Hazards Plan has as an objective to "develop up-to-date research about hazards" and a strategy under that objective to "study the threat, possible mitigation and policy changes for sea-level rise". As a first step toward accurate mapping of possible sea-level rise scenarios, the city is exploring options for acquiring lidar. Policies developed for floodplain management foreshadow the broad methods the city is likely to use in its response.

Property values are high, and there is a long-standing practice of armoring shores to facilitate port-related activities and more recently, protect waterfront structures from shore erosion. In most areas, there is not enough room between the harbor and waterfront buildings to fit a dike. Even where there is room, the loss of waterfront views would be unacceptable in tourist and residential areas (see Section 6.5 in Chapter 6; Titus, 1990). In addition, storm sewers, which drain by gravity into the harbor, would have to be fitted with pumping systems.

Fells Point Historic District

This historic community has 24 ha (60 ac) within the 100-year flood plain. Fells Point is a Federal Historic District and pending approval as a Local Historic District. The row houses here were built predominantly in the early-tomid-nineteenth century and cannot be easily elevated. Elevating brick and stone structures is always more difficult than elevating a wood frame structure. But because row houses are, by definition, attached to each other, elevating them one at a time is not feasible. Many of these homes have basements, which already flood. FEMA regulations do not permit basements in new construction in the floodplain (44 CFR §60.3[c] [2]) and treat existing basements as requiring mitigation. Possible mitigation for basements includes relocation of utilities, reinforcement of walls, and eliminating the basement by filling it with soil. In theory, homes could be remodeled to add stairways and doors to convert what is now the second floor to a first floor and convert the first floors to basements. But doing so would reduce the livable space. Moreover, federal and local preservation laws, as well as community sensibilities, preclude adding third stories to these homes. Elevating streets is also problematic because below-grade utilities need to be elevated. In the last decade only one street (one block of Caroline Street) has been elevated specifically to reduce flooding.

FEMA Flood Hazard Mapping and Sea-level Rise

Baltimore City is a participating jurisdiction in the National Flood Insurance Program through its regulation of development in the floodplain and through overall floodplain management. The city is currently funded through the Cooperative Technical Partnership (CTP) to update its flood maps. Federal flood mapping policies require that Flood Insurance Rate Maps be based on existing conditions (see Section 10.7.5.3 in Chapter 10). Therefore, the floodplain maps do not consider future sea-level rise. As a result, the city will be permitting new structures with effective functional lifespan of 50 to 100 years but elevated only to current flood elevations. One strategy to surmount this limitation is to add "freeboard", or additional elevation to the effective BFE. Baltimore already requires one additional foot of freeboard.

The City of Baltimore is concerned, however, that 0.3 to 0.6 additional meters of freeboard is inequitable and inefficient. If flood levels will be, for example, 1 meter higher than the flood maps currently assume, then lands just outside the current flood boundary are also potentially vulnerable. If the city were to add 1 meter of freeboard to property in the floodplain, without addressing adjacent properties outside the floodplain, then adjacent property owners would have divergent requirements that city officials would find difficult to justify (see Figure 10.6).

Infrastructure

Baltimore has two regional sewerage plants. One of them, the Patapsco Wastewater Treatment Plant, sits on ground that is less than 2 meters above mean sea level and floods occasionally (see Box Figure A1.6). The facility itself is elevated and currently drains by gravity into the Patapsco River (USGS 7.5-minute map series). With a significant rise in sea level, however, pumping will be needed and possibly additional protections against storms. (Smith, 1998; Titus et al., 1987). Numerous streets, with associated conduits and utility piping, are within the existing coastal floodplain and would potentially be affected by sea-level rise (see Box Figure A1.6).

Source: http://www.epa.gov/climatechange/effects/coastal/pdfs/ccsp_app1.pdf p.219

Frequently Used Abbreviations and Acronyms

BWI: Baltimore Washington International Airport

CO2-equivalent: Carbon Dioxide Equivalent

DBED: Maryland Department of Business and Economic Development

DGS: Maryland Department of General Services

DCHD: Maryland Department of Housing and Community Development

DHMH: Maryland Department of Health and Mental Hygiene

DNR: Maryland Department of Natural Resources

EPA: U.S. Environmental Protection Agency

GGRA: Greenhouse Gas Emissions Reduction Act

GHG: Greenhouse Gas

HVAC: Heating, Ventilation and Air Conditioning

LEED: Leadership in Energy and Environmental Design

MACT: Maximum Achievable Control Technology

MARC: Maryland Area Regional Commuter

MHCD: Maryland Department of Housing and Development

MDA: Maryland Department of Agriculture

MDE: Maryland Department of the Environment

MDP: Maryland Department of Planning

MDOT: Maryland Department of Transportation

MEA: Maryland Energy Administration

MIA: Maryland Insurance Administration

PJM: Pennsylvania Jersey Maryland Interconnection, LLC

PSC: Maryland Public Service Commission

REC: Renewable Energy Credit

RGGI: Regional Greenhouse Gas Initiative

RPS: Maryland Renewable Energy Portfolio Standard

VMT: Vehicle Miles Traveled

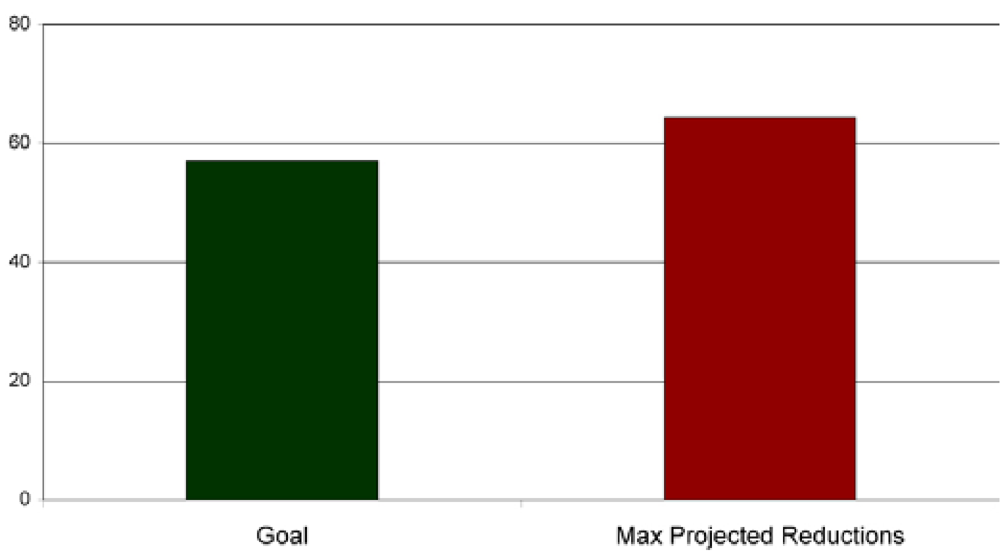
Chapter

6 Summary of Reduction Strategies

Background and Summary

The Greenhouse Gas Emissions Reduction Act of 2009 (GGRA) requires the Maryland Department of the Environment (MDE) to coordinate with other State agencies to develop and implement a plan to, by 2020, achieve a minimum 25% reduction in greenhouse gas (GHG) emissions below 2006 levels, while also creating jobs and improving Maryland's economy. Figure 6-1 shows that Maryland is on track to not only meet, but to exceed, the 25% reduction goal by 2020.

Figure 6-1
Projected GHG Emission Reductions



This chapter summarizes the 65 programs that are included in the plan at this time.

The law requires that the plan be developed in two steps. A draft of the plan is required by the end of 2011 with the final plan due at the end of 2012. The intent of the two-step process is to provide an opportunity for input from stakeholders and the Maryland General Assembly.

Chapter 7 summarizes the current projections for job creation and other economic benefits. Full implementation of the plan will result in annual benefits of approximately 36,000 jobs, $6.1 billion in economic output and $2.1 billion in wages.

Responsible Agencies

The plan is comprised of 65 regulatory programs being implemented by 11 State agencies. In this chapter, the programs are organized and discussed by business sector. Figure 6-2 identifies the programs that are being implemented by each agency.

Figure 6-2. GHG Reduction Programs by Agency

MDE Programs:

The Regional Greenhouse Gas Initiative (RGGI)
Maryland Clean Cars Program
National Fuel Efficiency & Emissions Standards for Medium- and Heavy- Duty Trucks
Clean Fuel Standard
Recycling & Source Reduction
GHG Early Voluntary Reductions
GHG New Source Performance Standard
Title V Permits for GHG Sources
The Transportation and Climate Initiative
Leadership-By-Example: Local Government-
Leadership-By-Example: Federal Government
Leadership-By-Example: Maryland Colleges and Universities
GHG Emissions Inventory Development
Program Analysis, Goals and Overall Implementation
Outreach and Public Education
GHG Emissions Reductions from Imported Power
Boiler Maximum Achievable Control Technology (MACT)
GHG Prevention of Significant Deterioration Permitting Program
Energy Efficiency in the Power Sector: General

Maryland Department of Transportation (MDOT) Programs:

Public Transportation Initiatives
Initiatives to Double Transit Ridership by 2020
Intercity Transportation Initiatives
Bike and Pedestrian Initiatives
Pricing Initiatives
Transportation Technology Initiatives
Electric Vehicle Initiatives
Low Emitting Vehicle Initiatives
Evaluate the GHG Emissions Impacts from Major New Projects and Plans
Airport Initiatives
Port Initiatives
Freight and Freight Rail Strategies
Federal Renewable Fuels Standard
Corporate Average Fuel Economy (CAFE) Standards: Model Years 2008-2011

Maryland Energy Administration (MEA) Programs:

EMPOWER: Energy Efficiency in the Residential Sector
Promoting Hybrid and Electric Vehicles
EMPOWER: Energy Efficiency in the Commercial and Industrial Sectors
EMPOWER: Energy Efficiency: Appliances and Other Products
EMPOWER: Utility Responsibility
The Maryland Renewable Energy Portfolio Standard Program
Incentives and Grant Programs to Support Renewable Energy
Offshore Wind Initiatives to Support Renewable Energy
Combined Heat and Power

Maryland Department of Natural Resources (DNR) Programs:

Managing Forests to Capture Carbon
Creating Ecosystems Markets to Encourage GHG Emissions Reductions
Increasing Urban Trees to Capture Carbon
Creating and Protecting Wetlands and Waterway Borders to Capture Carbon
Geological Opportunities to Store Carbon
Planting Forests in Maryland
Expanded Use of Forests and Feedstocks for Energy Production

Other Maryland Agency Programs:

Policy	Lead Agency*
State of Maryland Initiative to Lead by Example	DGS
State of Maryland Carbon and Footprint Initiatives	DGS
Green Buildings	DGS
Main Street Initiatives	DHCD
Building and Trade Codes in Maryland	DHCD
Energy Efficiency for Affordable Housing	DHCD
Reducing GHG Emissions from the Transportation Sector through Land Use and Location Efficiency	MDP
Transportation GHG Targets for Local Governments and Metropolitan Planning Organizations	MDP
Funding Mechanisms for Smart Growth	MDP
GHG Benefits from Priority Funding Areas and Other Growth Boundaries	MDP
Conservation of Ag Land for GHG Benefits	MDA
Buy Local for GHG Benefits	MDA
Nutrient Trading for GHG Benefits	MDA
Pay-As-You-Drive® Insurance in Maryland	MIA
Job Creation and Economic Development Initiatives	DBED
Public Health Initiatives Related to Climate Change	DHMH

** DGS – Maryland Department of General Services; DHCD – Maryland Department of Housing and Community Development; MDP – Maryland Department of Planning; MDA – Maryland Department of Agriculture; MIA – Maryland Insurance Administration; DBED – Maryland Department of Business and Economic Development; DHMH – Maryland Department of Health and Mental Hygiene.*

Program-by-Program Reduction Summary

The plan includes programs that reduce emissions from all sectors that contribute to Maryland emissions. Figure 6-3 shows Maryland's 2006 GHG emissions inventory by key sectors.

Figure 6-3
Maryland's 2006 GHG Emissions
(in million metric tons of CO2-equivalent, percentage)

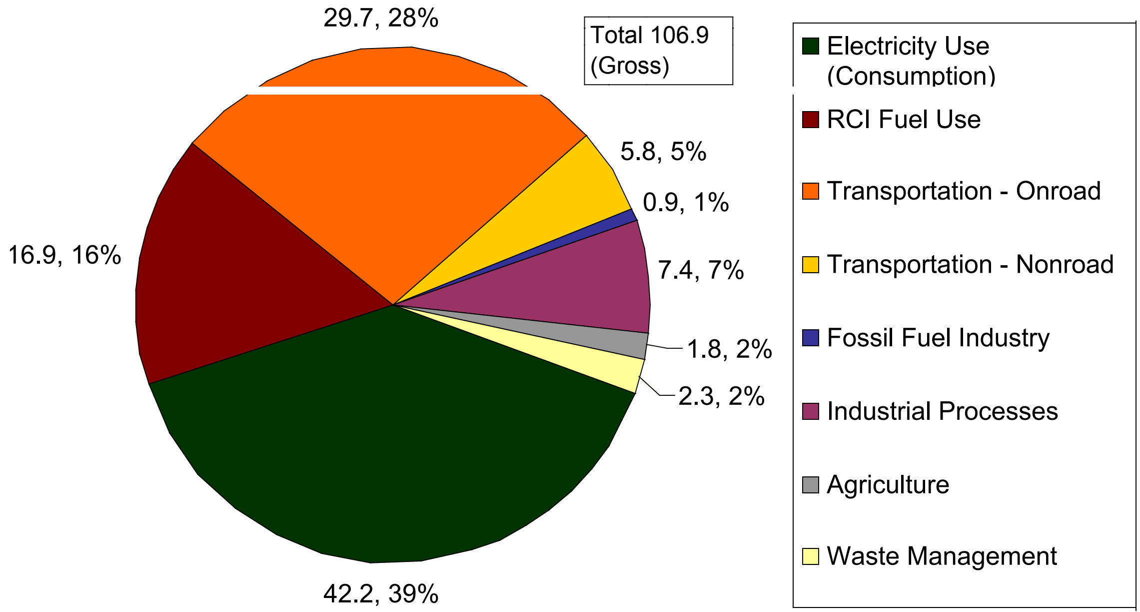


Figure 6-4 identifies the potential GHG emissions reductions from each measure.

Figure 6-4
GHG Reduction Programs by Sector

ENERGY		
Program Number	Program	Potential GHG Reductions (million metric tons of CO_2-equivalent)
E-1	The Regional Greenhouse Gas Initiative (RGGI)	17.71
E-2	EMPOWER: Energy Efficiency in the Residential Sector	7.27
E-3	EMPOWER: Energy Efficiency in the Commercial and Industrial Sectors	Included in Energy-2
E-4	EMPOWER: Energy Efficiency: Appliances and Other Products	Included in Energy-2
E-5	Energy Efficiency in the Power Sector: General	Included in Energy-2
E-6	EMPOWER: Utility Responsibility	Included in Energy-2
E-7	The Maryland Renewable Energy Portfolio Standard Program	6.78
E-8	Incentives and Grant Programs to Support Renewable Energy	Included in Energy-7
E-9	Offshore Wind Initiatives to Support Renewable Energy	Included in Energy-7
E-10	GHG Emissions Reductions from Imported Power	2.75
E-11	GHG New Source Performance Standard	4.84
E-12	Boiler Maximum Achievable Control Technology (MACT)	0.10
E-13	GHG Prevention of Significant Deterioration Permitting Program	Not Quantified
E-14	Combined Heat and Power	Included in Energy-2
E-15	Main Street Initiatives	0.02
E-16	Energy Efficiency for Affordable Housing	0.04
Total		**39.51**

Solar Photovoltaics

Photovoltaics are best known as a method for generating electric power by using solar cells to convert energy from the sun into a flow of electrons. The photovoltaic effect refers to photons of light exciting electrons into a higher state of energy, allowing them to act as charge carriers for an electric current. The term photovoltaic denotes the unbiased operating mode of a photodiode in which current through the device is entirely due to the transduced light energy. Virtually all photovoltaic devices are some type of photodiode.

Solar cells produce direct current electricity from sun light, which can be used to power equipment or to recharge a battery. The first practical application of photovoltaics was to power orbiting satellites and other spacecraft, but today the majority of photovoltaic modules are used for grid connected power generation. In this case an inverter is required to convert the direct current to alternating current. There is a smaller market for off-grid power for remote dwellings, boats, recreational vehicles, electric cars, roadside emergency telephones, remote sensing, and cathodic protection of pipelines.

Source: http://en.wikipedia.org/wiki/Photovoltaics#Solar_cells

TRANSPORTATION		
Program Number	Program	Potential GHG Reductions (million metric tons of CO_2-equivalent)
T-1	Maryland Clean Cars Program	Included in Transportation-10
T-2	National Fuel Efficiency & Emissions Standards for Medium- and Heavy- Duty Trucks	0.88
T-3	Clean Fuel Standard	2.42
T-4	The Transportation and Climate Initiative	0.07
T-5	Public Transportation Initiatives	1.97
T-6	Initiatives to Double Transit Ridership by 2020	Included in Transportation-5
T-7	Intercity Transportation Initiatives	0.76
T-8	Bike and Pedestrian Initiatives	0.41
T-9	Pricing Initiatives	2.21
T-10	Transportation Technology Initiatives	9.48
T-11	Electric Vehicle Initiatives	Included in Transportation-10
T-12	Low Emitting Vehicle Initiatives	Included in Transportation-10
T-13	Evaluate the GHG Emissions Impacts from Major New Projects and Plans	Not Yet Quantified
T-14	Airport Initiatives	Included in Transportation-10
T-15	Port Initiatives	Included in Transportation-10
T-16	Freight and Freight Rail Programs	Included in Transportation-7 or Transportation-10
T-17	Federal Renewable Fuels Standard	Included in Transportation-10
T-18	Corporate Average Fuel Economy (CAFE) Standards: Model Years 2008-2011	Included in Transportation-10

TRANSPORTATION		
Program Number	Program	Potential GHG Reductions (million metric tons of CO_2-equivalent)
T-19	Promoting Hybrid and Electric Vehicles	Included in Transportation-4
T-20	Pay-As-You-Drive® Insurance in Maryland	0.09
Total		**18.29**

AG AND FORESTRY		
Program Number	Program	Potential GHG Reductions (million metric tons of CO_2-equivalent)
A&F-1	Managing Forests to Capture Carbon	2.70
A&F-2	Creating Ecosystems Markets to Encourage GHG Emissions Reductions	0.82
A&F-3	Increasing Urban Trees to Capture Carbon	1.32
A&F-4	Creating and Protecting Wetlands and Waterway Borders to Capture Carbon	0.65
A&F-5	Geological Opportunities to Store Carbon	Not Quantified
A&F-6	Planting Forests in Maryland	0.62
A&F-7	Expanded Use of Forests and Feedstocks for Energy Production	3.07
A&F-8	Conservation of Ag Land for GHG Benefits	0.28
A&F-9	Buy Local for GHG Benefits	0.05
A&F-10	Nutrient Trading for GHG Benefits	0.21
Total		**9.72**

RECYCLING		
Program Number	Program	Potential GHG Reductions (million metric tons of CO_2-equivalent)
R-1	Recycling & Source Reduction	2.32
Total		**2.32**

MULTI-SECTOR		
Program Number	Program	Potential GHG Reductions (million metric tons of CO_2-equivalent)
MS-1	GHG Emissions Inventory Development	Not Quantified
MS-2	Program Analysis, Goals and Overall Implementation	Not Quantified
MS-3	Outreach and Public Education	0.05
Total		**0.05**

BUILDINGS		
Program Number	Program	Potential GHG Reductions (million metric tons of CO_2-equivalent)
B-1	Green Buildings	Included in Innovative Initiatives-5
B-2	Building and Trade Codes in Maryland	5.40
Total		**5.40**

LAND USE		
Program Number	Program	Potential GHG Reductions (million metric tons of CO_2-equivalent)
LU-1	Reducing GHG Emissions from the Transportation Sector through Land Use and Location Efficiency	1.01
LU-2	Transportation GHG Targets for Local Governments and Metropolitan Planning Organizations	Included in Land Use-1
LU-3	Funding Mechanisms for Smart Growth	Included in Land Use-1
LU-4	GHG Benefits from Priority Funding Areas and Other Growth Boundaries	Included in Land Use-1
Total		**1.01**

MARYLAND'S INNOVATIVE INITIATIVES		
Program Number	Program	Potential GHG Reductions (million metric tons of CO_2-equivalent)
II-1	Leadership-By-Example: Local Government-	0.57
II-2	Leadership-By-Example: Federal Government	0.87
II-3	Leadership-By-Example: Maryland Colleges and Universities	0.57
II-4	GHG Early Voluntary Reductions	1.03
II-5	State of Maryland Initiative to Lead by Example	2.30
II-6	State of Maryland Carbon and Footprint Initiatives	Included in Innovative Initiatives-5
II-7	Job Creation and Economic Development Initiatives	Not Yet Quantified
II-8	Public Health Initiatives Related to Climate Change	Not Yet Quantified
II-9	Title V Permits for GHG Sources	Not Quantified
Total		**5.34**

TOTAL RANGE OF ESTIMATED GHG EMISSIONS REDUCTIONS	
Sector	Total Expected GHG Reductions (million metric tons of CO2-equivalent)
Energy	39.51
Transportation	18.29
Ag and Forestry	9.72
Recycling	2.32
Multi-Sector	0.05
Buildings	5.40
Land Use	1.01
Innovative Initiatives	5.07
Total	**81.64**
Total adjusted for estimated overlap	**64**
Reductions needed (25% by 2020)	**57**

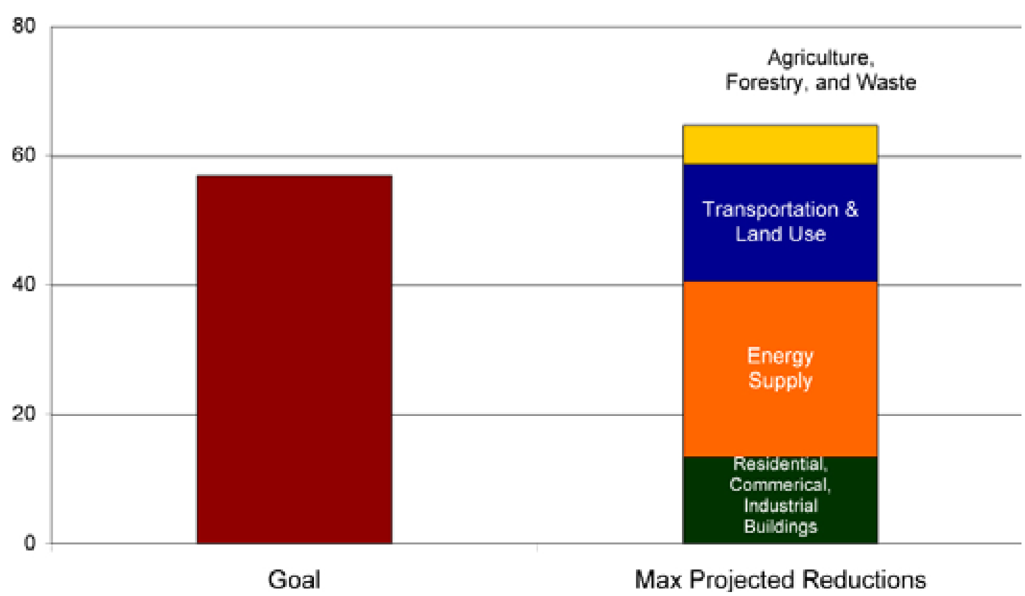
Many of the programs in Figure 6-4 are closely related and affect each other. When implemented together, the resulting synergy may result in a slightly smaller reduction than the projected reduction calculated for each program separately.

In Figure 6-4, the total potential reduction from all measures combined is discounted by approximately 20 million metric tons to account for potential double-counting. This discount represents a cautious assumption about the potential overlap between related programs and is based upon the earlier emission reduction quantification effort for the 2008 Climate Action Plan. An updated overlap analysis is underway and will be complete in 2012. The total projected GHG emission reductions resulting from implementation of the plan will be adjusted as necessary based upon the completed analysis.

Figures 6-5 and 6-6 depict in graph form each sector's contribution to the total estimated reduction.

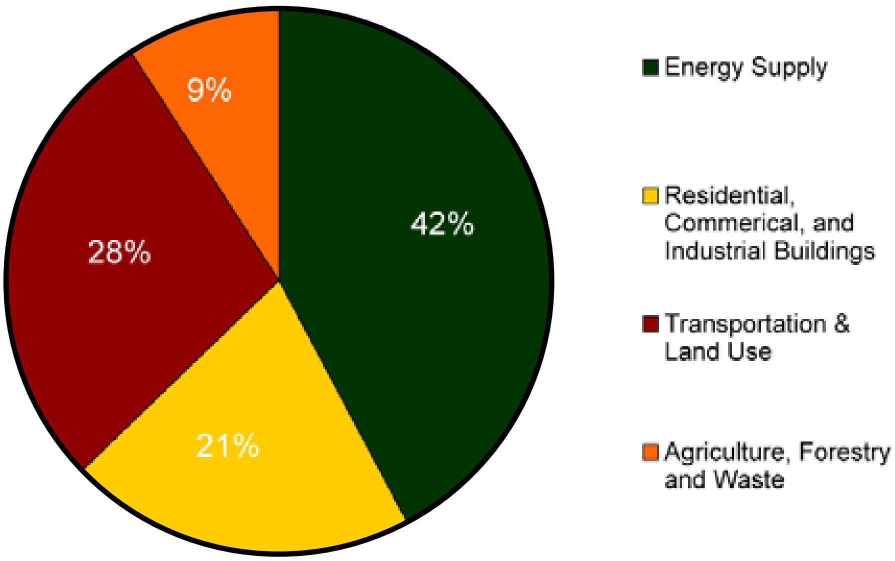
Figure 6-6 provides further detail on the total reductions by sector. It shows that very significant reductions are being achieved in the energy supply and residential, commercial and industrial energy use sectors, and that slightly less, but still meaningful, reductions are underway in both the transportation and land use sector and the agriculture, forestry and waste sector.

Figure 6- 5
Potential Sector Contributions to GHG Reduction Goal
(in million metric tons of CO2-equivalent)



MDE, MDOT and MDP have begun an analysis and stakeholder process to investigate potential options to further reduce GHG emissions while creating jobs and boosting the economic recovery. This effort may result in the inclusion of new or modified initiatives in the final 2012 plan.

Figure 6- 6
Sector Contributions to GHG Reduction Goal
(in million metric tons of CO2-equivalent)

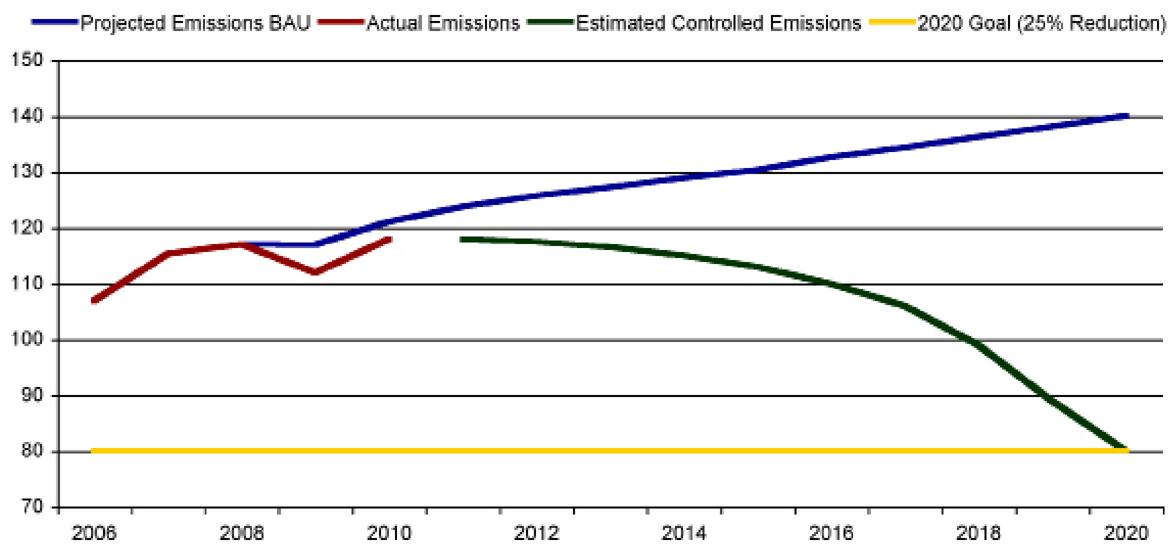


Understanding the Reduction Requirement

A reduction of 57 million metric tons of GHGs is needed to achieve a 25% reduction from 2006 levels by 2020. This reduction includes offsetting unmitigated growth (called the "business-as-usual" forecast) between 2006 and 2020. Figure 6-7 is a visualization of how the reduction requirement and unmitigated growth are related.

Business-as-usual forecasting is important because in the absence of regulatory programs requiring GHG emission reductions, emissions will continue to grow through 2020, thereby increasing the size of the reduction needed to reduce emissions by 25% from 2006 levels. The business-as-usual forecast accounts for this growth in emissions. In Figure 6-7, the green line depicts the business-as-usual forecast.

Figure 6-7
Projected Unregulated Growth of Maryland GHG Emissions through 2020 Compared to GGRA 2020 Goal
(in million metric tons of CO2-equivalent)



Refining Projected Emission Reductions

In 2012, MDE and other State agencies implementing the 2012 GGRA Plan will continue to collect data and refine the "business-as-usual" emissions inventory projections and projected GHG emission reduction estimates as appropriate. In particular, MDE will continue to work with MEA and the PSC to refine estimates for the energy sector. MDE also has retained independent consultants with expertise in GHG emission calculations to continue to refine projected reductions and to analyze the benefits from overlapping programs.

MDE requests specific comment on projected emission reductions and any related information or studies that could further assist with the effort to quantify GHG emission reductions resulting from implementation of the programs in this plan.

Uncertainty in the Quantification Effort

Estimating the potential GHG emission reductions from the 65 programs included in the plan requires that several key assumptions be made.

The most significant assumption used to estimate reductions is that the programs will continue to be implemented successfully between 2012 and 2020. The reduction estimates used throughout this plan are based upon that concept. Successful implementation depends on many factors including, but not limited to, continued economic recovery, continued private sector innovation and investment into the clean energy economy and continued funding and authority to support program implementation.

Each State agency will continue working through the Governor's Office and with the General Assembly to ensure that continued funding and legislative authority is sufficient to allow each agency to successfully implement their respective programs.

The GGRA also requires that MDE provide the Governor and the General Assembly with a status report on implementation in 2015. If a program is not being successfully implemented, it will be noted in the 2015 status report. The report also will provide recommendations for addressing the implementation issues or suggest new programs to replace the under-performing program and make up the shortfall.

Appendix C provides more detail on the GHG emission reduction estimates for each program. This appendix not only shows the estimated reductions assuming successful implementation, but it also provides a lower bound, illustrating minimum potential reduction estimate for each program. Achieving a 25% reduction in GHG emissions by 2020 is dependent upon successful implementation of the programs in the plan.

The Programs

The following sections of this chapter focus on the specific climate programs by business sector. Included in each business sector is a summary of each individual GHG reduction program and its contribution toward the sector and the total estimated GHG emission reduction goals.

The Energy Sector

The electricity supply sector accounts for GHG emissions occurring as a result of the combustion of fossil fuel at electricity generating facilities located both in and outside of the State. Electricity consumption accounted for about 41% of Maryland's gross GHG emissions in 2006 (about 42 million metric tons of CO2-equivalent), which was higher than the national average share of emissions from electricity consumption (34%). Carbon dioxide represents more than 99.5% of total sector GHG emissions, with methane and nitrous oxide CO2-equivalent emissions comprising the balance.

Maryland is a net importer of electricity, meaning that the State consumes more electricity than is produced in the State. Sales associated with imported power accounted for 28% of the electricity consumed in Maryland in 2006. GHG emissions from power produced in-state are dominated by coal-fired generation, followed by oil-fired and natural gas-fired generation.

In 2006, GHG emissions associated with Maryland's electricity consumption (42 million metric tons of CO2-equivalent) were about 10 million metric tons of CO2-equivalent higher than those associated with in-state electricity generation (32.0 million metric tons of CO2-equivalent). The higher level for consumption-based emissions reflects GHG emissions associated with net imports of electricity to meet Maryland's electricity demand. Projections of electricity sales for 2006 through 2020 indicate that Maryland will remain a net importer of electricity. The 2020 "business-as-usual" emissions inventory projection assumes that in-state generation-based emissions will increase by about 10 million metric tons of CO2-equivalent, and that consumption-based emissions (associated with electricity generated out-of-state, but consumed in-state) will increase by about 6 million metric tons of CO2-equivalent.

Reductions from the energy sector are critical to achieving the 2020 goal. sixteen of the GHG reduction programs described in this section are designed to reduce GHG emissions from the energy sector. Full implementation of the 16 energy sector programs will result in an estimated GHG reduction of 39.51 million metric tons of CO2-equivalent (Figure 6-8), more than half of the total reduction needed to meet the goal.

Figure 6-4
GHG Reduction Programs by Sector

ENERGY		
Program Number	Program	Potential GHG Reductions (million metric tons of CO_2-equivalent)
E-1	The Regional Greenhouse Gas Initiative (RGGI)	17.71
E-2	EMPOWER: Energy Efficiency in the Residential Sector	7.27
E-3	EMPOWER: Energy Efficiency in the Commercial and Industrial Sectors	Included in Energy-2
E-4	EMPOWER: Energy Efficiency: Appliances and Other Products	Included in Energy-2
E-5	Energy Efficiency in the Power Sector: General	Included in Energy-2
E-6	EMPOWER: Utility Responsibility	Included in Energy-2
E-7	The Maryland Renewable Energy Portfolio Standard Program	6.78
E-8	Incentives and Grant Programs to Support Renewable Energy	Included in Energy-7
E-9	Offshore Wind Initiatives to Support Renewable Energy	Included in Energy-7
E-10	GHG Emissions Reductions from Imported Power	2.75
E-11	GHG New Source Performance Standard	4.84
E-12	Boiler Maximum Achievable Control Technology (MACT)	0.10
E-13	GHG Prevention of Significant Deterioration Permitting Program	Not Quantified
E-14	Combined Heat and Power	Included in Energy-2
E-15	Main Street Initiatives	0.02
E-16	Energy Efficiency for Affordable Housing	0.04
Total		**39.51**

Energy – 1: The Regional Greenhouse Gas Initiative (RGGI)

Lead Agency: MDE

Program Description

The Regional Greenhouse Gas Initiative (RGGI) is a cooperative effort by nine Northeast and Mid-Atlantic states to design and implement a regional cap-and-trade program to reduce carbon dioxide emissions from power plants in the region. RGGI reduces emissions through an emissions cap applied to the nine-state geographic region. Under the initiative, the participating states issue "allowances" equal to the number of tons of GHG emissions allowed under the regional cap. A single allowance permits a source to emit one ton of carbon dioxide.

At the end of each three-year compliance period, each power plant subject to RGGI must have received or purchased, either at auction or on the secondary market, the number of allowances equivalent to the number of tons of carbon dioxide emitted by the power plant during the compliance period. In simple terms, the cap operates as a ceiling on regional emissions and guarantees emission reductions. By adding a cost to every ton of carbon dioxide emitted through the requirement to purchase allowances, sources have an economic incentive to minimize emissions whenever possible.

RGGI's goal is to reduce carbon dioxide emissions from the power sector by 10% by 2019. As the first cap and trade GHG emission reduction program of its kind in the nation, however, an important secondary goal was to demonstrate that a GHG cap-and-trade program could work. In this regard, RGGI selected the modest 10% reduction target. RGGI is designed to stabilize power plant carbon dioxide emissions through 2014. Beginning in 2015, RGGI requires a 2.5% carbon dioxide emission reduction per year through 2019. As the first three-year compliance period comes to an end, RGGI demonstrated that a GHG cap-and-trade program can work. In 2012, the RGGI states will undertake a comprehensive program review, which will include an evaluation of the existing emissions cap and consideration of various options to strengthen the program.

Because no control technologies exist to reduce carbon dioxide pollution at this time, most of the RGGI reductions will be achieved through implementation of energy efficiency programs and reducing demand for electricity.

The Healthy Air Act of 2006 required Maryland to join RGGI. RGGI applies to electric generating units of 25 megawatt capacity or greater. Most of the power plants in Maryland are subject to RGGI. Two industrial plants, New Page and RG Steel, are also subject to RGGI, but may apply for an exemption from the program under certain conditions. More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from the RGGI program by 2020 are estimated to be 17.71 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The RGGI program is expected to create and retain jobs and increase the State Gross Domestic Product (GDP). RESI's 2011 Study estimated that RGGI, once fully operational, would support a total of about 430 jobs, $83 million in economic output, and $23 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

The RGGI program is mandated by State law and is fully implemented and enforceable through regulations (COMAR 26.09) adopted and enforced by MDE.

Energy – 2, 3, 4 and 6: The EmPOWER Maryland Programs

Launched by a 2007 Executive Order and codified by the General Assembly in the 2008 Session, EmPOWER Maryland is designed to reduce per capita electricity use by Maryland consumers by 15% by 2015. The EmPOWER Maryland suite of energy efficiency and renewable energy investment programs are funded in part with revenue paid into the Strategic Energy Investment Fund from the auction of RGGI allowances.

Together with utility-funded programs, MEA's programs are intended to achieve the EmPOWER Maryland goal. MEA is the lead State agency responsible for implementing the EmPOWER Maryland programs. More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020 from the EmPOWER Programs

The potential emission reduction from this bundle of programs by 2020 is estimated to be 7.27 million metric tons of CO2-equivalent. Because these programs are all related, MEA has aggregated the potential emission reductions from the full set of programs.

Appendix C provides a more detailed description of the process used to quantify GHG reductions from the EmPOWER Maryland programs and additional information on implementation.

Job Creation and Economic Benefits

The EmPOWER programs (Energy 2, 3, 4 and 6) are expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the EmPOWER programs would support a total of about 4,000 jobs, $500 million in economic output, and $200 million in wages on average annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

The EmPOWER Maryland programs are mandated and funded by State law, specifically State Government Article, §9-20B of the State Government Article of the Maryland Code.

Energy – 2: EmPOWER: Energy Efficiency in the Residential Sector

Lead Agency: MEA

Program Description

MEA's residential energy efficiency programs are part of the EmPOWER Maryland suite of energy efficiency programs MEA administers using revenues paid into the Strategic Energy Investment Fund from the auction of RGGI allowances. Together with utility-funded programs, MEA's programs in all sectors, including residential, commercial and industrial, are intended to achieve the EmPOWER Maryland goal of a 15% reduction in per capita energy use by 2015. Programs funded and administered through other State agencies including DHCD, as well as federal programs, also contribute to the EmPOWER goal.

Under this program, MEA has put in place a variety of programs focusing on increasing energy efficiency in Maryland homes, such as the EmPower Maryland Empowering Finance Initiative, the EmPower Maryland Residential Incentives, the MEA Home Performance Rebate Program, and the Clean Energy Communities Grants program. These programs include several coordinated efforts with other State agencies for incentivizing upgrades in the home building envelop. MEA energy efficiency programs utilize funding from both the State and federal governments.

More information on this program can be found in the appendix of this report.

Energy – 3: EmPOWER: Energy Efficiency in the Commercial and Industrial Sectors

Lead Agency: MEA

Program Description

MEA's commercial and industrial energy efficiency program is also part of the EmPOWER Maryland suite of energy efficiency programs MEA administers using revenues paid into the Strategic Energy Investment Fund from the auction of the RGGI allowances.

MEA administers four programs that target energy efficiency improvements in the commercial and industrial sectors, which represent approximately 33% of electricity consumption in Maryland. These programs offer incentives for energy audits and funding for upgrades. The four programs are: 1) Maryland Save Energy Now; 2) the Lawton Loan Program.; 3) the Energy Efficiency and Conservation Block Grant Program; and 4) the State Agencies Loan Program. These programs receive funding from both State and federal governments.

More information on this program can be found in the appendix of this report.

Energy – 4: EmPOWER: Energy Efficiency Appliances and Other Products

Lead Agency: MEA

Program Description

In this proposed plan, this measure has been broken out as a separate initiative. In the final plan, it will be included as a sub-element of Energy-2.

In addition to phasing out of the incandescent light bulbs, Congress has established numerous energy efficiency appliance standards that will contribute to reducing energy use in Maryland. In addition, Maryland has its own energy efficiency standards beyond those of the federal government, in particular for bottle-type water dispensers and commercial hot food holding cabinets. Bills have been introduced in prior years to adopt a variety of new standards, such as California's standard for televisions. Televisions alone consume over 5% of all residential electricity nationwide (and some large flat screen TVs use as much power as a common refrigerator). MEA will continue to work locally and with federal authorities and energy officials from other states to advocate for more stringent and comprehensive state and national energy efficiency appliance standards.

More information on this program can be found in the appendix of this report.

Energy – 5: Energy Efficiency in the Power Sector: General

Lead Agency: MDE

Program Description

This program is still being analyzed for potential inclusion in the final plan.

This program was still being discussed in late 2011 by the interested State agencies. For now, MDE has been identified as the lead on this program. Other sections of this plan that were based upon analyses that had to be completed much earlier (e.g., Appendix B), may show that MEA was originally the lead on this program. That is no longer the case.

MDE is requesting comment on this potential strategy.

The potential for biomass co-firing in Maryland is dependent on the boilers and technologies in use at electricity generators, including the capital costs to retrofit coal facilities, the availability of biomass resources, and the environmental benefits of co-firing. Test results indicate that the high alkali content of biomass fuels may interfere with the effectiveness of catalytic reduction systems designed to control emissions of nitrogen oxides, which are ozone forming pollutants.

