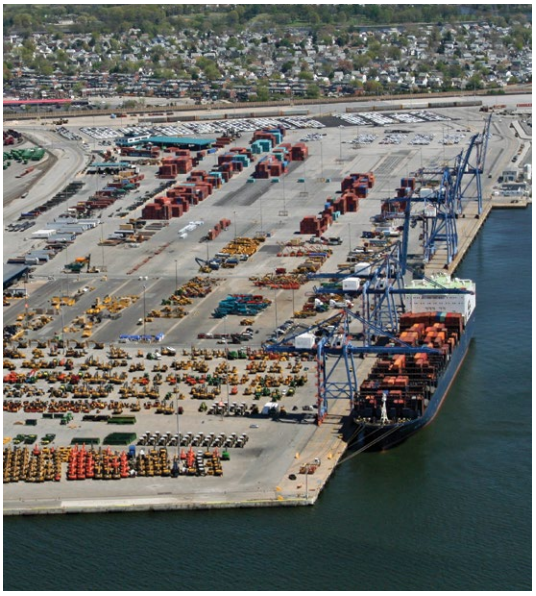

Maryland's Greenhouse Gas Reduction Plan

Executive Summary

The Maryland Department of the Environment is the agency responsible for preparing and submitting this Executive Summary of the 2013 Greenhouse Gas Reduction Plan.

For more information
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Climate change is real.

Scientists agree.

It's happening now.
It's harmful and human-caused.

We can make a difference through our actions.

The earth's climate is changing. The time to act is now.

Under Governor Martin O'Malley's leadership, Maryland has chosen to move forward, even as most states and the United States Congress have not. Greater action by the states will encourage the Nation to address climate change. In 2009, Governor Martin O'Malley and Maryland's General Assembly charged the State with developing a Greenhouse Gas Reduction Plan (referred to as *the Plan*) that will reduce greenhouse gases 25 percent by the year 2020. In drafting and implementing the Plan, Maryland State Government has committed to making the smartest environmental and economic decisions possible, and to implementing the most effective climate change strategies.

Now is the moment in time to commit to reducing greenhouse gas emissions in Maryland and beyond. We can choose to reduce our greenhouse gas emissions now, or we can let these gases continue to increase until we are dealing with a full-fledged crisis. The longer we delay, the less effective and more expensive mitigation will become.

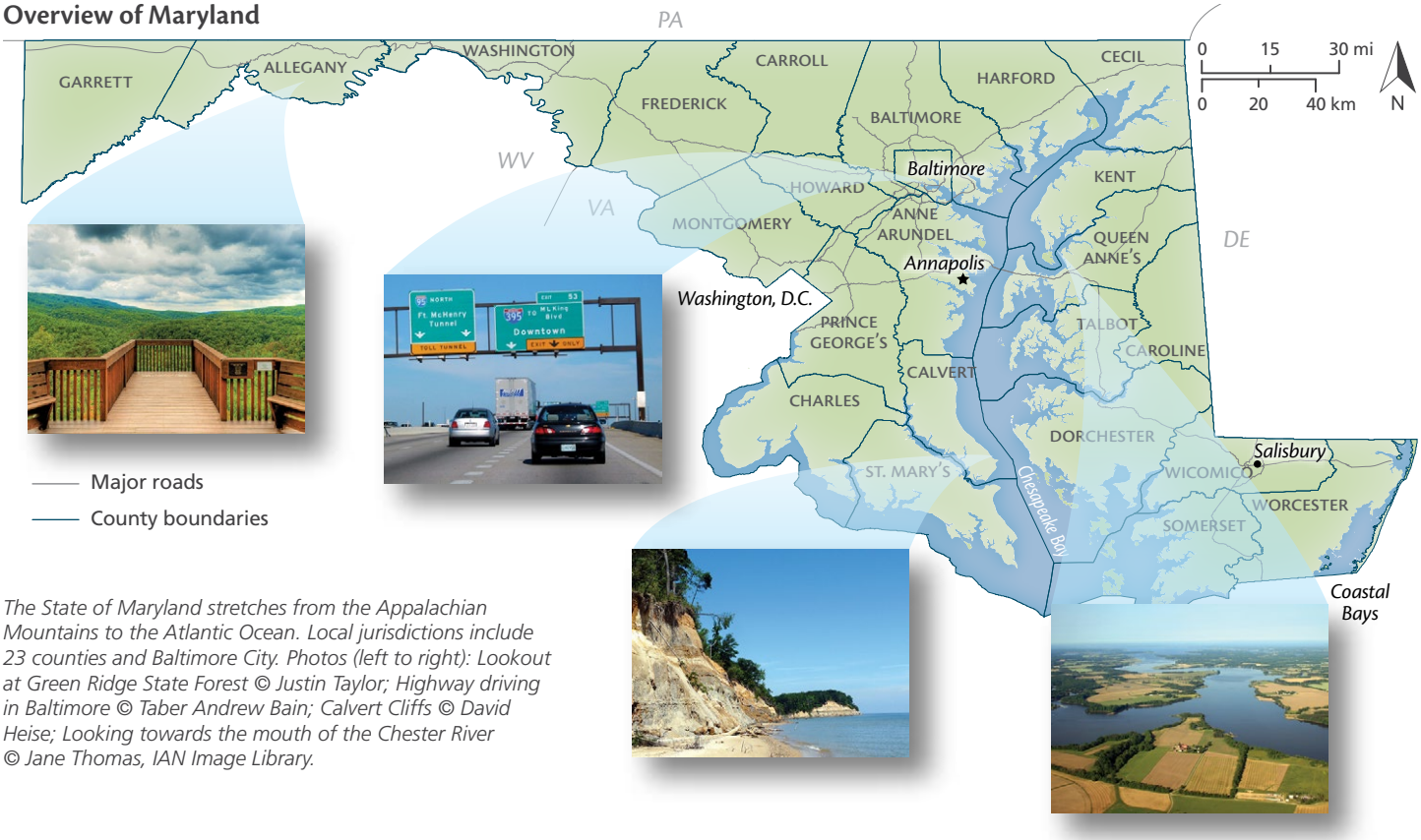
In addition to reducing greenhouse gas emissions, Maryland's 2009 Greenhouse Gas Emissions Reduction Act requires *the Plan* to have a positive impact on job creation and economic growth in Maryland. Current analyses project that *the Plan* would result in estimated economic benefits of $1.6 billion and support over 37,000 jobs.

This executive summary provides an overview of Maryland's *Plan*. The following 13 pages describe Maryland's vulnerability to climate change and summarize Maryland's 150-plus Greenhouse Gas Reduction programs and initiatives and their associated benefits. The full Greenhouse Gas Reduction Plan can be accessed at **climatechange.maryland.gov**.

"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 O'Malley

Overview of Maryland



The State of Maryland stretches from the Appalachian Mountains to the Atlantic Ocean. Local jurisdictions include 23 counties and Baltimore City. Photos (left to right): Lookout at Green Ridge State Forest © Justin Taylor; Highway driving in Baltimore © Taber Andrew Bain; Calvert Cliffs © David Heise; Looking towards the mouth of the Chester River © Jane Thomas, IAN Image Library.

