Climate Action Plan
Executive Summary

Commission on Climate Change

August 2008

REPORT OVERVIEW

On April 20, 2007, Governor Martin O'Malley signed Executive Order 01.01.2007.07 (the Order) establishing the Maryland Commission on Climate Change (the Commission). Sixteen State agency heads and six members of the General Assembly comprise the Commission. The principal charge of the Commission is to develop a Plan of Action (the ***Climate Action Plan***) to address the drivers of climate change, to prepare for its likely impacts in Maryland, and to establish goals and timetables for implementation.

The Order emphasized Maryland's particular vulnerability to climate change impacts of sea level rise, increased storm intensity, extreme droughts and heat waves, and increased wind and rainfall events. It recognized that human activities such as coastal development, burning of fossil fuels, and increasing greenhouse gas (GHG) emissions are contributing to the causes and consequences of climate change. While noting Maryland's recent climate initiatives, the Order emphasized that continued leadership by example by Maryland State and local governments is imperative.

The Commission is supported by three Working Groups whose members were appointed by the Commission Chair, Shari T. Wilson, Secretary, Maryland Department of the Environment (MDE): Scientific and Technical Working Group (STWG), chaired by Donald Boesch, President, University of Maryland Center for Environmental Science, and co-chaired by Frank W. Dawson, Assistant Secretary of Maryland's Department of Natural Resources (DNR); Greenhouse Gas and Carbon Mitigation Working Group (MWG), chaired by George (Tad) Aburn, Director of MDE's Air and Radiation Management Administration, and co-chaired by Malcolm Woolf, Director, Maryland Energy Administration (MEA); and Adaptation and Response Working Group (ARWG), chaired by John R. Griffin, Secretary of DNR, and co-chaired by Richard Eberhart Hall, Secretary, Maryland Department of Planning (MDP). These Working Groups and the technical work groups (TWGs) that support them represent diverse stakeholder interests and bring broad perspective and expertise to the Commission's work. The Commission's work was facilitated by a consultant, the Center for Climate Strategies (CCS).

The Executive Order

Governor Martin O'Malley Signs the Executive Order Creating The Maryland Commission on Climate Change

Governor O'Malley's Executive Order charged the Commission and its three Working Groups to prepare a ***Climate Action Plan*** (this report) that addresses three key questions:

- What can the State's best scientists tell us about how and when climate change will affect Maryland's citizens and natural resources?
- What can Maryland do to adapt to the consequences of climate change?
- What can Maryland do to reduce emissions of GHGs and the State's carbon footprint to begin reversing global warming trends?

A very brief summary of the Commission's findings in these three areas follows. The summary of results by chapter, beginning on p. 11, provides a more detailed overview and summary of the Commission's process, the analyses that were completed, and the findings. Chapters 2, 4, 5 and the Appendices provide even greater detail on the efforts undertaken by each Working Group.

The Science

An important foundation for the ***Climate Action Plan*** (***Plan***) is the assessment of the likely consequences of the changing global climate to Maryland's agricultural industry, forestry resources, fisheries resources, freshwater supply, aquatic and terrestrial ecosystems, and human health. The *Comprehensive Climate Change Impact Assessment* (Chapter 2 of the ***Plan***), which was undertaken by the Commission's Scientific and Technical Working Group (STWG), based its efforts on extensive literature review and model projections. Supercomputer models were used to estimate the responses of climate to increased GHG concentrations and to project future conditions in Maryland.

Recent and Likely Climate Change

Maryland's climate warmed after the peak of the last Ice Age, 20,000 years ago, but has been relatively stable for the past 6,000 years. Atmospheric concentrations of GHGs, however, have dramatically increased since pre-industrial times. Carbon dioxide concentrations exceed those experienced over the last 650,000 years. Average global temperature and sea level began to increase rapidly during the 20th century. Annual average temperature is projected to increase by about 3°F by mid-century and is likely unavoidable.

The amount of warming later in the century is dependent on the degree of mitigation of GHG emissions, with summer temperatures projected to increase by as much 9°F and heat waves extending throughout most summers if GHG emissions continue to grow. Precipitation is projected to increase during the winter, but become more episodic. Projections of precipitation are much less certain than for temperature, but the mean projections indicated modest increases of about 10 per cent or so are likely in the winter and spring. Because of more intermittent rainfall and increased evaporation with warmer temperatures, droughts lasting several weeks are more likely to occur during the summer.

More specific analysis of the following areas was also conducted:

- Water resources & aquatic environments
- Farms & forests
- Coastal vulnerability
- Chesapeake Bay & coastal ecosystems
- Human health
- Mitigation & adaptation

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 lang-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 greenhouse gases.

Adaptation

The Commission's Adaptation and Response Working Group (ARWG) was charged with developing a *Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change* (Chapter 5 of the ***Plan***).

With over 3,000 miles of coastline, Maryland is poised in a very precarious position when it comes to the impacts of climate change. Maryland's coast is particularly vulnerable to both episodic storm events, such as hurricanes and Nor'easters, as well as chronic problems associated with shore erosion, coastal flooding, storm surge, and inundation. Problems such as these are both driven by and exacerbated by climate change and sea level rise.

Climate change, sea level rise and associated coastal storms are putting Maryland's people, property, natural resources, and public investments at risk. To protect Maryland's future economic well-being, environmental heritage and public safety, and to guide the fundamental intent of its *Comprehensive Strategy*, the ARWG recommends that the Governor and the Maryland General Assembly take legislative and policy actions to:

- Promote programs and policies aimed at the avoidance and/or reduction of impact to the existing-built environment, as well as to future growth and development in vulnerable coastal areas;
- Shift to sustainable economies and investments; and, avoid assumption of the financial risk of development and redevelopment in highly hazardous coastal areas;
- Enhance preparedness and planning efforts to protect human health, safety and welfare;
- Protect and restore Maryland's natural shoreline and its resources, including its tidal wetlands and marshes, vegetated buffers, and Bay Islands, that inherently shield Maryland's shoreline and interior.

The ARWG also suggested that policies in the following areas be implemented. The Commission has adopted the ARWG recommendations. Chapter 5 provides a more detailed description of each policy.

Reduction of Impact to Existing and Future Growth

- Integrated Planning
- Adaptation of Vulnerable Coastal Infrastructure
- Building Code Revisions and Infrastructure Design Standards

Financial and Economic Well-Being

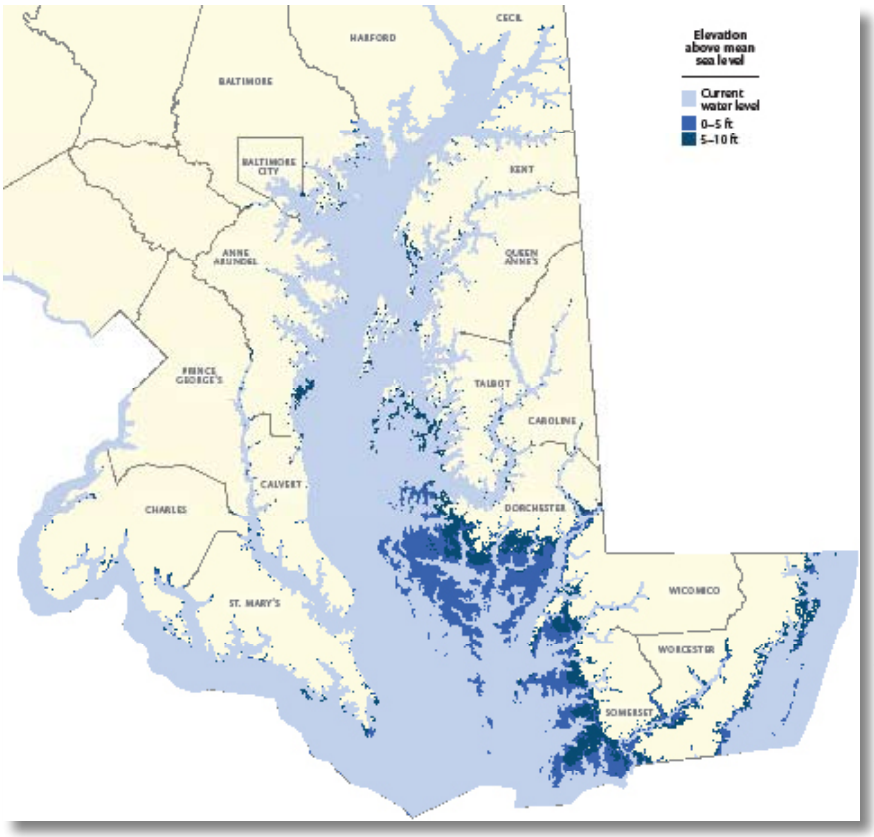
- Resource-Based Industry Economic Initiative
- Climate Change Insurance Advisory Committee
- Disclosure
- Green Economic Development Initiative

Protection of Human Health, Safety and Welfare

- Inter-Agency Coordination
- Health Impact Assessments
- Vector-borne Surveillance and Control

Natural Resource Protection

- Natural Resource Protection Areas
- Forest and Wetland



Maryland Department of Natural Resources.

Sea-level rise vulnerability in the coastal areas of Maryland, calculated using LIDAR elevation data. Note: LIDAR elevation data were not available for Baltimore City, Harford County, and Prince George's County. Therefore, vulnerability data do not exist for those areas and cannot be shown on this map.

Protection
- Shoreline and Buffer Area Management

Adaptation and Response Toolbox
- Integrated Observation Systems
- GIS Mapping, Modeling and Monitoring
- Public Awareness, Outreach, Training and Capacity Building

Future Steps and Directions
- Local Government Planning Guidance
- Adaptation-Stat
- Future Adaptation Strategy Development

Smith Island—Maryland's last inhabited Chesapeake Bay island community—is vulnerable to sea-level rise. Photo by Tom Darden.

Mitigation

The Commission, based upon the recommendations of its Greenhouse Gas and Carbon Mitigation Working Group (MWG) in the *Comprehensive Greenhouse Gas and Carbon Footprint Reduction Strategy* (Chapter 4 of the ***Plan***), is recommending that Maryland begin implementing forty-two GHG reduction strategies to begin reducing global warming. Table ES-1, Mitigation Policies (p.10), lists the forty-two strategies and identifies the State lead agency responsible for implementation. Chapter 4 and Appendix D provide additional information on each strategy.

The Commission has established the following science-based goals for reducing GHG emissions in Maryland. All goals use a 2006 base year.

- 10 per cent reduction by 2012
- 15 per cent reduction by 2015
- 25 per cent to 50 per cent reduction by 2020
- 90 per cent reduction by 2050

Chapter 4 also discusses the goal setting process.