Other factors that need to be considered in evaluating the potential for co-firing of existing electric generation units with biomass include the following:

- Availability of biomass resources within a 50-mile radius of a Maryland coal-fired facility; beyond this, the transportation costs become excessive.
- Initial capital investment required for co-firing retrofits which varies depending upon the co-firing percentage of total heat input.
- Potential emission reductions of sulfur dioxide as a result of substituting biomass for coal can improve facilities' compliance with air quality standards, as an alternative to investing in emissions controls or switching to natural gas.
- The potential for sale of renewable energy credits in Maryland and surrounding states.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020
Emission reductions from this potential program have not been calculated at this time.

Implementation
This program is not being implemented at this time.

Energy – 6: EmPOWER: Utility Responsibility
Lead Agency: MEA

Program Description
EmPower Maryland mandated that PSC require each utility to propose cost-effective energy efficiency, conservation, and demand response programs designed to achieve targeted per capita energy reductions of at least 5% by the end of 2011 and an additional 10% by the end of 2015.

The five participating utilities are Potomac Edison, formerly known as Allegheny Power; Baltimore Gas and Electric; Delmarva Power and Light; Potomac Electric Power Company; and Southern Maryland Electric Cooperative. These utilities are responsible for two thirds of the EmPOWER 15% reduction goal. Energy savings targets are spread amongst all customer classes, including low-to-moderate income customers.

The five utilities developed portfolios, based on a three-year planning cycle beginning with the Program Planning Year 2009 – 2011. Plans are now under development for the upcoming 2012 – 2014 program cycle. Residential energy efficiency and conservation programs could include discounted compact fluorescent light bulbs and appliances, HVAC rebates, home energy audits and incentives for energy efficiency upgrades, and low income programs. PSC expects the utilities to revise or enhance their plans to provide additional resources to meet the 2015 goal.

Implementation:

This program is mandated by State law. The utilities submitted program enhancements and improvements to PSC in early September 2011 for the 2012-2015 program cycle, which will improve current programs and add new energy efficiency measures. In 2012, MEA will begin evaluating the EmPOWER Maryland goals for 2016 and beyond.

More information on this program can be found in the appendix of this report.

Energy – 7 to 9: The Maryland Renewable Energy Portfolio Standard (RPS) Programs

The Maryland Renewable Energy Portfolio Standard (RPS) is a law that requires Maryland to achieve 20% of its electricity from renewable sources by 2022. The RPS contains a mechanism that incentivizes the development of renewable energy through the purchase of renewable energy certificates (RECs). The State also runs a number of other incentive programs to support renewable energy and achieve the RPS goal. Collectively, the RPS and the State programs are the RPS bundle of programs. The State's RPS recognized the environmental and consumer benefits associated with renewable energy and facilitates development of a diversity of renewable energy sources.

Legislation in 2008 amended and strengthened the RPS (Renewable Portfolio Standard Percentage Requirements – Acceleration (Senate Bill 209/House Bill 375)).

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020 from the Renewable Energy Programs

The potential emission reductions from this bundle of programs by 2020 is estimated to be 6.78 million metric tons of CO2-equivalent. Estimated emission reductions from all RPS programs are aggregated.

Job Creation and Economic Benefits

This bundle of programs is expected to create and retain jobs and increase the State gross domestic product. If the greatest GHG emission benefits for this program are achieved, each investment of $1 million creates 13.5 jobs (resulting in $713,026 in wages) and contributes $1,849,354 to the State's gross domestic product. Applying this $1 million scale to the total industry-wide investment in

The energy crisis has not yet overwhelmed us, but it will if we do not act quickly. It's a problem that we will not be able to solve in the next few years, and it's likely to get progressively worse through the rest of this century. We must not be selfish or timid if we hope to have a decent world for our children and grandchildren.

We simply must balance our demand for energy with our rapidly shrinking resources.

By acting now we can control our future instead of letting the future control us.

Jimmy Carter, 39th President of the United States,
Address to the Nation
April 18, 1977

renewables expected from 2006-2022, more than 200,000 jobs will be created (or more than 12,000 jobs on average annually). This equates to approximately $10.8 billion in wages overall, (or over $675 million on average annually). It also equates to over $1.7 billion annually contributed to the State's gross domestic product by 2020. Chapter 7 provides more detail on job creation and economic benefits associated with this program.

Energy – 7: The Maryland Renewable Energy Portfolio Standard (RPS) Program

Lead Agency: MEA

Program Description

The RPS is implemented through the creation, sale and transfer of Renewable Energy Credits (RECs). Electricity suppliers are required to purchase specified percentages of RECs from renewable resources. Tier 1 sources (meaning solar energy; wind; qualifying biomass; qualifying methane; geothermal; ocean; qualifying fuel cell, qualifying hydroelectric power, poultry litter-to-energy; waste-to-energy; and refuse-derived fuel) and solar set-aside requirements gradually increase until they peak in 2022 at 18% and 2%, respectively, and are subsequently maintained at those levels. Maryland's Tier 2 sources (meaning eligible hydroelectric power) requirement remains constant at 2.5% through 2018, after which it sunsets. The development of renewable energy sources is further promoted by requiring electricity suppliers to pay a financial penalty for failing to acquire sufficient RECs to satisfy the RPS. The penalty is used to support the development of new Tier 1 renewable sources in the State.

The RPS is designed to create a stable and predictable market for renewable energy and to foster additional development and growth in the renewable energy industry.

Implementation

The RPS is mandated by §§7-701 through §7-713 of the Public Utilities Article of the Maryland Code. MEA is the lead State agency on implementation of RPS programs.

Appendix C provides a more detailed description of the process used to quantify GHG reductions and additional information on implementation.

Energy – 8: Incentives and Grant Programs to Support Renewable Energy

Lead Agency: MEA

Program Description

MEA administers a number of incentives and grant programs to promote and accelerate the development of renewable energy production in Maryland, from utility scale facilities to on-site distributed generation.

These programs range from tax incentives to grants and include the Commercial Clean Energy Grant Program, the Residential Clean Energy Grant Program, the Clean Energy Incentive Tax Credit Program, the Generating Clean Horizons Program, Project Sunburst, and various biomass and land-based wind programs.

Implementation

This is a voluntary incentive based program. Funding for the incentive and grant programs comes from the Strategic Energy Investment Fund.

Energy – 9: Offshore Wind Initiatives to Support Renewable Energy

Lead Agency: MEA

Details on Maryland's offshore wind program can be found in Section 9.

Energy – 10: GHG Emission Reductions from Imported Power

Lead Agency: MDE

Program Description

GHG emissions from the energy supply sector in Maryland include emissions from fossil fuel-fired electricity generation and represent a substantial portion of the State's overall GHG emissions. Approximately 30% of electricity consumption in Maryland is generated out-of-state in the surrounding Pennsylvania Jersey Maryland Interconnection LLC (PJM) electricity grid region. Electricity demand in Maryland is expected to increase over time and thus, if unmitigated, GHG emissions will also likely increase.

Maryland monitors the carbon intensity of the full PJM grid mix and evaluates the potential impacts associated with actual emissions data. Maryland has also, in conjunction with the RGGI program, participated in evaluating the carbon intensity (the amount of carbon for each unit of energy generated) of the RGGI states power generation profiles. Results of this work demonstrate that the RGGI states currently generate electricity that is higher in carbon intensity than electricity generated in neighboring non-RGGI states.

Since Maryland imports approximately 30% of its electricity, it is important to look at the full fuel mix of the PJM region when determining the carbon intensity of electricity imported into Maryland. The PJM region is made up of 13 other states Washington, D.C. For various reasons, especially the cost of natural gas, the carbon dioxide emissions per megawatt-hour in the PJM area have declined over the past five years. PJM analysis suggests that this trend is expected to continue.

Proposed federal rules (see Energy-11: GHG New Source Performance Standard and Energy-12: Boiler Maximum Achievable Control Technology) also are expected to reduce GHG emissions from out-of-state power generators. The potential reductions from those efforts are addressed separately.

The Maryland Public Service Commission has commented that there is no accounting system in place that could track a per unit GHG emission rate for electricity. MDE has decided to keep this program in place with the hopes that such a tracking mechanism would be available sometime before 2020. The PSC offers that increasing Maryland's RPS goals would serve the same purpose as the program above.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 2.75 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

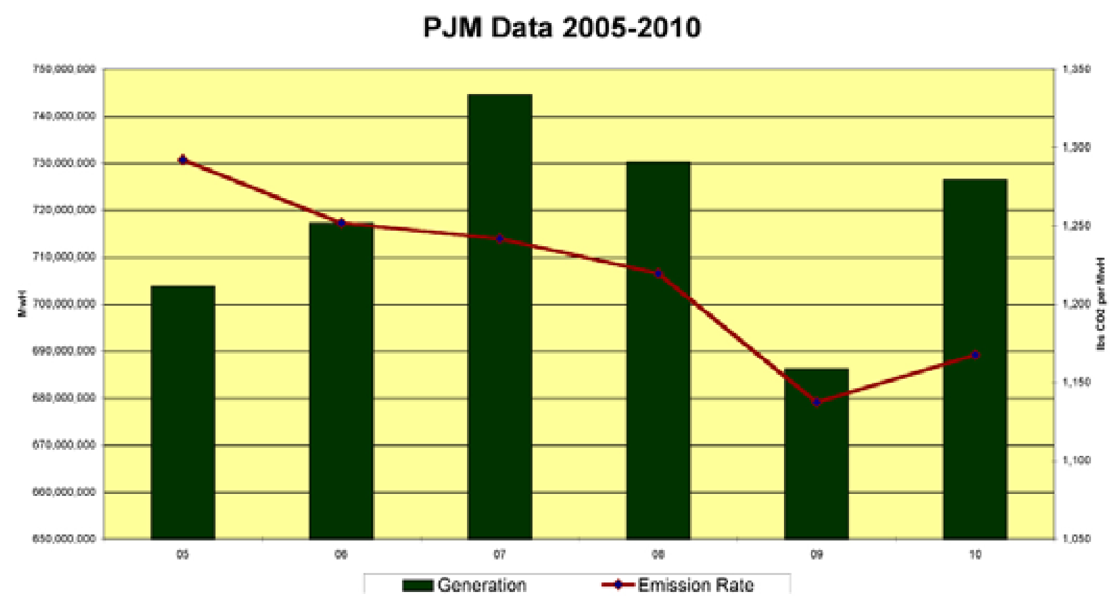
The GHG Emissions Reduction from Imported Power program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the GHG Emissions Reduction from Imported Power program, once fully operational, would support a total of about three jobs, $1 million in economic output, and $230,000 in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

Maryland does not currently have the statutory authority to regulate imported electricity. The reductions achievable from this measure likely will be driven by the expected trend toward lower carbon intensity generation in the regional electricity generation market from which Maryland imports electricity. Actual GHG emission reductions resulting from this program will be affected by any changes in the amount of electricity that Maryland imports from out of state. Projected reductions from this program will be analyzed and updated as part of the 2015 status report required by GGRA.

Figure 6-9 shows that the carbon intensity of power generated within the PJM system has been trending downward since 2005. The bars in Figure 6-9 show the total demand (in MWh) on the PJM system, while the line depicts the carbon dioxide emissions per MWh. While carbon dioxide emissions per MWh rose from 2009 to 2010, the increase was proportionally small, given the significantly greater demand for electricity on the PJM system during the same period. The better comparison is between 2008 and 2010 because electricity demand was similar in those two years.

Figure 6-9
Carbon Emissions and Intensity Compared to Total Megawatt-hours of Electricity Generation in the PJM region



Energy – 11: GHG New Source Performance Standard

Lead Agency: MDE

Program Description

EPA will use the New Source Performance Standard authority under the federal Clean Air Act to promulgate new regulations to reduce GHG emissions from fossil fuel-fired power plants. The new rule would apply to new or modified electricity generating units and establish GHG emission guidelines for existing electricity generating units. EPA is coordinating this action on GHGs with a number of other required regulatory actions for other pollutants, thereby enabling electricity generating units to develop multi-pollutant strategies to reduce pollutants in a more efficient and cost-effective way than would be possible by addressing multiple pollutants separately.

There are currently few potential projects in Maryland for new or modified fossil fuel-fired electricity generating units. However, other states in the PJM grid region, such as Virginia and Pennsylvania, are constructing new fossil fuel-fired electricity generating units and moving forward with modifications to existing electricity generating units. Because Maryland imports 30% of its electricity from states like

Pennsylvania and Virginia, Maryland will benefit from reductions in GHG emissions required by the new GHG New Source Performance Standard.

EPA plans to propose GHG standards based on existing technologies for power plants. EPA will issue final standards in May 2012 and November 2012 respectively.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 4.84 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The GHG New Source Performance Standard program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the GHG New Source Performance Standard program, once fully operational, would support a total of about six jobs, $2 million in economic output, and $410,000 in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

After EPA adopts the new federal GHG New Source Performance Standard, MDE and other State environmental agencies will adopt the federal rule into State regulations. EPA is required to implement and enforce the new requirements in any state that does not adopt the federal standards.

Energy – 12: Boiler Maximum Achievable Control Technology (MACT)

Lead Agency: MDE

Program Description

EPA has developed new air emissions requirements for industrial, commercial, and institutional boilers. The new regulation, known as National Emission Standard for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers, will affect thousands of boilers at facilities nationwide considered as major sources of hazardous air pollutants that also emit GHGs. These regulations were finalized on March 21, 2011 but will not become effective until proceedings for judicial review are completed or until EPA completes its reconsideration of the rule, whichever is earlier.

The federal rule will apply to any stationary source with a boiler or group of stationary sources with boilers that emit 10 tons per year of any single hazardous air pollutant or 25 tons per year of any combination of hazardous air pollutants. The rule requires each boiler to meet pollution emission limits on an annual and continuous basis.

Among other things, the Boiler rule will require operators to conduct a boiler tune-up to improve efficiency, minimize fuel consumption and reduce emissions. EPA estimates there will be a 1% fuel savings due to the tune-ups, which equates to an equivalent 1%t reduction in GHG emissions.

More information on this program can be found in the appendix of this report.

Estimated GHG Emissions Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 0.10 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Boiler MACT program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Boiler MACT program, once fully operational, would support a total of about 42 jobs, $14 million in economic output, and $2 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

MDE will adopt the final federal requirements into State regulations to ensure that these requirements are implemented and enforced.

Energy – 13: GHG Prevention of Significant Deterioration Permitting Program

Lead Agency: MDE

Program Description

The Prevention of Significant Deterioration program is a preconstruction review and permitting program applicable to new major stationary sources and major modifications at existing major stationary sources. It requires the application of Best Available Control Technology to control emissions of certain pollutants, which now include GHG. A Best Available Control Technology determination is based on consideration of a number of factors, including the cost effectiveness of the controls and energy and environmental impacts. As of July 2011, this program's Best Available Control Technology requirements apply to all new major sources of GHG emissions and major modifications at GHG emitting facilities. This means that GHG sources subject to the requirements must evaluate and apply currently available measures (and later technology as it develops) to reduce GHG emissions

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

Although it is not possible to quantify future emissions reductions from this program by 2020 at this time, this program has the potential to further reduce GHG reductions occurring in the future.

Job Creation and Economic Benefits

The GHG Prevention of Significant Deterioration Permitting program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the GHG Prevention of Significant Deterioration Permitting program, once fully operational, would support a total of about one job, $180,000 in economic output, and $50,000 in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

MDE has adopted regulations to implement and enforce this program in Maryland.

Commencing on July 1, 2011, the federal Best Available Control Technology program applied to new sources with the potential to emit 100,000 tons per year of -CO_2-equivalent and to modifications of existing sources that increase net -CO_2-equivalent emissions by at least 75,000 tons per year.

Beginning on July 1, 2013, additional sources will be included and a possible permanent exclusion from permitting will be determined for some source categories. EPA will complete a streamlining study by April 30, 2015. No sources with GHG emissions below 50,000 tons per year of -CO_2-equivalent and no modification resulting in net GHG increases of less than 50,000 tons per year of CO_2-equivalent emissions will be subject to this program's permitting requirements before April 30, 2016.

Energy – 14: Combined Heat and Power

Lead Agency: MEA and MDE, in coordination with other State agencies

Program Description

In this proposed plan, this measure has been broken out as a separate initiative. In the final plan, it will be included as a sub-element of Energy-3.

Combined heat and power, also called co-generation, is a system designed to generate both power and thermal energy from a single fuel source. A combined heat and power system utilizes generated thermal energy for heating or cooling, achieving efficiency levels of up to 80%. The increased efficiency means more energy is generated from a single fuel source. Therefore, GHG emissions from a combined heat and power system are less than from a typical system which produces electric and thermal energy separately. Expanding the use of these systems can greatly increase a facility's level of energy efficiency and decrease energy costs. Moreover, combined heat and power is an efficient, clean, and reliable approach to generating power while also reducing GHG emissions.

Several State agencies, such as MEA and DNR, are actively engaged in promoting the increased use of combined heat and power at industries and institutions around the State. Currently, there are approximately 21 combined heat and power units located in Maryland, fired by fossil fuels, biomass, and waste.

Increasing the number of combined heat and power units in Maryland is a voluntary initiative. State agencies can facilitate the expansion of combined heat and power units through education and outreach about the benefits of these systems and the enactment of incentives such as: (1) direct subsidies, tax credits or exemptions for purchasing, selling or operating combined heat and power systems; (2) tax credits for each kilowatt-hour or british thermal unit generated from a qualifying facility; and (3) feed-in tariffs.

MEA has offered assistance to the State's industrial sector through the Maryland Save Energy Now program. Support offered through this program includes:

- Low cost energy assessments for industrial facilities in Maryland.
- Free monthly training webinars on various industrial energy efficiency topics, including combined heat and power.
- Information on financial incentives and other helpful resources for businesses, including those offered by Maryland's utilities, MEA, and federal agencies such as U.S. Department of Energy, and third party investors.

More information on this program can be found in the appendix of this report.

Implementation

This is a voluntary program.

Energy – 15: Main Street Initiatives

Lead Agency: DHCD

Program Description

Buildings have a large impact on the natural environment. Energy use is the source of about 70% of GHG emissions. Energy use by buildings comprises up to 48% of total energy use. DHCD received a $20 million competitive award in 2010 from the American Recovery and Reinvestment Act of 2009 to promote energy efficiency in buildings through the federal retrofit program.

In 2010, DHCD received a $20 million competitive award from U.S. Department of Energy to promote energy efficiency through its federal Energy Efficiency and Conservation Block Grant retrofit program, now known as Better Buildings.

DHCD's award was titled "Investing in Main Street: Energy Efficiency for Economic Growth," and was a holistic, community-based approach to target individual households, multifamily rental properties and commercial properties for energy efficiency retrofits that will result in significant, measurable reductions in energy consumption and accompanying savings. Components of the program under development include: a Green Retrofit Improvement Program that targets small business owners; a Multifamily "Preservation and Energy Efficiency" program for renters; and an Efficient Home Program for homeowners.

The $20 million in federal funds is expected to leverage more than five times that amount in other funds. An estimated 2,000 homeowners and 20 buildings (approximately 2,000 affordable rental units) will benefit from energy efficiency retrofits in the first three years of this program. In addition, 900 historical commercial properties are projected to benefit from energy audits and low-interest retrofit financing in concert with DHCD's Neighborhood BusinessWorks program. The federal funding will also be used to establish a State-wide Energy Efficiency Purchasing Cooperative to maximize purchasing power for retrofits.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 0.02 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Main Street Initiatives program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Main Street Initiatives program, once fully operational, would support a total of about 365 jobs, $61 million in economic output, and $26 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

This program was established as a result of a competitive grant award, from U.S. Department of Energy. It is an incentive based voluntary program.

Energy – 16: Energy Efficiency for Affordable Housing

Lead Agency: DHCD

Program Description

Energy efficiency is defined as using a particular technology that requires less energy to perform the same function. Energy efficiency is recognized as the most cost effective way to achieve GHG reductions. Additional costs of efficiency upgrades in buildings are often offset by lower utility bills, making energy efficiency essential to affordable housing.

Through various energy efficiency programs, DHCD works with other government agencies to incorporate energy efficiency into affordable rental housing developments and eligible low-income households. DHCD also assists eligible low-income households with the installation of energy conservation materials in their dwelling units and energy audits/studies to determine the appropriate energy efficiencies for a building.

Through the Green Grant Rental Housing Preservation Program, DHCD promotes energy efficiency in affordable rental housing developments in eight counties (Anne Arundel, Baltimore, Cecil, Frederick, Harford, Howard, Prince George's and St. Mary's) affected by the federal Base Realignment and Closure process. In partnership with MEA, the Green Grant program reimburses eligible applicants for costs associated with energy audits for multi-family rental housing or for LEED accreditation and training. The Green Grant funding comes in the form of a $75,000 grant and matching funds of $200,000 from MEA.

In addition, DHCD operates the federally-funded Weatherization Assistance Program, which helps eligible low income households with the installation of energy conservation materials in their dwelling units. DHCD Multifamily Rental Housing program provides incentives for sustainable development through its competitive awarding of federal Low Income Housing Tax Credits. About $9.5 million from MEA supported DHCD's Multifamily Energy Efficiency and Housing Affordability program and the Green Grant under the Maryland Base Realignment and Closure Preservation Initiative. Through the American Recovery and Reinvestment Act, DHCD received approximately $52 million in funding for U.S. Department of Energy's Energy Efficiency and Conservation Block Grant program.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 0.04 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Energy Efficiency for Affordable Housing program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Energy Efficiency for Affordable Housing program, once fully operational, would support a total of about one job, \$170,000 in economic output, and \$50,000 in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

This initiative is a voluntary incentive based program. It receives funding from State and federal sources, including MEA and U.S. Department of Energy.

"With Maryland's commitment to reducing greenhouse gas emissions, our Clean Cars Act and electric vehicle legislation, and our ambitious Smart, Green, & Growing agenda, we are leading the nation's efforts in sustainability. Working together, we can continue to build a shared, clean energy future for us all."

Governor Martin O'Malley,
March 1, 2011

Photo by Mark Finkenstaedt, November 2010. The University of Maryland University College Academic Center at Largo "Green Zone" Parking

The Transportation Sector

The transportation sector is expected to be a larger contributor to future GHG emissions growth in Maryland. GHG emissions from this sector are the result of fossil-fuel consumed primarily for transportation purposes, both onroad mobile sources and nonroad mobile sources of transportation. Onroad mobile sources include the vehicles traditionally operated on public roadways. These include cars, light-duty trucks, vans, buses, and other diesel vehicles including medium- and heavy-duty trucks.

The majority of CO2-equivalent emissions from the transportation sector are associated with onroad gasoline-powered vehicles, with onroad diesel-powered vehicles also representing a significant percentage. Emissions from other modes of transportation, such as airplanes, trains and commercial marine vessels, are included under the general category of nonroad mobile sources. Nonroad mobile sources include motorized vehicles and equipment that are normally not operated on public roadways, such as lawn and garden equipment, airport service equipment, and locomotives.

The transportation sector accounted for about 32% of Maryland's gross GHG emissions in 2006 (about 35 million metric tons of CO2-equivalent), which was higher than the national average of 27% emissions from transportation fuel consumption (http://epa.gov/climatechange/emissions/downloads11/GHG-Fast-Facts-2009.pdf). In 2006, onroad gasoline vehicles accounted for about 71% of transportation GHG emissions. Onroad diesel vehicles accounted for another 14% of emissions, and air travel for roughly 5.5%. Marine vessels, rail, and other sources, such as natural gas- and liquefied petroleum gas-fueled vehicles used in transport applications, accounted for the remaining 10% of transportation emissions.

There are 20 GHG reduction programs described in detail throughout this section that are designed to reduce GHG emissions from the transportation sector. Full implementation of the 20 transportation sector programs has the potential to reduce GHG emissions by 18.29 million metric tons of CO2-equivalent (Figure 6-10). This is approximately one-third of the total estimated reductions needed to meet the GGRA goal.

The GHG estimates are likely to change over time given the continuing effort to quantify GHG reductions, the level of necessary future funding, and future advances in vehicle technology and low carbon fuels.

Figure 6-10
Transportation Sector GHG Reduction Programs

TRANSPORTATION		
Program Number	Program	Potential GHG Reductions (million metric tons of CO_2-equivalent)
T-1	Maryland Clean Cars Program	Included in Transportation-10
T-2	National Fuel Efficiency & Emissions Standards for Medium- and Heavy- Duty Trucks	0.88
T-3	Clean Fuel Standard	2.42
T-4	The Transportation and Climate Initiative	0.07
T-5	Public Transportation Initiatives	1.97
T-6	Initiatives to Double Transit Ridership by 2020	Included in Transportation-5
T-7	Intercity Transportation Initiatives	0.76
T-8	Bike and Pedestrian Initiatives	0.41
T-9	Pricing Initiatives	2.21
T-10	Transportation Technology Initiatives	9.48
T-11	Electric Vehicle Initiatives	Included in Transportation-10
T-12	Low Emitting Vehicle Initiatives	Included in Transportation-10
T-13	Evaluate the GHG Emissions Impacts from Major New Projects and Plans	Not Yet Quantified
T-14	Airport Initiatives	Included in Transportation-10
T-15	Port Initiatives	Included in Transportation-10
T-16	Freight and Freight Rail Programs	Included in Transportation-7 or Transportation-10
T-17	Federal Renewable Fuels Standard	Included in Transportation-10
T-18	Corporate Average Fuel Economy (CAFE) Standards: Model Years 2008-2011	Included in Transportation-10

TRANSPORTATION		
Program Number	Program	Potential GHG Reductions (million metric tons of CO_2-equivalent)
T-19	Promoting Hybrid and Electric Vehicles	Included in Transportation-4
T-20	Pay-As-You-Drive® Insurance in Maryland	0.09
Total		**18.29**

Transportation – 1: Maryland Clean Cars Program

Lead Agency: MDE

Program Description

The Maryland Clean Cars Act of 2007 required MDE to adopt regulations implementing the California Clean Car Program. The California Clean Car Program establishes a GHG emission standard based on fleet-wide averages; it does not set specific GHG emission standards for individual vehicles. It is the responsibility of the manufacturers to show the fleet average. The fleet GHG standard under the Maryland Clean Cars Act of 2007 began with model year 2011 vehicles.

On May 19, 2009, President Obama announced new GHG and fuel economy standards for passenger vehicles and light-duty trucks that would be set through a joint rulemaking process between EPA and the National Highway Traffic Safety Administration. These new standards will be phased in beginning with model year 2012 and, when fully implemented in model year 2016, attain the same fuel economy and GHG levels as the California Clean Car Program.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

For quantification and modeling purposes, the emission benefits and costs associated with this program have been aggregated with emissions reductions under Transportation-10 (Transportation Technologies), Transportation-17 (Renewable Fuel Standard), and Transportation-18 (Corporate Average Fuel Economy Standards: Model Years 2008-2011). By 2020, the potential emission reductions from these four programs combined are estimated to be 9.48 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Maryland Clean Cars Program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Maryland Clean Cars Program, once fully operational, would support a total of about eight jobs, $11 million in economic output, and $3 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

This program is mandated by the Maryland Clean Cars Act of 2007 and has been fully implemented through regulations codified in COMAR 26.11.34, the Low Emissions Vehicle Program, adopted and enforced by MDE.

Transportation – 2: National Fuel Efficiency & Emission Standards for Medium- and Heavy- Duty Trucks

Lead Agency: MDE

Program Description

The National Fuel Efficiency & Emission Standards for the Medium- and Heavy-Duty Trucks program announced in 2010 is the first program designed to reduce GHG emissions and improve fuel efficiency for medium- and heavy-duty vehicles. The program is the result of collaboration between EPA and the National Highway Traffic Safety Administration in response to President Obama's Presidential Memorandum issued in May of 2010. Medium- and heavy-duty vehicles make up the transportation sector's second largest contributor to fossil fuel consumption and GHG emissions.

EPA and U.S. Department of Transportation are each proposing complementary standards under their respective authority covering model years 2014-2018. EPA and National Highway Transportation Safety Administration are proposing emission standards for carbon dioxide and fuel consumption standards, respectively, for the following regulatory categories: combination tractors, heavy-duty pickup trucks and vans, and vocational vehicles. EPA is also proposing to include recreational on-highway vehicles in its rulemaking while the National Highway Transportation Safety Administration is not including them. For this proposal the heavy-duty fleet includes all onroad vehicles rated at 8,500 lbs or more, except those covered by the current GHG emissions and federal Corporate Average Fuel Economy standards for model years 2012-2016.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 0.88 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The National Fuel Efficiency & Emission Standards for Medium- and Heavy-Duty Trucks program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the National Fuel Efficiency & Emission Standards for Medium- and Heavy-Duty Trucks program, once fully operational, would support a total of about six jobs, $880,000 in economic output, and $270,000 in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

The federal regulations for implementation of this program were finalized in August 2011. The program will be federally enforced jointly by EPA and the National Highway Transportation Safety Administration.

Transportation – 3: Clean Fuels Standard

Lead Agency: MDE

Program Description

The Clean Fuels Standard program is a cooperative effort being undertaken by eleven Northeast and Mid-Atlantic States to design and implement a regional low carbon fuel standard to reduce the carbon intensity of transportation fuels. The Clean Fuels Standard program is a collaboration of commissioners from the environmental and energy agencies in those 11 states. This effort is still in the analysis stage and there are no specific plans on implementation at this time.

Transportation fuels account for approximately one-third of GHG emissions from the Northeast and Mid-Atlantic states. A Clean Fuels Standard is designed to reduce the GHG emissions from these fuels. This program would be a market-based program to address the carbon content of fuels by lowering their carbon intensity through the use of low-carbon fuel alternatives. Carbon intensity is defined as the total GHG emissions released per unit of energy produced by the fuel over its full lifecycle. By analyzing the total GHG emissions released during the full lifecycle, including production, transport, and consumption, the fuels can be measured and compared with respect to their carbon intensity. The nation's first clean fuel standard was initiated by California in 2007.

The Memorandum of Understanding signed by the 11 Northeast and Mid-Atlantic governors in December 2009 committed the states to conduct an economic analysis, develop preliminary recommendations on program elements, and draft a program framework based on this previous work

A preliminary analysis suggests that a Clean Fuels Standard could reduce GHG emissions from the transportation sector, promote a more diverse fuel mix that would diminish the region's reliance on imported oil, and help protect consumers from price volatility in the global oil market. Results of the preliminary analysis indicate that as the price of gasoline and diesel increases, consumers would see greater savings under a Clean Fuels Standard.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

If finalized, the potential emission reductions from this program by 2020 are conservatively estimated to be 2.42 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Clean Fuels Standard program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Clean Fuels Standard program, once fully operational, would support a total of about 40 jobs, $5 million in economic output, and $1 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

This program is still under development. At this time, the 11 states involved in the partnership have not made any decisions about program design or implementation. If finalized, this program would be implemented through regulations adopted by MDE.

MDE will be reevaluating this program as part of the 2015 status report required by the GGRA.

Transportation – 4: The Transportation and Climate Initiative

Lead Agency: MDE/MDOT

Program Description

The Transportation and Climate Initiative is a regional effort of Maryland and 10 other Northeast and Mid-Atlantic States and Washington, D.C. to reduce GHG emissions in the region's transportation sector, minimize the transportation system's reliance on high-carbon fuels, promote sustainable growth to address the challenges of vehicle-miles traveled, and help build the clean energy economy across the region.

Recognizing that the transportation sector currently accounts for approximately 30% of GHG emissions in the Mid-Atlantic and Northeastern U.S., the energy, environment and transportation agency heads from the region convened a summit in Wilmington, Delaware in June 2010 to launch the Transportation Climate Initiative.

On June 16, 2010 they signed a Declaration of Intent, affirming their intent to work collaboratively to reduce GHG emissions from the region's transportation sector.

The collaborative also is expected to advance current efforts of individual states to: reduce traffic congestion; encourage job growth and accommodate the flow of goods and services; establish state and local land use strategies that increase commercial and residential housing density and encourage transit-friendly design; improve the performance of existing highway, transit and other transportation modes while enhancing neighborhoods and urban centers; and promote mixed-use development that supports viable alternatives to driving.

The Transportation and Climate Initiative has established a steering committee, an overall staff work group and four topic-specific work groups. Although it has not formulated specific reduction goals at this time, the 3-year strategic work plan builds on reduction targets established in the climate action plans and statutes adopted by most participating states. The Transportation and Climate Initiative agency heads met in June 2011. At this one-year milestone, they provided strategic guidance to agency staff working group on plan implementation. In late 2011 the Transportation and Climate Initiative was awarded a $1 million grant to assist with implementation of a regional program.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020, at this time, are estimated to be very small, about 0.07 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Transportation Climate Initiative program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Transportation Climate Initiative program, once fully operational, would support a total of about two jobs, $270,000 in economic output, and $80,000 in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

The Transportation and Climate Initiative is a multi-state collaborative and voluntary initiative.

Transportation – 5: Public Transportation Initiatives

Lead Agency: MDOT

Program Description

For several decades, vehicle miles traveled (VMT) has risen faster than the increase in population, in Maryland and nationwide. Land use development over the past 40 to 50 years has put more people living beyond the reach of easy access to transit facilities. This initiative to enhance public transit is part of the State's efforts to make transit more available for use by more people, thereby reducing mobile GHG emissions.

These strategies are intended to reduce GHG emissions produced by automobiles by encouraging the use of public transportation. Examples include locally operated transit systems, smart card implementation, transit oriented development, tax incentives, and ride sharing.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

For quantification purposes, the potential benefits and costs associated with this program have been aggregated under Transportation-6: Initiatives to Double Transit Ridership by 2020. The potential emission reductions from these two programs by 2020 are estimated to be 1.97 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Public Transportation Initiatives program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Public Transportation Initiatives program, once fully operational, would support a total of about 489 jobs, \$68 million in economic output, and \$21 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Pay-as-you-drive insurance saves money and fuel

Car insurance company Progressive leads the charge to reward drivers for driving less, driving safer

Pay-as-you-drive (PAYD) insurance, like Progressive's SnapshotSM program, provides drivers with a financial incentive to drive less and in safer ways. Drivers who volunteer for the program are eligible to receive discounts on car insurance.

Snapshot combines driving data, wireless technology and Progressive's knowledge of predictive behavior to charge drivers a rate based on how much and when they drive. When customers choose to participate, they receive a small, self-installed device that plugs into their car's onboard diagnostic system. It records data including how much and how the vehicle is driven and teaches drivers about their driving habits.

PAYD programs like Snapshot can also lead to safer roadways and a cleaner environment. The changes drivers are generally encouraged to make to maximize their savings, such as driving defensively and driving fewer miles, also have a positive impact on road safety and result in fewer carbon emissions.

Because Progressive developed usage-based insurance to give drivers more control over car insurance costs, the company has not tracked gas consumption savings or reduced greenhouse gas emissions. However, according to the Environmental Defense Fund, driving defensively can help reduce carbon emissions, too. Aggressive driving can burn and extra 125 gallons of gas per y ear and reduce gas mileage an average of 33 percent on highways and 5 percent in towns.

Pay-as-you-drive insurance, known generically as usage-based insurance, promotes less and safer driving. Since the company piloted the first PAYD program in the late 1990's, more than a quarter of a million drivers have participated. Since then, Progressive has analyzed more than 2 billion miles driven and learned that participating drivers are less likely to be involved in car crashes.

Maryland was one of the earliest states to introduce usage-based insurance. Progressive thanks the Maryland Department of Insurance and the Maryland Department of the Environment for their support of this transformative insurance product. As a result, thousands of Maryland drivers enrolled in Snapshot are saving money.

Implementation

This program includes mandatory drivers, such as executive orders and laws, as well as voluntary measures.

Transportation – 6: Initiatives to Double Transit Ridership by 2020

Lead Agency: MDOT

Program Description

This program is designed to advance the effort to meet a goal set by The O'Malley-Brown Administration of doubling transit ridership by 2020 and the continuation of that same growth rate beyond 2020. In order to achieve this growth, actions are needed to increase the attractiveness and convenience of public transportation, improve the operational efficiency of the system, and increase system capacity. Actions related to land use planning, pricing disincentives for driving cars, and bike and pedestrian access improvements are also necessary to achieve the ridership goal. Initiative in this program include:

MARC East Baltimore Station

A new station is planned for east Baltimore City in 2015. There is a potential tie-in with Baltimore City's proposed Greektown pedestrian and transit center project.

Expand Transit (Purple Line, Corridor Cities Transitway, Red Line)

Major projects planned for opening by 2020 in the Washington region include the Purple Line which runs from Bethesda Metro station to New Carrolton Metro station and the Corridor Cities Transitway which runs from Shady Grove Metro station to COMSAT. A major project in the Baltimore region is the Red Line that extends east to west in Baltimore City from the center city to Highlandtown in the east.

MARC Growth and Investment Plan

Consistent with the desire to expand and improve transit throughout Maryland, the O'Malley/Brown Administration's MARC Growth and Investment Plan is a multi-phased, multi-year plan to triple the capacity of MARC, Maryland's commuter rail system.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

For quantification purposes, the emission benefits and costs associated with this program have been aggregated with emissions reductions under Transportation-5: Public Transportation Initiatives. The potential emission reductions from these two programs by 2020 are estimated to be 1.97 million metric tons of CO_2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Initiative to Double Transit Ridership by 2020 program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Initiative to Double Transit Ridership by 2020 program, once fully operational, would support a total of about 146 jobs, $19 million in economic output, and $6 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

Projects that contribute to a reduction in VMT growth and/or improve transit system efficiency are a subset of the State's complete Consolidated Transportation Program. The current Consolidated Transportation Program projects applicable to doubling transit ridership by 2020 include all Maryland Transit Administration and Washington Metropolitan Area Transit Authority capital projects dedicated to the expansion and increased level of service of public transportation services in Maryland.

Transportation – 7: Intercity Transportation Initiatives

Lead Agency: MDOT

Program Description

Traffic congestion along the Interstate 95 corridor between Baltimore and Washington, D.C. has been steadily increasing over the past decades. The State is implementing strategies to reduce congestion and mobile emissions, including GHGs, by providing alternatives to single occupant vehicle use as well as improvements to Maryland's transportation systems. These strategies enhance connectivity and reliability of non-automobile intercity passenger options through infrastructure and technology investments. This includes expansion of intercity passenger rail and bus services as well as improved connections between air, rail, intercity bus, and regional or local transit systems.

More information on this program can be found in the appendix of this report.

MARC Station Parking Enhancements

Maryland Area Regional Commuter (MARC) rail services have been enhanced through construction of additional parking at stations throughout the Baltimore region.

National Gateway

The National Gateway Project is a package of rail infrastructure and intermodal terminal projects that will enhance transportation service options along three major freight rail corridors owned and operated by CSX Transportation through the Midwest and along the Atlantic coast. The improvements will allow trains to carry double-stacked containers, increase freight capacity, and make the corridor more marketable to major East Coast ports and shippers.

Refurbishing MARC and other rail vehicles

In order to ensure the reliability, safety and comfort of MARC equipment, the rolling stock is periodically overhauled. Between FY05 and FY12, twenty-three locomotives are scheduled to be overhauled and retrofitted to meet cleaner federally required standards.

Update on Maryland High Speed Rail

In September 2010, MDOT signed an agreement with the Federal Railroad Administration that obligated $9.4 million in high-speed stimulus funds to complete environmental and engineering work to replace the BWI Station, which serves Baltimore/Washington International Airport.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 0.76 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Intercity Transportation Initiatives program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Intercity Transportation Initiatives program, once fully operational, would support a total of about 625 jobs, $110 million in economic output, and $31 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

The majority of measures from this program are part of MDOT's Consolidated Transportation Program; some measures are federally funded.

Transportation – 8: Bike and Pedestrian Initiatives

Lead Agency: MDOT

Program Description

This program is part of the State's effort to reduce GHG and other motor vehicle emissions from cars by providing alternatives to single occupant vehicle use. Building appropriate infrastructure for additional bicycle and pedestrian travel in urban areas provides alternatives to traveling by car. Initiatives in this program include:

Bicycle/Pedestrian Enhancements

The Maryland State Highway Administration has worked to engineer, implement, and promote new and improved bicycle and pedestrian facilities.

Bike Racks on Buses, MARC, Subway, Light Rail

In Maryland, public transportation accommodates bicycles to encourage bicyclists to travel longer distances.

Construction of Bike Lanes and Bike Paths

Additional bicycle paths being considered include the Capital Crescent Trail, Patuxent Branch, Rock Creek, B & A, BWI, North Central Rail, and Fair Hill Trails.

East Coast Greenway

The East Coast Greenway is the planned backbone of an emerging network of bicycle trails along the eastern seaboard from Maine to Florida.

Bike and pedestrian initiatives include infrastructure design and construction policies; funding; regulatory, and land use strategies; and education and marketing measures. These initiatives result in improved bike and pedestrian amenities, resulting in an increase in the number of trips made on foot or bicycle, particularly in urban areas adjacent to Maryland's trail networks.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 0.41 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Bike and Pedestrian Initiatives program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Bike and Pedestrian Initiatives program, once fully operational, would support a total of about 135 jobs, \$17 million in economic output, and \$5 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

The measures that comprise this program are included in the Consolidated Transportation Program.

Transportation – 9: Pricing Initiatives

Lead Agency: MDOT

Program Description

This program includes transportation pricing disincentives and travel demand management incentive programs. Projects are tied to commute alternatives and programs including ridesharing (Commuter Connections), guaranteed ride home, transportation demand program management and marketing, outreach and education programs (Clean Air Partners), parking cash-out subsidies, transportation information kiosks, local car-sharing programs, telework partnerships, parking fees, and vanpool programs. Initiatives in this program include:

Electronic Toll Collection

The Maryland Transportation Authority implemented its electronic toll collection system at the authority's three harbor crossing facilities in 1999. As of 2011, more than 60% of vehicles using the Maryland Transportation Authority facilities used electronic toll tags. The Maryland Transportation Authority is a member of the E-Z Pass Inter-Agency Group, a coalition of Northeast Toll Authorities.