Climate change is real

Climate change refers to changes in weather patterns on a global, continental, regional, or local scale. On a global scale, temperatures and sea levels are rising, rainfall patterns are shifting, and wildlife habitats are changing (IPCC 2007). Climate change is increasing the number and severity of hurricanes, winter storms, droughts, and other extreme weather events. The effects of climate change in Maryland are already apparent in rising seas, summer heat waves, and more frequent and violent thunderstorms. All of these changes affect Maryland's citizens, their livelihoods, and the State's economy.

Maryland is vulnerable

Maryland is among the states most vulnerable to climate change (MCCC 2008). Rising sea levels, along with increased storm intensity, will have devastating and far-reaching environmental and economic impacts on the Chesapeake Bay and on the quality of life Marylanders enjoy. Maryland's sizable farming community could suffer costly losses during extreme droughts and heat waves. Marylanders everywhere will face increased risk of flooding and significant property damage as a result of heavier precipitation and other extreme weather events. Children, the elderly, and other sensitive populations are vulnerable to the effects of heat waves and increased air pollution (Boicourt and Johnson 2010). For these reasons, addressing climate change must be among the State's highest priorities.

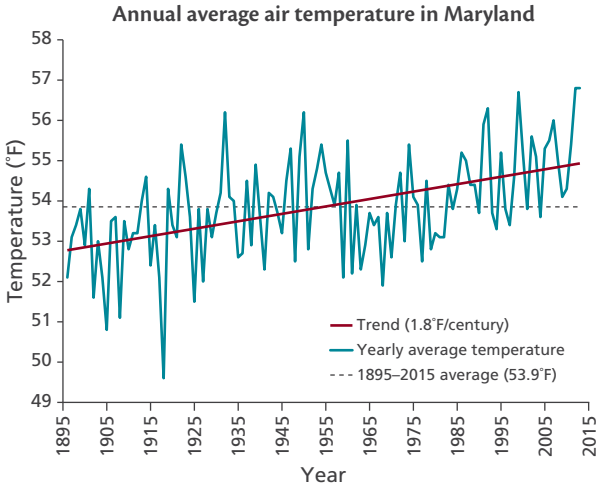
Maryland temperatures are rising

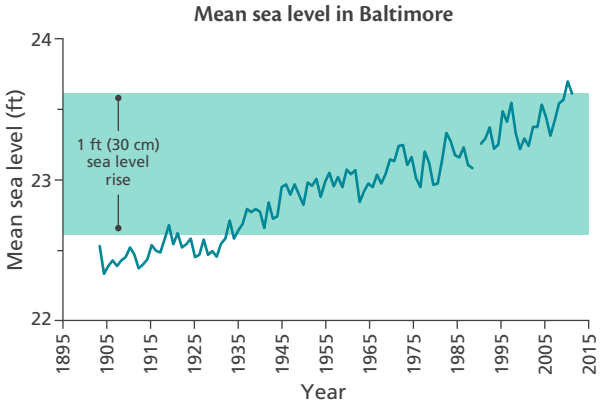
The Intergovernmental Panel on Climate Change concluded that we cannot deny that the earth is warming, and that most of the observed increases in temperatures are related to increases in greenhouse gas emissions over the last 50 years (IPCC 2007). Long-term temperature data show that average temperatures in Maryland have risen in the last century and will continue to rise in the future (NCDC 2012). Marylanders around the State are already noticing warmer winter days, more intense heat and humidity in the summer, and more damage due to storms.

Coastal sea levels are rising in Maryland

Historic tide gauge records demonstrate that sea levels are rising along Maryland's coast. Due to a combination of global sea level rise and land subsidence, sea levels have risen approximately one foot within Maryland's waters over the last 100 years. As our climate changes, sea levels are expected to continue to rise—potentially twice as fast as during the 20th century. Maryland is at risk of experiencing another one-foot rise in sea level by 2050 and as much as a three-foot rise by 2100, contributing to higher storm wave heights, greater flooding in low-lying coastal areas, exacerbated shoreline erosion, and damage to property and infrastructure. The sea level rise map (page 3) depicts the counties in Maryland that are the most vulnerable to sea level rise.

DON BOESCH





Top: Downtown Annapolis was flooded during Hurricane Isabel in 2003. The combination of rising sea levels and extreme events like hurricanes will mean even more flooding in the future.

Middle: Data from the National Climatic Data Center illustrates that temperatures in Maryland have increased ~1.8°F per century since 1895 (NCDC 2013).

Bottom: The long-term tide gauge in Baltimore Harbor shows a steady rise in sea level since the early 1900s (PSMSL 2013).

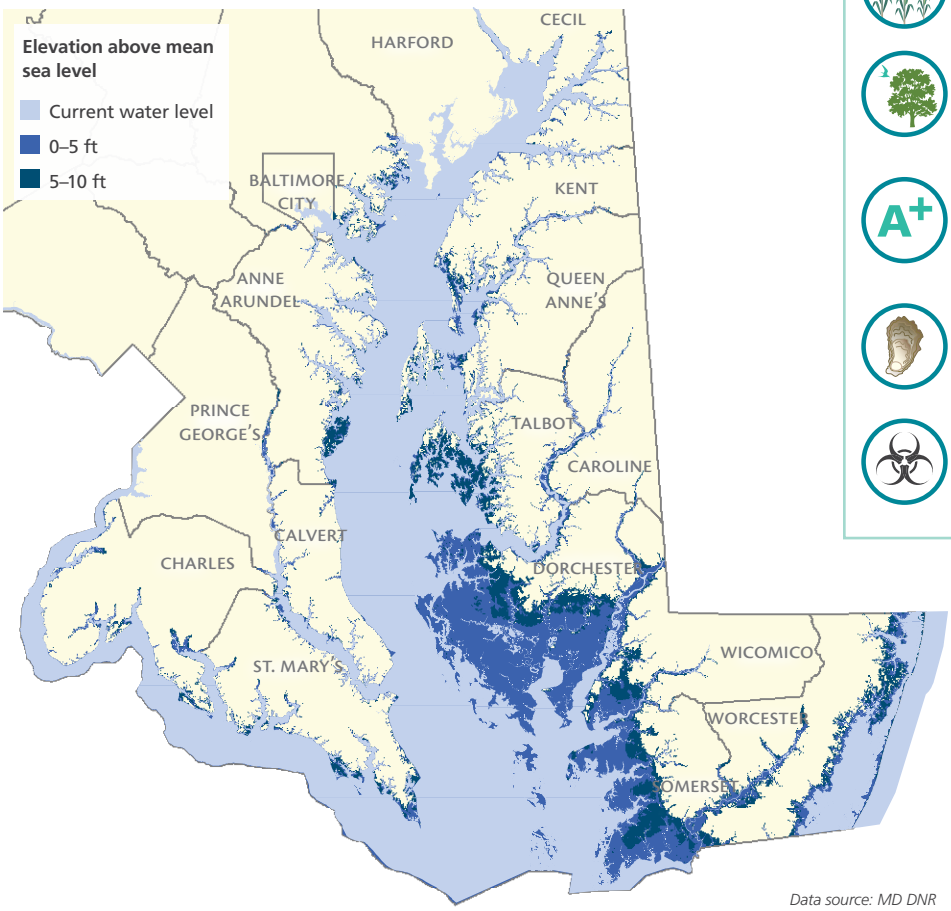
Extreme events are more frequent

Maryland is experiencing more frequent extreme rain and storm events, and more flooding as a result of sea level rise and coastal storms. August and September of 2011 were the State's wettest in 117 years. Increasing temperatures, which allow air to trap more moisture, will make these storm events more common. July of 2011 and 2012 were the second and third hottest on record (NCDC 2012). Extreme events affect human health both directly and indirectly. Warmer temperatures and poor air quality increase respiratory illness and other health problems in our vulnerable populations. Extreme events can directly damage infrastructure such as water treatment and supply, transportation, and electricity systems.

