Power Plants and Global Warming

Impacts on Maryland and Strategies for Reducing Emissions

MaryPIRG Foundation

Acknowledgments

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Executive Summary

By tapping its energy efficiency potential and developing its renewable energy resources, Maryland can meet its electricity needs while producing less global warming pollution than it does today. With a strong cap on global warming emissions from the state's seven oldest coal-fired power plants, Maryland could reduce its global warming emissions from those facilities by at least 15 percent below current levels by 2018 by using energy efficiency and renewable energy.

Global warming presents a serious threat to Maryland's environment, economy and way of life.

- Since the beginning of the Industrial Age, the concentration of carbon dioxide in the atmosphere has increased by 31 percent, a rate of increase unprecedented in the past 20,000 years. As a result, global average temperatures have begun to rise. The decade from 1990 to 2000 was the warmest decade in 1,000 years.
- The first signs of global warming have already begun to appear in Maryland. The average temperature in College Park has increased by 2.4° F in the past 100 years. Rising sea levels, combined with land subsidence, have swallowed 13 islands in the Chesapeake Bay and consume 260 acres of land each year.
- Temperatures in Maryland are projected to increase by 2° to 9° F by 2100, and precipitation could increase by 20 percent. As a result of these changes, Maryland will likely experience worse air quality, increased insect-borne disease, declining agricultural production and the loss of plant and animal species, including the Baltimore Oriole, the state bird.
- Ocean levels are expected to rise another 19 inches by 2100. Thousands of acres of land, especially on the Eastern Shore, are vulnerable to complete submersion or to inundation during high tides.

Electricity generation, especially from coal-fired power plants, is a major source of Maryland's global warming pollution.

- The state's seven oldest coal-fired power plants are responsible for approximately 31 percent of Maryland's emissions of carbon dioxide, releasing 23.1 million metric tons of carbon dioxide in 2004.

- Electricity demand is projected to rise by 25 percent by 2018, potentially increasing global warming emissions from the state's dirtiest plants.

Maryland can limit future increases in global warming pollution by establishing strong emission reduction targets for the state's oldest coal-fired power plants.

- A carbon cap would establish a maximum allowable level of emissions from coal plants. Facilities would be required to hold allowances for each unit of carbon dioxide they emit. Those that reduce pollution below the cap level would be able to sell their excess allowances to plants that emit more than the cap allows.

The most reasonable approaches to reducing the need for power from coal-fired plants—and thus cutting emissions—are energy efficiency measures to reduce consumption and full implementation of the state's renewable energy standard to increase generation from clean sources.

- The state has sufficient efficiency potential to reduce power demand by 14 million megawatt-hours (MWh), or 16.5 percent of total electricity demand projected for 2018. This would return electricity demand in 2018 to 2006 levels.
- Maryland's renewable energy standard (RES) requires that 7 percent of the electricity consumed in the state come from clean, renewable sources by 2018. Assuming Maryland enacts strong efficiency measures to control demand for electricity, the RES could result in the generation of 4.7 million MWh of clean electricity.
- By stabilizing demand for electricity, energy efficiency measures would ease pressure to increase electricity production at carbon-intensive coal plants. Carbon-free renewable energy could substitute for some of the power currently produced at coal plants. Under this scenario, emissions at the state's oldest coal-fired power plants could be reduced by 15 percent in 2018.

It is clear that Maryland can achieve dramatic reductions in the amount of pollution generated from the state's seven oldest coal plants. To capture this potential, the state should:

- Establish a strong goal for reducing global warming emissions from coal-fired power plants.
- Structure the carbon cap so that revenues generated by the auctioning of emission allowances support additional carbon reduction efforts, including energy efficiency.
- Ensure full implementation of the renewable energy standard. Consider pursuing greater development of renewable energy resources to increase the amount of carbon-free power Maryland consumes.

Introduction

Countries around the world have recognized that global warming is a serious threat and have begun to reduce their emissions. At the federal level, the United States has not joined this effort, neither acknowledging the risks of global warming nor making any effort to reduce carbon dioxide pollution. Instead, states must lead, creating and implementing plans to cut global warming pollution.

Maryland should act now to reduce its global warming pollution and protect the long-term well-being of the state. Particularly important are emissions from coal-fired power plants, which are a major source of the state's global warming pollution. In doing so, Maryland would join more than a dozen states that have already taken action to curb electric-sector global warming emissions and reduce the risks their states face from global warming.

The six New England states have joined several eastern Canadian provinces to address the threat global warming presents to the region. In 2001, they agreed to reduce global warming emissions in the region by 10 percent below 1990 levels by 2020. Meeting this goal will require emission reductions from all sectors, including electricity generation, transportation, commercial and residential energy use, and waste management.

A broader coalition of states has joined together in the Regional Greenhouse Gas Initiative. A group of New England and Mid-Atlantic states has just reached agreeement on a system to reduce emissions from electricity generation.

Action has not been limited to the East Coast. Oregon, Washington and California have joined efforts through the West Coast Governors' Global Warming Initiative to create region-wide goals for reducing emissions through state level action. Most recently, in California, Governor Schwarzenegger signed an executive order establishing a goal of reducing the state's total global warming emissions to 1990 levels by 2020. The governor's order further seeks to reduce pollution to 80 percent below 1990 levels by 2050, near the level scientists think is necessary to stabilize concentrations of carbon dioxide in the atmosphere.[1] In addition, New Mexico and Arizona have begun creating plans for cutting their emissions.

Recognizing the dangers of global warming and in the absence of action at the federal level, states across the country have begun to reduce their global warming emissions. Though global warming could have serious consequences for the state, Maryland has failed to take action to address its role in the problem. The state should act now to curb its global warming emissions, beginning with the electricity sector.

Global Warming and Maryland

Human activities over the last century—particularly the burning of fossil fuels—have changed the composition of the atmosphere in ways that threaten dramatic alteration of the global climate in the years to come. Those changes will have serious repercussions for Maryland.

Recent Climate Trends

Water vapor, carbon dioxide and other gases in the atmosphere help the earth retain some of the sun's heat, maintaining the earth's temperature and allowing life to flourish. Without these gases in the atmosphere, temperatures on earth would be too cold for humans and other life forms to survive.