Programs Under Consideration

MDOT continues to work with metropolitan planning organizations, the Maryland General Assembly, and stakeholders to identify additional pricing initiatives to consider. Several of these efforts include high occupancy toll lanes, VMT fees, congestion pricing and managed lanes, parking impact fees, and employer commute incentives.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 2.21 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Pricing Initiatives program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Pricing Initiatives program, once fully operational, would support a total of about 7,635 jobs, $1 billion in economic output, and $417 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

Projects identified in this program contribute to a change in VMT growth and/or improve Maryland's transportation systems efficiencies and are a subset of the State's complete Consolidated Transportation Program.

Transportation – 10: Transportation Technology Initiatives

Lead Agency: MDOT

Program Description

Transportation technology initiatives are significant contributors to mobile emissions reductions and are an important element of the State's efforts to help reduce GHGs. Projects under this program include intelligent transportation systems, traffic operational improvements, engine replacements, clean vehicle technology and State and federal initiatives. Initiatives in this program include:

Traffic Flow Improvements

The Coordinated Highways Action Response Team program, operated by MDOT and the Maryland State Police, focuses on non-recurring congestion, such as backups caused by accidents. The State-wide Operations Center, and the three satellite operations centers in the region, survey the State's roadways to quickly identify incidents through the use of intelligent transportation system technology and direct emergency responders to the accident scenes.

Maryland 511 is Maryland's official travel information service. Maryland 511 provides travelers with reliable, current traffic and weather information, as well as links to other transportation services. Maryland 511 helps motorists reach their destination in the most efficient manner when traveling in Maryland.

Truck Stop Electrification

Truck stop electrification allows truckers to shut down their engines and obtain electric power and "creature comforts" while resting. Truck stop electrification reduces diesel emissions and noise as well as wear and tear on the truck engine.

Traffic Signal Synchronization

The Maryland State Highway Administration has instituted a program to review and retime its 1,200 traffic signals in the Baltimore region. The timing of each traffic signal system is reviewed and updated at least every three years.

Telework Partnership with Employers
The Baltimore Metropolitan Council and the Metropolitan Washington Council of Governments participate in a bi-regional program, known as Telework Partnership with Employers, to assist employers to establish home-based telecommuting programs for their employees. Since October 1999, over 25 large and small private sector employers as well as two nonprofit organizations have participated in the bi-regional telework partnership program.

Light-Emitting Diode Traffic Signals
MDOT works with Baltimore City and other State jurisdictions to replace traditional traffic signal heads with light-emitting diode signal heads. Replacing Baltimore City's 39,000 light-emitting diode signal heads could result in a 90% power savings.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

For quantification and modeling purposes, the emission benefits and costs associated with this program have been aggregated with emission reductions under Transportation-1 (The Maryland Clean Cars Program), Transportation-17 (Renewable Fuels Standard) and Transportation-18 (Corporate Average Fuel Economy Standards: Model Years 2008-2011). The potential emission reductions from these four programs by 2020, when combined, are estimated to be 9.48 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Transportation Technology Initiatives program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Transportation Technology Initiatives program, once fully operational, would support a total of about 1,632 jobs, $236 million in economic output, and $70 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

Projects that contribute to a change in VMT growth and/or improve system efficiency are a subset of the State's complete Consolidated Transportation Program.

Transportation – 11: Electric Vehicle Initiatives

Lead Agency: MDOT

Program Description

Initiatives to expand use of electric vehicles are part of efforts by the State to reduce emissions of GHGs and other air pollutants by providing viable alternatives to internal combustion engine vehicles. Electric vehicles can reduce mobile emissions because they use battery power for propulsion rather than an internal combustion engine. GHG emissions associated with electricity use are capped as part of the RGGI program described under the energy section of this chapter. The following are a variety of initiatives to encourage electric vehicle usage.

Vehicle-to-Grid (V2G)

MDOT, MEA, and MDE continue to evaluate and consider V2G opportunities in Maryland to provide electric power to the grid during times of peak demand when electric vehicles are parked.

Electric Vehicles

MDOT has been working closely with MDE, MEA, Baltimore City and the Baltimore Electric Vehicle Initiative to select appropriate locations for electric vehicle re-charging stations around the State. Several of the re-charging stations have been located at MDOT and modal facilities such as MDOT Headquarters in Hanover, the Baltimore Washington International Airport MARC/AMTRAK station, the BWI parking garage and park-and-ride lots maintained by MDOT modal agencies.

Baltimore City Electric Vehicle Infrastructure

There is a Baltimore Regional Transportation Board Congestion Mitigation and Air Quality Subcommittee recommendation to install at least 8 electric vehicle charging units in public garages in Baltimore in early 2012.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

In order to account for similarities across programs, all emission benefits and costs by 2020 associated with transportation technologies, including electric vehicle initiatives, have been aggregated under policy Transportation – 10: Transportation Technologies.

.Job Creation and Economic Benefits

The Electric Vehicle Initiatives program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Electric Vehicle Initiatives program, once fully operational, would support a total of about 49 jobs, $8 million in economic output, and $2 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

The majority of this program is voluntary, although some of the measures receive federal funding and are being implemented. Initiatives identified for further analysis and possible implementation under this program area: incentives for low-carbon fuels and infrastructure, marketing and education campaigns, and technology improvements for on-highway vehicles.

Transportation – 12: Low Emitting Vehicle Initiatives

Lead Agency: MDOT

Program Description

Initiatives to encourage use of low emitting vehicles are part of efforts by MDOT and other State agencies to reduce emissions of GHGs and other air pollutants by providing lower emitting alternatives to internal combustion engine vehicles. Along with encouraging the use of low emitting vehicles, such as hybrids, programs such as car-sharing can help to reduce the number of personal cars by allowing rentals at locations like commuter rail stations so that people can travel by transit and then extend their trips by car for errands or recreation.

The following initiatives were identified for further analysis and possible implementation under this program area:

- Incentives for Low-GHG Vehicles – Provide incentives to increase purchases of fuel-efficient or low-GHG vehicles/fleets.
- Technology Advances for Non-highway Vehicles – Encourage or incentivize retrofits and/or replacement of old, diesel-powered non-highway engines, such as switchyard locomotives, with new hybrid locomotives.
- Incentives for Low-Carbon Fuels and Infrastructure – Incentivize the demand for clean low-carbon fuels and the development of infrastructure to provide for increased availability/accessibility of alternative fuels and plug-in locations for electric vehicles.

Maryland will continue to analyze many different strategies to promote lower emitting vehicles and seek funding sources at the State and federal level and to purchase low emitting buses and vehicles.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

For quantification and modeling purposes, the emission benefits and costs associated with this program by 2020 have been aggregated with emission reductions under Transportation-1 (Maryland Clean Cars Program), Transportation-10 (Transportation Technologies), Transportation-17 (Renewable Fuel Standard), and Transportation-18 (Corporate Average Fuel Economy Standards: Model Years 2008-2011). The potential emission reductions from the four above programs by 2020, when combined, are estimated to be 9.48 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions

Job Creation and Economic Benefits

The Low Emitting Vehicle Initiatives program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Low Emitting Vehicle Initiatives program, once fully operational, would support a total of about 0.2 jobs, $30,000 in economic output, and $9,000 in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

Projects that contribute to a reduction in VMT growth and/or improve system efficiency are a subset of the State's complete Consolidated Transportation Program. Current Consolidated Transportation Program projects applicable to transportation technology initiatives include Maryland Transit Administration diesel-hybrid electric bus purchases.

Transportation – 13: Evaluate the GHG Emissions Impacts from Major New Projects and Plans

Lead Agency: MDOT

Program Description

This program focuses on the process of evaluating GHG emissions from all major State and local projects. The goals of this program are to understand how new, major projects may affect the State's ability to achieve a 25% reduction in GHG emissions by 2020 and to develop guidance for the State and other major project sponsors to use in evaluating the impacts of new projects. MDOT identified three potential strategies under this program:

- Active participation in framing national GHG emissions evaluation policy;
- Evaluation of GHG emissions for major projects through the National Environmental Policy Act process; and
- Evaluation of GHG Emissions through State-wide/regional planning efforts including an effort that will link to, but be separate from, the transportation-conformity process and establishes voluntary out-year emission targets for GHGs for the Baltimore and Washington regions. .

Maryland also is considering a program that would insure that both short and long term GHG emissions reduction goals are considered in state and local land-use and transportation planning processes.

A process for evaluating GHG emission impacts of new major projects is currently under development at the national level and will inform the planning process at the State level.

Estimated GHG Emission Reductions in 2020

The implementation strategies under this program are assumed to contribute to the overall 2020 goal of reducing GHG emissions from the transportation sector; however, the GHG emissions impact of implementing this program is not yet quantified since components are still being determined.

Job Creation and Economic Benefits

There will be direct, indirect and induced effects to the economy stemming from the Evaluate the GHG Emissions Impacts from Major New Projects and Plans program and increased demand of the evaluation efforts for the transportation programs. However, these effects can not be quantified at this time and the job creation and economic benefits from the implementation of the transportation programs are not counted towards this program. Chapter 7 provides more detail on the job creation and economic benefits of the associated programs.

Implementation

MDOT and MDE will continue to analyze and develop implementation strategies for this program.

MDOT is currently working with the American Association of State Highway and Transportation Officials, and the Northeast Association of State Transportation Officials at the national level, to develop a unified procedure for measuring and determining the effects of projects on GHG emissions.

MDE is developing regulations to begin implementing the piece of this program that would be done in parallel to the transportation conformity process. This new program will establish voluntary, long-term planning targets for GHG emission. Progress toward these targets will be assessed in a process that is separate from, but be done in the same time frame as, the existing transportation conformity process in Maryland. This program would also build from the technical and interagency consultation frameworks already in place because of the transportation conformity program. This new program will be an independent effort that links to, but does not interfere with, the existing transportation conformity program.

These regulations are expected to be in place by the end of 2012.

The general authority for MDOT and MDE to implement this program is included in the following statutes and regulations:

- The MDE part of this strategy is authorized under the Environment Article, §§101, 1-404, 2-101—2-103, 2-301—2-303, 10-102, and 10-103 of the Annotated Code of Maryland. COMAR 26.11.26 is being amended to implement this program. This regulation was originally adopted and published into the Maryland Register effective June 5, 1995 with several revisions through January 29, 2007.

- The MDOT part of this strategy is authorized under Transportation Article, Title 2 of the Annotated Code of Maryland. These authorities allow MDOT to develop Maryland's Consolidated Transportation Program. The Consolidated Transportation Program is Maryland's six-year capital budget for transportation projects. The Capital Program includes major and minor projects being implemented by MDOT and its modal agencies and related authorities within the Department, including, the Maryland Transportation Authority, and Washington Metropolitan Area Transit Authority.

Transportation – 14: Airport Initiatives

Lead Agency: MDOT

Program Description

A 2011 energy audit for the Maryland Aviation Administration evaluated the potential emissions impact of reductions in consumption of electricity and conventional vehicle fuel at the BWI airport. These reductions would result in lower GHG emissions through the utilization of more energy efficient technologies and fuel conservation measures. The following initiatives are intended to both reduce criteria pollutant emissions and GHG emissions. A list of these measures is provided below with details in Appendix C.

- Compressed Natural Gas Buses
- Air Emissions Reductions
- BWI Energy Audit
- BWI Utility Master Plan
- BWI Energy Efficiency
- Enhanced Access to BWI by Other Travel Modes
- BWI's Periodic Air Quality Assessments

A proposed Air Quality Management Plan would address future air quality requirements including GHG emissions reduction.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

For quantification and modeling purposes, the emission benefits and costs associated with this program by 2020 have been aggregated with emission reductions under Transportation-1 (Maryland Clean Cars Program), Transportation-10 (Transportation Technologies), Transportation-17 (Renewable Fuel Standard), and Transportation-18 (Corporate Average Fuel Economy Standards: Model Years 2008-2011). The potential emission reductions from the four above programs by 2020, when combined, are estimated to be 9.48 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Airport Initiatives program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Airport Initiatives program, once fully operational, would support a total of about 148 jobs, $31 million in economic output, and $9 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

The Maryland Aviation Administration supports a wide range of initiatives geared toward reducing GHG emissions and improving the airport's air quality. There are multiple aviation industry advancements that reduce GHGs. These include use of bio-fuels for aircraft use and conversion of the airline ground support equipment fleet, such as aircraft tugs and baggage belt loaders, to non-gasoline technologies (electric and/or natural gas). Many of these programs are part of the Environmental Impact Statements created for Maryland's State-owned airports. The Environmental Impact Statement process is part of the environmental permitting process required for project approval. Air quality analysis and general conformity considerations are part of the required evaluation in the Federal process as well as comparable State processes. The Maryland Aviation Administration does not have the authority to require use of aircraft engine technologies that are more environmentally protective than those which comply with existing federal regulations.

Transportation – 15: Port Initiatives

Lead Agency: MDOT

Program Description

The Maryland Port Administration has implemented an Environmental Management System as well as other initiatives to reduce the environmental footprint associated with Maryland's deepwater seaport. The Maryland Port Administration's emission reduction strategy includes use of cleaner diesel fuel port fleet vehicles, use of diesel operated equipment, reduced truck emissions through turn time efficiency improvements, and idle reductions.

In 2006, the Maryland Port Administration partnered with Port stakeholders to oversee various physical and operational improvements to terminal gates at the Dundalk and Seagirt Marine Terminals. Since then, the Maryland Port Administration has used ultra-low sulfur diesel fuel blended with bio-diesel in all of its "on road" as well as "off road" diesel engines. Annually, more than 75% of the Maryland Port Administration's fleet purchases consist of alternatively fueled vehicles. Beginning in the fall of 2006 and continuing through 2010, Maryland Port Administration received a series of EPA and U.S. Department of Energy grants to retrofit ship-to-shore crane, and the entire fleet of rubber tire gantry cranes with diesel oxidation catalysts.

Current initiatives include:

- A Green Port Strategy will be developed consistent with industry trends and initiatives including EPA's Strategy for Sustainable Seaports.
- In 2011, MPA's Environmental Management System became ISO 14001:2004 certified, which is an internationally recognized standard for environmental programs. An EMS establishes the requirements for a structured management system that identifies legal requirements for identifying and eliminating or minimizing significant environmental impacts.
- POB Clean Diesel Program, Phase I, funded by an EPA grant allowed for the installation of 79 emission reduction technologies on fleet vehicles and equipment, cargo handling equipment at terminals, cranes, harbor crafts, dray trucks, and locomotives.
- The Maryland Port Administration fleet now includes flex-fuel, alternative fuel, clean idle, and hybrid vehicles and equipment. As part of the procurement process, MPA Fleet Department considers "environmentally preferable" equipment when making a purchase.
- The Maryland Port Administration is working with MARAMA to implement a

Dray Truck Replacement Program and fund an energy performance contract, including energy efficiency improvements such as solar panels, geo-thermal heating and air conditioning systems and lighting upgrades.

- The POB Clean Diesel Program (Phase II) in cooperation with the Mid-Atlantic Dray Truck Replacement Program, will provide funding to replace older dray trucks with more efficient engines to achieve a reduction in air emission and GHG.

Estimated GHG Emission Reductions in 2020

For quantification and modeling purposes, the emission benefits and costs associated with this program by 2020 have been aggregated with emission reductions under Transportation-1 (Maryland Clean Cars Program), Transportation-10 (Transportation Technologies), Transportation-17 (Renewable Fuel Standard), and Transportation-18 (Corporate Average Fuel Economy Standards: Model Years 2008-2011). The potential emission reductions from the four above programs by 2020, when combined, are estimated to be 9.48 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Port Initiatives program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Port Initiatives program, once fully operational, would support a total of about 0.4 jobs, $90,000 in economic output, and $20,000 in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

This is a voluntary program. The Maryland Port Administration has ongoing and planned administrative, management, maintenance, and operations strategies that will reduce energy consumption and GHG emissions from its transportation sector.

Transportation – 16: Freight & Freight Rail Programs

Lead Agency: MDOT

Program Description

The State is implementing initiatives to encourage and improve rail and freight transport. These initiatives focus on improving the efficiency of freight transportation to help reduce emissions of GHG and other pollutants from the transportation sector. These efforts enhance connectivity and reliability of multimodal freight through infrastructure and technology investments, such as expansion and bottleneck relief on priority truck and rail corridors and enhanced intermodal freight connections at Maryland's intermodal terminals and ports. The following strategies are examples of the initiatives to encourage and improve rail and freight transport throughout Maryland; more details can be located in Appendix C.

Auxiliary Power Units for Existing Locomotives

Auxiliary power units have been installed on diesel locomotives to reduce the need for long idling periods.

Technology Advances for Non-highway Vehicles

MDOT continues to analyze opportunities to incentivize retrofits or promote replacement of old, diesel-powered non-highway engines, like switch-yard locomotives, with new hybrid locomotives.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

For quantification and modeling purposes, the emission benefits and costs associated with this program by 2020 have been aggregated with emission reductions under Transportation-1 (Maryland Clean Cars Program), Transportation-10 (Transportation Technologies), Transportation-17 (Renewable Fuel Standard), and Transportation-18 (Corporate Average Fuel Economy Standards: Model Years 2008-2011). The potential emission reductions from the four above programs by 2020, when combined, are estimated to be 9.48 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Freight & Freight Rail Programs are expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Freight & Freight Rail Programs, once fully operational, would support a total of about 601 jobs, $62 million in economic output, and $24 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

Projects that contribute to a change in truck VMT growth and/or improve system efficiency are a subset of the State's complete Consolidated Transportation Program. Major roadway capacity projects impacting truck freight movement in Maryland are planned for completion by 2020, such as: I-695 from I-95 South to MD 122, I-695 from I-83 to I-95 North, MD 32 grade separation and interchange at I-795, MD 4 upgrade in Prince Georges County, and US 50 access control improvements in Wicomico County.

The State will continue to expand this ongoing effort while seeking funding sources at the State and federal level and continuing to work with State and federal lawmakers on legislation.

Transportation – 17: Federal Renewable Fuels Standard

Lead Agency: MDOT

Program Description

The Renewable Fuel Standard, adopted by EPA, was originally mandated under the Energy Policy Act of 2005. The federal Energy Independence and Security Act of 2007 expanded the Renewable Fuel Standard in a number of ways. EPA used estimates provided by U.S. Department of Energy's Energy Information Agency to determine the total volume of transportation fuel expected to be used in the U.S. during the next year. A preliminary standard was issued in the spring of 2010 with a final rulemaking projected for 2012, pending resolution of legal issues. The federal law developed new categories of renewable fuel and required the application of lifecycle GHG threshold performance standards to ensure that each category of renewable fuels emits fewer GHGs than the conventional fuel it replaces.

The Renewable Fuel Standard includes diesel fuel as a medium for renewable fuel. The standard required the blending of 9 billion gallons of renewable fuel in 2008 and requires the blending of 36 billion gallons by the end of 2012. A qualified renewable fuel reduces lifecycle GHG emissions by at least 20%; qualified advanced biofuels reduce lifecycle GHG emissions by 50%. The volume of ethanol is capped at 12 billion gallons in 2010 and increases to 15 billion gallons in 2015 where it remains fixed thereafter. The law included a mandate for use of 1 billion gallons of advanced biofuels in 2010 and requires the use of 21 billion gallons by the end of 2022.

To ensure that the fuel supply sold in the U.S. meets the mandated volume of renewable fuels, EPA established a system of tradable unique Renewable Identification Numbers issued by the biofuel producer or importer at the point of production or port of importation. Fuel blenders are required to include a quantity of biofuels equal to a percentage of their total annual sales. Each blender must show that it has enough Renewable Identification Numbers at the end of each year to meet its share for each of the four mandated standards.

Estimated GHG Emission Reductions in 2020

For quantification and modeling purposes, the emission benefits and costs associated with this program by 2020 have been aggregated with emission reductions under Transportation-1 (Maryland Clean Cars Program), Transportation-10 (Transportation Technologies), and Transportation-18 (Corporate Average Fuel Economy Standards: Model Years 2008-2011). The potential emission reductions from the four programs by 2020, when combined, are estimated to be 9.48 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Federal Renewable Fuels Standard program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Federal Renewable Fuels Standard program, once fully operational, would support a total of about 79 jobs, $10 million in economic output, and $3 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

This federal program has been implemented through regulations adopted by EPA, which are now fully enforceable by EPA.

Transportation – 18: Corporate Average Fuel Economy Standards: Model Years 2008-2011

Lead Agency: MDOT

Program Description

The federal Energy Independence and Security Act of 2007 established a goal for increasing the national fuel economy to 35 miles per gallon by the year 2020. The fuel economy standard is the sales-weighted fuel economy average for a vehicle manufacturer for the current model year of vehicles with a gross vehicle weight rating of 8,500 lbs or less. This standard includes passenger vehicles and light duty trucks.

Since introduction in 1975, Corporate Average Fuel Economy standards have increased very slowly from the initial 18 miles per gallon standard. Each year the National Highway Traffic Safety Administration analyzes the effect of its new proposed standard on the environment as well as employment.

New fuel efficiency and GHG standards have been adopted through a joint rulemaking by the National Highway Traffic Safety Administration and EPA for model years 2012-2016. These new GHG standards, along with a faster phase in of fuel economy standards, will replace those adopted following passage of the 2007 federal law. The 2008-2011 fuel efficiency standards are applicable to model year 2008-2011 vehicles.

Estimated GHG Emission Reductions in 2020

For quantification and modeling purposes, the emission benefits and costs associated with this program by 2020 have been aggregated with emission reductions under Transportation-1 (Maryland Clean Cars Program), Transportation-10 (Transportation Technologies), and Transportation-17 (Renewable Fuel Standard). The potential emission reductions from the four programs by 2020, when combined, are estimated to be 9.48 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Corporate Average Fuel Economy Standards: Model Years 2008-2011 program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Corporate Average Fuel Economy Standards: Model Years 2008-2011 program, once fully operational, would support a total of about 36 jobs, $4 million in economic output, and $1 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

This program was implemented through federal regulations adopted by the National Highway Traffic Safety Administration. The requirements are fully enforceable by the National Highway Traffic Safety Administration. Since its implementation, new national GHG and fuel economy standards have been adopted through a joint agency agreement between EPA and the National Highway Traffic Safety Administration. These new standards will improve upon the current standards set forth in this program and succeed this program as the enforceable fuel economy standards. While these standards are applicable through model year 2011 vehicles, these vehicles will remain in the fleet and will still be producing benefits in 2020.

Transportation – 19: Promoting Hybrid and Electric Vehicles

Lead Agency: MEA

Program Description

Maryland's transportation infrastructure plays a vital role in the movement of people within the State, throughout the region, and along the entire East Coast. MEA and MDOT are implementing the following voluntary, incentive-based programs to promote hybrid and electric vehicles.

Existing Programs:

Electric Vehicle Infrastructure Program

MEA established the Electric Vehicle Infrastructure Program in early 2010 to facililtate the installation of electric vehicle recharging stations. To date, MEA has issued two grants under the program totaling $594,000 to fund the installation of 82 public recharging stations across the State.

Maryland Hybrid Truck Goods Movement Initiative

Through the Maryland Hybrid Truck Goods Movement Initiative, MEA partnered with Maryland Clean Cities and several of the most prominent and progressive fleets in the U.S. to expeditiously implement the nation's largest deployment of heavy-duty hybrid trucks utilized in goods movement. MEA received a $5.9 million U.S. Department of Energy grant to assist in purchasing and deploying 143 heavy duty hybrid vehicles.

Electric Vehicle Tax Credit (House Bill 490, 2010 Session)

In 2010, the Maryland legislature enacted legislation providing a credit against the motor vehicle excise tax for certain qualified plug-in electric drive vehicles. This is a three-year program and each vehicle is eligible for up to $2,000. This program is administered by MDOT and paid for by MEA utilizing money from the Strategic Energy Investment Fund.

Electric Vehicle Charging Station Tax Credit (House Bill 163, 2010 Session)

This legislation allows a State income tax credit of up to $400, for tax years 2011 through 2013 for 20% of the cost of qualified electric vehicle recharging equipment placed in service by a taxpayer during a taxable year. This program is administered and funded by MEA utilizing money from the Strategic Energy Investment Fund.

Electric Vehicle Council

The Maryland Electric Vehicle Infrastructure Council was established by the General Assembly in the 2011 legislative session. This Council was tasked with developing an action plan to facilitate the successful integration of electric vehicles within Maryland's transportation sector. The Council submitted an interim report to the Legislature in December 2011; a final report is due on or before December 1, 2012.

Electric Vehicle Pilot Program

The Electric Vehicle Pilot Program requires PSC to establish a pilot program for charging electric vehicles by June 30, 2013. This program allows utilities to participate and include incentives for residential, commercial, and governmental customers to recharge electric vehicles in ways that will accomplish specified goals, namely modifying behavior so that recharging occurs during off peak hours. PSC must report to the Governor and the General Assembly on the program by February 1, 2015.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

In order to account for similarities across programs, all emission benefits and costs associated with this program by 2020 have been aggregated under Transportation – 4: The Transportation and Climate Initiative. Accounting for all similar electric vehicles under Transportation - 4 ensures that any overestimations of emission reductions due to redundancies across similar transportation programs are eliminated.

Job Creation and Economic Benefits

The Promoting Hybrid and Electric Vehicles program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Promoting Hybrid and Electric Vehicles program, once fully operational, would support a total of about 120 jobs, $15 million in economic output, and $4 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

MEA has primary responsibility for administering the Electric Vehicle Infrastructure Program, Maryland Hybrid Truck Goods Movement Initiative Program, and the Electric Vehicle Charging State Tax Credit Program. MDOT has primary responsibility for administering the Electric Vehicle Tax Credit Program.

Transportation – 20: Pay-As-You-Drive® Insurance in Maryland

Lead Agency: MIA

Program Description

Pay-As-You-Drive® automobile insurance is also known as use-based insurance. Generally, use-based insurance plans are designed to align the amount of premium paid with actual vehicle usage. The distance an automobile is driven, the speed at which it is driven, and the time of day it is driven, all are factors that can be used to determine premiums under a use-based plan.

Under traditional automobile insurance plans, insurance companies rely on the consumer to provide information at the time the policy is written about the number of miles the consumer expects to drive during the policy period. In contrast, under use-based plans, the consumer generally uses a telematics device to provide information about actual mileage and other driving behaviors to the insurance carrier. The carrier can use that information to adjust the price of coverage based on the degree of risk posed by the insured's actual driving behaviors.

In the fall of 2008, Progressive Insurance Group started offering its "MyRate" use-based program in Maryland. Consumers who elect to participate in this program receive a wireless device that plugs into their car. This device measures how, how much and when the car is being driven. Cars driven less often, in less risky ways, and at less risky times of day can receive a lower premium. Customers signing up for the program could receive up to a 10% discount, and at renewal, could earn up to a 25% discount. There is a $30 technology expense for the cost of the wireless device and transmission of the data. This is imposed each policy period, according to a September 15, 2008, Progressive news release.

As of 2008, the GMAC Insurance Group also offered a Pay-As-You-Go insurance program to OnStar subscribers in Maryland. It works as a discount program: the fewer miles driven, the higher the discount earned. Customers driving less than 2500 miles annually may be eligible for up to a 50% discount. All information is transmitted through the OnStar Vehicle Diagnostic reports, so it is necessary to have an OnStar-equipped vehicle with an active OnStar subscription.

As of August 2011, the Progressive and GMAC Insurance Groups were the only insurers offering a use-based insurance program for private passenger automobiles in Maryland. Some carriers are offering programs or pilot programs similar to Pay-As-You-Drive® in other states.

MIA led a workgroup with MDE, MDOT, the insurance industry, consumer advocacy groups and other stakeholders to review the opportunities and barriers to expanding the Pay-As-You-Drive® program to other companies. An analysis of Pay-As-You-Drive® insurance was conducted by the group and *Review of Pay-As-You-Drive® Programs in Maryland* was issued in September 2009. *Review of Pay-As-You-Drive® Programs in Maryland* concluded:

> "Even though it is unclear to what extent the Pay-As-You-Drive® Program will reduce GHG production, it is beneficial to encourage the expansion of these programs in the state in that they offer more options to consumers. Based on this, it is recommended that meetings be held with insurance carriers to discuss whether they would consider offering Pay-As-You-Drive® programs in the state."

In keeping with that recommendation, MIA conducted a survey of the major carriers writing private passenger automobile insurance in the State to determine whether they offer or intend to offer use-based insurance in Maryland in the future. These carriers wrote polices for approximately 74% of the premiums in calendar year 2009.

Survey results were published on September 22, 2010 in an MIA report titled *2010 Carrier Survey Results for Pay-As-You-Drive®*. While a number of the carriers were considering use-based programs in Maryland, survey participants indicated that they did not intend to offer such programs any sooner than 2012. Carriers who were not considering offering use-based programs in Maryland cited the cost of developing the product and the regulatory environment as the reason. MIA continues to work with carriers interested in offering such products in Maryland on a long-term or pilot basis.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 0.09 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Pay-As-You-Drive® Insurance program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Pay-As-You-Drive® Insurance program, once fully operational, would support a total of about 12 jobs, $1 million in economic output, and $520,000 in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

This is a voluntary program.

National Academy of Sciences Releases Report Stressing Need for Immediate Action to Reduce GHGs and to Prepare and Adapt for the Impact of Climate Change (May 12, 2011)

The National Research Council of the National Academy of Sciences released a climate change report warning that the risk of dangerous climate change impacts is growing with every ton of GHG emitted into the atmosphere. The report is the final one in a series of reports requested by Congress, entitled "America's Climate Choices." The new report confirms that the preponderance of scientific evidence points to human-caused emissions of GHGs as the most likely cause for climate change, as the trend cannot be explained by natural factors. Substantial reductions of GHG emissions should be "among the highest priorities in the national response," said the scientists who wrote the report. While state and local actions to reduce GHG emissions are potentially quite significant, according to the report, they are not likely to yield as much reductions as a coordinated national response would. The report says the most efficient way to accelerate emissions reductions is through a nationally uniform price on GHG emissions with a price trajectory sufficient to spur investments in energy efficiency and low-carbon technologies. The authors also deemed the risks of sticking to "business-as-usual" to be a much greater concern than the risks associated with a strong response. Finally, while aggressive efforts to cut GHG emissions will help mitigate the impacts of climate change, they will not be sufficient to avert global warming, so the U.S. needs to mobilize now to reduce vulnerability to climate change impacts.

http://www.nap.edu/catalog.php?record_id=12781

The Agriculture and Forestry Sector

The agriculture and forestry sectors are a source of GHG emissions, contributing a small percentage of Maryland's overall GHG emissions, but these sectors also offer unique opportunities to remove carbon dioxide from the atmosphere. Forests, grasslands, croplands, and wetlands all possess carbon-reducing and energy-related benefits that are extensive and complex. Activities in Maryland that can contribute to the increase in net GHG emissions include clearing an area of forest to create cropland, tilling and fertilizing crop lands, or draining a wetland.

More significantly, agriculture and forest lands offer carbon sequestration opportunities that are not possible in other sectors. Through appropriate management, technology and energy conscious choices, the potential for carbon sequestration from the atmosphere can be optimized and the net GHG emissions from the agriculture and forestry sector reduced. Trees and plants remove carbon dioxide from the air and store carbon in their trunks and branches.

Forests make up 44% of Maryland's land cover. In 2000, Maryland forests absorbed an estimated 11.5 million more metric tons of CO2-equivalents than they emitted. Urban forests around Maryland absorbed an additional 2.4 million metric tons of CO2-equivalents.

Sustainable forest and urban forest management is essential for healthy productive forests. Sustainably managed natural resources can maximize carbon sequestration and reduce GHG levels in the atmosphere. Increasing the acreage and enhancing the condition of forests and urban trees is a critical component of mitigating climate change.

Lower surface temperatures of sidewalks and roads resulting from the shade of tree canopies reduce the need for air conditioning in buildings, thereby reducing the need for the production and transmission of electricity. Reduced energy production, in turn, reduces GHG emissions from power plants. Shade and lower surface temperatures reduce the evaporation of chemicals from car engines and reduce the need for air conditioning in cars. All of the examples above reduce the combustion of fossil fuels and emissions of GHGs from cars and power plants.

Agricultural lands both sequester carbon dioxide from the atmosphere and release GHGs through tilling and fertilizer applications. Agricultural practices in Maryland contribute 2.3 million metric tons of CO2-equivalents (5% below the national average). Even though this is a small percent of Maryland's total GHG emissions, there are opportunities for reducing energy use and climate-affecting factors.

Agricultural GHG emissions include methane and nitrous oxide emissions from enteric fermentation (digestion), manure management, agricultural soils, and combustion of agricultural residue. Emissions from agricultural soils account for the largest portions of agricultural emissions. The agricultural soils category includes nitrous oxide emissions resulting from fertilizer application (synthetic, organic, and livestock) and production of nitrogen-fixing crops. No-till farming and precision fertilization are among the most effective management practices that reduce GHG emissions during the producstion of crops.

Opportunities for GHG mitigation in the agriculture and forestry sector involve measures that reduce emissions across other business sectors. For example, production of liquid fuels from biomass can offset emissions from the transportation sector, while biomass energy can replace fossil-fuel generated power and the associated emissions in the energy supply sector.

Ten of the GHG reduction programs that are described in detail in this section, are designed to reduce GHG emissions from the agriculture and forestry sector and through carbon sequestration. Full implementation of the ten agriculture and forestry sector programs results in potential GHG reductions of 9.8 million metric tons of CO2-equivalent (Figure 6-11). The contribution of these ten reduction programs is over one-tenth of the total reductions needed to meet the GGRA goal.

Figure 6-11
Ag and Forestry Sector GHG Reduction Programs

AG AND FORESTRY		
Program Number	Program	Potential GHG Reductions (million metric tons of CO_2-equivalent)
A&F-1	Managing Forests to Capture Carbon	2.70
A&F-2	Creating Ecosystems Markets to Encourage GHG Emissions Reductions	0.82
A&F-3	Increasing Urban Trees to Capture Carbon	1.32
A&F-4	Creating and Protecting Wetlands and Waterway Borders to Capture Carbon	0.65
A&F-5	Geological Opportunities to Store Carbon	Not Quantified
A&F-6	Planting Forests in Maryland	0.62
A&F-7	Expanded Use of Forests and Feedstocks for Energy Production	3.07
A&F-8	Conservation of Ag Land for GHG Benefits	0.28
A&F-9	Buy Local for GHG Benefits	0.05
A&F-10	Nutrient Trading for GHG Benefits	0.21
Total		**9.72**

Ag and Forestry – 1: Managing Forests to Capture Carbon

Lead Agency: DNR

Program Description

This program will promote sustainable forestry management practices in existing Maryland forests on public and private lands to capture carbon. The enhanced productivity resulting from enrolling unmanaged forests into management regimes will increase rates of carbon dioxide sequestration in forest biomass, increase amounts of carbon stored in harvested, durable wood products which will result in economic benefits, and increased availability of renewable biomass for energy production.

By 2020, the implementation goal is to improve sustainable forest management on 30,000 acres of private land annually; improve sustainable forest management on 100% of State-owned resource lands; and achieve third party certification of sustainable management on 50% of State-owned forest lands. Additional potential initiatives include the establishment of a carbon credit market aggregation service with private entities, and the pursuit of legislation to amend the Woodland Incentive Program to allow use with federal cost-share programs. These strategies will be accomplished through the development and adoption of the State-wide Forest Assessment and Response plan, a 5-year strategic planning document required by the 2008 Farm Bill as a condition of access to federal forestry funds.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 2.70 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Managing Forests to Capture Carbon program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Managing Forests to Capture Carbon program, once fully operational, would support a total of about 11 jobs, $1 million in economic output, and $840,000 in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

From July 1, 2010 through March 31, 2011, DNR prepared management plans for 10,394 acres of forest on private forest land and implemented 2,224 acres of forest improvements. In 2009, DNR implemented a Carbon Sequestration Pilot project to assess forest planting and management techniques for approximately 174 acres of Maryland forests. The Woodland Incentive Program statute, Natural Resources Article §5-304, was amended in 2010 and a State-wide Forest Assessment was completed.

Establishing a carbon credit aggregation service with private entities continues to be explored. The current productivity of these programs cannot be attained if there is a future reduction in staff and funding.

Ag and Forestry – 2: Creating Ecosystems Markets to Encourage GHG Emission Reductions

Lead Agency: DNR

Program Description

Increased attention to the benefits and cost efficiencies that ecosystem markets could provide has spurred evaluation of the potential its programs and policies may have for fostering carbon market development. Maryland's Forest Conservation Act and Critical Area Act require mitigation for natural resource impacts generated through land development, and mitigation banking is an option to address these mitigation requirements

If DNR's Ecosystem Services Working Group determines that certain markets should be fostered, then mitigation benefits could begin to be calculated. Benefits could be categorized as avoidance/minimization benefits and net environmental enhancements.

In fall 2010, DNR convened the Ecosystem Services Working Group, which consists of representatives from State agencies, the private sector, and a non-profit organization. The Working Group assessed existing programs to determine which practices and programs could play a role in promoting private sector involvement in developing ecosystem markets. Ecosystem services programs, policies, and current or potential markets assessed by the Ecosystem Services Working Group include wetlands, streams and waterways, forests, critical areas, species and habitats, nutrients, carbon and biomass.

The Ecosystem Services Workgroup produced an interim report in December 2010 that evaluated the status of potential or existing resource markets in the Maryland and constituted a workplan in preparation for the final report released in October 2011. As the next step in this process, Governor O'Malley has directed his Chesapeake Bay cabinet agencies to work together to review the recommendations and propose an action plan and timeline for expanding ecosystem markets in Maryland.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 0.82 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Creating Ecosystems Markets to Encourage GHG Emission Reductions program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Creating Ecosystems Markets to Encourage GHG Emission Reductions program, once fully operational, would support a total of about 4,709 jobs, $825 million in economic output, and $346 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

This program is still under development. If determined to be feasible, the program will be implemented through new legislation, as needed, and adoption of new regulations or amendment of existing regulations by the appropriate State agencies, including DNR, MDE and MDA.

Ag and Forestry – 3: Increasing Urban Trees to Capture Carbon

Lead Agency: DNR

Program Description

Efforts are currently in place to maintain and improve the health and longevity of trees in urban areas and increase the urban tree canopy cover throughout Maryland. Trees in urban areas help absorb GHG emissions from power production, vehicles and the operation and maintenance of the built environment. Urban trees shield buildings from cold winds and lower ambient summertime temperatures, reducing heating and cooling costs and the demand for energy production. Reduced heat slows the formation of ground level ozone as well as the evaporation of fuel from motor vehicles.

The Urban Tree Canopy Initiative targets Maryland counties, particularly counties with significant urban areas. The implementation goal is to establish, by 2020, urban canopy goals for 50% (74 communities) of the area developed primarily before 1984, with an overall goal of achieving a 10% cumulative increase in urban tree canopy throughout Maryland.

To date, 79 communities have received urban tree canopy assessments, 75 communities are awaiting completion of their urban tree canopy assessments, and eight communities have established goals. The Marylanders Plant Trees program's tree registry documents 68,771 trees that have been planted and registered as of February 8, 2012.

A working commitment exists with local communities to secure funding for conducting urban tree canopy assessments and adoption and implementation of urban tree canopy goals by local communities. DNR provides outreach and education on the role of trees in the built environment and control methods for invasive species. DNR also continues to develop incentives for diverting wood from waste-stream to value-stream and works to encourage policies requiring tree canopies around schools (Green Schools Program), nursing homes, shelters and public buildings located in proximity to at-risk populations. The U.S. Forest Service provided a grant to DNR, which has enabled the Chesapeake Bay Trust to award funding for Maryland communities to implement "greening" plans that increase forest canopy, reduce stormwater runoff, improve air quality, and enhance the quality of life in urban areas.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 1.32 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Increasing Urban Trees to Capture Carbon program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Increasing Urban Trees to Capture Carbon program, once fully operational, would support a total of about 2,953 jobs, $512 million in economic output, and $223 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

The following statutes and regulations authorize the State and/or local jurisdictions to review development projects (from subdivisions to road construction to individual houses) with regard to their impact on existing trees and forest, and require tree and forest mitigation:

Forest Conservation Act, NRA 5-1601--5-1613 Annotated Code of Maryland
Forest Conservation Regulations, COMAR 08.19.01 -- 08.19.06
Reforestation Law, NRA 5-103, Annotated Code of Maryland
Roadside Tree Law, NRA 5-401 – 5-406, Annotated Code of Maryland
Roadside Tree Care Regulations, COMAR 08.07.02.01 -- .10

The following statute and regulations gives DNR the authority to license tree care workers to ensure that tree care work is conducted consistent with industry standards.

Tree Expert Law, NRA 5-415—5-423, Annotated Code of Maryland
Licensed Tree Experts, COMAR 08.07.07.01 -- .08

The Maryland DNR Forest Service assists local jurisdictions through the implementation of the above statutes and regulations, and also via requests for assistance from local jurisdictions. Tree planting assistance for local governments and citizens also is provided through the TreeMendousMD and Marylanders Plant Trees programs.

Funding to implement the urban canopy implementation plan's tree plantings can be obtained from the local jurisdiction's Forest Conservation ordinance fee-in-lieu fund.

Ag and Forestry – 4: Creating and Protecting Wetlands and Waterway Borders to Capture Carbon

Lead Agency: DNR

Program Description

Wetlands and marshlands are known to be very efficient at sequestering carbon. DNR is pursuing the creation, protection and restoration of wetlands to promote carbon sequestration through several means, including undertaking on-the-ground wetland restoration projects through its Coastal Wetlands Initiative, the development of a terrestrial carbon sequestration protocol; a DNR Power Plant Research Project wetland study in Dorchester County, and the Sea Level Affecting Marshes Model.

Targets for on the ground wetland restoration are currently being established under Maryland's Phase II Watershed Implementation Plan (WIP) for the Chesapeake Bay TMDL. The Proposed Strategy (Draft, January 25, 2012) sets forth a target of 11,141 acres of wetland restoration by 2025. A total of 223 of these wetland restoration acres will be restored on public lands between 2012 and 2013 by DNR, with the additional acreage to be on private lands through the Conservation Reserve Enhancement Program administered by MDA. Between 2009 and 2011, 319 acres of wetlands were restored on public lands by DNR. Goals beyond 2013 for wetland restoration on public lands have not yet been established. It is DNR's intent to align its Chesapeake Bay TMDL wetland restoration goals with proposed 2020 carbon sequestration targets. They will be working with MDE and MDA to finalize targets in the coming months.