Impacts

New data and better information confirm that past predictions of the severity and cost of global climate change impacts were conservative: greenhouse gas emissions have increased more rapidly than predicted; Arctic sea ice has retreated faster than models projected; and sea level has risen at a faster rate than expected (National Academy of Sciences 2010). A growing economy and population means that even more assets are at risk. Interdependencies among social, economic, and environmental changes can ripple through the economy to magnify climate impacts (Boesch 2008). The economic, environmental, and social costs of inaction are simply not acceptable.

Sea level rise in Maryland



Data source: MD DNR

Vulnerability to sea level rise in the coastal areas of Maryland, calculated using LiDAR (Light Detection and Ranging) elevation data. Elevation data were not available for Baltimore City, Harford County, and Prince George's County.

The high cost of inaction

- *Temperature is projected to increase substantially, especially due to higher emissions.*
- *Sea level rise is likely to accelerate, inundating hundreds of square miles of wetlands and land.*
- *Rain and wind from hurricanes are likely to increase.*
- *Precipitation is projected to increase during the winter and become more episodic.*
- *Urban flooding will likely worsen because rainfall events will be more intense.*
- *Health risks due to heat stress will increase.*
- *The number of respiratory illnesses is likely to increase.*
- *Crop production may increase initially, but then decline.*
- *Biodiversity of plants and animals associated with forests is likely to decline.*
- *Chesapeake and Coastal Bays restoration goals will be more difficult to achieve.*
- *As ocean water becomes more acidic, shellfish production and food webs may be harmed.*
- *An increased risk of diseases caused by bacteria and viruses.*

The Plan is good for Maryland

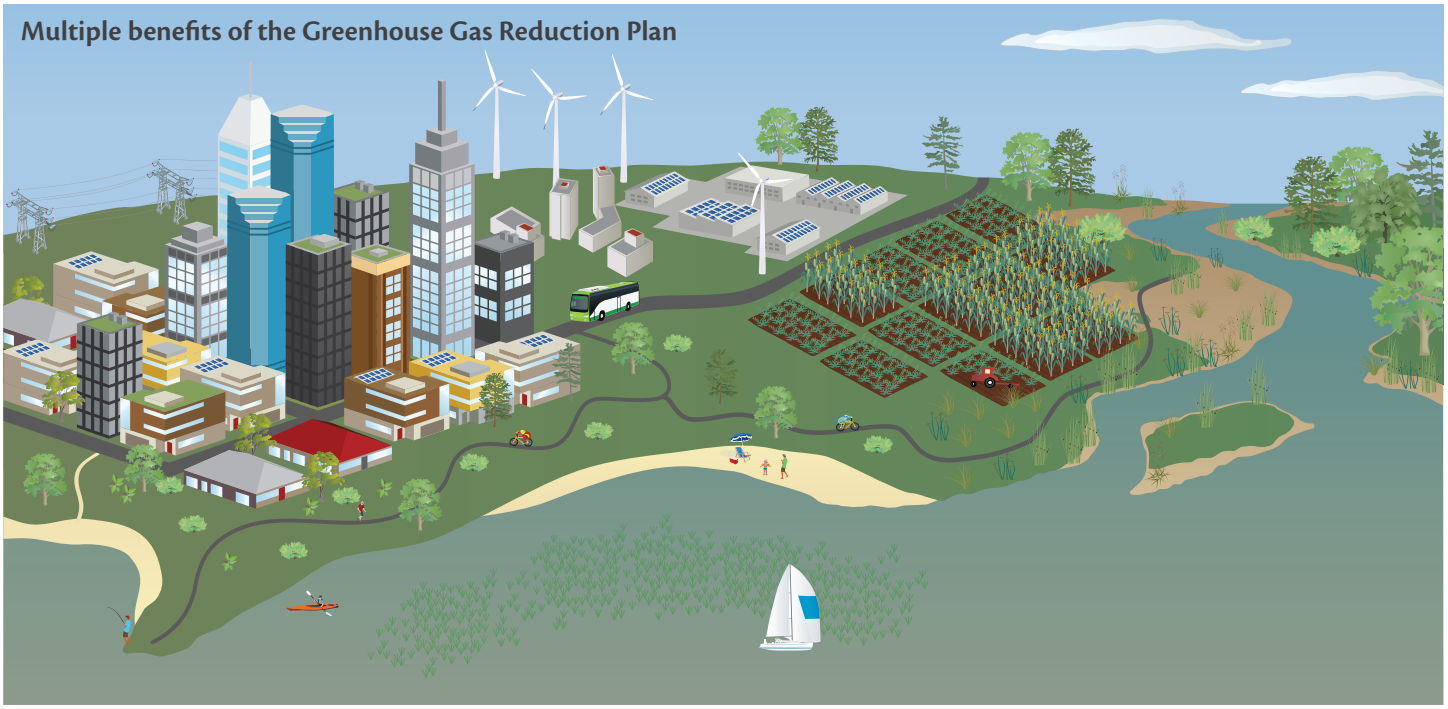
In 2009, Maryland Governor Martin O'Malley signed into law the Greenhouse Gas Emissions Reduction Act of 2009. The law requires the State to develop and implement a Greenhouse Gas Reduction Plan (*the Plan*) to reduce greenhouse gas emissions 25 percent from a 2006 baseline by 2020. *The Plan* lays out a blueprint which, if fully implemented, can achieve the 25 percent greenhouse gas reduction required by law, while achieving positive job and other economic benefits.

Multiple benefits

The Plan will support a green economy, preserve valuable agricultural and forest land, aid in restoring Chesapeake Bay, diversify energy sources, and promote renewable energy. *The Plan's* 150-plus programs and initiatives will aid in expanding the State's economy, including its renewable energy, transportation, green buildings, agriculture, fisheries, and forestry sectors. Therefore, while the principal aim of *the Plan* is to reduce greenhouse gas emissions and reduce the impacts of climate change, the implementation of *the Plan* will result in widespread economic, public health, and environmental benefits.

Green economy

Historically, environmental legislation (e.g., the Federal *Clean Water Act* and *Clean Air Act*) has led to significant economic and human health benefits nationwide. *The Plan* will support new industry and will accelerate investments in green technologies here in Maryland. *The Plan* focuses on investments in the energy, transportation, and land use sectors of our economy. Implementing *the Plan* will lead to increased investments in



Low-impact development (high-density housing near stores and jobs) is designed to minimize the impact of sprawl on the environment. It reduces emissions by contributing to lower vehicle miles traveled and stimulates the economy.

Investing in green energy will reduce emissions and stimulate the economy.

Reduced air pollution from factories and traffic improves public health (respiratory illnesses like asthma) and supports Bay restoration. This improves tourism and our economy.

Preserving forests, agricultural lands, and wetlands improves quality of life, and removes carbon dioxide from the environment.

energy efficiency, green building practices, and renewable energy. Investing in Maryland's green economy now will encourage smarter investments and support more sustainable economic growth for generations to come. Current analyses project that *the Plan* would result in estimated economic benefits of $1.6 billion and support over 37,000 jobs.