However, human activities such as burning fossil fuels have increased the concentration of carbon dioxide and other gases and, as a result, the atmosphere traps more of the sun's heat. Since 1750, the concentration of carbon dioxide in the atmosphere has increased by 31 percent as a result of human activity. The current rate of increase in carbon dioxide concentrations is unprecedented in the last 20,000 years.[2] Concentrations of other global warming gases have increased as well.

This change in the composition of the atmosphere has begun to change the earth's climate. Global average temperatures increased during the 20th century by about 1 °F. In the context of the past 1,000 years, this amount of temperature change is unprecedented, with 1990 to 2000 being the warmest decade in the millennium.[3] Figure 1 shows temperature trends for the past 1,000 years with a relatively recent upward spike. Temperatures in the past 150 years have been measured; earlier temperatures are derived from proxy measures such as tree rings, corals, and ice cores.

This warming trend cannot be explained by natural variables—such as solar cycles or volcanic eruptions—but it does correspond to models of climate change based on human influence.[5]

Cold seasons have been shorter and extreme low temperatures less frequent. Since the late 1960s, Northern Hemisphere snow cover has decreased by 10 percent and the duration of ice cover on lakes and rivers has decreased by two weeks.[6] Glaciers around the world have been retreating.[7] Arctic sea ice has been reduced to record low levels.[8]

Oceans have risen as sea ice has melted. Average sea levels have risen 0.1 to 0.2 meters in the past century.[9]

Precipitation patterns have changed. In Asia and Africa, droughts have been more frequent and severe, a change that is consistent with models of climate change.[10]

Hurricanes and cyclones have become more powerful. From 1975 to 1989, only 20 percent of storms were considered Category 4 or 5, the classification given to the most severe storms. That proportion has increased to 35 percent in the period from 1990 to 2004.[11] In addition, tropical storms may be increasing in frequency, but that trend is not yet entirely clear. However, 2005 was a record-setting year with 26 named tropical storms in the North Atlantic, compared to an average of nine.[12]

In Maryland, changes have also begun to appear. The average temperature in College Park has risen by 2.4° F in the past 100 years. In many parts of the state, precipitation has increased by 10 percent.[13]

Predictions for the Future

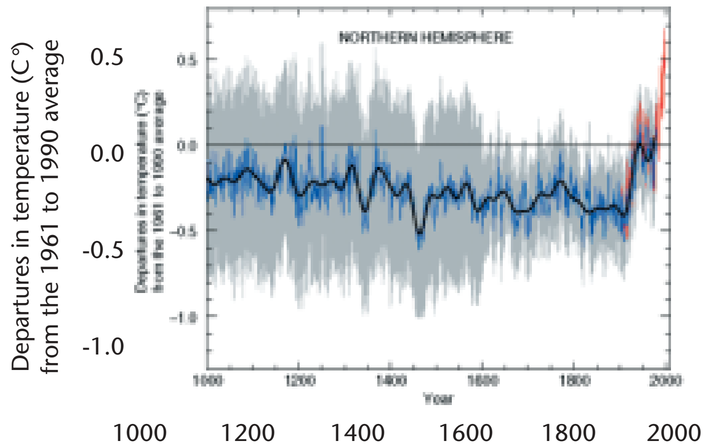
The earth's climate system is extraordinarily complex, making the ultimate impacts of global warming in a particular location—as well as the pace of change—difficult to predict. However, it is certain that global warming will have widespread impacts.

Temperature increases in the past century have been modest compared to the increases projected for the next 100 years. Global temperatures could rise by an additional 2.5° F to 10.4° F over the period 1990 to 2100.[14]

Maryland's climate is also expected to grow warmer, with spring temperatures rising by 1° F to 7° F by 2100.[15] Other seasons would be warmer, with average temperatures 2 to 9° F higher. Precipitation is projected to increase by an average of 20 percent. The increase would be concentrated in the winter and would likely result in more extremely wet or snowy days.

Temperatures may gradually rise,

Figure 1. Northern Hemisphere Temperature Trends[4]



changing precipitation patterns, plant and animal distribution and storm patterns over the course of decades, or higher temperatures may trigger a more sudden change in the earth's climate.

Historically, the climate has experienced large shifts in a single decade. Approximately 12,500 years ago, the earth's climate changed dramatically. In some places, temperatures may have fallen by as much as 10° F in just 10 years.[16] Frigid conditions persisted for roughly 1,000 years before returning to more normal temperatures. Scientists do not fully understand the cause of these changes but theorize that a seemingly gradual shift may cross a climate threshold and trigger rapid alterations.[17] Variations in atmospheric carbon dioxide concentrations, changes in solar radiation exposure due to shifts in the earth's orbit, and disruption of global ocean currents, all facilitated by positive feedback mechanisms, may be factors that push the climate toward thresholds that lead to rapid temperature changes.

Impacts of Global Warming

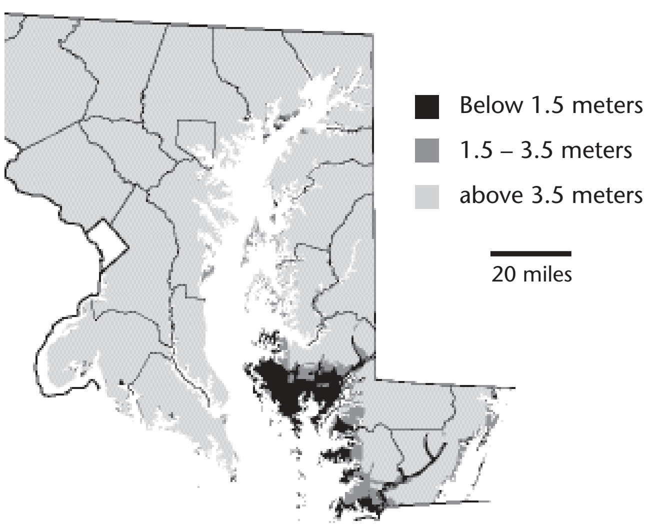
No matter what form global warming takes or how quickly it emerges, its effects will be felt across Maryland, in the environment, economy, and public health.

