Climate Change Policy and Maryland: Issues to Consider in the Greenhouse Gas Emissions Debate

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January 30, 2009

The Honorable Thomas V. Mike Miller, Jr., President of the Senate
The Honorable Michael E. Busch, Speaker of the House of Delegates
Members, Maryland General Assembly

Ladies and Gentlemen:

In recent years, climate change has surfaced as one of the key environmental issues facing the world. In response to concerns about the impacts of climate change on human health, the environment, and the economy, several proposals to address climate change through the reduction of greenhouse gas (GHG) emissions have been introduced in Congress and in several states, including Maryland, in recent years.

Because legislation addressing this issue is expected to be reintroduced during the 2009 session, during the 2008 interim, the Natural Resources, Environment, and Transportation Workgroup of the Office of Policy Analysis prepared this report. The report provides background on the issue; an overview and the status of federal proposals to reduce GHG emissions; Maryland's efforts to reduce GHG emissions; actions other states and countries have taken; a literature review of the costs and benefits of reducing GHG emissions; and a discussion of possible economic impacts on Maryland of enacting legislation to reduce GHG emissions. Finally, the report highlights a number of policy issues and questions that should be considered by the General Assembly when debating any legislation addressing the reduction of GHG emissions in Maryland.

I trust this report will prove useful to you during the 2009 session as the General Assembly tackles the issue of climate change.

For further information regarding this report, please contact Lesley Cook or Ryane Necessary of the Office of Policy Analysis at 410-946-5510 and 410-946-5350, respectively.

Sincerely,

Warren G. Deschenaux
Director

WGD/LGC/kjl

Contents

Executive Summary

According to the Intergovernmental Panel on Climate Change, there is now scientific evidence that the world's temperatures are climbing and that human activities are very likely contributing to the increase. Continued global warming is expected to affect sea levels and weather patterns, resulting in impacts on human health, the environment, and the economy. Maryland in particular is quite vulnerable to the impacts of sea level rise given the large amount of low-lying land in the State.

Because the federal government is doing little to require reductions in the greenhouse gas (GHG) emissions that contribute to global warming, several states, including Maryland, have taken steps to reduce their GHG footprint by encouraging energy efficiency, energy conservation, and the use of alternative energy sources. Many states have also established specific GHG reduction goals, as have several other countries. Although legislation was introduced during both the 2007 and 2008 sessions to require reductions in GHG emissions in Maryland, that legislation was not successful.

Because legislation addressing GHG emissions is expected to be reintroduced during the 2009 session, this report provides background on the issue; an overview and the status of federal proposals to reduce GHG emissions; Maryland's efforts to reduce GHG emissions; actions other states and countries have taken; a literature review of the costs and benefits of reducing GHG emissions; and a discussion of possible economic impacts on Maryland of enacting legislation to reduce GHG emissions. Finally, the report highlights a number of policy issues and questions that should be considered by the General Assembly when debating any legislation relating to the reduction of GHG emissions in Maryland.

Chapter 1. Background

Climate Change, Global Warming, and the Greenhouse Effect

According to the U.S. Environmental Protection Agency (EPA) and the National Academies of Science, climate change refers to any significant change in climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). EPA reports that climate change may result from:

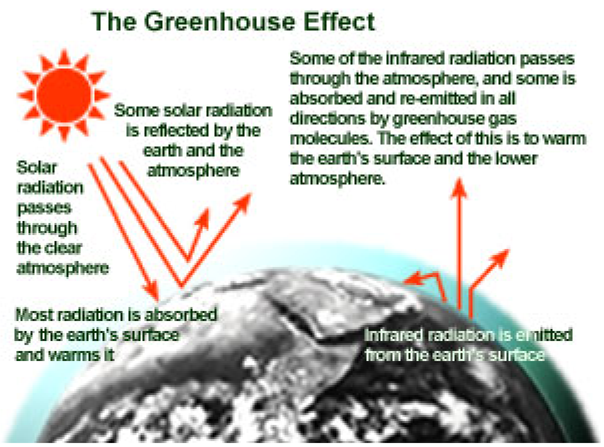
- natural factors, such as changes in the sun's intensity or slow changes in the Earth's orbit around the sun;
- natural processes within the climate system (*e.g.* changes in ocean circulation); and
- human activities that change the Earth's atmospheric composition (*e.g.* through burning fossil fuels) and land use (*e.g.* deforestation, reforestation, urbanization, desertification, etc.).

Global warming is a significant climate change concern. The Earth absorbs some energy from the sun and radiates the rest back into space, where some of it is absorbed by "greenhouse gases" (GHGs) in the atmosphere, which warms the Earth's surface (see **Exhibit 1.1**). This process is known as the "greenhouse effect." EPA advises that without this natural "greenhouse effect," temperatures would be about 60ºF lower than they are now, and life as we know it today would not be possible. However, EPA reports that during the past century, humans have substantially added to the amount of GHGs in the atmosphere by burning fossil fuels such as coal, natural gas, oil, and gasoline. According to EPA, the added gases – primarily carbon dioxide (CO_2) and methane – are enhancing the natural greenhouse effect, and likely contributing to an increase in global average temperature and related climate changes.

The significant role humans have played in climate change is further supported by the Intergovernmental Panel on Climate Change (IPCC). A 2007 IPCC report concluded that:

- Global atmospheric concentrations of CO_2, methane, and nitrous oxide have increased markedly as a result of human activities since 1750.
- Global increases in CO_2 concentration are due primarily to fossil fuel use and land use change, while those of methane and nitrous oxide are primarily due to agriculture.
- The understanding of human-induced warming and cooling influences on climate has improved recently, leading to very high confidence that the globally averaged net effect of human activities since 1750 has been one of warming.

Exhibit 1.1
The Greenhouse Effect



Source: U.S. Environmental Protection Agency

- The observed widespread warming of the atmosphere and ocean, together with ice mass loss, support the conclusion that is extremely unlikely that global climate change of the past 50 years can be explained without external forcing, and very likely that it is not due to known natural causes alone.

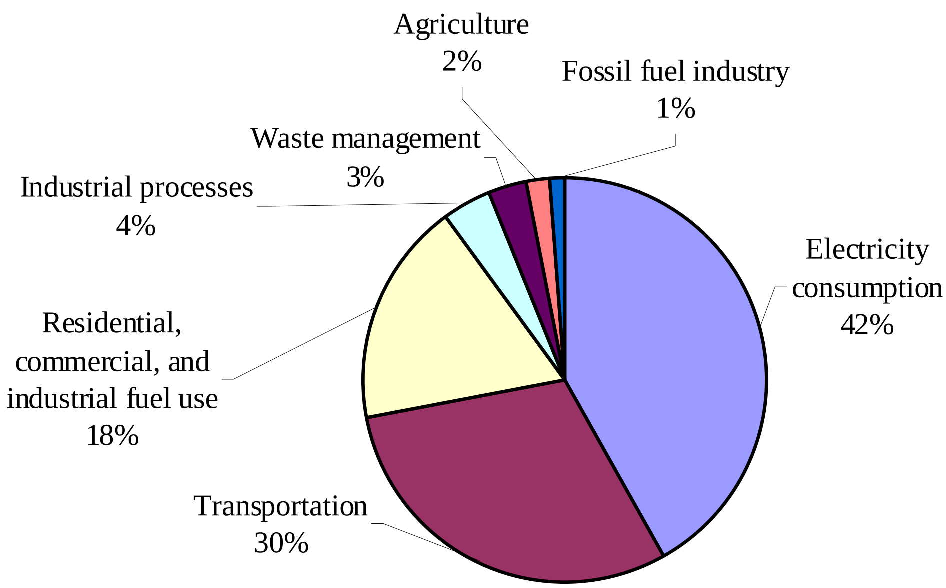
- Even if GHG concentrations were to be stabilized, anthropogenic warming and sea level rise would continue for centuries due to the time scales associated with climate processes and feedbacks.

Sources of GHGs in Maryland and Historical and Projected GHG Emissions

According to the Maryland Commission on Climate Change, and as shown in **Exhibit 1.2**, in 2005, the largest GHG emission sources in Maryland were electricity consumption and transportation. Other sources include residential, commercial, and industrial fuel use; industrial processes; waste management; agriculture; and the fossil fuel industry.

In 2005, Maryland's GHG footprint (which includes GHG emissions from sources within the State and emissions from out-of-state that are created by consumption in Maryland) totaled approximately 109 million metric tons of CO_2 equivalent. Due to increases in population and consumption, Maryland's GHG emissions are expected to continue to grow over time. Although Maryland has already taken several steps to increase energy efficiency and conservation,

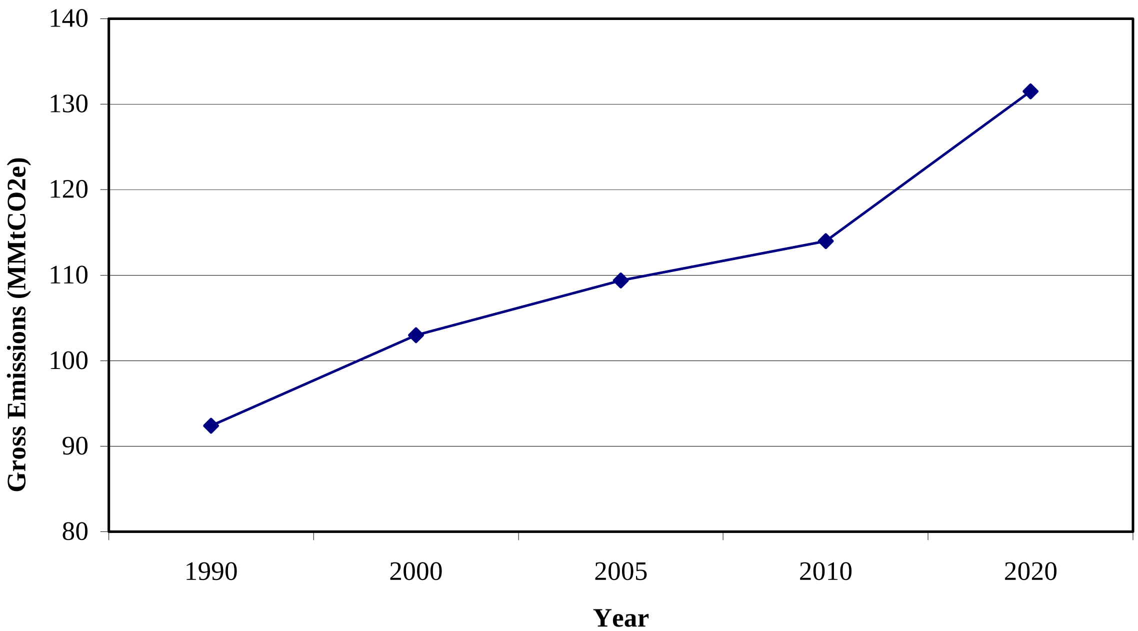
Exhibit 1.2
Sources of GHG Emissions in Maryland 2005



Source: Maryland Commission on Climate Change

promote renewable energy, and reduce GHG emissions from certain power plants, without any new programs, the commission estimates that Maryland can expect to exceed 130 million metric tons of CO_2 equivalent ($MMtCO_2e$) by 2020. **Exhibit 1.3** shows estimated historical gross GHG emissions in Maryland for 1990, 2000, and 2005 and projected emissions for 2010 and 2020. According to the commission, Maryland's gross GHG emissions increased by about 18% from 1990 to 2005, while national emissions rose by 16% over that same time period. The growth in Maryland's emissions from 1990 to 2005 is primarily associated with the transportation and electricity consumption sectors.

Exhibit 1.3
Estimated Historical and Projected Gross GHG Emissions in Maryland



GHG: greenhouse gas

Source: Maryland Commission on Climate Change

The Impacts of Climate Change

Continued global warming is expected to affect sea levels and weather patterns, resulting in impacts on human health, the environment, and the economy. According to EPA, scientists have already observed some changes, including sea level rise, shrinking glaciers, thawing of permafrost, changes in the range and distribution of plants and animals, trees blooming earlier, the lengthening of growing seasons, and ice on rivers and lakes freezing later and breaking up earlier. The global and State-level impacts of climate change are described in more detail in the following sections.

Sea Level Rise

Global Impact

Sea level rise is expected to continue due to a combination of melting glaciers and the thermal expansion of the seas as oceans warm. Rising sea levels could have significant impacts on low-lying areas and island nations throughout the world as a result of severe flooding and associated loss of land.

State Impact

The University of Maryland indicates that the State is the third most vulnerable state in the nation based on the percent of land below 1.5 meters elevation. The Maryland Commission on Climate Change's Climate Action Plan indicates that sea level rise in Maryland is very likely to accelerate, inundating hundreds of square miles of wetlands and land.

Extreme Weather

Global Impact

Scientists predict that climate change will have a significant impact on global weather patterns, causing more extreme weather, including more floods and more droughts, extended heat waves, more forest fires, and more powerful storms. According to IPCC, future changes in weather patterns will affect different regions in different ways. As precipitation increases in certain areas and decreases in others, for example, forests and farms may be more productive in some regions and less productive in others.

State Impact

The Maryland Commission on Climate Change's Climate Action Plan concludes that rains and winds from hurricanes are likely to increase, but changes in their frequency cannot now be predicted.

Human Health Impacts

Global Impact

Climate change is also expected to have consequences for human health. Extreme temperatures and more severe storms can contribute to the spread of infectious disease and threaten the availability and/or quality of water resources and food. IPCC notes that human beings are exposed directly to climate change through changing weather patterns (for example, more intense and frequent extreme events) and indirectly through changes in water, air, food quality and quantity, ecosystems, agriculture, and economy.

State Impact

The Maryland Commission on Climate Change's Climate Action Plan concludes that health risks due to heat stress are very likely to increase in Maryland if emissions are not reduced. Under a high emissions scenario, heat waves are projected to greatly increase risks of illness and death before the end of the century. Respiratory illnesses are likely to increase as more ground-level ozone is formed under prolonged, higher temperatures. However, the commission notes that increased risks of pathogenic diseases in Maryland may be less likely due to public health precautions and treatment.

Economic Impacts

Global Impact

Climate change will have a significant economic impact in certain areas. As sea levels rise and as more intense floods and droughts occur, millions of people could be permanently displaced. At risk in particular are developing countries, which are generally already located in warmer areas with high rainfall variability and have poor quality healthcare and public services. These countries are also largely dependent on agriculture, which is thought to be the most climate-sensitive of all economic sectors. Because of these factors, climate change has the potential to result in mass migration.

State Impact

According to the University of Maryland's Center for Integrative Environmental Research (CIER), Maryland's extensive coastal infrastructure, including transportation and energy supply networks and coastal developments, will likely endure the greatest portion of total economic impacts of climate change in the region. CIER notes that the value of Maryland's insured coastal property is one of the highest in the country. According to CIER, in addition to these potential impacts on coastal infrastructure, changes in water quality and water temperature on the coast may negatively affect the ocean economy sector, which employs over 50,000 people, contributes around $1.7 million in wages to the economy, and nearly $2.5 billion to the Gross State Product. Similarly, CIER reports that the coastal economy sector, which employs nearly 2.5 million and generates roughly $250.0 billion for the State, will likely be impacted. Finally, the forestry and agricultural industries will likely face declines in productivity as more severe weather events add unpredictability and risk to those sectors.

The Maryland Commission on Climate Change's Climate Action Plan echoes several of these concerns, noting that the largest impact in Maryland will be on its coastal infrastructure and development, and that population and economic growth trends will likely place more people and infrastructure at risk of the negative impacts of climate change in the coming years.

With respect to industrial and urban coastal impacts, the commission highlights the likelihood of significant impacts to transportation and trade in the Baltimore/Washington corridor as a result of sea level rise and extreme weather events. With respect to coastal shipping, the commission notes that sea level rise poses a serious threat to accessing and operating Maryland ports; according to the commission, the Port of Baltimore produces $1.98 billion (in 2007 dollars) in annual economic benefits and provides for 127,000 maritime-related jobs.

Despite the potentially significant impacts to Maryland's industrial and urban areas, the commission concludes that the most visible and possibly more expensive economic impacts will occur along the residential and rural portions of Maryland's coast. Sea level rise in Maryland is predicted to claim more land than the national average, with Maryland's southeastern counties most vulnerable due to their low-lying topography and exposure to the ocean.

Other economic impacts identified in the Climate Action Plan include impacts on tourism, agriculture, and health-related economic losses. The commission notes that in 2006, Maryland's tourism industry generated roughly $11.72 billion (in 2007 dollars) in visitor spending, directly supported 116,000 jobs, and created $920 million (in 2007 dollars) in State and local tax revenue. A loss of economic activity is expected as a result of climate change due to a weakening coastal infrastructure, beach erosion, and the threat of inundation in certain areas like Ocean City. Businesses dependent on ecotourism, hunting, and fishing will also likely suffer losses.

With respect to impacts on the agricultural sector, the commission notes that the total value of agricultural products in Maryland totaled nearly $1.5 billion (in 2007 dollars) in 2002. The commission concludes that as a result of climate change, crop production may increase initially but then decline later in the century if emissions are not reduced. In the long run, climate change impacts will require adaptation by Maryland's agricultural industry, including changes in crop or animal varieties, increased irrigation, and air conditioning for some livestock. With respect to the forest products industry, the fifth largest industry in the State, the commission notes that timber production is likely to decline late in the century as a result of heat stress, drought, and climate-related disturbances such as forest fires and storms.

Environmental Damage

Global Impact

In addition to the impacts on human health and the economy, climate change will obviously have an impact on ecosystems across the world. The Pew Center on Global Climate Change reports that climate change holds the potential of inflicting severe damage on the ecosystems that support all life, from hazards to coral reefs due to warmer and more acidic ocean waters, to threats to polar bears because of declines in sea ice. The loss of unique systems is anticipated, with mass extinctions likely.

State Impact

According to the Maryland Commission on Climate Change, aquatic ecosystems in Maryland will likely be degraded by more flash runoff and increased temperatures. Habitat suitability for native fishes and other organisms will likely be limited as a result of intensified rainfall events and warmer surfaces. Living resources will likely change in terms of species composition and abundance. Northern species (such as soft shell clams and eelgrass) are likely to be eliminated later in the century, while southern species will likely increase in abundance. The biodiversity within Maryland's forests is likely to decline, and habitat alterations may change the types of bird species that currently inhabit Maryland's forests.

Other Impacts

Other potential impacts resulting from climate change include concerns regarding national security (resulting from political instability, mass movements of refugees, terrorism, or conflicts over water and other resources in certain countries), impacts on energy production and use, and impacts on water resources.

Mitigation vs. Adaptation

Scientists contend that avoiding the most severe impacts of climate change will likely require reductions in emissions of the GHGs that are contributing to climate change. However, although mitigation is certainly important, adaptation will also be necessary in certain areas since some degree of future climate change is expected to occur regardless of the level of future GHG emissions. Ultimately, the extent of the impacts of climate change will depend in part on the sensitivity of those areas to climate change, but also on their ability to adapt.

The Climate Change Policy Framework

The Federal Level

Despite an increasing awareness that human-induced activities can have an impact on our climate, the U.S. government has yet to take decisive leadership on this issue. Current U.S. GHG policy consists largely of voluntary programs and partnerships to meet a national goal of reducing the GHG intensity of the American economy by 18% from 2002 to 2012.

Federal regulatory efforts to reduce GHG emissions are just beginning to be explored. In response to the April 2007 Supreme Court decision in *Massachusetts v. EPA*, which found that GHG emissions could be regulated if EPA determines they cause or contribute to air pollution that may reasonably be anticipated to endanger public health or welfare, EPA issued an Advance Notice of Proposed Rulemaking on June 11, 2008, to discuss and solicit public input on the specific effects of climate change and the potential regulation of GHG emissions from stationary and mobile sources. The advance notice was published in the Federal Register on July 30, 2008, and EPA accepted comments on the notice through November 28, 2008.

And although several bills addressing GHG reductions have been introduced in Congress in recent years, to date, no federal legislation has been enacted.

States Start to Take Action

In the absence of federal action, in September 2006, the Governor of California signed landmark legislation (AB 32) to reduce GHG emissions in that state. The legislation requires the California Air Resources Board to develop regulations and market mechanisms that will reduce California's GHG emissions by 25% by 2020. A handful of other states have followed California's lead by establishing mandatory emission reductions through legislation, and several states have established statewide targets for such reductions.

In Maryland, numerous policies and programs have been implemented in the past several years that address energy conservation and efficiency, renewable energy, and GHG emissions. In addition, in August 2008, the Maryland Commission on Climate Change issued its Climate Action Plan that establishes specific goals for reducing GHG emissions in the State; recommends several mitigation strategies to achieve those goals; and calls for several adaptation measures to address the impacts that will likely occur even if emissions are reduced from today's levels.

The next several chapters of this report provide more information regarding federal efforts to reduce GHG emissions, Maryland's efforts to address this issue, and what other states and countries are doing to reduce GHG emissions.

Chapter 2. Federal Proposals – Overview and Status

U.S. Climate Change Policy

To date, United States climate change policy has focused on voluntary initiatives to reduce growth in greenhouse gas (GHG) emissions. In February 2002, President George W. Bush committed the United States to a strategy to reduce GHG intensity in the American economy by 18% between 2002 and 2012. GHG intensity measures the ratio of GHG emissions to economic output. According to the Bush Administration, meeting this commitment will prevent the release of more than 100 million metric tons of carbon-equivalent emissions annually by 2012. In order to reduce GHG intensity, the federal government administers numerous voluntary public-private partnerships that focus on energy efficiency, renewable energy, alternative fuels, best management agricultural practices, and new technologies.

Despite this national goal, the Bush Administration was opposed to setting firm targets for GHG emissions reductions. Although the United States signed the Kyoto Protocol in 1998, to date, the treaty has not been ratified. The Kyoto Protocol is an international agreement that sets binding targets for 37 industrialized countries and the European community for reducing GHG emissions. The targets amount to an average of a 5% decrease in emissions from 1990 levels over a five-year period from 2008 to 2012. To date, 180 nations have ratified this treaty. In 2001, the Bush Administration announced its opposition to the Kyoto Protocol, claiming that it could potentially cause harm to the U.S. economy.

Currently, the Kyoto Protocol's mandatory caps apply only to developed countries, while developing countries are exempt from emissions reductions. At the 2007 Group of Eight (G8) Summit, President Bush said that the United States will consider mandatory caps if rapidly developing countries such as China and India were also bound by the mandatory caps. However, at the 2008 G8 Summit, President Bush, along with the other G8 leaders (Japan, Germany, Britain, France, Italy, Canada, and Russia) endorsed a communiqué that declares the countries will consider and adopt actions to reduce GHG emissions by at least 50% by 2050 as part of a new United Nations treaty to be negotiated in Copenhagen at the end of 2009. The G8 leaders also expect China and India to promise meaningful actions to reduce GHG emissions as a part of that treaty. Despite the fact that this was the first commitment by the United States to join the major industrialized nations to reduce GHG emissions, a number of international climate change experts felt that the G8 leaders did not go far enough, and that a 2050 target, without any specific actions or requirements for mid-term reductions, is weak and ambiguous.

Federal Legislation

According to the Pew Center on Global Climate Change (Pew Center), members of the 110th Congress introduced legislation related to global climate change faster than any previous Congress. As of July 2008, lawmakers had introduced more than 235 bills, resolutions, and amendments specifically addressing global climate change and GHG emissions – compared with the 106 pieces of relevant legislation the previous Congress submitted during its entire two-year (2005-2006) term. The bills that were introduced include various proposals such as cap-and-trade systems, U.S. participation in international climate change negotiations, and mandatory controls on emissions of GHGs. The primary bills introduced as of July 2008 that include specific GHG emissions reductions are shown in **Exhibit 2.1** in order of introduction date.

Exhibit 2.1

Primary Bills That Include Specific Emissions Reductions

(As of July 2008)

Bill	Title	Sponsor	Introduction Date and Status	GHG Reduction Targets	Market Mechanisms?
S. 280	Climate Stewardship and Innovation Act of 2007	Senator Lieberman	Jan. 12, 2007 Bill is currently in the Senate Committee on Environment and Public Works. Hearings held July 24, 2007.	Economy divided into sectors – electricity, transportation, industry, and commercial. Each sector subject to sector-wide emissions cap. Cap steadily declines until it is equal to 1/3 of the 2004 levels.	Yes, market-driven system of tradable greenhouse gas (GHG) allowances, inter-sector emissions trading, and alternative mechanisms such as carbon sequestration projects.
S. 309	Global Warming Pollution Reduction Act	Senator Sanders	Jan. 16, 2007 Bill is currently in the Senate Committee on Environment and Public Works.	Cap on GHG emissions on economy-wide basis beginning 2010. By 2020, U.S. emissions would be capped at 1990 levels. By 2050, 20% below 1990 levels.	Yes, the Environmental Protection Agency (EPA) has discretion to employ market-based allowance trading program.

Exhibit 1.3 (continued)

Bill	Title	Sponsor	Introduction Date and Status	GHG Reduction Targets	Market Mechanisms?
S. 317	Electric Utility Cap and Trade Act of 2007	Senator Feinstein	Jan. 17, 2007 Bill is currently in the Senate Committee on Environment and Public Works.	GHG emissions for electric generating facilities of 25 megawatt capacity and greater would be limited beginning in 2011. In 2011, emissions would be at 2006 levels, in 2015 would be at 2001 levels, in the years 2016 to 2019, reduce by 1.0% from previous year, and in 2020 and onward, an additional 1.5% from previous year.	Cap-and-trade systems, emissions credits distributed through auction and allocation, but with auctioning reaching 100% in 2036 and after.
S. 485	Global Warming Reduction Act of 2007	Senator Kerry	Feb. 1, 2007 Bill is currently in the Senate Finance Committee.	Economy-wide cap beginning 2010. By 2020, GHG emissions capped at 1990 levels. After 2020, emissions would be reduced 2.5% annual from their previous year's level until 2031 and then emissions would be reduced by 3.5% from previous year through 2050.	Allowance trading system. EPA would design cap and trade system and have description over scope of system and which sectors would be included.
H.R. 620	Climate Stewardship Act	Senator Oliver	Feb. 7, 2007 Bill is in the House Subcommittee on Fisheries, Wildlife, and Oceans.	Modified version of S. 280 – but same division into four sectors. Emissions caps are more stringent though. Reductions would be set at 2004 levels in 2012 and then steadily decline until the cap is equal to 25% of 2004 levels.	Trading allowances, and compliance through alternative means such as credits from foreign sources, sequestration. But only 15% of the source's reduction requirement may come from these mechanisms.