The protection and restoration of wetlands can offer significant opportunities for carbon sequestration. Recognizing this, DNR is working on three projects to advance, promote and assess potential wetland carbon sequestration opportunities in the State. The first is a DNR Power Plant Research Program project with the University of Maryland to study carbon sequestration processes in selected marsh segments in the Blackwater National Wildlife Refuge. The aim of this project is to develop a terrestrial carbon sequestration protocol that is generally applicable to estuarine wetlands and tidal marshes, and which will lead to projects that produce carbon offsets that can be used to compensate for greenhouse gas emissions.

The second is a study of wetlands in Dorchester County to estimate gross sequestration and net accumulation based on the current understanding of carbon dynamics in coastal wetlands. The final project is a DNR study, completed in 2011, which used the Sea Level Affecting Marshes Model to identify areas projected to convert into new wetlands under future sea level rise conditions. Using this modeling, the State is now working to target lands that may support coastal wetland establishment; these areas are otherwise known as wetland migration areas. Future carbon sequestration can be achieved through wetland establishment and restoration activities that enhance these targeting areas for wetland migration. Modeling results are accessible on DNR's Coastal Atlas (http://www.dnr.state.md.us/ccp/coastalatlas/index.asp).

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be .65 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Creating and Protecting Wetlands and Waterway Borders to Capture Carbon program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Creating and Protecting Wetlands and Waterway Borders to Capture Carbon program, once fully operational, would support a total of about 1,181 jobs, $155 million in economic output, and $48 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

This program is being implemented through a suite of programs and strategies including on-the-ground wetland restoration efforts through DNR's Coastal Wetlands Initiative, green infrastructure planning, offsets under RGGI or other offset trading mechanisms, tax incentives, fee-in-lieu payments, and acquisition of landward properties to allow migration of coastal wetlands at risk of inundation from sea level rise. For the purposes of the Final GGRA Plan, DNR's intent is to align its Chesapeake Bay TMDL wetland restoration goals with proposed 2020 carbon sequestration targets. They will be working with MDE and MDA to finalize targets in the coming months.

Ag and Forestry – 5: Geological Opportunities to Store Carbon

Lead Agency: DNR

Program Description

Natural geologic reservoirs have held oil, natural gas, water, and even carbon dioxide, for millions of years with no or minimal leakage. These same natural geologic systems are thought to offer both near-term opportunities and longer-term possibilities for future storage of man-made carbon dioxide emissions. This program is designed to identify the location and extent of these reservoirs in Maryland to determine their integrity through a series of test injections and finally to develop an appropriate regulatory environment for safe deployment.

The U.S. Department of Energy has a carbon sequestration partnership program to develop regionally appropriate approaches for carbon sequestration. The Midwest Regional Carbon Sequestration Partnership, of which Maryland is a member, is analyzing potential geological carbon sequestration. Ultimately, test injections of carbon dioxide in target geologic formations will be monitored. One option in Maryland may be the use of carbon dioxide in enhanced oil and gas recovery and particularly shale gas.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

Since geological carbon sequestration is a new program for Maryland, potential GHG reduction benefits from this program by 2020 have not yet been quantified.

Job Creation and Economic Benefits

The Geological Opportunities to Store Carbon program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Geological Opportunities to Store Carbon program, once fully operational, would support a total of about 715 jobs, $124 million in economic output, and $54 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

This program is voluntary.

Pursuit of geological sequestration projects is not presently underway in any eastern state, including Maryland. As technology improves, geologic carbon sequestration should be considered as a near term possibility requiring further analysis, research and engineering development. Due to the costs involved, geologic sequestration may require cooperative studies, partnerships, and funding at the federal level and with industry.

Phase I of the Midwest Regional Carbon Sequestration Partnership estimated geologic sequestration potentials for Maryland. Ultimately, test injections of carbon dioxide in target geologic formations will be monitored for migration of the injected gas, geochemical alterations in the subsurface and the containment integrity. Regulations relating to underground injection will need to be developed prior to these techniques coming into routine use. Developing a beneficial use program for the stored carbon dioxide will be important to manage associated costs.

Ag and Forestry – 6: Planting Forests in Maryland

Lead Agency: DNR

Program Description

Increasing forest and tree cover provides benefits for GHG reduction in addition to carbon sequestration. This program promotes forest cover and associated carbon stocks by regenerating or establishing healthy, functional forests through afforestation (on lands that have not, in recent history, been forested, including agricultural lands) and reforestation (on lands with little or no present forest cover) where current beneficial practices are not displaced. Successful establishment requires commitment for as long as twenty years. Forest patches should be of sufficient size to function as a community of trees and related species.

This program promotes practices, such as soil preparation, erosion control, and supplemental planting, to ensure optimum conditions to support forest growth. Included is identification of areas in need of physical intervention to return forest habitats to full vigor. Additional concerns include linking islands of fragmented forests to restore function, recovering severely disturbed lands, and reversing the effects of continued toxicity on those disturbed lands.

By 2020, the implementation goal is to achieve afforestation and/or reforestation of 43,030 acres for Years 2011-2020. DNR will work with federal and state partners, local governments, and non-profits to create, restore, and enhance forests.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be .62 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Planting Forests in Maryland program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Planting Forests in Maryland program, once fully operational, would support a total of about 14 jobs, $1 million in economic output, and $610,000 in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

As of June 2011, the Forest Brigade met its goal of planting one million trees. As reported on the Bay Stat website, 301 acres of forested buffers have been planted. LandServer was officially introduced to the public by DNR and key non-profit partners, including the Pinchot Institute for Conservation, Forestry for the Bay, and the Alliance for the Bay. To insure that the current productivity of this program is maintained, DNR continues to work with the Governor's office and the Maryland General Assembly to maintain appropriate staff and funding.

DNR is implementing this policy through a suite of efforts, policies and programs, including:

Public Lands

- State Forest System Annual Workplan Implementation
- Natural Filters

Private Lands:

- Technical Assistance
  - Forest Stewardship Plan Implementation
- Financial Assistance
  - State and Federal Cost Sharing
    - Woodland Incentive Program (WIP – State/MDFS)
    - Environmental Quality Incentive Program (EQIP – Federal/NRCS)
    - Conservation Reserve Enhancement (CREP – Federal/NRCS)

The Sustainable Forestry Act of 2009 established the Sustainable Forestry Council as an advisory body for DNR relative to the restoration, management and protections of the State's tree and forest resources. The Council's first charge is to make recommendations to DNR's Secretary on the following by December 31, 2011:

- Define what is meant by "No Net Loss"

- Suggest a base year and a method and/or metrics to track net forest cover
- Suggest strategies and incentives for obtaining No Net Loss of forests by building on the previous work of the No Net Loss Taskforce
- Seed Tree Law

The Council's recommendations will become part of Maryland's Watershed Implementation Plan upon review and adoption by DNR.

Ag and Forestry – 7: Biomass for Energy Production

Lead Agency: DNR

Program Description

Maryland is working to promote the use of locally produced woody biomass for generation of thermal energy and electricity. Energy from forest by-products can be used to offset fossil fuel-based energy production and associated GHG emissions. There are many end users that could potentially benefit from such a program, including Maryland's public schools which could enjoy wood heating and cooling; hospitals which could utilize wood as primary heating/cooling source; municipalities which could utilize local fuel markets as key component of their urban tree management programs; and all rural landowners which would have access to a wood fuel market.

Thousands of potential sites exist within Maryland, such as schools, hospitals, and college campuses, which would be prime candidates for wood-fired combined-heat-and-power systems. These systems provide the heating and cooling needs for the facilities they serve and utilize excess thermal capacity to generate electricity. Thousands of additional sites exist, such as residential communities, businesses, and institutions, throughout Maryland ideally suited for simple thermal-only systems, which are designed to provide only the heating and cooling needs of the facility.

DNR continues to work to eliminate the numerous barriers that exist to advancing wood energy in Maryland: awareness of wood as a viable, and preferred, energy source; State procurement systems that currently do not recognize wood energy systems as an option for consideration in HVAC design; lack of emission standards reflecting the state-of-art emission controls, etc. The favorable economic structure of wood energy systems would likely lead to the development of wood energy market in Maryland, if not for the many barriers currently existing hindering facilities from taking advantage of these systems.

Removing, or at least reducing, these barriers would enable residential and commercial stakeholders to pursue adopting wood energy systems. DNR is working within State government to insure that wood energy is comparable to wind and solar as a viable and desirable form of renewable energy.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 3.07 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Biomass for Energy Production program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Biomass for Energy Production program, once fully operational, would support a total of about four jobs, $1 million in economic output, and $280,000 in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

Various grants, loans, and cost-share programs offered by MEA, MDE, and other agencies will support implementation. Amendments to a number of existing laws and regulations would offer additional implementation assistance, including:

- Amending Renewable Fuels Standard to accommodate renewable thermal energy.
- Recognizing modern emission control technologies utilized by wood energy systems in air quality permitting regulation.
- Specifically including wood energy systems as option for HVAC design in State buildings.

Additionally, DNR is working with several outside groups to promote and advance implementation, including:

- US Forest Service—Woody Biomass Utilization Program http://www.fs.fed.us/woodybiomass/index.shtml
- Fuels for Schools—a venture between public schools, State Foresters, and Regional Foresters of the Forest Service to helps public schools retrofit their current fuel or gas heating system to small-scale biomass heating systems. http://www.fuelsforschools.info/
- Biomass Energy Resource Center—assists communities, colleges and universities, State and local governments, businesses, utilities, schools, and others in making the most of their local energy resources. http://www.biomasscenter.org/
- Alliance for Green Heat—promotes high-efficiency wood combustion as a low-carbon, sustainable, local and affordable heating solution. http://www.forgreenheat.org/

Ag and Forestry-8: Conservation of Ag Land for GHG Benefits

Lead Agency: MDA

Program Description

Land conservation offers an important mechanism for mitigating and adapting to climate change. Healthy and vigorous forests and grasslands provide both direct benefits to GHG reductions and also serve as the preferred land-use for avoiding emissions and capturing GHGs. Wetlands and marshlands provide one of the best ways to prevent property damage and maintain healthy environments in coastal areas as well as reduce nutrient, sediment, and other pollution into the Chesapeake Bay and other bodies of water. Deforestation and other land-use changes account for as much as 25% of global GHG emissions. In addition, the increasing rate of sea level rise and associated erosion threaten Maryland's shoreline and associated coastal wetlands, removing another natural sink for GHGs. For these reasons and more, MDA is working to safeguard Maryland's network of natural areas, agricultural lands and coastal lands through the MDA's established conservation programs and practices.

MDA will decrease the conversion and development of agricultural lands through the protection of productive farmland and will continue to pursue policies and programs that complement those of DNR and MDP by preserving existing forested, grassed, and wetland areas on agricultural land. MDA and its partners also will collaborate to implement policies, programs, and strategies to sequester additional carbon and avoid or reduce GHG emissions associated with growth and development.

Established in 1977 and one of the first programs of its kind in the country, the Maryland Agricultural Land Preservation Foundation retains prime farmland and woodland as a viable local base of food and fiber production in the State through the purchase of permanent preservation easements. The preservation of agricultural land limits the expansion of random urban development, maintains agricultural and forest lands as open space and wildlife habitat, and enhances the environmental quality of the Chesapeake Bay ecosystem. By the end of the 2010 fiscal year, the Foundation had permanently protected more than 280,000 acres on approximately 2,100 farms located across Maryland's 23 counties By 2020, the State expects to have protected 962,000 acres of productive farmland from development.

Maryland also has partnered with U.S. Department of Agriculture since 1977 in the national Conservation Reserve Enhancement Program to offer rental payments for long-term, leased easements, along with other cash incentives, to encourage agricultural producers to protect environmentally sensitive lands and improve wildlife habitat. When fully implemented, this federal program will have planted up to 16,000 acres of marginal land into grass, shrubs, and trees, established 77,000 acres of riparian buffers and 5,000 acres of water and wetland habitat, and restored 2,000 acres for declining, threatened, or endangered species.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 0.28 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Conservation of Ag Land for GHG Benefits program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Conservation of Ag Land for GHG Benefits program, once fully operational, would support a total of about 3,373 jobs, $444 million in economic output, and $138 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

Senate Bill 297 creating the Maryland Agricultural Land Preservation Foundation in its present form was enacted and signed into law in 1977. Since the Maryland Agricultural Land Preservation Foundation is closely tied to State statute, different aspects of the program are subject to review and revision every legislative session. As a national initiative, the Conservation Reserve Enhancement Program receives its authorization pursuant to the 1996 Federal Agriculture Improvement and Reform Act. Memoranda of Agreement incorporating the Conservation Reserve Enhancement Program proposals and renewals are signed by the U.S. Secretary of Agriculture and the governor of each participating state.

Although participation in both programs is voluntary, the financial incentives provided by the purchase of easements through the Maryland Agricultural Land Preservation Foundation guarantees that the land will permanently preserved for agricultural use and helps to keep Maryland's agricultural base intact. Similarly, Maryland landowners participating in the Conservation Reserve Enhancement Program can receive five types of payments that incentivize the installation and maintenance of eligible conservation practices.

Ag and Forestry – 9: Buy Local for GHG Benefits

Lead Agency: MDA

Program Description

MDA's "Buy Local" campaign remains successful in promoting local farms as preferred sources of food to Marylanders by helping agricultural producers market their products directly to supermarket, food service, institutional, and other wholesale buyers, as well as consumers. Increasing the sale and consumption of locally grown products increases the sequestration of carbon dioxide on Maryland's agricultural lands. The enhanced productivity resulting from increased agricultural production yields increased rates of carbon sequestration in agricultural biomass, increased amounts of carbon stored in harvested crops, and increased availability of renewable biomass for energy production.

In the past two years the growth of the public's interest in the source of their food coupled with MDA programs has sparked unprecedented consumer preference for locally-grown and -made agricultural products. Agriculture provides a traceable and healthy supply of local foods. Buying locally-grown products strengthens local economies and the health of the environment, keeps land open and productive and improves quality of life. Farmers' markets provide an important source of income for farmers as more consumers seek the freshness, quality, and wide selection of locally-grown produce. By talking one-on-one with farmers, consumers develop a bond of trust in the integrity and accountability of Maryland's growers.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be .05 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Buy Local for GHG Benefits program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Buy Local for GHG Benefits program, once fully operational, would support a total of about 2,827 jobs, $481 million in economic output, and $170 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

MDA received legislative authority under House Bill 421, "Advertising or Identifying Agricultural Products as Locally Grown" in the 2010 Session to regulate the use of the terms "locally grown" and "local" when advertising or identifying agricultural products. In cooperation with the University of Maryland and Maryland farmers' market managers, MDA was awarded a federal matching grant to assess the economic impact of farmers' markets, identify ways to expand customer base and increase sales, and explore the formation of a State-wide market association. U.S. Department of Agriculture funding was received to promote the use of locally-produced, sustainable protein foods in the healthcare facilities and institutions.

By 2020, MDA aims to raise the number of farmers' markets by 20%, establish a State farmers' market association, and increase direct sales (buy/grower) by 20%. The web site Maryland's Best has been created as an online tool to find local products from Maryland farmers.

Ag and Forestry – 10: Nutrient Trading for GHG Benefits

Lead Agency: MDA

Program Description

Since many of the agronomic, land use, and structural practices promoted by the Maryland Nutrient Trading Program administered by MDA also store carbon and lower other GHG emissions, the existing nutrient marketplace provides a platform for the addition of a voluntary carbon component. Just like the nutrient market, carbon trading offers entities under regulatory requirements a potentially more cost-effective means to meet their obligations while providing farmers and landowners the opportunity to receive compensation for implementing and maintaining conservation practices.

MDA will add carbon credits and enhanced nutrient credits to the Maryland Nutrient Trading Program. Carbon and enhanced nutrient credits would be "stacked" onto existing nutrient credits as tradable commodities, thereby increasing the potential value of the total credit package and taking an incremental step in creating a comprehensive environmental marketplace.

The Maryland Nutrient Trading Program developed by MDA maintains the embedded capacity to stack carbon and sediment on the existing platform.Through a federal grant awarded to the World Resources Institute in 2010, MDA joined with agencies from four other Bay states in the development, testing, and rollout of an interstate trading model, as well as a farm profit calculator to help landowners, producers, and service providers conduct cost benefit analyses of trading participation.

State soil conservation staff and other interested third parties continued to be trained in the use of the Nutrient Trading Program's online assessment tool, marketplace, and registry. MDA continues to hold public meetings across the State to provide an overview of both point and nonpoint source policies, the salient features of the Nutrient Trading Program, and future carbon stacking opportunities. By 2020, MDA aims to achieve participation by 10% of farms and landowners in providing nutrient and carbon credits to an active environmental market in Maryland and establish commonalities among Bay State trading programs and create a shared platform to facilitate interstate trades.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 0.21 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Nutrient Trading for GHG Benefits program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Nutrient Trading for GHG Benefits program, once fully operational, would support a total of about 484 jobs, $84 million in economic output, and $36 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

This program is still under development and will be voluntary.

A number of wetland bird species such as the American bittern, common loon, and sora are projected to decline as a result of climate driven changes including degradation of inland wetlands (due to summer drought and winter or spring flooding) and loss or degradation of coastal wetlands (due to rising sea levels). Overall, significant change is projected for many of the Northeast's most colorful species, such as certain wood warblers; most beautiful singers, including the hermit thrush and veery; and iconic species, such as the Baltimore oriole, goldfinch, and common loon. Although many of the negatively affected species may persist in more northerly Canadian habitats, this will be cold comfort to bird enthusiasts in the U.S. Northeast.

Source: http://www.climatechoices.org/assets/documents/climatechoices/confronting-climate-change-in-the-u-s-northeast.pdf p.52


Coca-Cola

The Recycling Sector

Recycling converts used or waste products into new materials. Plastics, paper, metal, glass, electronics, cloth, batteries and biodegradable waste are commonly recycled into new materials. In addition to reducing GHG emissions, recycling helps the environment in other ways. Recycling saves energy when materials are recycled instead of new materials being manufactured. Coal, gasoline, and diesel fuel are often used in manufacturing processes, and resulting GHG emissions are avoided through recycling. Additionally, recycling reduces the amount of material ending up in landfills today.

GHG emissions generated from waste in landfills are projected to increase in Chapter 3's Inventory and Forecast. GHG emissions associated from waste include solid waste management, solid waste combustion, and wastewater management. Recycling reduces waste emissions. Actions taken to increase waste recycling can reduce GHG emissions not only in the State, such as landfill methane gas emissions, but also outside the State, such as emissions associated with the energy used to make products from virgin materials versus recycled materials.

One of the GHG reduction programs is designed to reduce GHG emissions from the recycling sector. Full implementation of this recycling sector program results in GHG reductions of potentially 2.32 million metric tons of CO2-equivalent (Figure 6-12).

Figure 6-12
Recycling Sector GHG Reduction Programs

RECYCLING		
Program Number	Program	Potential GHG Reductions (million metric tons of CO_2-equivalent)
R-1	Recycling & Source Reduction	2.32
Total		**2.32**

Recycling – 1: Recycling & Source Reduction

Lead Agency: MDE

Program Description

Waste diversion saves energy, reduces GHGs and other pollutants generated in the manufacturing process and at landfills, saves natural resources, and reduces the amount of waste disposed at solid waste acceptance facilities (e.g., incinerators, landfills, etc.). This program will reduce the volume of waste from residential, commercial, and government sectors through programs that reduce the generation of wastes, expand recycling and upcycling (adding value to the re-manufactured product), and enhance reuse of product components and manufacturers' lifetime product responsibility. Increased recycling and reduced waste disposal would limit GHG emissions at landfills as well as in energy used to extract and process raw materials and produce value-added commodities.

This program reduces the amount of waste generated per person and waste disposed in Maryland. The main waste generation goal is to maintain a maximum 1.36 tons per person per year waste generation by increasing the source reduction credit rate achieved from 3.55% in 2006 to 3.98% in 2012 to 4.20% in 2015 and 4.56% in 2020. The main waste disposal goal is to reduce the amount of waste disposed by 3.75% by 2012, 7.22% by 2015, and 13.81% by 2020. Work continues in order to increase the recycling rate achieved from 41.16% in 2006 to 47.16% in 2012 to 50.16% in 2015 to 55.17% in 2020.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 2.32 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Recycling & Source Reduction program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Recycling & Source Reduction program, once fully operational, would support a total of about 568 jobs, $104 million in economic output, and $37 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

State Government is required to reduce by recycling the amount of the solid waste stream generated for disposal by at least 20%. House Bill 595 (2010) (Environment Article §9-1706 Annotated Code of Maryland) required implementation of a State Agency Recycling Plan, and a Solid Waste Management Study Group was formed, as a result of House Bill 982 (2010).

The Maryland Recycling Act mandates MDE to reduce the disposal of solid waste in Maryland through management, education and regulation. This law requires:

- Each jurisdiction to develop and implement recycling programs by January 1, 1994. Jurisdictions with populations greater than 150,000 are required to recycle 20% or more of their waste and jurisdictions with populations less than 150,000 are required to recycle 15% or more of their waste. In no case is the recycling rate to be less than 10%.
- Each jurisdiction to select the materials to be recycled and the manner in which they are separated and processed. If a jurisdiction fails to meet the specified reductions, State and local authorities can prohibit the issuance of building permits for all new construction.
- State government to reduce by recycling the amount of the solid waste stream generated for disposal by at least 20% or to an amount that is determined practical and economically feasible, but in no case may the amount to be recycled be less than 10%.
- Telephone directories distributed in the State to have a recycled content, by weight, of 40% for 2005 and all subsequent years.
- Newsprint distributed in the State to have a 3-year rolling average recycled content, by weight, of 40% in 2005 and all subsequent years.

Additional legislation impacting recycling in Maryland includes:

- Banning scrap tires from disposal in a landfill after January 1, 1994 (1991).
- Requiring permits for private natural wood waste recycling facilities (1992).
- Addressing, by counties, the feasibility of composting mixed solid waste when developing solid waste management plans (1992).
- Composting in the calculation of the recycling rate (1992).
- Banning separately collected yard waste from disposal at solid waste acceptance facilities (1994).
- Requiring mercuric oxide battery manufacturers to be responsible for the collection, transportation, and recycling or disposal of these batteries sold or offered for promotional purposes in the State (1994).

- Establishing a program or system for the collection, recycling, or disposal of each cell, rechargeable battery or rechargeable product sold in the State (1994).
- Establishing a voluntary, State-wide waste diversion goal of 40% by the year 2005, consisting of a 35% recycling rate plus up to 5% credit or source reduction activities (2000).
- Reducing the impact of mercury in the environment by requiring that MDE provide outreach assistance to schools, businesses, and the general public relating to the proper management and recycling of mercury containing products. The law also prohibits the sale of mercury thermometers beginning in 2002 (2001).
- Prohibiting the sale of mercury containing thermostats by October 2007. Requiring MDE to report to the governor and legislature detailing the State-wide collection, reclamation, and recycling of all products containing mercury (2006).
- Requiring manufacturers of an average of more than 1,000 computers and video display devices in the previous three years who sell or offer for sale their product in Maryland to register and pay a fee to MDE. Fees may be used to provide grants to counties and municipalities for computer and video display device recycling activities. Replaces the 2005 computer recycling pilot program (2007).
- Requiring motor vehicle manufacturers to develop and submit to MDE a mercury minimization plan that includes information on mercury switch removal from motor vehicles (2009).
- Requiring a county recycling plan to address the collection, processing, marketing, and disposition of recyclable materials from county public schools; requiring a county to submit a revised recycling plan to MDE by October 1, 2010 (2009).
- Requiring, by July 1, 2010, the State Agency Recycling Plan to address the placement of collection bins and the recycling of aluminum, glass, paper, and plastic. Each agency and unit of State government must implement this plan by January 1, 2012 (2009).
- Requiring a county recycling plan to address the collection and recycling of fluorescent and compact fluorescent lights that contain mercury; requiring a county to submit a revised recycling plan to MDE by October 1, 2011 (2010).
- Requiring MDE to conduct a study to evaluate solid waste management processes that reduce the solid waste stream through recycling and source reduction (2010).

MDE regularly participates in the National Partnership for Environmental Priorities program, Maryland Recycling Network, and various other groups to discuss a variety of recycling-related issues. Additionally, MDE partners with the Maryland Environmental Service to operate a program to increase the number of used oil collection facilities, provide public education material, and maintain an information center to encourage citizens to recycle used motor oil.

Perdue Farm's chickens go cluck cluck for solar panels

Jan. 21, 2011

Perdue, a major supplier of chicken in the eastern U.S., is adding solar power to two of its sites in Maryland. The company signed a power-purchase agreement with Washington Gas Energy Services, Inc., allowing them to install 3.7 megawatts of photovoltaics on Perdue property and to sell the farm the power produced under a 15-year power-purchase agreement.

The 91-year-old, family-owned company made the decision because it is expected to produce long-term savings. "When we ran the numbers, we saw that by having a long-term deal with a supplier of electricity, we could lower energy costs over life of the project," said Perdue spokesperson Luis Luna. "It means a way for us to control our energy costs going forward."

In a press release, Steve Schwalb, Perdue's vice president of environmental sustainability said, "Using solar power means, we'll have a clean-energy source that doesn't pollute or create greenhouse gases, while lowering Perdue's energy costs." The 11,000 panels at the installations will produce about a quarter of the energy used at Perdue's Salisbury, Md., headquarters and at its feed mill in Bridgeville, Del. "We're calculating on a very conservative basis," said Luna. "At peak production, it will produce about 90 percent [of the power needed]. Some days we'll be producing over 100 percent."

The electricity produced by the photovoltaic arrays is expected to reduce Perdue's carbon footprint by 3,000 tons per year, according to Schwalb. He said that's equivalent to eliminating the greenhouse gas emissions of 300,000 gallons of gasoline annually. This isn't the company's first foray into sustainability, said Luna.

"It's been a focus of the founder and their children to do business in a way that's right or sustainable," Luna said. "The company has always been frugal and has been about using resources wisely and trying to be good stewards. Stewardship is one of the tenants of the company." Standard Solar Inc. is installing the arrays, which should start this September.

http://www.cleanenergyauthority.com/solar-energy-news/perdue-chicken-installing-solar-panels-012111/

The Multi-Sector Sector

Some programs relating to reducing Maryland's GHG emissions cut across multiple or all sectors. Multi-sector recommendations typically encourage, enable, or otherwise support GHG mitigation activities and other GHG reduction actions. The programs considered for this sector are not always easily quantifiable in terms of GHG reductions and cost-effectiveness. Nonetheless, if successfully implemented, they will likely contribute to GHG reductions and enhance the economic benefits described for each of the other 65 programs that were quantified.

Three of the GHG reduction programs, which are described in detail throughout this section, are designed to ultimately reduce GHG emissions from areas that extend across multiple sectors. Full implementation of the three multi-sector programs results in GHG reductions of potentially 0.047 million metric tons of CO2-equivalent (Figure 6-13).

Figure 6-13
Multi-Sector GHG Reduction Programs

MULTI-SECTOR		
Program Number	Program	Potential GHG Reductions (million metric tons of CO_2-equivalent)
MS-1	GHG Emissions Inventory Development	Not Quantified
MS-2	Program Analysis, Goals and Overall Implementation	Not Quantified
MS-3	Outreach and Public Education	0.05
Total	**0.05**	

Multi-Sector – 1: Greenhouse Gas Emissions Inventory Development

Lead Agency: MDE

Program Description

As a starting point for developing a plan to reduce GHG emissions, Maryland must be aware of what its total GHG emissions are as of a starting date and from where the emissions come. The State must identify all sources that emit GHGs and determine the total annual amount of GHG emissions. The GGRA chose 2006 as a base year for Maryland's process, and as the year for the first inventory. MDE must review and publish an updated State-wide GHG emissions inventory for calendar year 2011, and again every third calendar year thereafter. Impacts of GHG reduction programs implemented after 2006 will show up in the 2011 calendar year inventory.

Estimated GHG Emission Reductions in 2020

Although no emissions reductions can be attributed directly to this program by 2020, development of a State-wide inventory and forecast will allow for a more thorough refinement and development of existing and future programs, potentially increasing their total reductions.

Job Creation and Economic Benefits

There will be direct, indirect and induced effects to the economy stemming from more thorough refinement and development of existing and future programs resulting from the Greenhouse Gas Emissions Inventory Development program. However, these effects can not be quantified at this time and the job creation and economic benefits from the implementation of individual programs are not counted towards this program. Chapter 7 and Appendix E provide more detail on the job creation and economic benefits of the associated programs.

Implementation

The GGRA required MDE to publish a consumption-based, "bottom-up" inventory specific to Maryland's source based emissions. MDE incorporated the technical work from the 2008 Climate Action Plan as a starting point in its development of a bottom-up inventory required under the GGRA.

On June 1, 2011, MDE published an inventory of State-wide GHG emissions for calendar year 2006 and, based on 2005 GHG control measures, a projected "business-as-usual" inventory for calendar year 2020. This 2020 projection will include all GHG emissions control measures implemented in Maryland prior to 2006.

Multi-Sector – 2: Program Analysis, Goals and Overall Implementation

Lead Agency: MDE

Program Description

Maryland GHG emissions have increased by about 18% since 1990, a faster rate of growth than the U.S. as a whole. Per capita GHG emissions by Maryland citizens also grew between 1990 and 2005, a period when per capita GHG emissions for the U.S. as a whole decreased. This program identified the need for State-wide goals and targets to address Maryland's growth in GHG emissions.

Through a science-based, consensus-building stakeholder process, the State-wide goals and targets were developed for consideration by the Maryland Commission on Climate Change, which were then recommended in its 2007 Interim Report and included as a core element of the 2008 Climate Action Plan. The Maryland Commission on Climate change suggested the following goals for Maryland: (1) 25% to 50% below 2006 levels by 2020, 25% being a minimum, regulatory driver and 50% an aspirational goal to reward deeper, market-based cuts; (2) 90% below 2006 levels by 2050, a non-regulatory goal to drive climate neutral technology innovations; (3) interim targets of 10% reductions by 2012 and 15% by 2015 to spur early actions; and (4) a science-based review of the goals every four years. In 2009, Maryland adopted the 2020 GHG emissions reduction goal as part of the GGRA.

In 2015, the GGRA requires MDE to submit a status report on the GGRA Plan and other information. As part of that report, MDE will be providing information on the 2020 reduction requirement and on options for establishing a 2050 reduction target consistent with the science. Any new reduction requirements would need to be built into revised legislation.

Estimated GHG Emission Reductions in 2020

Although no emissions reductions can be attributed directly to the development of this program by 2020, passage of a legislative goal to reduce State-wide GHG emissions will ensure that climate change programs will be developed and implemented.

Job Creation and Economic Benefits

There will be direct, indirect and induced effects to the economy stemming from more thorough refinement and development of existing and future programs resulting from the Program Analysis, Goals and Overall Implementation program. However, these effects can not be quantified at this time and the job creation and economic benefits from the implementation of individual programs are not counted towards this program. Chapter 7 and Appendix E provide more detail on the job creation and economic benefits of the associated programs.

Implementation

In 2009, GGRA was signed into law, officially establishing a GHG emissions reduction State-wide goal of 25% by 2020, from a 2006 baseline.

Multi-Sector – 3: Outreach and Public Education

Lead Agency: A multi-agency effort coordinated by MDE

Program Description

State-sponsored public education and outreach combined with community actions form the foundation for behavioral and life style changes necessary to reduce GHG emissions. This program is designed to promote new actions and encourage continuation of existing efforts such as the educational efforts and action campaigns of State agencies, such as MDE, DNR, Maryland State Department of Education, and University of Maryland; electric utilities; non-profit organizations; faith communities; and others. This combination of efforts insures that scientifically based factual information is made available through public education and outreach efforts and reaches all segments of the public. Many of these activities are already underway, including:

- Maryland-Delaware Climate Change Education, Assessment and Research
- College Climate Action Group
- Maryland Department of Education Environmental Literacy Curriculum
- The Governor's Regional Environmental Education Network

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be .05 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

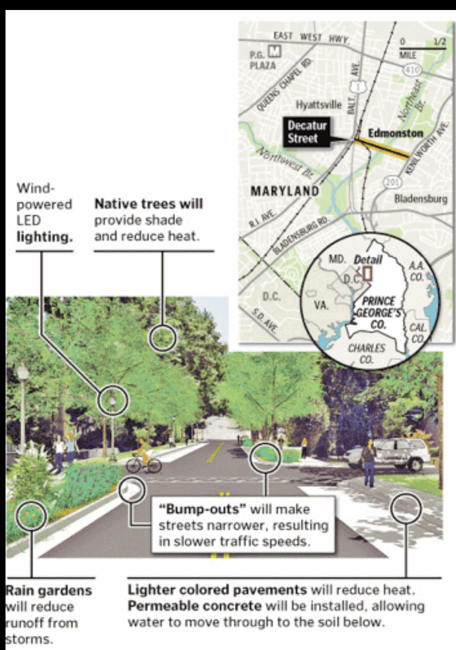
The Outreach and Public Education program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Outreach and Public Education program, once fully operational, would support a total of about one job, $190,000 in economic output, and $60,000 in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

This is a voluntary program.

Outreach and public education are supporting efforts to other programs. It does not exist as a separate, quantifiable entity. In the 2008 Climate Action Plan, these activities were presented as part of the cross-cutting group of programs which were not quantified for GHG reductions.

All programs to reduce GHG emissions should include an educational component to ensure that people understand what is trying to be accomplished. Extending the traditional methods to include social media and other evolving communication techniques must be considered for successful education and outreach.



Edmonston Green Street Project

Edmonston, Maryland, a town on the outskirts of D.C. on the Anacostia River, has numerous flooding issues from stormwater runoff caused by impervious surfaces. The town created the Edmonston Green Street Project, a project designated to make Decatur Street a green street that consists of planting new trees with large canopies to reduce heat, bike paths to add more pedestrians, and permeable pavement that will infiltrate rainwater. The town added bio-retention gardens and filtration systems so that water can flow through the ground, be filtered, and not cause street flooding. The system captures roughly 1.33" of rainfall for each storm; this means that 90% of all rainshowers in one year that will be filtered. The town also uses energy efficient light bulbs for street lighting, powered by wind energy, that shine below the tree canopy rather than above. The project took about two years to complete. The town's website allows access for everyone to view its engineering plans for this sustainable project.

http://edmonstonmd.gov/GoingGreen.html

The Buildings Sector

Since buildings require large amounts of energy to heat, cool, maintain, and operate, it is not a surprise that buildings account for almost a third of the total energy use and carbon dioxide emissions in the U.S. Given the long lifetime of most buildings, it is necessary that both existing and new buildings achieve the greatest energy efficiency possible. This includes all aspects of buildings, including site location and design, the design of the building itself, how the building is constructed, and the type of materials used, among others.

Increasing energy efficiency in Maryland State government's buildings has the potential to reduce Maryland's GHG emissions through decreasing the need for power generation from fossil fuel-fired sources. In addition to reducing GHG emissions, this will create reductions in nitrogen oxides, sulfur dioxide and mercury, all of which are harmful to the environment.

Two of the GHG reduction programs, which are described in detail throughout this section, are designed to reduce emissions from the building sector. Full implementation of the two building sector programs results in GHG reductions of potentially 5.4 million metric tons of CO2-equivalent (Figure 6-14).

The range of GHG benefits are likely to fluctuate in the face of the following: continued refinement for quantifying GHG benefits, future program decisions on the level of funding, and future advances in technology.

Figure 6-14
Building Sector GHG Reduction Programs

BUILDINGS		
Program Number	Program	Potential GHG Reductions (million metric tons of CO_2-equivalent)
B-1	Green Buildings	Included in Innovative Initiatives-5
B-2	Building and Trade Codes in Maryland	5.40
Total		**5.40**

Buildings – 1: Green Building Initiatives

Lead Agency: DGS

Program Description

Created in 2007, the Maryland Green Building Council evaluates current high performance building technologies and provides recommendations for Maryland government buildings. Buildings are significant consumers of energy and other resources. In addition to reducing regional GHG emissions, green buildings reduce waste output and water usage. DGS ensures State government buildings receiving upgrades/retrofits to lighting systems, water source heat pump replacements, building envelope infiltration reductions, window replacements, steam traps, occupancy controls, and automated energy management systems meet the 2009 High Performance Building standards. DGS also participates, on behalf of Maryland, in the International Code Council process to improve and develop building codes at the national level.

By the end of 2011, environmental footprints for all State government agencies will be published, which establish a pilot program and usable database for tracking building code adoption, implementation, compliance, etc, and train approximately 1,100 people each year on the latest Maryland Building Performance Standards.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

Quantification of potential GHG reductions from this program by 2020 are aggregated under Innovative Initiatives-5: State of Maryland Initiative to Lead by Example.

Job Creation and Economic Benefits

The Green Building Initiatives program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Green Buildings Initiatives program, once fully operational, would support a total of about 15 jobs, $2 million in economic output, and $1 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

This program is required under the High Performance Buildings Act, Maryland State Finance and Procurement Article §3-602, Annotated Code of Maryland. The Green Building Council continues to pursue projects qualified to be designed as High Performance Green Buildings. This includes State capital projects, such as renovations to the Low House of Delegates Building in Annapolis and educational facilities such as the new School of Business Complex proposed by Morgan State University. A complete list of all projects involved with the High Performance Green Building program can be found in the Green Building Council's 2010 annual report.

Buildings – 2: Building Codes

Lead Agency: DHCD

Program Description

Given the long lifetime of most buildings, amending State and local building codes to include minimum energy efficiency requirements and update energy efficiency codes provides long-term GHG savings. The State-wide building code known as the Maryland Building Performance Standards must be adopted and implemented by DHCD.

As required by Statute, Maryland's core building code is based on the International Business Code and the International Residential Code. The Maryland Building Performance Standards is updated by regulation every three years following the three-year cycle of the International Code Council for publishing new editions of the International Residential Code and the International Business Code. Except for energy conservation standards, DHCD may not adopt provisions that are more stringent than what is contained in either international code.

The Maryland Building Performance Standards Statute requires local jurisdictions with building code authority to adopt the standards. Successful adoption and implementation of building codes depends on strong partnerships between the State and local jurisdictions with code authorities.

More information on this program can be found in the appendix of this report.

The Thompson Creek Window Company is a privately owned and family operated manufacturer and installer of energy efficient home improvement replacement products. Founding in 1980, their roots were planted as a manufacturer of energy efficient, maintenance free vinyl replacement windows. Since that time, they have evolved into one of the leading specialty home improvement contracting companies in the nation. Thompson Creek employs a staff of 339 at two locations: their manufacturing plant and distribution center in Landover, Maryland, and their corporate headquarters and administrative offices in Lanham, Maryland. Their market territory includes Maryland, Delaware, Virginia and Washington DC.

For 31 years, Thompson Creek has manufactured and installed vinyl replacement windows that are designed specifically for the mid-Atlantic area. Rather than purchasing a "one types fits all" window made for homes all across the nation, Thompson Creek customers have windows designed for our weather extremes. The window design decreases the amount of heat lost in the winter, and insulates homes in the summer to keep the cool air in and the sun's heat out.

Local manufacturing provides another benefit to the environment: windows that are built and installed locally cut down significantly on the amount of time they spend on trucks. Being close to the customer eliminates long-distance shipping, reducing the amount of pollution and cutting down on our carbon footprint.

Thompson Creek's manufacturing process utilizes computer-aided raw material optimization programs, designed to maximize raw material yield and minimize scrap. Our yield rate averages 90% and the 10% scrap we generate is recycled. We recycle glass, vinyl and aluminum. Thompson Creek recycles over 144 tons of glass each year. In 2010, Thompson Creek recycled 101,925 pounds of vinyl from our manufacturing facility. 97% of this vinyl was able to be reused for other products such as vinyl fences and vinyl gutters.

Thompson Creek windows are among the "best of the best" that have earned the ENERGY STAR certification – energy-efficient products that offer savings on energy bills without sacrificing performance, features, and comfort. This energy efficiency helps cut down on the two pounds of CO_2 produced with every kilowatt of energy used. Thompson Creek windows not only meet the current EPA guidelines for ENERGY STAR designation, they actually exceed the new guidelines set for implementation in 2013.

Thompson Creek's vinyl replacement windows have earned the "Green Approved Product" designation by the NAHB Research Center. This means that Thompson Creek windows have met independent, third-party criteria that their products meet the qualifications for recognition in buildings certified to the National green Building Standard.

In addition to their energy efficient windows, Thompson Creek's product mix also includes doors, vinyl siding and a clog-free gutter system.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 5.40 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Building Codes program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Building Codes program, once fully operational, would support a total of about 23 jobs, $3 million in economic output, and $950,000 in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

The Maryland Building Performance Standards (Code of Maryland Regulations 05.02.07) adopted most recently (January 1, 2010) includes the 2009 International Energy Conservation Code, which is the latest energy code published by the International Code Council. Local jurisdictions were required to adopt the 2010 standard by July 1, 2010. The most recently adopted standard has been estimated to achieve 15% energy efficiency improvements over the prior 2006 energy code. The next energy code will be released in 2012 and is expected to achieve an additional 15% in energy efficiency improvements over the 2009 codes.

In 2011, approximately 60 local jurisdictions are required to adopt the current Maryland Building Performance Standards and DHCD will track local jurisdictions on the Maryland Codes Administration website. In 2020, Maryland will have adopted the latest, nationally-accepted, building and trade codes into the Maryland Building Performance Standards, which will be from the 2018 International Code Council.


OWENS CORNING
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FILM FACED FOR DAMAGE CONTROL

"As a global hub of innovation – a leader in science, security, health, discovery and information technology – Maryland is well-positioned to transform the challenges we face into jobs and opportunity."

Governor Martin O'Malley,
February 2011

"No family can make real progress without a job. In our State, where there is no such thing as a spare Marylander, the most important job we create is the next one. No state is better positioned than we are to transform global challenges into the jobs and opportunities of the new economy."