Rising Sea Levels

As global temperatures increase, ocean levels will rise due to melting polar ice caps and the expansion of surface water as it grows warmer. This will dramatically change the look of Maryland's coastline.

Low-lying land, such as the wetlands and farms along the Chesapeake Bay, will be flooded. Sea level near Baltimore has risen seven inches in the past 100 years.[18] Maryland's vulnerability to sea rise is exacerbated by a separate trend: the state is sinking by more than six inches per century as it recovers from glaciers that covered the region thousands of years ago.[19]

Figure 2. Map of Land Vulnerable to Sea Level Rise[20]



Areas shown in black could be flooded at high tide if global warming causes sea level to rise 2 feet. Land subsidence and tidal variations also play a role.

The net effect of rising sea levels and sinking land has been a one-foot increase in water level in the past 100 years, and along Maryland's 3,100 miles of coastline, the loss of 260 acres of land each year to the ocean.[21] Thirteen islands in the bay have disappeared.[22] Smith Island has lost 30 percent of its land area since 1850 and 1,400 acre Poplar Island has disappeared almost entirely.[23]

By 2100, ocean levels are expected to be another 19 inches higher.[24] Statewide, an estimated 380,000 acres of land are less than five feet above sea level and are vulnerable to inundation during high tides or to complete submersion.[25] Wicomico, Somerset and Dorchester counties are most at risk. By one estimate, shorelines in those counties could migrate inland by three to six miles.[26]

As sea level rises, beaches and wetlands are the first areas to be claimed by the ocean. Because of coastal development, new wetlands and beaches will not form and the state will lose valuable wildlife habitat and recreation areas. Development just inland from current wetlands and beaches often is protected by storm walls, preventing the evolution of new coastal wetlands through the inundation of low-lying land. From 1978 to 1998, Maryland landowners constructed more than 300 miles of seawalls and other barriers against rising ocean levels, meaning that wetlands on the ocean side of those barriers will not be able to migrate inland.[27]

Before the ocean overtakes coastal land, salt water seeps into the freshwater below it, penetrating aquifers and drinking-water wells. Water no longer can be used for drinking or irrigating. Rising water levels can also impair the function of septic systems, making it very difficult to sell affected homes.[28]

Declining Water Quality

Global warming may trigger a decline in water quality in the Chesapeake Bay, harming fish and crab populations. Increased precipitation in the bay's watershed will boost stream flows and the amount of nutrients that run off into the bay. Excess nutrients promote algal blooms, which can deplete oxygen levels below those needed by aquatic animals. Already, nutrient pollution causes algal blooms and areas of oxygen depletion covering more than one-third of the bay each summer.[29] The problem will grow worse as water temperatures rise, because warmer water cannot retain oxygen as easily.

Warming may cause the bay to be more or less salty. If water is saltier due to higher ocean levels, oyster diseases may spread more readily. However, too much fresh water from increased river and stream flows can kill oysters.[30]

The Loss of Plant and Animal Species

Higher temperatures and changes in precipitation will alter the mix of plants and animals that can survive in Maryland. Forested areas may shrink or become less dense. Hardwood trees could migrate north and be replaced by southern pines and oaks. Insect populations may thrive as temperatures increase.

As plant types change, birds and other animals may have to move northward to find suitable habitat. By one estimate, 34 species of birds that currently spend at least part of the year in Maryland may be forced out of the state by a changing climate, including the Baltimore Oriole, the state bird.[31]

The loss of wetlands and declining water quality in the Chesapeake Bay will harm waterfowl. Wetlands provide habitat for resident, migrating and wintering birds, such as Northern pintail ducks, osprey, snowy egrets, and redhead ducks, and the loss of wetlands to rising sea levels may cause a decline in bird populations.[32] Food supplies may dwindle as algal blooms and depleted oxygen levels impair the growth of the aquatic plants that are an important food source for many waterfowl.[33]

Changing plant and animal populations will have an economic impact on the state. In 2001, people who hunted, fished, or watched wildlife in Maryland spent $1.7 billion in the state's economy, supporting nearly 25,000 jobs.[34] Smaller wildlife populations may decrease the state's attractiveness as a destination for people seeking an outdoor experience.

Threats to Public Health

Higher temperatures will increase weather-related illnesses and fatalities. The number of heat-related deaths in Maryland could increase by 50 percent during summer heat waves.[35] Air quality could decline as hot summer days facilitate the formation of smog, ground-level pollution that can inflict respiratory damage. Smog levels in Maryland are already high enough to cause health problems and could increase further as temperatures rise.[36]

The incidence of insect-borne disease may rise also, as mosquito and tick populations thrive in warm, wet weather.[37] Mosquitoes in Maryland have already been found to carry West Nile virus, malaria, dengue fever and St. Louis encephalitis. Ticks may transmit Lyme disease.

Public health may also suffer if water quality declines. Evaporation from surface waters may increase with higher temperatures, and lead to greater concentrations of pollutants.

Declining Agricultural Production

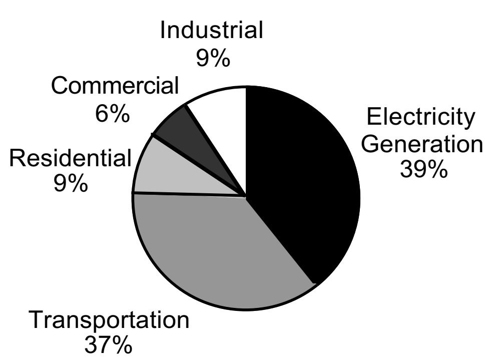
Higher temperatures and increased precipitation would affect Maryland's $1.3 billion agricultural industry. The state's primary crops are corn, hay, soybeans and wheat. Higher temperatures would decrease corn and hay production, while soybean and wheat production could rise or fall, depending on precipitation changes.[38]

Sources of Global Warming Pollution in Maryland

The primary global warming pollutant in the United States is carbon diox ide, which accounts for 85 percent of global warming pollution.[39] Carbon dioxide is released through the combustion of fossil fuels to power cars, heat buildings and generate electricity. Other global warming gases are released in far smaller quantities from sources such as landfills, agricultural activities and refrigeration units.