Exhibit 1.3 (continued)

Bill	Title	Sponsor	Introduction Date and Status	GHG Reduction Targets	Market Mechanisms?
H.R. 1590	Safe Climate Act of 2007	Rep. Waxman	Mar. 20, 2007 Bill is currently in the House Subcommittee on Energy and Air Quality.	Similar to S. 485 – caps GHG emissions on economy-wide basis beginning in 2010. Beginning 2020, emissions caps would be at 1990 levels. After 2020, emissions would be reduced by roughly 5% annually from their previous level through 2050. By 2050, GHG emissions are expected to be capped at 80% below 1990 levels.	Allowance trading system includes allocation scheme that requires an unspecified percentage of allowances to be auctioned.
S.1766	Low Carbon Economy Act of 2007	Senator Bingaman (with bipartisan cosponsors)	Jul. 11, 2007 Bill is currently in the Senate Committee on Environment and Public Works.	Caps on GHGs emitted by petroleum refineries, natural gas processing plants, fossil fuel importers, and large coal-consuming facilities. GHG emissions reductions to 2006 levels by 2020 and to 1990 levels by 2030.	Yes, would have allowances, and have a carbon credit auction.
S.3036 (formerly S.2191)	Lieberman-Warner Climate Security Act of 2008	Senator Boxer	May 20, 2008 Favorably reported by the Senate Environment and Public Works Committee on Dec. 5, 2007. Considered by Senate on June 6, 2008.	Establishes a market-based cap-and-trade program for GHG emissions from covered sectors; 4% below 2005 levels by 2012; 19% below 2005 levels by 2020; and 71% below 2005 levels by 2050.	Yes, it allocates approximately 75% of the allowances for free and the remaining 25% by auction in 2012; the proportion of auctioned allowances would increase to over 50% by 2032.

Source: The National Conference of State Legislatures; Pew Center on Global Climate Change; Congressional Research Service, Library of Congress (Thomas)

Lieberman-Warner Climate Security Act of 2008 Makes It to the Senate Floor

The Lieberman-Warner Climate Security Act of 2008 (S. 3036) was the first GHG cap-and-trade bill ever to have been voted out of committee and taken to the Senate floor. Major provisions of the legislation are discussed below.

Cap-and-trade Provisions

According to the Pew Center, S. 3036 would have established a cap-and-trade program[1] to cover an estimated 87% of U.S. GHG emissions. Under the bill, GHG emissions from "covered sectors" would have been reduced by:

- 4% below 2005 levels by 2012;
- 19% below 2005 levels by 2020; and
- 71% below 2005 levels by 2050.

Covered sectors would have included coal-fired power plants and other entities using more than 5,000 metric tons of coal; natural gas processors and importers; petroleum processors and refiners; manufacturers and importers of more than 10,000 metric tons of GHGs; and entities that emit more than 10,000 metric tons of hydrochlorofluorocarbons (HFCs). (The bill would have established a separate cap-and-trade for HFCs produced or imported.)

Beginning in 2012, a majority of the allowances would have been allocated for free, while the rest would have been auctioned off. Allowances would have been allocated to reward and encourage the development of energy efficient and renewable energy practices. Over time, the proportion of allowances auctioned would have increased.

Auction proceeds would have been used to fund research into low-carbon electricity, carbon capture and sequestration, other advanced research, and incentives; provide financial relief to consumers; provide transition assistance to workers and carbon-intensive manufacturers; protect natural resources; and reduce the national deficit.

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[1] The U.S. Environmental Protection Agency defines a cap-and-trade program as a market-based policy tool for protecting human health and the environment. A cap-and-trade program first sets an aggressive cap, or maximum limit, on emissions. Sources covered by the program then receive authorizations to emit in the form of emissions allowances, with the total amount of allowances limited by the cap. Each source can design its own compliance strategy to meet the overall reduction requirement, including sale or purchase of allowances, installation of pollution controls, and implementation of efficiency measures, among other options. Individual control requirements are not specified under a cap-and-trade program, but each source must surrender allowances equal to its actual emissions in order to comply.

Efforts to Prevent Economic Hardship

S. 3036 would have established measures to contain the cost of the cap-and-trade program, including allowing the use of domestic and international offsets; recognizing early action by companies; and providing for the banking and borrowing of allowances, among other things.

On June 2, 2008, S. 3036 was brought up for debate before the full U.S. Senate. However, due to an unrelated dispute over judicial nominations, opponents of the bill used a Senate courtesy to force legislative clerks to read the entire 492 page bill into the record. Therefore, little debate on the bill actually occurred. After one week, the bill was pulled from the floor following a procedural vote to invoke cloture (to end the debate on the bill). On June 6, 2008, the motion to invoke cloture failed by a vote of 48-36. Although six senators who were absent entered statements into the record saying they would have voted for cloture had they been present, 60 votes would have been needed to close debate on the bill and move to a final vote.

Proponents of S. 3036 believe it showed a commitment by Congress to address climate change and laid a foundation for future proposals. Opponents, however, were quick to point out that many of the votes cast in support of cloture were not necessarily votes for S. 3036. In particular, 10 Democratic senators (9 of who voted for cloture) sent a letter to Majority Leader Harry Reid and Senator Barbara Boxer after the vote stating their opposition to the bill in its current form.

What the vote did signify, however, is that there are still major issues that need to be resolved with respect to national climate change legislation. The most difficult and perhaps, most contentious issue, is how to minimize and contain overall costs and how to provide relief for those affected, including energy-intensive industries, those disadvantaged by higher fuel prices, regions of the country where coal burning is the major source of electricity, and consumers who will be faced with higher electricity prices. In addition, given the numerous interest groups all vying for a "piece of the pie," another issue that will need to be resolved is how to allocate the estimated trillions of dollars that could be generated by the sale of allowances under a federal cap-and-trade program.

More Action Expected in the 111th Congress

In October 2008, Committee Chairman John Dingell and Subcommittee Chairman Rick Boucher of the House Committee on Energy and Commerce released a discussion draft of climate change legislation that would amend the Clean Air Act to establish an economy-wide cap-and-trade program to reduce GHG emissions. The discussion draft, which would cover approximately 88% of U.S. GHG emissions, would reduce covered emissions to 6% below 2005 levels by 2020, 44% below 2005 levels by 2030, and 80% below 2005 levels by 2050. The discussion draft is the culmination of nearly two years of work on climate change by the committee.

President Barack Obama

President Barack Obama supports the implementation of an economy-wide cap-and-trade system to reduce carbon emissions by 80% by 2050. The President aims to begin reducing emissions immediately by establishing strong annual reduction targets, including a mandate of reducing emissions to 1990 levels by 2020. He supports a cap-and-trade system that would require all pollution credits to be auctioned and to invest some of the auction proceeds to support the development and deployment of clean energy, energy efficiency, and transition costs for American workers. In addition, President Obama plans to increase funding for federal science and research for clean energy projects, establish a national low carbon fuel standard, establish a federal renewable portfolio standard, and increase fuel economy standards.

Chapter 3. Maryland's Efforts to Reduce Greenhouse Gas Emissions

Introduction

Over the past decade, Maryland has taken a number of steps to improve air quality, increase energy efficiency, and promote renewable energy. This chapter will provide a description of legislation enacted in Maryland over the past 10 years that has resulted in, or could lead to, a significant reduction of greenhouse gas (GHG) emissions in the State. Related regulatory efforts are also described. This chapter will also provide information pertaining to unsuccessful efforts to reduce GHG emissions, including the delay in the implementation of the portions of the Clean Cars Act of 2007 relating to GHG emissions as well as the unsuccessful introduction of legislation during the 2007 and 2008 sessions which would have established mandatory reductions of GHG emissions statewide. Finally, the chapter will conclude with a discussion of the Maryland Commission on Climate Change and the recommendations included in the commission's August 2008 Climate Action Plan.

Legislative and Regulatory Efforts Implemented Over the Past Decade

Air Quality

In recent years, the General Assembly has adopted legislation that reduces harmful emissions from both power plants and motor vehicles. These are the two largest sources of GHG emissions in Maryland. Once fully implemented, the recent legislation will result in GHG emission reductions.

Power Plants

In 2006, the General Assembly passed the *Healthy Air Act (Senate Bill 154/House Bill 189, Chapters 23 and 301)*. The Acts, which established limits on emissions of various pollutants from seven coal-fired power plants in the State, also address carbon dioxide (CO_2) emissions by requiring the Governor to include the State in the Regional Greenhouse Gas Initiative (RGGI). RGGI began in 2003 as a cooperative effort by nine Northeast and Mid-Atlantic States to discuss the design of a regional cap-and-trade program initially covering CO_2 emissions from power plants in the region while maintaining energy affordability and reliability and accommodating, to the extent feasible, the diversity in policies and programs in individual states. After the cap-and-trade program for power plants is implemented, the states may consider expanding the program to other kinds of sources.

At this time, there are 10 participating states which include Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont. In addition, the District of Columbia, Pennsylvania, Ontario, Quebec, the Eastern

Canadian Provinces, and New Brunswick are observers to the process. The participating states signed a memorandum of understanding (MOU) in December 2005 that outlines the program in detail. In August 2006, the participating states issued a model rule for the RGGI program. The model rule forms the basis for individual state regulatory and statutory proposals to implement the program. The states made substantial revisions to the draft model rule in response to public comments. Some of the changes made to the model rule required substantive changes to the MOU. As a result, an amendment to the MOU was also agreed to and signed by the agency heads of the energy regulatory and environmental agencies in each participating state. Governor Martin J. O'Malley signed onto the MOU on behalf of the State by a second amendment in April 2007.

The centerpiece of RGGI is the CO_2 Budget Trading Program. Under the model rule, all fossil fuel-fired units serving an electricity generator with a nameplate capacity equal to or greater than 25 megawatts (MW) must comply with the program. Participating states must stabilize power sector CO_2 emissions over the first six years of program implementation (2009 through 2014) at a level roughly equal to current emissions, before initiating an emissions decline of 2.5% per year for the next four years (2015 through 2018). This approach will result in a 2018 annual emissions budget that is 10% smaller than the initial 2009 annual emissions budget. This phased approach with initially modest emissions reductions is intended to provide market signals and regulatory certainty so that electricity generators can begin planning for, and investing in, lower carbon alternatives throughout the region, but without creating dramatic wholesale electricity price impacts and attendant retail electricity rate impacts.

The RGGI MOU apportions CO_2 allowances among signatory states through a process based on historical emissions and negotiation. The emissions budgets of all the signatory states comprise the regional emissions budget, or the RGGI "cap." Each state will allocate allowances up to the amount of its emissions budget, with each allowance allowing a regulated source to emit one ton of CO_2. The initial base annual CO_2 emissions budget for Maryland is 37,503,983 short tons.

The first three-year compliance period begins January 1, 2009, and ends December 31, 2011. Allowances will be identified with a vintage corresponding to the allowance's respective allocation year. All allowances made available for auction by states for a respective compliance period will be offered for sale prior to the end of that compliance period. Future allowance vintages will be made available for sale in a quantity up to 50% of their respective annual allocation, and such offerings may be for allowances extending up to four allocation years into the future.

The participating states have agreed to allocate at least 25% of their allowances to support consumer benefit and strategic energy programs. Individual participating states may choose how to allocate the remaining 75% of their allowances, but the clear trend among the RGGI states is to auction nearly all of their allowances and dedicate the proceeds to support consumer benefits. According to RGGI, New York, Massachusetts, Vermont, Rhode Island, Connecticut, and Maine have all publicly stated their commitment to auction 100%, or nearly 100%, of their allowances to support consumer benefit programs. Allocating allowances to support consumer benefits leads to lowering of electricity demand, reducing the overall compliance costs of the program and its impact on ratepayers. In Maryland, legislation addressing the allocation of auction revenues was enacted in 2008 and is addressed in more detail later in this chapter.

As of July 2008, Maryland had adopted two sets of regulations to implement RGGI – one on April 4, 2008 (establishing the CO_2 Budget Trading Program), and the other on July 17, 2008 (relating to the auction/sale of allowances under the program). The regulations establish various allowance accounts, monitoring requirements, recordkeeping requirements, eligible offset projects, and auction procedures. They also provide for the distribution of allowances, with approximately 85% of the total number of allowances to be sold at auction. There are provisions, however, that allow for a smaller percentage of allowances to be auctioned if the allowance price rises above a certain threshold price. The Maryland Department of the Environment (MDE) recently proposed additional regulations relating to RGGI that are expected to take effect in the spring of 2009.

The first regional auction was held on September 25, 2008; the states that offered allowances for sale in that auction included Connecticut, Maine, Maryland, Massachusetts, Rhode Island, and Vermont. Maryland offered approximately 5.3 million of its total annual budget of 37.5 million allowances for sale. The allowances were sold at a price of $3.07 per allowance, generating approximately $16.4 million in revenue. The second regional auction, in which all 10 RGGI states participated, was held on December 17, 2009. Maryland again offered approximately 5.3 million allowances for sale. All allowances were sold at a price of $3.38 per allowance, generating an additional $18.0 million in revenue. RGGI intends to hold quarterly auctions during the first three-year compliance period. The next auction is scheduled for March 18, 2009.

Motor Vehicles

Beginning in 2000, the *Commuter Benefits Act of 2000 (Senate Bill 244/House Bill 310, Chapters 356 and 357)* authorized a credit against the State income tax for employers who provided employees a "cash in lieu of parking program" or a "guaranteed ride home." A cash in lieu of parking program authorizes an employer to provide an employee a cash allowance instead of a parking space. This is intended to encourage employees to use alternative transportation to work, such as walking, biking, carpooling, or riding mass transit. Further, providing a guaranteed ride home program allows employees who did not drive to work to leave work early in the case of an illness or other emergency. Both programs are aimed at helping the State achieve compliance with air quality standards by reducing traffic congestion, increasing mass transit ridership, and ultimately reducing vehicle miles traveled. In 2002, the *Commuter Benefits Act 2002 (House Bill 339, Chapter 507)* increased the maximum amount of the tax credit from $30 to $50 per employee per month.

After failed attempts in 2003 through 2005, the General Assembly passed the *Maryland Clean Cars Act of 2007 (Senate Bill 103/House Bill 131, Chapters 111 and 112)*. The Acts require MDE, in consultation with the Motor Vehicle Administration (MVA), to establish, by regulation, a Low Emissions Vehicle (LEV) program applicable to vehicles of the 2011 model year and each model year thereafter. The program must be authorized by Section 177 of the federal Clean Air Act (CAA). MDE, as part of the program, must establish motor vehicle emissions standards and compliance requirements for each model year included in the program. MDE is authorized to adopt California's regulations, procedures, and certification data by reference and motor vehicle emissions inspection, recall, and warranty requirements.

The LEV program is to be modeled after California's LEV program. Although CAA preempts individual state authority to require on-board controls for mobile sources, Congress made an exception for California because of that state's acute air quality problems and because the state's economy is large enough to make it reasonable for manufacturers to make cars that comply with the more stringent standards. CAA also allows other states to adopt California's standards under certain conditions. Adopting a LEV program in Maryland is expected to reduce GHG emissions from the transportation sector by approximately 20% once fully implemented. However, although this legislation was enacted in 2007, the regulations necessary to implement the portions of the program relating to GHG emissions have yet to go into effect. This delay in implementation is discussed in greater detail in this section under "Delayed Efforts and Unsuccessful Legislative Proposals."

Energy Efficiency

According to the Maryland Commission on Climate Change, energy efficiency is the fastest and cheapest approach available to reduce GHG emissions. The National Action Plan for Energy Efficiency, developed by the U.S. Department of Energy (DOE) and EPA in 2006, states that energy efficiency can also reduce energy bills, stabilize energy prices, improve electric and natural gas system reliability, and reduce air pollution. It is for these reasons and others that the State has promoted and encouraged the purchase of energy efficient products and the use of energy efficient practices since 2000.

Energy Efficiency in General

In 2008, the General Assembly passed the *Maryland Strategic Energy Investment Program (Senate Bill 268/House Bill 368, Chapters 127 and 128)*. The Acts establish a Maryland Strategic Energy Investment Program and a Maryland Strategic Energy Investment Fund within the Maryland Energy Administration (MEA) to receive RGGI auction proceeds. Pursuant to the Acts, RGGI proceeds must be distributed as follows:

- 17.0% transferred to the Department of Human Resources for electricity assistance programs;
- 23.0% to provide rate relief to residential customers;
- at least 46.0% for energy efficiency, conservation, and demand response programs;

- up to 10.5% for renewable and clean energy programs and initiatives, energy-related public education and outreach, and climate change programs; and

- up to 3.5% (but not more than $4.0 million) for MEA administration.

A portion of the fund will be redirected to MDE to support RGGI implementation and other climate change programs. The Acts also created a Strategic Energy Investment Advisory Board staffed by MEA to review and make recommendations on MEA's proposed uses of and expenditures from the fund.

The *EmPOWER Maryland Energy Efficiency Act of 2008 (House Bill 374, Chapter 131)* establishes a per-capita State goal of achieving a 15% reduction in electricity consumption and a 15% reduction in peak demand by the end of 2015 from 2007 levels. Beginning with the 2008 calendar year and each year thereafter, the Public Service Commission (PSC) must calculate the per-capita electricity consumption and peak demand for the year. The Act requires PSC, among other things, on or before December 31, 2008, and to the extent it determines that cost effective energy efficiency and conservation programs are available for each affected class, to require electric companies to procure and provide customers with a cost-effective demand response program that is designed to achieve targeted electricity savings and demand reduction through 2015.

Also in 2008, the General Assembly passed the *Jane E. Lawton Loan Program (Senate Bill 885/House Bill 1301, Chapters 466 and 467 of 2008).* The Acts consolidate, with limited modifications, the existing Community Energy Loan Program and Energy Efficiency and Economic Development Loan Program into the Jane E. Lawton Loan Program and establish a related special fund to fund the program. The program will provide financial assistance in the form of low-interest loans to nonprofit organizations, local jurisdictions, and eligible businesses for projects to (1) promote energy conservation; (2) reduce consumption of fossil fuels; (3) improve energy efficiency; and (4) enhance energy-related economic development and stability in business, commercial, and industrial sectors.

Energy Efficient Products and Appliances

The *Maryland Clean Energy Incentive Act (Senate Bill 670/House Bill 20, Chapters 295 and 296 of 2000)* provided an incentive to purchase energy efficient products through the use of four tax incentives. The Acts exempted from the sales and use tax (1) clothes washers, room air conditioners, and refrigerators that meet or exceed applicable Energy Star efficiency guidelines; and (2) fuel cells and energy efficient heating and cooling equipment that meet specified energy efficiency requirements. Chapters 295 and 296 also provided incentives for the use of renewable energy sources and are described again later in this section.

In 2004, the *Maryland Energy Efficiency Standards Act (Senate Bill 394/House Bill 747, Chapters 2 and 5)* established minimum energy efficiency standards for nine household and commercial products to be sold in Maryland after March 1, 2005, or installed in Maryland after

January 1, 2006. In response to difficulties implementing the Acts, in 2005, the General Assembly passed *State Government – Energy Efficiency Standards (House Bill 1030, Chapter 411)*, which repealed the energy efficiency standards for certain products; modified the requirements for others; limited the labeling requirements to products sold through retailers; and provided for a one-year delay in the effective date of the labeling requirements. In 2007, however, the *Maryland Energy Efficiency Standards Act of 2007 (Senate Bill 674, Chapter 568)* added several new products to the 2004 Acts.

Passed during the 2007 special session, the *Transportation and State Investment Act (House Bill 5, Chapter 6)* exempted from the State sales and use tax the purchase of specified Energy Star products or solar hot water heaters made on the Saturday immediately preceding the third Monday in February through that Monday. The Act applies to purchases of eligible Energy Star air conditioners, clothes washers or dryers, furnaces, heat pumps, standard size refrigerators, compact fluorescent light bulbs, dehumidifiers, programmable thermostats, and solar water heaters once a year beginning in February 2011.

Energy Efficiency in Buildings

In 2006, the *State Buildings Energy Efficiency and Conservation Act (Senate Bill 267, Chapter 427)* updated target percentages and dates for the reduction of energy consumption in State buildings that were originally established by Chapter 490 of 1992. Chapter 490 required the Department of General Services (DGS), in cooperation with MEA, to set energy performance standards that required the average energy consumption per square foot in State buildings to be reduced by 15% below 1992 levels by 1996 and 25% below 1992 levels by 2001. It also required each State agency to conduct an energy consumption analysis and to upgrade its energy conservation plan by specified dates. Chapter 427 updated these percentages to require the average energy consumption per square foot in State buildings to be reduced by 5% below 2006 levels by 2009 and 10% below 2006 levels by 2010. The Act also altered the dates by which each State agency must conduct energy consumption analyses on each of its buildings and upgrade its energy conservation plan.

In 2007, the *Maryland Green Building Council (Senate Bill 332/House Bill 942, Chapters 115 and 116)* codified the Maryland Green Building Council. The council was required to evaluate high performance building technologies, make recommendations on the most cost-effective green building technologies the State should consider using, and develop a list of building types for which green building technologies should not be applied. As a result of the recommendations made by the Maryland Green Building Council in its December 2007 report, in 2008 the General Assembly passed the *High Performance Buildings Act (Senate Bill 208, Chapter 124)*. The Act requires new or renovated State buildings and new school buildings to be constructed as high performance buildings under specified circumstances.

Renewable Energy

Renewable energy is energy generated from sources such as sunlight, wind, geothermal heat, and biomass. Using renewable energy sources to generate electricity generally results in little to no GHG emissions, can decrease dependence on fossil fuel sources, and can reduce water consumption, thermal pollution, waste, noise, and adverse land-use impacts. Over the past 10 years, Maryland has encouraged the development and use of renewable energy sources through the establishment of tax credits, grants, and other renewable energy generation requirements. These efforts are described below.

Tax Incentives

The *Maryland Clean Energy Incentive Act (Senate Bill 670/House Bill 20, Chapters 295 and 296 of 2000),* among other things, authorized a credit against the State income tax for the costs of specified equipment that uses solar energy to generate electricity or provides hot water for use within a structure. The Acts also provided for a production credit against the State income tax to an individual or corporation that produces and sells electricity that is generated from specified qualified energy resources, including wind, biomass, poultry waste, and methane gas. The *Maryland Clean Energy Incentive Act of 2006 (Senate Bill 314, Chapter 129)* reauthorized the tax credit by (1) authorizing MEA to award a total of $25 million in credits until December 31, 2010; (2) altering the types of energy resources that can qualify for the credit; and (3) changing the dates a facility can qualify for the credit if it is originally placed in service or begins co-firing a qualified energy resource on or after January 1, 2006, but before January 1, 2011.

Renewable Portfolio Standard (RPS)

In 2004, Maryland joined at least 13 other states at that time by adopting its own RPS. An RPS is a policy that requires retail suppliers of electricity to meet a portion of their energy supply needs with eligible forms of renewable energy. *Electricity Regulation – Renewable Energy Portfolio Standard and Credit Trading – Maryland Renewable Energy Fund (Senate Bill 869/House Bill 1308, Chapters 487 and 488)* required PSC to establish an RPS that would apply to retail electric sales in the State beginning in 2006. The Acts required electricity suppliers to include specified amounts of renewable energy as part of its portfolio of generating fuels for retail sales. The RPS divides the eligible renewable energy sources into two categories, Tier 1 and Tier 2 sources, and provides percentage requirements for each year, beginning in 2006 through 2019. Tier 1 renewable energy sources include solar, wind, qualifying biomass, methane from anaerobic decomposition of organic materials in a landfill or wastewater treatment plant, geothermal, ocean, and fuel cells powered by other Tier 1 sources. Tier 2 renewable energy sources include hydroelectric power, the incineration of poultry litter, and waste-to-energy. If retail electricity contains fewer kilowatt hours from Tier 1 and Tier 2 renewable sources than are required to comply with the standard for that year, the supplier must pay a compliance fee. Pursuant to Chapters 127 and 128 of 2008, such compliance fees are to be paid into the Maryland Strategic Energy Investment Fund within MEA.

In 2007, *Electricity – Net Energy Metering – Renewable Energy Portfolio Standard – Solar Energy (Senate Bill 595/House Bill 1016, Chapters 119 and 120)* added a small but increasing solar component to the RPS. The Acts also altered provisions on net energy metering to accommodate increased use of solar generation in the State.

In 2008, the General Assembly passed *Renewable Portfolio Standard Percentage Requirements – Acceleration (Senate Bill 209/House Bill 375, Chapters 125 and 126)*. The Acts increase the percentage requirements of the RPS from 9.5 to 20.0% in 2022 and beyond. Effective January 1, 2011, Tier 1 compliance fees are increased from 2 to 4 cents per kilowatt hour. Beginning January 1, 2011, the Acts also restrict acceptable renewable energy resources to those within the PJM region (*i.e.*, the wholesale, bulk power control area in which Maryland resides) or in a control area that is adjacent to the PJM region, if the electricity is delivered into the region. The Acts provide a compliance fee mechanism that terminates on December 31, 2018. The mechanism allows PSC to delay electric suppliers' scheduled RPS requirements for Tier 1 (nonsolar) resources under specified conditions.

Solar/Geothermal

To encourage the use of solar energy, in 2004 the General Assembly established the *Solar Energy Grant Program (Senate Bill 485, Chapter 128)* to provide grants to individuals, local governments, and businesses for a portion of the costs of acquiring and installing photovoltaic property and solar water heating property. In 2005, the General Assembly established a similar program to provide grants to individuals for a portion of the costs of acquiring and installing geothermal heat pumps *(Maryland Energy Administration – Geothermal Heat Pump Grant Program, Senate Bill 361, Chapter 476)*.

In 2008, the General Assembly increased the grant limits under both programs with the passage of *Solar and Geothermal Tax Incentive and Grant Program (House Bill 377, Chapter 132)*. The Act also exempts the sale of specified solar energy and geothermal equipment from the State sales and use tax and exempts specified solar energy property from State and local real property taxes.