Governor Martin O'Malley,
February 2011

The Land Use Sector

Many land use activities in Maryland release GHGs. Clearing forests to create cropland, building roads or buildings, and the designs for cities and towns all impact Maryland's GHG emissions profile. One way to reduce GHG emissions is to consider how land use affects Marylanders' ability to travel to various destinations within the State. Developing incentives and requirements for regional land use patterns that achieve land use and location efficiency reduce motor vehicle dependence. In addition, reducing vehicle miles traveled reduces GHG emissions. To maximize GHG reductions, land development projects and regional land use patterns attempt to reduce motor vehicle travel through a variety of methods such as closing the distance between homes and jobs, decreasing distances between origins and destinations, increasing the accessibility of alternative transportation options, and centrally locating public facilities, among others.

Four of the GHG reduction programs, which are described in detail throughout this section, are designed to reduce emissions from the land use sector. Full implementation of the four land use sector programs results in GHG reductions of potentially 1.01 million metric tons of CO2-equivalent (Figure 6-15).

The range of GHG benefits are likely to fluctuate in the face of the following: continued refinement for quantifying GHG benefits future advances in technology, and funding.

Figure 6-15
Land Use Sector GHG Reduction Programs

LAND USE		
Program Number	Program	Potential GHG Reductions (million metric tons of CO_2-equivalent)
LU-1	Reducing GHG Emissions from the Transportation Sector through Land Use and Location Efficiency	1.01
LU-2	Transportation GHG Targets for Local Governments and Metropolitan Planning Organizations	Included in Land Use-1
LU-3	Funding Mechanisms for Smart Growth	Included in Land Use-1
LU-4	GHG Benefits from Priority Funding Areas and Other Growth Boundaries/Targeting	Included in Land Use-1
Total		**1.01**

Land Use – 1: Reducing Transportation Emissions through Smart Growth and Land Use/Location Efficiency

Lead Agency: MDP

Program Description

This program reduces Marylanders' dependence on motor vehicle travel, especially single-occupant vehicles, by developing incentives and requirements for development projects and regional land use patterns that achieve land use/location efficiency with regard to transportation. The purpose is to reduce VMTs and the combustion of fossil fuels. Land use/location efficiency means that residences, jobs, shopping, schools, and recreational opportunities are very close to each other and that alternative transportation modes (walking, biking and mass transit) are convenient and easily accessed. The Smart Growth development pattern, together with land use/location efficiency, results in shorter trip lengths, less need for automobile and truck travel, and greater use of alternative transportation modes.

Between 2009 and 2030, VMT is expected to increase by 42% while population is expected to grow by 19%. This development trend is primarily the result of dispersed land use patterns in Maryland, which have sprawled over the past five decades. The only method to ensure a reduction in overall transportation emissions over time is to sharply reduce the rate of growth in VMT, which will require a significant adjustment of land use patterns away from automobile-oriented development. County and municipal governments in Maryland use their land use planning and zoning authority to meet community needs.

In addition to implementation of current smart growth programs and policies (e.g., 2009 Smart, Green and Growing legislation), MDP and sister agencies will implement PlanMaryland and recommendations from the Maryland Sustainable Growth Commission. MDP and sister agencies will investigate the feasibility in Maryland of implementing California's Senate Bill 375 bill and will develop sustainability criteria (e.g., a decrease or no net increase in VMTs) that local transportation plans and projects must achieve in order to receive State transportation funds. MDP and sister agencies will investigate the feasibility of implementing Rule 9510 of the San Joaquin Valley Air Pollution Control District in Maryland and perform a VMT Fee Pilot Project Study in Maryland. The study will examine the use of variable VMT pricing as a GHG reduction strategy and as an alternative funding mechanism for State transportation needs. Until an updated transportation model is in place that can adequately take into account the GHG reduction benefits of land use/location efficiency factors, MDP recommends additional metrics to determine progress. Examples include the number of people and businesses within a certain distance from transit stations and bus stops, and the share of land use within Maryland that is supportive of alternative transportation modes.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 1.01 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions

Job Creation and Economic Benefits

The Reducing Transportation Issues through Smart Growth program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Reducing Transportation Issues through Smart Growth program, once fully operational, would support a total of about 33 jobs, $50 million in economic output, and $20 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

Additional statutory or regulatory authority, along with new State policies, will be needed to implement some of the above recommendations. New programs will include a mix of incentives and requirements.

Land Use – 2: GHG Targets for Local Government's Transportation and Land Use Planning

Lead Agency: MDP

Program Description

Many local governments are implementing land use policies that support compact, transit-oriented development in suburban areas while protecting rural agricultural areas. By their very nature, these approaches mitigate against climate change by reducing VMT, preserving natural areas that serve to sequester carbon, and creating more compact, energy-efficient buildings. Establishing transportation GHG targets for local governments and metropolitan planning organizations will facilitate the development and implementation of local land use policies and plans that ensure achievement and long-term maintenance of Maryland's climate change mitigation goals.

MDP will be working with MDE and MDOT to develop tools and procedures that will allow existing planning processes to analyze how decisions may increase or decrease GHG emissions in the future.

One example is the existing Transportation Conformity process under the federal Clean Air Act. This requirement insures that State and local transportation planning does not increase criteria pollutant emissions in a way that jeopardizes the states' Clean Air Act mandated air quality plans. By 2012, GHG emissions will also be analyzed to insure consistency with the GGRA. MDP, MDE and MDOT will work with local planning agencies to consider the establishment of voluntary GHG targets for future out years. The Metropolitan Washington Council of Governments has established an overall GHG reduction goal for its membership and has begun a process to establish a transportation sub-goal.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The estimated GHG emission reductions for this program by 2020 are aggregated under Land Use-1 and assume that 75% of Maryland's new development between 2011 and 2020 will be compact development.

Job Creation and Economic Benefits

The GHG Targets for Local Government's Transportation and Land Use Planning program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the GHG Targets for Local Government's Transportation and Land Use Planning program, once fully operational, would support a total of about 106 jobs, $20 million in economic output, and $5 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

This is a voluntary effort.

The Smart and Sustainable Growth Act of 2009 (House Bill 297/Senate Bill 280) requires implementation of the following: incorporation of the 12 new planning visions in local comprehensive plans, development of local land use goals, and submittal of local annual reports. MDP works with other State agencies to support existing local programs and policies that reduce GHGs as well as community planning efforts that link GHG reductions, land use changes, smart transportation investments, and efficient energy management/distribution systems.

Land Use – 3: Land Use Planning GHG Benefits

Lead Agency: MDP

Program Description

By properly managing growth, communities can reduce the negative effects of sprawl and reduce GHG emissions. Smart growth is characterized by compact, transit-oriented, bicycle-friendly land use, with neighborhood schools, walkable streets, mixed-use development and a wide range of housing choices. Smart growth concentrates new development and redevelopment in areas with existing or planned infrastructure to avoid sprawl which is generally defined as the increased development of land in suburban and rural areas outside of their respective urban centers. This increased development in the outskirts of towns, villages and metropolitan areas is often accompanied by a lack of development, redevelopment or reuse of land within the urban centers themselves and results in an increase in GHG emissions.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The estimated GHG emission reductions for this program by 2020 are aggregated under Land Use-1 and assume that 75% of Maryland's new development between 2011 and 2020 will be compact development.

Job Creation and Economic Benefits

The Land Use Planning GHG Benefits program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Land Use Planning GHG Benefits program, once fully operational, would support a total of about 806 jobs, $156 million in economic output, and $44 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

The Smart Growth Subcabinet, MDP and sister agencies work to implement the Sustainable Communities Act of 2010 and any new funding mechanisms developed as a result of PlanMaryland or recommended by the Sustainable Growth Commission. The Sustainable Communities Act of 2010 strengthens reinvestment and revitalization in Maryland's older communities and promotes equitable, affordable housing by expanding energy-efficient housing choices for people of all ages, incomes, races, and ethnicities. New State policies might be needed to implement any new funding mechanisms developed as a result of PlanMaryland or recommended by the Sustainable Growth Commission.

Land Use-4: Growth boundary GHG benefits (Priority Funding Area GHG benefits)

Lead Agency: MDP

Program Description

Maryland established Priority Funding Areas to preserve existing communities, to target State resources to build on past investments, and to reduce development pressure on critical farmland and natural resource areas. By encouraging projects in already developed areas, Priority Funding Areas reduce the GHG emissions associated with sprawl. Priority Funding Areas are geographic growth areas defined under Maryland law and designated by local jurisdictions to provide a map for targeting State investment in infrastructure. The law directs the use of State funding for roads, water and sewer plants, economic development and other growth-related needs toward Priority Funding Areas, recognizing that these investments are the most important tool the State has to influence growth and development.

The implementation of PlanMaryland is a priority. The plan will include evaluation of existing plans, programs and procedures and recommendations for additional programs and policies, many in support of Priority Funding Areas. Additionally, the development and implementation of the accounting for growth strategy of Maryland's Phase I Watershed Implementation Plan, which will create strong disincentives for sprawl development, also continues.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The estimated GHG emission reductions for this program by 2020 are aggregated under Land Use-1 and assume that 75% of Maryland's new development between 2011 and 2020 will be compact development.

Job Creation and Economic Benefits

The Growth boundary GHG benefits program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Growth boundary GHG benefits program, once fully operational, would support a total of about 46 jobs, \$6 million in economic output, and \$1 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

Based on the evaluation of existing programs and procedures, additional statutory or regulatory authority, along with new State policies, might be needed to implement the recommendations of PlanMaryland that relate to Priority Funding Areas.

Maryland's Innovative Initiatives

In addition to the different sectors that contribute directly to Maryland's GHG emissions, it is possible to lay the foundation for previously unavailable GHG reduction opportunities in the future. These opportunities may originate through the expansion of existing programs or through the creation of new ones. Regardless of their source, innovative thinking today is required to lay the path to achieving future reductions. This can be accomplished through State and federal leadership, public education and training, and the continued examination of existing programs.

Nine of the GHG reduction programs, which are described in detail throughout this section, are designed to reduce emissions through innovative initiatives in Maryland. Full implementation of the nine initiative programs results in GHG reductions of potentially 5.34 million metric tons of CO2-equivalent (Figure 6-16).

The range of GHG benefits are likely to fluctuate in the face of the following: continued refinement for quantifying GHG benefits, future program decisions on the level of funding, and future advances in technology.

Figure 6-16
Maryland's Innovative Initiatives GHG Reduction Programs

MARYLAND'S INNOVATIVE INITIATIVES		
Program Number	Program	Potential GHG Reductions (million metric tons of CO_2-equivalent)
II-1	Leadership-By-Example: Local Government-	0.57
II-2	Leadership-By-Example: Federal Government	0.87
II-3	Leadership-By-Example: Maryland Colleges and Universities	0.57
II-4	GHG Early Voluntary Reductions	1.03
II-5	State of Maryland Initiative to Lead by Example	2.30
II-6	State of Maryland Carbon and Footprint Initiatives	Included in Innovative Initiatives-5
II-7	Job Creation and Economic Development Initiatives	Not Yet Quantified
II-8	Public Health Initiatives Related to Climate Change	Not Yet Quantified
II-9	Title V Permits for GHG Sources	Not Quantified
Total		**5.34**

Innovative Initiatives – 1: Leadership-By-Example – Local Government

Lead Agency: MDE

Program Description

Maryland county and municipal governments, together with State agencies, are adopting policies and practices to obtain high performance and energy-efficient buildings, facilities and vehicle fleets, and reduce the carbon footprint in purchasing, procurement and other government operations. Some jurisdictions have conducted GHG inventories, adopted climate action plans and targets, and implemented tracking protocol, such as those provided by the International Council for Local Environmental Initiatives. Where local government protocols for tracking quantifiable reductions exist, MDE conducted a survey to track actual and projected success in GHG emissions reductions. Results from a State-wide survey conducted by MDE provide a 2010 snapshot of local government GHG reduction programs.

In 2010, MDE launched a comprehensive survey to gain a State-wide view of local government's actions that will contribute to Maryland's sustainability and GHG reduction goals. Data collection will be finalized and survey results will be shared toward the end of 2011. Survey results to date show many local governments have GHG emissions reduction efforts underway. Some are identifying significant GHG reductions; others are in planning stages of conducting GHG inventories, adopting reduction targets, developing and implementing climate action plans, and tracking progress.

MDE and DNR continue to collaborate to provide forums for local governments and universities in the State to network and share best practices for implementing climate programs. MDE's survey results will inform this process and will also build on DNR's online Sustainability Network, where citizens, businesses and organizations can share sustainability and GHG projects and connect with others across the State interested in starting sustainability plans, energy reduction programs, rain gardens, and other green projects.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 0.57 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Leadership-By-Example – Local Government program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Leadership-By-Example – Local Government program, once fully operational, would support a total of about 931 jobs, $180 million in economic output, and $51 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

This program combines both voluntary and mandatory initiatives. There are a wide range of implementation tools being used at the local level including ordinances, resolutions, and voluntary sustainability plans.

Innovative Initiatives – 2: Leadership-By-Example – Federal Government

Lead Agency: MDE

Program Description

Federal agencies with facilities located in Maryland are implementing suites of lead-by-example programs to improve efficiency, reduce waste, and integrate renewable energy and sustainable practices into their operations, facilities and fleets. These programs include tools to benchmark and track energy use and GHG emissions in order to report progress. Examples of programs include energy reduction in public buildings, facilities and lands, improved efficiencies in fleet vehicles and fuels, water conservation, waste reduction and recycling, purchasing of products and services with lower life-cycle impacts, and greater use of renewable energy.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 0.87 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

REDUCING MARYLAND STATE GOVERNMENT'S ENVIRONMENTAL FOOTPRINT

State Government Environment Footprint Reduction Goals

Power Consumption – Building Energy

1. Track completion of all state building Phase I Energy Plans.
2. Monitor energy goals for all state agencies/buildings.
3. Require auto shutdown programs for electronic equipment and lights.
4. Utilize the EPEAT procurement standards and purchase ENERGY STAR® rated equipment.
5. Install timers or motion detectors to automatically turn off lights.
6. Adjust water heater settings to between 105 and 115 degrees F.
7. Clean air filters and heating coils.
8. Track staff/student training programs for energy conservation.
9. Replace incandescent light fixtures with LED light fixtures.
10. Assess progress through StateStat.

Vehicle Fuel

1. Track fleet maintenance practices intended to improve fuel efficiency.
2. Implement employee driver training programs designed to improve fuel efficiency.
3. Monitor mobile fuel use by agency and make data available for footprint reduction planning.
4. Include hybrid and electric vehicles in the definition of "alternative" fueled vehicles.

Waste Generation

1. Establish recycling programs.
2. Implement staff/student training and education programs on waste reduction.
3. Track recycling of aluminum, plastic, paper and glass.
4. Develop source reduction credit program/accounting for state agencies.
5. Include recycling and reporting in contracts for waste hauling.

Water Consumption

1. Evaluate compliance with state water conservation goals.
2. Audit annual water use of each state building.
3. Implement staff/student training and education programs on water conservation.
4. Inspect for plumbing leaks.
5. Install faucet aerators in all state buildings.
6. Convert to low flow faucets and low flow or dual/flush toilets.
7. Replace showerheads with low flow models.
8. Perform vehicle and window washing as needed.
9. Limit irrigation activities to the coolest parts of the day and re-use collected rainwater.

Information in this graphic comes from Maryland's Environmental Footprint Annual Report for 2009. Fore more information, visit http://www.green.maryland.gov/pdfs/CY09_Annual_Report.pdf

Job Creation and Economic Benefits

The Leadership-By-Example – Federal Government program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Leadership-By-Example – Federal Government program, once fully operational, would support a total of about 1,278 jobs, $149 million in economic output, and $47 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

In 2009 President Obama signed an executive order, "Federal Leadership in Environmental, Energy, and Economic Performance", which calls on the federal government to reduce its GHG emissions from direct sources to 28% below 2008 levels by 2020 and implement aggressive energy and water efficiency programs (Executive Order 13514, issued October 8, 2009). Federal agencies are specifically directed to set agency-wide reduction targets for Scopes 1, 2 and 3 GHG emissions and to develop and implement Strategic Sustainability Performance Plans designed to meet the targets. In July 2010 the President expanded the federal government-wide target to require a 13% reduction by 2020 for GHG emissions from indirect sources, such as employee travel and commuting.

Data available for FY09 shows that the federal government nationally decreased energy consumption per square foot of building space by approximately 13.1% compared with FY03, surpassing the FY09 goal of 12%. The federal government also purchased or produced 2,331 gigawatt-hours of electricity from renewable sources – approximately 4.2% of its electricity use – surpassing the goal of 3% for FY09. EPA continues to provide assistance in determining the amount of federal reductions which have occurred in Maryland.

Innovative Initiatives – 3: Leadership-By-Example – Maryland University Lead by Example Initiatives

Lead Agency: MDE

Program Description

In Maryland, the presidents' of 22 colleges and universities have signed the American College and University Presidents Climate Commitment, which requires each school to complete a GHG inventory, develop a climate action plan and implement strategies to reduce GHG emissions to achieve a set target. Schools are encouraged to commit to become climate neutral by a certain date, meaning GHG emissions sourced from the school be reduced or mitigated from a base year, with remaining emissions offset by purchasing carbon credits or other means.

All of the Maryland institutions have committed to other tangible actions in addition to the general requirements of the American College and University Presidents Climate Commitment, including:

- Establish a policy that all new campus construction will be built to at least the U.S. Green Building Council's LEED Silver standard or equivalent.
- Adopt a policy requiring purchase of Energy Star certified products in all areas for which such ratings exist.
- Establish a policy offsetting all GHG emissions generated by air travel paid for by the institution.
- Encourage use of and provide access to public transportation for all faculty, staff, students and visitors to the institution.
- Within one year of signing this document, begin purchasing or producing at least 15% of the institution's electricity consumption from renewable sources.
- Establish a policy or a committee that supports climate and sustainability shareholder proposals at companies where endowment is invested.
- Participate in the Waste Minimizations component of the national RecycleMania competitions, and adopt three or more associated measures to reduce waste.

Of the 22 Maryland institutions, 20 have completed a GHG inventory and nine have completed a climate action plan thus far. The targets vary by institution, with some target dates as soon as 2012. For more aggressive reductions, the target dates are extended to 2030 and beyond.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 0.57 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The Leadership-By-Example – Maryland University Lead by Example Initiatives program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Leadership-By-Example – Maryland University Lead by Example Initiatives program, once fully operational, would support a total of about 64 jobs, $9 million in economic output, and $3 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

This is a voluntary initiative.

Innovative Initiatives – 4: Voluntary Stationary Source Reductions

Lead Agency: MDE

Program Description

GGRA provides two paths for sources in the State's manufacturing sector to follow to potentially get credit for any voluntary programs that they are implementing. Either companies may simply take totally voluntary action and provide a good faith estimate of potential reductions, which if appropriate, included in the plan as a reduction, or a company can implement an early voluntary GHG emissions reduction plan, which must be approved by MDE before January 1, 2012 and secure a formal "credit."

Since a future GHG program could be one required by either State or federal law, it is important for a Maryland voluntary early reductions program to comply with federal, regional and State programs currently in existence. This creates an incentive for companies to implement GHG reduction measures before the advent of a mandatory program. Offering a program resulting in credits for early voluntary reductions is consistent with proposed federal GHG legislation. Although implementation of an early reduction program in Maryland is still under development, participation in such a program would be voluntary.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 1.03 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

There is still a considerable amount of work being developed to better quantify the potential reductions from this measure.

Job Creation and Economic Benefits

The Voluntary Stationary Source Reductions program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Voluntary Stationary Source Reductions program, once fully operational, would support a total of about three jobs, $590,000 in economic output, and $250,000 in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

This is a voluntary program.

MDE is working with sources in the manufacturing sector to make sure that early, voluntary programs to conserve energy or in other ways reduce GHG emissions have the potential to become a credit if and when some form of a national GHG reduction program is finalized.

A survey is being completed that will provide more detail on the voluntary reduction efforts. This information will be available in later versions of the 2012 GGRA Plan.

Innovative Initiatives – 5: State of Maryland Initiatives to Lead by Example

Lead Agency: DGS

Program Description

Maryland State government has initiated lead-by-example programs to improve efficiency, reduce waste, and integrate renewable energy and sustainable practices in its agencies' operations and facilities. These programs are embodied in five major initiatives:

- High Performance Buildings
- Green Maryland Act of 2010
- Maryland Environmental Footprint
- Generating Clean Horizons
- Project Sunburst

Collectively, the five initiatives significantly advance the recommendations of the Maryland Commission on Climate Change for the State and local governments to lead by example by reducing their carbon footprints in the construction and operation of their buildings and facilities and in their purchasing practices.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

The potential emission reductions from this program by 2020 are estimated to be 2.30 million metric tons of CO2-equivalent. Appendix C provides a more detailed description of the process used to quantify GHG reductions.

Job Creation and Economic Benefits

The State of Maryland Initiatives to Lead by Example program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the State of Maryland Initiatives to Lead by Example program, once fully operational, would support a total of about 16 jobs, $3 million in economic output, and $900,000 in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

Maryland's lead-by-example programs in high performance buildings and procurement mandatory in that they are driven by law, such as the Maryland State Finance and Procurement Article §3-602, Annotated Code of Maryland. DGS shares responsibility with the Board of Public Works, MDE, Department of Budget and Management, Maryland Green Building Council, and Maryland Green Purchasing Committee for administering them. Programmatic progress is tracked in annual reports which both the Maryland Green Building Council and the Maryland Green Purchasing Committee are required to submit to the General Assembly.

Innovative Initiatives – 6: State of Maryland Carbon and Footprint Initiatives

Lead Agency: DGS

Program Description

The Maryland Environmental Footprint program was launched by Governor O'Malley in 2009 to calculate, reduce, track and report the environmental footprint of State agencies and universities in five areas: 1) electricity and building energy; 2) water use; 3) vehicle fuel; 4) waste/recycling; and 5) aggregate GHG emissions. The program is part of the Governor's Smart, Green and Growing initiative to "… strengthen the State's leadership role in fostering smarter, more sustainable growth and to inspire action among all Marylanders to achieve a more sustainable future."

The Maryland Environmental Footprint is part of a comprehensive suite of lead-by-example programs the State government has initiated to reduce its agencies' carbon footprints in the construction and operation of its buildings and facilities and in its purchasing practices. Collectively, the programs significantly advance the lead-by-example recommendations of the Maryland Commission on Climate Change. The annual progress of each agency and university, and the State government as a whole, is tracked on the Maryland Environmental Footprint page of Maryland's Smart, Green and Growing website. The website also contains a link to the 2009 Annual Report on the Footprint initiative, which summarizes the major achievements of the first year and recommends next steps for 2010 and beyond. The Report's recommended next steps include:

- Training of State agency staff and university students.
- Identifying additional targets for Footprint reductions.

- Considering adding additional Footprint parameters, including stormwater management, nitrogen sources, forest canopy cover, reduction of impervious surfaces and others.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

All emission benefits and costs associated with this program by 2020 have been aggregated under Innovative Initiatives-5: State of Maryland Initiatives to Lead by Example.

Job Creation and Economic Benefits

The State of Maryland Carbon and Footprint Initiatives program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the State of Maryland Carbon and Footprint Initiatives program, once fully operational, would support a total of about 318 jobs, $61 million in economic output, and $17 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

The Maryland Environmental Footprint program is driven by an executive order. DGS, Maryland Environmental Services and DNR have primary responsibility for administering the program. Programmatic progress is tracked on the Governor's Maryland Environmental Footprint page of Maryland's Smart, Green and Growing website and in the Maryland Environmental Footprint's annual reports, also published on the website.

Innovative Initiatives – 7: Job Creation and Economic Development Initiatives Related to Climate Change

Lead Agency: DBED

Program Description

This program promotes economic development opportunities associated with reducing GHG emissions in Maryland. It is based on Governor O'Malley's aggressive goal of creating, retaining or placing 100,000 green jobs by 2015. To support this goal, the Department of Business and Economic Development (DBED) formed a

Green Jobs & Industry Task Force. The Green Jobs and Industry Task Force issued recommendations to Governor O'Malley in July, 2010 and made six recommendations: Strengthen coordination and communication across State agencies, partners and stakeholders to provide strategic vision for advancing a green economy; promote energy and resource efficiency efforts; develop and foster clean, local energy production and industrial capacity; capitalize upon economic opportunities to restore and protect Maryland's natural resources; promote sustainable development practices that create jobs, generate prosperity and make Maryland more self-reliant; and increase access to capital for green businesses and projects.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

There are no GHG reductions associated with this program by 2020. While this program is not directly tied to a quantifiable reduction in GHGs, it will help to reduce them. For example, if selected industries are forced to move offshore, then global GHG emissions may rise due to a lack of comparable controls outside the U.S.

Job Creation and Economic Benefits

The Job Creation and Economic Development Initiatives Related to Climate Change program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Job Creation and Economic Development Initiatives Related to Climate Change program, once fully operational, would support a total of about 807 jobs, \$106 million in economic output, and \$33 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

This is a voluntary initiative.

DBED works with public and private sectors to create job opportunities in Maryland and aims to attract new businesses, stimulate private investment, create jobs and encourage the expansion and retention of existing companies by providing workforce training and financial assistance to businesses relocating to or expanding within Maryland. To spur economic development in Maryland, DBED participates on both multi-agency initiatives and green business organization activities.

The Green Jobs and Industry Task Force issued its next steps, including:
- Prioritize recommendations, placing greatest emphasis on those with the most potential to create jobs and promote economic recovery immediately; develop an action plan to implement these recommendations;
- Outline the budgetary and workforce resources necessary to implement these changes; draft legislation for consideration at future General Assembly sessions to implement recommendations requiring legislative action; and
- Convene short-term public-private working groups to handle specific issues raised within the recommendations.

Innovative Initiatives – 8: Public Health Initiatives Related to Climate Change

Lead Agency: DHMH

Program Description

Climate change will have profound and largely negative effects on the health of Maryland's citizens. Throughout the world, the prevalence of some diseases and other threats to human health depend largely on local climate. Extreme temperatures can lead directly to loss of life, while climate-related disturbances in ecological systems, such as changes in the range of infective parasites, can indirectly impact the incidence of serious infectious diseases. In addition, warm temperatures can increase air and water pollution, which in turn harm human health.

Dealing with these negative effects will be costly in terms of actual dollars spent for health care by State government, private businesses, and individuals; increased burden of disease on individuals; time off work and out of school; and lost productive years of life. However, many strategies for reducing GHG emissions have beneficial effects on health, such as improved air quality. Because the potential risks to health of unmitigated climate change are so extreme and the potential health benefits of certain policies to reduce GHG emissions are significant, these risks, costs, and benefits were considered for all climate change and energy policies.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

There are no GHG reductions associated with this program by 2020. The development within the Department of Health and Mental Hygiene (DHMH) of more specific adaptation strategies associated with climate change will be coordinated with MDE, MDP, and the Maryland Emergency Management Administration and will depend on existing surveillance activities for vector-borne disease and environmental public health tracking.

Job Creation and Economic Benefits

The Public Health Initiatives Related to Climate Change program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Public Health Initiatives Related to Climate Change program, once fully operational, would support a total of about 40 jobs, $5 million in economic output, and $1 million in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

This program builds on existing DHMH programs and can be carried out under DHMH Secretary's general authority related to surveillance and control of threats to public health.

DHMH continues to improve the capabilities of its Environmental Public Health Tracking infrastructure. This is online tool presents both health and environmental data at various levels that can be used by the public and, in a secure fashion, by health department personnel, to present detailed information about health and environmental data at a detailed level sufficient to be useful for health impact assessment. The tracking program is used to provide useful information and data to communities concerned about environmental public health issues. Work also continues with the Commission on Environmental Justice and Sustainable Communities, MDE, and MDP on the introduction of health indicators that could be used by MDP and other agencies to evaluate the potential impacts of climate change adaptation or mitigation strategies, as well as the potential health consequences of projects related to adaptation to sea level rise.

DHMH believes there is a rationale for explicitly addressing the potential health impacts of many of the cross cutting programs mentioned in this report. One mechanism would be the health impact assessment, in the same manner that this report addresses economic growth and employment.

Innovative Initiatives – 9: Title V Permits for GHG Sources

Lead Agency: MDE

Program Description

Along with Title V of the 1990 Clean Air Act Amendments, Congress adopted measures that required all states to develop and implement operating permit programs. Congress' main goal in establishing the Title V program was to achieve a broad-based tool to aid in implementing the Clean Air Act and enhancing enforcement. Maryland received final full approval from EPA of its Title V permit program in February 2003.

More information on this program can be found in the appendix of this report.

Estimated GHG Emission Reductions in 2020

Title V air permits will not result directly in any GHG reductions by 2020. However, Title V will result in improved compliance with federal Clean Air Act requirements including GHGs and other pollutants, via the following:

- Improved clarity regarding applicability of requirements;
- Discovery and required correction of noncompliance prior to receiving a permit;
- Improved monitoring, recordkeeping, and reporting concerning compliance status;
- Self-certification of compliance with applicable requirements initially and annually, and prompt reporting of deviations from permit requirements;
- Enhanced opportunity for the public to understand and monitor sources' compliance obligations; and improved ability of EPA, permitting authorities, and the public to enforce federal Clean Air Act requirements.

Job Creation and Economic Benefits

The Title V Permits for GHG Sources program is expected to create and retain jobs and increase the State GDP. RESI's 2011 Study estimated that the Title V Permits for GHG Sources program, once fully operational, would support a total of about three jobs, $600,000 in economic output, and $170,000 in wages annually. Chapter 7 and Appendix E provide more detail on the RESI studies and the job creation and economic benefits associated with this program.

Implementation

Requirements for the Title V air operating permits program, with respect to GHG emissions, were established in EPA's GHG Tailoring Rule, which was finalized in May 2010. These requirements are included in various locations in Title 26 of the Code of Maryland regulations, as of June 2011.

As of July 1, 2011, new sources or existing sources not previously subject to Title V requirements that emit or have the potential to emit at least 100,000 tons per year CO2-equivalent are now subject to the requirement to obtain a Title V air operating permit. Beginning July 1, 2013, additional sources will be included and a possible permanent exclusion from permitting will be determined for some source categories. EPA is also establishing an enforceable commitment that it will complete a streamlining study by April 30, 2015 to evaluate the status of Title V permitting for GHG emitting sources.

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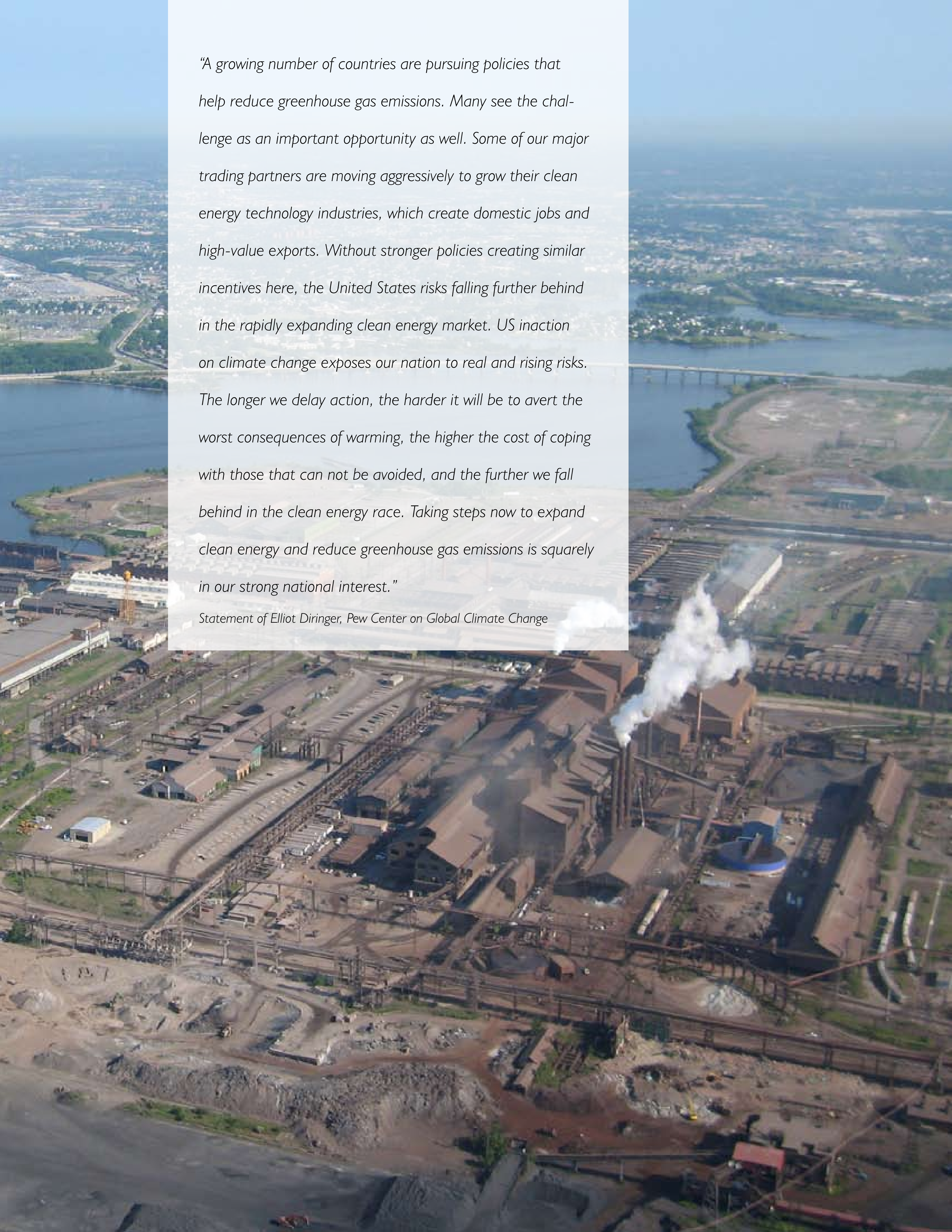
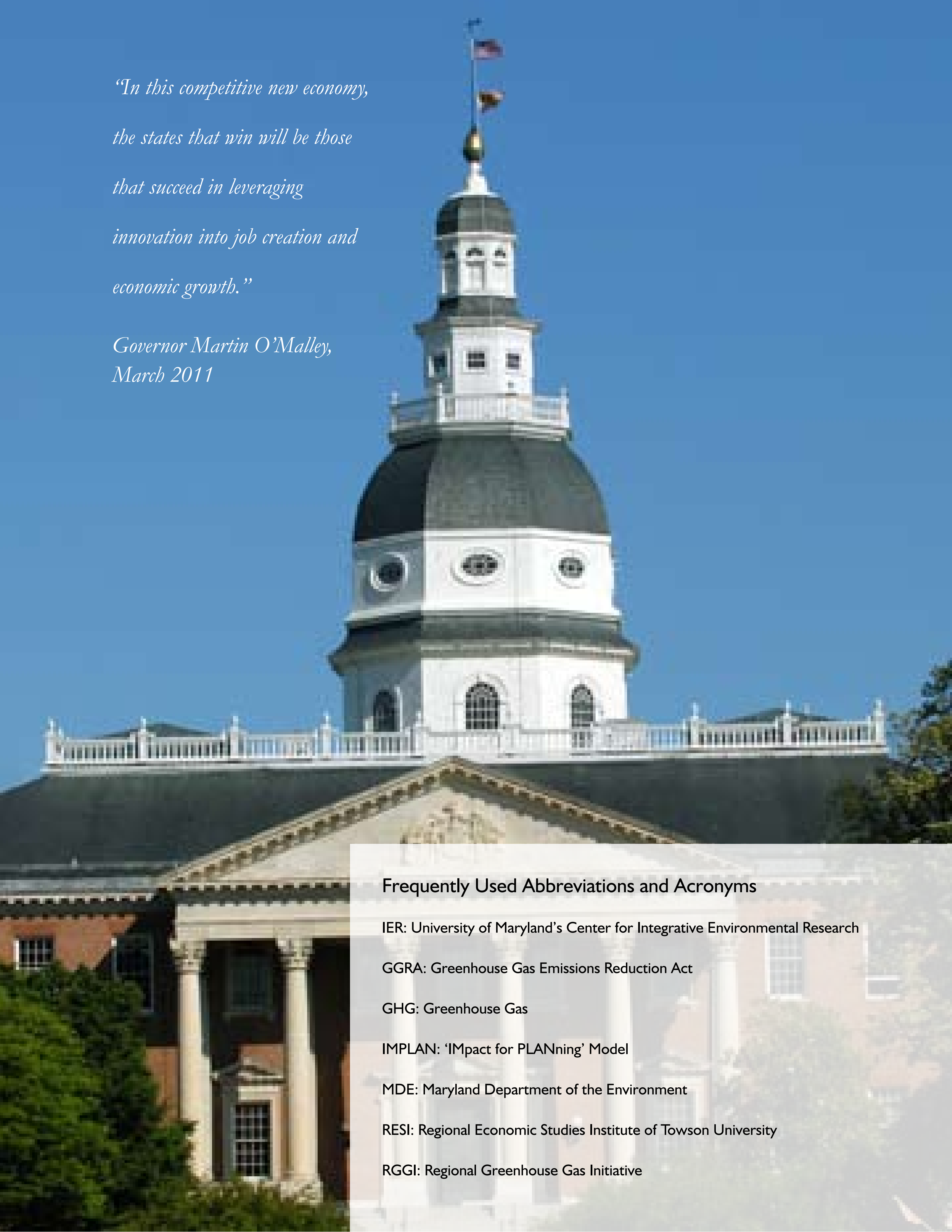


"A growing number of countries are pursuing policies that help reduce greenhouse gas emissions. Many see the challenge as an important opportunity as well. Some of our major trading partners are moving aggressively to grow their clean energy technology industries, which create domestic jobs and high-value exports. Without stronger policies creating similar incentives here, the United States risks falling further behind in the rapidly expanding clean energy market. US inaction on climate change exposes our nation to real and rising risks. The longer we delay action, the harder it will be to avert the worst consequences of warming, the higher the cost of coping with those that can not be avoided, and the further we fall behind in the clean energy race. Taking steps now to expand clean energy and reduce greenhouse gas emissions is squarely in our strong national interest."

Statement of Elliot Diringer, Pew Center on Global Climate Change



"In this competitive new economy, the states that win will be those that succeed in leveraging innovation into job creation and economic growth."

Governor Martin O'Malley, March 2011

Frequently Used Abbreviations and Acronyms

IER: University of Maryland's Center for Integrative Environmental Research

GGRA: Greenhouse Gas Emissions Reduction Act

GHG: Greenhouse Gas

IMPLAN: 'IMpact for PLANning' Model

MDE: Maryland Department of the Environment

RESI: Regional Economic Studies Institute of Towson University

RGGI: Regional Greenhouse Gas Initiative

Chapter

7 Maryland Jobs and the Economy

Introduction

In 2009, Governor Martin O'Malley and the Maryland General Assembly passed the Greenhouse Gas Emission Reduction Act of 2009 (GGRA), requiring the State to develop and implement a Plan (GGRA Plan) to reduce greenhouse gas (GHG) emissions 25% in Maryland from a 2006 baseline by 2020. The GGRA also required that the GGRA Plan have a positive impact on job growth and economic activity in the State.

This chapter provides a summary of the GGRA related economic analyses that have been conducted to date. Additional analyses will be completed and incorporated before the GGRA Plan is finalized in December. Appendix E includes more detailed information.

Overview of Economic Analyses

Two separate analyses assessing the likely impact of the GGRA on jobs and economic growth in Maryland have been completed. The first, a 2010 Regional Economic Studies Institute of Towson University (RESI) Synthesis Analysis gathered and synthesized information from prior studies and it built on work already completed by University of Maryland's Center for Integrative Environmental Research (CIER), as part of the State's 2008 Climate Action Plan. RESI's 2010 Analysis included information from the following:

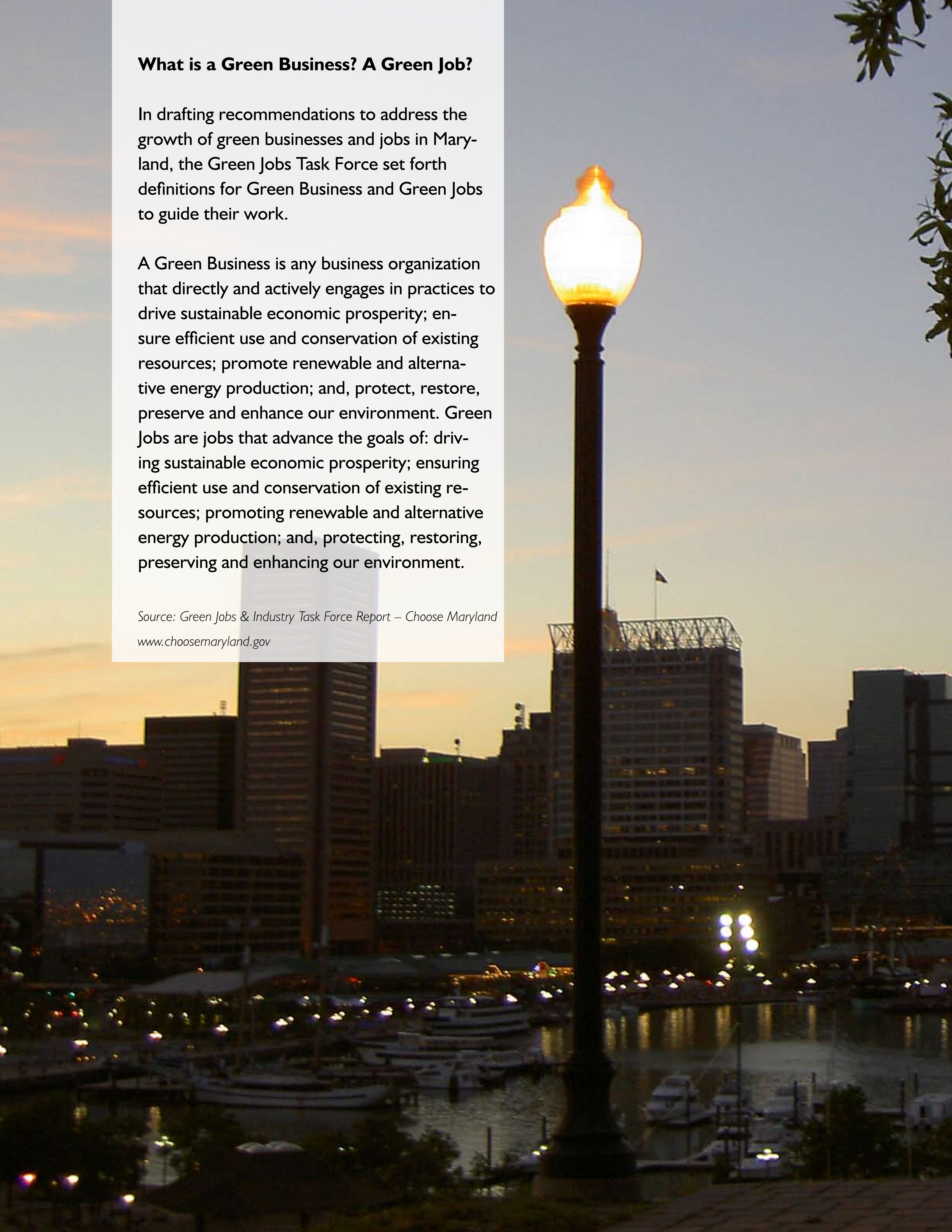
Source: http://www.msa.md.gov/msa/md statehouse/html/home.html

What is a Green Business? A Green Job?

