other hand, has remained mostly unchanged over the past five years, although year-to-year fuel deliveries to individual power plants shows considerably more variation.

Recently permitted generation facilities are expected to mostly utilize existing transportation infrastructure for fuel delivery. Delmarva Power is currently evaluating both rail and barge to transport coal to the proposed Dorchester 1 power plant in Dorchester County. If rail is chosen, the operation of nearly two unit coal trains per week over the Cambridge-Preston branch line would represent a significant increase in traffic over the state-owned line, which is currently subsidized. If barge is used for coal delivery, more than five barge loads per week would navigate the Nanticoke River between its mouth on the Chesapeake Bay and Vienna. This option would also require the transshipment of coal via truck from a barge unloading area to the plant, a distance of about two miles.

For the Panda-Brandywine facility currently being built, natural gas will be supplied via pipeline from an existing gas pipeline in Charles County located south of the facility. The majority of the pipeline will be located within an existing rail corridor to minimize environmental and social impacts during construction.

3.6.3.3 Summary

Transportation has rarely been a major issue in the siting or operation of Maryland utilities. With most generation facilities supplied by barge, rail, or pipeline, the transport of fuel from source to destination is largely unseen by Maryland's population. Where public roads are used, the additional traffic generated has usually been small due to modest consumption of truck-transported fuels. A moderate increase in traffic attributable to the transport of coal to one Maryland utility (PE's R.P. Smith plant) occurs on lightly traveled roads in a predominantly rural region.

Transportation issues have had a higher profile in two recent licensing proceedings, although for different reasons. In the evaluation of the Panda-Brandywine cogeneration facility, public concern focused upon the collocation of a natural gas pipeline within an active rail corridor that, in the future, may be part of a commuter rail system extending into southern Maryland. Extensive utilization of existing corridors is usually inevitable when generating facilities are located in urbanized environments, although public safety does not have to be compromised.

With respect to the proposed Dorchester project, transportation impacts are likely to hinge upon Delmarva Power's modal choice for the delivery of coal. If unit trains are used, the increase in traffic on the state-

subsidized Cambridge-Preston branch line would improve the line's economic viability. If barges are used, traffic conflicts could increase along the route between the barge unloading area and the plant site. Delmarva Power's choice will largely be determined by economics, although the costs and benefits associated with these externalities will also have to be factored into the equation.

4.0 *UPDATE ON POWER PLANT AND ENERGY ENVIRONMENTAL ISSUES*

4.1 *CHESAPEAKE BAY PROGRAM*

The Power Plant Siting Program, precursor to PPRP, was created in 1971 in response to public concern about the proposed Calvert Cliffs Nuclear Power Plant. Calvert Cliffs became the focus of many of the initial environmental studies, including studies of the Chesapeake Bay, conducted by PPRP and the facility's owner, BGE.

During the 1970s and early 1980s, the health of the Chesapeake Bay and its living resources declined significantly because of a variety of anthropogenic factors. Increasing public concern about the state of the Bay led to the establishment of the Chesapeake Bay Program in 1983. Twenty years after the initiation of the Power Plant Siting Program, data from many of the long-term, scientifically rigorous studies conducted at Calvert Cliffs and other power plant sites continue to be used in Bay research. Thus, the motivations and forces that created and sustained PPRP are very similar to those that foster the Chesapeake Bay Program.

4.1.1 *Power Plants as Sources of Impact on the Bay*

The Chesapeake Bay Program, a cooperative state and federal effort, has identified several environmental factors that contribute significantly to the degradation of the Bay and the decline of its living resources. Key among these factors is high loading of nutrients (phosphorus and nitrogen), which results in excessive production of algae. The excess algae block light from reaching submerged aquatic vegetation and decrease dissolved oxygen levels in deeper portions of the Bay as dead algae decompose. Major sources of nutrients entering the Bay include effluents from sewage treatment plants, runoff from urban and agricultural lands, and deposition of nitrogen from the atmosphere. The introduction of toxics into the Bay also has been one of the Chesapeake Bay Program's major concerns because of the effects of toxics on organisms in all links of the Bay's food chain and the potential human health risk posed by toxics. Primary sources of toxics include industrial discharges and runoff from the Bay's watershed. Some of the toxics in watershed runoff originate from atmospheric deposition.