Wind

In 2007, Maryland encouraged the generation of electricity from wind with the enactment of *Public Utility Companies – Generating Stations – Wind (Senate Bill 566, Chapter 163)*. This Act authorized a wind powered energy generating facility to be built without requiring a certificate of public convenience and necessity as long as certain conditions are met, including an opportunity for public comment at hearings held by PSC within a county or municipality where the generating station is proposed to be located. This abbreviated process reduces costs for applicants, and may encourage the development of electricity generating stations powered by wind for local governments to power public buildings, for businesses for on-site use, or for sale to the wholesale power market.

Clean Energy

Finally, in 2008 the State created the *Maryland Clean Energy Center (House Bill 1337, Chapter 137)* as a body politic and corporate and as an instrumentality of the State to (1) generally promote and assist the development of the clean energy industry in the State; (2) promote the deployment of clean energy technology in the State; and (3) collect, analyze, and disseminate industry data.

Delayed Efforts and Unsuccessful Legislative Proposals

Maryland Clean Cars Act of 2007 – Implementation Delay

Although the Maryland Clean Cars Act was enacted in 2007, a part of the program that establishes GHG (CO_2) vehicle emissions standards cannot go into effect without EPA approval. Since California was the first state in the country to adopt GHG emissions standards for automobiles, it requested a waiver from EPA on December 21, 2005. After EPA failed to act on the waiver, California, as well as 14 other states, including Maryland, that also sought to adopt California's standards, sued EPA on November 8, 2007, to force action on the waiver. On December 19, 2007, EPA Administrator Stephen L. Johnson denied California's waiver request, subsequently preventing the other 14 states from adopting their own GHG vehicle emissions standards as well. On January 2, 2008, California and 15 states, including Maryland, filed separate petitions in the U.S. Court of Appeals for the 9th Circuit to reverse EPA's waiver denial. On May 5, 2008, they also petitioned the U.S. Court of Appeals for the District of Columbia Circuit. On July 25, 2008, the U.S. Court of Appeals for the 9th Circuit dismissed the petitions filed by California and the other 15 states on procedural grounds.

Therefore, as of January 6, 2009, the only petition pending is before the U.S. Court of Appeals for the District of Columbia Circuit. However, many expect the new EPA administrator appointed by President Obama to grant the waiver upon taking office. Nonetheless, Maryland is positioned to move forward with the parts of the Clean Cars Program that require stricter vehicle emissions standards for volatile organic compounds (VOCs) and nitrogen oxides (NO_x) beginning in model year 2011.

Global Warming Solutions Legislation Introduced in Recent Sessions

Senate Bill 409/House Bill 890 of 2007

These bills, introduced but not passed during the 2007 legislative session, and modeled after California's AB 32, would have required the State, by 2020, to reduce statewide GHG emissions to 1990 levels. In addition, the bills would have established other deadlines for the implementation and collection of a GHG emissions fee to be paid by sources of GHGs in the State, and for the adoption of regulations to help achieve the statewide GHG emissions limit.

The bills also would have established an Office of Climate Change within MDE to implement activities relating to the establishment of a statewide GHG emissions limit.

The bills were heard by the Senate Education, Health, and Environmental Affairs Committee and the House Economic Matters and Environmental Matters Committees, but no further action was taken. Proponents lauded the bill as an aggressive attempt to address climate change in the absence of federal action. Opponents argued that a national GHG policy is preferable because actions taken in Maryland would do little to impact the effects of global climate change.

Senate Bill 309/House Bill 712 of 2008

These bills, introduced during the 2008 legislative session, were modeled after Senate Bill 409/House Bill 890 of 2007. After a substantial number of amendments were added to Senate Bill 309 (SB 309) by the Senate Education, Health, and Environmental Affairs Committee and by members on the Senate floor, the Senate passed SB 309 by a vote of 31-16. However, the House Economic Matters and Environmental Matters Committees did not take a vote on House Bill 712 or SB 309. Below is a summary of the third reader version of SB 309 as passed by the Senate as well as a summary of the major arguments raised by proponents and opponents of the legislation.

Summary of SB 309 (As Passed by the Senate)

Required Reductions: The bill would have required MDE to develop plans, adopt regulations, and implement programs to reduce GHG emissions by 25% from 2006 levels by 2020. The bill would have established various deadlines for MDE to develop and publish the measures that would have been used to achieve the required reductions; to adopt specified regulations; to develop specified inventories and plans; and to submit specified reports.

Long-term Goal and Plan: The bill also would have required MDE, by June 1, 2012, to develop and publish a plan to reduce GHG emissions by 90% from 2006 levels by 2050. The plan would have included regulatory and other programs, research, development, technological advancement initiatives, and a schedule for adopting and implementing the plan.

Implementation: The bill would have established various requirements for MDE as it published and implemented three phases of emissions reduction measures. Among other things, MDE would have been required to evaluate the potential costs, economic benefits, and other benefits to the State's economy, environment, and public health. The measures developed by MDE would have included direct emissions reduction measures, alternative compliance mechanisms, and potential incentives for achieving the required reductions. MDE would have been required to establish a threshold of GHG emissions below which the emissions reduction requirements would not have applied.

The bill also would have established several requirements with respect to regulations relating to the reporting and monitoring of GHG emissions. MDE would have been required to review and update its emissions reporting requirements as necessary.

Cap-and-trade System: The bill would have established various requirements for the cap-and-trade system that MDE would have been authorized to develop for GHG sources. Among other things, the system would have been required to be designed to achieve reductions through the maximum technologically feasible and cost-effective means. Revenues generated from the auction of allowances under the system would have been deposited into the Maryland Strategic Energy Investment Fund.

Voluntary Reductions: The bill would have required MDE to adopt methodologies for the quantification of voluntary GHG emissions reductions and to adopt regulations that enable the State to monitor and verify voluntary reductions.

Funding and Contingency Provisions: Auction proceeds received by MDE from RGGI or from any other sale of GHG allowances by MDE would have been used to implement the bill. Prior to the bill's implementation, MDE would have had to determine whether it had received adequate revenues from RGGI auction proceeds to pay for the costs of implementing the bill. If it had received adequate revenues, then the bill's provisions would have taken effect the first day of the month after the receipt by the Department of Legislative Services (DLS) of that determination. If such a determination was not received by DLS by December 31, 2008, the bill would have terminated.

Major Arguments Raised by Proponents and Opponents of SB 309

Proponents of SB 309 argued that, with so much coastline in the State, Maryland is extremely vulnerable to the effects of climate change and global warming. They argued that, in the absence of federal action, Maryland should be a national leader in setting State-specific GHG emission reduction goals. They also argued that unchecked, climate change and global warming could have a profound effect on the Chesapeake Bay eco-system and its surrounding communities. They stressed the need to move away from fossil-fuel based energy sources to renewable sources, as well as the importance and potential benefits of more energy efficient practices. They alleged that in the long run, SB 309 would actually save consumers money by increasing energy efficiency. Finally, proponents claimed that the bill would create and attract new jobs in clean energy industries in the State.

Opponents argued that SB 309 would hurt Maryland's economy, would cause a dramatic increase in electricity rates, and would cause certain emissions-intensive industries (steel, aluminum, coal, cement, brick, and paper) to have to cut jobs or close down altogether. They claimed that the goals in SB 309 would require shutting down some of Maryland's electricity fleet, which could threaten reliability and exacerbate a projected energy shortfall that the State is expected to experience by 2011. Finally, opponents argued that a national approach to climate change and global warming is more appropriate because reductions in Maryland alone would not go far enough to measurably affect the global environment.

The Maryland Commission on Climate Change

On April 20, 2007, Governor Martin O'Malley signed Executive Order 01.01.2007.07 establishing the Maryland Commission on Climate Change. The commission was charged with developing a Plan of Action to address the drivers and causes of climate change, to prepare for the likely consequences and impacts of climate change to Maryland, and to establish firm benchmarks and timetables for implementing the Plan of Action.

The commission consists of 21 members and is supported by three working groups: the Scientific and Technical Working Group, the Greenhouse Gas and Carbon Mitigation Working Group, and the Adaptation and Response Working Group. The working groups are intended to represent diverse stakeholder interests and provide perspective and expertise to the commission's work. In addition, The Center for Climate Strategies is facilitating the commission's work. The center is a nonpartisan, nonprofit partnership organization that helps public officials, private stakeholders, and technical experts develop and implement strategies to reduce GHG pollution and adapt to a changing climate.

The commission has met regularly since it was established in April 2007. In January 2008, the commission presented an interim report that included timetables and benchmarks for reducing Maryland's GHG emissions and preliminary recommendations for legislation and executive actions. Among other things, the commission recommended that the Governor and the General Assembly work in partnership to develop and adopt legislation during the 2008 session requiring the State to develop and implement programs to reduce GHG emissions by 25% by 2020 and by 90% by 2050 (from 2006 levels).

Climate Action Plan

The commission released its final Climate Action Plan in August 2008. The plan includes a comprehensive assessment of climate change impacts in Maryland and a review and assessment of the costs of inaction. Most notably, however, the plan establishes a set of science-based GHG reduction goals and a suite of 42 mitigation strategies that will, according to the commission, allow the State to reverse the trend of continuing growth in GHG emissions as quickly as possible. The plan also includes a comprehensive strategy for reducing Maryland's vulnerability to climate change, which was developed by the Adaptation and Response Working Group.

Emissions Reduction Goals

The reduction goals outlined in the plan are listed below. All of the goals use 2006 as the base year. **Exhibit 3.1** shows the equivalent goals from a 1990 baseline.

- 10% reduction by 2012;
- 15% reduction by 2015;

- 25 to 50% reduction by 2020; and

- 90% reduction by 2050.

According to the commission, recent actions by Maryland will get the State close to the 25% reduction target by 2020. Additionally, the commission projects that the 42 mitigation policies outlined in the plan will achieve an approximate 40 to 55% reduction from 2006 levels by 2020.

Exhibit 3.1

Climate Action Plan's Goals (from a 2006 Baseline) and Equivalent Goals from a 1990 Baseline

Year	Maryland's Goals (2006 Baseline)	Equivalent Goals (1990 Baseline)
2012	10% reduction from 2006 levels	15% above 1990 levels
2015	15% reduction from 2006 levels	9% above 1990 levels
2020	25% reduction from 2006 levels	4% reduction from 1990 levels
2020	50% reduction from 2006 levels	36% reduction from 1990 levels
2050	90% reduction from 2006 levels	87% reduction from 1990 levels

Source: Maryland Commission on Climate Change

Recommended Mitigation Strategies

The mitigation policies are divided into five broad categories: (1) residential, commercial, and industrial, (2) energy supply, (3) agriculture, forestry, and waste, (4) transportation and land use; and (5) cross-cutting. Several of the 42 policies are already in progress and specific information related to each policy can be found in the plan. A brief summary of the policies is provided below.

Residential, Commercial, and Industrial

- ***Improve Building/Trade Codes –*** Mandate periodic and regular review and adoption of State and local building/trade codes, particularly energy efficiency requirements, to ensure best management practices; reduce energy consumption per square foot by 15% by 2010 and by 50% by 2020; and develop a training and certification program for code officials and contractors on energy efficiency and related green building/trade codes.

- ***Demand-side Management and Energy Efficiency –*** Increase investment in electricity and natural gas demand-side management programs; create a Public Benefit Fund to increase the funding and scope of existing energy efficiency programs; and achieve reductions in per-capita electricity and natural gas use.

- ***Low-cost Loans for Energy Efficiency –*** Establish revolving loan funds for small-scale residential and commercial energy efficiency projects.

- ***Improved Design, Construction, Appliances, and Lighting in New and Existing State and Local Government Buildings; "Government Lead-by-example" –*** Reduce per-unit-floor-area consumption of carbon-based electricity by 15% by 2010, 50% by 2020, and 100% carbon-neutral by 2030 for government-owned and leased buildings.

- ***More Stringent Appliance/Equipment Efficiency Standards –*** Establish State minimum efficiency standards for appliances not covered by federal standards.

- ***Energy Efficiency Resource Standard –*** Establish a market-based mechanism to require more efficient use of electricity and natural gas.

- ***Promotion and Incentives for Energy Efficient Lighting –*** Phase out the sale or use of energy-inefficient incandescent light bulbs in the State.

Energy Supply

- ***Promotion of Renewable Energy –*** Encourage renewable energy development by removing regulatory and financial barriers to large-scale centralized facilities and on-site generation.

- ***Technology-focused Initiatives for Electricity Supply –*** Establish a set of policies to provide State government and other private and public parties with resources and incentives for analysis, targeted research and development, market development, and adoption of GHG-reducing technologies not covered by other policies.

- ***GHG Cap-and-trade –*** Adopt a statewide cap-and-trade program closely modeled after RGGI.

- ***Clean Distributed Generation –*** Revise regulatory policies and remove institutional barriers to encourage investment in distributed renewables and Combined Heat and Power.

- ***Integrated Resource Planning –*** Develop a comprehensive State resource adequacy plan for Maryland to meet the reliability, environmental, and economic policies of the State.

- ***Renewable Portfolio Standard* –** Strengthen the existing RPS to achieve 20% renewable energy by 2020.

- ***Efficiency Improvements and Repowering Existing Plants* –** Promote the identification and pursuit of cost-effective emissions reductions from existing generating units through improving their operating efficiency, adding biomass, or other fuel changes.

- ***Generation Performance Standards* –** Establish a mandate to require load-serving entities to acquire electricity on an average portfolio basis, with the portfolio meeting a per-unit emission rate below a specified standard, in order to encourage the purchase of energy and capacity from low-carbon or renewable technologies.

Agriculture, Forestry, and Waste

- ***Forest Management for Enhanced Carbon Sequestration* –** Improve sustainable forest management on public and private lands.

- ***Managing Urban Trees and Forests for GHG Benefits* –** Enhance green infrastructure planning, develop incentives to better use urban wood recovery, and achieve an urban tree canopy goal of 50% by 2020.

- ***Afforestation, Reforestation, and Restoration of Forests and Wetlands* –** Establish sufficient acreage in forests to offset the loss of 900 acres each month through 2020; establish riparian buffers at a rate of 360 miles per year through 2020 continuing until 70% of all stream miles in the State are buffered; and increase wetland areas wherever feasible.

- ***Protection and Conservation of Agricultural Land, Coastal Wetlands, and Forested Land* –** Leverage funds to protect and conserve agricultural lands, forestlands, wetlands, and coastal areas.

- ***"Buy Local" Programs for Sustainable Agriculture, Wood, and Wood Products* –** Promote the sustainable production and consumption of locally produced agricultural goods.

- ***Expanded Use of Forest and Farm Feedstocks and By-products for Energy Production* –** Increase the use of biomass from urban and rural feedstocks, including processing by-products for the generation of electricity, thermal energy, and transportation fuels; and reduce methane emissions from livestock manure by installing manure digesters and energy recovery projects.

- ***In-state Liquid Biodiesel Production –*** Promote sustainable in-state production and consumption of transportation biofuels to displace the use of fossil fuels. This policy option does not include the use of any feedstocks that could be used as food or animal feed, such as corn.

- ***Nutrient Trading with Carbon Benefits –*** Establish a system of nutrient trading to provide the opportunity to create significant carbon sequestration benefits.

- ***Waste Management and Advanced Recycling –*** Reduce the volume of waste from residential, commercial, and government sectors through various programs.

Transportation and Land Use

- ***Land Use and Location Efficiency –*** Implement land-use planning and development strategies that reduce the number of vehicle miles traveled by adopting statewide growth management plans and planning process reforms to encourage more compact development, transit-oriented development, and transportation management systems, while ensuring a competitive economy and affordable housing opportunities for Maryland residents.

- ***Transit –*** Shift passenger transportation mode choice to increase transit ridership and carpooling.
- ***Intercity Travel –*** Provide transportation infrastructure between cities to create connectivity of non-auto and non-truck transportation modes by building capacity of express rail and bus, marketing of new and improved or expanded services, shifting short and mid-distance air travel to modern rail, and supporting auto-free tourism development.

- ***Pay-as-you-drive (PAYD) Insurance –*** Make PAYD insurance, which ties consumer insurance costs to actual motor vehicle travel use, with adjustment for other rating factors such as driving record, age, and the vehicle driven, available to all Maryland drivers.

- ***Bike and Pedestrian Infrastructure –*** Improve, add, and promote sidewalks and bikeways to increase pedestrian and bicycle travel and reduce automobile use.

- ***Incentives, Pricing, and Resource Measures –*** Establish incentives, pricing, and resource measures to help allocate scarce resources and encourage wise stewardship when transportation consumers make choices.

- ***Transportation Technologies –*** Reduce GHG emissions from on-road vehicles and off-road engine vehicles (including marine, rail, and other off-road engine and vehicles, such as construction equipment) through deploying technology designed to cut GHG emission rates per unit of travel activity.

- ***Evaluate GHG from Major Projects –*** Require an evaluation of GHG emissions for all transportation and land use-related major capital projects on the State and local levels.

Cross-cutting

- ***GHG Inventory and Forecasting –*** Establish a formal statewide GHG inventory and forecast.

- ***GHG Report and Registry –*** Develop and manage a GHG emissions reporting system and require regular reporting.

- ***Statewide GHG Reduction Goals and Targets –*** Set statewide GHG reduction goals and targets.

- ***State and Local Government Lead-by-example –*** Adopt policies that improve the energy efficiency of public buildings, facilities, and operations through procurement processes.

- ***Public Education and Outreach –*** Foster awareness of climate change issues and effects among the State's citizens.

- ***Review Institutional Capacity –*** Review and create the governance and organizational capacity to execute GHG mitigation policies, implement programs, monitor and analyze results, and modify and update policies and programs as necessary over time.

- ***Participate in Regional, Multi-state and National Efforts –*** Collaborate with partner states or other organizations to offer broader and more economically efficient opportunities to reduce GHG emissions.

- ***Promote Economic Development Opportunities –*** Work with public and private entities to identify, promote, and finance opportunities for job creation related to new approaches to transportation, land use, green construction, recycling and reuse, and energy-efficient products and services.

- ***Create Capacity to Address Climate Change in an "After Peak Oil" Context –*** Take a proactive stance to deal with the eventual declining supply of oil by establishing a council of experts and stakeholders to review and evaluate all proposed climate change and energy-related policies and legislation.

- ***Public Health Risks –*** Establish a council of experts and stakeholders to review all proposed climate change and energy-related policies and legislation relating to health benefits and risks to all Maryland citizens.

Recommended Adaptation Strategies

Included within the comprehensive strategy for reducing Maryland's vulnerability to climate change are several priority policy recommendations that were developed by the Adaptation and Response Working Group. These recommendations are intended to reduce the vulnerability of the State's natural and cultural resources and communities to the impacts of climate change, and are focused on sea level rise and coastal hazards. Overall, the recommendations are intended to achieve four general purposes: (1) promote programs and policies aimed at the avoidance or reduction of impact to the existing-built environment, as well as to future growth and development in vulnerable coastal regions; (2) shift to sustainable economies and investments and avoid assumption of the financial risk of development/redevelopment in highly hazardous coastal areas; (3) enhance preparedness and planning efforts to protect human health, safety, and welfare; and (4) protect and restore Maryland's natural shoreline and its resources.

Exhibit 3.2 provides a summary of the plan's key recommendations for adaptation policy. Specific information related to the recommendations can be found in the plan.

Exhibit 3.2
Key Adaptation Recommendations Identified in the Climate Action Plan

Subject	Recommendation
Coastal Erosion	Integration of coastal adaptation and response plans within existing State and local policies
Infrastructure	State and local plans to identify and protect vulnerable infrastructure
Buildings	Enhanced coastal area building codes to ensure new construction considers climate change
Natural Resources	Long range planning in resource intensive industries to minimize future economic loss
Insurance	Advisory committee to study challenges regarding availability and affordability of insurance
Coastal Properties	*Maryland Sea-Level Rise Disclosure and Advisory Statement* for prospective property purchasers
Economic Preparedness	Promotion of market opportunities related to climate change adaptation and response activities
Emergency Management	Increased coordination among emergency preparedness agencies
Public Health	Health impact assessments to evaluate impact of climate change sensitive projects or policies

Exhibit 3.2 (continued)

Subject	Recommendation
Disease Control	Vector-borne surveillance and control programs
Vulnerable Resources	Identification of high priority protection areas and associated cost-effective protection actions
Wetlands and Buffers	Sustainable shoreline and buffer area management practices
Monitoring Systems	Observation systems to improve detection of climate changes and ecological impacts
State Government	Performance measures for departments and agencies to assist in statewide adaptation measures

Source: Maryland Commission on Climate Change's Climate Action Plan

Recommendation to Create a Federal-state Partnership

The plan concludes with a section that calls for the building of a federal-state partnership in climate change protection. In general, it recommends that U.S. climate mitigation policy be structured in accordance with six major principles:

- A national climate policy should include ongoing federal-state consultation, collaboration, and information-sharing.
- A national policy should include national science-based mandatory GHG reduction goals.
- A national policy should establish a cap-and-trade program covering emissions from power plants, large industrial sources, and producers of transportation fuels and natural gas, which should include a meaningful role for states in the allocation of allowances, use of auction revenues, and offset rules.
- A national policy should also include national technical and performance standards and research and development funding for technological advancement and improved energy efficiency in sectors not amenable to cap-and-trade.
- Federal law should be amended to create a regulatory and funding framework for reducing GHG emissions in the transportation sector through State implementation plans and the transportation conformity process.

- A national policy should not preempt state governments that take more stringent actions than the federal government to reduce GHG emissions within their jurisdictions, and should include incentives for “first-mover” states.

Conclusion

The State has implemented a number of programs over the years that will help Maryland reduce the rate of growth in GHG emissions. While some of these programs have been fully implemented, others are just beginning to be implemented. Accordingly, even without the adoption of any new programs, Maryland can expect to see additional benefits over the next several years. Despite this, as discussed earlier, the Maryland Commission on Climate Change believes that the State must take additional steps to reduce GHG emissions and adapt to climate change. The next chapter will provide some context to the recommendations outlined in the Climate Action Plan by providing an overview of the steps other states and countries are taking to reduce GHG emissions.

Chapter 4. What Are Other States and Countries Doing?

Greenhouse Gas Reduction Targets

In the absence of a federal mandate to reduce greenhouse gas (GHG) emissions, many states have recently established their own reduction targets. Several other countries have also established specific GHG emission reduction targets. These efforts are described below.

State Targets

As of August 2008, 20 states had established statewide targets for GHG emission reductions, as shown in **Exhibit 4.1**. Half of these targets were adopted by state legislatures and half were established by executive order or agency pronouncements. Five targets take the form of binding state emission caps and two others are contained in legislation in conjunction with several other mandatory provisions. All but three states with emission targets are currently participants or observers in one of the three major regional GHG reduction initiatives – the Western Climate Initiative (WCI), the Midwestern Regional Greenhouse Gas Reduction Accord (MRGGRA), or the Regional Greenhouse Gas Initiative (RGGI). In addition, several Northeastern states have also participated since 2001 in the New England Governors and Eastern Canadian Premiers Climate Change Action Plan ("New England Climate Action Plan," or "NECAP").

Exhibit 4.1
States with Greenhouse Gas Emissions Targets

State	Action	Reduction Goals	Mandatory	Market System
Arizona	Executive Order 2006-2013	2000 level by 2020 50% below 2000 level by 2040	No	Yes, WCI
California	Chapter 488, 2006	2000 level by 2010 1990 level by 2020 80% below 1990 level by 2050	Yes	Yes, establishing a state cap-and-trade program linked to WCI
Colorado	Executive Order D-004-08, 2008	20% below 2005 level by 2020 80% below 2005 level by 2050	No	No; however, the State is currently an observer of the WCI

Exhibit 4.1 (continued)

State	Action	Reduction Goals	Mandatory	Market System
Connecticut	Public Act No. 08-98, 2008	10% below 1990 level by 2020 80% below 2001 level by 2050	Yes	Yes, RGGI
Florida	Chapter 2008-227	2000 level by 2017 1990 level by 2025 80% below 1990 level by 2050	No	Yes, state cap-and-trade under development
Hawaii	Act 234, 2007	By 2020, reduce to 1990 levels	Yes	Undecided, regulatory regime under development by state task force
Illinois	Governor's announced target	1990 levels by 2020 60% below 1990 level by 2050	No	State government participation in Chicago Climate Exchange; cap-and-trade to be developed under MRGGRA
Maine	Chapter 237, 2003; Signed MOU to Implement RGGI	1990 level by 2010 10% below 1990 level by 2020; 75-80% below 2003 level over the "long term"	No	Yes, RGGI
Massachusetts	Signed MOU to Implement RGGI; also signed NECAP in 2001	RGGI goal: cap at 2009 levels 10% below 2009 level by 2019 The goal stated in NECAP is to reduce to: 1990 level by 2010; 10% below 1990 level by 2020; 75-85% below 2003 level over the "long term"	No	Yes, RGGI

Exhibit 4.1 (continued)

State	Action	Reduction Goals	Mandatory	Market System
Minnesota	Chapter 136, 2007; Also signed MRGGRA	15% below 2005 level by 2015 30% below 2005 level by 2025 80% below 2005 level by 2050	Some Mandatory Provisions	Yes. Must consider cap-and-trade; also cap-and-trade to be developed under MRGGRA
New Hampshire	Signed MOU to Implement RGGI; also signed NECAP in 2001	RGGI goal: cap at 2009 levels 10% below 2009 level by 2019 The goal stated in NECAP is to reduce to: 1990 level by 2010; 10% below 1990 level by 2020; 75-85% below 2003 level over the "long term"	No	Yes, RGGI
New Jersey	Act A 3301, 2007	1990 level by 2020 80% below 2006 level by 2050	Yes	Yes, RGGI
New Mexico	Executive Order 05-033, 2007	2000 level by 2012 10% below 2000 level by 2020 75% below 2000 level by 2050	No	Yes, WCI
New York	State Energy Plan of 2002	5% below 1990 level by 2010 10% below 1990 level by 2020	No	Yes, RGGI
Oregon	Chapter 907, 2007	Cap at 2010 level 10% below 1990 level by 2020 75% below 1990 level by 2050	No	Yes, WCI
Rhode Island	Signed MOU to Implement RGGI; also signed NECAP in 2001	RGGI goal: cap at 2009 levels 10% below 2009 level by 2019 The goal stated in NECAP is to reduce to: 1990 level by 2010; 10% below 1990 level by 2020; 75-85% below 2003 level over the "long term"	No	Yes, RGGI
Utah	State Department of Environmental Quality Goal	2005 level by 2020	No	Yes, WCI

Exhibit 4.1 (continued)

State	Action	Reduction Goals	Mandatory	Market System
Vermont	Act 168, 2006; also signed NECAP in 2001	25% below 1990 level by 2012 50% below 1990 level by 2028 75% below 1990 level by 2050 "if practicable"	Some Mandatory Provisions	Yes, RGGI
Virginia	Executive Order 59, 2007	30% below "business as usual" level by 2025	No	No, currently studying actions necessary to implement target
Washington	Chapter 14, 2008	1990 level by 2020 25% below 1990 by 2035 50% below 1990 by 2050	Yes	Yes, WCI

WCI: Western Climate Initiative
RGGI: Regional Greenhouse Gas Initiative
MRGGRA: Midwestern Regional Greenhouse Gas Reduction Accord
MOU: Memorandum of Understanding
NECAP: New England Climate Action Plan

Source: The National Conference of State Legislatures; Pew Center on Global Climate Change; Congressional Research Service; Environmental Protection Agency; and listed states' web sites

International Targets

Exhibit 4.2 shows the national emissions reduction targets for several countries. Many of these targets are the product of cooperation and coordination, such as international multilateral treaties like the Kyoto Protocol. Because of this responsibility sharing, some national targets do not actually require that emissions be capped below current levels, but rather attempt to stabilize emissions at a date in the near future. A few countries (China and India, for example) have committed to reducing emissions but have yet to establish a specific target.