Air quality benefits

The Plan supports Maryland's multi-pollutant reduction approach. There are critical linkages between greenhouse gases and other air pollutants. Studies have shown that climate change, if unaddressed, will result in increased ozone and fine particle levels. Energy efficiency and other programs that are designed to lower greenhouse gas emissions also reduce emissions of nitrogen oxide, sulfur dioxide, mercury, other toxic metals, diesel exhaust, and black carbon. Working in concert on climate, energy, criteria pollutant, and toxics issues maximizes efficiencies and benefits and ensures that any adverse environmental and health effects are minimized.

Chesapeake Bay restoration benefits

Nearly one-third of the nitrogen pollution in the Chesapeake Bay comes from air pollution (nitrogen oxide). *The Plan's* strategies to reduce greenhouse gas emissions will also reduce Maryland's nitrogen oxide emissions, thereby advancing the State's efforts to restore the Bay. In addition, slowing the rate of sea level rise can have a positive impact on the living resources of the Bay by reducing sediment loads and improving habitat quality.

Renewable energy

Renewable energy is unlimited, economically sustainable, and emissions-free. Wind and solar generation is expanding markedly in Maryland and is supporting thousands of jobs. Wind power is one of the most efficient, deployable, scalable, and affordable renewable energy technologies (MEA 2013). Maryland's wind speeds are high enough to generate significant energy. Solar energy, geothermal heating and cooling, and bioenergy (organic materials from waste products) are all potential sources of renewable energy in Maryland.

Carbon dioxide-equivalent

A scale has been developed to allow the comparison of all the greenhouse gases 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 greenhouse gas. The goals, inventory, and reductions in* the Plan *are expressed as carbon dioxide-equivalents annually.

UNIVERSITY OF MARYLAND BALTIMORE COUNTY

EDUARDO INFANTES

ANDREW JOHNSON

Top: Programs that lower greenhouse gas emissions may also reduce emissions of nitrogen oxide, sulfur dioxide, mercury, and other toxic metals, and help prevent air pollution such as the haze seen here in 2009 in Baltimore.

Middle: The Greenhouse Gas Reduction Plan has multiple benefits, including reducing nutrient pollution of our air and water.

Bottom: Investing in renewable energy, such as wind power, reduces greenhouse gas emissions and also supports a green economy.

Key features of *the Plan*

Summary of *the Plan*

To achieve a 25 percent reduction in Maryland's greenhouse gas emissions by 2020, the State, through its implementation of the 150-plus programs and initiatives described in *the Plan*, must reduce Maryland's greenhouse gas emissions by 55 million metric tons of carbon dioxide-equivalent annually. This reduction includes offsetting growth that is expected to occur between 2006 and 2020 (called the 'business-as-usual' forecast).

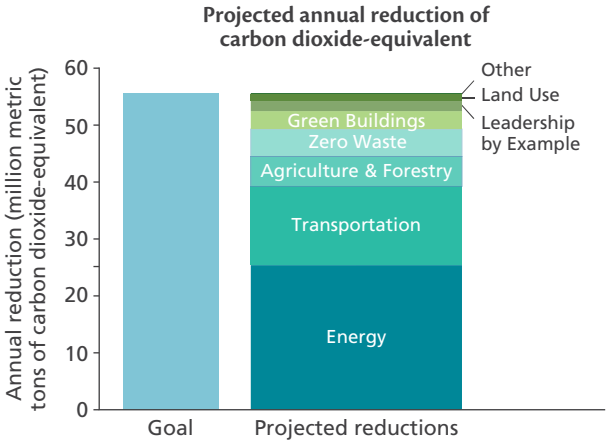
Business-as-usual forecasting is important because in the absence of regulatory programs requiring greenhouse gas emissions reductions, emissions will continue to grow through 2020. This increases the size of the reduction needed to reduce emissions by 25 percent from 2006 levels. The business-as-usual forecast accounts for this growth in emissions. In the middle figure opposite, the red line depicts the business-as-usual forecast.

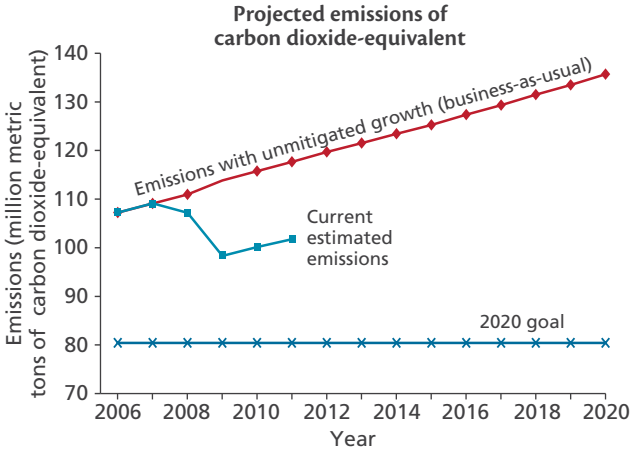
Comprehensive plan

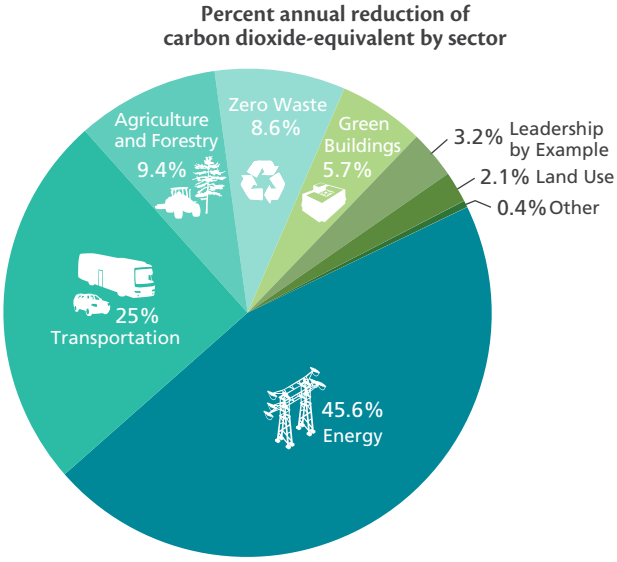
The Plan is a comprehensive, multi-sector, multi-agency plan that incorporates many innovative strategies. This includes programs that do not directly reduce carbon dioxide-equivalent, but rather absorb carbon dioxide from the atmosphere. The State has held numerous public and stakeholder meetings and has been receptive to a broad range of ideas. More than a dozen state agencies and non-governmental organizations assisted in drafting *the Plan*.

Attainable goals

The goal of reducing emissions 25 percent is attainable by strengthening and building on current programs, such as the *Maryland Renewable Energy Portfolio Standard* and *EmPOWER Maryland*, and by incorporating cutting-edge technology and strategies. Since the initial release of the draft *Plan* in February 2012, over 1,000 public comments have been received and a number of strategy and program enhancements have been added. The State will continue to explore new areas and develop new programs before 2020. The next page summarizes *the Plan's* key programs and their anticipated reductions, as initially drafted, and with the addition of planned enhancements. The implementation of these programs will drive more than 80 percent of Maryland's greenhouse gas emissions reductions.







Top: To reach the reduction goal of 55 million metric tons of carbon dioxide-equivalent annually, enhanced programs throughout all sectors (energy, transportation, agriculture, etc.) have been identified.