Figure ES-1, "GHG Reduction Potential from Maryland's Recent and Proposed Actions" (p.18) shows the potential reductions that Maryland projects based on the full implementation of the forty-two measures included in the *Comprehensive Greenhouse Gas and Carbon Footprint Reduction Strategy*. The figure shows that by 2020, the ***Climate Action Plan*** can achieve reductions that will be consistent with the goals established by the Commission. Because of the uncertainty in some of the analysis, the Commission expects the 2020 reduction levels to be between 40 and 55 per cent, approaching the higher-level target of a 50 per cent reduction by 2020.

Another key policy embodied in the ***Plan*** is that the current trend of continuing growth in GHG emissions should be reversed as quickly as possible. Figure ES-1 shows that Maryland can start reducing that trend soon if the MWG policies are implemented.

Figure ES-1 also shows that recent actions by Maryland, like the Regional Greenhouse Gas Initiative (RGGI) and the Clean Cars Program (CA LEV), and new programs adopted through legislation in 2008 will get the state close to the 25 per cent reduction target by 2020.

Figures ES-2 (p.19), ES-3 (p.19) and ES-4 (p.20) show the potential emission reductions from the forty-two strategies. Figures ES-2 and ES-3 show the aggregated benefits of the strategies in 2020 and 2012. Figure ES-4 shows the strategy-by-strategy reduction estimates in 2020 and 2012.

Figure ES-2, "Projected Emissions by 2020", shows that by 2020, the strategies are expected to achieve reductions that are consistent with the reduction goals set by the Commission. The Commission's 2020 goal is to achieve a 25 per cent to 50 per cent reduction from 2006 levels. The forty-two strategies are projected to achieve an approximate 40 per cent to 55 per cent reduction from 2006 levels by 2020. As discussed in Chapter 4, there is considerable uncertainty associated with calculating the aggregated benefits of the forty-two strategies. Figure ES-2 also shows that early actions, already taken in Maryland, will achieve about 60 per cent to 70 per cent of the reductions needed to meet the 25 per cent reduction goal.

Figure ES-3, "Projected Emissions by 2012", shows the same information for 2012. 2012 is an important milestone as early reductions are critical. The science tells us that a ton of reduction in 2012 is much more effective than a ton of reduction in 2050. The reductions from the forty-two strategies are expected to exceed the Commission's 2012 10 per cent reduction goal. They are projected to achieve an approximate 15 per cent to 22 per cent reduction from 2006 levels by 2012. Early actions also contribute significantly in 2012. Early actions are expected to achieve about 40 per cent to 50 per cent of the reductions needed to meet the 2012 goal.

Figure ES-4, "Annual Greenhouse Gas Reduction Potential of Maryland Policy Options in 2020 and 2012", shows the individual reductions from each of the forty-two strategies in 2020 and 2012.

Implementing the Commission's suite of forty-two mitigation reduction strategies is estimated to also provide a net economic benefit to the state. Preliminary analysis indicates that by 2020, implementation of these forty-two strategies could result in a net economic benefit to the state of approximately 2 billion dollars.

STEPS IN THE RIGHT DIRECTION

Maryland has already taken some important early actions toward reaching these goals.

➤ *The Healthy Air Act.*
Adopted as State law in 2006, the Act included a provision for Maryland to join the Regional Greenhouse Gas Initiative (RGGI), a groundbreaking cap and trade program designed to reduce CO_2 emissions from power plants in participating states in the Northeast and Mid-Atlantic. The Maryland allocation in RGGI is expected to reduce CO_2 emissions by approximately 8.7 million tons by 2020. Maryland will participate in RGGI's historic first auction of CO_2 allowances in September 2008, the first ever in the U.S.

➤ *The Clean Cars Act.*
Adopted as State law in 2007, this law requires implementation of the California Clean Cars program (CA LEV). By requiring more rigorous emissions standards beginning in vehicle model year 2011, it will start reducing GHG emissions in Maryland as early as 2010, achieving reductions of about 6 million metric tons by 2020.

➤ ***EmPOWER Maryland*** *Program.*
Launched by Governor 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 by Maryland consumers by 15 per cent in 2015. This could reduce GHG emissions by about 7 million tons in 2020.

➤ *Commission on Climate Change.*
Governor O'Malley established the Commission by executive order in April 2007 to advise the Governor and General Assembly on matters related to climate change and to develop a ***Climate Action Plan***.

➤ *2008 Legislation*
As summarized in Chapter 7 of this ***Plan***, nearly all of the Commission's Early Action recommendations for legislation were adopted as law in the General Assembly's 2008 Session. Significant early reductions will be achieved through the following 2008 laws:

- ***EmPOWER Maryland*** *Energy Efficiency Act of 2008*
- *Regional Greenhouse Gas Initiative – Maryland Strategic Energy Investment Program*
- *High Performance Buildings Act of 2008*
- *Renewable Portfolio Standard Per centage Requirements – Acceleration*

The General Assembly adopted other laws in 2008 designed to reduce GHG emissions that weren't part of the Commission's Early Action recommendations. These include increased grants and tax incentives for solar and geothermal installations, a law to spur development around transit stations, low interest loans for energy efficiency projects, and establishment of the Maryland Clean Energy Center. These are discussed in greater detail in Chapter 7.

Next Steps

The State agency leads will begin the implementation process for each of the forty-two mitigation strategies and nineteen adaptation strategies through the development of an implementation plan for each. These implementation plans will likely involve significant stakeholder processes. The Commission will be meeting in the Fall of 2008 and the Spring of 2009 to be briefed on the status of the policies in the ***Climate Action Plan*** and the implementation plan for each.

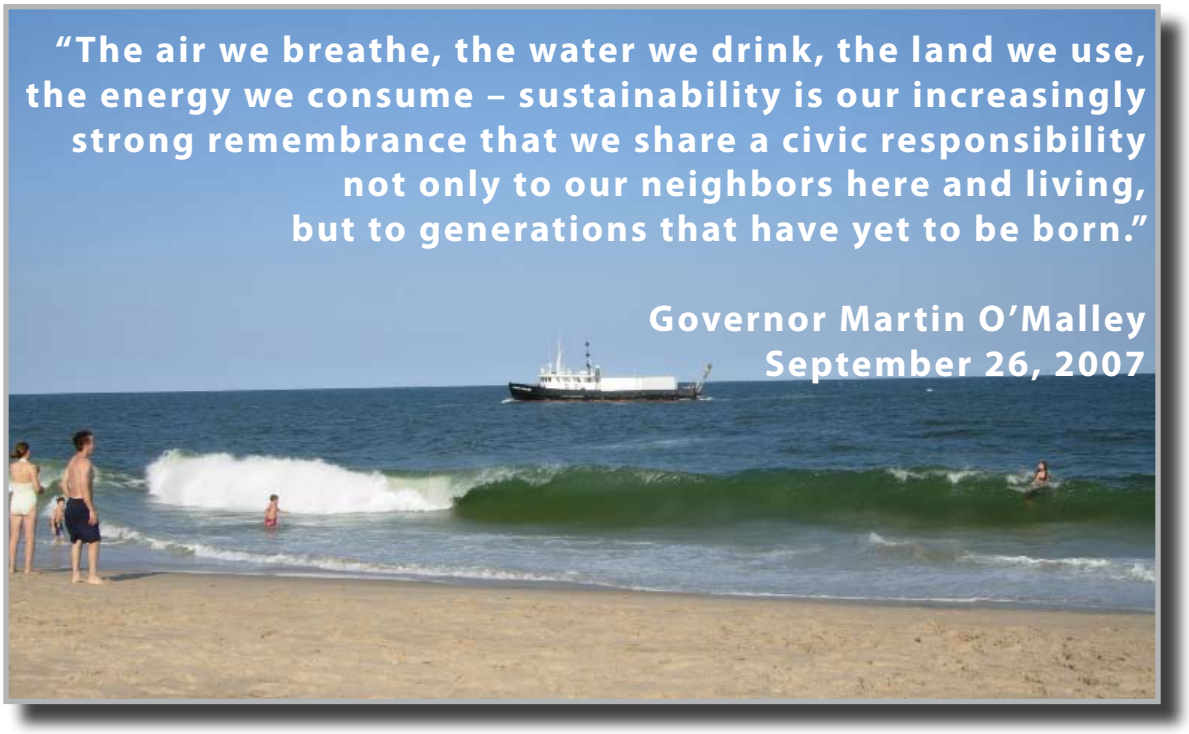


Table ES-1
Mitigation Policies

Policy Option	*Number*	*Agency*
Cross-Cutting (CC)		
GHG Inventory & Forecasting	CC-1	MDE
GHG Report & Registry	CC-2	MDE
Statewide GHG Reduction Goals & Targets	CC-3	MDE
State & Local Government Lead-by-Example	CC-4	MDE
Public Education & Outreach	CC-5	MDE
Review Institutional Capacity	CC-7	Commission
Participate in Regional, Multi-State & National Efforts	CC-8	MDE
Promote Economic Development Opportunities	CC-9	DBED
"After Peak Oil"	CC-10	MEA
Public Health Risks	CC-11	DHMH
Residential, Commercial & Industrial (RCI)		
Improved Building & Trade Codes	RCI-1	DHCD
Demand-Side Management & Energy Efficiency	RCI-2	MEA
Low-Cost Loans for Energy Efficiency	RCI-3	MEA
Improved Design, Construction, Appliances & Lighting	RCI-4	MDE
More Stringent Appliance / Equipment Efficiency Standards	RCI-7	MEA
Energy Efficiency Resource Standard	RCI-10	MEA
Promotion & Incentives for Energy Efficiency Lighting	RCI-11	MEA
Energy Supply (ES)		
Promotion of Renewable Energy	ES-1	MEA
Technology-Focused Initiatives for Electricity Supply	ES-2	MEA
GHG Cap-and-Trade	ES-3	MDE
Clean Distributed Generation	ES-5	MEA
Integrated Resource Planning	ES-6	PSC
Renewable Portfolio Standard	ES-7	PSC
Efficiency Improvements & Repowering Existing Plants	ES-8	MEA
Generation Performance Standards	ES-10	MDE
Agriculture, Forestry & Waste (AFW)		
Forest Management for Enhanced Carbon Sequestration	AFW-1	DNR
Managing Urban Trees & Forests	AFW-2	DNR
Afforestation, Reforestation & Restoration of Forests & Wetlands	AFW-3	DNR
Protection & Conservation of Agricultural Land, Coastal Wetlands & Forested Land	AFW-4	MDA
"Buy Local" Programs	AFW-5	MDA
Expanded Use of Forest & Farm Feedstocks & By-Products for Energy Production	AFW-6	DNR
In-State Liquid Biodiesel Production	AFW-7b	MEA
Nutrient Trading with Carbon Benefits	AFW-8	MDE
Waste Management & Advanced Recycling	AFW-9	MDE
Transportation & Land Use (TLU)		
Land Use & Location Efficiency	TLU-2	MDOT
Transit	TLU-3	MDOT
Intercity Travel	TLU-5	MDOT
Pay-As-You-Drive Insurance	TLU-6	MDOT
Bike & Pedestrian Infrastructure	TLU-8	MDOT
Incentives, Pricing & Resource Measures	TLU-9	MDOT
Transportation Technologies	TLU-10	MDOT
Evaluate GHG from Major Projects	TLU-11	MDOT

SUMMARY OF RESULTS BY CHAPTER

Chapter 1: Introduction

In April 2007, Governor Martin O'Malley established the Maryland Commission on Climate Change (Commission) through Executive Order 01.01.2007.07. The Commission was to develop a Plan of Action, or ***Climate Action Plan***, that discusses the drivers and consequences of climate change, necessary preparations for its ensuing impacts, and establishes firm benchmarks and timetables for policy implementation. The Commission is chaired by the Secretary of the Environment, Shari T. Wilson, and includes legislative and major State agency leaders. The Executive Order established three Working Groups within the Commission: the Greenhouse Gas and Carbon Mitigation Working Group (MWG), the Adaptation and Response Working Group (ARWG), and the Scientific and Technical Working Group (STWG). Each Working Group developed subgroups, called Technical Work Groups in MWG and ARWG.