Exhibit 4.2

Notable International Greenhouse Gas Reduction Targets

Country	Emissions Reduction Target	Source Law	Reduction Program
Australia	8% below 1990 by 2008-2012	Kyoto Commitment	Federal cap-and-trade
Austria[1]	13% below 1990 by 2008-2012	EC Council Decision	EU ETS
Belgium[1]	7.5% below 1990 by 2008-2012	EC Council Decision	EU ETS
Canada	6% below 1990 by 2008-2012	Kyoto Commitment	Federal cap-and-trade (Proposed)
China	No specific target	Domestic National Plan	Energy Intensity, Renewable Energy, and Afforestation Targets
Denmark[1]	21% below 1990 by 2008-2012	EC Council Decision	EU ETS
European Community	8% below 1990 by 2008-2012	Kyoto Commitment	EU ETS
Finland[1]	At 1990 by 2008-2012	EC Council Decision	EU ETS
France[1]	At 1990 by 2008-2012	EC Council Decision	EU ETS
Germany[1]	21% below 1990 by 2008-2012	EC Council Decision	EU ETS
Greece[1]	25% above 1990 by 2008-2012	EC Council Decision	EU ETS
India	No specific target	Domestic National Plan	National Action Plan on Climate Change
Ireland[1]	13% above 1990 by 2008-2012	EC Council Decision	EU ETS
Italy[1]	6.5% below 1990 by 2008-2012	EC Council Decision	EU ETS
Japan	6% below 1990 by 2008-2012	Kyoto Commitment	Voluntary Targets
Luxembourg[1]	28% below 1990 by 2008-2012	EC Council Decision	EU ETS
Mexico	24% below 2007 by 2014; 50% below 2002 by 2050	Domestic National Target	National Strategy on Climate Change
Netherlands[1]	6% below 1990 by 2008-2012	EC Council Decision	EU ETS

Exhibit 4.2 (continued)

Country	Emissions Reduction Target	Source Law	Reduction Program
New Zealand	At 1990 by 2008-2012	Kyoto Commitment	NZ ETS
Portugal[1]	27% above 1990 by 2008-2012	EC Council Decision	EU ETS
Russia	At 1990 by 2012; 50% below 2008 by 2050	Kyoto Commitment; Group of Eight (G8) Commitment	Kyoto Protocol Flexible Mechanisms; Domestic Program
Spain[1]	15% above 1990 by 2008-2012	EC Council Decision	EU ETS
Sweden[1]	4% above 1990 by 2008-2012	EC Council Decision	EU ETS
United Kingdom[1]	12.5% below 1990 by 2012; 20% below 1990 by 2020; and 60% below 1990 by 2050	EC Council Decision; Domestic National Target	EU ETS / Carbon Reduction Commitments (Proposed Supplementary Cap and Trade)

[1] According to the Pew Center, the EU-15 nations have joined a "bubble" which allows the joint fulfillment of the Kyoto commitments and preserves the collective emissions reduction goal of 8% below 1990 levels by 2008-2012.

EC: European Community
EU: European Union
EU ETS: European Union's European Trading System
BC: British Columbia
NZ ETS: New Zealand's European Trading System

Source: Pew Center on Global Climate Change; International Emissions Trading Association; United Nations Framework Convention on Climate Change

Carbon Reduction Policies

Governments across the world are attempting to meet the aforementioned emissions targets through a range of policy options. The majority of these policies may be categorized as either a carbon reduction policy or an alternative energy or energy efficiency and conservation policy. What immediately follows are a few examples of direct carbon reduction policy approaches being implemented by various U.S. states as well as other countries.

Traditional Regulation

Modern climate change policy has become synonymous with the cap-and-trade system due to the pioneering efforts following the Kyoto Protocol, the successful implementation of the

European Union's European Trading System, and the proliferation of regional cap-and-trade initiatives now involving 31 U.S. states. Despite this recent trend, environmental policies have traditionally implemented what is often referred to as command-and-control regulation. This traditional regulatory approach was originally preferred because of its simple, direct, and effective method for reducing pollution. Although this form of regulation has generally fallen out of favor, there are many ancillary forms of command-and-control climate policies in use by state regulators.

Case Study: Oregon and the Power Plant Fuel Performance Standard

Oregon's House Bill 3283 of 1997 authorized the Oregon Energy Facility Siting Council to issue regulations strictly limiting the carbon dioxide (CO_2) emission potential of power generators' fuel inputs. These standards prohibit utilities from developing power plants in-state, or contracting to purchase power from out-of-state, that pollute at a rate above that of the most efficient combined-cycle gas-fired power plants available. Recently, Oregon's pacific coast neighbors, Washington and California, enacted similar standards. In addition, Oregon and Washington have complemented these utility regulations with legislation that require utilities to purchase offset credits from qualifying energy providers and other carbon mitigation projects to offset a portion of the GHG emissions of even the compliant, high-efficiency generators. Fuel performance standards and carbon offset policies are rare outside of the West Coast, although Massachusetts and New Hampshire have recently integrated similar policies into their comprehensive climate policies.

The Carbon Taxation Approach

Imposing a tax on carbon is considered to be a highly efficient policy tool by economists and many business leaders. The reason for this is simple: whereas taxation on income and capital gains taxes various public goods, taxation on GHG emissions are taxes on public "bads."

Case Study: British Columbia and Carbon Taxes

The Canadian province of British Columbia has managed to accomplish what neither the first Clinton Administration, nor any U.S. state could – enact a form of carbon tax. Beginning on July 1, 2008, the provincial government instituted a carbon tax to be levied at the wholesale level on all emissions from the combustion of fossil fuels. The tax is currently set at $5 per ton of CO_2-equivalent and will be increased by an additional $5 per year. British Columbia was able to pass carbon tax legislation in large part due to its revenue-neutral structure. The revenue collected from the carbon taxes pay for tax cuts on personal and business income, thereby shifting taxes from public goods onto harmful activities.

Internationally, various forms of carbon taxation have been implemented in several Scandinavian countries, while in the United States the only such policy exists at the local level in Boulder, Colorado. The City of Boulder enacted a carbon tax in 2006 that is levied as a small charge on the electric bills of ratepayers. The city set the level of the carbon tax based on its budgetary needs, rather than attempting to determine a level necessary to affect electricity consumption habits or to offset a certain portion of city carbon emissions. Other carbon tax policies may be structured to achieve any number of other goals and imposed on any combination of GHG emissions and emitting sectors.

The Cap-and-trade Approach

The cap-and-trade approach is a hybrid policy that shares characteristics with both traditional, command-and-control environmental regulation, and the market-oriented emphasis of a carbon tax. Indeed, the name itself reveals this mix. The cap is set by environmental regulators at a level sufficient to protect the climate, while trading rules are devised so as to allow the regulated community to comply with the cap at the lowest cost possible. While some firms may be able to reduce their emissions to comply with the cap, others may find it more cost effective to purchase emission credits (or allowances) to comply. Market participants set the rate for these credits depending on how many firms can reduce their emissions enough to supply credits, and how many firms are demanding them.

In only a few years, cap-and-trade has become the dominant model of climate policy in the United States, largely due to the development of the three regional climate change institutions. As of November 2005, only a few states had committed to reducing statewide GHG emissions, and no state had enacted a statewide GHG cap-and-trade system. However, in December 2005, 7 states announced participation in RGGI; 5 more states joined together to form the WCI in February 2007; and in November 2007, an additional 6 states formed the MRGGRA. By the summer of 2008, a total of 31 states had joined one of these three regional climate agreements as participants or observers in a cap-and-trade system, and 3 other states – Florida, Hawaii, and Virginia – were considering the establishment of their own statewide systems.

Case Study: A Comparison of the Three Regional Climate Initiatives

	RGGI	**WCI**	**MRGGRA**
Date Established	December, 2005	February, 2007	November, 2007
Trading Begins	January 1, 2009	2012	May 15, 2010
Covered Sectors	Specified power plants above threshold size	Utilities Industrial Commercial Transportation	To be determined "multi-sector"
Covered Emissions	Carbon dioxide	Six greenhouse gases	To be determined "greenhouse gases"
Share of Total U.S. GHG Emissions	10%	13%	14%

Alternative Energy, Energy Efficiency, and Energy Conservation Policies

Long before states began to develop GHG emissions reduction targets, they had enacted various energy policies to encourage alternative energy, energy efficiency, and energy conservation.

Alternative Energy Policies

Renewable Portfolio Standard

Perhaps the most high-profile alternative energy strategy is the renewable portfolio standard (RPS). An RPS requires state utilities to ensure that a specified portion of their electric load generation is derived from renewable energy sources. Several studies have shown how important an RPS is for the development of renewable energy. States with an RPS in place have essentially established a guaranteed market for the alternative energy industries. It is no surprise then that the vast majority of private sector renewable energy capital investment has flowed to the 27 states (including Maryland) and the District of Columbia that have enacted an RPS policy.

Each RPS can be constructed quite differently with varying target levels required to be met over various periods of time. Some state standards reward certain forms of renewable energy more than others, and some standards encompass as many forms of energy as possible to encourage the development of new industries. Many of the more recently enacted RPS laws express climate change mitigation as a specified purpose of the policy and have integrated it with the state's overall climate action plan. For example, policymakers may allow renewable energy credits granted to generators of renewable energy under the RPS to sell these credits within a cap-and-trade market.

Utility Interconnection Standards

Although the RPS may be considered the centerpiece of alternative energy policy, there are several other complementary strategies that may be used to encourage a shift to other, cleaner forms of energy. One such policy is a utility interconnection standard, of which net metering is a well known form. Interconnection standards establish clear rules allowing certain forms of distributed generators, such as residential solar panels or small commercial combined heat and power gas generators, to connect to the grid and sell their electricity. These rules encourage the proliferation of alternative energy technologies by reducing the regulatory obstacles and time delays that would otherwise exist. Net metering is a specific and increasingly common interconnection rule that allows entities who generate their own electricity to essentially "roll back" their electricity meters, reducing their bills, and perhaps even earning a profit if they produce more electricity than they consume. Forty-four states, including Maryland, have developed net metering rules, making it one of the most common climate or clean energy policies.

Subsidies

States may also encourage the development and use of renewable energy through various subsidies. One such example is a public benefit fund. These are accounts supported by revenues from small surcharges imposed on electricity ratepayers with proceeds used to subsidize renewable generators. Twenty-four states currently administer public benefit funds, 18 of which are members of the Clean Energy States Alliance, a national organization dedicated to furthering optimal public benefit fund policies. Another common alternative energy subsidy is a green pricing program. This is a program that requires state utilities to offer their customers the option of paying a premium on their electric bills for renewable energy. Only 6 states have such a policy in place, largely because in 38 other states utilities voluntarily offer a green pricing option to their customers.

Case Study: Minnesota and Alternative Energy Policy

With the enactment of the Minnesota Next Generation Energy Initiative in 2007, the state became one of the national leaders in comprehensive alternative energy policy. This law gave Minnesota one of the most ambitious renewable portfolio standards, requiring 25% of its energy to come from renewable sources by 2025 (including 30% for the state's largest utility). Minnesota had already been recognized as a leader in the development of net metering, enacting the first such program in 1981. The state is also one of only six to mandate that all state electric utilities offer their ratepayers the choice of renewable energy. In 2003, the

> Minnesota legislature created a state renewable energy public benefit fund, and the following year the Public Utility Commission established interconnection standards for distributed generation facilities. With all of these policies in place, it is not surprising that in 2007, Minnesota became the third fastest growing market for renewable energy in the United States, with 5.74% of electricity generation coming from non-hydropower renewable energy.

Advanced Technologies

Policies that promote technological advancement in nuclear- and fossil fuel-based generation are also important in developing an alternative energy system. Nuclear power generation yields no GHG emissions, clean coal technology dramatically reduces GHG emissions from the extraction and generation of coal, and natural gas can be combusted with tremendous efficiency in combined heat and power processes. The promotion of these types of advanced technologies is especially important in certain states where one of these traditional fuels provides a dominant source of electricity generation, or where extraction or refining is a vital part of the economy.

Case Study: Illinois, Indiana, and Ohio – Cleaner Fossil Fuel Policies

> Tied together by the waters of the Ohio River, Illinois, Indiana, and Ohio also share a similar approach to alternative energy policy. These are the only three states that emphasize both clean coal climate policy and output-based energy policy. The coal industry is important to each state's economy and labor market. This is why each state has found it prudent to encourage their coal industries to adapt to a carbon constrained future early, promoting clean coal technologies. In addition, these states implement output-based regulations for fossil fuel users. An output-based policy is one that focuses on how much pollution is produced per unit of power, or in other words, the generator's overall efficiency. By tailoring regulations based on the output efficiency, rather than composition of fuel inputs, policymakers create incentives for fossil fuel generators to become more efficient and for utilities to upgrade to newer and more efficient boilers and turbines.

Energy Conservation and Efficiency Policies

There are essentially four major energy conservation and efficiency policies: (1) electric utility measures, including energy efficiency portfolio standards; (2) the energy efficiency public benefit fund; (3) residential and commercial building codes; and (4) appliance efficiency standards. As of August 2008, all but four states have enacted at least one of these measures.

Energy Efficiency Portfolio Standard

The energy efficiency portfolio standard is implemented to encourage a reduction in energy generation. This is no small task because it requires utilities to behave contrary to their centuries-old business model and traditional regulatory mandate. Whereas traditional utility regulation generally increases costs for the regulated utility, an energy efficiency portfolio standard actually transforms utilities' entire business model. Whether deregulated or not, utilities are paid to generate more electricity, not less; there is no incentive for a utility to expend capital on improvements that will lead to decreased future revenues. An energy efficiency portfolio standard and other similar policies are designed, in part, to decouple the amount of electricity generated or delivered from the profits of the utility. Twenty-one states, including Maryland, currently implement an energy efficiency portfolio standard.

Case Study: Utility Decoupling Policies

One fundamental challenge in creating effective regulatory policy is attempting to align the interests of private market actors with that of the public generally. California and Connecticut have been pioneers in the creation of two market-based energy efficiency policies. As far back as 1982, California's Public Utility Commission has overseen the implementation of a utility decoupling policy. The policy allows utilities to recover some or all of the avoided costs of added generation capacity. Since then, several other states, including Maryland, have established some form of a decoupling policy. Connecticut has become a leader in what is perhaps the next generation of market-based efficiency incentives, called "white certificates." Similar to a renewable energy credit granted to a renewable generator as part of an RPS, a white certificate is granted to a utility or other entity based on the amount of energy saved or reduced by one of its projects. A state can either allow for a portion of RPS compliance to come from the generation of white certificates or mandate that a certain percentage of utility expenditures be derived from the purchase of those certificates. These policies enable states to meet energy efficiency goals with all of the economic and environmental benefits that come with it, while compensating utilities and other firms for their investments.

Energy Efficiency Public Benefit Fund

A closely linked energy efficiency policy is the energy efficiency public benefit fund. Like the renewable energy public benefit fund, this simple policy requires the addition of a small surcharge on ratepayers to fund efficiency initiatives for the state. This policy provides an important synergy with the energy efficiency portfolio standard because states may use this fund to compensate utilities and their shareholders for lost revenues. Twenty-one states currently administer an energy efficiency public benefit fund.

Residential and Commercial Building Codes

Building codes are another important policy because they lock in future energy savings for the decades- or centuries-long lifespan of homes or buildings. When a state enacts a building code law, it typically adopts the standards developed by national or international institutions like the International Codes Council. The 1998 version of the International Energy Conservation Code's residential building code is compliant with the federal Energy Conservation and Production Act (ECPA), and has been adopted in 36 states, including Maryland. The 1999 version of the American Society of Heating, Refrigerating and Air-Conditioning Engineers, a commercial building code, is compliant with ECPA and has also been adopted in 36 states, including Maryland. These codes generally regulate the leakage of heat through windows and wall materials, as well as the energy efficiency of heating and cooling equipment. Although these codes may seem mundane, they are vitally important as a significant portion of all GHG emissions in the United States is attributable to energy consumed by, or within, buildings.

Appliance Efficiency Standards

The fourth major category of energy efficiency policy is the appliance efficiency standard. Appliance efficiency standards have figured prominently in federal energy policy since the 1980s. According to the U.S. Department of Energy (DOE) and the American Council for an Energy Efficient Economy (ACEEE), the cumulative effect of successive energy bills and executive branch energy efficiency policies over the past quarter century have led to an estimated 2.5% reduction in national electricity use. By covering additional appliances or enhancing existing standards under new policies, an additional 5% of electricity consumption could be saved. And with a benefit-cost ratio of 5:1, it should not be surprising that 14 states, including Maryland, have sought federal waivers to enact appliance efficiency standards that go beyond the federal standards. According to DOE and ACEEE, existing appliance standards have saved an estimated $50 billion between 1990 and 2000, and the next generation of appliance efficiency standards could be worth more than $80 billion more in savings for ratepayers.

Conclusion

In the absence of federally mandated reductions in GHG emissions, 20 states have proceeded to establish their own reduction targets, as have many countries around the world. These states, as well as several others, such as Maryland, that do not have specific reduction goals, have taken numerous efforts to address climate change through a patchwork of policies relating to carbon reduction, alternative energy, and energy conservation and efficiency.

Chapter 5. Economic Impacts of Reducing Greenhouse Gas Emissions: A Review of the Literature

Introduction

This chapter presents a summary of findings from a survey of literature on climate change policies and their economic impacts. The survey covered a wide variety of sources from academia, international institutions, business consultancies, and government scientists and economists. Given the degree of uncertainty involved in understanding climate change, it should not be a surprise that there is significant disagreement in the results and conclusions of many of these studies.

Excessive Greenhouse Gas (GHG) Emissions – Market Barriers and Failures

It is widely recognized that existing technologies can substantially improve the economy's energy efficiency and, in doing so, reduce emissions. There is disagreement, however, on the cost of more widespread adoption of these technologies. One school of thought, the "technologists," assert that numerous market barriers impede widespread adoption of these technologies and that government initiatives can overcome these barriers and reduce emissions while realizing substantial cost savings through resulting reductions in energy expenditures. On the other hand, most economists maintain that energy efficiency improvements that yield true cost savings largely will be adopted without the need for government intervention. In other words, if opportunities truly exist to reduce costs while reducing emissions, why would potential beneficiaries of these opportunities not undertake them voluntarily? Generally, economists believe that technologies are not adopted either because barriers that prevent broader adoption reflect real economic costs associated with their adoption or as a result of a true market failure. In the case of a true market failure, government initiatives can potentially correct the failure and improve energy efficiency while yielding economic gains.

Although researchers have reached consensus in identifying a few examples where a true market failure impedes energy efficiency (a commonly cited example is a landlord's lack of incentive in purchasing more energy efficient appliances that would lower tenants' energy bills), researchers disagree over the extent of such opportunities throughout the economy. In addition, while government can implement policies that correct the market failure, the costs of such policies might exceed the resulting savings.

Alternative Approaches to Address Market Failure

There is widespread agreement that the core market failure leading to excessive GHG emissions is the failure of emitters to internalize the social cost of their emissions, and, thereby, the social benefit of emission reductions. Disagreement exists, however, over the policy approach to be implemented in order to correct the market failure and reduce emissions. The first approach is for policymakers to identify and mandate which technologies or standards should be adopted. This approach is commonly referred to as a "command-and-control" policy. The second approach is to impose a cost on emitters proportional to the amount of damage that is done to the environment from the activity, forcing the producers to internalize the social costs associated with the activity. This approach includes levying a carbon tax or implementing a cap-and-trade policy such as the Regional Greenhouse Gas Initiative (RGGI). Imposing such a cost is economically efficient in that it leads to an allocation of resources in which each resource is employed where it has the highest economic value.

Command-and-control policies that impose standards or policies initially seem appealing because they do not appear to impose a direct cost to consumers. However, decades of environmental research suggest that an incentive-based approach for mitigating pollutants is substantially more economically efficient (and less costly) than command-and-control policies. Command-and-control approaches rely on policymakers to determine where or how emissions should be cut while incentive-based policies use the power of markets to identify the least expensive sources of emissions reductions.

In addition to cost advantages, incentive-based approaches offer the additional benefit of reduced uncertainty relative to command-and-control approaches. Depending on the choice of incentive-based approaches, policymakers can be certain of either the total amount of emissions reduced or the total cost to the economy. But, under a command-and-control policy, there is no certainty about the cost of the proposal. In addition, in some cases, there is also no certainty about the level of emissions reductions. Finally, incentive-based approaches provide another advantage by allowing the government to raise revenue through a tax or the sale of emissions allowances and use that revenue to help offset the adverse effects of GHG mitigation policies on the economy and on households.

More generally, many commentators note that environmental regulation is too costly and that it "hurts the economy." If a product or service is taxed efficiently, where the marginal environmental benefit equals the marginal cost of the activity, although the *observed* cost of the product or service increases, there is no *net* increase in costs, but merely a *transfer* of costs. For example, a tax on motor gasoline that internalizes the damages caused by driving would increase the observed cost of driving but would reduce costs caused by driving (medical bills incurred as a result of asthma resulting from vehicle pollutants and damage to the environment).

The following is a more detailed description of two of the more common incentive-based approaches used to address the market failure responsible for excessive GHG emissions: the cap-and-trade approach and the carbon taxation approach.

The Cap-and-trade Approach

Today, the near universal policy approach to climate change mitigation is cap-and-trade policy. Maryland is now a part of RGGI, which initiated its first auction of carbon dioxide (CO_2) allowances in September 2008. The European Union (EU) has been operating its European Trading System (ETS) since 2005, while Canada, the United Kingdom, Australia, New Zealand, Taiwan, and the Western and Midwestern regions of the United States are all in various stages of planning or implementing their own cap-and-trade systems. Many business leaders anticipate that the United States will soon implement its own federal cap-and-trade program, and some financial institutions have estimated that because of cap-and-trade systems, the global carbon (CO_2) market will become the world's largest commodity market.

Many studies have analyzed existing cap-and-trade programs in order to provide policymakers with valuable lessons on how to design new cap-and-trade programs to be as flexible and economically efficient as possible. When designing a cap-and-trade program, policymakers are faced with significant decisions that will impact the integrity of the cap, the cost-effectiveness of emission reductions, and the impact on businesses and households. These policy decisions generally involve the following criteria:

- **Ease of Implementation:** Would the policy be easy to carry out and enforce?
- **Carbon-target Effectiveness:** Would the policy achieve the target level of emissions?
- **Incremental-cost Certainty:** Would the policy establish an upper limit on economic costs and minimize price volatility?
- **Cost-effectiveness:** Would the policy achieve GHG reductions at the lowest possible cost?
- **Distributional Effects:** How are costs and benefits to be distributed among U.S. households of different income levels and among U.S. producers?

The literature analyzing cap-and-trade design indicates that the most controversial feature usually involves the various approaches to allocating emissions allowances. There are two primary allocation considerations. First, how should initial allowances be distributed during each trading period, and second, who should be allocated allowances and on what basis? When Congress debated the merits of a nationwide GHG cap-and-trade system in June 2008, allocation was a highly contested issue. In that debate, consideration of equity appeared to trump that of economic efficiency.

Distributional and Efficiency Considerations

The right to emit GHGs has substantial value under a cap-and-trade program. How these emission rights are allocated has a significant impact on government budgets, economic impacts, and how gains and losses are distributed among firms and households. The Congressional Budget Office (CBO) recently estimated that emission rights under various congressional proposals would be worth $50 billion to $300 billion by 2020 (in 2006 dollars). In its estimate of S. 3036 (the Lieberman-Warner bill), a proposal that was debated by the U.S. Senate in June, CBO estimated that emissions rights would be worth $112 billion by 2012 and would continue to increase in value.

The ultimate effect that a cap-and-trade program has on the economy is the result of both market forces as increased costs impact the economy, and government allocation of resources as determined by specific cap-and-trade rules. The introduction of a price on GHG emissions interacts with all parts of the economy by shifting costs through various markets. Obtaining allowances or cutting emissions becomes an additional cost of doing business. Much like a tax imposed on businesses, a substantial portion of this cost is passed along to consumers and other firms via higher prices. This increased cost is essential to incentivizing emission reductions, but it also reduces demand. This disproportionately affects energy and energy-intensive industries. Returns on investment are reduced, which increases pressure on firms to reduce employment and wages. Although investor losses are typically dispersed, employment impacts are concentrated among certain industries.

The allocation of resources through the functioning of a cap-and-trade program's specific rules and structure can offset or exacerbate these market-based impacts. The magnitude of economic costs is increased or decreased depending on the extent to which economic efficiency is incorporated into the program's design. Particularly, the economic costs associated with cap-and-trade could be lessened if the revenue generated from the sale of allowances is used to lower tax rates or prevent future tax increases.

Any system that imposes a price on carbon is naturally regressive because energy prices and prices for energy-intensive goods and services impose a larger burden, relative to income, on lower-income households than on higher-income households. CBO estimated that price increases resulting from a 15.0% cut in emissions would cost a household in the poorest one-fifth of all households $680, or 3.3% of income, compared with $2,180, or 1.7%, for the wealthiest fifth. However, the CBO analysis also illustrates that selling allowances, and the subsequent decision on how revenue is used, allows a cap-and-trade program to be structured as either progressive or regressive depending on how revenue proceeds are used. Three policy options were analyzed: sell allowances and use the revenue generated to pay a lump-sum to every U.S. household ("cap-and-dividend"); use the revenue generated from the sale of allowances instead to cut corporate income taxes; and allocate allowances freely to energy-intensive sectors.