In drafting recommendations to address the growth of green businesses and jobs in Maryland, the Green Jobs Task Force set forth definitions for Green Business and Green Jobs to guide their work.

A Green Business is any business organization that directly and actively engages in practices to drive sustainable economic prosperity; ensure efficient use and conservation of existing resources; promote renewable and alternative energy production; and, protect, restore, preserve and enhance our environment. Green Jobs are jobs that advance the goals of: driving sustainable economic prosperity; ensuring efficient use and conservation of existing resources; promoting renewable and alternative energy production; and, protecting, restoring, preserving and enhancing our environment.

Source: Green Jobs & Industry Task Force Report – Choose Maryland
www.choosemaryland.gov



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The second, a 2011 RESI analysis, estimated the cumulative and individual economic impacts of the GGRA Plan's 65 GHG reduction programs. This more detailed analysis provides the best current estimate of the likely economic impact of the GGRA.

Current Best Estimate of Job Creation and Other Economic Benefits

The recently completed economic and other analyses of the GGRA Plan confirm that the State is on track to achieve the required 25% GHG reduction by 2020, and that it will aid in creating jobs and growing Maryland's economy in doing so. The studies also show that the GGRA Plan is likely to aid Maryland in its efforts to restore the Chesapeake Bay, embrace clean energy, support smarter, more sustainable development., and improve air quality.

RESI's economic analyses concluded that the GGRA Plan, when fully implemented, will result in annual benefits of approximately 36,000 jobs, $6.1 billion in added economic output, and $2.1 billion in added wages.

Note that RESI's analyses did not include any estimated impacts or benefits associated with any of the transitory construction or other build out/up activities associated with the Plan's 65 programs. For example, the many temporary jobs that are likely to be supported by the State's transit expansion and transit-oriented development programs were not included in RESI's initial analyses. Further analyses, with updated program implementation and funding information, will be incorporated prior to the Plan's completion.

Multiple Environmental and Economic Benefits

The GGRA Plan is more than just a GHG reduction plan. As noted above, it is Plan that will also help Maryland address other priority growth and environmental issues. Maryland is confronting many challenges in complying with Chesapeake Bay restoration requirements and in meeting recently adopted new health standards for ground level ozone, NO2 and SO2. A new, tougher fine particle standard is also expected in 2012 or 2013, and Maryland continues to struggle with fish consumption advisories for Mercury and regional haze compliance issues. The GGRA Plan will aid the State in addressing all of these issues.

There are, of course, numerous public health and other benefits associated cleaner air and water and MDE is working with the Northeast Stases for Coordinated Air Use Management (NESCAUM) to complete an environmental and economic cost-benefit analysis that will quantify their significance. This analysis will be available for the final plan. Chapter 5 provides additional information on the analysis being prepared by NESCAUM.

The remainder of this chapter provides summary information from the two separate, but supportive, RESI studies.

The 2011 RESI Study - Benefits from the Proposed GGRA Plan on Maryland's Economy.

Overview

The 2011 RESI Study includes a preliminary economic and jobs analysis for each of the 65 programs included in the proposed GGRA Plan. The 65 programs, which are being implemented by 11 State agencies, have been organized into eight subject areas: energy, transportation, agriculture and forestry, recycling, multi-sector strategies, buildings, land use, and innovative initiatives. Chapter 6, which summarizes the 65 programs, and the full report on the 2011 RESI Study (included as Appendix E of this proposed plan) are similarly organized. The findings in this section should be considered preliminary findings. They will be refined in a further analysis to be developed and completed by the end of 2012.

Appendix E provides a detailed report on the 2011 RESI Study. This Appendix includes descriptions of the methodology, the assumptions, the modeling used in the study and details on how each of the 65 programs were analyzed. RESI coordinated with MDE to develop the methodology and with all of the implementing State agencies to gather data and determine the assumptions to be used in the economic modeling.

Investment and Operation Phases

In a coordinated effort involving RESI and all of the State agencies implementing the GGRA programs, two phases were modeled for each program and subprogram: an investment phase and an operation phase. The impacts of each program and subprogram are estimated for both phases.

The investment phase refers to the entire period during which an agency is developing, investing in, and implementing a program and its subprograms. The operation phase refers to the period during which a program and its subprograms have already been implemented and savings associated with the program and its subprograms are being realized. In other words, it is the period during which the goals of the program and subprograms have been achieved and individuals and/or business entities are gaining something from these goals being achieved in the form of cost savings, increased income, etc.

The investment and operation phase were modeled using available information on current or planned implementation and funding from each of the 11 State agencies responsible for the 65 programs in the plan. Further detailed economic analysis, using updated information on implementation and funding, will be included in the final plan.

RESI used the IMPLAN input/output model to quantify the economic and fiscal impacts of the 65 strategies in the proposed GGRA plan. The economic impacts presented include the following: employment, output, and wages. "Employment" refers to the number of jobs expected to be generated due to the modeled change in the economy. "Output" refers to the amount of State gross domestic product expected to be generated due to the modeled change. "Wages" refers to the earnings (salaries, wages, etc.) expected to be generated. The fiscal impacts presented include the combined State and local tax revenues (property, income, sales, payroll, and other tax revenues) expected to be generated due to the modeled change in the economy.

To quantify the economic impacts of an event, economists measure three types of impacts: direct, indirect, and induced. The direct economic effects are generated as the event creates jobs and businesses hire workers to support the event's activities. The indirect economic impacts occur as the vendors purchase goods and services from other firms. In either case the increases in employment generate an increase in household income, as new job opportunities are created and income levels rise.

From DBED's "Economic Pulse" newsletter 7/28/11/:

Brookings: MD Clean Jobs 43,000+ in 2010
A new study, "Sizing the Clean Economy: A National and Regional Green Jobs Assessment" helps to more clearly define and measure the clean economy. Maryland had 43,207 clean jobs in 2010, or 1.7% of all Maryland jobs, according to the report released by the Metropolitan Policy Program at Brookings. Between 2003 and 2010 Maryland added 8,370 clean jobs to see the sector grow by 3.1% annually. On average, each clean economy job in Maryland produces $9,143 in exports, and pays a median annual wage of $44,790. Report | State profiles

http://www.brookings.edu/~/media/Files/Programs/Metro/clean_economy/0713_clean_economy.pdf

This drives the induced economic impacts that result from households increasing their purchases at local businesses. The total economic impact represents the sum of direct, indirect, and induced impacts.

Consider the following example. A new firm opens in a region and directly employs 100 workers. The firm purchases supplies, both from outside the region as well as from local suppliers, which leads to increased business for local firms, thereby hypothetically creating jobs for another 100 workers. This is called the indirect effect. The workers at the firm and at suppliers spend their income mostly in the local area, hypothetically creating jobs for another 50 workers. This is the induced effect. The direct, indirect and induced effects add up to 250 jobs created from the original 100 jobs. Thus, in terms of employment, the total economic impact of the firm in our example is 250.

Summary of Findings - Overall Employment, Output and Wage Impacts

A summary of RESI's preliminary findings, by the major subject areas used in the plan, including the total economic impacts (employment, output, and wages) for each subject area overall for the investment phase and the operation phase can be found in Figures 7-1 and 7-2. For economic impacts broken down by type (direct, indirect, induced, and total), please refer to the next section on economic impacts.

Figure 7-1
Average Economic Impacts by Subject Area—
Investment Phase per $1 million Investment

Subject Area	Employment	Output	Wages
Energy	17	$1,949,711	$454,732
Transportation	13	$1,857,687	$289,214
Agriculture and Forestry	28	$1,776,977	$556,274
Recycling	12	$1,829,493	$625,625
Multi-Sector	12	$1,797,988	$638,975
Buildings	12	$1,785,590	$654,874
Land Use	12	$1,851,662	$711,657
Innovative Initiatives	11	$1,800,888	$630,770
Average	**15**	**$1,831,249**	**$570,265**

Source: RESI

Total average economic impacts for the investment phase have been included on a basis of per $1 million invested. The results in Figure 7-1 reflect the total average economic impacts of a $1 million investment for a policy within each subject area. As the level of investment was modeled as a uniform amount across all policies ($1 million), a total for all 65 policies cannot yet be estimated. Instead, the total average economic impacts of a $1 million investment in a policy are included. Further detailed economic analysis, using updated information on implementation and funding will be included in the final plan. For more information regarding the investment phase, please refer to Appendix E.

Figure 7-2
Annual Economic Impacts
by Subject Area—Operation Phase

Subject Area	Employment	Output	Wages
Energy	2,793	$488,058,326	$165,611,533
Transportation	11,848	$2,077,970,194	$604,118,519
Agriculture and Forestry	16,275	$2,633,645,666	$1,019,994,530
Recycling	568	$104,113,041	$37,207,473
Multi-Sector	1	$196,064	$61,054
Buildings	39	$5,791,698	$2,144,306
Land Use	993	$233,220,468	$70,893,340
Innovative Initiatives	3,464	$517,147,877	$155,929,994
Total		**35,981**	**$6,060,143,334**

Source: RESI

The programs will support a total of 35,981 jobs, $6.1 billion in output, and $2.1 billion in wages annually once in operation.

A green job, as defined by the United Nations Environment Program, is "work in agricultural, manufacturing, research and development, administrative, and service activities that contribute(s) substantially to preserving or restoring environmental quality. Specifically, but not exclusively, this includes jobs that help to protect ecosystems and biodiversity; reduce energy, materials, and water consumption through high efficiency strategies; de-carbonize the economy; and minimize or altogether avoid generation of all forms of waste and pollution."

Source: United Nations Environment Programme Green Jobs Report

Maryland's Top 10 Employers

A mix of private companies, universities, federal agencies and military installations comprise Maryland's major employers, including:

1. Fort Meade (41,000)
2. Univ. System of MD (35,803)
3. Johns Hopkins U (27,000)
4. Johns Hopkins Hospital (20,273)
5. NIH (17,842)
6. Walmart (17,715)
7. UM Medical System (15,000)
8. Medstar Health (14,867)
9. Aberdeen Proving Gr. (13,984)
10. Giant Food (13,403)

*based on a 2010 survey

http://www.choosemaryland.org/work/Pages/default.aspx

Figure 7-2A Table provides a summary of RESI's preliminary findings for each of the 65 programs in the proposed plan. These findings include the total economic impacts (employment, output, and wages) for each program, sorted by subject area.

Figure 7-2A
Annual Economic Impacts
by Subject Area—Operation Phase

Subject Area	Employment	Output	Wages
Energy			
Regional Greenhouse Gas Initiative	10.6	$503,712	$550,495
GHG Reductions from Imported Power	3.4	$1,202,854	$233,921
Federal New Source Performance Standard	6.0	$2,117,023	$411,702
MACT	42.0	$14,764,866	$2,871,352
GHG Prevention of Significant Deterioration Permitting Program	1.0	$185,542	$52,513
Energy Efficiency in Residential Sector	231.9	$31,926,210	$9,821,266
Energy Efficiency in the Commercial and Industrial Sectors	393.0	$68,175,594	$29,690,325
Energy Efficiency—Appliances and Other Products	73.4	$9,676,958	$3,013,413
Energy Efficiency in the Power Sector—General	120.8	$42,464,967	$8,258,243
EmPOWER—Utility Subprogram	485.1	$64,271,951	$24,384,529
Maryland Renewable Energy Portfolio Standard Subprogram	237.7	$34,192,370	$10,790,049
Incentives and Gran Subprograms to Support Renewable Energy	228.0	$36,609,013	$13,839,951
Offshore Wind Initiatives to Support Renewable Energy	48.2	$8,274,770	$3,568,963
Combined Heat and Power	125.2	$27,316,786	$9,047,056
Main Street365.3	$61,458,638	$26,013,155	
Weatherization and Energy Efficiency for Low-Income Houses	1.3	$172,209	$53,626
Subtotal	**2,792.5**	**$488,058,326**	**$165,611,533**

Figure 7-2A
Annual Economic Impacts
by Subject Area—Operation Phase

Subject Area	Employment	Output	Wages
Transportation			
Maryland Clean Cars Subprogram	84.9	$11,230,937	$3,496,984
Federal Medium- and Heavy-Duty GHG Standards	6.7	$889,541	$276,977
Clean Fuel Standard	40.1	$5,300,615	$1,650,456
Transportation and Climate Initiative	2.1	$276,049	$85,962
Public Transportation Initiatives	489.5	$68,074,479	$21,049,577
Initiatives to Double Transit Ridership by 2020	146.5	$19,309,783	$6,013,083
Intercity Transportation Initiatives	625.8	$110,180,141	$31,847,142
Bike and Pedestrian Initiatives	135.6	$17,872,933	$5,565,646
Pricing Initiatives	7,635.0	$1,472,695,087	$417,112,058
Transportation Technology Initiatives	1,632.2	$236,592,059	$70,923,137
Electric Vehicles Initiative	49.2	$8,765,629	$2,523,226
Low-Emitting Vehicles Initiatives	0.2	$32,907	$9,313
Airport Initiatives	148.8	$31,446,741	$9,024,737
Port Initiatives0.4	$95,426	$22,710	
Freight and Freight Rail Strategies	601.3	$62,239,636	$24,262,661
Renewable Fuels Standard	79.3	$10,462,205	$3,257,939
CAFÉ Standards: Model Years 2008-2011	36.9	$4,862,636	$1,514,229
Promoting Hybrid and Electric Vehicles	120.8	$15,952,694	$4,956,197
PAYD Insurance in Maryland	12.8	$1,690,694	$526,484
Subtotal	**11,848.0**	**$2,077,970,194**	**$604,118,519**

Figure 7-2A
Annual Economic Impacts
by Subject Area—Operation Phase

Subject Area	Employment	Output	Wages
Agriculture and Forestry			
Managing Forests to Capture Carbon			
Creating Ecosystem Markets to Encourage	11.2	$1,940,687	$845,165
GHG Emissions Reductions	4,709.2	$825,567,152	$346,839,622
Increasing Urban Trees to Capture Carbon	2,953.1	$512,286,938	$222,099,866
Creating and Protecting Wetlands and			
Waterway Borders to Capture Carbon	1,181.7	$155,809,336	$48,519,158
Geological Opportunities to Store Carbon	715.2	$124,062,205	$54,028,825
Planting Forests in Maryland	14.9	$1,970,266	$613,542
Biomass for Energy Production	4.1	$1,441,292	$280,291
Conservation of Agricultural Land for GHG Benefits	3,373.8	$44,838,551	$138,523,097
Buy Local for GHG Benefits	2,827.0	$481,641,936	$170,625,123
Nutrient Trading for GHG Benefits	484.7	$84,087,304	$36,619,841
Subtotal	**16,274.9**	**$2,633,645,666**	**$1,019,994,530**
Recycling			
Recycling and Source Reductions	568.3	$104,113,041	$37,207,473
Subtotal	**568.3**	**$104,113,041**	**$37,207,473**
Multi-Sector			
Outreach and Public Education	1.5	$196,064	$61,054
Subtotal 1.5	**$196,064**	**$61,054**	
Buildings			
Green Building Initiatives	15.7	$2,729,153	$1,188,540
Building Codes	23.2	$3,062,545	$955,766
Subtotal	**38.9**	**$5,791,698**	**$2,144,306**

Figure 7-2A
Annual Economic Impacts
by Subject Area—Operation Phase

Subject Area	Employment	Output	Wages
Land Use			
Reducing Transportation Issues through Smart Growth	33.7	$50,442,556	$20,892,882
GHG Targets for Local Government's Transportation and Land Use Planning	106.6	$20,629,272	$5,838,610
Land Use Planning GHG Benefits	806.2	$156,034,869	$44,161,848
Growth Boundary GHG Benefits	46.4	$6,113,771	$1,903,833
Subtotal	**992.9**	**$233,220,468**	**$70,893,340**
Innovative Initiatives			
Leadership-by-Example—Local Government	931.7	$180,311,946	$51,032,880
Leadership-by-Example—Federal Government	1,278.5	$149,330,718	$47,903,786
Leadership-by-Example—Maryland University Lead-by-Example Initiatives	64.9	$9,706,815	$3,409,622
Voluntary Stationary Source Reductions	3.4	$595,602	$259,383
State of Maryland Initiatives to Lead by Example	16.6	$3,206,111	$907,411
State of Maryland Carbon and Footprint Initiatives	318.4	$61,629,311	$17,442,667
Job Creation and Economic Development Initiatives Related to Climate Change	807.3	$106,444,546	$33,146,921
Public Health Initiatives Related to Climate Change	40.4	$5,321,944	$1,657,258
Title V Permits for GHG Sources	3.1	$600,884	$170,066
Subtotal	**3,464.2**	**$517,147,877**	**$155,929,994**
Total	**35,981.2**	**$6,060,143,334**	**$2,055,960,749**

The RESI analysis also found that the programs would generate a significant fiscal impact (state and local tax revenues). For fiscal impacts broken down by subject area for the investment and operation phases, please refer to the next section.

Economic Impacts Findings – Direct, Indirect and Induced Impacts

RESI's findings show that all programs and subprograms will have a significant positive economic impact overall. The direct, indirect, induced, and total economic impacts (employment, output, and wages) for each program and subprogram for the investment phase and the operation phase by agency and strategy were calculated.

Investment Phase Benefits

The direct, indirect, induced, and total economic impacts for all programs for the investment phase can be found in Figures 7-3 through 7-5. For more information regarding types of impacts, please refer to Appendix E.

Figure 7-3
Employment Impacts by Subject Area
Investment Phase (per $1 million Invested)

Subject Area	Direct	Indirect	Induced	Total
Energy	10	3	5	17
Transportation	7	3	4	13
Agriculture and Forestry	20	4	5	28
Recycling	5	3	3	12
Multi-Sector	6	2	3	12
Buildings	7	2	3	12
Land Use	6	2	3	12
Innovative Initiatives	5	2	3	11
Average	**8**	**3**	**4**	**15**

Source: RESI

Figure 7-4
Economic Output Impacts by Subject Area
Investment Phase (per $1 million Invested)

Subject Area	Direct	Indirect	Induced	Total
Energy	$1,000,000	$360,511	$589,200	$1,949,711
Transportation	$1,000,000	$385,409	$472,279	$1,857,687
Agriculture and Forestry	$1,000,000	$307,973	$469,004	$1,776,977
Recycling	$1,000,000	$391,928	$437,565	$1,829,493
Multi-Sector	$1,000,000	$356,040	$441,948	$1,797,988
Buildings	$1,000,000	$327,313	$458,276	$1,785,590
Land Use	$1,000,000	$355,667	$495,995	$1,851,662
Innovative Initiatives	$1,000,000	$354,777	$446,111	$1,800,888
Average	**$1,000,000**	**$354,952**	**$476,297**	**$1,831,249**

Source: RESI

Figure 7-5
Wage Impacts by Subject Area
Investment Phase (per $1 million Invested)

Subject Area	Direct	Indirect	Induced	Total
Energy	$535,733	$1	$98,227	$454,732
Transportation	$416,466	$54,564	$61,206	$289,214
Agriculture and Forestry	$300,961	$109,361	$145,952	$556,274
Recycling	$353,891	$135,570	$136,164	$625,625
Multi-Sector	$383,986	$117,461	$137,527	$638,975
Buildings	$398,579	$113,686	$142,609	$654,874
Land Use	$431,936	$125,375	$154,346	$711,657
Innovative Initiatives	$369,280	$122,666	$138,823	$630,770
Average	**$398,854**	**$97,336**	**$126,857**	**$570,265**

Source: RESI

Operation Phase Benefits

The direct, indirect, induced, and total economic impacts for all programs for the operation phase can be found in Figures 7-6 through 7-8.

Figure 7-6
Annual Employment Impacts by Subject Area
Operation Phase

Subject Area	Direct	Indirect	Induced	Total
Energy	715	508	1,570	2,793
Transportation	3,884	3,498	4,466	11,848
Agriculture and Forestry	5,090	2,667	8,518	16,275
Recycling	223	168	177	568
Multi-Sector	0	0	1	1
Buildings	7	3	29	39
Land Use	342	349	302	993
Innovative Initiatives	1,196	824	1,444	3,464
Total	**11,457**	**8,017**	**16,507**	**35,981**

Source: RESI

Figure 7-7
Annual Economic Output Impacts by Subject Area
Operation Phase

Subject Area	Direct	Indirect	Induced	Total
Energy	$205,734,931	$79,212,979	$203,110,416	$488,058,326
Transportation	$947,918,396	$542,309,575	$587,742,223	$2,077,970,194
Agriculture and Forestry	$1,099,293,491	$412,590,239	$1,121,761,936	$2,633,645,666
Recycling	$54,338,583	$26,489,250	$23,285,209	$104,113,041
Multi-Sector	$0	$0	$196,064	$196,064
Buildings	$1,469,529	$546,782	$3,775,387	$5,791,698
Land Use	$112,338,456	$62,566,847	$58,315,165	$233,220,468
Innovative Initiatives	$185,636,475	$141,301,879	$190,209,523	$517,147,877
Total	**$2,606,729,860**	**$1,265,017,551**	**$2,188,395,923**	**$6,060,143,334**

Source: RESI

Figure 7-8
Annual Wage Impacts by Subject Area
Operation Phase

Subject Area	Direct	Indirect	Induced	Total
Energy	$75,988,500	$25,256,014	$64,367,019	$165,611,533
Transportation	$246,857,049	$174,315,202	$182,946,267	$604,118,519
Agriculture and Forestry	$536,503,529	$134,289,176	$349,201,825	$1,019,994,530
Recycling	$21,544,779	$8,416,848	$7,245,845	$37,207,473
Multi-Sector	$0	$0	$61,054	$61,054
Buildings	$794,306	$174,505	$1,175,495	$2,144,306
Land Use	$34,802,400	$19,845,026	$16,245,914	$70,893,340
Innovative Initiatives	$55,088,347	$41,627,545	$59,214,102	$155,929,994
Total	**$971,578,910**	**$403,924,317**	**$680,457,522**	**$2,055,960,749**

Source: RESI

The 2010 RESI Synthesis Analysis – Review and Synthesis of Earlier Relevant Studies

Overview

As the 65 strategies that make up the proposed GGRA plan were being finalized in 2009 and 2010, RESI gathered, analyzed and synthesized the results from available studies between 2000 and 2010. The 2010 RESI Synthesis Analysis included both a literature review and synthesis of the economic benefits from earlier relevant studies and a validation of the economic benefits estimated in the 2008 Climate Action Plan.

Below is a summary of the literature review and validation.

Literature Review

- Many of the reports expect job creation in clean energy (energy efficiency, renewable energy, green energy facilities, etc.), construction, transportation and retrofitting of buildings. These are industries which would experience direct impacts.
- Among the three University of Maryland's Center for Integrative Environmental Research (CIER) studies, job creation estimates vary somewhat based on the study period and evolving assumptions regarding the Regional Greenhouse Gas

Initiative (RGGI), but remain in a conservative range between 0 and 4,200 up to the year 2025.

- Differences occur depending on the focus topic of each CIER study (such as energy efficiency spending, policy implementation, etc.).
- A preliminary study conducted by RESI for MDE found that various RGGI energy efficiency funding scenarios would result in green job creation ranging from 64 to 125 jobs by 2020. The number of jobs created increases as the amount of RGGI revenues devoted to energy efficiency increases. The majority of these jobs would occur in construction, administrative support, professional services, and manufacturing.

Validation

- According to the 2008 Climate Action Plan, the Center for Climate Strategies estimates an economic impact of $2 billion by 2020 from climate policy implementation.
- GHG reduction estimates and cost effectiveness data for quantified policies provided by the Center for Climate Strategies in the 2008 Climate Action Plan were used to validate its findings and create upper and lower estimates of the economic impacts.
- RESI found that implementation of quantified 2008 Climate Action Plan policies would result in economic activity, or a change in State gross domestic product, between $535.4 million and $6.1 billion by 2020.

Based on a comprehensive literature review of readily available data related to Maryland's climate mitigation programs, there will be a net economic benefit to the State in the range of $0.5 billion to $6.0 billion by 2020.

The Literature Review Summary of Findings

RESI has collected and analyzed relevant reports from reliable sources detailing the economic impacts of various forms of climate action in Maryland, including those from CIER and the International Center for Sustainable Development. As assumptions vary, so do the estimated economic impacts. This section details the main findings in regard to economic impacts including job creation, job types created and State gross domestic product from each report.

A summary of findings by topic for all studies included in the literature review can be found in Figure 7-9. The industries and job types affected as well as employment and State gross domestic product impacts have been included where available.

Figure 7-9
Sumary of Findings

Study	Industries and Job Types	Employment	State
Economic Development Potential of Clean Energy Technology in Maryland and Feasibility Study for a Maryland Clean Energy Center (International Center for Sustainable Development, December 2006)	• Electricity and natural gas • Renewable energy • Ethanol production • Business incubation of… - Specialized construction - Environmental manufacturing - Architectural and engineering services - Specialized design services	144,000-326,000	$1.6 billion
Economic and Energy Impacts from Maryland's Potential Participation in the Regional Greenhouse Gas Initiative (CIER, January 2007)*	Not specified	1,200 (2010) 2,800 (2025)	$100 million (2010) $200 million (2025)

Study	Industries and Job Types	Employment	State
Climate Action Plan (Maryland Commission on Climate Change, August 2008)	• Green building - Construction - Design • Retrofitting • Transportation improvements • Green energy facilities - Design - Construction - Operation	144,000-326,000	$16 billion
The Role of Energy Efficiency Spending in Maryland's Implementation of the Regional Greenhouse Gas Initiative (CIER, October 2008)	• Energy auditing, installation and retrofitting • Construction • Retail • Education • Healthcare • Administrative support • Professional services	100% scenario— 4,200 (2020) 50% scenario— 1,700 (2020)	100% scenario— $150 million (2010) $500 million (2020) 50% scenario— $25 million (2020) $250 million (2020)
Climate Change Policy and Maryland: Issues to Consider in the Greenhouse Gas Emissions Debate (Dept. of Legislative Services, January 2009)	Not specified	Not specified	$238-938 million (2030) $1.0-2.9 billion (2050)
RGGI Green Job Estimations: Preliminary Analysis (RESI, September 2010)	• Largest estimated job gains in… - Construction - Administrative support - Professional services	50% spending level—64 100% spending level—125	Not specified
Meeting Maryland's Greenhouse Gas Reduction Goals (CIER/ RESI, TBD)	• Renewable energy • Energy efficiency • Transportation • Research, design and consulting services • Environmental protection • Agriculture and forestry • Manufacturing • Recycling and waste reduction • Governmental and regulatory administration	Mid—17.7 Low—595.3 High—(650.0)	Mid—($3.6 million) Low—$133.1 million High—($162.7 million

Sources: CIER, Dept. of Legislative Services, International Center for Sustainable Development, Maryland Commission on Climate Change, RESI

Synopsis of Each Study in the Literature Review

The remainder of this section provides a brief overview of the findings of the analysis included in the literature review. Appendix E provides more detailed information on each of these studies.

Economic Development Potential of Clean Energy Technology in Maryland and Feasibility Study for a Maryland Clean Energy Center (2006)

A report from the International Center for Sustainable Development released in December 2006 detailed the feasibility and impacts of clean energy technology in Maryland from estimated energy efficiency and renewable energy scenarios. Based on a conservative estimate (20 percent energy efficiency improvement, 10 percent renewable energy increase, and 10 percent ethanol production increase), approximately 144,000 jobs, $16 billion in State gross domestic product, $5.7 billion in wages, and $973 million in tax revenues would be created in the State over a 20-year period. A more optimistic estimate (40 percent energy efficiency improvement, 30 percent renewable energy increase and 30 percent ethanol production increase) would result in double the economic impacts of the conservative estimate, according to the report.

RESI analyzed the total economic impacts of energy efficiency—electricity; energy efficiency—natural gas; renewable energy—wind power, solar photovoltaic, and biomass; alternative energy—ethanol; firm attraction, expansion, and start-up activity; and business incubation as they relate to a proposed clean energy and renewable research center in Maryland. State-wide job creation ranges were estimated for each scenario, as shown in Figure 7-10.

Figure 7-10
Job Creation by Scenario

Scenario	Job Creation (2006-2025)
Energy Efficiency—Electricity	
Baseline—20% reduction in electricity consumption	93,400
Mid-range—30% reduction	142,815
High—40% reduction	194,562
Energy Efficiency—Natural Gas	
Baseline—10% reduction in natural gas consumption	11,551
Mid-range—15% reduction	17,496
High—20% reduction	28,319
Renewable Energy	
Baseline—10% of current and projected electricity consumption	15,030
Mid-range—20% of current and projected electricity consumption	30,552
High—30% of current and projected electricity consumption	46,723
Alternative Energy—Ethanol	
Baseline—10% of gasoline consumption	56,867
Mid-range—20% of gasoline consumption	118,356
High—30% of gasoline consumption	182,311
Firm Attraction, Expansion, and Start-Up Activity	
MD will achieve 25% as much as MA's job creation analysis	3,750
MD will achieve 50%	7,500
MD will achieve 75%	11,250
MD will achieve 100%	14,999
Business Incubation	
Incubator funding support of $10 million per year for firms in specialized construction, environmental manufacturing, architectural and engineering services, and specialized design services	159

Maryland's Climate Action Plan (2008)

Source: International Center for Sustainable Development, RESI

The 2008 Climate Action Plan quotes the estimates of job creation from the 2006 International Center for Sustainable Development study (between 144,000 and 326,000 jobs over a 20-year period). The 2008 Climate Action Plan also provides estimates of the economic impacts of implementing 42 climate mitigation strategies: approximately $16 billion in State gross domestic product, $5.7 billion in wages and $973 million in local tax revenues over 20 years. The climate policies which were determined to be quantifiable in the 2008 Climate Action Plan are projected to generate $2 billion in economic activity by 2020.

RESI analyzed the findings relating to the quantifiable policies in the 2008 Climate Acton Plan. RESI's validation of these findings can be found below.

Economic and Energy Impacts from Maryland's Potential Participation in the Regional Greenhouse Gas Initiative (2007)

CIER released a report in January 2007 discussing the economic and energy impacts of Maryland's participation in the RGGI. This analysis occurred before Maryland developed the necessary statutory and regulatory framework required to participate in the RGGI. However, based on industry trends and proposed RGGI programmatic actions at the time, CIER estimated that the impact of Maryland's participation in RGGI for electricity ratepayers would mostly result in decreased costs of electricity bills by more than $100 million in 2010 and more than $200 million in 2025. According to the report, this would translate to a total annual decrease of approximately $22 for the average residential electricity bill in 2010.

The study also found that Maryland's participation in RGGI would have little net economic impact for Maryland due to the fact that "positive economic impacts from reduced electricity costs and energy efficiency investments are partially offset by reduced investment and profits in the electricity generating sector." The estimated economic impact of Maryland's participation in RGGI on State gross domestic product came to approximately $100 million for 2010; CIER estimated it would then increase to $200 million in 2015 and beyond. According to the report, "More jobs are created by efficiency investments than are lost in the electricity sector, as efficiency activities tend to be more labor intensive than power generation. Combined with job growth stimulated by electricity cost savings, joining RGGI generates over 1,800 jobs in 2010 increasing to a net gain of nearly 4,000 jobs by 2025."

The Role of Energy Efficiency Spending in Maryland's Implementation of the Regional Greenhouse Gas Initiative (2008)

Another CIER study from October 2008 further analyzed Maryland's participation in RGGI by estimating the economic impacts resulting from energy efficiency spending scenarios. RESI contributed to the impact analysis. A 100 percent energy efficiency spending scenario would result in approximately $150 million in additional State revenue in 2010 and more than $500 million in 2020 in State gross domestic product, whereas a 50 percent spending scenario would result in an additional $25 million in 2010 and more than $250 million in 2020. The related employment impacts are an additional 4,200 and 1,700 jobs in 2020 and the related fiscal impacts (allowance revenue) are an additional $74 million in 2010 and an increase to $140 million in 2020 and an additional $26 million in 2010 and more than $50 million in 2020, respectively, for the two spending scenarios.

According to the report, direct employment gains for services such as energy audits, installations and retrofits will occur as businesses and consumers seek energy efficiency improvements. Although the final report does not discuss in detail the specific industry sectors experiencing possible employment gains due to RGGI implementation, RESI retains some detailed impact data from its portion of the analysis. According to the IMpact analysis for PLANning (or IMPLAN) model output, new direct jobs would be created mainly in construction, education, and retail by 2025. New indirect jobs would be created mainly in administrative support, professional services, and retail, whereas new induced jobs would be created mainly in healthcare, retail, and accommodations and food service by 2025. For more information regarding the IMPLAN model and direct, indirect, and induced effects, please refer to Appendix E.

RGGI Green Job Estimations: Preliminary Analysis (2010)

A preliminary study completed by RESI for MDE in September 2010 analyzed the potential green job creation which could result from various RGGI energy efficiency funding scenarios. RESI used a baseline scenario which assumed a 25 percent energy efficiency spending level; a 50 percent spending level, and a 100 percent spending level. According to the report:

> "Increasing the share of RGGI funds directed to energy efficiency is expected to have a small positive impact on Maryland employment. Jobs created by electricity bill savings to residential and non-residential customers are the largest contributor and grow the fastest over time due to energy efficiencies accumulating with sustained investment."

Under the 50 percent and 100 percent spending scenarios, total green job creation compared to the baseline came to 64 jobs and 125 jobs, respectively, by 2020. According to RESI's analysis, the majority of these jobs would occur in the following industrial sectors: construction, administrative support, professional services, and manufacturing.

Other Legislation

The Department of Legislative Services analyzed the potential effects of specific pending federal climate legislation in a January 2009 report. Specifically, the report estimated economic impacts of the Lieberman-Warner Climate Security Act, which did not become enacted as a federal law. Analysis of the bill was conducted by the U.S. Environmental Protection Agency, and the results apply to the U.S. overall. According to the report, "As a result of the bill, annual reductions in gross domestic product would range from 0.9 percent ($238 billion) and 3.8 percent ($938 billion) in 2030, and between 2.4 percent ($1.012 billion) and 6.9 percent ($2.856 billion) in 2050." It is important to note that the results from this analysis reflect overall national effects; some states may derive comparatively positive economic impacts in comparison to other states with regards to climate mitigation policies.

While the specific industries which could experience job creation or retention directly related to the bill were not identified in the report, it does outline basic industries which could be affected by unmitigated climate change as well as the developing mitigation strategy recommendations in Maryland. Unmitigated climate change in Maryland is likely to affect the coastal economy and related industries, as well as the agriculture and forestry sectors and transportation and trade. The aforementioned strategies later became the recommended policies included in the 2008 Climate Action Plan. One of the cross-cutting recommendations, "Promote Economic Development Opportunities," recommended that Maryland "work with public and private entities to identify, promote, and finance opportunities for job creation related to new approaches to transportation, land use, green construction, recycling and reuse, and energy-efficient products and services." As this mitigation strategy was only a recommendation at the time the report was published, further detail for these industries was not available.

Synthesis

The climate policy studies introduced in the literature review section have estimated economic impacts resulting from a variety of assumptions, scenarios and legislation. Despite the challenge to compare these findings, there are some commonalities.

Among the CIER studies (many of which included contributions from RESI), job creation estimates vary somewhat based on the study period and evolving assumptions regarding Maryland's participation in RGGI, but remain in a conservative range between 0 and 4,200 up to the year 2025. Differences between the estimates can be explained by the focus of each study (such as energy efficiency spending versus policy implementation). Given that the CIER studies establish assumptions based on solid data (when available) and reasonable expectations, the aforementioned range seems to be a conservative estimate. In addition, RESI's recent findings of green job creation based on RGGI energy efficiency funding scenarios (ranging from 64 to 125 jobs by 2020) fit the range of job impacts estimated in various CIER reports.

Other similarities among the studies occur where industries and job types relating to job creation estimates are discussed. Many of the reports—including those from CIER, the International Center for Sustainable Development, the Maryland Commission on Climate Change, and RESI—expect job creation primarily occurring in industries such as clean energy (energy efficiency, renewable energy, green energy facilities, etc.), construction, transportation, and retrofitting. These are industries which would likely experience direct employment impacts. Although some of the studies reported the indirect and induced employment impacts as well, many of those studies did not report the specific industries experiencing indirect and induced impacts in detail. RESI's findings for the 2008 CIER report offered a general idea of these, as discussed in the previous section. A comparison of the specific ranges of job creation estimates between these studies is not as simple as with the CIER studies alone given that the study topics, assumptions, and study periods (i.e. span of years for which employment impacts are being estimated) involved in these studies varies much more widely.

Validation of the 2008 Climate Action Plan Economic Analyses

RESI reviewed the Center for Climate Strategies' data included in the 2008 Climate Action Plan, which included an estimate of $2 billion in economic activity resulting from all climate policies quantified by the Center for Climate Strategies and implemented by 2020. In order to validate this figure, RESI used the estimated GHG reductions for 2008-2020 and the cost effectiveness for each policy from the 2008 Climate Action Plan with quantified data as provided in Appendix D.

In most cases, the cost of policy implementation to the State government would also involve positive economic activity (generally in the form of sales) for related industry sector(s). In other words, the policies require that State government would change current behavior in order to implement policies by paying businesses for appropriate and related goods and services which assist in climate mitigation. RESI translated climate policy descriptions into related industries in order to determine inputs for this project element. RESI used IMPLAN, an input/output model, to assess the economic impacts. For more information regarding IMPLAN and RESI's methodology, please refer to the end of this section.

This method provides an updated and more in-depth idea of the economic activity resulting from the original 2008 Climate Action Plan policies. The economic activity associated with the current actual and proposed policy implementations is a separate analysis to be included in the December report deliverable. RESI's findings in regard to the economic impacts of the original climate policies quantified by the Center for Climate Strategies can be found in Figure 7-11.

Figure 7-11
Total Economic Impacts, 2008-2020

Impact	Direct	Indirect	Induced	Total
Employment	12,885.8	19,210.0	28,735.1	60,830.9
State GDP	$535,400,052	$1,997,584,042	$3,589,203,173	$6,122,187,267
Wages	$4,198,494,747	$858,913,077	$1,117,659,963	$6,175,067,787

Source: RESI

For the purposes of validation, RESI considers the lower bound to be an additional $535.4 million (direct impact to State gross domestic product) and the upper bound to be $6.1 billion (total impact to State gross domestic product). While this range is broad, it does encompass the Center for Climate Strategies' estimate of $2 billion in economic activity by 2020. In addition, it provides both a conservative estimate and a somewhat less cautious estimate. A median estimate between the lower and upper bounds would be approximately $3.3 billion.

If implementation of the original 2008 Climate Action Plan policies were to proceed exactly as planned and Maryland's economy reacted ideally and generated all potential spin-offs (indirect and induced impacts), the upper bound would be achievable. The lower bound, on the other hand, provides a conservative estimate which would account for potential fluctuations in the way Maryland's economy reacts to industry change. Such fluctuations could potentially include a variety of events which could affect Maryland's economy, including but not limited to firm relocation or closure, State legislation, natural disasters, etc. However, because these are merely hypothetical and generalized possibilities, the extent of the effects cannot be reasonably estimated. Simply put, the lower bound provides a cautious estimate. Because policy implementation will likely not occur exactly as the 2008 Climate Action Plan anticipates, this estimate is also a valid result to consider and expect.

The other economic impacts (employment and wages) included in Figure 1 reveal other effects of climate policy implementation on Maryland. According to RESI's analysis, overall employment from implementing the original 2008 Climate Action Plan policies is estimated to increase between 12,900 and 60,800 by 2020, and wages are estimated to increase between \$4.2 billion and \$6.2 billion by 2020. Although there may be fluctuations in the way Maryland's economy reacts to policy implementation and some industries may be subject to certain costs in the short-term, the results will be positive overall by 2020.

Conclusions – Literature Search and Synthesis

RESI completed a comprehensive literature review of readily available data related to Maryland's climate mitigation strategies and programs in development or already enacted. RESI also verified findings in the 2008 Climate Action Plan relating to potential economic impacts of mitigation strategies on Maryland's economy.

RESI's literature review indicates that it is likely that GHG reduction policy implementation in Maryland will have a positive effect overall in the next few decades. Although the level of positive economic impact is dependent on specific assumptions and parameters, there is no indication that climate policy implementation will have a net negative effect on Maryland's economy.

Review of the Center for Climate Strategies' data included in the 2008 Climate Action Plan report revealed estimated economic impacts above what was expected ($2 billion in economic activity by 2020). By RESI's estimates, the positive economic impact could range between $535.4 million (direct impact to State gross domestic product) and $6.1 billion (total impact to State gross domestic product). Other economic impacts (employment and wages, for example) would be correspondingly positive as well.