Over-exploitation of the Bay's fish and shellfish resources and degradation of critical habitats for commercial, recreational, and ecologically important species are also significant concerns for the

BENTHIC INVERTEBRATE COMMUNITIES AND THE CHESAPEAKE BAY

Benthic invertebrate communities were recently used to describe bottom habitat condition throughout the Chesapeake Bay using data from PPRP and other studies. Benthic organisms are considered reliable environmental indicators because they have limited mobility and therefore cannot avoid changes in habitat quality, and because they are sensitive to changes in bottom water dissolved oxygen concentrations and sediment chemical contaminants.

Using the benthic Restoration Goals, it is now possible to describe the condition of benthic communities from different habitats on a single and uniform scale. The Restoration Goals are a set of salinity, and sediment habitat-specific benthic community attribute levels expected for relatively unstressed communities. Community attributes such as biodiversity, total biomass, and the proportion of pollution tolerant organisms are included in the goals. The Restoration Goals Index (RGI) measures the extent to which the Restoration Goal is being attained.

The RGI was applied to benthic monitoring data collected throughout Chesapeake Bay from 1985-1990 to produce a map of current benthic community conditions in Chesapeake Bay (see accompanying map on following page). Benthic communities in the deep mainstem, the lower Rappahannock and Elizabeth Rivers in Virginia, the lower Potomac, and Baltimore Harbor are in the worst condition. Benthos of the upper and lower Bay, and the upper portions of the tributaries are in the best condition. Most of the degradation in benthic community condition was related to low dissolved oxygen. Contaminants, mainly zinc, lead, and mercury, explained a small portion of the variation in benthic response.

Chesapeake Bay Benthic Community Conditions

Chesapeake Bay Program. One important objective of the Program is to remove obstacles to upstream migration of anadromous fish that use Bay tributaries as spawning and nursery areas.

Constructing and operating power plants clearly has the potential to contribute to most of the key environmental issues being addressed within the Chesapeake Bay Program. For example, emissions from power plants may contribute to atmospheric nitrogen loading to the Bay's watersheds. Power plants release a variety of toxics, including mercury, through atmospheric emissions and runoff. Power plants that use Bay water for cooling reduce fish and crab stocks by entraining larvae and impinging juveniles and adults. In addition, hydroelectric plants on the Susquehanna River have been obstacles to upstream migration of anadromous fish into the largest tributary of the Bay. Fish passage facilities at those dams play an essential role in meeting the Chesapeake Bay Program's goal to restore anadromous fish. Most recently, the focus has shifted to the Bay's tributaries to address the sources of adverse effects on the Bay. Many power plants in Maryland are situated on major tributaries, and PPRP's studies at those plants have yielded information that may contribute to developing the Chesapeake Bay Program's tributary management plans.

4.1.2 *Relationship of PPRP to Chesapeake Bay Program Activities and Objectives*

CEIR-8 described the contributions of past PPRP-sponsored studies to the Chesapeake Bay Program's accomplishments (PPRP 1993). PPRP continues to support one of the Chesapeake Bay Program's most notable monitoring efforts, the Long-Term Benthic Monitoring Program (LTB). LTB is a major element of the Chesapeake Bay Program's comprehensive effort to monitor the status, trends, and changes in the Bay ecosystem. PPRP recently administered a research project to establish benthic restoration goals for the Bay's tributaries using LTB data and data collected in the companion Virginia benthic monitoring program. LTB benthic data have proven invaluable for tracking changes in the status of the Bay's living resources in response to the Chesapeake Bay Program's enhancement and management efforts.