Exhibit 5.1 illustrates the distributional impact and the efficiency cost (cost of the program measured as a percentage of gross domestic product) of the three options studied by CBO. Selling allowances and transferring revenue has a larger impact on lower-income households than allocating allowances freely. Providing transitional assistance by allocating allowances freely or transferring some of the auction-based revenue to impacted sectors would impose greater costs to the economy and to lower-income households than using revenues to provide equal rebates to all households. Economic costs would be reduced by more than one-half if revenues are used to reduce corporate income taxes, but would have the greatest impact on the lowest-income households.

A recent analysis conducted by Resources for the Future (RFF) examined the effects of 10 different cap-and-trade programs by income level. Like the CBO study, RFF found that differences in cap-and-trade rules lead to substantial variability in economic efficiency and distributional effects. As shown in **Exhibit 5.2**, seven of the policies analyzed were found to be progressive, and three regressive.

Cap-and-trade rules also impact the natural tradeoff between equity and efficiency that is caused by imposing a price on carbon. For example, using revenues from the sale of allowances to reduce the distortionary effect of existing taxes increases economic efficiency but, depending on the nature of the tax, may also disproportionately burden or relieve persons of differing income levels. In an analysis of this equity-efficiency tradeoff by RFF, it was noted that there were only two policies that did not involve some degree of tradeoff. The study found that a policy involving free allocation of allowances through a system of grandfathering was both regressive and low-efficiency, while a policy that sold allowances and reinvested the revenues in energy efficiency was both progressive and more efficient (the study also noted, however, that implementation of a cost-effective energy efficiency program is particularly difficult).

Exhibit 5.1
Effect (% Change) on Average After-tax Household Income, by Income Group, of a 15% Cut in CO_2 Emissions, with Allowance Values Used in Various Ways

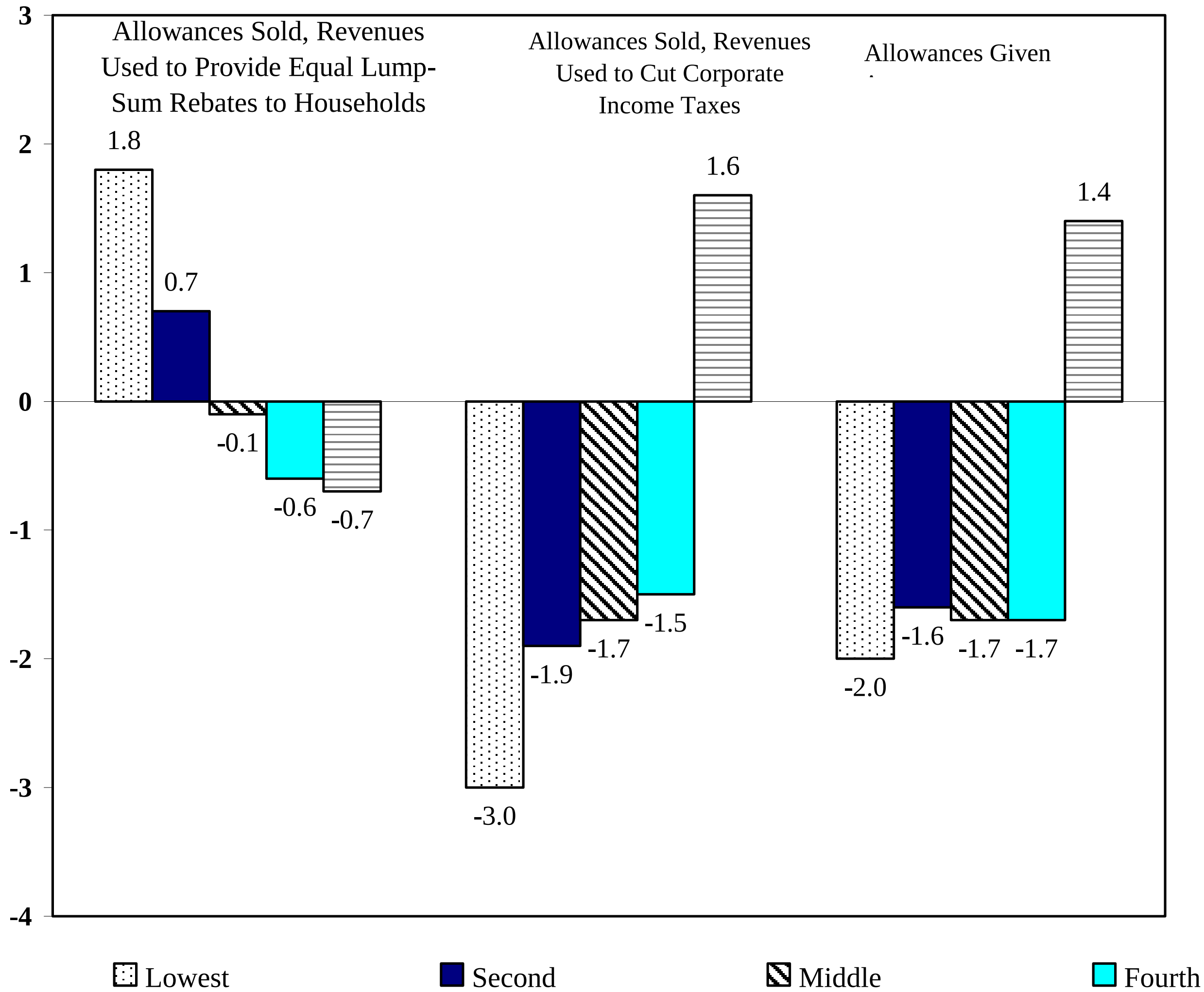
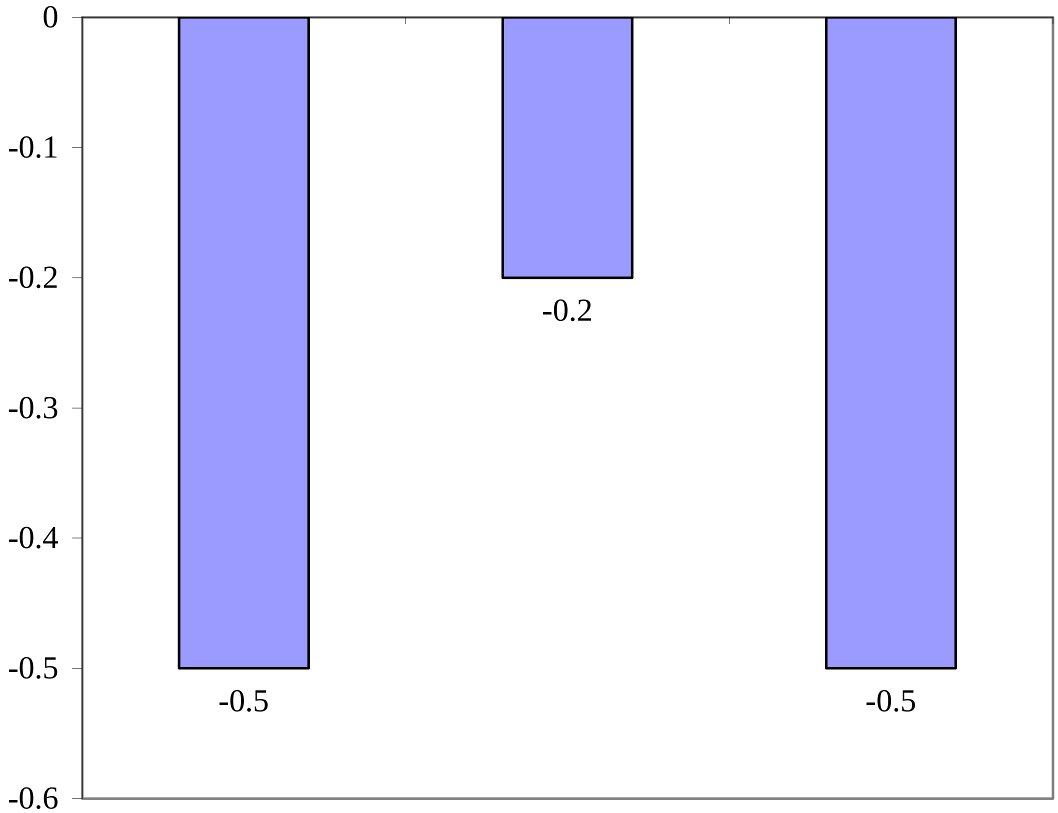


Exhibit 5.1 (continued)

Efficiency Cost (% Change) of Each Policy as a Percentage of GDP



CO_2: carbon dioxide
GDP: Gross Domestic Product

Source: Congressional Budget Office

Exhibit 5.2
Distributional Effects of 10 Cap-and-trade Policies

Progressive	Regressive
Expand the Earned Income Credit	Reduce Payroll Taxes (Social Security, Medicare)
Energy Efficiency Investments	Free Allocation to Emitters
Cap-and-dividend (taxable)	Reduce Income Taxes
Exclude Home Heating from Cap-and-trade	
Free Allocation of Allowances to Electricity Consumers	
Exclude Transportation Sector from Cap-and-trade	
Cap-and-dividend (non-taxable)	

Note: In column 1, the most progressive policies are listed first; in column 2, the least regressive policies are shown first.

Source: Resources for the Future

Transitional Assistance to Energy Industries

Several bills recently introduced in Congress contained provisions that would have set aside a modest percentage of allowances to provide transitional assistance to energy-intensive industries. Designing a cap-and-trade program with transitional assistance should ideally provide additional benefits only to sectors that are disproportionately affected, and only in an amount that would not produce windfall profits for those sectors. Because transitional assistance decreases economic efficiency and increases the burden on low-income households, such a policy should be carefully crafted to provide only the level of relief necessary. It should also be noted that because the additional profits from the value of allowances provided would not depend on how much a company produced, such profits would be unlikely to prevent declines in production and potential job losses that price increases (and a drop in demand) could engender.

In both the EU cap-and-trade system and the U.S. acid rain cap-and-trade program, allowances were allocated freely. Several studies have estimated that a free allocation approach could cost two to three times that of an auctioning approach in the long-run. These analyses may have influenced the design of more recent cap-and-trade programs relating to the sale of allowances at auction. For example, the Model RGGI Rule allows for some discretion by states in their allocation method, and at least four states – New York, Vermont, Maine, and Massachusetts – have decided to auction 100% of their allowances.

Program Design Flexibility

An optimal cap-and-trade program provides firms with the flexibility to make greater reductions when the costs of doing so are low. Economic activity, energy markets, and weather all influence the cost of reductions in any given year. Providing flexibility from year to year also reduces volatility in the price of allowances. Given the importance of fossil fuels in the economy, it is important to provide price stability in order to stabilize energy prices, markets, and inflation as well as to provide certainty for investment planning.

Researchers have identified several cap-and-trade features that provide flexibility to lower costs and reduce volatility. These include provisions addressing the following:

- **Price Ceiling and Price Floor:** The establishment of a price ceiling provides a safety valve that prevents the cost of emission reductions from exceeding either the point of maximum environmental benefit or a level specified by legislators. A price floor prevents prices from falling below a point expected to achieve certain benefits.

- **Borrowing and Banking:** Both of these features would allow firms to shift reductions away from higher-cost years. Companies could either borrow allowances from future years or bank allowances resulting from additional reductions made in lower-cost years.

- **Offsets:** Additional flexibility can be provided by allowing firms to obtain offset credits for certain types of projects. Offset credits represent emissions reduced or prevented by an alternative project such as one that caps the methane releases of a landfill.

Lessons Learned from Existing Clean Air Act Cap-and-trade Programs

Cap-and-trade has been integral to the implementation of certain Clean Air Act programs since 1990. Significant research has been undertaken to understand the effectiveness of programs such as the acid rain sulfur dioxide (SO_2) reduction program. This program impacts approximately 3,500 electric generating units and is estimated to cost about $3 billion annually (in 2000 dollars), primarily for pollution abatement technologies and switching to lower sulfur fuels. Most experts agree that the cap has been effective; SO_2 emissions in 2005 were about 41% lower than 1980 levels. Just as important, researchers that have studied the effectiveness of this and other existing programs generally agree that cap-and-trade programs:

- have generated sizable cost savings over non-market approaches;

- have induced technological improvement within regulated industries;

- may be improved upon to achieve greater efficiency in the emissions trading markets, and overall economic cost savings;

- have achieved greater levels of economic efficiency when allowance banking is permitted;
- would likely achieve much greater efficiencies if allowances are not allocated freely; and
- have very complex interactions with fiscal policy and the overall economy, and, therefore, require researchers to fully account for all costs.

The Carbon Taxation Approach

Taxes are considered by economists to be a natural, if unavoidable, barrier to economic efficiency. A tax on carbon has the exact opposite effect by actually enhancing efficiency. As noted by economist William Nordhaus of Yale University, taxes on pollution serve to remove the subsidy inherent in harmful or wasteful activities; it forces responsible parties to internalize their economic externalities (here, emissions). However, it is important to note that the essential feature of a carbon tax is merely the price it places on carbon emissions, something also accomplished by a cap-and-trade system. Thus, when evaluating cap-and-trade versus a carbon tax, other considerations such as flexibility and ease of implementation become important.

A carbon tax is generally considered to be more attuned to economic efficiency than a cap-and-trade system. Whereas cap-and-trade allows the government to set a desired cap on pollution, a carbon tax allows government to set a cap on costs. Under a carbon tax, the government establishes the tax rate and polluting entities adjust their behavior accordingly. However, in practice, cap-and-trade systems are being developed with a number of flexible mechanisms (as discussed earlier) such as offset credits, the banking and borrowing of tradable allowances, price ceilings, and market oversight committees, all of which allow policymakers to build economic efficiency into the system. The incorporation of a price ceiling or "safety valve" price alone can negate much of the price certainty advantage of a carbon tax, albeit at the cost of reducing innovation with artificially low carbon prices.

The other theoretical advantage a tax has is its ease of implementation. There are two essential obstacles to the implementation of cap-and-trade regulation. The first is that posed by the influence of industry and other interest groups. This could mean either attempting to block the passage of the law or affecting the rules of the system or the allocation of allowances for a particular industry. While a carbon tax would also face opposition, a tax is much less complex in its rules and structure, thereby presenting fewer opportunities for opposition. The second major obstacle to implementation of cap-and-trade is administrative burden. A complex regulatory scheme could require substantial government resources to administer. Because the federal government and all 50 states have a great depth of experience with the administration and collection of taxes, fewer resources would be required to implement a carbon tax.

In sum, while many experts claim that a carbon tax is theoretically superior to a cap-and-trade system, others note that a cap-and-trade system can be constructed so as to be nearly equal in economic efficiency. Many also note that even if a carbon tax is theoretically much simpler to implement and less susceptible to influence from special interests, cap-and-trade programs have the practical advantages of experience and policy momentum. In any event, the choice between the two systems is not nearly as significant as the enactment of either policy, because both approaches accomplish the essential goal of establishing a carbon price.

Economic Analyses Relating to Climate Change Mitigation Policies

Climate change skepticism has given way to a new source of opposition founded on the idea that the cost of any climate change policy enacted today will actually outweigh the cost of long-term climate induced damage. A great number of economic analyses have been undertaken to attempt to bring clarity to the public and to policymakers on the costs and benefits of climate change policies. This section discusses the role of traditional cost-benefit analysis and alternative forms of economic analysis relating to climate change mitigation policy.

Traditional Cost-benefit Analyses

In October 2006, British economist Sir Nicholas Stern released what has perhaps become the most high-profile cost-benefit analysis of climate change. The study, now commonly referred to as the Stern report, concluded that the long-term benefit of addressing climate change through mitigation and adaptation polices enacted today would far outweigh costs. This provoked a series of competing analyses that either addressed the inadequacies of the Stern report or promoted conflicting assumptions and methodologies. Although there were many technical points of contention in the various analyses, the most prominent disagreement was in the discount rate used in the projection of future costs. Even the slightest variation in a discount rate can yield dramatically different results in an analysis that spans many decades and trillions of dollars in global economic output.

The most well-known response to the Stern report came from American economist William Nordhaus of Yale University. The Nordhaus study concluded that GHG reduction policies should be enacted, but that the appropriate carbon price should be no more than $7.40 per ton of CO_2. This represents the price that would bring about the optimum level of reductions. In this optimal scenario, the world could avoid an estimated $5 trillion in climate damages at a cost of $2 trillion in lower global economic output, thus creating a net present value of $3 trillion. According to Nordhaus' calculations, there would be an additional $17 trillion of climate related damage that should be left unaddressed. The implication is that any dollar expended above $3 trillion would yield less than $1 in avoided cost and would, thereby, be sub-optimal. In this scenario, carbon prices would follow a defined "policy ramp" reaching $90 per ton in 2050 and $200 per ton by 2100. Nordhaus advocated limiting investment in climate policies today and deferring more extensive actions for future generations that would presumably be wealthier and more able to confront climate change than the current population.

In general terms, the multitude of traditional cost-benefit analyses of climate change policy suffers from a fundamental problem related to long-term forecasting. As **Exhibit 5.3** demonstrates, there is somewhat of an inverse relationship between time and precision in forecasting for economics and climatology. Although this is a fairly crude generalization, it reveals an inherent challenge for policymakers.

This challenge, combined with the vigorous academic debate surrounding the Stern report, means it is unlikely in the short-term that there will be any generally agreed-upon way to measure the cost of a climate policy (cost) versus the avoided cost of future climate damages (benefit). In the absence of an agreed-upon model for traditional cost-benefit analysis, there are a few alternative methods to aid policymakers in understanding the costs and benefits of various climate policies. These are discussed later in this chapter.

Exhibit 5.3
Relationship between Precision and Time in Climate Forecasting

	Short-term	**Long-term**
Climatologic Forecasting	Uncertainty in rates of change, feedback loops, "tipping" points for catastrophic change, and small-scale climatic change.	Greater understanding of basic cause-and-effect phenomena, confirmation of the basic principles of climate change on a global and geophysical scale.
Economic Forecasting	Institutional competence and experience with short-run forecasting and modeling, advanced understanding of microeconomic phenomena.	Uncertainty in rate of technological change, major discrepancies using differing discount rates, and tremendous complexity in external factors.

Source: Department of Legislative Services

The McKinsey & Company Study

The McKinsey study involved the consultation of over 100 recognized experts in various fields to determine the feasibility of commercializing 250 emerging technologies. The study looked at GHG abatement potential, incremental costs associated with commercialization, barriers to market penetration, and amenability to policy incentives, among other considerations. These data provided McKinsey with a range of estimates for both cost and abatement potential. Each point was plotted on a graph and three curves emerged representing the cost (dollars) and benefit (tons of GHG reduced) based on low, mid, and high levels of national commitment. The middle curve is depicted in **Exhibit 5.4**.

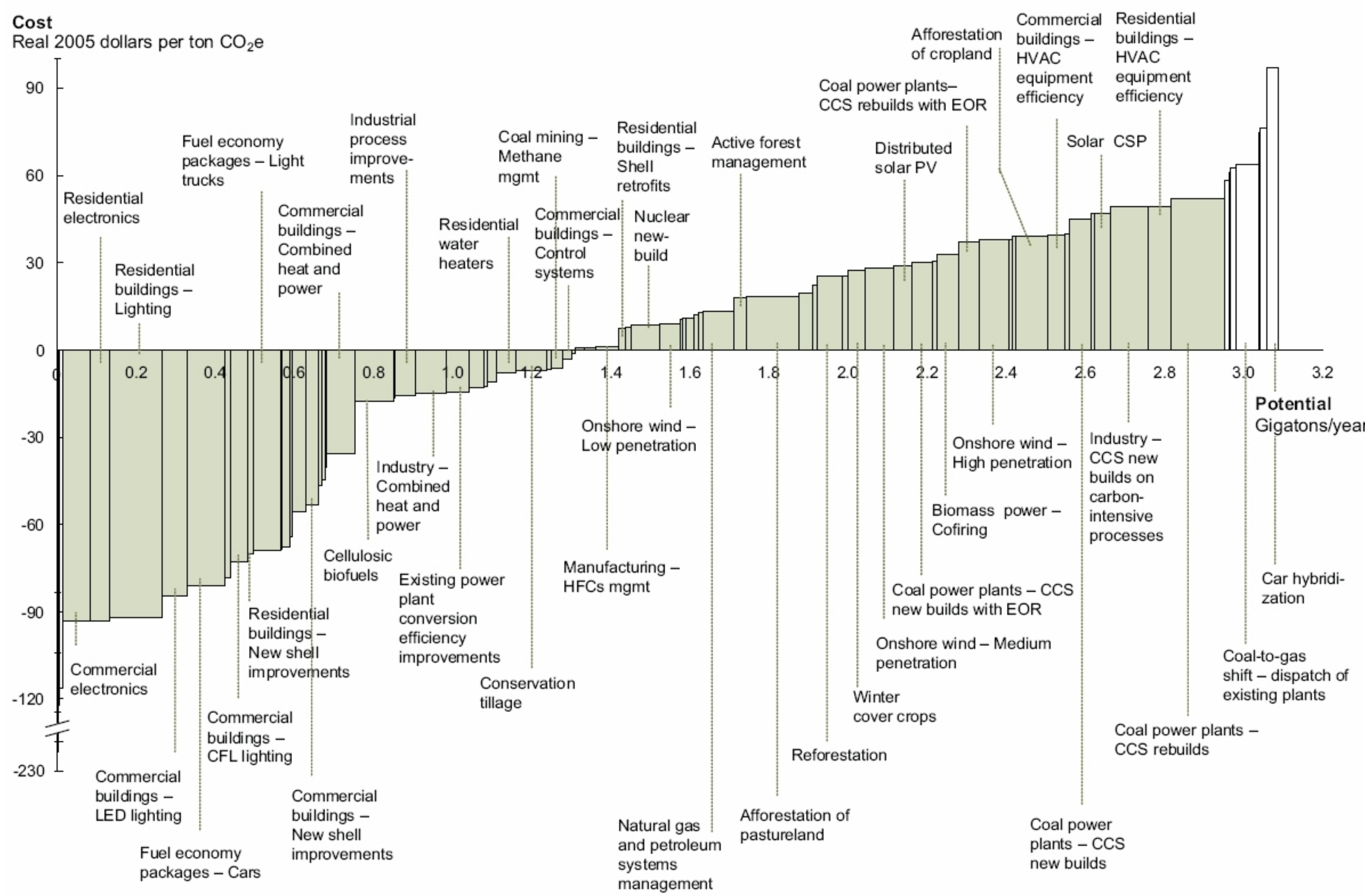
The McKinsey study notes that only the abatement curve representing a high level of national commitment conforms to GHG reductions envisioned by the majority of climate change legislation considered in the 110th Congress. The study concludes that the United States could meet most proposed reduction targets at a cost of under $50 per ton of CO_2 equivalent. Carbon capture and sequestration (CCS) technology would likely be responsible for the greatest GHG reduction of the 250 technologies considered. The study also revealed that 40% of all technological opportunities could be harnessed at a net negative cost, or savings, to the American economy. In essence, what makes the McKinsey study such a useful policy tool is that it gives meaning to the goal of establishing a carbon price through either a carbon tax or cap-and-trade program. As carbon prices rise, more technological solutions become economically viable.

Princeton University Wedges Model

The Princeton University study was authored by two professors and first published in the journal *Science*. The basis of the study was a graph plotting GHG emissions over time under a business as usual scenario and a stabilization scenario in which emissions cease to grow. The difference between these two scenarios is depicted on the graph as a triangle. That triangle represents the reduction in GHG emissions necessary to stabilize atmospheric GHG emissions at 2006 levels. Breaking that triangle into seven evenly sized "wedges," the two professors then considered which currently existing or emerging technologies have the potential to bring about GHG reductions roughly the size of each wedge. The professors found at least 15 technologies or other societal changes great enough to reduce current emissions by 25 billion tons, the size of one wedge, at a reasonable cost.

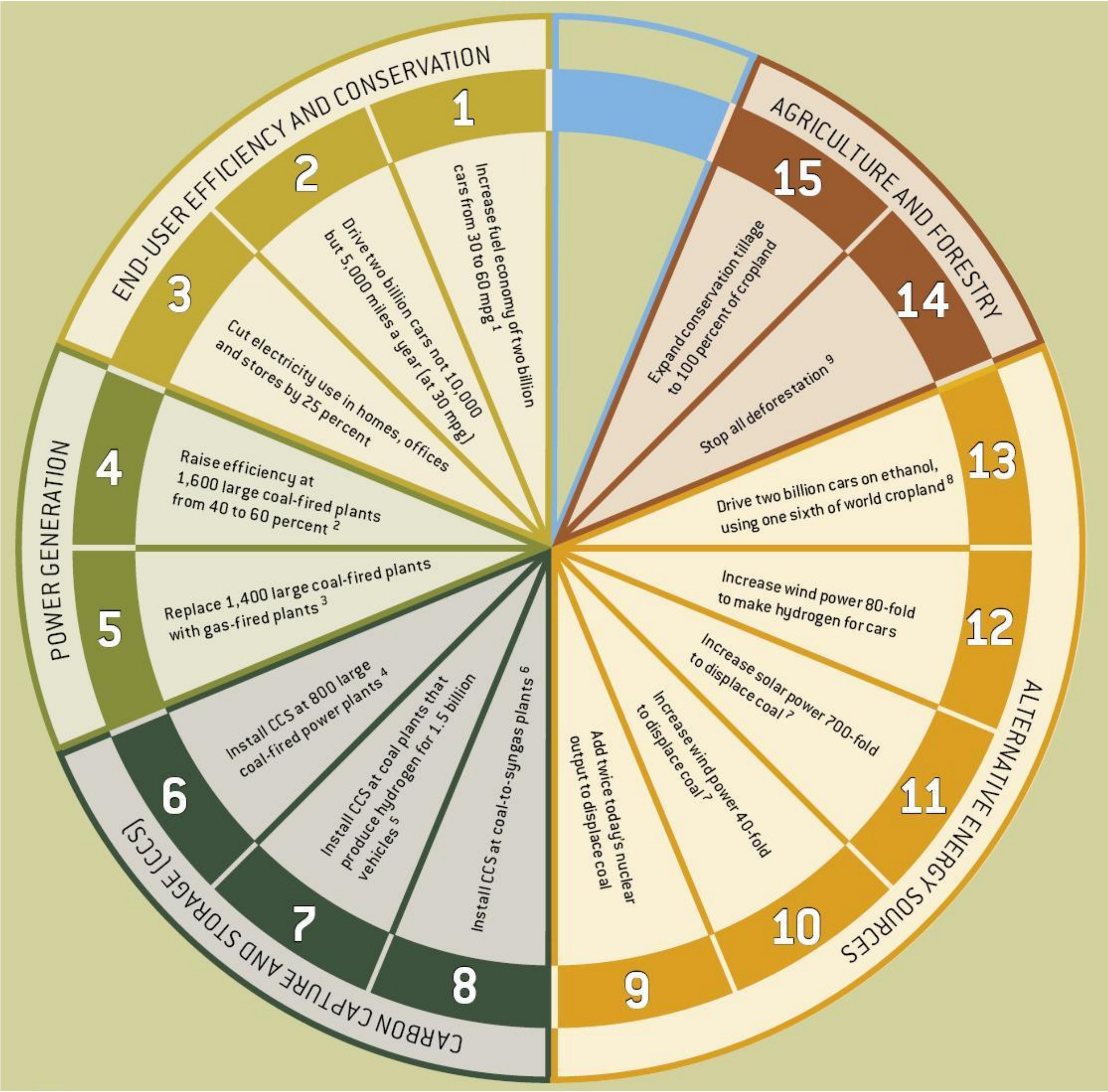
According to the study, policymakers can stabilize GHG emissions at today's levels by adopting any 7 of the 15 wedges shown in **Exhibit 5.5**. The wedges model has become so successful as a graphical climate policy tool that investment bank Goldman Sachs, in conjunction with the World Resources Institute, has worked to implement the wedges model as a financial and policy oriented approach to solving climate change.