Data collected by the federal Energy Information Administration shows that electricity generation is the single biggest source of carbon dioxide in Maryland (see Figure 3).[40] Though the transportation sector may consume more energy, global warming emissions are higher from the electricity sector because power generators are so reliant on coal, a carbon-intensive energy source.

Figure 3. Sources of Carbon Dioxide Emissions in Maryland[41]

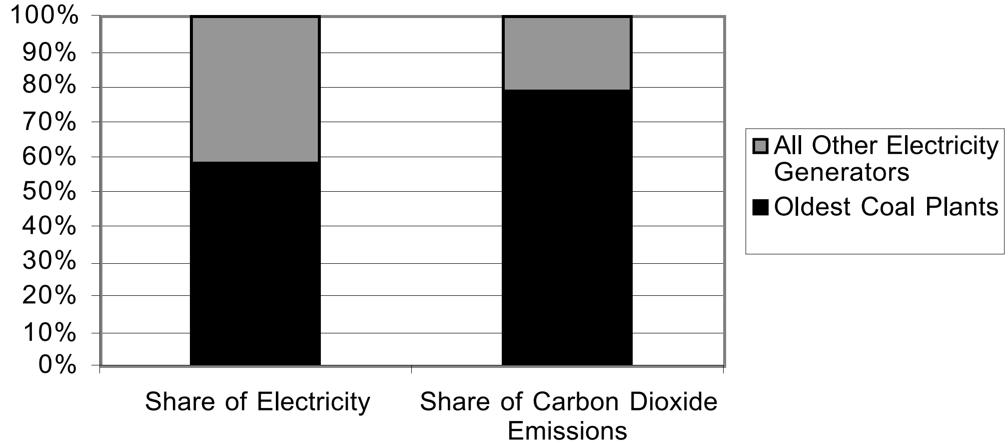


Nearly 60 percent of electricity generated in the state comes from coal-fired power plants.[42] Another 10 percent comes from other fossil fuels. The 52.1 million megawatt-hours (MWh) of electricity generated in Maryland in 2004 resulted in the release of 29.1 million metric tons of carbon dioxide.[43]

The state's seven oldest coal-fired power plants were responsible for the bulk of that carbon dioxide pollution. They produced approximately 59 percent of the power generated in the state but 80 percent of the carbon dioxide released during electricity generation in 2004. (See Figure 4.) Overall, these seven plants produced an estimated 23.0 million metric tons of carbon dioxide, 31 percent of the state's carbon dioxide pollution (see Table 1).[44]

Global warming emissions from in-state electricity generation are only part of Maryland's electricity-related emissions. Because the state consumes approximately 25 percent more power than it generates,

Figure 4. Electricity Output Versus Carbon Dioxide Emissions of Maryland Power Plants[45]



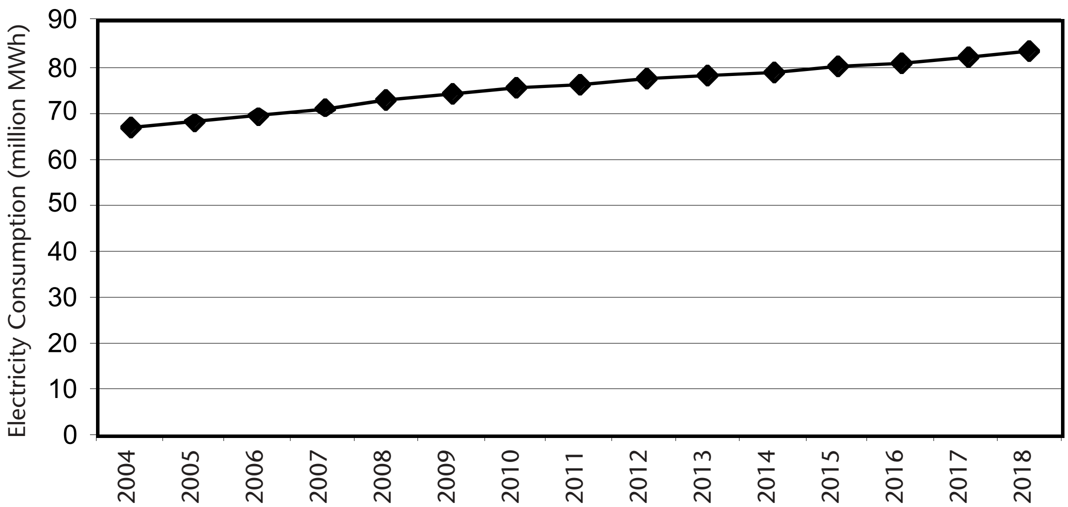
the state imports power that results in the release of global warming pollution in other states. Maryland imports power from the regional grid, which includes New Jersey, Delaware, most of Pennsylvania and West Virginia and portions of other states. More than half of the power generated in the regional grid comes from coal-fired power plants, resulting in significant global warming pollution regionally from power produced for Maryland.[47]

The global warming impact of Maryland's electricity use is increasing because the state's consumption of electricity is on the rise. In 2004, Maryland consumed 67 million MWh of electricity, an increase of 22 percent since 1994.[48] The Energy Information Administration projects that regional electricity consumption will increase by an average of 1.5 percent annually in the coming years, meaning that by 2018 Maryland will consume 83 million

Table 1. Emissions versus Generation from Maryland's Oldest Coal-Fired Power Plants[46]

Plant	First Year of Operation (for oldest unit)	Electricity Generation (MWh)	Carbon Dioxide Emissions ($MTCO_2$)	Emission Rate ($MTCO_2$/MWh)
Morgantown	1970	6,629,205	4,087,202	0.62
Chalk Point	1964	6,294,387	4,468,610	0.71
Dickerson	1960	3,517,288	2,667,281	0.76
C. P. Crane	1961	1,951,753	1,573,902	0.81
Brandon Shores	1984	8,445,693	7,063,267	0.84
Herbert A. Wagner	1956	3,378,878	2,884,061	0.85
R. Paul Smith	1947	350,695	340,742	0.97

Figure 5. Projected Growth in Maryland Electricity Consumption



MWh of power annually, 25 percent more than in 2004.[49] (See Figure 5.) Depending on the carbon-intensity of Maryland's power sources, this increase in electricity consumption could mean a large increase in global warming pollution.