In addition to the LTB, PPRP continues to provide partial funding for several other elements of the state's Chesapeake Bay monitoring program, including:

- **Phytoplankton-Microzooplankton Component** which includes measurements of phytoplankton and microzooplankton species composition and abundance, vertical and horizontal in vivo

fluorescence (chlorophyll) profiles for biomass estimates, primary productivity, and presence/absence of zebra mussel veligers.

- **Mesozooplankton Component** which are collected with a towed netting system to determine abundance and biomass of larger zooplankton populations in the Bay and its tributaries.
- **Nutrient Bioassay Component** which is intended to determine the nutrient most limiting to phytoplankton growth in the Chesapeake Bay and its tributaries at various times of the year.
- **Sediment Oxygen and Nutrient Exchange (SONE) Component** which measures the flux of oxygen and nutrients into and out of the sediments of the Chesapeake Bay and its tributaries, and measures a number of characteristics of sediment enrichment, including nutrient content and oxidation state.

PPRP's continuing toxics studies, described in Section 4.2, augment Chesapeake Bay Program efforts to assess sources, consequences, and means of mitigating the effects of toxics introduced into the Bay. A recently completed PPRP project investigated the contribution of power plants to mercury loadings to Maryland's environment. Mercury is an environmental contaminant of significant public interest, particularly regarding its presence in the tissue of edible fish. Extensive ongoing work, funded by PPRP, is devoted to characterizing atmospheric deposition of trace elements, including organic and inorganic toxics, to the Bay and its watershed. A one-year PPRP field program that monitors loadings of atmospheric trace elements to the Bay is being continued for two additional years under Chesapeake Bay Program funding.

Four additional studies sponsored PPRP are designed to improve estimates of deposition fluxes of particles. The first focuses on the size distributions of atmospheric particles entering the Bay, and how size changes with different meteorological conditions. The second is a model-based approach for estimating deposition velocities of particles. A third PPRP-sponsored study estimates the extent to which trace elements from atmospheric deposition are transmitted through forested watersheds to Bay tributaries. The fourth study investigates the feasibility of using trace elements to identify sources of toxic emissions deposited in the Bay watershed. All of these studies will develop means of determining the sources of toxics loadings to Chesapeake Bay, including power plants, and will help identify potential means of reducing or eliminating those loadings.

PPRP is working closely with MDE to define and evaluate contaminant loadings in the Bay and its tributaries and is assisting MDE in developing toxic discharge criteria for power plants. These efforts will further

contribute to identifying the contribution of power plants to toxics loadings to the Bay and the appropriate regulatory measures for reducing those loadings as established in the Chesapeake Bay Program's toxics control strategy.

In further support of the Chesapeake Bay Program's efforts to reduce nutrient loading to the Bay, PPRP recently co-funded a study with MDE to evaluate the potential effects of the CAA Amendments of 1990 on NO_x emissions and nitrate deposition to the Chesapeake Bay watershed. That study suggested that aggressively controlling NO_x emissions (going beyond the standard requirements of the CAA) in a region encompassing the District of Columbia and 20 states east of the Mississippi River could significantly reduce atmospheric nitrate deposition to the Bay.

PPRP continues to coordinate its research, monitoring, and assessment efforts with ongoing Chesapeake Bay Program studies and activities to ensure that the contribution of power plants to Bay impacts and means of mitigating those impacts are identified and addressed efficiently.

4.2 *TOXIC SUBSTANCES*

Power plants, like other industrial sources, can release toxic chemicals into the air, surface water, and ground water. Toxic substances are chemicals which, if released into the environment in sufficient amounts, have the potential to adversely affect human health or environmental resources. Research in this area is termed "fate and effects" because it looks at how toxic substances are released, where in the environment they end up, and what the consequences of the releases might be for people, plants, and animals. PPRP has sponsored a range of fate and effects research on toxic substances related to power plants.