Exhibit 5.4
McKinsey & Company GHG Abatement Curve



Source: *Reducing US Greenhouse Gas Emissions: How Much at What Cost?* McKinsey & Company. 2007

Exhibit 5.5
The Princeton University Climate Stabilization Wedges Model



Source: Robert Socolow and Steven Pacala, Princteon University, reproduced from *Scientific American*

The International Energy Agency Least Cost Model

Using a similar approach, the International Energy Agency (IEA) has developed a sophisticated technology-based economic analysis. Adopting the International Panel on Climate Change (IPCC) conclusion that the atmosphere cannot be allowed to increase by more than 2.4 degrees Celsius, IEA set out to determine what combination of technologies would produce the necessary emissions reductions at the least possible cost. Using climate sensitivity models from IPCC, the study determined that emissions in 2050 would need to be about half of what they were in 2007. The study then estimated the increase in global research and development (R&D) spending needed to bring about commercialization of the emerging technologies based on current data and understanding of R&D economics. The study concludes that the least cost combination of technologies is comprised of 36% end-use efficiency gains, 21% renewable energy, 19% CCS and 24% nuclear capacity additions, switching to lower carbon fossil fuels, and increases in generation efficiency. A subsequent IEA report concluded that the cost of replacing fossil fuel power plants with alternative energy would cost approximately $3.6 trillion from 2010-2030. To put this amount in context, over $4.0 trillion has been spent to address the global financial crisis in 2008 alone.

Full-cost Accounting

For decades, economists have attempted to develop a method to account for the full cost of goods and services. This involves the creation of accounting rules to properly measure the value of market externalities. For example, the full cost of a barrel of oil would include not only its market cost, but also the cost of all ancillary systems, infrastructure, costs to remediate environmental and climate damage, public health costs, R&D costs, and government expenditures to secure that supply, among other costs. Assuming that a full cost could be established and imposed on a barrel of oil or ton of coal, the market could instantaneously provide the correct price difference between conventional and alternative energy sources. In 2002, a study by the United Kingdom's Government Economic Service advised that the full cost of carbon was over $100 per ton of CO_2. At even fractions of this amount, renewable energy would reach grid parity with coal and other fossil fuels.

Copenhagen Consensus Center Complementarity Model

The majority of attention to climate policy is given to mitigation measures such as cap-and-trade and carbon taxation. At least one study has attempted to quantify the value of a more balanced approach that considers adaptation measures and subsidies for R&D of emerging clean energy technology and geoengineering science. The Copenhagen Consensus Center established a cost-benefit calculus of various climate policy combinations. The study revealed that enacting mitigation policies such as cap-and-trade or a carbon tax alone may result in a substantial net cost to the economy. However, if the same amount is expended to include implementation of adaptation policies and the funding of R&D efforts, the resulting cost-benefit ratio could increase by nearly a factor of three. The study concluded that a principle of "complementarity" is essential to creating an optimal climate policy portfolio.

The U.S. Government Accountability Office Survey of Climate Experts

Recognizing that no two economic analyses of climate change policy share an agreed upon methodology or result, perhaps the most useful analysis for policymakers is simply a survey of the experts and their conclusions. The U.S. Government Accountability Office distributed a survey to experts in climate policy economics designed to answer very basic questions for policymakers. In the presence of substantial uncertainty and disagreement among most experts, this study stands out by highlighting the points of consensus or significant agreement that do exist, and that can provide the basis for policy action today. Highlights are discussed below.

- All respondents agreed that the federal government should reduce GHG emissions by establishing a market-based mechanism that applies to all sectors of the economy. Respondents were split over whether a carbon tax or a cap-and-trade program is the preferred method, however.

- Respondents rated cost-effectiveness as the most important criteria in evaluating GHG mitigation policies.

- 16 of 18 respondents agreed that the United States should begin limiting GHG emissions as soon as possible, even if that means acting unilaterally.

- 14 of 18 respondents expressed a "moderate" level of certainty that a portfolio of policies that limit GHG emissions would at least produce benefits greater than costs.

- Respondents also considered the effectiveness of additional GHG mitigation policies that would complement a market-based program. Respondents identified participation in international climate agreements and funding low-carbon technologies as the two most important complementary policies.

- Respondents appeared to disagree over the importance of energy efficiency as a complementary policy, as six respondents ranked energy efficiency improvements as not at all important, while seven respondents identified energy efficiency improvements as at least quite important. Respondents identified energy efficiency program strengths to include the potential to reduce overall costs, political feasibility, and the importance in the presence of real market failures. On the other hand, energy efficiency was also viewed as an insufficient policy on its own, unnecessary in the presence of a robust incentive-based program, and economically inefficient. Further, such programs were identified to have limited potential benefits and an unequal burden of costs.

Chapter 6. Economic Impacts of Reducing Greenhouse Gas Emissions in Maryland

In an effort to provide some insight into the potential impacts of reducing greenhouse gas (GHG) emissions in Maryland, this chapter provides background information on measuring economic impacts in general; an overview of specific analyses that have been conducted to assess the economic impact of GHG mitigation legislation recently introduced in the U.S. and enacted in California; an overview of Maryland's energy and emissions profile; a discussion of major factors that influence GHG emissions; an explanation of potential impacts on the manufacturing sector; and a critique of the Maryland Commission on Climate Change's estimates of the net benefits of implementing the Climate Action Plan.

Measuring Economic Impacts in General

Most economic analyses estimate the impact of GHG mitigation by measuring how the policy would impact several key macroeconomic indicators. The previous chapter discussed how the distribution of these costs could vary substantially across regions and by income level. This chapter discusses how the distribution of costs can also vary by economic sector.

The most common measures of cost employed include measuring the changes in:

- **Gross Domestic Product (GDP):** GHG mitigation policies impose costs on firms and individuals and induce them to reallocate resources, causing economic output to grow more slowly in the absence of regulation. The impact these additional costs would have is typically measured as the reduction in GDP relative to what the GDP would have been in the absence of regulation. Changes in GDP are generally not an absolute reduction compared with current levels, but a reduction in future growth rates.

- **Employment:** Higher prices for energy- and carbon-intensive goods and services can reduce employment growth in two main ways. First, slower economic growth will dampen job creation. Second, increases in energy prices will effectively increase the costs of virtually all goods, reducing the buying power of workers' wages. Lower real wages can reduce the incentive of some individuals to seek work.

- **Consumption:** Slower economic and job growth can reduce consumption per-household, a measure that is often used to measure the well-being of households. GHG policies can not only reduce GDP growth, but also the relative contributions of each component. Many analyses conclude that GHG policies will require additional investment which will displace household consumption.

- **Energy Prices:** A necessary component of any mitigation strategy is increasing the cost of carbon-emitting sources including electricity, gasoline, and other fuels. Price increases can be translated as average cost increases to households and provide guidance on the competitive impacts of the policies on U.S. industry, which consumes a relatively large amount of energy.

A computable general equilibrium (CGE) model is typically used to estimate how policies with no historic precedent will ripple through the economy and interact among businesses and households. These models are designed to fully capture direct and indirect impacts within the economy and influences from international economies. Several models that have been applied to estimate the impacts of national GHG mitigation policies include Massachusetts Institute of Technology's Emissions Prediction and Policy Analysis Model (EPPA), Research Triangle Institute (RTI) International's Applied Dynamic Analysis of the Global Economy (ADAGE), and the Inter-temporal General Equilibrium Model of the U.S. Economy (IGEM) developed for the U.S. Environmental Protection Agency (EPA). Typically, the models estimate the price per ton of carbon emissions that would be required to reach a specified goal, and how that price would in turn impact the economy. The estimates that are developed by these models depend on both the characteristics of the policy (how and how much must be reduced) and on the ability of the model to forecast long-term variables. Some of the most important factors that influence the cost include:

- **The Stringency of the Mandated Reductions:** Typically, this is measured by the total amount of emissions that must be reduced over the long-term (typically through 2030 or 2050). As more emissions are reduced, the marginal cost of abatement typically rises, as fewer low-cost abatement policies are available. More stringent policies can be substantially more expensive than less stringent approaches.

- **Policy Design and Approach:** As discussed in the previous chapter, policy design has a large impact on the total amount and distribution of costs. Other factors that influence costs include whether a policy is economy-wide or fragmented (which would generally increase costs); the availability of domestic and international offsets; and the extent of incentive-based methods employed.

- **The Geographic Scope of Actions Undertaken to Reduce GHG Emissions:** A wider adoption of policies will be more cost-effective. For example, the cost of a national policy is likely to be less to the extent that more countries adopt GHG mitigation policies. A more narrow adoption of abatement policies (international, national, regional, and state) present fewer lower-cost abatement opportunities and increase the likelihood of leakage.

- **The Pace of Technological Change:** Technologies will be designed to reduce carbon emissions once individuals and firms are provided an incentive to do so. The pace at which these technologies are developed and implemented will be a key determinant in total abatement costs. Examples include the degree to which additional nuclear power is technically, politically, and socially feasible as well as the extent of large-scale commercialization of carbon capture and sequestration technology and non-fossil fuel generation (biomass, wind, and solar).

Analyses of Recently Proposed and Enacted Legislation in the United States

Recent National Proposals

As mentioned in the previous chapter, several bills proposing to reduce GHG emissions have been recently introduced in the U.S. Congress, including the Low Carbon Intensity Act of 2007 (S. 1766), the Climate Stewardship and Innovation Act of 2007 (S. 280), and the Lieberman-Warner Climate Security Act of 2008 (S. 2191/S. 3036). Of these three proposals, the Lieberman-Warner Climate Security Act required the most stringent reductions; analyses of this proposal can provide guidance on the magnitude of the potential impact of Maryland mitigation policies given the similarity of target reductions recommended by the Maryland Commission on Climate Change.

The initial analysis of the Lieberman-Warner Climate Security Act conducted by EPA reached the following major conclusions:

- The estimated cost of GHG reductions in its base scenarios range between $61 and $83 per ton of carbon dioxide (CO_2) equivalent in 2030 and between $159 and $220 per ton in 2050.

- In the absence of regulation, GDP was projected to increase by approximately 97.0% from 2007 levels by 2030 and 215.0% by 2050. As a result of the bill, annual reductions in GDP would range from 0.9% ($238 billion) and 3.8% ($938 billion) in 2030 and between 2.4% ($1.012 billion) and 6.9% ($2.856 billion) in 2050.

- Average annual household consumption would be approximately $1,375 lower in 2030; in 2050, consumption would be $4,377 lower. The present value of the cumulative reduction in real consumption in the 2012 to 2030 period ranges from $624 billion to $787 billion and in 2012 to 2050 from about $2.0 trillion to $2.7 trillion.

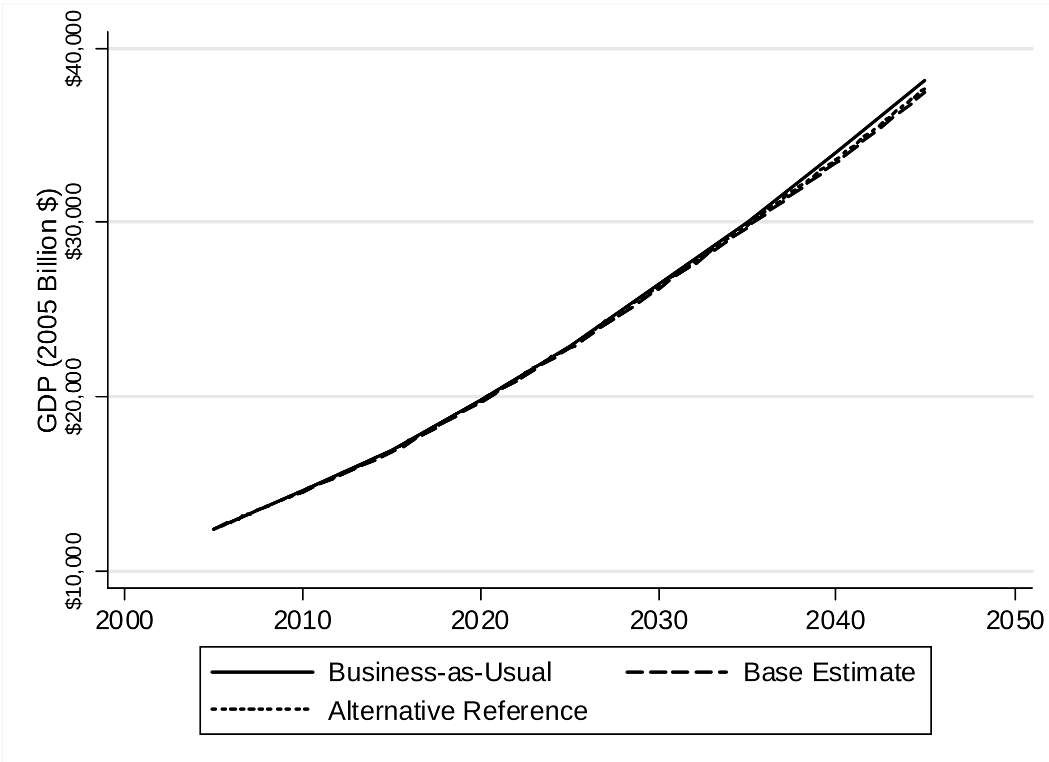
EPA noted that its base scenario assumes that carbon reduction technologies would be widely available and estimated that if technologies were limited, costs would increase by 80%. In addition, some analysts also believe that EPA and other research estimates underestimate costs because they assume a regulatory approach that produces a cost-effective abatement where firms will achieve reductions at the least cost under an incentive-based regime or that the policies are 100% effective. As discussed in the previous chapter, although incentive-based policies achieve substantial savings over alternative policy approaches, in practice, market imperfections have prevented emission abatement costs from being achieved at the lowest possible cost. On the other hand, analyses conducted by other organizations estimated smaller macroeconomic impacts than EPA estimated.

Although the macroeconomic impacts appear to be large in absolute terms, analyses by EPA and other organizations generally conclude that mitigation policies will have between a minimal and modest impact on these variables when measured relative to the size of the economy and to the annual change in these variables. **Exhibits 6.1 and 6.2** illustrate the relatively modest change in GDP and household consumption relative to the forecasted amount in the absence of regulation. Most GHG mitigation policies are estimated to reduce GDP in 2030 between one-fifth and three-fifths of 1.0% below the business-as-usual forecast. In EPA's analysis, GHG mitigation policies would reduce the annual growth rate in real GDP from 2.78 to 2.73% in the years from 2005 to 2050. The two estimates illustrated below show the low- and high-cost estimates of the nine different estimates conducted by EPA using the ADAGE model. EPA also presented estimates from the IGEM model which predicted larger impacts. The results from the ADAGE model, however, are more consistent with estimates conducted by other organizations.

As shown below, although the impacts seem large when described in absolute terms, they are not significant when measured relative to levels of GDP and consumption that would have occurred in the absence of regulation.

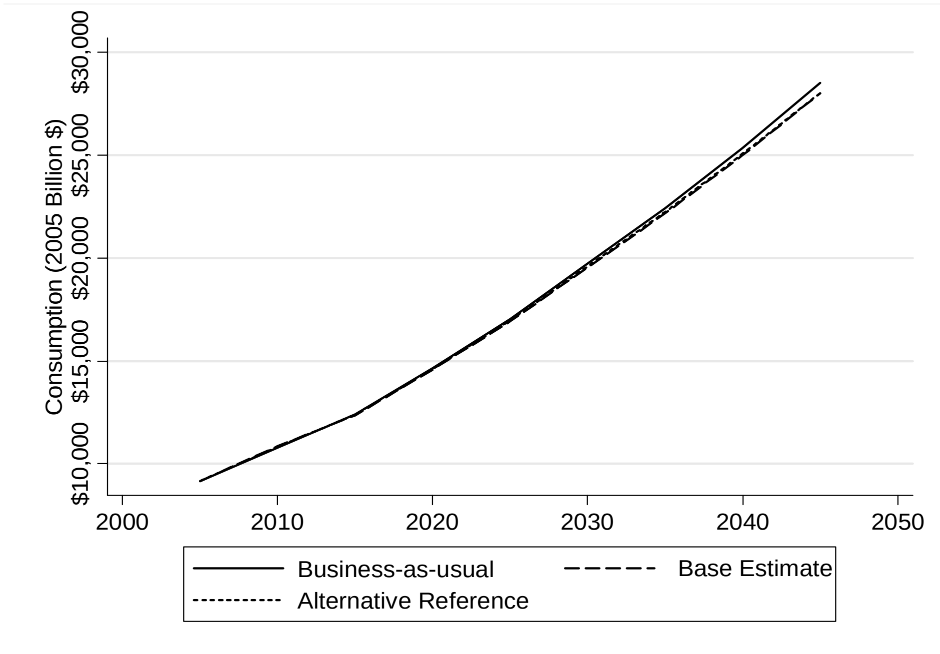
The EPA analysis did not forecast changes in employment. Research conducted by other organizations of similar legislation found that GHG mitigation policies would reduce total employment by 700,000 in 2030 but that the impact was minimal relative to a forecasted increase of 40 million jobs between 2005 and 2030. Although the reduction in total output, consumption, and employment are relatively small, these changes can mask more significant sector-level changes. For instance, one-half of the estimated job losses were estimated to occur in the manufacturing industry.

Exhibit 6.1
EPA Estimated Impact on Gross Domestic Product 2005-2050
Climate Security Act of 2008



Source: U.S. Environmental Protection Agency (EPA)

Exhibit 6.2
EPA Estimated Impact on Consumption
Climate Security Act of 2008



Source: U.S. Environmental Protection Agency (EPA)

The magnitude and distribution of the impacts from GHG policies throughout the economy will largely depend on several key factors. After a discussion of analyses relating to the economic impacts of California's GHG legislation, this chapter will discuss two of these factors: the distribution of energy consumption throughout Maryland's economy, and the energy intensity of fuels consumed in Maryland.

California's Global Warming Solutions Act (AB 32)

In 2006, California enacted the Global Warming Solutions Act, which limits California's GHG emissions to 1990 levels by 2020. The Act gives the California Air Resource Board substantial discretion in establishing policies to achieve emissions reductions. Three studies released in advance of the Act's passage attempted to quantify the emissions reduction potential and costs of various policy options. Each study assembled a different portfolio of options estimated to achieve the emissions reductions specified in the Act at no net economic cost. One study concluded that the 2020 emissions target could be reached while generating 83,000 jobs and increasing income by $4 billion by 2020. Another concluded that half of the emissions reductions could be achieved while increasing the California Gross State Product by $55 billion.

A subsequent analysis concluded that the 2020 target could be reached at a net economic benefit to the state.

Researchers at Resources for the Future (RFF) analyzed the methodology employed by the three California studies. RFF noted that the conclusions reached by the studies contradict the vast majority of other economic analyses of climate policy. In particular, RFF found that the studies underestimated the costs and overestimated the savings from energy efficiency investments, leading to a bottom-line discrepancy of billions of dollars. The RFF analysis also concluded that a market-based policy such as cap-and-trade should be the central mechanism used, with investments in energy efficiency or other programs only serving to complement the market-based approach. Finally, RFF noted that without a carefully crafted policy, some of the reductions achieved by California would come at the cost of emissions increases elsewhere. This phenomenon, known as emissions "leakage," could arise, if for example, California imported coal-based electricity from out of state.

The RFF study was not written to overrule or correct the three California studies that it analyzed. Rather, the importance of the RFF study was to provide a measure of caution to the public and policymakers and to provide lessons to those undertaking economic projections of climate policies. Foremost among these lessons are the following principles:

- Policy interactions must be properly accounted for in order to prevent double counting of emissions reductions. For instance, a policy promoting biomass electricity generation and the strengthening of renewable portfolio standards are designed for similar purposes and may lead to overlapping projections of reductions; the implementation of both policies will have a lesser effect on emissions than the sum of each policy's independent effects.

- Costs that are difficult to identify can be easily overlooked and omitted from the bottom line analysis. Examples of omitted costs include environmentally driven technology changes that reduce the quality of a good or impose small costs on a dispersed population of firms or households that are substantial in the aggregate.

- Overestimation of energy efficiency savings may be caused by a reliance on data from highly controlled studies that do not reflect real-world conditions. Several analyses note that there is a significant discrepancy between the private savings achieved by firms undertaking energy efficiency and demand reduction measures and the aggregate reduction in social cost from electricity savings. One of the principal causes of this is traditional electric utility ratemaking policies that are not properly restructured to account for new energy policies.

- Business as usual projections may be overstated, thereby overstating the effectiveness of proposed climate policies. To prevent this, care must be taken to develop the most accurate emissions inventory and baseline projections possible.

- Technology innovation and diffusion are notoriously difficult to project but critical to the accuracy of cost projections of climate policy. For example, numerous studies document the necessity of developing carbon capture and sequestration (CCS) technology if global emission reductions are to be achieved at a reasonable cost. Yet some experts caution that CCS infrastructure may be extremely costly, that its technology may be decades from commercialization, or that insurance costs have not been accounted for and may be significant.

Maryland's Energy and Emissions Profile

Understanding the patterns of energy consumption within the State is a necessary step in assessing the current amount of GHG emissions in Maryland and the impacts policies seeking to mitigate emissions would have on the economy. Energy consumption results from both the consumption of fuels to provide electricity and the primary consumption of fuels in the residential, commercial, and industrial sectors to provide space, water, and process heating and other energy-end uses. The Maryland Commission on Climate Change estimates that a little over 90% of GHG emissions in 2005 resulted from the consumption of energy.

Much of the profile that follows was developed from the U.S. Energy Information Administration's (EIA) State Energy database, which includes detailed state-level energy consumption data since 1960.

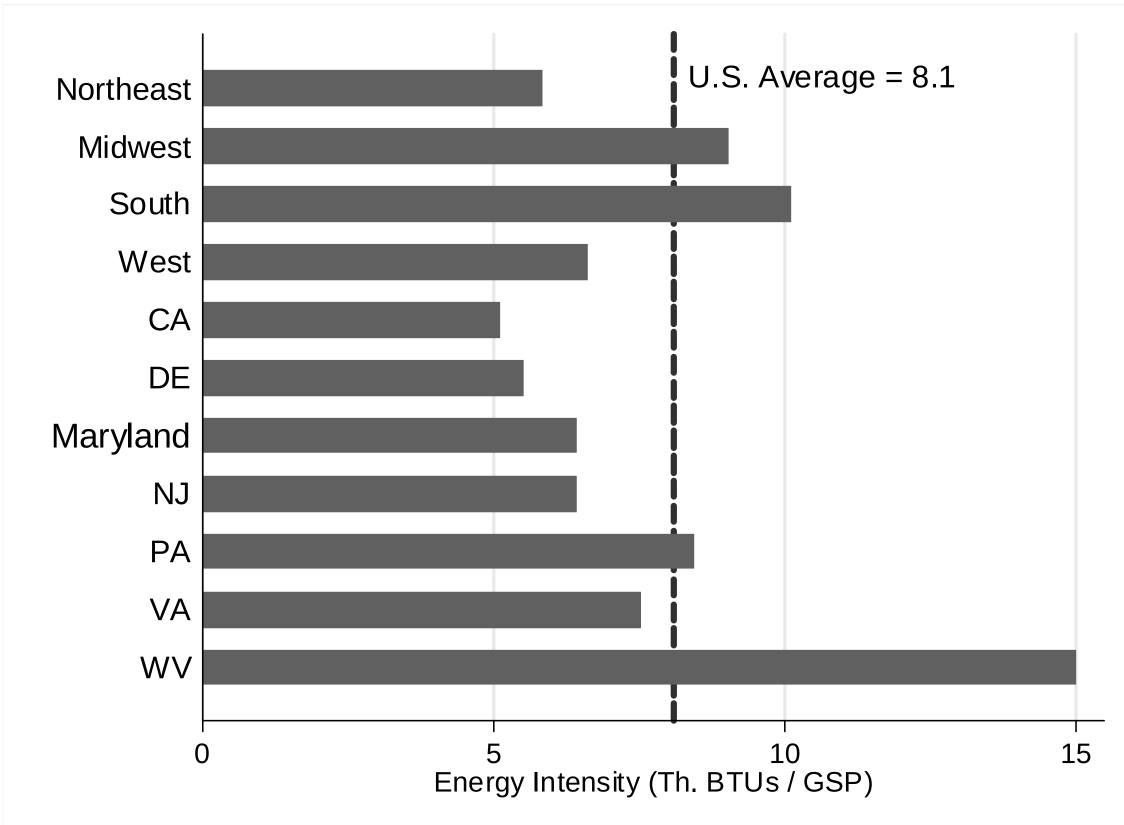
The State's population and economy has grown in the past several decades, causing an increase in the total demand for energy. As policymakers and researchers believe that reducing population and economic growth is neither practical nor desirable, efforts to decrease emissions have focused on reducing the amount of energy and carbon consumed relative to the size of the economy or population. These measures are typically expressed as intensities – the amount of carbon produced per unit of energy consumed or the amount of energy consumed relative to population, economic output, income, or employment.