As the facilitating agency for development of the ***Climate Action Plan (Plan)***, the Maryland Department of the Environment (MDE) produced an ***Interim Report*** on the ***Plan*** in January of 2008, with support from Maryland's Department of Natural Resources (DNR) and the University of Maryland Center for Environmental Science (UMCES). The ***Interim Report*** provided an update on the most current information emerging from each Working Group. Significantly, it included the Commission's recommendations for "Early Action" legislation, nearly all of which was adopted by the General Assembly in its 2008 Session.

The Commission and its Working Groups continued to assess climate change impacts in Maryland and fine-tune policy options in the ensuing months. The resulting reports: the STWG's *Comprehensive Climate Change Impact Assessment*; the MWG's *Comprehensive Greenhouse Gas and Carbon Footprint Reduction Strategy*; and the ARWG's *Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change*, appear as Chapters 2, 4 and 5, respectively, in this ***Climate Action Plan***.

Scientific and Technical Working Group (STWG)

Under the leadership of UMCES within the University System of Maryland, the Commission's STWG developed an assessment of the likely consequences of the changing global climate to Maryland's agricultural industry, forestry resources, fishery resources, aquatic and terrestrial ecosystems, and human health. The *Comprehensive Climate Change Impact Assessment* informs Maryland citizens and policy makers of the likely consequences of global climate change on the places we live and resources we depend on and provides an estimation of the consequences of climate change in Maryland that could be avoided by global actions to reduce emissions of GHGs.

Greenhouse Gas and Carbon Mitigation Working Group (MWG)

Under the leadership of MDE, the Commission's MWG and its Technical Work Groups (TWGs) developed forty-two mitigation policy options that form the core of the Commission's *Comprehensive Greenhouse Gas and Carbon Footprint Reduction Strategy*. These policies cover the broad areas of energy supply; transportation and land use; agriculture, forestry and waste; residential, commercial, and industrial; and cross-cutting issues. For each policy option whose goals were amenable to quantification, the amount of GHG reductions and the cost or cost savings of implementation were calculated. Cost-effectiveness figures (in dollars per ton of GHG reduction) were then developed and used to compile an overall cost-effective suite of policy recommendations to include in the ***Climate Action Plan***.

Adaptation and Response Working Group (ARWG)

Under the leadership of DNR, the Commission's ARWG completed Phase 1 of the *Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change*. Phase 1 focused on the development of adaptation and response strategies for impacts associated with sea level rise and coastal storms. Nineteen priority policy options were developed by the ARWG and its four TWGs. These focused on the broad categories of existing-built environment and infrastructure; future-built environment and infrastructure; human health, safety and welfare; and resources and resource-based industries. Each of the resulting policy option descriptions includes a detailed discussion of implementation mechanisms, related policies and programs in place, qualitative benefits and cost assessments and an overview of feasibility issues. The ***Climate Action Plan*** presents the final priority policy recommendations in support of the Commission's vision for protecting Maryland's future economic well-being, environmental heritage and public safety.

Chapter 2: Comprehensive Assessment of Climate Change Impacts in Maryland

An important foundation for the ***Climate Action Plan*** is the assessment of the likely consequences of the changing global climate to Maryland's agricultural industry, forestry resources, fisheries resources, freshwater supply, aquatic and terrestrial ecosystems, and human health. The assessment, which was undertaken by the STWG, based its efforts on extensive literature review and model projections. Supercomputer models were used to estimate the responses of climate to increased GHG concentrations and to project future conditions in Maryland. Changes in temperature and precipitation were projected through the 21st century. In order to estimate the degree of climate change in Maryland that could be avoided by actions to reduce emissions of GHGs, two emissions scenarios were employed. The higher emissions scenario assumes continued growth in global emissions throughout the century, while the lower emissions scenario assumes slower growth, a peak at mid-century, and thereafter a decline to about 40 per cent of present levels by the end of the century.

Recent and Likely Climate Change

Maryland's climate warmed after the peak of the last Ice Age, 20,000 years ago, but has been relatively stable for the past 6,000 years. Atmospheric concentrations of GHGs, however, have dramatically increased since pre-industrial times. Carbon dioxide concentrations exceed those experienced over the last 650,000 years. Average global temperature and sea level began to increase rapidly during the 20th century. Annual average temperature is projected to increase by about 3°F by mid-century and is likely unavoidable. The amount of warming later in the century is dependent on the degree of mitigation of GHG emissions, with summer temperatures projected to increase by as much 9°F and heat waves extending throughout most summers if GHG emissions continue to grow unchecked. Precipitation is projected to increase during the winter, but become more episodic, with more falling in extreme events. Projections of precipitation are much less certain than for temperature, but the mean projections indicated modest increases of about 10 per cent or so are likely in the winter and spring. Because of more intermittent rainfall and increased evaporation with warmer temperatures, droughts lasting several weeks are more likely to occur during the summer.

Water Resources & Aquatic Environments

Increased winter-spring precipitation would continue to adequately supply reservoirs, but not alleviate current overdrafts of groundwater aquifers. Water supplies in the greater Baltimore area would not be diminished, but the adequacy of summer water supplies in the greater Washington region, which rely on Potomac River flows, is less certain. Any increases in precipitation are unlikely to replace groundwater substantially enough to compensate excessive withdrawals of some aquifers. At the same time, summer droughts may increase groundwater demand for agricultural irrigation.

More intense rainfall resulting from the combined effects of global climate change and localized factors, for example the influence of the urban canopy on rainfall, is likely to increase peak flooding in urban environments. Continued increase in impervious surfaces attendant with development would exacerbate this problem. Aquatic ecosystems will likely be degraded by more flashy runoff and increased temperatures. Intensified rainfall events and warmer surfaces (roads, roofs, etc.) would result in rapid increases in stream temperatures, limiting habitat suitability for native fishes and other organisms. Higher peak flows and degraded streams would also transmit more nutrients and sediments to the Chesapeake Bay and its tidal tributaries, contributing to water quality impairment in the estuaries.

Farms & Forests

Crop production may increase initially, but then decline later in the century if emissions are not reduced. The longer growing season and higher carbon dioxide levels in the atmosphere are likely to increase crop production modestly during the first half of the century, but extreme weather events may limit this. Later in the century, crop production is likely to be reduced due to heat stress and summer drought under the higher emissions scenario. Milk and poultry production would be also reduced by heat stress. These changes will require adaptation by Maryland's agricultural industry, including changes in crop or animal varieties, increased irrigation, and air conditioning for some livestock.

The maple-beech-birch forest of Western Maryland is likely to fade away and pine trees to become more

dominant in Maryland's forests. Forest productivity in terms of timber produced is likely to decline late in the century under the higher emissions scenario as a result of heat stress, drought, and climate-related disturbances such as fires and storms. The biodiversity of plants and animals associated with Maryland's forests is likely to decline. Habitat alterations resulting from climate change may force out 34 or more bird species, including the emblematic Baltimore oriole, although southern species may replace them.

Coastal Vulnerability

Sea level in Maryland rose by 1 foot in the 20th century, partially because the land is sinking as a result of slow adjustments of the Earth after the last Ice Age. Maryland coastal regions have been subsiding at about a rate of 6 inches per century and should continue at this rate during this century. Additionally, the average level of the sea in this region rose by about the same amount (6 inches) during the past century, resulting in the observed 1-foot rise in the mean tidal level relative to the land. As a result, Maryland has experienced considerable shoreline erosion and deterioration of coastal wetlands which are a critical component of its bays and estuaries.

Sea-level rise is very likely to accelerate, inundating hundreds of square miles of wetlands and land. Projections that include accelerating the melting of ice would increase the relative sea-level along Maryland's shorelines by more than 1 foot by mid-century and 3 feet by late century if greenhouse gas emissions continue to grow. If sea level rises by 3 feet, most tidal wetlands would be lost—about 200 square miles of land would be inundated. New tidal wetlands developed on newly flooded land would not offset the loss of existing wetlands and significant negative effects on wetland-dependent living resources would result. Moreover, if sea level were to rise by 3 or more feet, this would mean that rapid and probably uncontrollable melting of land-based ice was underway and that sea level would rise at an even greater rate during subsequent centuries.

Rains and winds from hurricanes are likely to increase, but changes in their frequency cannot now be predicted. The destructive potential of Atlantic tropical storms and hurricanes has increased since 1970 in association with warming sea surface temperatures. This trend is likely to continue as ocean waters warm. Whether Maryland will be confronted with more frequent or powerful storms depends on storm tracks that cannot yet be predicted. However, there is a greater likelihood that storms striking Maryland would be more powerful than those experienced during the 20th century and would be accompanied by higher storm surges—made worse because of higher mean sea level—and greater rainfall amounts.

Chesapeake Bay & Coastal Ecosystems

Chesapeake and Coastal Bays restoration goals will likely be more difficult to achieve. Increased winter-spring runoff would wash more nutrients into the Bays and higher temperatures and stronger density stratification in the estuaries would tend to exacerbate water quality impairment, the alleviation of which is the prime restoration objective. Consequently, nutrient loads would have to be reduced beyond current targets to achieve water quality requirements. Very significant changes are also likely to occur that affect sediment delivery and sedimentation in the estuaries, but are difficult to quantitatively predict. These include potential increases in sediment loads from rivers as a result of increased runoff and more erosive extreme discharge events, including those caused by hurricanes, and from shoreline and wetland erosion as a result of accelerated sea-level rise.

Living resources will very likely change in species composition and abundance with warming. A mixture of northern, cool water species and southern, warm water species currently resides in the Chesapeake Bay. Northern species such as soft shell clams and eelgrass are likely to be eliminated later in the century, almost certainly if GHG emissions are not mitigated. Southern species are very likely to increase in abundance because the milder winters would allow or enhance overwintering populations.