Overall, it is very likely that GHG reduction policy implementation in Maryland will result in positive economic impacts for the State. The magnitude of these impacts will depend on which climate policies are implemented by State agencies and how and when they are implemented

Reference Page

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International Center for Sustainable Development, RESI

Climate Action Plan. *Rep. Maryland Commission on Climate Change, 27 Aug. 2008. Web. 1 Apr. 2011.*

Economic and Energy Impacts from Maryland's Potential Participation in the Regional Greenhouse Gas Initiative. *Rep. CIER, Jan. 2007. Web. 1 Apr. 2011.*

RGGI Green Job Estimations: Preliminary Analysis. Rep. *RESI of Towson University, Sept. 2010. 16 June 2011.*

Industrial sectors equate to their definitions as provided by North American Industry Classification System.

Climate Change Policy and Maryland: Issues to Consider in the Greenhouse Gas Emissions Debate. *Rep. Department of Legislative Services, Jan. 2009. Web. 1 Apr. 2011.*

Constellation Energy has published a Corporate Social Responsibility Report for each year beginning in 2007. An inventory of GHG emissions is performed each year. The GHG inventory is comprised of direct emissions from generating electricity and indirect emissions that result from ancillary business activities, including building energy consumption, employee commute and employee business travel. Although Constellation Energy is ranked 22nd in total generation among the top 100 U.S. electricity generators, they are ranked 85th in carbon dioxide intensity. All of the Corporate Social Responsibility Reports are available online: *http://www.constellation.com/SocialResponsibility/Pages/SocialResponsibility.aspx*

Constellation Energy policy statements and emissions information is available online: http://responsibility.constellation.com/environmental-performance/

Constellation Energy environmental and sustainability goals can be found online: *http://responsibility.constellation.com/sustainability-approach/enviro-sustainability-goals/*

Frequently Used Abbreviations and Acronyms

BMPs; Best Management Practices

MDE: Maryland Department of the Environment

"The Strategy": Maryland's Climate Change Adaptation Strategy

DNR: Maryland Department of Natural Resources

UMCES: University of Maryland Center for Environmental Science

Chapter 8 Adaptation

Climate Change Adaptation

Climate change will affect Maryland in a variety of ways. More obvious impacts could include an increased risk for extreme events such as drought, storms, flooding, and forest fires; more heat-related stress; the spread of existing or new vector-born disease; and increased erosion and inundation of low-lying areas along the State's shoreline and coast. In many cases, Maryland is already experiencing these problems to some degree today. Climate change raises the stakes in managing these problems by changing the frequency, intensity, extent and magnitude of these problems.

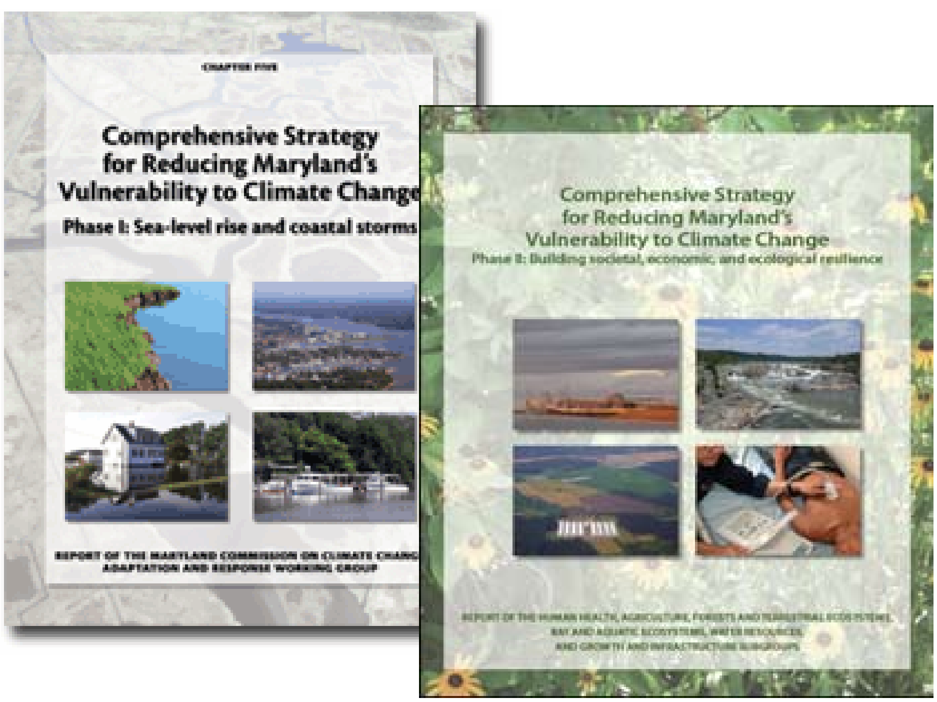
As the State moves forward with actions that will reduce greenhouse gases and ultimately result in increased energy efficiency, a more sustainable economy, and cleaner air; climate impacts will still be felt into the future. Therefore, adaptation, together with mitigation, is necessary to address climate change. It is noted, however, that these actions are by no means independent of each other and any program or policy to mitigate the effects of climate change will complement steps to reduce the State's risk to climate impacts.

Climate change adaptation is an extremely complex process and there is no single means of response. As stressed in a recent report by the National Academies, climate change adaptation must be a highly integrated process that occurs on a continuum, across all levels of government, involving many internal and external

Source: NASA/Goddard Space Flight Center Scientific Visualization Studio partners and individual actions, and often evolves at different spatial and temporal scales. That said, the State is already taking steps to enhance the resilience of a broad spectrum of our natural and human-based systems to the consequences of climate change.

Maryland's strategy for increasing resilience of its ecosystems and built infrastructure

Maryland's Climate Action Plan includes two climate change adaptation strategies that are currently being used to guide state-level adaptation planning efforts. The first strategy (Phase I), released in 2008, addresses the impacts associated with sea level rise and coastal storms. The second strategy (Phase II), released in 2011 as a compendium to the Climate Action Plan, addresses changes in precipitation patterns and increased temperature and the likely impacts to human health, agriculture, forest and terrestrial ecosystems, bay and aquatic environments, water resources, and population growth and infrastructure. Together, the strategies are the product of the work of more than 100 experts from the governmental, nonprofit, and private sectors that held a series of meetings for the purpose of interpreting the most recent climate change literature, evaluating adaptation options, and recommending strategies to reduce Maryland's overall climate change vulnerability.



The strategies provide the basis for guiding and prioritizing state-level activities with respect to both climate science and adaptation policy over the near and longer terms. Implementation of a variety of projects designed to implement components of the strategies is well underway and additional efforts have been identified as high-priorities for early action. Summaries of Maryland's Phase I and II adaptation strategies, including current and planned near-term implementation efforts, are outlined below.

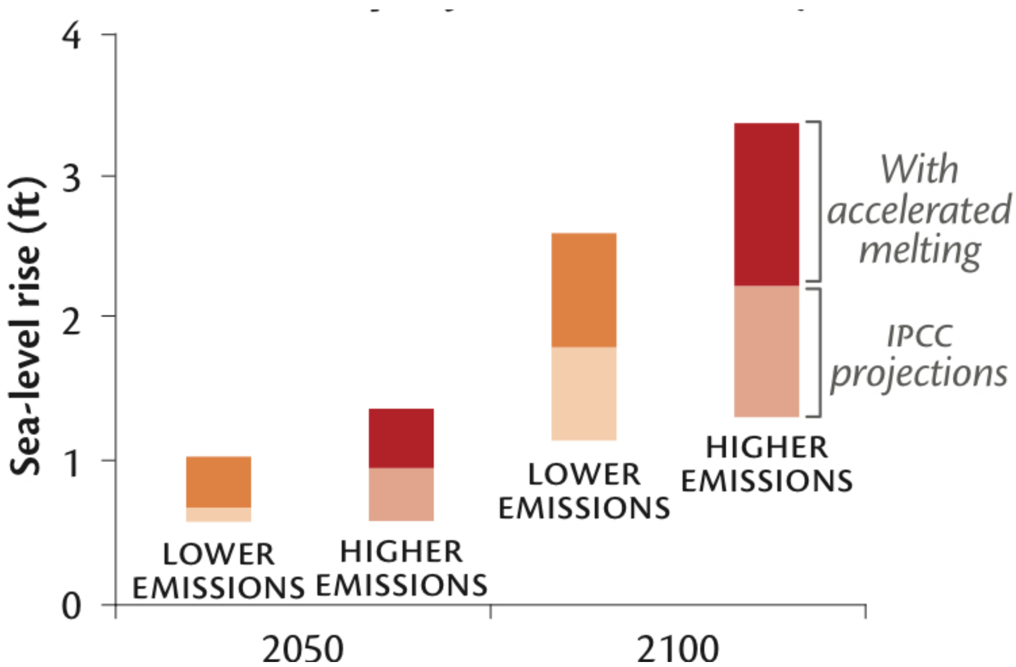
Leading by Example

Maryland Department of Natural Resources (DNR)

Initiative: "Lead by Example" Policy: *Building Resilience to Climate Change*

Description: DNR has the lead role among State agencies in advancing the scientific understanding of Maryland's vulnerability to climate change, and advocating for sound planning to avoid or minimize the anticipated impacts. In October 2010, DNR issued a new policy to direct its investments in and management of land, resources, and assets so as to better understand, mitigate and adapt to climate change. The policy establishes practices and procedures related to new land investments, facility siting and design, habitat restoration, government operations, research and monitoring, and resource planning. The goal of the policy is to lead by example; and along the way, encourage and educate others in the methods for managing natural resources and designing facilities with an understanding of the effects of climate change.

Figure 8-1
Sea-level Rise Projections in Maryland



Source: Maryland Climate Action Plan (2008). Image courtesy of UMCES and MD DNR

Sea Level Rise and Coastal Storms

Background

The Chesapeake Bay region's geography and geology make the State one of the three most vulnerable areas of the country to changes resulting from sea level rise – only Louisiana and Southern Florida are more susceptible. Historic tide records show sea level increased approximately one foot in the Chesapeake Bay over the last 100 years. Estimates provided by the Scientific and Technical Workgroup of the Maryland Commission on Climate Change indicate that Maryland is projected to experience between 2.7 to 3.4 feet of sea level rise over the next century.

The Phase I Strategy, produced by the Maryland Commission on Climate Change's Adaptation and Response Working Group, detailed the actions necessary to protect Maryland's future economic well-being, environmental heritage, and public safety in the face of climate change and sea level rise.

SEA-LEVEL RISE ACTION PLAN—KEY RECOMMENDATIONS

Take action now to protect human habitat and infrastructure from future risks.
Require the integration of coastal erosion, coastal storm, and sea-level rise adaptation and response planning strategies into existing state and local policies and programs. ***Develop*** and ***implement*** state and local adaptation policies (i.e., protect, retreat, abandon) for vulnerable infrastructure. ***Strengthen*** building codes and construction techniques for new infrastructure and buildings in vulnerable coastal areas.

Minimize risks and shift to sustainable economies and investments.
Develop and ***implement*** long-range plans to minimize the economic impacts of sea-level rise to natural resource-based industries. ***Establish*** an Advisory Committee to advise the state of the risks that climate change poses to the availability and affordability of insurance. ***Develop*** a Maryland Sea-Level Rise Disclosure and Advisory Statement to inform prospective coastal property purchasers of the potential impacts of climate change. ***Recruit, foster,*** and ***promote*** market opportunities related to climate change adaptation and response.

Guarantee the safety and well-being of Maryland's citizens in times of foreseen and unforeseen risk.
Strengthen coordination and management across agencies responsible for human health and safety. ***Conduct*** health impact assessments to evaluate the public health consequences of climate change and sea-level rise-related projects and/or policies. ***Develop*** a coordinated plan to assure adequacy of vector-borne surveillance and control programs.

Retain and expand forests, wetlands, and beaches to protect us from coastal flooding.
Identify high priority protection areas and strategically and cost-effectively direct protection and restoration actions. ***Develop*** and ***implement*** a package of appropriate regulations, financial incentives, and educational, outreach, and enforcement approaches to retain and expand forests and wetlands in areas suitable for long-term survival. ***Promote*** and ***support*** sustainable shoreline and buffer area management practices.

Give state and local governments the right tools to anticipate and plan for sea-level rise and climate change.
Strengthen federal, state, local and regional observation systems to improve the detection of biological, physical, and chemical responses to climate change and sea-level rise. ***Update*** and ***maintain*** state-wide mapping, modeling, and monitoring products. ***Utilize*** new and existing educational, outreach, training, and capacity-building programs to disseminate information and resources related to climate change and sea-level rise.

State and local governments must commit resources and time to assure progress.
Develop state-wide sea-level rise planning guidance to advise adaptation and response planning at the local level. ***Develop*** and ***implement*** a system of performance measures to track Maryland's success at reducing its vulnerability to climate change and sea-level rise.

Implementation Status

In 2008 Maryland passed two pieces of key legislation called for in the Strategy: The Living Shoreline Protection Act, and amendments to the Chesapeake and Coastal Bays Critical Area Act. Both will reduce Maryland's vulnerability over time, and protect natural resources from the impacts of sea level rise by restoring natural shoreline buffers such as grasses and wetlands, helping to limit new growth in vulnerable areas. In addition to these two pieces of legislation, a variety of other projects designed to implement the Strategy have been completed or are currently underway.

DNR

Initiative: Local Government Technical and Financial Assistance: *Coast Smart Communities*

Description: DNR developed the Coast-Smart Communities Initiative to support local level implementation of the adaptation strategy. Under the initiative, DNR administers a competitive grant program to provide financial and technical assistance to local governments looking to reduce their vulnerability to the effects of coastal hazards and sea level rise through planning and permitting activities. Grants of up to $75,000, drawn from the State's federal Coastal Zone Management Act funds, are awarded on an annual basis and may be renewed for up to three additional years. A community self-assessment tool currently in development will allow for improved targeting of grants to help address coastal hazards in the most vulnerable communities.

Initiative: Adaptation Toolbox: *The Coastal Atlas*

Description: Maryland is using the latest technology and detailed information to undertake state-of-the-art sea level rise mapping and research. Results acquired by both DNR and individual Maryland counties are housed on Maryland's Coastal Atlas, an online mapping application designed to provide easy access to the data and tools needed by local governments to become ready, adaptive, and resilient to the impacts of sea level rise and coastal hazards. Data products and technical tools currently available on The Coastal Atlas include: State-wide sea level rise vulnerability mapping, historic shoreline position and erosion rate calculations, a comprehensive shoreline inventory, storm surge inundation modeling and information relating to erosion vulnerability. The Coastal Atlas mapping application will undergo a drastic overhaul to its design and tools in early 2012 to make it easier to use and to provide increased functionality.

Maryland Department of Transportation (MDOT)

Initiative: ***Transportation Vulnerability Assessment***

Description: MDOT is working to assess Maryland's critical transportation facilities and systems' vulnerability to projected sea level rise and extreme weather damage. This assessment will provide the information necessary to evaluate options for dealing with potential impacts to infrastructure and connectivity, as well as aid in the development of adaptation policies for existing and planned transportation facilities. The assessment will ultimately influence long-term strategic planning for system adaptation that can account for the uncertainty of future climactic conditions. Among Maryland agencies, the Maryland State Highway Administration and the Maryland Transportation Authority have the largest and most geographically dispersed network of facilities requiring the most complex long-term action plan. The two agencies are currently in the process of assessing and inventorying their mode-specific transportation system vulnerability and expect to issue action plans by June 2012.

Initiative: ***Maryland Port Administration (MPA) Climate Change Vulnerability Assessment and Recommendations***

Description: As a component of the overall Maryland Transportation Initiative described above, the Maryland Port Administration prepared the report, "Climate Change Vulnerability Assessment and Recommendations" in 2010. The report provides recommendations for future capital investments based on the findings of the vulnerability assessment. In response, MPA developed a policy titled "Incorporating Climate Change and Sea Level Rise Information into the Public Marine Terminal and Harbor Development Process." The policy identifies the need for MPA to make infrastructure and facility improvement decisions that consider climate change and sea level rise. As MPA reviews its Strategic Plan and Marine Terminal Development Plans, it plans to factor sea level rise and potential storm surge inundation into its evaluation of proposed projects. Additionally, MPA proposes, as a participant in the Maryland Dredged Material Management and Federal Dredge Material Management Programs, to work with its partners to incorporate climate change vulnerability analysis into decision-making processes.

Photo Credit: Joanna Woerner, UMCES

Maryland Department of Planning, Maryland Historical Trust (MHT)

Initiative: ***Historical, Archaeological, and Cultural Resources Vulnerability Study***
Description: Rising sea levels, erosion, and major storms all pose a significant threat to historic and archeological sites, districts, and landscapes. In 2010, MHT completed a vulnerability assessment of historical and cultural resources in Maryland. The types of resources evaluated were national historic landmarks, properties listed on the National Register of Historic Places, Maryland Historic Trust preservation easements, locations on the Maryland Inventory of Historic Properties, archeological sites, and National Register-eligible buildings. The study was completed using inundation level data from DNR in a geographic information system. The results from this preliminary assessment raise awareness of this issue, which now will be addressed through the PreserveMaryland planning process, and included in the forthcoming long-range historic preservation comprehensive plan.

Maryland Insurance Administration (MIA)

Initiative: ***Climate Change Insurance Advisory Committee***

Description: In the fall of 2008, the Maryland Insurance Commissioner convened a Climate Change Insurance Advisory Committee. The committee was charged with:

- Reviewing the adequacy of the data available to insurers to assess the risk imposed by climate change;
- Examining whether adaptive options are available to help mitigate losses and whether rating can be structured to provide an incentive for these options; and
- Reviewing ways to promote partnerships with policyholders for loss mitigation.

The committee released its final report in December 2010.

Maryland Department of the Environment (MDE)

Initiative: ***Living Shoreline Regulation Development***

Description: In 2008, the Maryland legislature enacted the Living Shoreline Protection Act requiring riparian property owners to rely upon "living shorelines" – nonstructural shoreline stabilization measures such as marsh creation – whenever feasible, to protect shorelines from erosion while also providing critical wildlife habitat. A variety of State agencies are involved in implementing the program and related efforts. MDE is charged with developing implementing regulations in cooperation with DNR. MDE is expected to publish draft regulations in 2012 providing a process for applicants to obtain a waiver to the requirement wherever non-structural measures are not feasible. In addition, MDE has mapped areas where traditional structural solutions are allowed without seeking a waiver. The maps are available on the MDE website.

Department of Housing and Community Development (DHCD)

Initiative: ***Review of Current State-wide Building Codes and Recommendations for Enhancement in Coastal Regions of Maryland***

Description: As required under Section 2 of the Omnibus Coastal Property Insurance Reform Act of 2009 (Act), Chapter 540 (House Bill 1353), DHCD conducted reviews and prepared a report to members of the Senate Finance Committee and House Economic Matters Committee (Members) on "…enhanced building codes for coastal regions of the State that promote disaster-resistant construction in the coastal regions of the State..." The report was delivered to Members in October, 2010. The report was also provided to planning boards of the counties in the coastal areas of the State.

Photo Credit: Joanna Woerner, UMCES

Maryland Emergency Management Agency (MEMA)

Initiative: ***State Hazard Mitigation Plan***

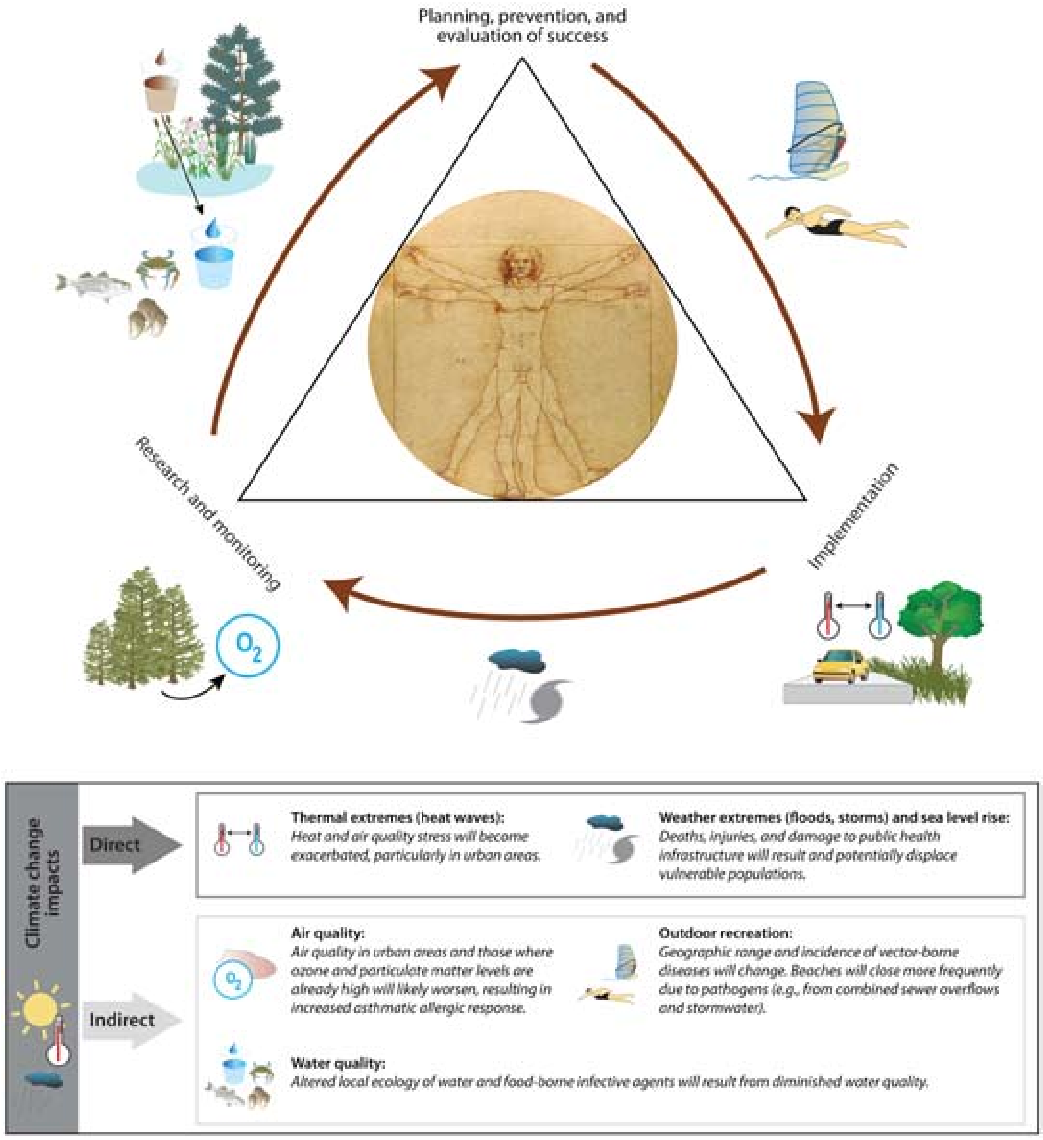
Description: Maryland's 2011 State Hazard Mitigation Plan was approved by Governor Martin O'Malley in September 2011. Vulnerability to climate change, coastal hazards and sea level rise issues was evaluated as part of the State risk assessment and specific adaptation strategies were included in the overall mitigation plan. Future iterations of the State Hazard Mitigation Plan are expected to include risks associated with non-coastal impacts of climate change as prioritized in the mitigation plan.

Human Health

Background

Climate change poses serious health risks to people in Maryland, including heat-related stress and cardiovascular mortality and morbidity, respiratory illness, altered infectious disease patterns (both vector-borne and water-borne diseases), impacts to water supply and quality, and direct or mental harm from extreme storm events and flooding. There is a need to manage these preventable impacts, particularly in a system that historically has been able to adapt to and reduce the vulnerability of health risks. But without appropriate action, highly preventable mortality and health complications that are influenced by climate are likely to increase.

Climate Impacts Likely to Affect Human Health
Courtesy of UMCES and MD DNR



Courtesy of UMCES and MD DNR

Climate change represents an overlying stressor that changes the environmental context of health, and disproportionately affects certain populations and communities. Many of these health issues will result from interactions between climate change, ecological changes, and the characteristics of existing infrastructure (e.g., lack of shade or air conditioning; old or unsuitable water supply and treatment facilities). Other impacts to nutrition and mental health may occur, though these are less certain, and include increased food-borne illness or psychological effects from extreme events. Harmful algal blooms and water-borne diseases also may affect the health of Maryland's citizens. The vulnerability of Maryland's citizens to climate risks is shaped by the degree to which they are exposed to these influences and also by a number of factors affecting their sensitivity and adaptive capacity.

Human Health

Priority Recommendations		Lead Agency	Key Partners	Priority	Timeframe	Potential Cost
Conduct vulnerability assessments to gain a better understanding of risk and inform preventative measures.	Assess potential health threats and the sufficiency of Maryland's response capacity.	DHMH	MEMA	TBD	TBD	TBD
	Evaluate impacts to food safety and availability.	DHMH	MDA	medium	medium-term	TBD
	Assess the vulnerability of Maryland's populations and communities to changing health threats.	DHMH	MDP, MDE	medium	long-term	TBD
	Identify potential barriers to effective emergency response.	DHMH	MEMA	high	medium-term	TBD
Integrate impact reduction strategies into State and local planning practices.	Improve response capacity through the development of new or expanded programs.	DHMH	MEMA	medium	long-term	high
	Address climate-related health risks in hazard mitigation and emergency response plans.	DHMH	MEMA	medium	TBD	TBD
	Support community engagement in planning and emergency response decisions.	DHMH	MEMA	medium	long-term	TBD
	Pursue opportunities to enhance protection of Maryland's "green infrastructure".	DNR	DHMH, MDP	TBD	TBD	TBD
Streamline and revise data collection and information dissemination channels.	Improve the resolution and availability of health and population data.	DHMH	UMD, MDP, CDC, EPA	high	ongoing	high
	Analyze health and population data along with other spatially explicit information (e.g., land use, air quality, water quality).	DHMH	DNR, MDP, MDE, EPA, CDC	high	ongoing	high

Courtesy of UMCES and MD DNR

"Even as our (oyster) population stood at 1 percent of historic levels, we did not give up ... and we now have exciting new evidence that — like our blue crab — our native oyster has not given up either. We now have reason to be more optimistic than ever about the recovery of this iconic species, a recovery that would further improve water quality, create green jobs and support local economies. Moving forward, it is our responsibility to strengthen our restoration commitment, our enforcement actions and our investment to further protect our future broodstock."

Governor Martin O'Malley, February 2011

Implementation Status

Maryland Department of Health and Mental Hygiene (DHMH)

Initiative/Action*: Promote the assessment of health impacts when evaluating State policies on Greenhouse Gas Reductions*

Description: To ensure that risks, costs, and benefits are evaluated in a systematic manner, the Department of Health and Mental Hygiene will work with other state agencies to review all climate change and energy related policies and legislation for health benefits and risks to all Maryland's citizens. Careful attention will be given to vulnerable populations such as children and senior citizens.

Initiative/Action: ***Enhanced Environmental Public Health Tracking infrastructure***

Description: A combined effort is needed in order to minimize the public health risks of climate change. Through continued coordination between DHMH and other State agencies, preemptive measures can be taken to both prevent and minimize the impact of climate change on public health. In 2002, DHMH received Center for Disease Control funding to plan for a State-wide Environmental Public Health Tracking Network that will be part of the national tracking network. Maryland used the funding to build capacity and enhance infrastructure. The results range from starting or improving surveillance, to enabling faster responses to environmental public health questions, and faster action to prevent disease.

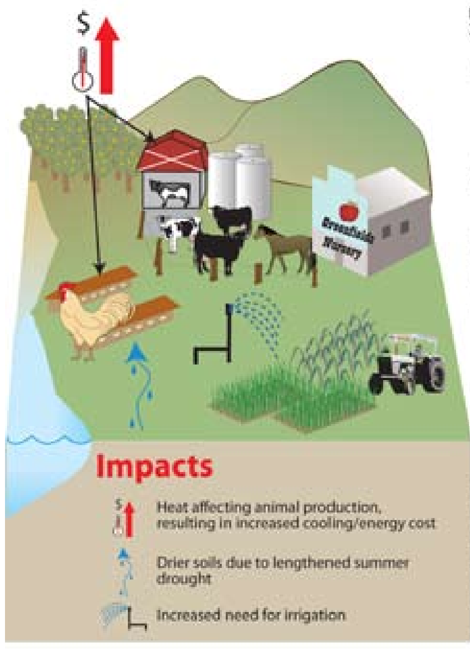
Initiative/Action*: Development of Climate Health Indicators*
Description: DHMH is working with the Commission on Environmental Justice and Sustainable Communities, MDE and MDP on the introduction of health indicators that could be used by MDP and other agencies to evaluate the potential impacts of climate change adaptation or mitigation strategies, as well as the potential health consequences of projects related to adaptation to sea level rise. DHMH has strengthened its coordination with DNR and MDE related to monitoring and reporting of Chesapeake Bay-related health concerns, specifically with respect to harmful algal blooms.

Agriculture

Background

Agriculture is the largest commercial industry in Maryland, employing about 350,000 people, primarily in the north-central and Eastern Shore regions. Farms occupy about two million acres, or about one-third of the State's land, though individually the farms are, on average, much smaller than those in other states. Maryland's agriculture is diverse, including nursery plants, dairy products, beef cattle, vegetables, wheat, horses, and fruit. Poultry, fed by largely locally produced corn and soybeans, maintains the largest market value. Projected increases in temperature, precipitation variability, and frequency of extreme events associated with climate change are likely to affect the conditions upon which farming has been established. Many of the stressors farms already face are likely to intensify or become less predictable: drought frequency, winter flooding, pests and disease, and ozone levels. These changes occur in the current context of the high economic uncertainty and small profit margins, and are likely to result in increased costs to both farmers and consumers.

Major Maryland Agriculture Products, Likely Climate Impacts, and Adaptation Strategies



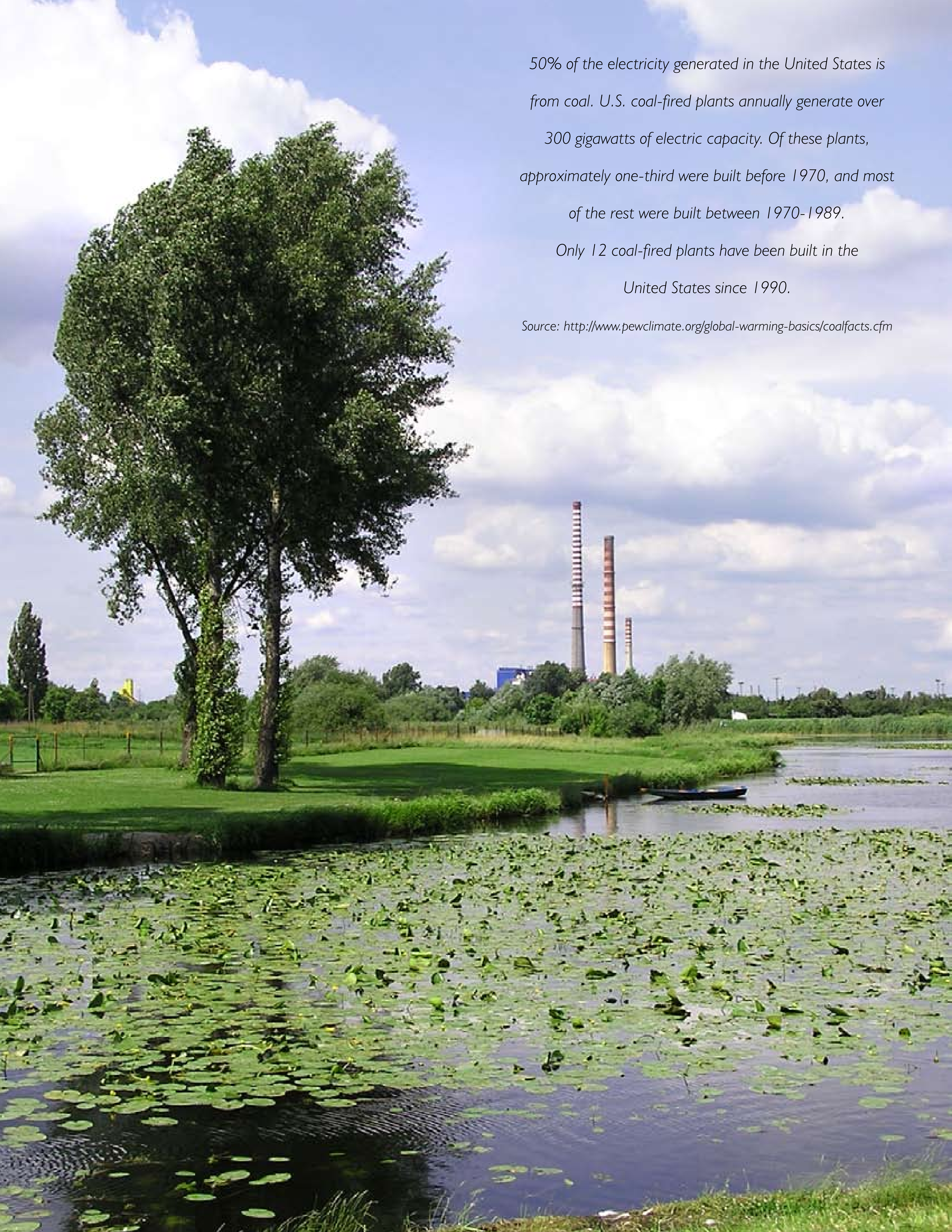
Product (ranked by 2007 market value, USDA Census)	Climate impact	Adaptation strategy
Poultry	Increased cooling costs; decreased production; changing disease presence	Improve energy efficiency of housing; bioenergy use; improve ability to monitor disease and quarantine
Grains, oilseeds, dry beans, peas	Water stress: increased irrigation use; winter flooding; changes in crop yield quantity and quality	Diversify cultivar and crop types; improve water management systems; improve pest forecasting
Nursery, greenhouse, floriculture, sod	Increased cooling costs; water stress	Establish emergency response systems; improve energy efficency of housing
Milk and dairy	Decreased milk productivity; changing disease presence; low-quality pasture during drought	Increase shade and cooling; improve ability to monitor disease and quarantine; manage pastures for drought
Cattle and calves	Changing disease presence; heat stress; low-quality pasture during drought	Increase shade and cooling; improve ability to monitor disease and quarantine; manage pastures for drought; farm heat-toleant breeds
Vegetables, melons, potatoes, other crops, hay	Water stress: increased irrigation use; winter flooding; changes in crop yield quantity and quality	Diversify cultivar and crop types; improve water management systems; improve pest forecasting
Horses, ponies, mules, burros, donkeys	Heat stress; low-quality pasture during drought	Increase shade and cooling; manage pastures for drought education about heat stress
Fruit trees, nuts, berries	Water stress: increased irrigation use; increased pest damage	Diversify cultivar and crop types; improve water management systems; improve pest forecasting

Courtesy of UMCES and MD DNR

To adapt to a changing climate, farmers will require guidance on climate smart crop species, and strategies to reduce poultry and livestock loss and stress associated with heat. More intense water management will be needed to offset the impacts of growth, and uncertainty in water supplies on agricultural production and water resources.

50% of the electricity generated in the United States is from coal. U.S. coal-fired plants annually generate over 300 gigawatts of electric capacity. Of these plants, approximately one-third were built before 1970, and most of the rest were built between 1970-1989. Only 12 coal-fired plants have been built in the United States since 1990.

Source: http://www.pewclimate.org/global-warming-basics/coalfacts.cfm



AGRICULTURE

	Priority Recommendations	Lead Agency	Key Partners	Priority	Timeframe	Potential Cost
Increase crop diversity, protect against pests and disease, and intensify water management.	Promote diversification of crop species and varieties.	MDA	UMD Extension (UME), local agricultural producers	low	ongoing	TBD
	Intensify water management and conservation through research, funding, and incentives.	MDA	UME, MDE, DNR, USDA, EPA, Bay Trust	high	ongoing	high
	Protect against incoming pests, weeds, and disease.	MDA	UME	low	ongoing	TBD
	Support innovative solutions that foster adaptation and also reduce energy costs and carbon footprints.	MDA	UME, MEA	medium	ongoing	TBD
Strengthen applied research, risk communication, and technical support	Enhance dissemination channels to improve the relay of climate information.	MDA	UME, SCDs, NRCS, NGOs, commodity orgs	low	ongoing	TBD
	Identify opportunities to support the transition of farm and agricultural practices.	MDA	UME, NRCS, Farm Credit, insurance industry	low	long-term	TBD
	Enhance emergency response and risk management.	MDA	UME, Farm Credit, insurance industry	low	ongoing	TBD
Enhance existing best management practices and land conservation targets.	Evaluate the effectiveness of BMPs under future climate change scenarios.	MDA	UMD, DNR, MDE	low	ongoing	TBD
	Assess and revise targets for agricultural land preservation.	MDA	local and regional land trusts	low	ongoing	TBD

Courtesy of UMCES and MD DNR

It is the broad goal of these strategies to help reduce stress on agricultural operations and to build the resilience of Maryland farms, despite changes they may face in the future, and to improve the quality of the Chesapeake Bay and its watershed. As climate change may affect the intensity of how farmers manage, alter effectiveness of agricultural BMPs, and affect the implementation of relevant regulations, farmers need to be prepared and supported for adjustments that may be required.

Implementation Status

Maryland Department of Agriculture

Initiative/Action: *Invasive Plants Advisory Committee*

Description: The invasive plant bill (HB 831) addresses the nursery trade of invasive plant species in the State of Maryland. This bill will address the negative impacts of an increase in invasive species expected to occur as a result of changes in temperature and rainfall patterns. The bill establishes the Invasive Plants Advisory Committee in the Department of Agriculture; providing for the membership and charge of the Committee; requiring the Secretary of Agriculture to adopt regulations relating to invasive plants by October 1, 2012; prohibiting specified activities involving specified invasive plants under specified circumstances; authorizing the Secretary to take specified action upon finding invasive plants; etc. The bill recognizes the economic, ecological, and health impacts of invasive species and aims to increase ecosystem resilience. It will employ a comprehensive science-based risk assessment protocol that will generate a tiered list of the State's invasive plants. It will ban the most highly invasive species and includes a provision that will require retailers to post signs, warning consumers of the environmental hazards of these plants.

Maryland Department of Health and Mental Hygiene/DNR/MDA

Initiative/Action: ***Vector-borne disease surveillance and control***

Description: Maryland State officials continue to track the spread of WNV and other arboviral activity in the State in vector species, host animals, and humans. This allows for ongoing enhancement and deployment of effective tools to support surveillance, prevention, and control of West Nile virus and other arthropod-borne viruses, including novel or emerging pathogens that threaten the health of Maryland residents. In addition, the Mid-Atlantic Zoonotic and Vector Borne Disease Inter-Agency Workgroup (MAZV), a collaboration between DHMH, DNR, MDA, and researchers, practitioners, and federal agency partners meets regularly to monitor and discuss vector borne disease activities in Maryland and the surrounding regions.

Forests and Terrestrial Ecosystems

Background

The diversity of Maryland's forests and terrestrial ecosystems reflects the wide variety of environmental conditions found across the State's five major physiographic provinces. Not only do forested systems regulate climate and sequester carbon, but they play a major role in any adaptation plan to reduce the impacts of urban heat, enhance migration corridors, mitigate flooding, protect drinking water supplies, and reduce nutrient and sediment runoff. From the mountains to the sea, one can hike through western Maryland's thick groves of hemlock lining deep gorges, across grassy serpentine barrens supporting the unique purple-flowered fringed gentian, by vernal pools inhabited by salamanders, and through the pine forests and hardwood swamps of the Eastern Shore. The State's forests are mostly privately owned and only 27 percent are permanently protected from development. These habitats and their plant and animal communities are shaped mainly by geology, climate, and interactions with other species. They also are subject to many existing stressors such as development, pests and pollution, limiting their capacity to adapt.

Forests and terrestrial ecosystems contribute an estimated $2.2 billion to Maryland's economy and $24 billion in ecological services. The condition of these ecosystems and the services they provide is likely to be altered by climate change. Climate change will alter distributions of species and habitats and exacerbate existing stressors at an uncertain rate and degree. Native species populations may decline, increase, or migrate from the State, while new species may migrate in due to habitat shifts. Services provided by forests such as temperature regulation, water filtration, aesthetic value, and habitat may be altered. Existing stressors on species and habitats may be exacerbated by climate change.