As part of fate and effects, PPRP utilizes human health and ecological risk assessments to examine toxic impacts. Human health assessment has been applied primarily to atmospheric emissions and is described in Section 4.2.1. In assessing possible effects of atmospheric emissions as well as releases to water, PPRP has also applied ecological risk assessments following the U.S. EPA guidance recently issued (USEPA 1992). The U.S. EPA framework involves identifying and characterizing the chemicals that may stress natural populations, characterizing the types of effects that these chemicals may cause, and defining the pathways through which chemicals travel to expose the populations. Potential or real effects of toxic substances are carefully identified for the purpose of protecting exposed populations, and any effects are interpreted in terms of their ecological significance. Uncertainties in an analysis are reported so that decisions can take into account these uncertainties, as appropriate.

4.2.1 *Toxic Substances in the Air*

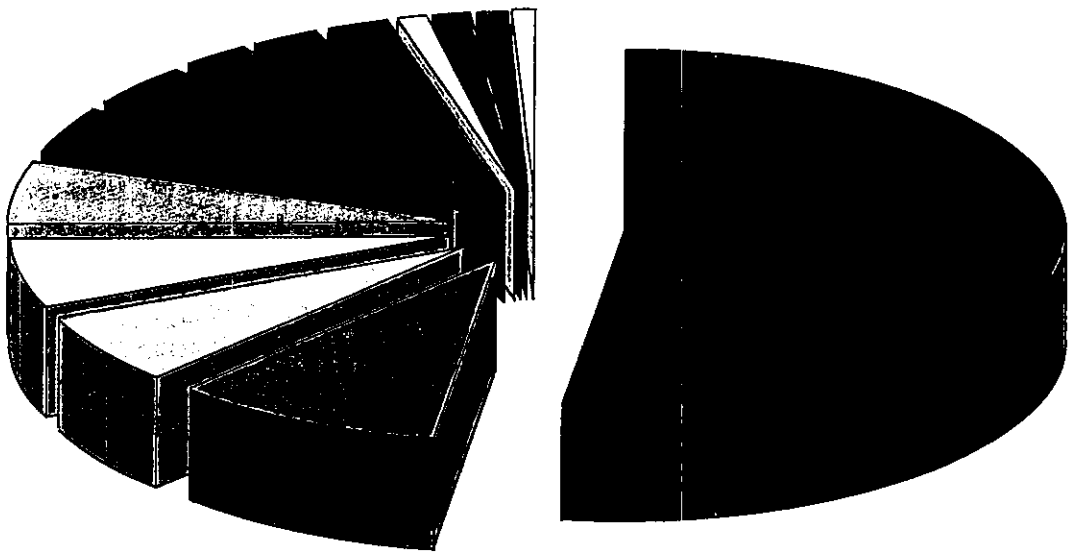
There is increasing public awareness and concern over the impacts of toxic substances released to the atmosphere, also referred to as **hazardous air pollutants (HAPs).** The concerns relate to both routine emissions, such as those from automobiles and other fuel combustion, and accidental releases. They relate to carcinogens (pollutants that cause cancer) and non-carcinogens (pollutants that produce detrimental, non-cancerous health effects such as respiratory ailments). Motor vehicles are currently believed to be the major sources of routine toxic emissions in urban areas (see Figure 4-1) (USEPA 1989). Power plants are responsible for most of the coal/oil combustion-based emissions, which comprise 2% of the total HAPs emissions.

People can be affected by toxic substances through the air they breathe — **direct pathway** — and through the food they eat — **indirect pathway.** Toxic substances deposited in farming areas or in watersheds that support fish can end up in food. Such indirect pathways can be complex. For example, toxic emissions to the atmosphere can be carried to the soil by rain, then absorbed by the roots of garden fruits and vegetables, eventually contaminating the produce that reaches our dinner tables.

The State of Maryland, as well as the federal government, are in the process of evaluating the effects of toxic emissions. These efforts examine uncertainty in the current understanding of exposure pathways and potential risks. A margin of safety is usually used in formulating regulations to protect people, and worst case scenarios are often assumed. For example, air regulations for toxic emissions are frequently developed to protect a hypothetical person exposed throughout his or her lifetime, outdoors, at the location of maximum exposure from a source of toxic substances. This is an unrealistic situation that errs on the side of overestimating risk. As our understanding of the processes involved improves, estimates of potential risks will continue to become more realistic.