As ocean water becomes more acidic, shellfish production could be affected. Increasing atmospheric carbon dioxide concentrations in the atmosphere have already lowered pH in the world's oceans, a trend that is very likely to continue. Recent research indicates that the rate at which oysters and other coastal shellfish build their calcium carbonate shells will likely be affected, but whether this would occur in Maryland has not been evaluated.

Human Health

Health risks due to heat stress are very likely to increase, if emissions are not reduced. Under the higher emissions scenario, heat waves are projected to greatly increase risks of illness and death before the end of the century, with an average of 24 days per summer exceeding 100°F. The poor, the elderly and urban populations are most susceptible. Some, but not all, of these increased risks can be reduced by air conditioning and other adaptation measures.

Respiratory illnesses are likely to increase, unless air pollution is greatly reduced. More ground-level ozone, responsible for multiple respiratory illnesses, is formed under prolonged, high temperatures. Releases of air pollutants (nitrogen oxides and volatile organic compounds) that cause ozone to be formed have been declining, but would have to be reduced much more to avoid a reversal in progress toward achieving air quality standards.

Increased risks of pathogenic diseases may be less likely. The mortality due to vector-borne and non-vector borne diseases in the United States is low because of public health precautions and treatment, which would likely adapt to changes in disease risks. Climate change might affect the exposure of Marylanders to pathogens such as the West Nile virus, but precautions and treatment could manage this risk.

Mitigation & Adaptation

Reduction of GHG emissions has substantial benefits for Maryland. The mitigation of global emissions by mid-century would very likely result in significantly lower sea-level rise, reduced public health risks, fewer extreme weather events, and less decline in agricultural and forest productivity and loss of biodiversity and species important to the Chesapeake Bay. More serious impacts beyond this century, such as sea-level rise of 10 feet or more, would be avoided.

Based on the projections made in the STWG's *Comprehensive Assessment of Climate Change Impacts in Maryland*, adaptation strategies for human health, water resources, and restoration of Maryland's bays should be evaluated and, where necessary, implemented. Adaptation measures to reduce coastal vulnerability should plan for a 1 foot rise in sea level by mid-century and a rise of at least 2 feet by late in the century. Depending on the course of GHG emissions, observations, and modeling, planning for increases in sea level of up to 4 feet by the end of the century may be required. The Commission should evaluate additional adaptation strategies related to human health, water resources, forest management, and restoration of the Chesapeake Bay and Maryland's Coastal Bays. Maryland should marshal and enhance its capacity for monitoring and assessment of climate impacts, as a more extensive, sustained, and coordinated system for monitoring the changing climate and its impacts is required. Because of its national laboratories, strong university programs, knowledge-based economy, and proximity to the nation's capital, Maryland is in a strong position to become a national and international leader in regional-to-global climate change analysis and its application to innovative mitigation and adaptation.

Chapter 3: Climate Change and the Cost of Inaction

The economic impacts of climate change on Maryland will depend on the exact physical changes that manifest. Although there is a degree of uncertainty, the consensus scientific literature agrees annual average temperatures will increase by 3-8° F, annual average precipitation will increase by roughly 20 per cent, there will be more frequent and intense late-winter storms, and sea levels will rise by 24-48 inches in Maryland throughout this century. The physical changes that develop will significantly alter the state's coastline, beachfront, agricultural productivity, species biodiversity and weather patterns that are tightly correlated with economic conditions. As Maryland's population grows by 20 per cent between now and 2020 and as the state's GDP grows at a rate between 60-70 per cent, economic losses from climate change will run in parallel. By becoming a more populated, developed, and economically robust state, there will be more avenues for direct and indirect effects of climate change to impact the state. The growing and interconnected nature of the state could potentially make it more vulnerable to the cascade effects of climate change if there isn't a strong effort now to stimulate a resilient and robust economy that can cope with the expected impacts of climate change.

Maryland's greatest challenge is likely to be in adapting to climate change along its expansive coast, as this is where the most significant economic and ecological impacts will occur. The state's economy is particularly vulnerable because of the scale of development along the coast and the high rate at which coastal erosion and subsequent water elevation will afflict its shoreline. Further development along the state's shoreline needs to be carried out with the understanding that the shoreline is not stationary and will steadily move inwards throughout the coming century. Legislators may want to consider legislation to circumvent health related impacts of climate change related to the urban heat island effect and decreases in fresh drinking water quality and quantity. The urban heat island effect can be mitigated through careful city planning and smart growth (e.g., incorporating more green space into development sites). One tactic for maintaining water quality is to encourage streamside tree planting and plant buffer strips as they absorb harmful pollutants as well as reduce water warming.

There are already considerable costs to society associated with infrastructures, agricultural and silvicultural practices, land use choices, transportation and consumptive behaviors that are not in sync with past and current climatic conditions. These costs are likely to increase as climate change accelerates. While some of the benefits from climate change may accrue to individual farms or businesses, the cost of dealing with adverse climate impacts are typically borne by society as a whole. These costs to society will not be uniformly distributed but felt most among small businesses and farms, the elderly and socially marginalized groups. Benefits from climate change may be fleeting -- for example, climate does not stop changing once a farm benefits from temporarily improved growing conditions. In contrast, costs of inaction are likely to stay and to increase. Climate models and impact assessments are becoming increasingly refined, generating information at higher spatial and temporal resolutions than previously possible. Yet, little consistency exists among studies to enable "summing up" impacts and cost figures across sectors and regions to arrive at a comprehensive, statewide result. To provide not just a comprehensive statewide assessment of impacts and cost, but to develop optimal portfolios for investment and policy strategies will require support for integrative environmental research that combines cutting-edge engineering solutions with environmental, economic and social analysis. The effort and resources required for an integrative approach likely pales in comparison to the cost of inaction.

Chapter 4: Greenhouse Gas and Carbon Footprint Reduction Strategy

The Commission's Mitigation Working Group (MWG) was charged with developing a *Comprehensive Greenhouse Gas and Carbon Footprint Reduction Strategy*. The Executive Order calls for the *Strategy* to recommend GHG emission reduction goals and short- and long-term strategies to mitigate and offset GHG emissions, and to provide a detailed timetable for each strategy.

Recommended GHG Emission Reduction Goals

The Commission's recommended goals are based on the findings of the Intergovernmental Panel on Climate Change (IPCC) that industrialized nations need to take substantial early actions to stem the growth in GHG emissions and then start to reduce them rapidly, achieving reductions of 25 per cent to 40 per cent below 2000 levels by 2020, and 80 per cent to 95 per cent below 2000 levels by 2050, in order to avoid the most dangerous anthropogenic changes to the earth's climate. Keying on this, the Commission set early, aggressive, consumption-based goals for Maryland, as follows: (1) 25 per cent to 50 per cent below 2006 levels by 2020, 25 per cent being a minimum, regulatory driver and 50 per cent an aspirational goal to reward deeper, market-based cuts; (2) 90 per cent below 2006 levels by 2050, a non-regulatory goal to drive climate-neutral technology innovations; (3) interim targets of 10 per cent reductions by 2012 and 15 per cent by 2015 to spur early actions; and (4) a science-based review of the goals every four years.

Commission's Key Mitigation Messages

The Commission's *Comprehensive Greenhouse Gas and Carbon Footprint Reduction Strategy* has three simple, overarching messages:

Early actions are key.

The science tells us that atmospheric concentrations of GHGs are fast approaching, if they haven't already reached, levels that could tip us into severe and unpredictable changes in the earth's climate. Given this and the long residence times of GHGs in the atmosphere, 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 we start today. Every year we delay (the "business as usual" scenario) increases the amount of reductions we will need to achieve in later years, until we may reach a point where the reduction measures are vastly harder, or impossible, and too expensive, and our 2020 and 2050 goals are not achievable. On the other hand, by implementing early and significant GHG reduction programs now, and phasing in medium- and long-term programs on an aggressive "ramp up" schedule, we will avoid continued rapid GHG accumulations and get on a sustainable glide path to our 2020 and 2050 goals.

Shrinking our GHG footprint will grow Maryland's economy.

Energy efficiency is the fastest and least expensive approach available to reduce GHG emissions. Most of the Commission's policy recommendations for reducing energy demand can be implemented right now. A recent study done for the Maryland Department of Business and Economic Development and the Maryland Energy Administration reached these conclusions about the impact of energy efficiency and clean energy programs on Maryland's economy:

- Energy efficiency can reduce energy costs to homeowners, businesses, institutions and government at a cost 60 per cent to 70 per cent cheaper than building new generating capacity in Maryland.
- Developing clean energy industries in Maryland will create thousands of "green collar" and R&D jobs, will increase wages and salaries for Maryland citizens, and will significantly boost the state's tax revenues and gross state product.
- By lagging behind other states that are already investing in the fast-growing clean energy industry, Maryland is missing out on huge economic development and job growth potential.

What we do in Maryland matters in Maryland.

Despite Maryland's small size, our state is responsible for almost as many GHG emissions as Sweden and Norway combined, and our per capita and statewide emissions are growing faster than the U.S. as a whole. We have a responsibility to adopt mitigation measures commensurate with our carbon footprint. These actions will

have many local benefits. In addition to lowering the demand for costly energy and boosting our state's economy, GHG reductions will reduce air and water pollutants in Maryland and, through Smart Growth and transit-oriented development programs, will reduce vehicle miles traveled, traffic congestion and lost productivity, suburban sprawl and attendant infrastructure investments, and loss of agricultural and forested lands.