The standard approach to measuring emissions is to estimate the emissions that are emitted as a result of producing all goods and services within a specified country, region, or state. This standard measure, production emissions, is used to develop commitments under the Kyoto Protocol. However, in the presence of interstate trade in electricity, a production-based measure might be an inaccurate way to characterize the relative amount of energy consumed by a state and carbon emitted as a result of economic activity within a state. Maryland imported 205.3 trillion British Thermal Units (BTUs) of energy in 2005 – about 25% of all electricity consumed and a little more than 10% of all energy consumed in the State. An alternative method is to measure emissions on a consumption basis – this corresponds to the goal of measuring emissions based on the end-user. For example, energy and emissions generated from a power plant in a surrounding state are apportioned to Maryland to the extent that this electricity is transported to Maryland to power homes and provide businesses with electricity needed to produce goods and services within Maryland. Throughout this section, consumption-based estimates are used except where data limitations warrant otherwise. It should also be noted that State-level policies can only, at best, indirectly influence carbon emissions that occur in other states. In 2005, power plant emissions that occurred in other states as a result of electricity imported to Maryland totaled approximately 12 million metric tons of CO_2 equivalent (MMtCO_2e) or about 11% of all Maryland consumption-based emissions.

Exhibit 6.3 illustrates one measure of the energy intensity (the amount of energy consumed relative to the Gross State Product (GSP)) of Maryland compared with U.S. regions, surrounding states, and California. A higher number corresponds to a higher level of energy intensity. By this measure, Maryland is the tenth least energy-intensive state, about one-fifth lower than the national average. A similar conclusion is reached if measured on a per-capita basis. Conversely, Maryland consumes about one-quarter more energy per economic output compared with California. On a national basis, the most energy-intensive states, which are about 2.5 times as energy-intensive as Maryland, are typically energy-producing states and/or or have high levels of heating demand during winter.

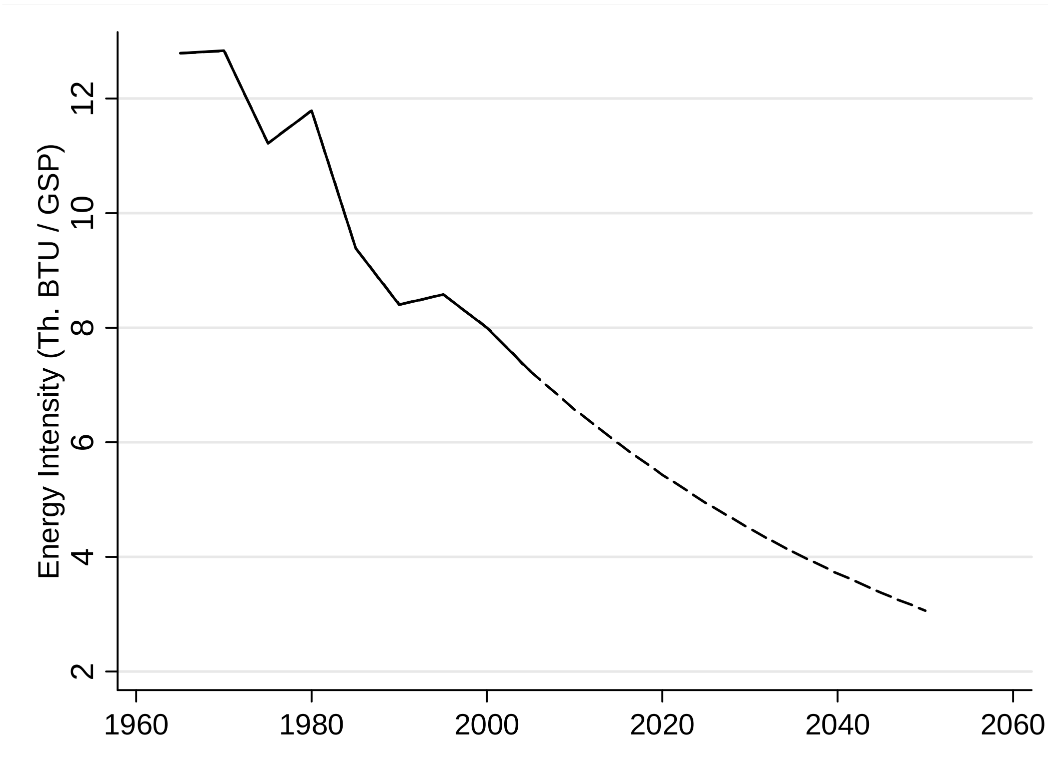
Maryland's economy has become less reliant on energy over the past few decades, driven largely by deindustrialization. For example, the amount of total State personal income derived from manufacturing decreased from 21% in 1960 to 4% in 2007 (compared with national rates of 25 and 9%). Maryland's energy intensity decreased most significantly in the 1980s and has also decreased since the mid-1990s. **Exhibit 6.4** illustrates the change in energy consumption relative to the State's economy since 1960 and also illustrates potential future energy intensity decreases if the State adopts GHG mitigation legislation. This forecast assumes that Maryland's experience will mirror that of the nation under EPA's analysis of the Lieberman-Warner Climate Security Act of 2008.

Exhibit 6.3
Energy Intensity of the U.S. and Maryland Economies
2005



Source: Department of Legislative Services based data from Energy Information Administration; Bureau of Economic Analysis

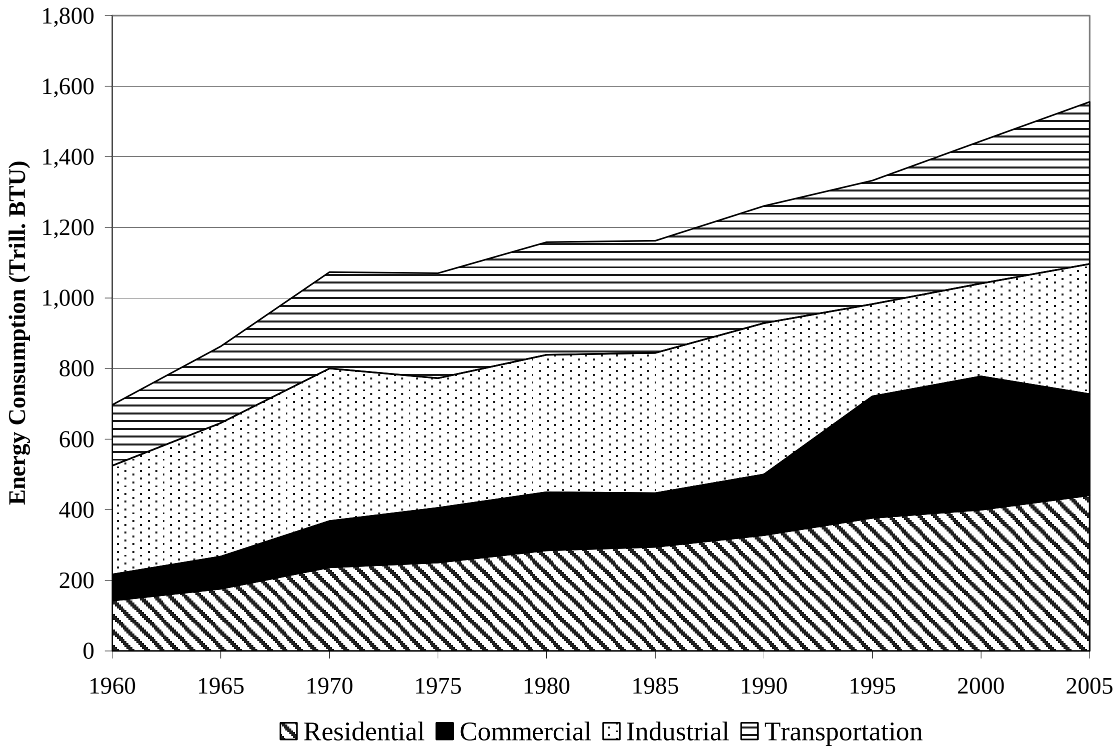
Exhibit 6.4
Maryland Economic Energy Intensity
Calendar 1960-2005



Source: Department of Legislative Services; Energy Information Administration; Bureau of Economic Analysis; U.S. Environmental Protection Agency

Although the State's economic energy intensity has decreased over time, energy consumption relative to the State's population has increased since 1960. Consumption per individual has increased by about one-quarter compared to 1960. Per-capita energy consumption increased in the 1960s and decreased during the 1980s; but, unlike economic energy intensity, has increased since the 1980s. Total energy consumption increased by 123.0% since 1960, an annual average increase of 1.8%. **Exhibit 6.5** shows this increase in total energy consumption and disaggregated by economic sector. In the exhibit, electricity production is distributed to its final end-use sector.

Exhibit 6.5
Sector-Level Energy Consumption in Maryland
Calendar 1960-2005



Note: Totals include fuels that are used for non-energy purposes.

Source: Department of Legislative Services; Energy Information Administration

Several factors, including economic growth rates and energy prices, contributed to the energy consumption fluctuations shown above. Annual consumption rates increased most rapidly in the 1960s (4.4%), slowest in the 1970s and 1980s (a little less than 0.8%) and has increased by about 1.5% annually since 1990. Annual energy use has increased most rapidly in the commercial sector (3.0%), followed by residential (2.5%), transportation (2.2%), and industry (0.4%). Although industrial energy demand increased in the last several years, total demand in that sector has decreased by 1.0% since 1990. In 2006, Maryland consumed about 1.5% of the nation's total energy consumption; however, as shown in **Exhibit 6.6**, there was variation in the amount consumed by each sector relative to total U.S. consumption.

Exhibit 6.6
Energy Consumption by Sector in the United States and Maryland

	Residential	Commercial	Industry	Transportation
Maryland	28.2%	18.3%	25.1%	28.4%
United States	21.5%	17.8%	32.9%	27.8%

Note: Average amount from 2002 to 2005 is used in an attempt to mitigate the impact of short-term energy demand fluctuations.

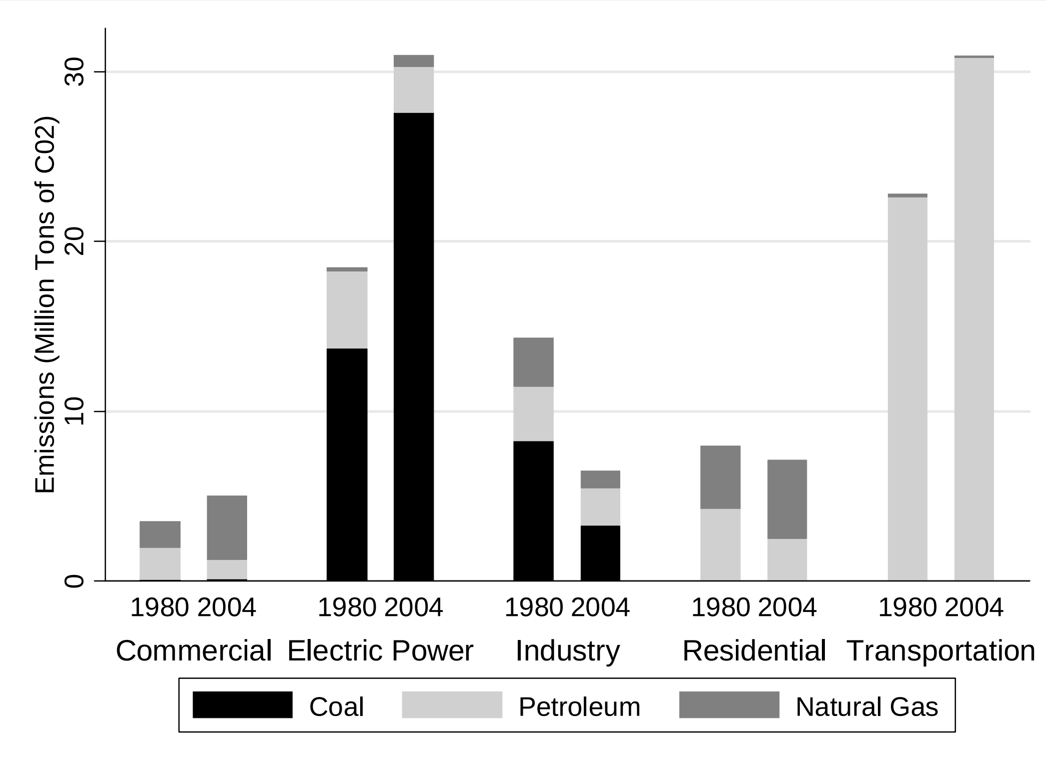
Source: Department of Legislative Services; Energy Information Administration

The distribution of energy within Maryland sectors and changes in total energy over time has a large impact on GHG emissions; however, the amount of emissions generated will ultimately depend on the carbon intensity[1] of the fuel consumed. Carbon intensity depends on the density and carbon content of the fuel used and the process used to combust the fuel. Of the major fossil fuels, coal is the most carbon intensive followed by petroleum products, while natural gas is the least carbon intensive. Natural gas is about one-quarter less carbon intense than motor gasoline and a little more than one-half less carbon intense than coal. Most petroleum products have a similar carbon intensity as motor gasoline except for residual fuel, which is used in electricity and industrial power production and is more carbon intensive, and little-used liquefied petroleum gases (low intensity) and carbonaceous petroleum coke. When looking at carbon emissions from an output basis, nuclear, hydroelectric, and wind power are carbon neutral. Biomass produces carbon when burned for energy, but growing biomass serves as a carbon sink, helping to offset the output emissions. According to EIA, petroleum products generated 49% of Maryland energy-related production CO_2 emissions in 2005, coal accounted for 38%, and natural gas accounted for 13%.

Exhibit 6.7 lists estimated production emissions by sector and fuel type and the change in emissions from 1980 to 2004. The transportation and electric power sectors account for a majority of energy-related emissions and the overall increase in emissions since 1980. Since these are production measures, this does not include interstate electricity imports. Data are limited in calculating the carbon intensity of electricity imports; however, the Maryland Commission on Climate Change's Climate Action Plan estimates that the carbon intensity of electricity imports is very similar to the carbon intensity of electricity produced in the State.

[1] The carbon intensity of a fuel is the amount of carbon by weight emitted per unit of energy consumed. A common measure of carbon intensity is the weight of carbon per BTU of energy. Fuel carbon intensity is distinct from the commonly used term carbon intensity which generally refers to the amount of carbon emitted per unit of economic output.

Exhibit 6.7
Carbon Emissions by Fuel and Sector
Calendar 1980-2004



Source: Department of Legislative Services; Energy Information Administration

Including imports would increase electric power emissions by about one-quarter of the amount in 2005, as shown in the exhibit.

Because electric power is not distributed in this analysis, caution should be used when assessing whether or not the commercial, industrial, and residential sectors have a lower overall amount of carbon emissions, which is the sum of primary fuels consumed (shown above for each of these sectors) and electricity consumed by the sector.

Since 1980, additional demand for electric power and transportation fuels has not been offset by a decrease in the carbon intensity in these sectors. Since the Calvert Cliffs Nuclear Power Plant began production, the mix of electric production has not changed away from carbon intense fuels such as coal and petroleum products. Maryland's coal-fired power plants typically supply more than one-half of the electricity generation within the State, nuclear power typically supplies more than one-fourth of generation, and petroleum- and natural gas-fired plants supply much of the remainder. In the transportation sector, motor fuel continues to be the dominant fuel consumed. Although changes in environmental regulations and the content of motor gasoline have impacted the carbon intensity of motor fuel, EIA estimates that since 1990, the carbon intensity of motor fuel consumed nationwide has not changed substantively.

Major Factors that Influence GHG Emissions

Researchers have developed various models and methods to understand the factors that influence energy consumption and GHG emissions over time. A straight-forward and commonly used model is the Kaya Identity, which can be used to decompose changes in energy use (or emissions) into four components: population, per-capita income, the energy intensity of output, and (for emissions) the carbon intensity of energy. This approach can illustrate whether CO_2 emissions or energy consumption trends reflect changes in energy intensities or are being driven by economic or population growth.

The Kaya Identity for energy consumption can be expressed by:

$$\text{Energy} = \text{Population} * \left(\frac{\text{Income}}{\text{Population}} \right) * \left(\frac{\text{Energy}}{\text{Income}} \right)$$

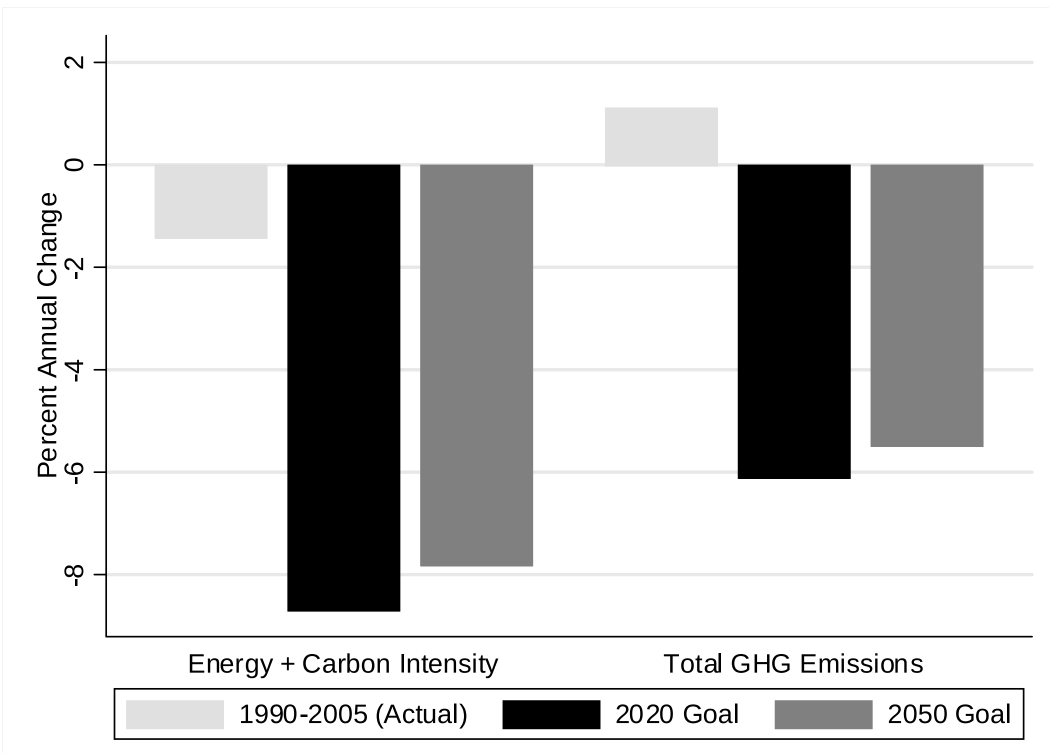
Determining CO_2 emissions would entail using the formula above plus adding a measure for carbon intensity. However, more accurate State-level data is available for energy consumption rather than CO_2 emissions. The equation above can be modified to decompose annual changes in energy use over time. Since 1960, Maryland's population increased by 1.3% annually, per-capita income increased by 2.2%, and energy intensity decreased by 1.7% (as measured against income). As mentioned previously, energy consumption, which is the sum of the three previous components, increased by 1.8% during this time period. In other words, the decrease in energy intensity that occurred during this time period was insufficient to offset the increase in demand for energy resulting from economic and population growth.

The Kaya Identity can also be used to characterize the magnitude of changes in intensities that are required to achieve specified emission reductions given forecasted changes in population and income. The State's population growth is expected to be more modest than in the past (about 40.0% less than the average rate since 1960) and will help dampen the increase in demand relative to the past. However, income is expected to increase at a similar rate over the long-term. If energy demand relative to income and population exhibits a similar pattern in the future, energy and carbon intensities would need to be reduced by a total of about 2.5% annually in order to stabilize Maryland emissions.

Relative to 2006 emissions, the Maryland Commission on Climate Change's Climate Action Plans recommends that GHG emissions should be reduced by 25 to 50% by 2020 and by

90% by 2050. Annual emission reductions would depend on the amount of emissions that would have been produced in the absence of regulation. Although researchers have devoted considerable attention to forecasting future emissions under a business-as-usual scenario, considerable potential for errors remain. In contrast, it is possible to provide an idea of the annual reductions in emissions required relative to recent trends. **Exhibit 6.8** illustrates the estimated annual percent change in total Maryland GHG emissions and the sum of the estimated change in both energy and carbon intensities that occurred from 1990 to 2005. Exhibit 6.8 also illustrates the estimated annual GHG emissions and total combined annual changes in energy and carbon intensities that would be required to meet the Climate Action Plan's 2020 and 2050 goals.

Exhibit 6.8
Estimated Annual Emissions and Intensity Reductions Required to Meet 2020 and 2050 Goals Recommended in the Climate Action Plan



Note: 2020 goal reflects the maximum 50% reduction. In calculating emissions reductions, it is assumed that emissions stabilize through 2009 before reducing in 2010 and thereafter.

Source: Department of Legislative Services

Due to measurement difficulties, potential forecast errors, and diminishing income-demand energy impacts in the future, these estimates should not be treated as precise point estimates but instead, used to provide a sense of the magnitude of the changes that would be required. Relative to recent trends, achieving the 2020 and 2050 goals would require total emissions and intensities changes that are of a magnitude larger. Although uncertainty exists over GHG emissions in the near-term and when and how much recently enacted legislation will begin to impact GHG emissions, more confidence can be placed in the required average annual emissions reductions. Because this represents an average amount, the actual amount reduced in any given year could be less. Emission increases in the near-term and slower-than estimated realized reductions from implementation strategies would necessitate higher annual reductions in later years.

GHG mitigation policies would increase the cost of fuels and electricity or impose additional costs that are required to increase energy efficiency and/or decrease carbon intensities. Firms that consume a relatively large amount of energy will incur a higher level of costs relative to output and revenues. Because the manufacturing industry is a relatively large consumer of energy in the State, the next section will focus on the potential impacts that GHG mitigation policies could have on that industry.

Impacts on the Manufacturing Sector, Generally

Even with a cost-effective strategy for reducing GHG emissions, some domestic producers will incur increased production costs and face increased challenges to their ability to remain competitive. Under national proposals, concern has been raised about trade-sensitive, energy-intensive sectors. The impact of GHG mitigation policies on the competitiveness of an industry will depend on the energy/carbon intensity of the industry and the degree to which firms can pass on increased costs to consumers. The extent to which consumers can substitute other, lower-carbon products and/or turn to imports will constrain firms' abilities to recover cost increases. The ability of consumers to substitute goods produced in other areas and in effect shift production to areas outside the purview of regulation will not only increase the costs of the policy but could also negate part of all of the environmental benefits of the policy.

Energy costs in most manufacturing industries are less than 2.0% of total production costs. However, energy costs are more than 3.0% in a number of energy-intensive industries such as refining, nonmetal mineral products, primary metals, and paper and printing. For these energy-intensive industries, productions costs were found in recent studies to rise by roughly 1.0 to 2.5% for each $10 increment in the price per ton of CO_2. It should be noted that cost impacts varied considerably within more narrowly defined categories. In the chemicals and plastics industries, energy costs comprise 2.9% of total costs. However, significant variance exists within the industry, as costs can range from 0.6 to 34.0%; five of these sub-sectors have costs exceeding 10.0% while three have shares less than 1.0%. Industries would be faced with increased energy and emission costs as well as increased costs for intermediate products. For example, steel producers would incur additional costs directly related to steel production as well as having to pay a higher price for inputs such as lime that produce emissions themselves. Firms also might be indirectly impacted by GHG mitigation policies. For example, firms that use natural gas, and therefore have relatively low carbon intensity, would likely incur increased costs as some firms switch from high carbon fuels to natural gas as part of an effort to curb emissions.

Several recent studies have examined whether European Union (EU) mitigation policies implemented to date have reduced industrial production. In addition, researchers at RFF have examined the impacts of a national emissions program on U.S. industrial production. Despite these efforts, research identifying which particular industries and firms in the United States would be impacted is relatively undeveloped, and methodologically robust research into the impacts of a state-level program has yet to be conducted. In addition, data limitations have limited the ability of researchers to analyze potential impacts. The most recent data on energy use by manufacturers is from 2002. More comprehensive data used by some studies is even older.

Recent EU Studies

Two recent studies conducted on behalf of the EU and by the International Energy Agency (IEA) estimated the initial impacts of the EU Emissions Trading Scheme (EU-ETS) on industrial production. Phase I of the EU-ETS applies to electricity generation, oil refineries, coke ovens, iron and steel, cement, lime, glass, ceramics, pulp and paper, and all combustion plants with a capacity over 20 megawatts. The studies estimated the impact of assessing a $10 per-ton charge on GHG emissions that applied to the consumption of fossil fuels for industrial combustion, process emissions, and electricity.

Results show that initial cost adjustments vary widely across industry sub-sectors. This variation reflects differences in energy intensity and, particularly in the case of the cement industry, differences in process emissions. Both studies estimate the largest price impacts were on Basic Oxygen Steel Furnace production (6.0%), aluminum (2.0 to 4.0%), and cement (13.0 to 14.0%). The EU study found large initial impacts in the petroleum industry (7.0%) (not studied by IEA) while the IEA study estimated large initial impacts on newsprint (4.0%) (not studied by the EU). Both studies found relatively modest impacts on demand (ranging from -2.0 to -0.36%) or total costs after pass-through to consumers. The studies also concluded that there was no evidence yet that EU-ETS had produced significant leakage by transferring industrial production to other countries that lacked GHG mitigation policies. This conclusion depends largely on two factors. First, 95.0% of allowances were transferred to emitters for free, providing a substantial income source for these firms that might not be available under a State or national program. Second, freight charges were found high enough to protect European industries from African and near-east Asian competitors. Since the publication of the EU analysis, however, the slowdown in the global economy has decreased the London Baltic Exchange’s chief price index, which monitors major trade routes for coal, iron ore, cement, and soft commodities such as grains and sugar, to a 22-year low.