Forests and Terrestrial Ecosystems

	Priority Recommendations	Lead Agency	Key Partners	Priority	Timeframe	Potential Cost
Expand land protection and restoration and revise targeting priorities.	Integrate climate data and models into existing resource assessments and spatial planning frameworks.	DNR	EPA, CBP, USDOI, USFWS, NGOs, NASA, NOAA	high	medium-term	medium
	Incorporate climate change adaptation strategies into State resource management plans.	DNR	MDP, EPA, CBP, USDOI, USFWS, NOAA, USFS, NGOs	high	medium-term	low
	Collaborate with federal partners to support regional and national adaptation planning.	DNR	EPA, CBP, USDOI, USFWS, NOAA, USFS, NGOs	medium	medium-term	low
	Update existing land protection targeting programs and project evaluation protocols.	DNR	EPA, CBP, USDOI, USFWS, NOAA, USFS, NGOs	high	ongoing	medium
	Develop climate change adaptation guidance and technical tools suitable for local government planning.	DNR	MDP, UME	high	ongoing	medium
Adjust management practices and reduce existing stressors.	Strengthen State and local programs to slow the loss and fragmentation of forest and terrestrial ecosystems to new development.	DNR	MDP, MDE, MDOT, USFWS, USFS, EPA, CBP, NGOs	high	ongoing	medium
	Review and revise forestry best management practices.	DNR	UME	medium	medium-term	medium
	Continue to support incorporation of the policies and strategies of Maryland's Sustainable Forestry Act of 2009 into State and local planning decisions.	DNR	State Forest Conservancy District Boards	high	ongoing	low
	Evaluate sustainable forestry certification programs for opportunities to enhance climate resilience.	DNR	Sustainable Forestry Initiative, Forestry Boards, Forest Stewardship Councils	medium	medium-term	medium
	Improve capacity to manage and respond to stressors exacerbated by climate change.	DNR	MDA, MD Invasive Species Council, Forest Health Emergency Contingency Program	medium	short-term	high
Foster stewardship on private lands.	Develop new tools to guide adaptation stewardship activities on private lands.	DNR	Forest Stewardship Councils, UMD Extension	high	short-term	medium
	Incorporate adapatation concerns into existing programs.	DNR	USFS, Forest Stewardship Councils, UMD Extension	high	short-term	medium
	Develop new conservation easement mechanisms to promote adaptation stewardship activities on private lands.	DNR	USFS, Forest Stewardship Councils, UME, MDA	high	ongoing	low

Courtesy of UMCES and MD DNR

Implementation Status

Maryland Department of Natural Resources

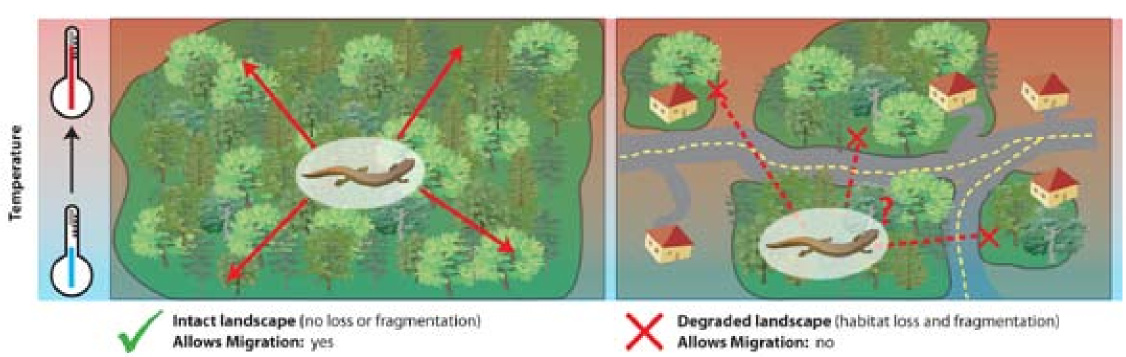
Initiative/Action: ***GreenPrint Update***

Description: Maryland's GreenPrint initiative identifies the most ecologically valuable areas in the State and designates these lands and waters as "Targeted Ecological Areas (TEAs)." TEAs are the "best of the best" natural resources across the State. TEAs were first defined in 2008 and included the most ecologically important large blocks of forests and wetlands; wildlife and rare species habitats; aquatic biodiversity areas; and forests for protecting water quality. In 2011, MDNR updated TEA designations to include coastal ecosystems; habitats for climate change adaptation and marsh migration, and areas for supporting commercial and recreational fisheries. Together, these areas are identified as conservation priorities by DNR for natural resources protection. The 2011 revisions are complete, but have not yet been implemented in DNR's conservation scoring protocol. After a period of testing and refinement, the protocol is anticipated to be adopted in January 2012.

Initiative/Action: ***Wildlife Vulnerability Assessment***

Description: DNR has conducted a vulnerability assessment of GCN species using Nature Serve's Climate Change Vulnerability Index. DNR also is participating in an expert panel effort in the northeast headed by the Manomet Center for Conservation Science to assess the likely impacts of climate change on northeastern fish and wildlife habitats and species of greatest conservation need. All of this information is planned for incorporation into the next version of Maryland's State Wildlife Action Plan.

Climate Change Interactions on Habitat Fragmentation and Degradation



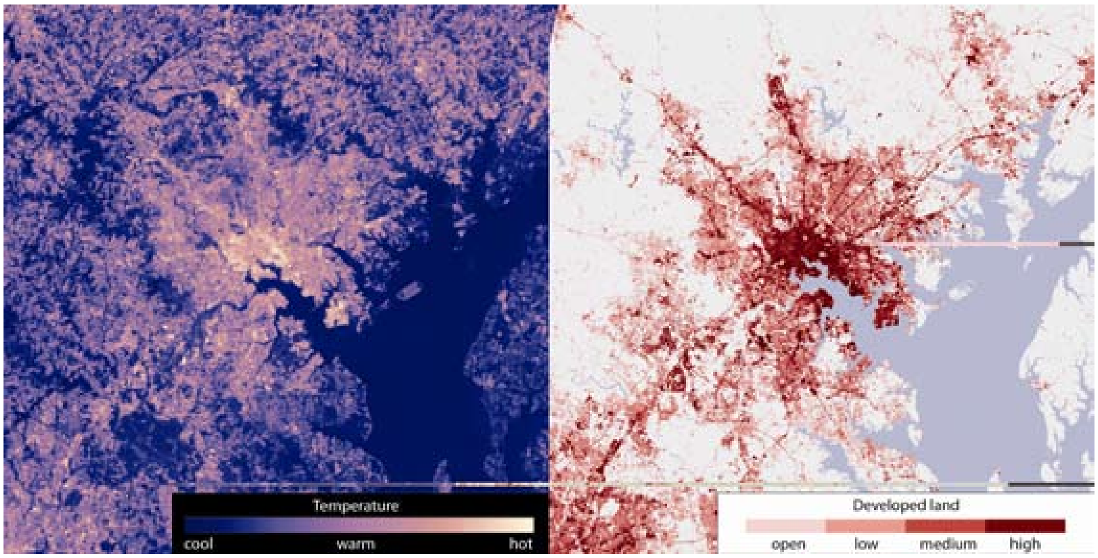
Courtesy of UMCES and MD DNR

Initiative/Action: ***Forest Management Plans***
Description: In 2011 DNR's Forest Service included climate change and adaptation information as a required element in forest management plans. These plans are required by any forest landowner who participates in State property tax abatement programs or USDA forestry programs, and thus will reach a wide audience.

Initiative/Action: ***Maryland Forest Resource Assessment and Strategy***
Description: DNR Forest Service has incorporated climate change into their 2010 Forest Resource Assessments as an additional stressor. Climate change also was identified as one of the top five areas for action in their five year strategy. As part of this, the Forest Service is working with other local, state, and federal agencies to incorporate adaptation into existing forestry programs.

Initiative/Action: ***Urban Tree Canopy Assessment***
Description: DNR is currently working to maintain and improve the health and longevity of trees in urban areas and increase the urban tree canopy cover throughout Maryland. Urban trees shield buildings from cold winds and lower ambient summertime temperatures, reducing heating and cooling costs and the demand for energy production and reducing vulnerability to the effects of heat waves on at-risk populations. Reduced heat slows the formation of ground level ozone as well as the evaporation of fuel from motor vehicles. Thirty-seven communities in Maryland have committed to participation in the UTC Goal effort to date. Baltimore, Annapolis, and the Frederick County Board of Education have already adopted goals; the other communities are in the process of assessing their existing and potential UTC. Communities like Baltimore also have begun to prioritize plantings for urban heat reduction and water quality improvement.

Developed areas in Baltimore exhibit the heat island effect on a hot August Day in 2011. Temperature signal is uncalibrated
(Data: NASA National Land Cover Database and Landsat 7 imagery)



Courtesy of UMCES and MD DNR

Bay and Aquatic Ecosystems

Background

The Chesapeake Bay is the largest estuary in the United States, fed by a watershed that stretches from mountains to sea, across 64,000 square miles (166,000 square kilometers), spanning six states — Maryland, Delaware, Virginia, West Virginia, Pennsylvania, New York, and the District of Columbia. Within its watersheds and oceanfront, Maryland's extensive aquatic ecosystems range from freshwater swamps and bogs, tidal and non-tidal freshwater rivers and marshes, tidal brackish and saline rivers and marshes to coastal bays. These ecosystems are influenced by precipitation, temperature, tropical storms, and human activity. Currently, the services provided by the Bay are estimated to be approximately $1 trillion annually. However, human development and pollution have degraded their natural resilience, leaving them more vulnerable to extreme events. Climate change will likely exac-

Photo Credit: P. Alejandro Diaz

erbate this problem, creating a greater threat to these ecosystems. The Bay already has warmed by 3 degrees Fahrenheit and additional temperature increases could change the composition of commercial fisheries and increase anoxia in the Bay. To protect its marine, estuarine and aquatic ecosystems against future damage, action is needed to alleviate existing stressors and to strategically conserve and restore critical bay and aquatic habitats.

Bay and Aquatic Ecosystems

	Priority Recommendations	Lead Agency	Key Partners	Priority	Timeframe	Potential Cost
Advance protection of at-risk species and habitats.	Revise state-level protection targeting programs to reflect climate change adaptation priorities.	DNR	UMD, USACE, USGS, USFWS, NOAA, NGOs	high	ongoing	low
	Develop new protection and conservation mechanisms to promote adaptation stewardship activities on private lands.	DNR	UMD, USACE, USGS, USDOI, USFWS, NOAA, NGOs	medium	medium-term	medium
	Amend legal mechanisms to designate and protect temperature-sensitive streams.	DNR	MDE, EPA	high	ongoing	medium
	Implement an adaptive management approach.	DNR	MDE, MDOT, MDA, MDP, federal partners, NGOs	high	medium-term	low

Bay and Aquatic Ecosystems, continued

	Priority Recommendations	Lead Agency	Key Partners	Priority	Timeframe	Potential Cost
Restore critical bay and aquatic habitats to enhance resilience.	Proactively pursue, design, and construct habitat restoration projects to enhance the resilience of bay and aquatic ecosystems.	DNR	USACE, USGS, USFWS, NOAA, EPA, CBP, NGOs	high	long-term	high
	Conduct an audit of state-owned lands to identify habitat restoration potential for enhancing ecosystem resilience and increasing on-site carbon sequestration.	DNR		medium	short-term	low
	Increase on-the-ground implementation of existing stream restoration practices.	DNR	USGS, EPA, CBP, USFWS	high	short-term	high
Reduce existing stressors.	Remove barriers to habitat connectivity.	DNR	MDE, USFWS, NOAA	high	ongoing	high
	Reduce impervious surface cover.	DNR, MDE	MDP	high	ongoing	high
	Prepare for new or expanding ranges of invasive species.	DNR	MDA, MD Invasive Species Council, USFWS	high	ongoing	medium
Foster a collective response to climate change.	Adjust bay and watershed restoration priorities in light of a changing climate.	DNR	MDE, UMD, NOAA, USGS, EPA, Penn State, USFWS	medium	ongoing in Coastal Plain	medium
	Integrate both adaptation and mitigation reduction strategies into natural resource management plans and programs.	DNR	USFWS, NOAA, NGOs	high	short-term	low
	Revise fishery and wildlife management to build climate resilient safeguards.	DNR	USFWS, NOAA, NGOs	high	long-term	medium
	Increase collaboration among federal, state, regional, and local climate change adaptation partners.	DNR	UMD, NOAA, USGS, EPA, NGOs	high	short-term	low

Courtesy of the UMCES and the MD DNR

Implementation Status

Maryland Department of Natural Resources

Initiative: ***Climate Change Criteria for Conservation***

Description: DNR recently completed a project, "Coastal Land Conservation in Maryland: Targeting Tools and Techniques for Sea Level Rise Adaptation and Response." The purpose of the project was to develop new conservation criteria to identify coastal habitats that may help Maryland proactively adapt to sea level rise and increased storm events associated with climate change. Climate change targeting criteria resulting from this project was used to develop new conservation areas for "GreenPrint" and a parcel-level scorecard used to review land acquisition projects. Trainings have been held with State land managers and conservation planners to share the new tools and datasets, and to implement them into current land conservation targeting and review processes.

Initiative/Action: ***Temperature Sensitive Stream Regulations***
Description: In 2011, DNR and MDE collaborated to create an update to Use Class III (Brook Trout) streams. Future coldwater protections are being assessed for contributing watersheds to these streams, and for the protection of streams that harbor coldwater dependent invertebrate species. Future models may address those streams that will be most sensitive to climate change, and those that will remain coldwater systems.

Photo Credit: US Fish and Wildlife Service

Initiative/Action: ***Guidelines and mapping for vulnerable ephemeral and headwater systems***
Description: DNR has identified ephemeral and intermittent freshwater habitats that are highly sensitive to changes in precipitation regimes and ultimately climate change. These habitats include ephemeral, intermittent, and headwater stream systems and vernal pools. Headwater streams support rare and endangered species, serve as migratory corridors, and process and store proportionally larger amounts of nutrients and sediment than larger streams. Mechanisms are now being explored to increase mapping of these systems, to develop model ordinances, and develop model field protocol for their identification and protection by local governments and organizations.

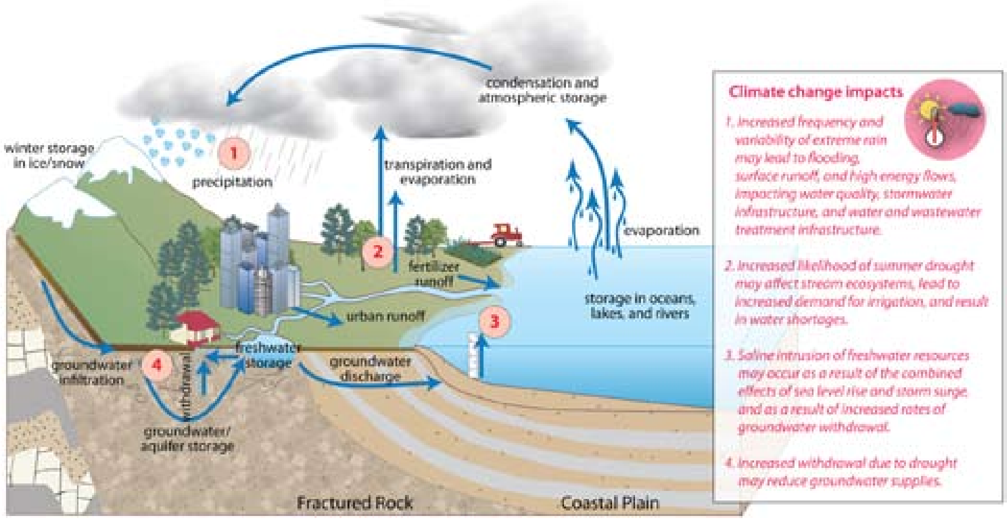
Initiative/Action: ***Climate-Smart Conservation Guidelines***
Description: DNR is participating on the National Wildlife Federation's Climate Smart Conservation Expert Work Group, convened to develop basic guidelines describing good climate-smart conservation. "Key Characteristics" of climate-smart conservation for wildlife and wildlife-habitat were developed by the Work Group and presented at the Adaptation 2011 Workshop in June 2011. DNR also served on NWF's Coastal Climate-Smart Expert Panel to develop more specific climate-smart guidance for living shoreline and coastal impoundment restoration projects. Once complete, DNR anticipates using NWF guidance to assist the agency with identifying best management practices for enhancing ecosystem resilience through habitat restoration projects design.

Water Resources

Background

Generally, Maryland citizens are blessed with an abundant supply of water. However, many water systems are already stressed during droughts, and infrastructure damage and water contamination occurs during floods. Future population growth will combine with more uncertain weather patterns to place more communities at risk of property damage, regulatory liabilities, and uncertain access to drinking water. For example, the eastern shore is particularly susceptible to salt water intrusion as demand increases and sea level rise, while the growing population in central and western Maryland stresses aquifers with inherently short-term storage capacities and risk of contamination.

Climate Change Impacts Likely to Impact Water Resources
Courtesy of the UMCES and the MD DNR



Courtesy of UMCES and MD DNR

In the past 30 years, Maryland's climate has become wetter and hotter, resulting in more runoff and longer heat waves. The State is currently experiencing higher precipitation in September and January. With a changing climate, Marylanders should expect more rain in the winter and spring and less in the summer, and more frequent and intense storm events. This will result in more frequent flooding and more numerous droughts. Current projections indicate that flooding will increase: 100-year floods will increase by 10-20% and 10-year storms will increase by 16-30%. There is a greater likelihood that more powerful rain and windstorms will strike Maryland as ocean waters warm, accompanied by higher storm surges and rainfall.

Water Resources

	Priority Recommendations	Lead Agency	Key Partners	Priority	Timeframe	Potential Cost
Ensure long-term safe and adequate water supply for humans and ecosystems.	Adopt and fund the recommendations of the 2008 "Wolman Committee" report.	MDE	DNR, MDP, local governments, federal partners	high	ongoing	high
	Manage water through the lens of future climate and population.	MDE	MDP, DNR, local governments	high	ongoing	TBD
	Enhance planning and coordination within the water resource community.	MDE	MDP, local governments	high	long-term	TBD
	Encourage water suppliers to evaluate and improve their resilience.	MDE	water utilities, local governments, MEMA, EPA	high	long-term	TBD
	Promote demand management and water conservation practices.	MDE	local governments, MDA, business community	medium	ongoing	TBD
	Assess, target, and protect high quality water recharge areas.	MDE	DNR, MDP	medium	long-term	TBD
Reduce the impacts of flooding and stormwater.	Encourage the removal of vulnerable or high-hazard water supply and treatment infrastructure.	MDE	water utilies, local governments	low	long-term	TBD
	Prevent inundation and overflow of on-site disposal systems.	MDE	local governments	medium	long-term	TBD
	Revise Clean Water Revolving Fund criteria.	MDE		low	short-term	low
	Invest in an improved understanding and communication of flood probabilities and hazards.	MDE	DNR	medium	long-term	TBD

Courtesy of UMCES and MD DNR

Implementation Status

Maryland Department of the Environment (MDE)

Initiative/Action: ***Coastal Plain and Fractured Rock Studies***

Description: MDE has two ongoing water supply studies that are being conducted with the assistance of the Maryland Geological Survey, the U.S. Geological Survey, and the Department of Natural Resources Monitoring and Non-Tidal Assessment Division. The Coastal Plain and Fractured Rock studies were initiated in 2006 and 2009, respectively. These studies will develop information and tools to help MDE make sound science-based decisions about water allocations, ensure ongoing sustainability of the resource, and evaluate the potential impacts of withdrawals on aquatic habitat. In addition, the studies will provide valuable information to assist local governments as they plan for future growth and water use needs. The Coastal Plain study involves a complex aquifer model, which will be capable of modeling various scenarios including the potential impacts of climate change. MDE is already using one important tool developed as part of these studies. The Aquifer Information System provides MDE's permit reviewers with up-to-date and easily accessible information for evaluating permit requests.

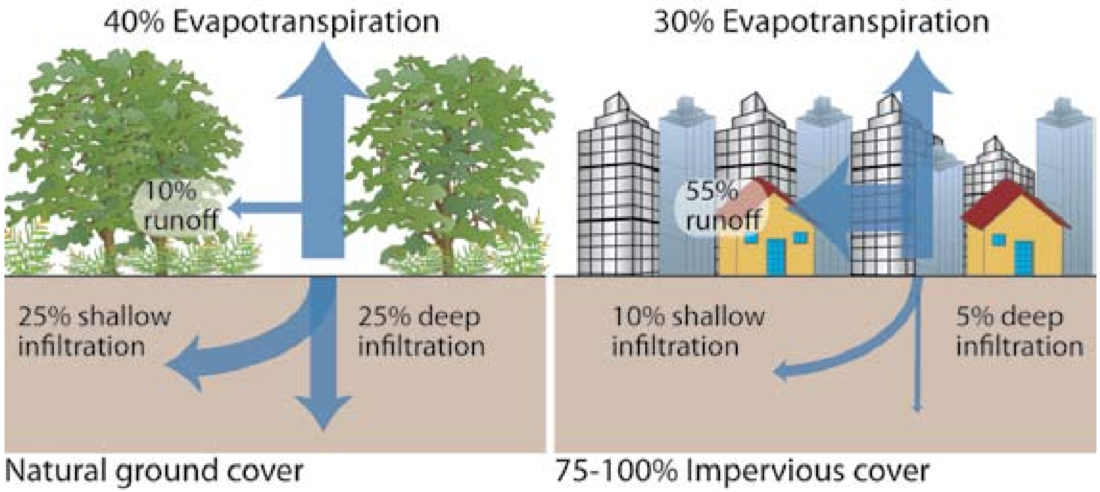
Photo Credit: Jim Schuyler, featured in Baltimore Sun

Initiative/Action: ***Developing source water protection implementation measures for vulnerable communities***
Description: MDE has delineated areas around each public water supply well or intake where measures should be taken to protect the water supplies from water quality impacts. A number of communities around the State have adopted land use ordinances or other measures to protect their water sources. MDE is now working with 20 vulnerable communities to assist them in developing and implementing protection measures.

Initiative/Action: ***Tools for water utilities***
Description: MDE is in the process of producing a publication for public drinking water systems that will provide the systems with information about the possible impacts of climate change on utilities and recommends a variety of adaptation measures to help water systems prepare for and/or avoid these impacts.

Initiative/Action: ***Environmental Site Design***
Description: Current Maryland law and regulations require that Environmental Site Design (ESD) be used to the maximum extent practicable (MEP) to control stormwater from new and redevelopment. The goal is that ESD planning techniques and practices are to be implemented to replicate runoff characteristics similar to "woods in good condition." These practices reduce runoff and improve water quality and ultimately help buffer communities from the impacts of climate change.

Filtration Capacity of Natural versus Impervious System



Courtesy of UMCES and MD DNR

Population Growth and Infrastructure

Background

Maryland's growing population lives and works primarily in a built environment and is reliant on transportation, water, and communication and energy networks, spanning a wide range of landscapes, from cooler Appalachian Mountains in the west, to low-lying areas of the Eastern Shore. These systems, regulated in part at the State level, but more directly influenced by local decision-making – are subject to pressures of shifting population and often — unreliable sources of funding support to address needed maintenance, planning and upgrade. The projected effects of climate change, including increases in precipitation variability and extremes, and winter precipitation and temperature, are likely to affect the frequency, severity and timing of many existing problems, such as stormwater, or buckling of roads and malfunctioning train systems due to heat waves. Historical and current climate conditions will no longer be adequate to guide planning, design, operation and maintenance decisions.

For sustainable development, planning efforts must reflect and address projections for both population growth and the effects of climate change. Many areas in Maryland are expected to experience increased growth and development. Decisions about growth need to factor in climate impact projections. Temperature and precipitation extremes will likely harm infrastructure and affect human health. Increases in precipitation and the intensity of storm events will likely exacerbate existing problems, particularly in urban areas. Problems associated with stormwater, flooding, heat stress and air quality will likely worsen. Building codes, infrastructure design, emergency management and planned development should be oriented to reduce impacts caused by increased climate variability and extremes. Maryland's built environment needs to be reinforced to prepare for new temperature and precipitation regimes. Over time, changes to the system including the operation, maintenance, design and management of much of the State's built infrastructure may become necessary.

Photo Credit: Leif Skoogfors

Population Growth and Infrastructure

Population Growth and Infrastructure

	Priority Recommendations	Lead Agency	Key Partners	Priority	Timeframe	Potential Cost
Ensure safety, clean water, clean air, and sufficient infrastructure.	Address funding and revenue constraints to ensure adequate support for current and future infrastructure needs.	MDOT, MDE	MEMA, DGS, utilities, local governments	medium	ongoing	TBD
	Conduct a comprehensive analysis of the vulnerability of Maryland's infrastructure.	MDOT, MDE	MEMA, DGS, utilities, local governments	medium	ongoing	high
	Develop a "lead by example" investment policy to guide State investments.	DNR	all State agencies	high	short-term	low
	Reduce regional air quality impacts in Maryland.	MDE	MDOT, EPA, MPOs, other states	high	medium-term	high
Plan for precipitation-related weather extremes and increase resilience to rising temperatures.	Assess the economic costs resulting from severe weather events.	MDOT	MEMA, utility providers, local governments	low	TBD	TBD
	Identify State investment needs to prepare for future weather emergencies.	MDOT, MEMA	utility providers, local governments	low	TBD	TBD
	Accelerate use of improved stormwater management strategies and environmental site design (ESD).	MDE	DGS, DNR, MDOT, UMD, local governments	high	ongoing	high
	Enhance the preparedness of transportation system and utility providers.	MDOT, MEMA	PSC, MEA, utility providers, MPOs	low	TBD	TBD
	Develop operation contingency plans for critical infrastructure.	MDOT, MEMA	utility providers	medium	ongoing	TBD
	Increase urban tree canopy.	DNR	local government	high	ongoing	high
	Strengthen building and infrastructure design standards.	DHCD	local government, MDOT, MEA, MDE, MEMA	high	ongoing	TBD
Institutionalize consideration of climate change.	Promote integration of climate change adaptation strategies into State and local policies and programs.	MDP	DNR, MEMA	high	long-term	medium
	Integrate climate vulnerability data into State and local spatial planning frameworks.	MDP	DNR	high	long-term	medium
	Consider climate change issues in combination with ongoing growth and development planning efforts.	MDP	Sustainable Growth Commission, local governments	high	short-term	low
	Explore incentives to promote sound planning practices.	MDP	MEA, UMD	high	medium-term	TBD
	Investigate the impacts of climate change on future energy needs.	DNR	MDE, MEA, MDA, DBED, MDP, MDOT	high	ongoing	medium
	Create a framework and standards for the placement and use of alternative energy.	DNR, MEA	MDE, MDA, DBED, MDP, MDOT, Critical Area Commission, UMD	high	ongoing	medium

Courtesy of UMCES and MD DNR

Implementation Status

Maryland Department of Planning

Initiative/Action: ***State Development Plan - PlanMaryland***

Description: In December 2011, Governor Martin O'Malley accepted "PlanMaryland," the State's first long-range plan for sustainable growth. PlanMaryland is an executive policy plan that better coordinates the smart growth efforts and programs of state government. PlanMaryland establishes five Preservation/Conservation Planning Area categories, including "Climate Change Impact Areas" as areas to protect and preserve. Climate Change Impact Areas are lands likely to experience two feet of relative sea level rise by the middle of the century and as much as four feet or more by the end of the century, as determined by Maryland's Commission on Climate Change. These areas also include lands made more vulnerable to storm surge damage or stormwater flooding from extreme weather events, as well as non-coastal areas sensitive to climate change impacts. Along with the Plan, the Governor filed an Executive Order to provide an overview of implementation. The Executive Order charges state agencies to work to identify changes in strategy to achieve the goals of the plan, and to work with local governments on delineating areas for future growth and preservation.

University of Maryland, Environmental Finance Center

Initiative/Action: ***Sustainable Maryland***

Description: The Sustainable Maryland Certified Program (http://www.efc.umd.edu/SustainableMaryland.html) was launched in June 2011. Certification criteria for a Climate Change Adaptation Element was developed by the Planning and Built Environment Task Force and is included in the program elements.

Tools, Research and Education to Inform Sound Decisions

Background

Maryland managers and decision-makers need the right tools to anticipate and plan for climate change. Long-term monitoring and research efforts are critical. As Maryland experiences a new suite of hydrologic and temperature conditions, the State will need to gain a better understanding of these conditions. Financial, educational, scientific and political support also will be necessary in order to assess conditions and to research new ways to build up the resilience of natural and built infrastructure to the impending impacts of climate change.

Investment in education also is essential to teach public officials, planners, and other decision makers how to use the tools to formulate and implement specific actions. Coordination with the public is necessary, particularly those most vulnerable and without the necessary resources to respond. In the short-term, there is a critical need to establish and disseminate state-specific climate data and information in order to develop a common understanding of future planning needs at both state and local scales. This is an important first step to ensuring climate issues are during infrastructure planning, design, construction and budget processes.

Implementation Status

Maryland Department of Natural Resources/University of Maryland, Center for Environmental Science

Initiative/Action: ***Information Dissemination***

Description: Information on both the Phase I and II adaptation strategies have been widely disseminated and presented at a variety of conferences, workshop and stakeholder events. Fact sheets for sea level rise and coastal storms, water resources and human health have been developed. Fact sheets for all other sectors are anticipated to be completed by March 2012. All fact sheets will be posted to the Maryland Smart, Green and Growing website and widely disseminated to agencies, stakeholders, and the public via existing networks and social media outlets.

Initiative/Action: ***Incorporation of climate change into education initiatives***

Description: In 2011, DNR assembled a series of talking points on climate impacts in Maryland to be utilized by its education staff. The next step will involve incorporating climate change into existing education and outreach programs. Messages of most relevance to citizens will be used as appropriate in outreach programs aiming to encourage stewardship actions; while more direct coastal education programs and materials are being developed for use in classroom settings.

University of Maryland, Maryland State Department of Education

Initiative/Action: ***MADE-CLEAR***

Description: The recently funded Maryland and Delaware Climate Change Education, Assessment and Research (MADE-CLEAR) planning initiative begins the process of coordinating education initiatives in the states of Maryland and Delaware. The goal of this program is to address climate change education needs throughout the two states and work with state agencies and informal and formal education outlets to provide needed material, professional development, and connections to green jobs.

Department of Natural Resources

Initiative/Action: ***Climate Change Adaptation Needs Assessment, Training and Technical Assistance***

Description: In 2012, the Chesapeake Bay National Estuarine Research Reserve's Coastal Training Program, DNR's Chesapeake and Coastal Program and Maryland Sea Grant initiated a needs assessment to better understand the training and technical needs of local governments to help them adapt to the impacts of climate change. The needs assessment will be completed in the spring of 2012. The results of the needs assessment will be used to deliver targeted training and technical assistance to communities in order to better prepare them for climate change, coastal flooding and storm inundation.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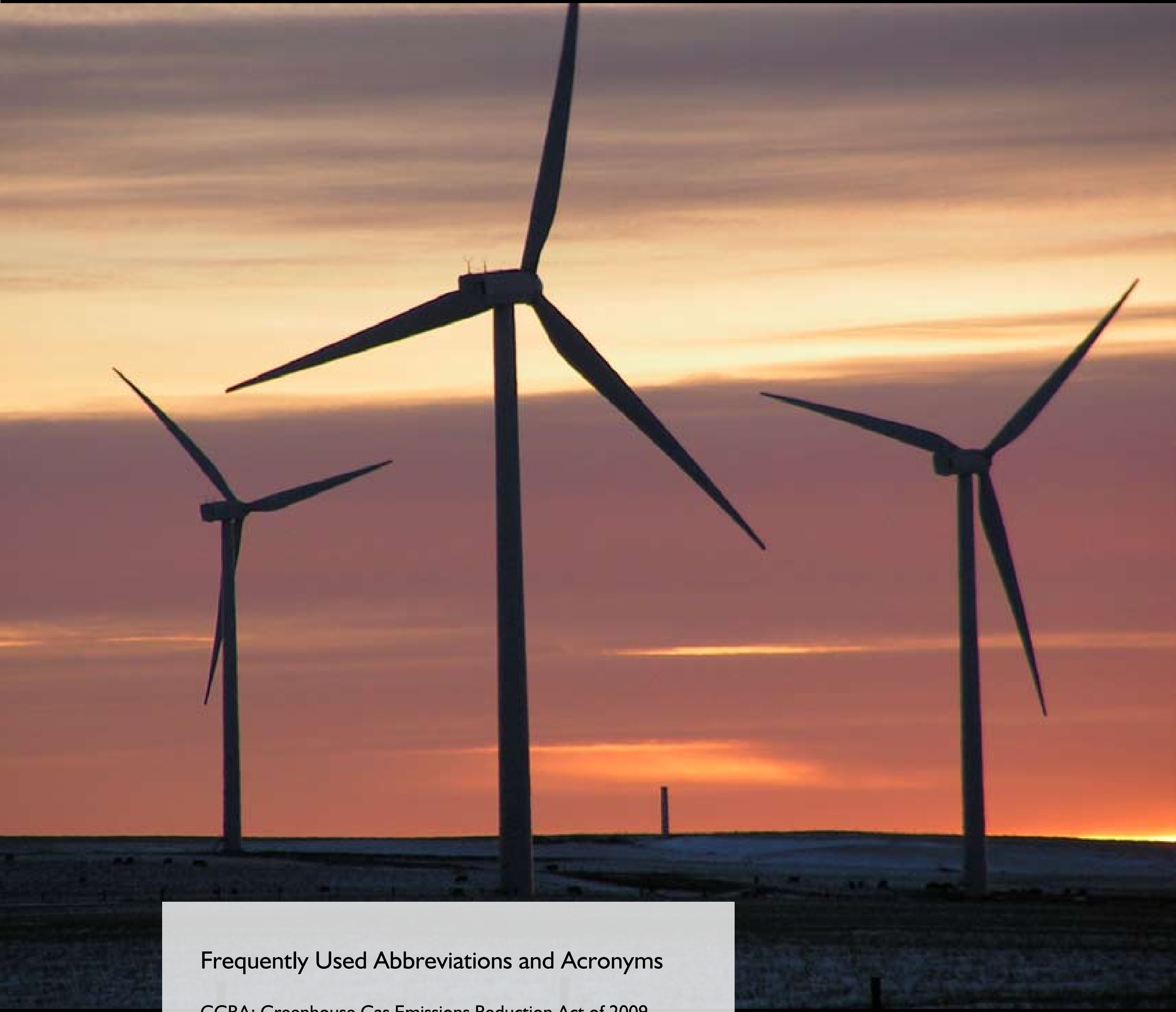

Frequently Used Abbreviations and Acronyms

GGRA: Greenhouse Gas Emissions Reduction Act of 2009

GHG: Greenhouse Gas

MDE: Maryland Department of the Environment

MW: Megawatt

RGGI: Regional Greenhouse Gas Initiative

Chapter 9 Legislative Priorities

Legislative Priorities for 2012

The three major legislative initiatives that are linked to the proposed GGRA plan are offshore wind and transportation funding. Each of these initiatives is described below.

The Maryland Offshore Wind Energy Act of 2012

Background: In 2008, the General Assembly doubled Maryland's Renewable Portfolio Standard, requiring electricity suppliers to purchase 20 percent of the electricity they sell from renewable sources by 2022. In order to meet this requirement with home grown generation, Maryland will need to markedly increase its generation of electricity from wind, solar, geo-thermal and bio-mass energy sources. The most compelling source at present is off-shore wind. Last year, the General Assembly chose to cut off a decision on offshore wind energy and to take a harder look at its variable policy considerations. Though the offshore wind industry has been operating in Europe for more than two decades, with 3,620 MW of installed capacity, there is currently no offshore wind energy generation in the United States. A number of states, however, have taken steps to promote the development of this industry.

Description: The Maryland Offshore Wind Energy Act of 2012 will enable Maryland to harness the clean, ultimately free and reliable wind energy blowing off of

Maryland's shores and create thousands of new offshore wind industry jobs in the process. By establishing an offshore wind renewable energy credit (OREC) carve-out within Maryland's existing Renewable Portfolio Standard (RPS), the bill will create the right policy framework to encourage private investment in this emerging industry and provide our citizens with clean renewable electricity. The OREC model being proposed would allow at least a 450 MW project to be built, creating 1,800 construction jobs and 360 ongoing maintenance jobs. The bill would limit the anticipated electricity rate impact to $2.00 per month for the average residential customer, which would not take effect until 2017.

Transportation Revenue

Background: Maryland has some of the worst traffic congestion of any state in the country, resulting in billions of dollars in lost hours for Maryland business and employees, and in a decrease in the quality of life for many Maryland families. When the gas tax was last raised to .23 cents a gallon in the early 1990s, the price of a gallon of gasoline in the United States was $1.08 cents. Twenty years later, while Maryland's roads, bridges, and maintenance related expenditures have expanded markedly, its transportation related revenues have failed to keep pace.

The recently completed Blue Ribbon Commission on Maryland's Transportation Needs report recommended an additional annual investment of $800 million.

Description: The proposed transportation funding bill would repeal the current state sales tax exemption for gasoline purchases and phase in Maryland's current 6% sales tax rate over three years. Revenues would be indexed to the price of gasoline ensuring that as the price of gasoline increases over time, the revenues to alleviate traffic congestion and address Maryland's other transportation challenges would also increase. Directing this financial support towards mass transit, bike, and other pedestrian and transportation projects will help to reduce GHG emissions generated from the transportation sector.

For more information on these initiatives please see:

- http://www.governor.maryland.gov/blog/?p=3558

The Sustainable Growth and Agriculture Preservation Act

Background: Current local government land use policies in Maryland essentially incentivize the consumption of valuable farm and forest lands and undermine State efforts to restore the health of Maryland's waters and Bays; reduce Maryland's GHG emissions; and support smarter, more sustainable growth.

Description: The Sustainable Growth and Agricultural Preservation Act of 2012 (SB 236/HB445) would create a more substantive planning process for guiding development on septic systems within local jurisdiction growth policies and direct future growth into existing growth areas. A decline in sprawl development would likely have a significant positive impact on the amount of land preserved and the vehicle miles traveled in Maryland, and result in corresponding reductions in the State's GHG emissions.

Updating the Proposed Plan

The proposed plan will be updated appropriately to reflect any new legislation adopted in 2012.

Recent Legislative Actions Supporting the GGRA Plan

Maryland Climate Legislation 2006 to 2011

The remainder of this chapter summarizes key legislative initiatives that are directly, or indirectly, supporting elements of the GGRA.

2006 Legislation

"Healthy Air Act" (Annotated Code of Maryland Environment Title 2 Ambient Air Quality Control Subtitle 10 Health Air Act Sections 2-1001 - 2-1005): A multi-pollutant power plan law that required deep emission reductions from coal-fired power plants in Maryland. The law also required Maryland to become part of the Regional Greenhouse Gas Initiative (RGGI), the country's first regional cap-and-trade program to reduce greenhouse gas (GHG) emissions from power generators.

2007 Legislation

- *"Maryland Clean Cars Act of 2007" (SB51/HB44)*

2008 Legislation

- *"Regional Greenhouse Gas Initiative – Maryland Strategic Energy Investment Program" (SB268/HB368)*
- *"EmPOWER Maryland Energy Efficiency Act of 2008" (HB374/SB205)*
- *"High Performance Buildings Act of 2008" (SB208)*
- *"Renewable Portfolio Standard Percentage Requirements – Acceleration" (SB209/HB375)*
- *"Renewable Energy Portfolio Standard – Tier 1 Renewable Source – Poultry Litter" (SB348/HB1166)*
- *"Solar and Geothermal Tax Incentive and Grant Program" (SB207/HB377): Increased incentives for purchasers of solar and geothermal systems.*
- *"Maryland Transit Administration – Transit–Oriented Development" (HB373/SB204)*
- *"Maryland Clean Energy Center" (HB1337)*
- *"Solar and Geothermal Tax and Grant Program" (SB 207/HB 377): Increased incentives for purchasers of solar and geothermal systems.*

2009 Legislation

- *"Greenhouse Gas Emissions Reduction Act of 2009" (HB315/SB278):* Requires MDE to develop a plan by December of 2012 that will reduce the State's GHG emissions 25% below 2006 levels by 2020. The plan must also help create jobs and have a positive impact on Maryland's economy.
- *"Smart, Green and Growing – Local Government Planning – Planning Visions" (HB294/SB273)*
- *"Smart, Green and Growing – Annual Report – Smart Growth Goals, Measures and Indicators and Implementation of Planning Visions" (HB295/SB276)*

"As the world's largest economy and the world's second largest emitter, America bears our share of responsibility in addressing climate change, and we intend to meet that responsibility."

– President Barack Obama

- *"Smart, Green and Growing – Smart and Sustainable Growth Act of 2009" (HB297/ SB280)*
- *"Transit Oriented Development- Tax Increment Financing" (HB300)*
- *"Environment – Green Building Council" (HB154/SB212)*
- *"Sales and Use and Property Tax – Exemptions – Solar Energy Equipment and Property" (SB621)*
- *"Alternative Energy Tax Incentive Act of 2009" (HB1171)*
- *"Sustainable Forestry Act of 2009" (SB549/)*
- *"Natural Resources – No Net Loss of Forest Policy – Forest Conservation Act" (SB666)*

- *"State Government – Recycling Program – Aluminum, Glass, Paper and Plastic" (HB 595)*

2010 Legislation

- *"Maryland Clean Energy Incentive Act of 2010" (HB 464/SB 287)*
- *"Motor Vehicle Excise Tax - Tax Credit for Electric Vehicles" (HB 469/SB 281)*
- *"High Occupancy Vehicle (HOV) Lanes - Use by Plug-In Vehicles" (HB 674)*
- *"Renewable Energy Portfolio Standard - Solar Energy" (HB 471/SB 27)*
- *"Smart, Green, and Growing - The Sustainable Communities Act of 2010" (HB 475/ SB 285)*
- *"Transportation - Consolidated Transportation Program - Evaluation and Selection of Proposed Capital Projects" (HB 1155/ SB 760)*
- *"Transportation Projects- Bicycle and Pedestrian Access – Funding and Reporting" (HB 282)*
- *"Green Maryland Act of 2010" (SB 693)*

- *"Solid Waste Management - Recycling and Source Reduction – Study" (HB 982)*
- *"Forest Conservation Fund - Contribution Rates - Priority Funding Areas" (HB 1352/ SB 914)*
- *"Maryland Agricultural Preservation Foundation - Farmland Preservation Partnership Program" (SB 95)*

2011 Legislation

- *"Income Tax – Tax Credit for Electric Vehicle Recharging Equipment" (HB 163)*
- *"Pilot Program for Charging Electric Vehicles" (SB179/HB164)*
- *"Maryland Electric Vehicle Infrastructure Council" (SB176/HB167)*
- *"Renewable Energy Portfolio - Waste-to-Energy and Refuse-Derived Fuel" (SB690/ HB1121).*
- *"Renewable Energy Portfolio Standard - Renewable Energy Credits Solar Water Heating Systems" (SB717/ HB 933)*
- *"Public Service Commission - Certificate of Public Convenience and Necessity - Renewable Source Generator Lead Line" (SB691/HB590)*
- *"State Vehicle Fleet and Gasoline Service Facilities - Use and Selling of Biofuels" (SB961/HB567)*
- *"Public Service Commission - Customer Education on Customer Choice" (SB244/ HB597)*