Maryland can reduce its future global warming emissions by reducing its consumption of dirty fuels. The state can achieve this goal by pursuing energy efficiency opportunities that allow Maryland to meet its energy needs with less electricity and by increasing its use of clean, renewable energy. Energy efficiency potential is abundant in Maryland and because Maryland relies on such carbon-intensive fuels, even a slight decline in energy use can yield a measurable drop in global warming pollution. Nationally, the U.S. Environmental Progection Agency emphasizes that "changes in electricity demand have a significant impact on coal consumption and associated carbon dioxide emissions."[50]

In addition to reducing global warming pollution by meeting the state's energy needs more efficiently, Maryland can use cleaner energy sources. Renewable energy sources do not emit global warming pollution. Renewable generation will rise as the state's recently adopted renewable energy standard takes effect.

As a first step to reducing emissions, Maryland should establish a firm target for reducing global warming pollution from the state's seven coal-fired power plants with the highest emissions.

Reducing Global Warming Emissions from Coal-Fired Power Plants

Maryland should commit to reducing global warming pollution from the electricity sector and should set a clear target for future emission levels as a number of Northeastern and Mid-Atlantic states have done. This will require reducing the amount of power produced at carbon-intensive power plants. The best option for curbing the need for power that results in high global warming emissions is to reduce electricity consumption through energy efficiency and increase generation from renewable resources. How much carbon emissions will be reduced as a result depends on whether efficiency gains and renewables offset generation from carbon-intensive coal-fired power plants or lower-emission gas plants. A strong carbon cap is essential for ensuring the greatest reductions in global warming emissions.

How a Carbon Cap Works

A carbon cap is the crucial component of a cap-and-trade system for reducing global warming pollution.

In a cap-and-trade approach, regulators establish an overall limit on pollutant emissions within an economic sector (the "cap"). The cap must be set at an achievable but ambitious level that begins to reduce emissions to the level necessary to protect the climate. The right level will be low enough to promote efficiency improvements, the development of renewable power sources, and shifts to cleaner methods of generation. If the cap is set at a weak level, it will fail to drive the innovation and technology change that allows greater reductions in the future.

This total amount of pollution is then converted into "allowances" to emit a given quantity of the pollutant. Regulated facilities must hold enough allowances to cover their pollution. The allowable level of pollution may decline over time as the cap is lowered.

Facilities that reduce their emissions below the cap do not need all their allowances, enabling them to sell their excess allowances to other facilities that may be having a harder time achieving emission reductions. Such trading allows the economic sector covered by the program to achieve the desired emission reductions at lower aggregate cost than a traditional regulatory approach in which the same standard applies to every plant.

Emissions allowances should not be given away for free. Polluting facilities

Cap-and-Trade Is Not Appropriate for All Pollutants

One of the characteristics of cap-and-trade regulation is that not all sources of pollution must achieve the same emission standard. Instead, facilities must reduce their collective emissions to a sector-wide standard and may obtain emission reductions wherever they are easiest or least expensive. This may mean that one plant reduces emissions significantly while another does not curtail its emissions at all.

When the pollutant in question is mercury, nitrogen oxides, or sulfur dioxide, high emissions at a single location can create a "hot spot" of pollution with localized health and environmental consequences. For example, mercury, a neurotoxin released by coal-fired power plants, often is deposited locally and makes fish unsafe to eat. Deposition of nitrogen oxides from power plants has resulted in an expansion of the summertime "dead zone" in the Chesapeake Bay where fish cannot survive.

In contrast, carbon dioxide does not cause localized impacts. It contributes equally to the problem of global warming in Maryland and in states across the country. Thus, carbon dioxide can be controlled through a cap-and-trade system that allows some plants to emit far more than others.

should have to pay for the right to continue polluting. This could be accomplished by auctioning allowances to facilities. The funding from such an auction could be directed toward energy efficiency programs, which would help meet the emissions cap at a lower cost.

A carbon cap in Maryland could be structured to allow the seven affected power plants to buy credits from each other and from facilities throughout the Northeastern and Mid-Atlantic states, if Maryland joined a regional cap-and-trade program. A group of states from Maine to New York to Delaware is participating in the Regional Greenhouse Gas Initiative (RGGI) to reduce global warming pollution from electricity generation. The RGGI participants have established a regional goal of keeping emissions constant through 2015 and reducing emissions by 10 percent by 2018.[51] To meet this multi-state cap, power generating facilities in those states will be required to hold allowances for each ton of global warming pollution they release. Plants that reduce their emissions the most will have credits to sell. By establishing a carbon cap on the state's oldest coal-fired power plants, Maryland can lay the groundwork for joining RGGI.

Options for Reducing Emissions

There are three major approaches for reducing global warming emissions from power plants. They can be used separately or in combination.

A power plant may be able to improve its *efficiency*, thereby reducing the amount of fuel needed to produce the same amount of electricity. Better use of fuel will reduce the carbon-intensity of the electricity generated. Improved maintenance and minor upgrades can improve the efficiency of a coal-fired power plant by 8 percent from traditional operating levels, resulting in a corresponding reduction in carbon emissions.[52] In addition to the incentives created by a carbon cap, recent increases in the cost of coal may encourage plant operators to improve plant efficiency.

The plant's owner can decide to *reduce output* for part of the year or hours of the day when demand for electricity is lowest. The resulting reduction in carbon dioxide emissions would generate emission reduction credits that could be sold to other power plants. This approach is feasible because energy efficiency and renewable energy are ready to meet future demand for electricity.

A third option for reducing carbon emissions is to *switch fuels* by converting existing coal-fired power plants to burn other fuels that are less carbon intensive, such as natural gas or biomass. Though fuel switching can provide a large drop in emissions, it is also a more expensive and carbon-intensive option than capturing economy-wide energy efficiency opportunities and developing renewable energy sources that reduce the need for generation at coal-fired plants.

Reducing Demand for Carbon-Intensive Electricity with Energy Efficiency

Efficiency investments can provide the energy needed by a growing population and economy, while reducing pressure to build new power plants or operate older facilities to maintain the reliability of the electricity system. Greater use of energy efficiency can help ease reliance on traditional, carbon-intensive energy sources.