Recent U.S. Studies

Preliminary results are also available for two recent RFF studies investigating the impact of a $10 per-ton charge on carbon emissions on industrial production in the United States. Both of these studies assumed that a GHG mitigation policy would not be part of a global policy and that producers would face competition from other countries not subject to GHG mitigation policies. Both studies generally estimated that production would decrease by less than 1.0% in most industries except for motor vehicles, chemicals and plastics, and primary metals (ranging from 1.0 to 1.5%). The second analysis found significantly larger impacts (-1.75 to 6.0%) in several industries including primary metals, fabricated metals, and machinery. Calculations from the second study also suggest that for most industries where energy is about 1.0% of total costs, providing free allowances equal to about 15.0% of a firm's emissions were sufficient to address the impact on shareholder wealth. The RFF studies also note that the results represented short- and intermediate-term results and results over the longer-term could be larger or smaller.

Impacts of a State Mitigation Program on Maryland Industry

Establishing a State-level cap-and-trade program would impose additional challenges to Maryland industries compared with a national regime. Maryland industries will typically not only face global competition from unregulated producers, but also from other states in the United States that have not enacted mitigation policies. These more proximate competitors would have substantially lower transportation costs than competitors in other countries. In the RFF studies, the share of consumption in each sector comprised of imported goods was estimated to range from a low of 8% in food to nearly three-quarters in textiles with a median level of about one-quarter. In contrast, consumers of Maryland industrial products would have substantially more options in switching to lower-cost unregulated producers.

A firm has limited options in the near-term after introduction of GHG mitigation policies that increase production costs of intermediate goods. For example, a chemical plant that incurs higher production costs cannot immediately and costlessly convert to more carbon-efficient methods. If a plant leaves prices unchanged, higher production costs will lead to reduced profits. If prices are increased, this would at first increase revenues and help offset higher production costs. However, higher prices would eventually lead to lower demand, employment, and profitability as customers reduce consumption of the good or switch to unregulated competitors that are located overseas, in another state, or both.

The extent of the decline in sales of a firm would depend on the behavior of other firms within the industry and other industries. Over the longer-term, firms will have a great ability to substitute more efficient processes and goods in production processes. The ability to switch to more efficient inputs and technologies would lessen the production and employment impacts. In addition, the broader economy would adjust and customers would adjust purchasing behavior as a result of new price signals.

The more narrow geographic scope of a State-level policy could constrain Maryland firms' ability to bridge the transition to the longer-term, where impacts would be less pronounced. First, Maryland firms would face much greater competition from unregulated firms with lower cost structures and would represent a smaller share of total production. As a result, in competitive markets, Maryland firms would be price-takers and would have a limited ability to charge more in order to recover increased costs. In the absence of a comprehensive national policy, the broader U.S. economy would not be adjusting, presenting Maryland firms with fewer and slower technological advances to efficiently reduce GHG emissions.

Another factor that suggests a greater impact would be realized in Maryland under a State-level program rather than a national program is that a State-level policy would narrow the ranges of GHG emitting activities that can be curbed, and fewer low-cost opportunities to curb emissions would exist. As a result, curbing emissions at the State level would likely impose higher costs than those studied in the EU and in the United States. On the other hand, through its participation in the Regional Greenhouse Gas Initiative (RGGI), Maryland has already begun to undertake efforts to curb emissions in the electricity sector. Through higher electricity prices, RGGI is providing a price signal to Maryland industries to reduce electricity consumption and, therefore, GHG emissions. This will reduce the level of total additional emissions reductions required of a firm under any new initiatives.

In general, GHG mitigation policies will impose higher costs on industries that are energy- and carbon-intensive. In order to provide context to the possible impacts to such industries in Maryland, the following sections provide additional information on the industrial consumption of electricity and fossil fuels and non-energy emissions that are the by-product of industrial processes; and assess the relative level of energy- and carbon-intensity of industries within Maryland.

Industrial Energy Consumption

The U.S. industrial end-use sector accounted for 28% of CO_2 emissions from fossil fuel combustion in 2005. On average, 55% of these emissions resulted from the direct consumption of fossil fuels for steam and process heat production. The remaining 45% was associated with electricity consumption for powering motors, electric furnaces, ovens, and lighting. The industrial end-use sector includes activities such as manufacturing, construction, mining, and agriculture. Manufacturing is the largest consumer of electricity, of which six industries – petroleum refineries, chemicals, primary metals, paper, food, and nonmetallic mineral products represent the vast majority of energy use. The Maryland Commission on Climate Change estimates that in 2005 the industrial sector emitted a total of 27.2 $MMtCO_2e$ or one-quarter of total Maryland consumption emissions. A little more than 80% of the amount emitted by the industrial sector was due to fuel and electricity consumption with the remaining amount resulting from industrial processes.

Exhibit 6.9 lists Maryland manufacturing employment in 2007 by the average national energy-intensity of the sub-sector and includes information where available on the average national carbon intensity of each sub-sector. Total Maryland manufacturing employment in 2007 totaled about 132,000, or about 5% of total State employment. As indicated below, a little more than one-half of these jobs are energy-intense industries which could be particularly sensitive to GHG mitigation policies.

Exhibit 6.9
Maryland Manufacturing Employment and Carbon- and Energy-intensity

	Maryland Employment		Energy	Carbon
Sub-sector and Industry	Subsector	% Total	Intensity	Intensity
Computer and Electronic Products	21,908	0.9%	0.5	
Miscellaneous	5,306	0.2%	0.6	
Machinery	7,699	0.3%	0.7	
Transportation Equipment	8,278	0.3%	0.7	
Furniture and Related Products	3,949	0.2%	0.9	
Apparel	1,434	0.1%	0.9	
Beverage and Tobacco Products	3,790	0.1%	1.0	
Electrical Equipment, Appliances, and Components	2,179	0.1%	1.0	
Printing and Related Support*	12,742	0.5%	1.1	
Leather and Allied Products*	179	0.01%	1.1	
Textile Product Mills*	983	0.0%	1.6	
Fabricated Metal Products*	9,945	0.4%	1.7	
Plastics and Rubber Products*	6,783	0.3%	2.1	
Food*	15,361	0.6%		
Wood Products*	3,083	0.1%	4.2	
Textile Mills*	1,307	0.1%	4.3	
Chemicals*	12,554	0.5%	8.5	41.5
Nonmetallic Mineral Products*	4,834	0.2%	11.7	68.1
Primary Metals*	3,603	0.1%	14.2	68.7
Petroleum and Coal Products*	868	0.03%	15.0	43.2
Paper*	4,810	0.2%	15.2	36.5
Total Energy-intensive Industries	**70,653**	**2.8%**		
U.S. Average			**4.2**	**49.5**

*Energy-intensive industry except for noted sub-sectors.

Source: Department of Legislative Services; Bureau of Labor Statistics; Energy Information Administration

Non-energy Industrial Process GHG Emissions

In addition to energy-related industrial emissions, GHG emissions are also produced as the byproducts of various non-energy related industrial activities (industrial processes). The chemical transformation of raw materials from one state to another can result in the release of CO_2, methane, or nitrous oxide (N_2O). Large sources of these CO_2 emissions include production of primary metals (iron, steel, and aluminum), nonmetallic minerals (cement, lime, and limestone), and petrochemicals as well as consumption of ammonia, used as a precursor in foodstuffs and fertilizers and soda ash (sodium carbonate) used in glass, chemicals, and detergents. N_2O industrial sources include nitric acid used in the production of fertilizers and adipic acid used in the production of nylon fibers, some plastics, clothing, carpets, and tires.

In addition to these processes, industrial production of man-made fluorinated compounds such as hydrofluorocarbons (HFCs), perfluorocarbons, and sulfur hexafluoride (SF_6), results in the emission of GHGs. The present contribution of these gases to the radiative forcing[2] effect of all man-made anthropogenic GHG emissions is small; however, because of their extremely long lifetimes, these gases will continue to accumulate in the atmosphere as long as emissions accumulate. In addition, many of these gases have high global warming potential; according to the Intergovernmental Panel on Climate Change, SF_6 is the most potent GHG. Although these emissions represent a relatively small share of the total GHGs emitted, national emissions from these compounds are expected to increase substantially in the near-term. HFC production is growing rapidly as they are the primary substitutes for ozone depleting substances, which are being phased out under the Montreal Protocol. Higher emissions result from aluminum production, hydrochlorofluorocarbon-22 production, semiconductor manufacture, electric power transmission and distribution, and magnesium and metal production and processing. These industrial processes totaled 320.9 teragrams of CO_2 equivalent, or 5% of total U.S. GHG emissions and a little less than one-fifth of total energy and non-energy industrial emissions. Less precise information about industrial processes is available on a state-level basis. By using production data in some instances and apportionment of national emissions to Maryland based on different factors, the Maryland Climate Action Plan estimates that industrial processes also constitute about 4% of total Maryland consumption GHG emissions.

Case Study: The Cement Industry

In cement manufacturing, CO_2 is emitted as a result of both the combustion of fossil fuels and process-related emissions. Transforming raw materials into cement – commonly referred to as clinker at the end of the production stage – requires intense heat and, therefore, energy. This intense heat converts calcium and silicon oxides to calcium silicates and also results in the release of CO_2. The amount of emissions depends on the fuel used to heat the raw materials, the

[2] Radiative forcing is a measurement of incoming solar radiation in the atmosphere. Positive radiative forcing happens when some alteration in atmospheric composition occurs that causes more energy to be absorbed by the Earth, whereas negative radiative forcing happens when an event causes more radiation to be reflected back out to space.

amount of lime used in production, and the energy intensity of the cement plant. (Modern plants save energy by capturing hot gases resulting from the cooling of clinker to heat raw materials before entering the kiln).

Although there is a relative paucity of recent state-level analyses of industries, EPA conducted a state-level analysis of the cement industry in 2001. This analysis concluded that, compared to other states, the Maryland cement industry ranked fourteenth in CO_2 emissions. In addition, Maryland plants were the fourth most carbon intense – about one-third more carbon intense than the national average. It should be noted that substantial changes within the industry, including the mix of fuels used and the gradual phase-out of more energy intensive wet-process cement production, could impact these conclusions.

According to the Portland Cement Association, three cement plants in Maryland produced about 2.6 million tons of cement in 2007. These plants employed a little less than 500 individuals. Continued weakness in the residential housing market will continue to dampen production, which is estimated to be about one-third lower in 2009 than 2006.

State-level GHG mitigation policies would likely increase the cost of cement production by increasing the cost of fossil fuels used by plants, mandating efficiency standards or the adoption of technologies, and imposing costs in some manner on cement plants from industrial process emissions. The extent price increases would negatively impact Maryland's cement industry, as measured by production and employment, would depend largely on the ability of customers to substitute other products for indigenous production. Generally, the cost of shipping cement quickly overtakes the value of the product, creating local industries. In addition, a lack of substitutes for concrete (the final end use product) could mitigate negative impacts. However, even though shipping costs are significant, about one-fifth of the concrete consumed nationwide is imported from other countries. Under a State-level GHG mitigation program, Maryland producers would also face competition from producers in nearby states that have significantly lower transportation costs than international competitors; there are currently 11 cement plants in surrounding states. The extent production would shift to other states would depend, at least in the near-term, on the ability of nearby plants to increase production; in 2007, U.S. plants operated at over 90% capacity. Over the long-term, however, sustained significant price differentials would likely shift some level of production away from the State to unregulated areas. In addition to impacting the industry itself, this will result in increased prices for consumers.

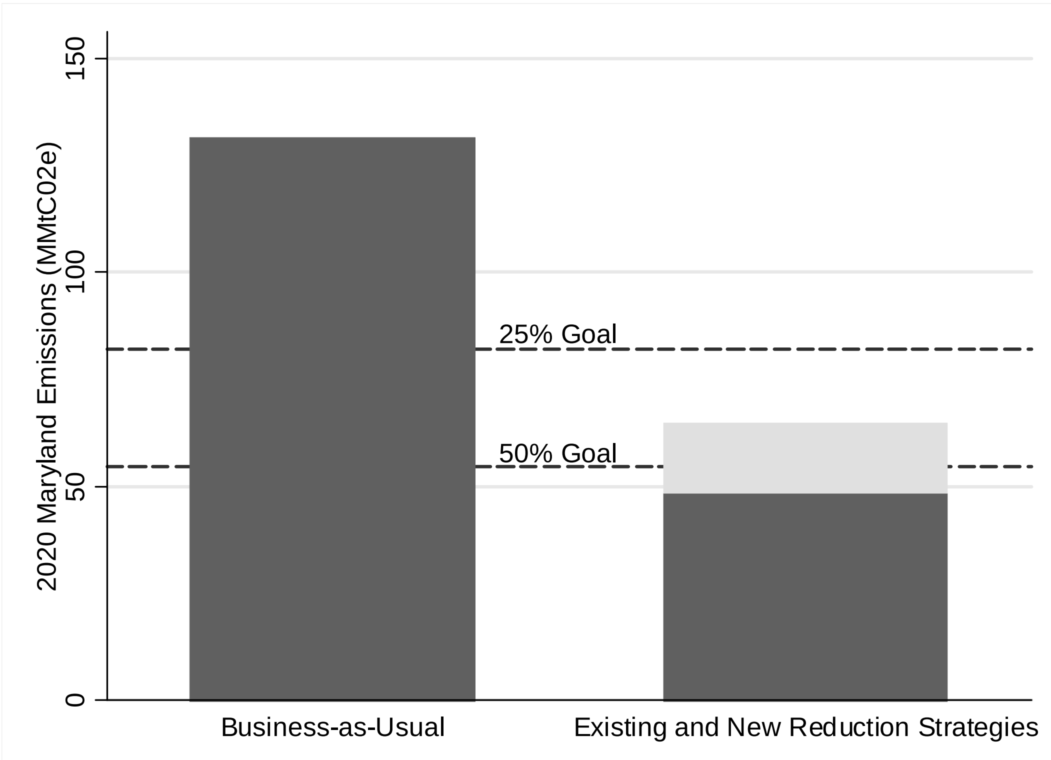
A Critique of Maryland's Climate Action Plan and Its Estimated Impact on Maryland's Economy

As described previously, the Maryland Commission on Climate Change's Climate Action Plan establishes goals for reducing GHG emissions relative to 2006 emissions, including a 25 to 50% reduction by 2020 and a 90% reduction by 2050. The plan also identifies 42 mitigation strategies that, combined with recent initiatives (such as the Clean Cars Program, RGGI, and legislation enacted in the 2008 session), are estimated to be sufficient to achieve the 2020 goal. The 42 mitigation strategies outlined in the plan are largely command-and-control policies rather than incentive-based policies. Of the recommended mitigation policies, 32 directly reduce emissions and are separated by sector of the economy. The greatest emission reductions are estimated to result from the Transportation and Land Use (8 policies) and Electricity (8 policies) sectors followed by Residential, Commercial, and Industrial Fuel Use (7 policies) and Agriculture, Forestry, and Waste (9 policies). Overall, the commission estimates that about one-half of the reductions will come from existing policies and that all policies combined will reduce emissions by about 40 to 55% by 2020 (compared to 2006 emissions).

Exhibit 6.10 illustrates the total estimated reduction in 2020 emissions achieved by the 42 mitigation strategies, as presented by the commission. The commission estimates that its recommended strategies, combined with existing policies, will reduce 2020 emissions by about 50 to 63% (66.5 – 83.1 $MMtCO_2$) over the business-as-usual scenario. For context, this reduction is equivalent to about two-thirds to four-fifths of current total Maryland emissions (including imported electricity).

The commission acknowledges that there is significant uncertainty about how much emissions will be reduced by the existing and recommended policies, the current and future amounts of emissions that will occur in the absence of regulation, and in the estimated benefits and costs that will accrue to the Maryland economy. Nonetheless, the commission estimates that existing and recommended reduction strategies will benefit the Maryland economy by $2 billion by 2020. This estimate is without regard to any environmental benefits of GHG mitigation and is similar to the conclusions reached by the three studies analyzing mitigation efforts in California.

Exhibit 6.10
Estimated Maryland GHG Emissions in 2020
In the Absence of Regulation and Under Existing and New Reduction Strategies



GHG: greenhouse gas

Note: Lightly shaded region depicts range of estimated reductions in 2020.

Source: Maryland Commission on Climate Change

It appears that the Climate Action Plan attempts to avoid some of the mistakes identified by RFF in the California studies by adjusting for potential overlaps between policies. However, the Department of Legislative Services has reviewed the data and methods employed in the plan and has concluded that many other potential errors identified in the California studies exist. Some examples of these errors include:

- **Omitted Costs:** It is difficult to achieve a full accounting of costs given the multiple indirect and direct impacts of GHG mitigation policies. However, the exclusion of relevant costs leads to an underestimation of policy costs and skews the ratio of benefits to costs. One example of an omitted cost relates to the estimation of costs and benefits from an expanded cap-and-trade program. The commission estimates that instituting a cap-and-trade program will have a net benefit to the Maryland economy, but it does not consider "indirect impacts through the broader economy of costs or savings resulting from this policy." This conclusion is in contrast to the vast majority of studies analyzing cap-and-trade programs.

- **Insufficient Adjustment for Overlap:** It appears that estimates were not adjusted for potential overlaps within the existing and proposed transportation and land use policies. Most of these policies would reduce vehicle miles traveled (VMT) in addition to an existing policy, the Low Emission Vehicle (LEV) Program, which will reduce the carbon intensity of driving. The implementation of the LEV Program, however, will reduce the effectiveness of policies that reduce VMT because fewer emissions will be generated per VMT. In addition, multiple policies that reduce VMT will not be as effective as if they were implemented separately. For example, increasing transit ridership will reduce the amount of VMT that can be reduced by pay-as-you-drive (PAYD) insurance. It appears that the commission estimates the reductions for each policy by applying the estimated reduction to total forecasted 2020 emissions, not adjusting for overlaps. The commission estimates that four policies would reduce VMT and emissions by about one-half in 2020. Although these policies would reduce VMT and emissions, and there is research that indicates it could be done efficiently in the case of PAYD insurance, when the policies are combined they will not create as large of a reduction as expected due to the interactions between them. In addition, implementation difficulties could preclude policies from achieving any reductions. In one policy, land use and location efficiency, it is assumed that a variety of policies will be implemented that reduce total VMT in 2020 by 18%.

- **Improper Benefit-cost Valuation:** One of the recommended transportation and land use policies is funding additional mass transit through the imposition of a carbon tax (which is a separate policy). It is clear that increased mass transit funding will decrease emissions and can provide substantial benefits such as reduced pollution and congestion. However, it is not clear that the commission's estimates of the effectiveness, costs, and benefits of increased transit funding are accurate. The commission estimates that a carbon tax would net $2.8 billion annually, which is about an 84.0% increase in total current State transit expenditures. It further assumes that this increase would translate to an 84.0% increase in ridership which would (by assuming each rider currently travels a statewide average of VMTs) reduce total 2020 VMTs by 7.14%. The commission then applies one study's estimate of the full cost of driving an automobile in 2020 ($1.14 per mile) to conclude that the net benefits of transit policies would be $2.6 billion in 2020. The commission presents an alternative calculation (current federal mileage reimbursement rate) to conclude the lower bound net savings would be $41.6 million in 2020. However, it is unclear if an 84.0% increase in transit funding would automatically result in an 84.0% increase in ridership. For example, the environmental assessment of the proposed extension of the Purple Line concluded that many riders of the Purple Line would be existing transit riders. In addition, the commission's application of the $1.14

cost savings per mile is not appropriate for several reasons. First, this is one study's estimate of the full cost of driving in 2020 and includes external costs (including petroleum consumption and pollution), governmental costs (road construction and maintenance) and internal costs (the largest of which are transit time and the purchase of a vehicle). Second, policies that encourage additional commuters to use public transit will not cause an absolute elimination of these costs but a reduction relative to current levels. Roads will still require State and federal maintenance expenditures; individuals will continue to have commuting times (potentially longer in some instances); and public transit will still pollute, consume petroleum, and have accidents (albeit considerably less than automobile travel).

- **Potential Forecast Errors:** The commission acknowledges that conducting a state-level inventory and forecast is still relatively undeveloped. The plan relies on an inventory and forecast produced by The Center for Climate Strategies. In creating the estimates, the center used the State Inventory Tool and data from the Emission Inventory Improvement Program developed by and available for download from EPA. Although adjustments were made where data are available to enhance accuracy, data limitations in some areas necessitated using national averages and apportionment to Maryland based on different factors. Moreover, some emission forecasts are straight-forward and could benefit from more robust methods. More precise inventory analysis and forecasts will allow for more informed decisions during the policymaking process about the potential impacts from GHG mitigation policies.

Conclusion

Most economic analyses conclude that a national, incentive-based GHG mitigation policy will impose significant costs to the economy, but that these costs are relatively small compared to the total economy. Most research concludes that a national, incentive-based GHG policy would reduce total GDP by less than 1%. However, despite a significant amount of research, considerable uncertainty remains over the ultimate economic impacts of such a policy. In addition, the choice and design of the specific mitigation programs implemented will affect the magnitude and distribution of GHG mitigation costs. Policies that are not incentive-based (*i.e.*, command-and-control) and/or do not implement economy-wide regulations will be much more costly. The distribution of costs within the economy will depend on several key factors, including the energy- and carbon-intensity of energy consumed by each sector. In Maryland, the manufacturing sector will likely experience a greater amount of employment and output losses relative to the rest of the economy as a result of GHG reduction policies. However, policies that attempt to mitigate these losses and exempt the manufacturing sector will only increase the total cost of GHG mitigation and shift the burden to other economic sectors. Ultimately, the cost of GHG mitigation policies, even those imposed on businesses, will be borne by individuals.

Maryland's Climate Action Plan is a positive step in assessing the options for the State to reduce GHG emissions. If effectively implemented, the policies will reduce emissions and, in some cases, reduce emissions at the lowest cost. However, as mentioned in the plan, considerable uncertainty exists over the effectiveness of the reductions that can be achieved and the benefits and costs involved. In most instances, more rigorous analysis is required before a conclusion can be reached about a program's costs, benefits, and effectiveness. Until this is done, it is not possible to determine whether the policies will have a net benefit to the economy and whether or not a policy is the most effective method of reducing emissions.

Chapter 7. Putting It All Together – Policy Considerations and Conclusions

This report raises a number of policy issues that should be considered by the General Assembly when considering any legislation relating to the reduction of greenhouse gases (GHGs) in Maryland. These are summarized below.

Federal vs. State Action

- The federal government may indeed take action on this issue, but it could be several years before a nationwide cap-and-trade program is implemented.

- In the absence of immediate federal action, states are moving forward with their own targets and policies. However, the most economically-efficient mitigation policy would be comprehensive in nature. Ideally, it would regulate as many economic sectors as possible, cover all GHGs, and be national or international in scope. A patchwork of cap-and-trade programs in some but not all states will not be as efficient as a more comprehensive regime.

- Despite such inefficiencies and costs, states may choose to enact GHG reduction policies in order to encourage the federal government to act, gain critical experience, act as early as possible, and/or establish their own mitigation programs. If Maryland does enact a GHG reduction program, the State's goals and policies should be reexamined if and when a federal program is adopted.

Maryland Is a Leader in Climate Policy – Is Additional Action Necessary?

- Over the past decade, Maryland has taken significant steps to increase energy efficiency and conservation and to encourage renewable energy sources. In the 2008 session in particular, several pieces of legislation were enacted that will help reduce energy consumption, increase the use of renewable energy, and help stimulate a clean energy industry in the State.

- The Maryland Commission on Climate Change has concluded that despite these recent actions, the State should take additional steps to reduce GHG emissions. One main recommendation is to establish mandatory reductions in GHG levels by certain dates, as many states and other countries have done.

- The 42 mitigation strategies recommended by the commission in its Climate Action Plan are largely command-and-control policies, leaving uncertainty regarding how much emissions will be reduced and the costs and benefits involved.

Economic Considerations

- While reducing GHGs will be costly, the costs of inaction are expected to be far greater and should not be overlooked.

- A price must be put on GHG emissions to reverse the market failure that has occurred. Accordingly, any GHG reduction program should incorporate the use of a market-based policy (such as a cap-and-trade program or a carbon tax).

- Policies should be evaluated based on cost-effectiveness. To reach any GHG emission reduction target, policies that are feasible and result in lower costs should be implemented over policies that are more costly.

- A mitigation policy can be designed to reduce total costs. Providing firms flexibility (through banking, borrowing, and offset provisions) is encouraged, as is a geographic scope as extensive as politically feasible.

- Considerable uncertainty exists regarding the total amount of emissions that need to be reduced to reach certain targets, the effectiveness of individual policies in reducing emissions, and the total costs of reducing emissions. Policy approaches must be flexible in order to react to unanticipated changes and outcomes and must be designed to mitigate the risk of large, unanticipated negative impacts.

- The distribution of costs resulting from a GHG reduction program will likely be unevenly distributed and will ultimately depend on the mitigation policies implemented and how those policies interact with the economy. Energy-intensive industries will likely be disproportionately affected. However, establishing transitional assistance can reduce or negate this economic burden, albeit at a cost to overall economic efficiency. Households and individuals will ultimately bear the cost of GHG mitigation policies, even if businesses are the primary regulated entity.

- Exempting certain sectors of the economy or households will reduce the effectiveness of the reduction strategy and increase total costs. Exemptions will serve only to shift costs to those who are not exempted.

- Several studies indicate that once the environmental benefits of reduced GHG emissions are accounted for, a carefully tailored GHG reduction program will provide net economic benefits. However, the extent of opportunities to reduce GHG emissions without at least a moderate negative impact to the economy in the short-run is unclear.

- While energy efficiency programs are seen by many researchers as the least costly method of reducing GHG emissions in the short run, they should not be the primary tool for doing so; rather, they should be used in conjunction with market-based mechanisms.

- While the establishment of a comprehensive mitigation policy is strongly encouraged by a number of experts, adaptation policy cannot be overlooked. As climatic changes accelerate, the preventative measures accomplished through prior adaptation policies will prove to be cost-effective.

- Finally, although early action is encouraged, it is important to acknowledge the initial economic burden of a comprehensive mitigation policy. It may not be prudent to enact such a policy in the midst of an economic recession.

Future Actions

- In order to establish an effective policy, the State needs to undertake a comprehensive GHG inventory and conduct robust and independent economic analyses of any mitigation proposals prior to implementation.

- Regardless of what types of policies are implemented, the State should continue to monitor the impact of existing programs, continue to make efforts to refine and improve them, and encourage coordination among the affected agencies to ensure a coordinated, comprehensive approach to addressing climate change.