Middle: The 2020 emissions goal (blue line) is 80.4 million metric tons of carbon dioxide-equivalent annual emissions, which is 55 million metric tons less annually than the projected emissions in 2020 with unmitigated growth or business-as-usual (red line). The light blue line is current estimated emissions.

Bottom: The major sectors where greenhouse gas emissions can be reduced are energy and transportation; however every sector will need to do its part to reduce emissions.

Key programs

The enhanced reductions are the result of measures to strengthen the listed programs as initially drafted in February 2012. Reductions are measured in million metric tons of carbon dioxide-equivalent and are an annual amount.

Sector	Program	Program description	Initial reductions	Enhanced reductions
	Maryland Renewable Energy Portfolio Standard	The intent of this law is to establish a market for new sources of mostly in-state renewable electricity generation by requiring that Maryland power providers supply 18 percent of electricity from renewable sources by 2020, increasing to 20 percent renewables by 2022. If 'black liquor' and other carbon-emitting fuels are eliminated as qualified sources, and if the State's Portfolio Standard is accelerated to require 25 percent of energy consumed by 2020, additional reductions would be realized.	6.86	10.96
	EmPOWER Maryland	Enacted in 2008, the EmPOWER Maryland Energy Efficiency Act set a target to reduce both Maryland's per capita total electricity consumption and peak load demand by 15 percent by 2015. EmPOWER includes numerous State- and utility-managed energy efficiency and conservation programs. The optimization of these programs should allow the State to increase its per capita electricity consumption reduction target above 15 percent and enable Maryland to achieve additional reductions.	8.42	10.52
	Zero waste	Zero waste is a concept that calls for the near-elimination of solid waste sent to landfills or incinerators for disposal. Instead, the vast majority of Maryland's solid waste will be reused, recycled, composted, or prevented through source reduction.	2.80	4.80
	Maryland Clean Cars	The Maryland Clean Cars Program adopts California's stricter vehicle emission standards and directly regulates carbon dioxide emissions. These standards became effective in Maryland for model year 2011 vehicles, significantly reducing a number of emissions including volatile organic compounds and nitrogen oxides.	4.33	4.33
	Regional Greenhouse Gas Initiative	The Regional Greenhouse Gas Initiative (RGGI) is a cooperative effort by nine Northeast and Mid-Atlantic states to design and implement a regional power plant emissions cap-and-trade program. Revenues from the program support energy efficiency programs and augment EmPOWER Maryland and the Renewable Energy Portfolio Standard. The recent agreement by Maryland and the other RGGI States to lower the RGGI cap from 165 to 91 million metric tons of carbon dioxide-equivalent will directly contribute to emissions reductions by 2020.	0.00	3.60
	Buildings codes	Given the long life of most buildings, upgrading State and local building codes to include minimum energy efficiency requirements provides long-term emissions savings. Maryland's Building Performance Standards are updated by regulation every three years following the three-year cycle of the International Code Council.	3.15	3.15
	Public transportation initiatives	For several decades, vehicle miles traveled have risen faster than the increase in population in Maryland and nationwide, and land use development over the past 40 to 50 years has put more people living beyond the reach of easy access to transit facilities. Planned transit and Transit Oriented Development expansions in Maryland should lessen vehicle miles traveled in the State.	2.00	2.89
	Corporate Average Fuel Economy (CAFE) Standards	First enacted by Congress in 1975, the purpose of the CAFE standard is to reduce energy consumption by increasing the fuel economy of cars and light trucks. Since introduction in 1975, CAFE standards have increased from the initial 18 miles per gallon standard to 35 miles per gallon by 2020, as established in the Federal Energy Independence and Security Act of 2007.	2.27	2.27
	Managing forests to capture carbon	Managing forests to capture carbon will promote sustainable management practices in existing Maryland forests on public and private lands. The enhanced productivity resulting from enrolling unmanaged forests into management regimes will increase the amount of carbon captured in forest biomass, amounts of carbon stored in harvested, durable wood products, and availability of renewable biomass for energy production.	1.80	1.80
	Planting forests in Maryland	Planting trees expands forest cover and associated carbon stocks by regenerating or establishing healthy, functional forests through practices such as soil preparation, erosion control, and supplemental planting to ensure optimum conditions to support forest growth. The implementation goal is to achieve the afforestation and/or reforestation of 43,030 acres in Maryland by 2020.	1.79	1.79

Energy

Estimated reduction of 25.3 million metric tons of carbon dioxide-equivalent annually.

More than 10,000 jobs supported.

$11.6–12.9 billion in output (Gross State Product).

$616–681 million in wages annually.

Electricity consumption accounted for about 40 percent of Maryland's gross greenhouse gas emissions in 2006, which was higher than the national average share of emissions from electricity consumption (34 percent). Energy programs that will reduce emissions include the Regional Greenhouse Gas Initiative, EmPOWER Maryland, and the Renewable Energy Portfolio Standard.

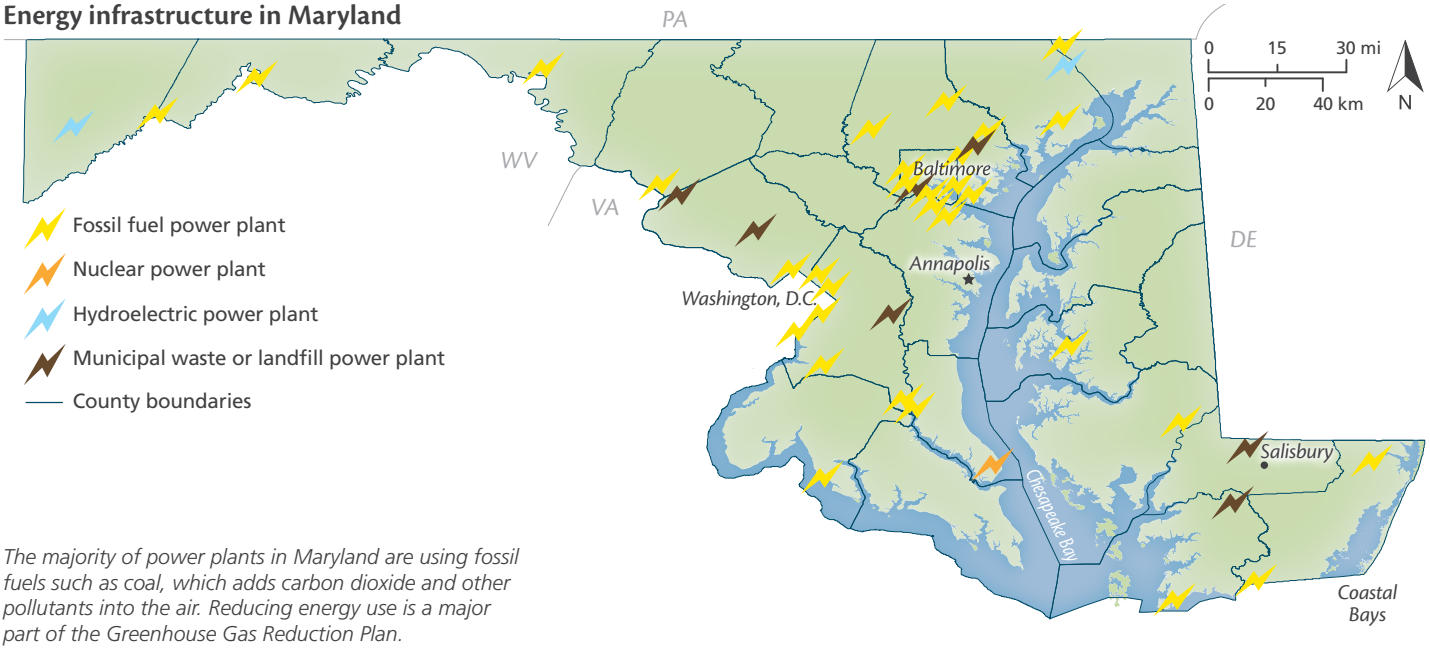
The electricity supply sector accounts for greenhouse gas emissions occurring as a result of the combustion of fossil fuels at electricity-generating facilities located both within the State and outside its borders. Reductions from the energy sector are critical to achieving the 2020 goal. Thirty programs and initiatives are designed to reduce greenhouse gas emissions from the energy sector. Full implementation of the 30 energy sector programs and initiatives will result in an estimated greenhouse gas reduction of 25.3 million metric tons of carbon dioxide-equivalent annually, which is nearly half of the total reduction needed to meet Maryland's greenhouse gas emissions goal.