Maryland has enough efficiency potential to stabilize electricity consumption near current levels. Efficiency savings are available everywhere that electricity is consumed. In homes, offices, businesses and industry, electricity provides heat and light, powers computers and appliances, and supports industrial processes. Better insulation and sealing of buildings and less power-intensive heating, lighting, appliances and processes can allow the state to function as it does today but with less electricity. (See text box "Potential Efficiency Measures Span All Sectors of the Economy" on page 19 for more details.)

Numerous studies have quantified the potential for reducing electricity consumption using energy efficiency.

The Northeast Energy Efficiency Partnerships (NEEP) submitted a detailed analysis of a proposed statewide energy efficiency program to the Public Service Commission of Maryland in 2000.[53] The proposal included 12 energy efficiency programs that would deliver the greatest long-term energy saving per dollar invested. (See Table 2.) NEEP's analysis of the proposal concluded that these programs could save the state 3,400 GWh per year in 10 years, or 5 percent of 2004 energy consumption.

Table 2. Energy Efficiency Programs Studied by NEEP

Residential Programs
Heating/cooling system repair
Electric heating/cooling system replacement
Energy Star appliance and consumer products
Energy Star lighting
Energy Star windows
New construction
Low-income assistance
Commercial & Industrial Programs
Industrial efficiency
Building operation and maintenance
Building retrofitting
Energy efficient construction and equipment replacement
Motor system optimization

Synapse Energy Economics analyzed eight national and regional studies of energy efficiency potential. The national studies included work conducted by the Oak Ridge and Lawrence Berkeley national laboratories, the Tellus Institute, the American

Council for an Energy Efficient Economy and the Union of Concerned Scientists. Regional studies looked at efficiency potential in the Southwest, Midwest, the South, and the Northwest.

The studies identified cost-effective and achievable electricity efficiency savings of 21 to 35 percent of projected demand by 2020.[54] The estimated savings identified by those studies varied based on assumptions about how aggressive public policy will be in promoting and supporting programs to tap into cost-effective efficiency. The greatest savings occur when efficiency programs are well funded and government establishes rigorous efficiency standards for buildings and appliances. In other words, cost-effective efficiency potential is widely available; how much of it will be developed is determined by the effectiveness of public policies in promoting and encouraging efficiency.

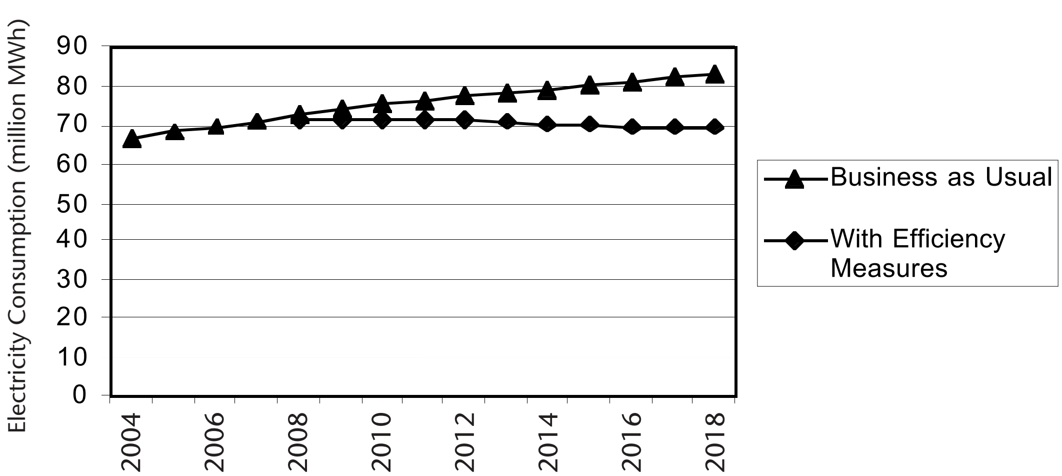
On average, Synapse concluded, the studies found that efficiency potential was 1.6 percent of electricity demand per year, or 16.5 percent in 10 years.[55] Achieving this level of savings requires long-term, concerted and aggressive policies to encourage energy efficiency.

Assuming Maryland implements efficiency measures beginning in 2008 and applying this average 1.6 percent annual savings potential to Maryland's projected electricity demand, the state could save 14 million MWh of electricity in 2018.[56] This is equal to 16.5 percent of power consumption projected for 2018 and would bring total 2018 consumption to 2006 levels. (See Figure 6.)

Achieving this reduction would require Maryland to resume investing in energy efficiency. Before the state deregulated its electricity system, Maryland had effective energy efficiency programs in place. In 1993, through the electric utilities, the state spent $31 million to support energy efficiency, though this declined to $14 million in 1998. This investment yielded annual energy savings equal to 3.5 percent of electricity sales.[57] Maryland should reestablish its energy efficiency programs and could fund them using revenues from the auctioning of emission allowances. In addition, the state should pursue efficiency standards for more appliances and commercial equipment and stronger energy codes for all buildings.

With consumption in 2018 not much greater than it is today, the state would be in a strong position to reduce global warming pollution below current levels. There would be no need to increase output from

Figure 6. Electricity Consumption in Maryland through 2018



Potential Efficiency Measures

Potential efficiency measures span all sectors of the economy and practically all uses of electricity.

Lighting and appliances hold a great deal of efficiency potential. In a typical home, 38 percent of the energy consumed is for lighting and for powering common appliances such as refrigerators, televisions and clothes dryers.[58] One-quarter of energy used in commercial buildings is for lighting. The amount of electricity required to light a home or office can be reduced by installing readily available compact fluorescent bulbs or upgrading the lighting system. And these changes could quickly pay for themselves. For example, commercial office buildings that have not recently upgraded their lighting system could reduce lighting expenses by half, producing net savings within one to three years.[59]

Appliances can be manufactured to consume less power, both when in use and when turned off. Refrigerators, freezers, electric hot water heaters, ceiling fans and other appliances can operate using less electricity. The amount of electricity consumed by appliances when they are not in use can also be reduced. Video and audio equipment and other appliances with a standby feature, which allows the use of a remote control, or that have an external power adapter, such as cell phone chargers, can be designed to draw far less power when the appliance is not in use. Maryland has already established standards for many of these appliances, but could set standards for more equipment.