At present, emissions of toxic substances from power plants are not regulated specifically either by the state or federal government, although many air toxics are regulated indirectly through controls on particulate matter emissions. Utilities and non-utility developers have also addressed air toxics emissions when seeking approval for new power plants in Maryland. Licensees have used MDE's exposure thresholds, applicable to industrial sources, to assess potential toxic effects to humans. In addition, the State has requested licensees, where warranted, to assess toxic effects to locally grown crops and other vegetation. Because of the uncertainties in the health impacts of power plants, the CAA Amendments of 1990 mandate studies of the effects of air toxic emissions from utility boilers,

Figure 4-1
Sources of Hazardous Air Pollutants



- Automobiles (52%)
- Platers (10%)
- Other (6%)
- Secondary Formation (6%)
- Waste Facilities (6%)
- Woodsmoke (4%)
- Manufacturing (4%)
- Gas Marketing (2.5%)
- Cooling Towers (2.5%)
- Coal/Oil Combustion (2%) (including power plants)
- Chemical Use/Production (1.3%)
- Solvent Use (1.3%)
- Municipal Waste Combustion (1%)
- Iron & Steel (0.8%)

and a special study of the effects of mercury emissions. The results of these studies eventually may be used to formulate federal regulations for controlling toxic emissions from power plants.

4.2.1.1 *Atmospheric Emissions of Toxic Substances*

There are many unanswered questions about the health effects of routine power plant toxic emissions. Two of the unanswered questions are related to indirect pathways of toxic exposure in general and to mercury emissions from coal burning in particular. Although the concern most frequently addressed is breathing contaminants in the atmosphere, current health risk studies indicate that, in rural settings, health risks from indirect pathways of exposure (deposition of contaminants by rain and incorporation into the food chain) also may be a potential concern.

Several studies of the health risks associated with utility emissions of toxic substances are underway currently. The U.S. EPA, the U.S. Department of Energy (DOE), and the Electric Power Research Institute (EPRI) are focusing on assessing risks from breathing contaminants and on obtaining more accurate emissions data to improve estimates of human health effects.

PPRP has conducted several investigations of toxic emissions from power plants. Preliminary results of PPRP's investigations suggest that metals are the toxic substances of greatest concern for health effects, but that predicted health effects due to emissions of metals are small for the proposed plants that PPRP has investigated. For example, a state-of-the-art, multipathway risk assessment was performed in conjunction with the licensing of PEPCO's Station H power plant in Montgomery County (Brower *et al.* 1990). This study indicated that health effects of toxic emissions from the proposed facility would be lower than any Food and Drug Administration health concerns, and would result primarily from consumption of food.

In response to local residents' concerns, PPRP recently assessed the potential effects on residents and local ecology of the Panda-Brandywine cogeneration facility proposed for construction in Prince George's County. Toxic emissions to the atmosphere are associated with occasional combustion of fuel oil as an emergency back-up for gas, and with use of sewage treatment plant effluent as makeup water in the cooling tower. It was important to consider the source of cooling water because people and plants might be exposed to chemicals carried in cooling tower drift emissions. PPRP performed both a human health and an ecological risk assessment to characterize the potential for adverse effects from exposure to ambient concentrations or from deposition of toxics. A wide variety of chemicals that might be released and several possible routes of exposure

to people and vegetation were considered. The analyses indicated that any environmental concentrations of chemicals resulting from proposed power plant operation would be close to background concentrations and safe for residents, their crops, and the surrounding natural vegetation.

PPRP is continuing its investigations and reviewing other studies to determine the potential effects of power plant toxic emissions on the residents of Maryland. PPRP is focusing its investigations on potential toxic emissions from the types of fuels burned in Maryland power plants, the effectiveness of rain in depositing contamination in the air onto soils and ponds close to power plants, and the toxicological effects of the pollutants.