Three important programs within the energy sector are the Regional Greenhouse Gas Initiative (RGGI), the EmPOWER Maryland Initiative, and the Renewable Portfolio Standard. RGGI is a cooperative effort by nine Northeast and Mid-Atlantic states to reduce carbon dioxide emissions from electricity-generating plants. In the United States, RGGI is the first program of its kind—a multi-state emissions cap-and-trade program with a market-based emissions trading system (see table page 7).

Under the EmPOWER Maryland initiative, the State's goal is to reduce energy consumption 15 percent by 2015. Energy efficiency is the fastest and most cost-effective approach available to reduce greenhouse gas emissions. Energy efficiency will not only help to reduce greenhouse gas emissions, but can also lower energy bills, help stabilize energy prices, and enhance electric and natural gas system reliability. Maryland's five utilities offer many programs to save home and business owners energy and money. The State is currently working to determine how to achieve even greater reductions and economic benefits from EmPOWER Maryland by expanding and strengthening EmPOWER Maryland's electricity and thermal energy efficiency goals.

Maryland's Renewable Portfolio Standard requires that 20 percent of Maryland's electricity be generated from renewable energy sources by 2022, including 2 percent from solar energy. This will result in more residential and commercial solar installations in those years. Electricity suppliers are required to purchase specified percentages of renewable energy certificates from renewable resources. The Renewable Portfolio Standard can play an even greater role in meeting Maryland's greenhouse gas emissions reduction goal if high carbon-emitting fuels are eventually removed from Tier I eligibility and if the overall Renewable Portfolio Standard is accelerated to 25 percent by 2020.

Energy infrastructure in Maryland



The majority of power plants in Maryland are using fossil fuels such as coal, which adds carbon dioxide and other pollutants into the air. Reducing energy use is a major part of the Greenhouse Gas Reduction Plan.

Data source: iMap.

Transportation

The Plan's efforts to foster smarter, more sustainable growth and to expand transportation options will improve the quality of life for all Marylanders. Investing in alternative transportation and supporting the development of high-density, low-impact, livable communities will reduce greenhouse gas emissions.

Estimated reduction of 13.8 million metric tons of carbon dioxide-equivalent annually.

More than 16,000 jobs supported.

$10.9–12 billion in output (Gross State Product).

$637–704 million in wages annually.

Reduced emissions occur through more stringent fuel standards, the Maryland Clean Cars Program, and lower vehicle miles traveled because of improved public transit. Photo © Wikimedia Commons

The transportation sector is expected to account for a larger share of future greenhouse gas emissions in Maryland. The majority of carbon dioxide-equivalent emissions from the transportation sector are associated with on-road gasoline-powered vehicles. On-road diesel-powered vehicles, airplanes, trains, and commercial marine vessels also contribute to greenhouse gas emissions.

Greenhouse gas emissions from this sector are the result of fossil fuel consumed primarily for transportation purposes. Full implementation of the 110 transportation sector programs and initiatives has the potential to reduce greenhouse emissions by 13.8 million metric tons of carbon dioxide-equivalent annually. This is more than a quarter of the total estimated reductions needed to meet the Greenhouse Gas Reduction Plan goal.

Transportation sector programs include: transit service expansion; electric and low-emitting vehicle incentives; traffic congestion mitigation; freight improvements; port and airport initiatives; and enhanced fuel economy standards (Maryland Clean Cars and federal CAFE standards).

Transportation infrastructure in Maryland

A large reduction in emissions will come from the transportation sector, which includes roads, ports, and airports. Photos (left to right): Baltimore during rush hour © istockphoto.com; Airplane at BWI © Rudi Riet; Port of Baltimore © istockphoto.com; Amtrak Susquehanna River Bridge © Wally Gobetz.

Data source: iMap.

Land Use

Estimated reduction of 1.1 million metric tons of carbon dioxide-equivalent annually.

More than 3,500 jobs supported.

$5.8–6.4 billion in output (Gross State Product).

$503–556 million in wages annually.

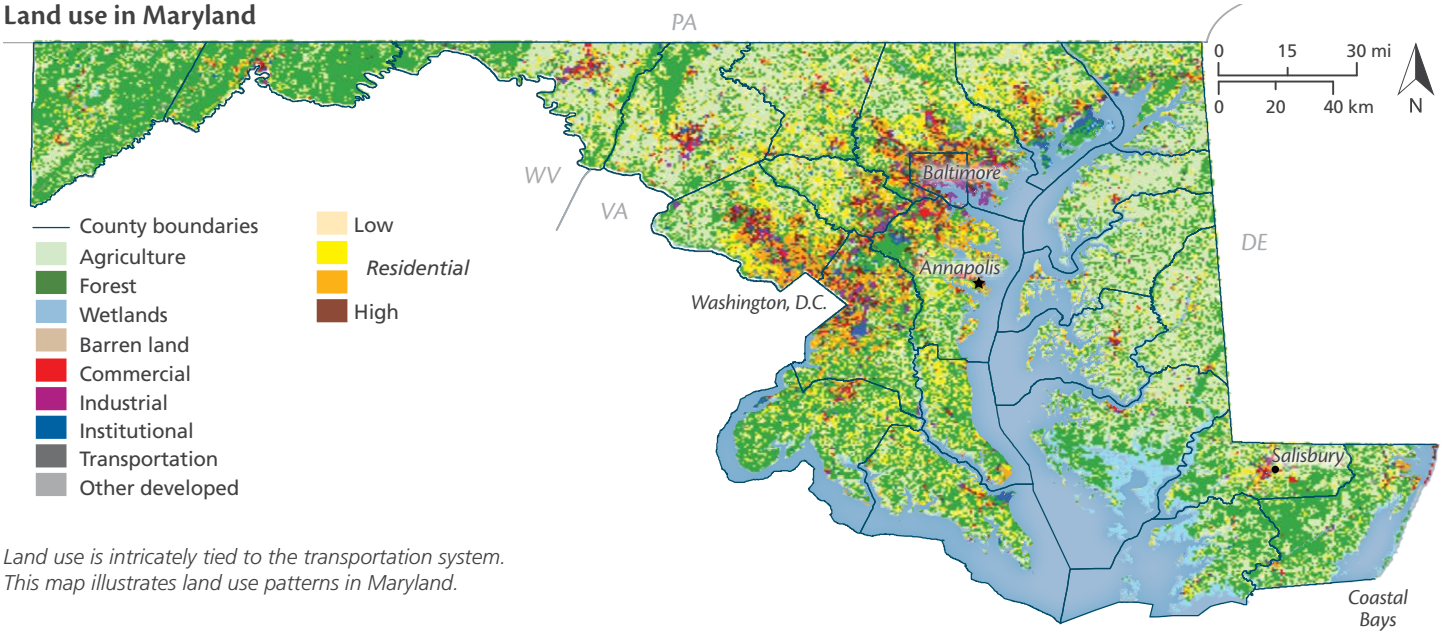
When forests and agricultural lands are converted to housing developments, greenhouse gas emissions increase due to loss of carbon storage when vegetation is removed, emissions from construction of roads and buildings, and increased dependence on motor vehicles. Photo © Ben Fertig, IAN Image Library