Recommended GHG Reduction Strategies

The Commission and its MWG were guided by the following principles as they developed and analyzed potential policy options:

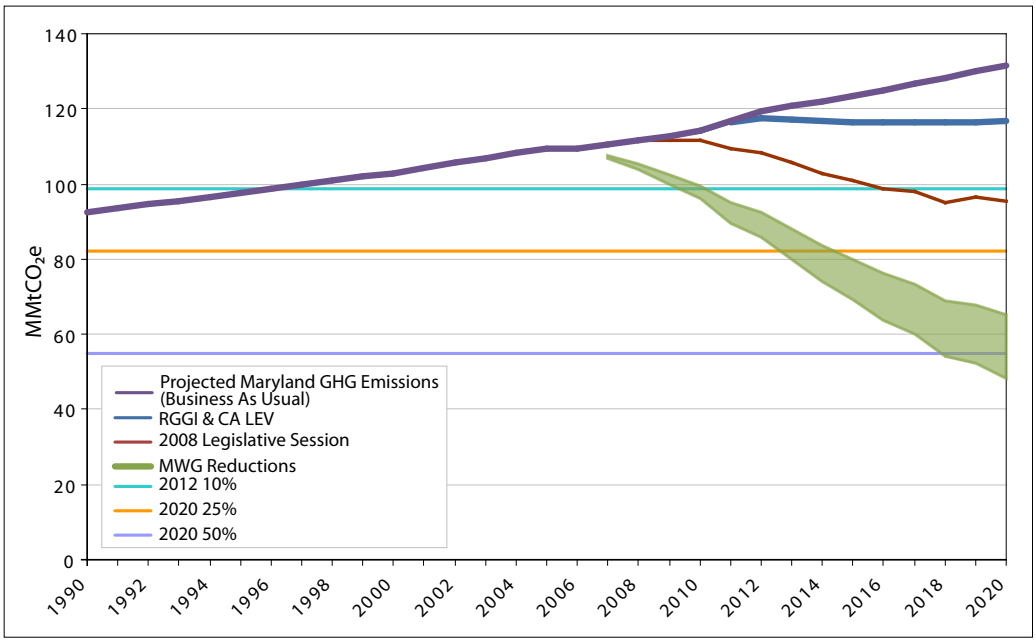
- Achieve significant long- and short-term emission reductions of GHGs in Maryland
- Demonstrate leadership
- Maximize the cost-effectiveness of the *Comprehensive Greenhouse Gas and Carbon Footprint Reduction Strategy*
- Provide savings to Maryland consumers and businesses
- Provide a net economic benefit to the State
- Drive job creation, business growth and economic development in Maryland

Starting from a catalogue of about 300 possible policy options for reducing GHG emissions, the Commission approved for further analysis fifty-four priority policy options. These were identified in the Commission's ***Interim Report***. The MWG and its five Technical Work Groups (TWGs) developed and refined each of these policy options from straw proposals into specific policy options. The process then further narrowed the list of policy options to a final suite of forty-two (several options were eliminated and a few were consolidated). Each policy option includes a description, a design and a goal, and each examines implementation mechanisms, feasibility and barriers, related existing programs, co-benefits, and key assumptions and uncertainties. Where appropriate, the policy's estimated reduction in GHG emissions has been quantified (expressed in million metric tons of CO_2 equivalent, or $MMtCO_2e$) based on the policy's stated goal. The cost or cost savings of achieving the reduction is also calculated for each quantified policy, expressed in dollars per ton. The forty-two policy options approved by the Commission form the core of the ***Climate Action Plan's*** mitigation strategy.

Some of the policy options have well-developed implementation mechanisms. Because of the scope of the Commission's work and its compressed time frame, the details of implementation for some policy options will need to be further analyzed and worked out by State agencies after the ***Plan*** is submitted to the Governor and the General Assembly. Where this is the case, it is so noted. The technical analyses that were performed to estimate reductions, costs or cost savings for each policy option were limited to what could be completed in a six-month time frame. There will be additional technical analysis of many of the policy options over the next several years.

As Figure ES-1, "GHG Reduction Potential from Maryland's Recent and Proposed Actions", shows, Maryland has already made significant progress in enacting programs that will dramatically reduce GHG emissions. The Maryland Clean Cars Program (CA LEV) and the Regional Greenhouse Gas Program (RGGI) (together, the blue line), and the ***EmPOWER Maryland*** and other 2008 legislative actions by the General Assembly aimed at reducing GHGs (the red line) get Maryland about 60 per cent of the way to the lower end of Maryland's 2020 goal (25 per cent reduction from 2006 levels). Adding in the reductions from all forty-two of the Commission's mitigation policy options (the green wedge*), the graph shows Maryland could easily make the lower end of the 2020 goal (25 per cent) and come within the range of the higher end of the goal (50 per cent), if all the policy options were adopted and aggressively implemented.

Figure ES-1 GHG Reduction Potential from Maryland's Recent and Proposed Actions



*The green wedge represents a range of potential emission reductions from the fourty-two recommended measures created due to uncertainty in calculating the benefits.

Figure ES-2, "Projected Emissions by 2020", shows how close recent actions (RGGI, Clean Cars, ***EmPOWER Maryland***, etc.) get Maryland to the 25 per cent goal by 2020.

Figure ES-2 Projected Emissions by 2020

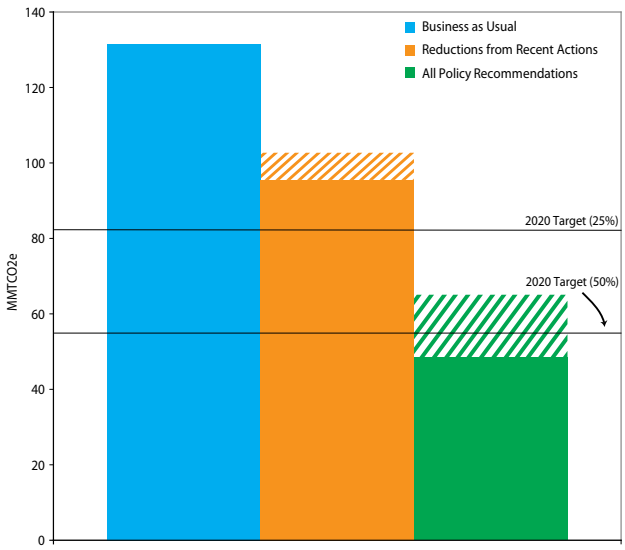


Figure ES-3, "Projected Emissions by 2012", shows that reductions from the forty-two strategies are projected to achieve an approximate 15 per cent to 22 per cent reduction from 2006 levels by 2012. Early actions are expected to achieve about 40 per cent to 50 per cent of the reductions needed to meet the 2012 goal.

Figure ES-3 Projected Emissions by 2012

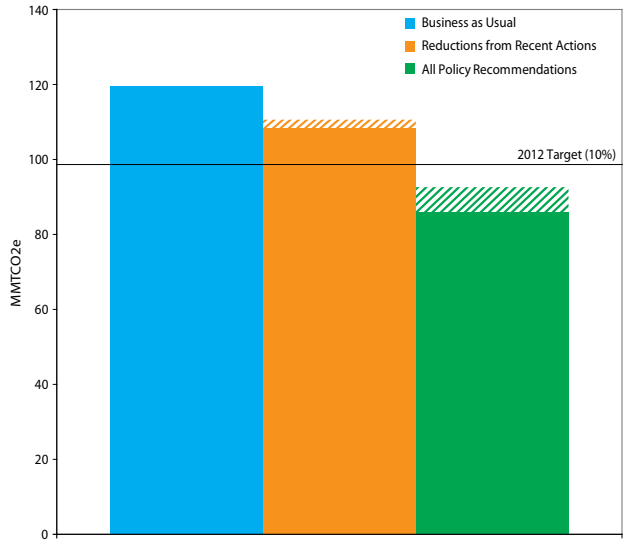


Figure ES-4, "Annual Greenhouse Gas Reduction Potential of Maryland Policy Options in 2020 and 2012", shows the individual reductions from each of the Commission's quantified policy options in 2020 and 2012.

Figure ES-4 Annual Greenhouse Gas Reduction Potential of Maryland Policy Options in 2020 and 2012 (The top bar in each pair represents 2020 emission reduction potential. The bottom bar in each pair represents 2012 emission reduction potential.)