4.2.1.2 *Mercury*

The concentration of mercury in the global atmosphere has been increasing at least since the industrial revolution (Slemr and Langer 1992). On a global basis, about one-half of the mercury released to the atmosphere through human activities can be attributed to the burning of fossil fuels — primarily coal, which contains trace amounts of the element (Douglas 1991). Mercury emitted to the atmosphere enters surface waters in rainwater and possibly through dry deposition. In many lakes in the U.S. and Canada, atmospheric deposition is believed to be the primary source of contamination because no other input has been identified (Glass *et al.* 1990; Sorensen *et al.* 1990). Mercury accumulates in fish and can cause toxic effects on the nervous systems of people and wildlife that eat contaminated fish (Eisler 1987; WHO 1990).

At present, 24 states have issued health advisories limiting consumption of fish because of high levels of mercury (USEPA 1993). The U.S. Food and Drug Administration (FDA) has an action level for mercury in fish tissues, which has been adopted by Maryland. A survey of 12 Pennsylvania lakes, completed in 1992, indicated one lake with walleye exceeding the FDA action level and several lakes with chain pickerel exceeding levels used by other states to issue advisories (Spotts and Rice 1992). As yet, no mercury concentrations above the FDA action level have been observed in fish from Maryland waters. In 1993, the U.S. EPA provided states with new guidance for issuing advisories on consuming mercury contaminated fish and new methods for determining safe levels of mercury for groups with different sensitivity and different rates of fish consumption (USEPA 1993).

There are many unanswered questions about the environmental fate and effects of mercury. They include questions about how much mercury is released during combustion, the chemical and physical properties of the released mercury, the transformations that occur after it is released to the

environment, and the toxicological effects on people and wildlife. In response to the growing concern, the CAA Amendments of 1990 specifically require the U.S. EPA to identify mercury emission sources, evaluate the contributions of power plants and municipal incinerators, identify control technologies, and evaluate the toxicological effects of eating mercury-contaminated fish. EPRI, in coordination with the U.S. EPA, is sponsoring studies on the environmental fate and effects of mercury and is attempting to resolve difficulties in the sampling and analysis of the element (Porcella 1990; Douglas 1991). PPRP is reviewing the results of mercury research to assess the implications for power plants in Maryland.

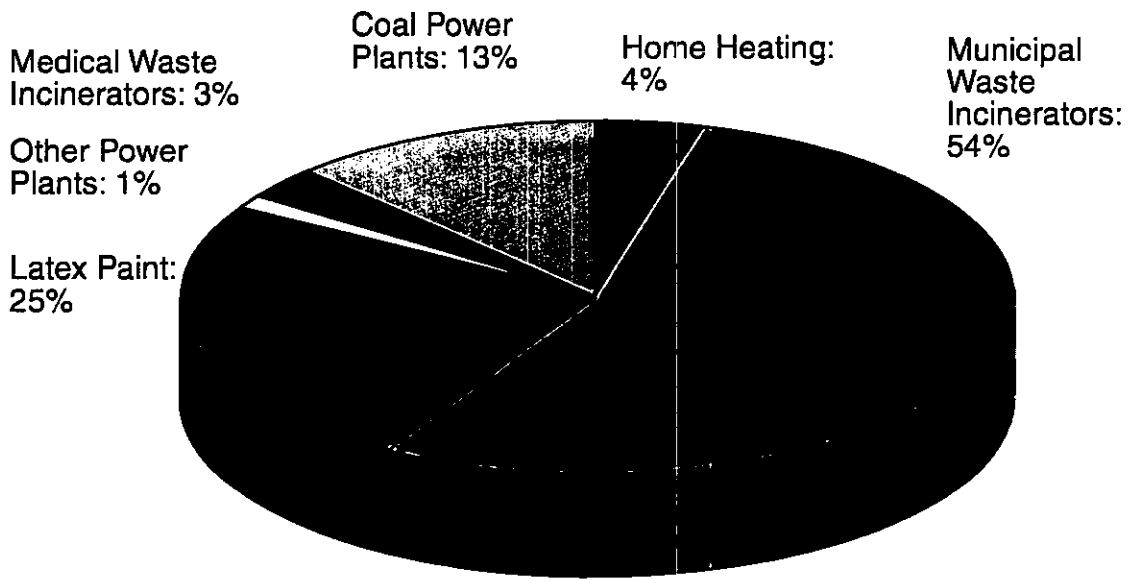
PPRP also initiated its own studies (PPRP 1994a) to determine whether mercury is a significant toxic chemical issue in Maryland, and to analyze atmospheric mercury emissions in Maryland for 1990, the latest year for which data were available. Three major sources contributed more than 90% of mercury released to the atmosphere: municipal incinerators burning batteries and other household products containing mercury, latex paints containing mercury, and coal-fired power plants (Figure 4-2). These studies indicate that, although coal-fired power plants contribute to mercury emissions, the resulting concentrations are not high enough to adversely affect humans or other organisms. At present, the importance of local atmospheric sources relative to out-of-state sources is not known.