The cooling and heating of buildings also offers efficiency potential through higher efficiency equipment and weatherproofing. Relatively few buildings in Maryland have electric heat, but many have electric cooling systems. The efficiency of air conditioners and fans on all types of furnaces can be improved, reducing the amount of electricity needed to achieve the desired temperature. New buildings can be constructed with better windows and doors, thicker insulation and more thorough sealing of all crevices where air might leak in so that the building passively maintains the right temperature. Existing buildings can be made more weatherproof with retrofitting.

Other efficiency opportunities are available in the industrial sector, where energy savings can come from more efficient motors, combined heat and power applications and advanced manufacturing technologies. Elsewhere, the efficiency of street lights and traffic signals can be upgraded.

Maryland can capture this efficiency potential by using a mix of common policy tools. Stronger energy codes can improve the energy efficiency of new residential and commercial buildings. Efficiency standards can reduce the power consumption of new appliances and commercial equipment. Statewide energy efficiency programs can provide financial incentives to all electricity customers to invest in power-saving measures such as improving building weatherization, replacing old appliances with more efficient ones, and designing more efficient processes. And energy efficiency programs can also promote the economic and environmental benefits of reducing power consumption through purchasing efficient products.

old coal-fired plants. And as generation from renewable sources increases, generation at the state's most carbon-intensive plants could be reduced.

In addition to making emission reductions easier to achieve, energy efficiency measures can save consumers money, reduce other pollution, and help stimulate the local economy. Although improving energy efficiency requires an initial investment, it would create positive economic benefits for the economy as a whole.

Efficiency Measures Are Cheaper than Generating and Delivering Electricity

Adding capacity to meet Maryland's projected demand for power would be expensive and would increase global warming pollution. Energy efficiency measures reduce expenditures for infrastructure and electricity.

Based on data from the federal Energy Information Administration, Maryland's electricity consumption is projected to increase by 25 percent by 2018 to be 17 million MWh greater than in 2004.[60] Projections by the federal government show that much of the new demand for power would be met with electricity produced at fossil fuel plants.[61] New fossil fuel power plants are expensive, and their operation will result in greater global warming pollution.

Investing in efficiency is cheaper. Energy efficiency can reduce the cost of cutting global warming pollution because it reduces costs to consumers in several ways. Those individuals and businesses that implement energy efficiency see direct reductions in their energy costs over time. All electricity consumers benefit from reduced costs to generate and supply power—particularly at peak periods when electricity is in high demand and is most costly to supply.

Investing in energy efficiency to reduce electricity demand costs less per unit of energy than purchasing power, thus saving money for consumers. For example, New Jersey reduced its electricity consumption in 2003 through the state's energy efficiency programs at an estimated cost of 1.9 cents per kilowatt-hour (kWh).[62] New England states achieved savings in 2002 for 2.4 cents per kWh.[63] In contrast, electricity cost an average of 8.6 cents per kWh in Maryland in mid-2005.[64]

Moreover, electricity rates do not include the broader social, economic, environmental or public health impacts of electricity generation.[65] Fine particulate air pollution from Maryland coal-fired power plants causes an estimated 670 premature deaths each year as well as many illnesses, imposing health care and other costs on the economy.[66] Rising natural gas prices—driven in part by increased demand from electric power plants—have had widespread economic ramifications beyond increases in electric rates. Environmental damage caused by the extraction of fossil fuel resources is extremely costly to remediate. Finally, the potential economic damage that could be caused by global warming is incalculable.

In addition, energy efficiency programs can be designed to reduce demand at peak periods, the most expensive times to provide electricity. Power producers must maintain enough generating and transmission capacity to meet demand on the hottest day of the summer. These "peaker" plants are less efficient and most frequently operate on natural gas, an increasingly costly fuel. Generation costs at natural gas plants are a major determinant of the electricity costs Maryland consumers pay.[67] As peak demand falls, total system costs and the average price of power may also fall.

Energy Efficiency Reduces Other Pollution

Burning fossil fuels produces not only carbon dioxide but also nitrogen oxides (NO_X) and sulfur dioxide (SO_2), and, in the case of coal, mercury. Energy efficiency measures reduce pressure to generate power at plants that burn fossil fuels and thus help lower emissions of health-threatening air pollution.

NO_X contributes to the formation of ground-level ozone, commonly known as smog, which can increase hospital emergency room visits, trigger asthma attacks and perhaps cause people to develop asthma in the first place.[68] Maryland frequently experiences smog concentrations that exceed federal health standards. Sulfur dioxide also causes respiratory problems, such as triggering asthma attacks, and can cause deadly heart attacks and strokes.[69] Mercury is a neurotoxin that is particularly dangerous to developing fetuses and small children. Reducing electricity demand can help reduce emissions of NO_X, SO_2 and mercury.

Energy Efficiency Can Stimulate the Local Economy

Moreover, energy efficiency improvements benefit local economies. By reducing energy costs, efficiency measures free up money that consumers can then use on other goods and services. And consumer spending on energy efficient products tends to benefit local merchants, as opposed to spending on fossil fuels, which tends to siphon consumer dollars outside of the state.

A 2004 study by Synapse Energy Economics found that making greater use of energy efficiency and renewable energy nationwide would reduce carbon dioxide pollution almost 50 percent below business as usual by 2025—and generate $36 billion annually in savings.[70]

A 2003 study by the Tellus Institute for the World Wildlife Fund found that a suite of national-level clean energy policies would reduce electricity demand by 25 percent below projections and carbon dioxide pollution by 60 percent below 2000 levels—while producing net energy savings of $100 billion annually by 2020.[71]

These savings represent money not spent on energy and instead available for consumers to spend in the local economy or for businesses to reinvest.

Energy Efficiency Produces Stability

Energy efficiency reduces consumers' vulnerability to changes in the price of power. In deregulated markets such as those in the Mid-Atlantic states, the price of power is most often determined by the costliest source of generation currently operating. Thus, electricity costs may experience major fluctuations, particularly as natural gas prices rise. Consumers whose consumption has been reduced through efficiency measures will not be as affected by these inevitable price swings in the market place.