How we develop our land affects the amount of greenhouse gases emitted. Clearing a forest removes a resource that stores carbon dioxide. Development of a forested area or cropland is also likely to be in a location that increases dependence on motor vehicles. The construction of roads and buildings also increases levels of greenhouse gases. *The Plan* encourages counties, cities, and towns to plan development in ways that minimize greenhouse gas levels. By better managing growth, local communities can limit harmful sprawl development and contribute to a reduction in Maryland's greenhouse gas emissions.

Incentives and requirements for local and regional land use patterns can reduce the dependence on motor vehicles to reduce vehicles miles traveled and greenhouse gas emissions. Development projects and local and regional land use patterns can be designed to minimize the distance between homes and jobs and other destinations. Public facilities can be centrally located. Development can also be planned to increase access to public transportation.

Full implementation of *The Plan's* two land use strategies has the potential to reduce annual greenhouse emissions by 1.1 million metric tons of carbon dioxide-equivalent by 2020.

Land use in Maryland



Land use is intricately tied to the transportation system. This map illustrates land use patterns in Maryland.

Data source: iMap.

Agriculture and Forestry

The agriculture and forestry sectors contribute a small percentage of Maryland's overall greenhouse gas emissions, but these sectors also offer unique opportunities to remove carbon dioxide from the atmosphere. Forests, grasslands, crop lands, and wetlands all possess carbon-reducing and energy-related benefits that are extensive and complex.

Forests, agricultural fields, and wetlands are all important in the Greenhouse Gas Reduction Plan because they store carbon. Photo © Michael Francis

Estimated reduction of 5.2 million metric tons of carbon dioxide-equivalent annually.

$2.4–2.7 billion in output (Gross State Product).

$85–94 million in wages annually.

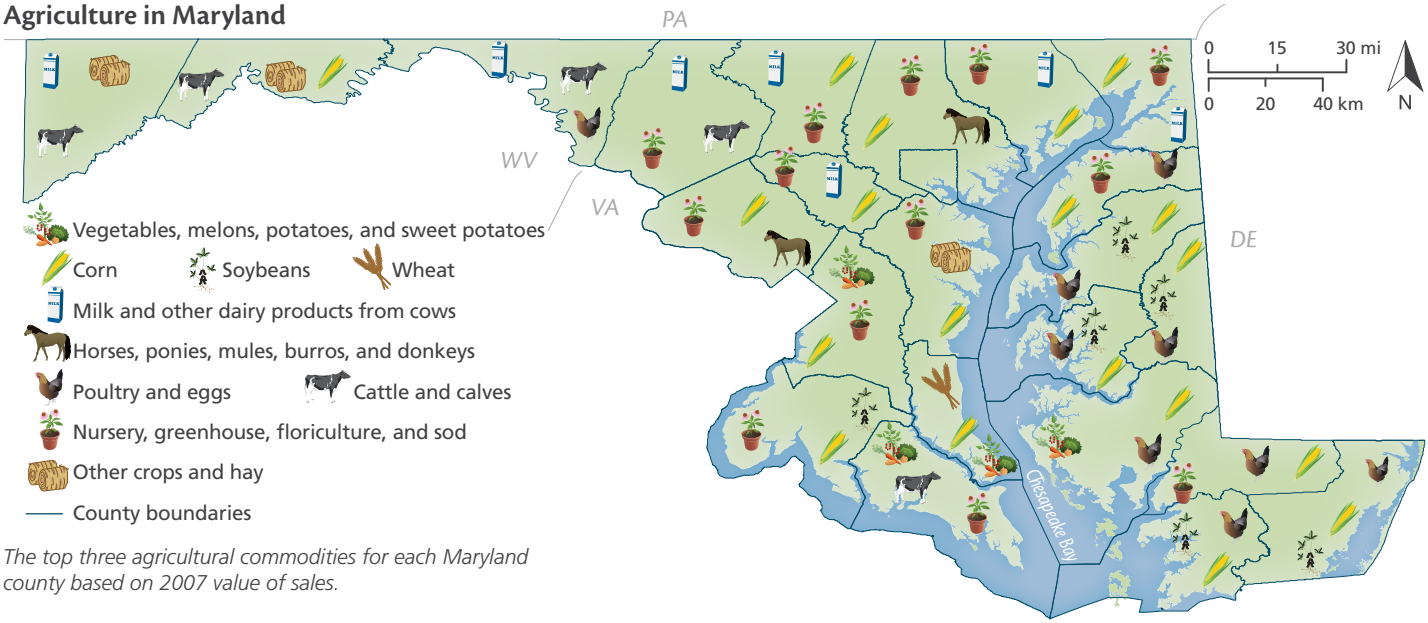
Activities in Maryland that can contribute to the increase in greenhouse gas emissions include clearing forest to create crop land, tilling and fertilizing crop lands, and draining wetlands. Through appropriate management, technology, and energy-conscious choices, the potential for carbon storage can be optimized and the net increase in greenhouse emissions from the agriculture and forestry sector reduced. Some programs that will help decrease greenhouse gas emissions are nutrient trading, managing forests to capture carbon, afforestation, and creating and protecting wetlands and buffers.

Emissions from cultivated soils account for the largest portions of agricultural emissions. They include 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 greenhouse gas emissions during the production of crops.

Sustainable forest and urban forest management is essential for mitigating climate change. Preserving forests and increasing forest canopy cover within urban and suburban settings stores carbon.

Full implementation of the agriculture and forestry sector policies will result in a potential greenhouse gas reduction of 5.2 million metric tons of carbon dioxide-equivalent annually. These 20 programs contribute nearly one-tenth of the total reductions needed to meet Maryland's 2020 greenhouse gas emissions reduction goal.

Agriculture in Maryland



The top three agricultural commodities for each Maryland county based on 2007 value of sales.

Adapted from Tom Rabenhorst and Joe School, Department of Geography and Environmental Systems, University of Maryland Baltimore County 2010

Zero Waste

Increased recycling of packaging is part of the State's strategy to eliminate solid waste. Photo © Lya Cattel

Residential and commercial waste releases greenhouse gases during processing or when buried in a landfill. The State is currently developing a zero waste strategy to eliminate 85 percent of Maryland's solid waste (residential and commercial garbage) by 2030. Instead, Maryland's waste would be reused, recycled, composted, or prevented through source reduction.