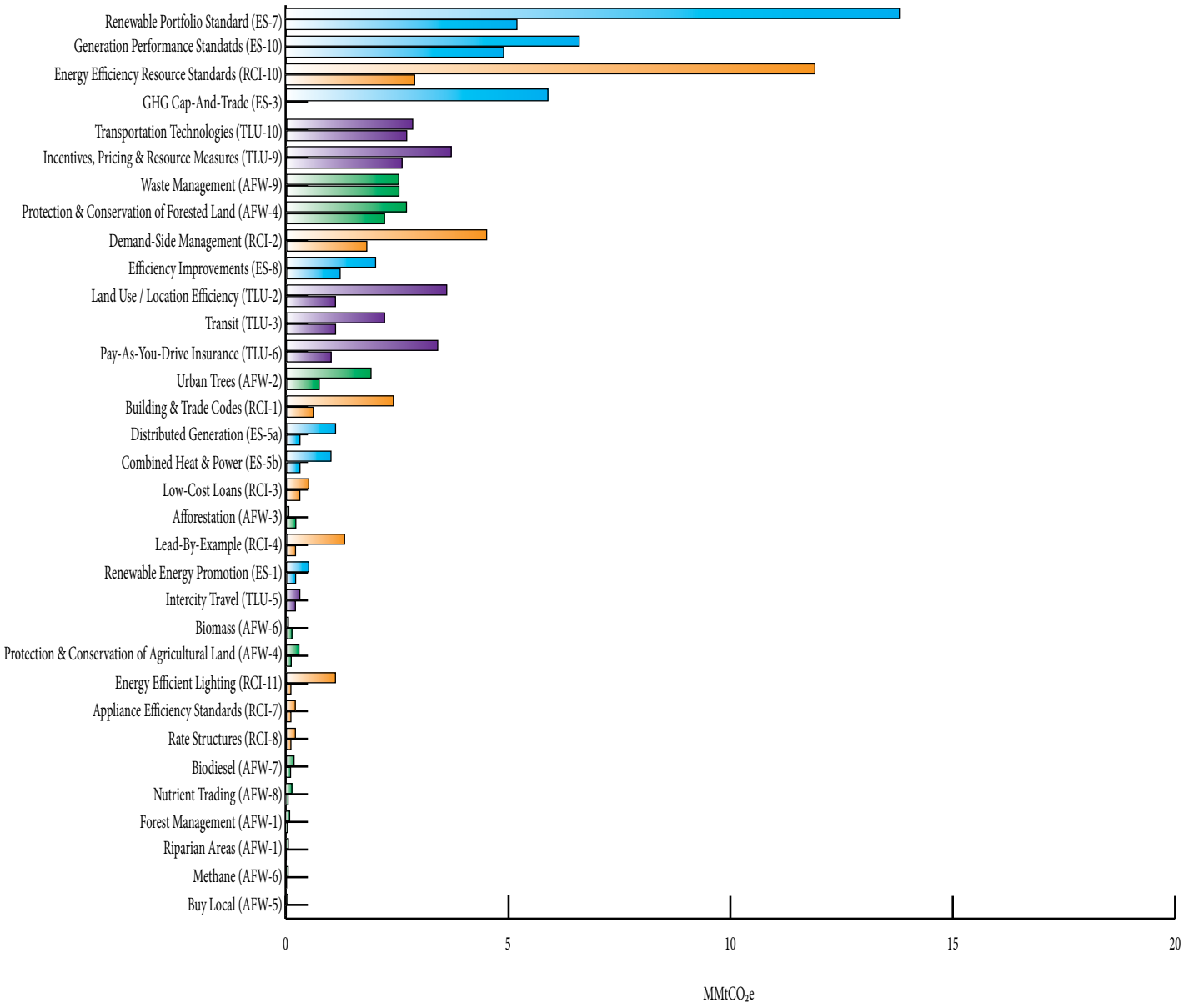
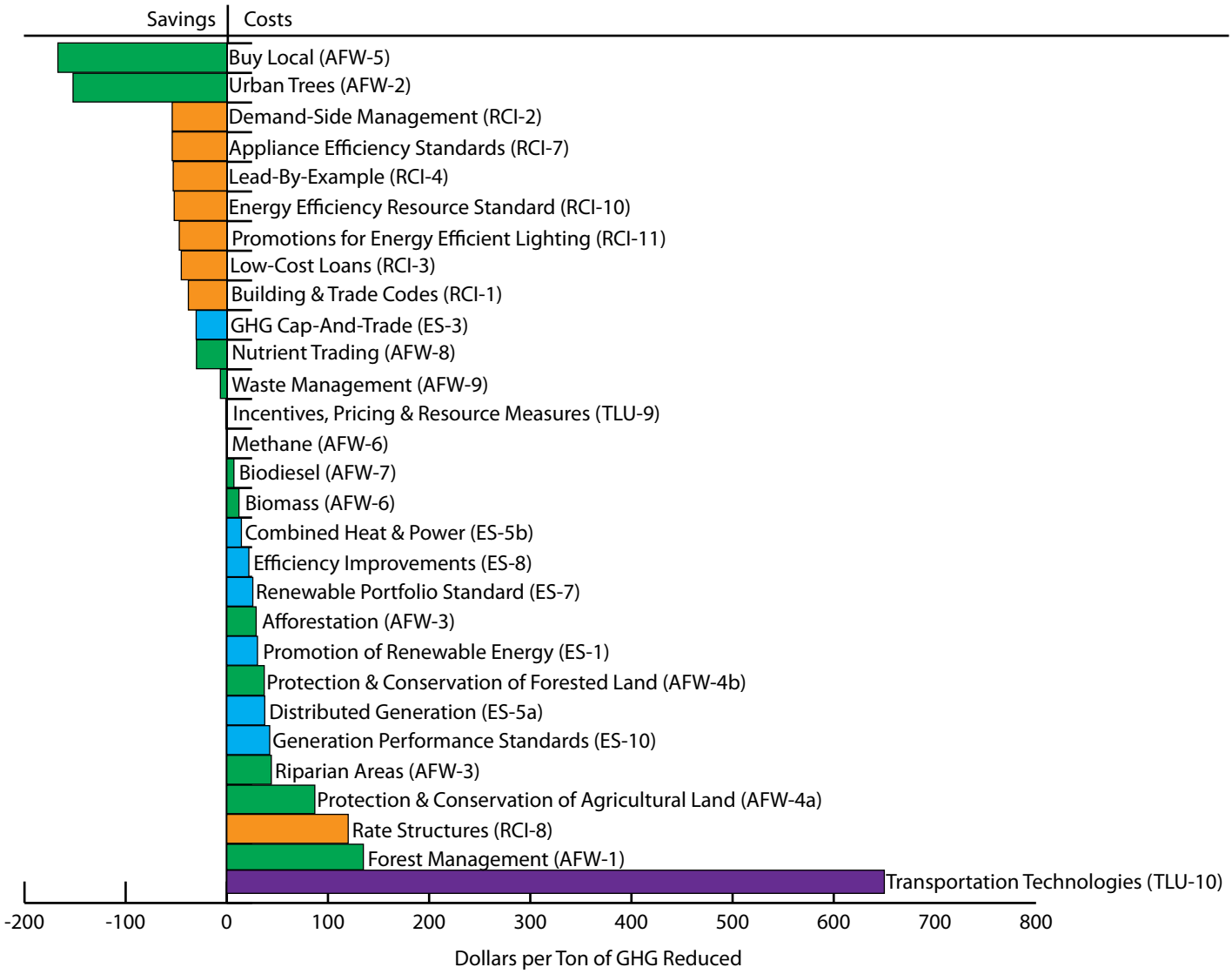


Figure ES-5, "Maryland Policy Options Ranked by Cost / Savings per Ton of GHG Reduced", shows the quantified policy options ranked by their cost-effectiveness. The measures to the left have a benefit to the State economy and the measures to the right have a direct cost to Maryland. In the aggregate, the policies yield a net economic benefit to Maryland, estimated to be approximately 2 billion dollars in 2020.

Figure ES-5 Maryland Policy Options Ranked by Cost / Savings per Ton of GHG Reduced



The charts on this and preceding pages are really illustrative in nature as quantifying emission reductions from GHG policies is a very complicated process. MDE has started to develop the resources necessary for a close review of GHG emission reduction potentials but the numbers generated by this process should be considered to be "based on the best available estimates" – they are in no way perfect.

Commission's Policy Options Bins

With forty-two measures to consider, the Commission decided to place the policies in "bins" based on the following criteria:

Bin 1: Higher Emission Reductions/ Easier to Implement
Bin 2: Lower Emission Reductions/ Easier to Implement
Bin 3: Higher Emission Reductions/ Harder to Implement
Bin 4: Lower Emission Reductions/ Harder to Implement

The actual policy options are described in detail, and the GHG reduction potential and cost-effectiveness of each, is quantified where possible, in Chapter 4 of this ***Plan*** and Appendix D. While too numerous to summarize here, the policies are sorted by name into the four Bin Tables below. The Commission identified a lead agency for each policy option (listed in the right-hand column), which is responsible for implementing the policy. In some cases a co-lead or assisting agency is also named.

The following abbreviations refer to the Technical Work Group (TWG) that developed the policy option:
AFW – Agriculture, Forestry and Waste TWG
ES – Energy Supply TWG
RCI – Residential, Commercial and Industrial TWG
TLU – Transportation and Land Use TWG
CC – Cross Cutting Issues TWG

The Commission's forty-two recommended mitigation strategies have evolved in the course of a rigorous, comprehensive, ten-month long stakeholder process which drew upon the expertise and commitment of MWG and TWG participants representing broad and diverse interests. While the work of these dedicated individuals is complete, the actual work of implementing the ***Climate Action Plan*** and getting Maryland on a sustainable trajectory to the 2020 and 2050 reduction goals just begins now, building on early initiatives such as RGGI, the Clean Cars and ***EmPOWER Maryland*** programs, and Maryland's Renewable Portfolio Standard.

Bin 1: Higher Emission Reduction / Easier Implementation

Policy Number	*Policy Name*	*Lead Agency*
ES-3	GHG Cap-and-Trade	MDE
TLU-10	Transportation Technologies	MDOT (MDE)
RCI-10	Energy Efficiency Resource Standard	MEA
CC-4	State & Local Government Lead by Example	MDE (MEA, MDOT)
RCI-4	Improved Design, Construction, Appliances & Lighting in Government	MDE (MEA, MDOT)
AFW-9	Waste Management / Advanced Recycling	MDE
ES-7	Renewable Portfolio Standard	PSC (MEA)
RCI-2	Demand Side Management & Energy Efficiency	MEA (PSC)
RCI-1	Improved Building & Trade Codes	DHCD (MEA)

Bin 2: Lower Emission Reduction / Easier Implementation

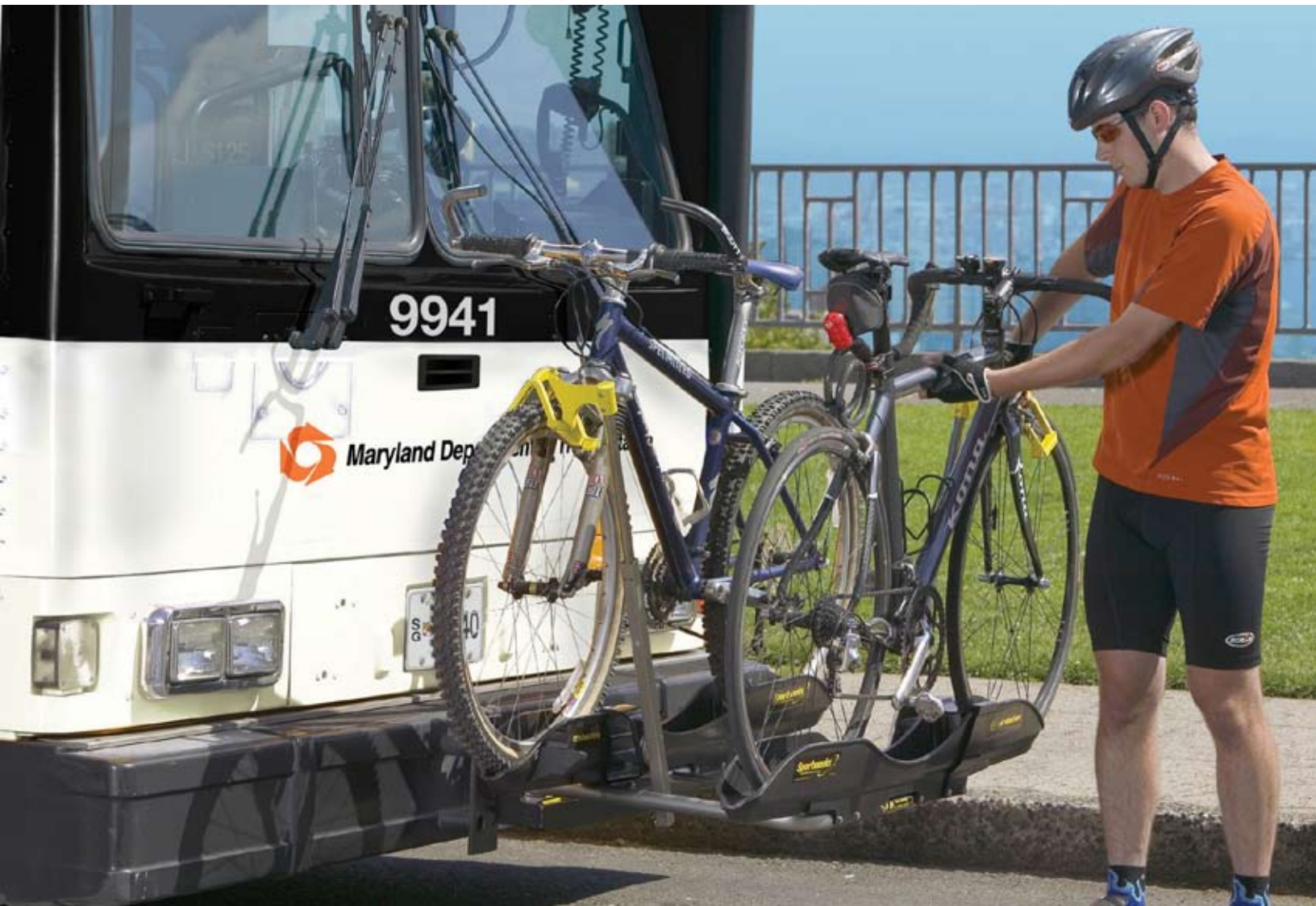
Policy Number	*Policy Name*	*Lead Agency*
CC-1	GHG Emission Inventories & Forecasting	MDE
CC-2	GHG Reporting & Registries	MDE
CC-3	Statewide GHG Reduction Goals	MDE
CC-5	Public Education & Outreach	MDE (MSDE, MEA)
CC-8	Participate in Regional, Multi-State & National Efforts	MDE
CC-7	Review Institutional Capacity	Commission
CC-10	After Peak Oil	MEA (MDE)
CC-11	Public Health Risks	DHMH (MDE)
RCI-11	Promotion & Incentives for Energy Efficient Lighting	MEA
ES-5	Clean Distributed Generation	MEA (PSC)
RCI-3	Low-Cost Loans for Energy Efficiency	MEA
ES-1	Promotion of Renewable Energy	MEA (PSC)
ES-6	Integrated Resource Planning	PSC (MEA)
RCI-7	More Stringent Appliance / Equipment & Efficiency Standards	MEA
CC-9	Promote Economic Development Opportunities	DBED (MEA)
ES-2	Technology Focused Initiatives for Electricity Supply	MEA
AFW-2	Managing Urban Trees & Forests	DNR
AFW-3	Afforestation, Reforestation, & Restoration of Forests & Wetlands	DNR (MDA)
AFW-4	Protection & Conservation of Agricultural Land, Coastal Wetlands & Forested Land	MDA
AFW-1	Forest Management for Enhanced Carbon Sequestration	DNR
AFW-5	Buy Local Programs	MDA (DNR)