In addition, the stability and reliability of the region's electricity system may be improved with efficiency measures. Reducing demand for power during times of peak use relieves pressure on the system when it is most stressed, such as hot summer days, cutting the likelihood of a service interruption.

Increasing Carbon-Free Generation with Renewable Energy

In 2004, Maryland adopted a renewable energy standard that requires a certain portion of electricity sold to Maryland consumers to come from clean, renewable resources. As this requirement is implemented, global warming pollution from electricity consumption will drop if the renewable energy replaces fossil fuel generation.

Clean, renewable energy does not produce global warming pollution. Wind and solar are emission-free. Biomass sources, such as burning of methane released from landfills or sewage treatment plants, release some global warming gases, but have far less of an impact than unburned methane released to the atmosphere.

The renewable energy standard will

increase the amount of renewable energy consumed in Maryland. Beginning in 2006, 1 percent of the power sold in the state must be from clean, renewable sources. The target level increases once every two years so that by 2019 and later, approximately 7.5 percent of the electricity consumed in Maryland will come from clean renewables.[72] In 2018 the RES will result in the generation of an estimated 4.7 million MWh of electricity from wind and biomass plants.

Maryland could increase development of renewable energy beyond this level to boost the amount of energy the state consumes from low-carbon sources. Incentives for the development and installation of solar energy and for the capture of methane from landfills and wastewater treatment plants are two readily available public policy options for increasing the state's renewable energy generation.

Potential Emission Reductions

By investing in energy efficiency, Maryland can essentially stabilize demand for electricity. Power consumption in 2018 would equal 2006 levels, meaning there would be no need to increase production at high-emission coal-fired power plants, build any new generation capacity that would raise global warming pollution or increase imports from the regional grid.

As the state's renewable energy standard becomes effective, generation of renewable energy will increase. By 2018, nearly 7.0 percent of the state's power will be provided by carbon-free sources. This renewable energy could substitute for some of the power currently produced at coal plants, allowing them to reduce their output. Because the renewable energy standard applies to all power consumed in the state, it represents more than 7.0 percent of power generated in Maryland and thus could replace a significantly higher percentage of power from the state's coal-fired power plants. This will happen only if a carbon cap is in place. If not, the renewable energy will reduce the need to build new fossil-fuel plants that are not as carbon intensive as existing coal plants. With a carbon cap, the electricity displaced will be more likely to come from the most carbon-intensive generators. Under this scenario, emissions at the state's oldest coal-fired power plants could be reduced by 3.5 million metric tons of carbon dioxide, or 15 percent, in 2018.

Policy Recommendations

To begin to address the threat presented by global warming, Maryland should reduce emissions from the coal-fired power plants that produce a significant portion of the state's global warming pollution.

Maryland can achieve this by establishing a carbon cap that will reduce emissions from coal-fired power plants. The carbon cap should be structured so that revenues generated by the auctioning of emission allowances support additional carbon reduction efforts, including energy efficiency.

Separately, Maryland needs to pursue aggressively the development of its renewable energy resources. A renewable energy standard was adopted in 2004, requiring that 7.0 percent of the electricity sold in the state in 2018 will come from clean, renewable sources. The state simply needs to ensure adequate implementation. In addition, the state should consider other support for renewable energy, such as expanding the use of solar power.

Methodology

Electricity Consumption and Projected Demand

Projected electricity use in Maryland was calculated using data and projections from the U.S. Department of Energy, Energy Information Administration (EIA). Current electricity use data came from EIA, *Current and Historical Monthly Retail Sales, Revenues, and Average Revenues per Kilowatt Hour by State and by Sector (Form EIA-826)*, downloaded from www.eia.doe.gov/cneaf/electricity/page/data.html, 22 July 2005. Projected consumption is based on EIA's projected rates of growth for the Mid-Atlantic region. The projected electricity growth rate is from EIA, *Annual Energy Outlook 2005 Supplemental Tables, Table 62: Electric Power Projections for Electricity Market Module Region, Mid-Atlantic Area Council*, February 2005. The regional growth rate was applied to a Maryland baseline.

Carbon Dioxide Emissions

We calculated carbon dioxide emissions for several different subsets of electricity generators. Emissions were calculated as follows:

We obtained fuel consumption data for electricity generators from the U.S. Department of Energy's Energy Information Administration, as presented in Form EIA-906 and Form EIA-920. Consumption of different fuels is provided for each generating facility.

Using fuel consumption specifically for electricity generation (as opposed to heat production), we translated fuel amounts by mass or volume into carbon dioxide emission amounts using a set of coefficients developed by the EIA for the Voluntary Reporting of Greenhouse Gases Program, with appropriate unit conversions.[73] For all biogenic biomass fuels, including wood waste, we assigned an emissions value of zero as suggested by the EIA. For municipal solid waste, we used the EIA derived value of 919 pounds of carbon dioxide per short ton of waste burned, reflecting the non-biogenic portion of municipal solid waste. Coal-based synthetic fuel, coal that has been sprayed with oil, was assigned a coefficient equal to sub-bituminous coal, per a recommendation from Perry Lindstrom, EIA, personal communication, 17 October 2005. Blast furnace gas was assigned a coefficient of 50.661 pounds of carbon dioxide per thousand cubic feet, based on data provided by Perry Lindstrom, EIA, personal communication, 19 October 2005.

Emissions from in-state power plants included fuel use at all Maryland-based generators listed in Form EIA-906 and Form EIA-920, including fuel classified as "state-fuel increment." Emissions from the state's seven oldest coal-fired power plants includes fuel consumed at the power plants in Maryland exempted from clean air rules.

Savings from Renewable Energy Standard

We assumed that Maryland's renewable energy standard will be fully implemented on the timeline established by the law. The standard applies to all electricity sold in the state except sales of more than 300 GWh to a single consumer.[75] We assumed the standard will apply to all power sold in the state except for power sold to Eastalco, an aluminum processor. Currently, Eastalco consumes approximately 350 MW continuously, or 3,100 GWh annually.[76] To ensure a conservative estimate of the savings possible with the renewable energy standard, we assumed that Eastalco will continue to operate and that the power it consumes will remain exempt from the standard.

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