The State's strategy sets forth specific policies to achieve these goals including actions aimed at increasing recycling of packaging (including beverage containers) and food waste. Composting of food scraps will be one of the State's major focuses in increasing waste diversion through 2020. While Marylanders do compost yard waste, a significant amount of food scraps is going into the trash. Capturing additional organics, especially food scraps, would provide a significant portion of the additional recycling needed to meet zero waste goals.

The strategy seeks to target all sources of waste including commercial, institutional, governmental, multi-family, and residential generators. Finally, the Zero Waste Strategy emphasizes product stewardship and extended producer responsibility which place the environmental and economic costs of products throughout their life-cycle on the producers of those products.

The strategy establishes goals of 60 percent recycling and 65 percent for waste diversion by 2020. These reductions help to reach the target of reducing 4.8 million metric tons of carbon dioxide-equivalent annually.

Green Buildings

A worker installing recycled blue jean denim insulation. Photo © BanksPhotos

Since buildings require large amounts of energy to heat, cool, maintain, and operate, it is not a surprise that they account for almost one-third of total energy use and carbon dioxide emissions in the United States. Given the long lifetime of most buildings, it is necessary that both existing and new buildings achieve the greatest energy efficiency possible. Reduced emissions will be achieved through energy efficiency practices undertaken in building design, site location, and construction practices. Energy-efficient building technology will be promoted and building codes will be updated. In addition to reducing greenhouse gas emissions, implementing these programs will reduce emissions of nitrogen oxides, sulfur dioxide, and mercury. Building programs will also reduce waste output and water usage. Full implementation of the green building sector initiatives will result in a potential emission reduction of 3.2 million metric tons of carbon dioxide-equivalent annually.

The Department of General Services ensures that lighting, water, building envelope infiltration, window, steam traps, occupancy controls, and automated energy management systems in State buildings meet 2009 High Performance Building standards.

Amending State and local building codes to include minimum energy efficiency requirements provides long-term greenhouse gas savings. The Statewide building code known as the Maryland Building Performance Standards is adopted and implemented by the Department of Housing and Community Development and is updated by regulation every three years.

Adapting to climate change

Climate impacts are occurring and will continue in the future, even 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. Therefore, adaptation strategies, together with mitigation, are necessary to address climate change. 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 vulnerability to climate change.

Climate change adaptation is an extremely complex process and there is no single means of response. A recent report by the National Academy of Sciences (2010) emphasized that climate change adaptation must be a highly integrated process that occurs across all levels of government, and with many internal and external partners and individual actions. Maryland is already taking important steps to enhance the resilience of a broad spectrum of natural and human-based systems to the consequences of climate change.

In December 2012, Governor O'Malley signed the Climate Change and CoastSmart Construction Executive Order, directing that all new and reconstructed state structures, as well as other infrastructure improvements, be planned and constructed to avoid or minimize future flood damage. The Executive Order enacts a number of policy directives, including directing all State agencies to consider the risk of coastal flooding and sea level rise when they design capital budget projects, and charging the Department of General Services with updating State architecture and engineering guidelines to require new and rebuilt structures to be elevated two or more feet above the 100-year base flood level. The Executive Order can be read in its entirety on governor.maryland.gov.

Maryland's strategy for increasing resilience

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) addresses the impacts associated with sea level rise and coastal storms. The second strategy (Phase II), released as a complement 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, more than 100 experts from the governmental, nonprofit, and private sectors participated in 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. 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.

Key recommendations for communities*

- *Take action now to protect human habitat and infrastructure from future risks.*
- *Minimize risks and shift to sustainable economies and investments.*
- *Guarantee the safety and well-being of Maryland's citizens in times of foreseen and unforeseen risk.*
- *Retain and expand forests, wetlands, and beaches to protect us from coastal flooding.*
- *Give State and local governments the right tools to anticipate and plan for sea level rise and climate change.*

***Determined by the Maryland Commission on Climate Change**

The State has produced several documents on its strategy for adapting to climate change. These products are available through the Maryland Department of Natural Resources.

What you can do

Energy and Green Buildings go hand-in-hand

- Use energy-saver light bulbs, such as compact fluorescents.
- Purchase *Energy Star* appliances, electronics, and lighting.
- Unplug all electronics when not in use, for example: your cell phone charger, TV, toaster, coffeemaker, computer.
- Install ceiling fans, window fans, and whole-house fans as a low-energy way to cool the house in summer.
- Upgrade your heating and cooling system with an energy-efficient one, including a programmable thermostat.
- Clean the lint filter on your dryer for higher efficiency, or hang your clothes outside on a line to dry (or inside on a rack).
- Sign up for renewable energy through your electric company.
- Weatherproof your home, sealing cracks and gaps.
- Buy furniture made from sustainable materials, such as bamboo and reclaimed wood.
- Use a reel lawnmower, which is quiet and has zero emissions.
- Always maintain your septic system, including gas emissions.
- Opt out of paper catalogs, phone books, and other 'junk' mail.
- Bring reusable canvas totes to use at the grocery store.
- Buy your produce locally to decrease the amount of vehicle miles that your food has to travel.
- And, remember, always *reduce, reuse,* and *recycle!*

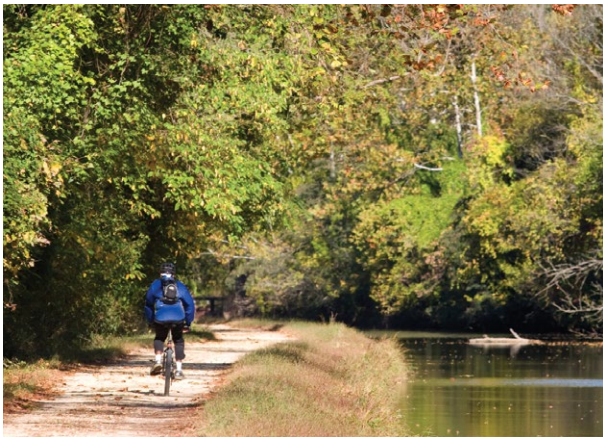
Transportation and Land Use go hand-in-hand

- Cycle instead of driving.
- Walk short distances rather than drive.
- Use public transportation or carpool for long trips.
- Take advantage of telecommuting.
- Shop online instead of using your car to drive to stores.
- Combine trips to the grocery store, library, and other places into one.
- Consider buying a fuel-efficient, low-greenhouse gas-emitting vehicle, such as a hybrid, electric, or diesel.
- Maintain your vehicle by getting a tune-up, an oil change, and properly inflating your tires.
- Drive efficiently: maintain the speed limit, use cruise control, decrease the weight of the car, and avoid idling.
- Reduce air friction by only using roof racks when necessary.
- Buy a home in a Low Impact Development area, if possible.
- Buy a home near your work to reduce commuter miles.
- Landscape with native trees and plants, and install rain gardens to reduce the amount of impervious surface on your property.

TONY TREMBLAY

BHASKARAN SUBRAMANIAN

ADRIENNE DIACZOK



BRIANNA MAY

Hanging your laundry outside saves energy and saves you money;

Supporting your local farmers market reduces vehicle miles traveled for both you and your produce;

Maryland state employees can drive and plug-in their electric cars at the Department of the Environment's headquarters;

Cycling along the Chesapeake & Ohio Canal.

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telecommute
improved public health
carpool
economic benefits
cycle
greenhouse gas reductions
Maryland leadership
adaptation
public transit
multi-pollutant benefits
Zero Waste
extreme event mitigation
reduce
increased resilience
green buildings