Bin 3: Higher Emission Reduction / Harder Implementation

Policy Number	*Policy Name*	*Lead Agency*
ES-8	Energy Improvements & Repowering Existing Plants	MEA (PSC)
ES-10	Generation Performance Standards	MDE (PSC, MEA)
TLU-2	Land Use & Location Efficiency	MDOT (MDP, MDE)
TLU-3	Transit	MDOT (MDP, MDE)
TLU-5	Intercity Travel	MDOT (MDP, MDE)
TLU-6	Pay-As-You-Drive Insurance	MDOT (MDP, MDE)
TLU-8	Bike & Pedestrian Infrastructure	MDOT (MDP, MDE)
TLU-9	Incentives, Pricing & Resource Measures	MDOT (MDP, MDE)
TLU-11	Evaluate GHGs from Major Projects	MDOT (MDP, MDE)

Bin 4: Lower Emission Reduction / Harder Implementation

Policy Number	*Policy Name*	*Lead Agency*
AFW-6	Expanded Use of Forese & Feedstocks for Energy Production	DNR (MDA)
AFW-7b	In-State Liquid Biodiesel Production	MEA (MDA)
AFW-8	Nutrient Trading with Carbon Benefits	MDE (MDA)



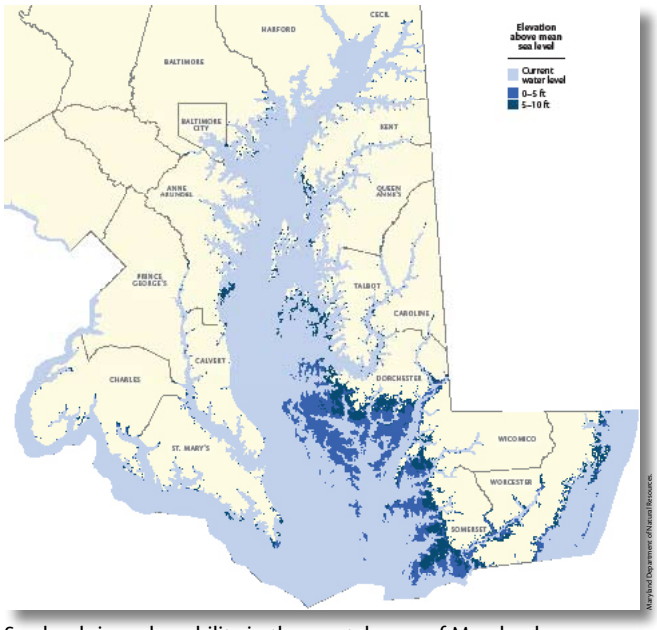
Chapter 5: Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change: Phase 1 Sea Level Rise & Coastal Storms

Introduction - We must take action now to plan for the impacts of climate change

The Commission's Adaptation and Response Working Group (ARWG) was charged with developing a *Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change*. The Executive Order calls for the *Strategy* to outline specific policy recommendations for reducing the vulnerability of the State's natural and cultural resources and communities to the impacts of climate change, with an initial focus on sea level rise and coastal hazards.

With over 3,000 miles of coastline, Maryland is poised in a very precarious position when it comes to the impacts of climate change. Maryland's coast is particularly vulnerable to both episodic storm events, such as hurricanes and Nor'easters, as well as chronic problems associated with shore erosion, coastal flooding, storm surge, and inundation. Problems such as these are both driven by and exacerbated by climate change and sea level rise.

Rising sea levels over the last 20,000 years have formed the Chesapeake Bay that we know today. While the rapid rate of sea level rise that occurred over the past 5,000 years has slowed, historic tide-gauge records show that levels are still rising and have increased approximately one-foot within Maryland's coastal waters in the past 100 years. Such a rate of rise is nearly twice that of the global average, over the same time period. In support of this ***Climate Action Plan***, the STWG assessed the 2007 global sea level rise projections of the Intergovernmental Panel on Climate Change (IPCC), along with regional land subsidence variables, and provided a conservative estimate that by the end of this century, Maryland may experience a relative sea level rise of 2.7 feet, under a lower-emission scenario, and as much as 3.4 feet under the higher-emission scenario,



Sea-level rise vulnerability in the coastal areas of Maryland, calculated using LIDAR elevation data. Note: LIDAR elevation data were not available for Baltimore City, Harford County, and Prince George's County. Therefore, vulnerability data do not exist for those areas and cannot be shown on this map.

Due to its geography and geology, the Chesapeake Bay region is ranked the third most vulnerable to sea level rise, behind Louisiana and Southern Florida. In fact, sea level rise impacts are already being detected all along Maryland's coast, as 13 charted Chesapeake Bay islands and large expanses of tidal wetlands have already disappeared. Two to three feet of additional sea level rise will result in a dramatic intensification of coastal flood events; increase shore erosion; cause the intrusion of salt-water into freshwater aquifers; and submerge thousands of acres of tidal wetlands, low-lying lands and the Chesapeake's last inhabited island community, Smith Island.

Sea level rise poses a significant threat to resources and infrastructure in Maryland's coastal zone. As growth and development continues, especially within low-lying Eastern Shore communities, these impacts are likely to escalate. In the short-term, coastal areas already under natural and human-induced stress are most vulnerable. Of these, barrier and bay islands, and Lower Eastern Shore of the Chesapeake Bay are in critical need of protection. However, much larger portions of Maryland's coast will become threatened over time.

Adaptation and response planning is crucial to Maryland's ability to sustainably manage its coastal zone. A "do nothing" approach will lead to unwise decisions and increased risk over time. Planners and legislators must realize that the implementation of measures to mitigate climate change and sea level rise impacts associated with erosion, flooding, and the inundation of low-lying lands is imperative to sustainable management, as well as protection of Maryland's coastal resources and communities.

This *Strategy* lays out the specific priority policy recommendations developed by the ARWG and approved by the Commission to address short- and long-term adaptation and response measures, planning and policy integration, education and outreach, performance measurement, and where necessary, the *Strategy* identifies new legislation and/or modifications to existing laws. Full versions of the priority policy recommendations, which include a detailed discussion of implementation mechanisms, related policies and programs in place, qualitative benefits and cost assessments and feasibility issues, are contained in Appendix E.

Vision/Statement of Intent - Protect Maryland's Future Economic Well-Being, Environmental Heritage, and Public Safety

Climate change, sea level rise and associated coastal storms, are putting Maryland's people, property, natural resources, and public investments at risk. To protect Maryland's future economic well-being, environmental heritage and public safety and to guide the fundamental intent of the *Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change*, the Commission recommends that the Governor and the Maryland General Assembly take legislative and policy actions to:

- Promote programs and policies aimed at the avoidance and/or reduction of impact to the existing-built environment, as well as to future growth and development in vulnerable coastal areas;
- Shift to sustainable economies and investments; and, avoid assumption of the financial risk of development and redevelopment in highly hazardous coastal areas;
- Enhance preparedness and planning efforts to protect human health, safety and welfare;
- Protect and restore Maryland's natural shoreline and its resources, including its tidal wetlands and marshes, vegetated buffers, and Bay Islands, that inherently shield Maryland's shoreline and interior.

Reduction of Impact to Existing and Future Growth and Development -Take action now to protect human habitat and infrastructure from future risks

Leadership by Maryland's State and local governments is imperative to reduce Maryland's vulnerability to climate change, sea level rise, and coastal storms. Maryland's State agencies and its local governments must take action now to protect human habitat and infrastructure from future risks. The State can accomplish this by taking steps to effectively reduce the impact to existing-built environments by requiring that public and private structures be elevated and designed to reduce damage; and to avoid future impact, by directing new growth and development away from areas vulnerable coastal areas.

Priority Policy Recommendations

- Integrated Planning: 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.
- Adaptation of Vulnerable Coastal Infrastructure: Develop and implement State and local adaptation policies (i.e., protect, retreat, abandon) for vulnerable public and private sector infrastructure.
- Building Code Revisions and Infrastructure Design Standards: Strengthen building codes and construction techniques for new infrastructure and buildings in vulnerable coastal areas.
- Financial and Economic Well-Being – Minimize risks and shift to sustainable economies and investments

Maryland's people, property, natural resources, and public investments are all vulnerable to climate change and sea level rise; and, at some point, the inevitability of climate change will require critical actions to protect them rather than purposeful foresight and preparedness planning. Two to three feet of sea level rise would inundate thousands of properties in of low-lying areas, and expose millions of dollars worth of public infrastructure to the threat of submergence and/or storm surge. Billions of dollars more of public and private investments are at risk. Over time, federal, State, and local government will not be able to afford to assist all in need - the costs will be just too high. Maryland should begin a sweeping shift to develop sustainable economies and investments and at the same time, must work hard to avoid the assumption of the financial risk of development and redevelopment in highly hazardous coastal areas.

Priority Policy Recommendations

- Resource-Based Industry Economic Initiative: Develop and implement long-range plans to minimize the economic impacts of sea level rise to natural resource-based industries.
- Climate Change Insurance Advisory Committee: Establish an independent Blue Ribbon Advisory Committee to advise the State of the risks that climate change poses to the availability and affordability of insurance.
- Disclosure: Develop a Maryland Sea Level Rise Disclosure and Advisory Statement to inform prospective coastal property purchasers of the potential impacts that climate change and sea level rise may pose to a particular piece of property.
- Green Economic Development Initiative: Recruit, foster, and promote market opportunities related to climate change adaptation and response.

Protection of Human Health, Safety and Welfare - Guarantee the safety and well-being of Maryland's citizens in times of foreseen and unforeseen risk

Sea level rise will impact both the coastline and some interior portions of Maryland and will change the way health-related infrastructure and programs are maintained and managed in the future. The general population may take for granted that clean and adequate water supplies are available, waste water is cared for and properly disposed of, and that our population is generally safe from the impact of coastal flood events and vector-borne illnesses. However, with a projected growing population in Maryland, mostly in coastal areas, protecting human health and safety will become an increasing large responsibility for the State and local governments. With that responsibility, new tools and adequate resources will be needed in order to protect Maryland's communities – both large and small.

Priority Policy Recommendations

- Inter-Agency Coordination: Strengthen coordination and management across Agencies responsible for human health and safety.
- Health Impact Assessments: Conduct Health Impact Assessments to evaluate the public health consequences of climate change and sea level rise-related projects and/or policies.
- Vector-borne Surveillance and Control: Develop a coordinated plan to assure adequacy of Vector-borne Surveillance and Control Programs.
- Natural Resource Protection - Retain and expand forests, wetlands and beaches to protect us from coastal flooding

Maryland's natural resource lands provide critical wildlife habitats, have regional significance for migratory birds, sequester large amounts of carbon, provide sediment and nutrient water quality benefits, and generate economic benefits through farming, forestry, fishing, and passive recreation. Natural resources, particularly coastal wetlands and barrier and bay islands, also play a vital role in protecting Maryland's shoreline and interior by absorbing the damaging impact of coastal floods, heavy winds, and strong waves. Identifying undeveloped lands and ecologically and economically important lands will be critical for targeted conservation and coordinated restoration in response to sea level rise and its associated effects. Preserving undeveloped, vulnerable lands also offers a significant opportunity to avoid placing people and property at risk to sea level rise and associated hazards including storm surge, coastal flooding, and erosion in the future.

Priority Policy Recommendations

- Natural Resource Protection Areas: Identify high priority protection areas and strategically and cost-effectively direct protection and restoration actions.
- Forest and Wetland Protection: Develop and implement a package of appropriate regulations, financial incentives, educational, outreach, and enforcement approaches to retain and expand forests and wetlands in areas suitable for long-term survival.
- Shoreline and Buffer Area Management: Promote and support sustainable shoreline and buffer area management practices.

Adaptation and Response Toolbox – Give State and local governments the right tools to anticipate and plan for sea level rise and climate change

To adequately plan and respond to sea level rise, it is imperative that both state and local governments have access to the right tools at the right time. Over the last ten years, the State of Maryland has made significant progress acquiring new technology and data, including the statewide high resolution topographic data and has utilized this data to undertake state-of-the-art sea level rise mapping and research. The State has also proactively been working with select state agencies and coastal counties to provide the necessary funding and technical assistance to build capacity to integrate data and mapping efforts into decision-making processes. Maryland is well on its way to providing the tools, technical resources, and educational programs, however, a continued commitment on the part of both State and local governments is still essential.

Priority Policy Recommendations

- Integrated Observation Systems: 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.
- GIS Mapping, Modeling and Monitoring: Update and maintain statewide sea level rise mapping, modeling, and monitoring products.
- Public Awareness, Outreach, Training and Capacity Building: Utilize new and existing educational, outreach, training and capacity building programs to disseminate information and resources related to climate change and sea level rise.

Future Steps and Directions – State and local governments must commit resources and time to assure progress

Planning for climate change and sea level rise is extremely complex - there are many potential impacts and there is no single remedy. While climate change and sea level rise are both gradual processes occurring slowly over time, the impacts of both are already being detected. Maryland's State and local governments must take specific action now to plan for the inevitable impacts. The recommendations laid out in this *Strategy* are intended to guide adaptation activities over the next five years and along the way, Maryland's state and local governments must measure and track progress, keeping in mind that many of the implementation strategies must be adaptable to change. Progress will take time, fiscal resources, flexibility, and continual commitment.

Priority Policy Recommendations

- Local Government Planning Guidance: Develop state-wide sea level rise planning guidance to advise adaptation and response planning at the local level.
- Adaptation-Stat: Develop and implement a system of performance measures to track Maryland's success at reducing its vulnerability to climate change and sea level rise.
- Future Adaptation Strategy Development: Pursue the development of adaptation strategies to reduce climate change vulnerability among affected sectors, including agriculture, forestry, water resources, aquatic and terrestrial ecosystems, and human health.

The Commission should continue to evaluate adaptation strategies in addition to sea level rise and coastal vulnerability over the next year and beyond. The sector-based impact and issue assessments provided by the STWG (Chapter 2 of the ***Plan***) will serve as a useful basis for evaluation of adaptation strategies appropriate for Maryland in the areas of human health; water resources; forest management; and the restoration of the Chesapeake and Maryland Coastal Bays. Phase II of the *Comprehensive Strategy to Reduce Maryland's Vulnerability to Climate Change* should be initiated within one-year. Sector-based working groups, comprised of a broad array of stakeholders and issue experts, will be necessary to fulfill this task.

Chapter 6: Building a Federal-State Partnership

Spurred by the growing momentum of state leadership in climate protection, the U.S. Congress is now seriously engaged in shaping a federal climate policy centered around an economy-wide GHG cap-and-trade program. The Administration and Congress should actively engage the states and regional consortiums such as RGGI in building a federal-state partnership in climate regulation. States should have an active role in establishing national science-based mandatory GHG reduction goals, and in deciding how emission allowances will be allocated in a national cap-and-trade program, how auction revenues will be distributed and can be used by the states, and how an offset credit program will work.

For sectors not amenable to a national cap-and-trade, the federal government should limit its sphere of regulation to the things it is uniquely positioned to do: adopt national technical and performance standards for certain sectors; fund research and development for technological advancement and improved energy efficiency; and amend the Clean Air Act and Surface Transportation Authorization Act and provide funding to enable states to use the Transportation Conformity Process to reduce GHG emissions in the transportation sector.

States should retain the autonomy to implement mitigation programs in areas within their traditional purview, such as land use, building codes, transportation, roads, water, sewer and other infrastructure, school curricula, and police powers. Other non-traditional programs better suited to state implementation include renewable portfolio standards tailored to capitalize on the state's natural resources and economy, utilities' demand-side management programs, integrated resource planning by state public service commissions, and removing siting and regulatory obstacles to clean distributed generation. Recognizing this is the fastest and most cost-effective path to energy efficiency and GHG reductions, Congress should *expressly* not preempt state programs and regulations that are at least as stringent as the federal standards, and should provide priority funding and other incentives for "first mover" states that adopt goals and mandatory climate action plans by a specified date and demonstrate adequate progress toward meeting the goals.

In the 110th Congress, Members have introduced numerous bills that would directly or indirectly address climate change. However, only a few of these bills address the issue of adaptation to climate change. Currently, there are no stand-alone adaptation bills; adaptation provisions are contained in broader legislation on climate action or research. Because of earlier GHG emissions, some level of warming will occur regardless of mitigation activity. The nation should strategically focus on preparing communities and natural systems to adapt to the effects of a changing climate. Maryland must prepare now to adapt and respond to existing and future impacts with the support of the next Administration and Congress.

Fundamental to the requirements for effective adaptation is the ability to monitor, assess, and forecast climate changes. This should be provided through enhanced federal programs for integrated observing systems and climate services in partnership with the states. Furthermore, Maryland should develop and implement a strategy, in partnership with the federal laboratories and programs based in the State, to become a national and international center of excellence for climate change science and technology.

Each of the fifty states faces its own unique set of global warming challenges and is in the best position to assess the risks and implement solutions. The Administration and Congress should recognize the primacy of states as "first responders" in protecting the health, safety and welfare of their citizens, economies, natural resources, and built environments, and to leave them the autonomy to continue their leadership and be the "laboratories for innovation" in climate protection.

Chapter 7: Legislative Update and Next Steps

2008 Legislation

Nearly all of the Commission's recommendations for "Early Action" legislation in the ***Interim Report*** were adopted by the General Assembly in its 2008 Session.

Early Action legislative highlights include:

- Adopting an Energy Efficiency Performance Standard
- Establishing a Publicly Administered Energy Investment Fund
- Amending State Building Codes to Improve Energy Efficiency
- Strengthening Maryland's Renewable Portfolio Standard
- Updating Jurisdictional Boundaries of Bays Critical Areas
- Protecting Shorelines

Next Steps

The Commission will prepare an annual update on the ***Climate Action Plan*** for the Governor and General Assembly every November as called for in the Executive Order. With the ***Plan*** complete, the focus will shift to implementing the policy options that are adopted.

The Commission recommends that Maryland's State government build the institutional capacity to address climate change comprehensively and systematically. Recommended options include the following:

- Adopt the ***Plan's*** GHG reduction goals as Maryland's goals.
- Create an Office of Climate Change within the Governor's office to oversee and coordinate ***Plan*** implementation.
- Prepare and update a statewide GHG inventory and forecast and establish reporting requirements and a registry for GHG sources.
- Establish policies and procedures to give emission reduction and offset credits to sources that take early actions to reduce emissions.
- Establish government lead-by-example policies and procedures for State agencies to: (1) demonstrate and implement best GHG reduction practices through the allocation of State fiscal resources and in operations, procurement, programs, high performance buildings, and management of state lands; and (2) implement sound sea level rise adaptation and response measures on State lands and through the allocation of State fiscal resources.
- Require State agencies to perform a Climate Impact Assessment, under approved protocol, prior to undertaking new capital projects.
- Develop and implement a system of performance measures to track Maryland's success at reducing its vulnerability to climate change and sea level rise (Adaptation-Stat).
- Create a statewide Education/Outreach program.
- Establish work groups recommended in the ***Plan*** to operate under the Commission's umbrella.

The Commission recommends that the lead and supporting State agencies identified in the policy options work together to develop policy implementation plans and start implementing policies immediately where possible, and report their progress to the Commission at its Spring 2009 meeting.

The Commission should continue to evaluate adaptation strategies in addition to sea level rise and coastal vulnerability over the next year and beyond. The sector-based impact and issue assessments provided by the STWG (Chapter 2 of the ***Plan***) will serve as a useful basis for evaluation of adaptation strategies appropriate for Maryland in the areas of human health; water resources; forest management; and the restoration of the Chesapeake and Maryland Coastal Bays. Phase II of the *Comprehensive Strategy to Reduce Maryland's Vulnerability to Climate Change* should be initiated within one-year. Sector-based working groups, comprised of a broad array of stakeholders and issue experts, will be necessary to fulfill this task.