4.2.1.3 *Accidental Releases of Toxic Substances*

There is always some possibility that hazardous substances stored and used at power plants and other industrial facilities could be released into the environment accidentally. Electric utilities must use several hazardous substances to operate their power plants, and, in most cases, there are no nonhazardous substitutes for these compounds. For example, ammonia and sulfur trioxide can be used in air pollution control systems. Chlorine is used routinely at power plant intakes to treat water and reduce biofouling. Hydrogen is used as a cooling medium for generators. Halon may be used in fire suppression systems designed to protect electrical and computer components. Although manufacture of polychlorinated biphenyls (PCBs) was discontinued in the United States in 1976, there are still some transformers in use today that contain the material. Atmospheric discharge of PCBs resulting from transformer fires or explosions can present risks to an exposed population. Accidental release of natural gas and liquefied petroleum gas poses risks of fire and explosion.

Regulations regarding accidental releases of toxic or hazardous substances into the environment have been promulgated under provisions of both Superfund and the CAA. Each of these are briefly summarized below.

Figure 4-2
Sources of Mercury Air Emissions in Maryland



- *Title III of the Superfund Amendments and Reauthorization Act of 1986* (SARA), also known as the Emergency Planning and Community Right-to-Know Act of 1986, provides a means for informing the public of the existence, quantities, and releases of hazardous substances. This law directs states, communities, and industry to work together to plan for chemical accidents, develop inventories of hazardous substances, track toxic chemical releases, and provide public access to information on hazardous substances. SARA Title III legislation was the direct result of the release of toxic chemicals in 1984 and 1985 in Bhopal, India, and Institute, West Virginia. Utilities have to comply with the law, but are currently exempt from certain portions.
- Under the *CAA Amendments of 1990*, the U.S. EPA has proposed regulations requiring risk management plans for potential releases of 77 acutely toxic substances and 63 flammable substances. Sources of toxic emissions, including power plants, that produce, process, handle, or store any listed substance in amounts exceeding the established threshold quantities will be required to prepare risk management plans. These plans must include an evaluation of worst-case off-site effects of accidental releases of the substances, and must detail the measures the facility will take to prevent and respond to an accidental release.

PPRP is presently evaluating the potential for accidental releases of listed substances from Maryland power plants. This investigation will also review current and proposed state and federal regulations to ensure that they adequately protect communities from the risks involved in power generation, in a cost-effective manner.

4.2.2 *Toxic Chemicals in Water*

4.2.2.1 *Chlorine*

Many Maryland power plants must draw in and use large quantities of river or Bay water to cool steam condenser tubing as part of the power generation process. The utilities frequently need to use chemical **biocides** to keep the condenser tubes clean and to keep aquatic organisms from clogging power plant systems. Chlorine is the most commonly used biocide, and trace amounts of it are released in the cooling water discharge.

In the 1970s and 1980s, concern over discharges of chlorine led the U.S. EPA and states to regulate the concentration and duration of chlorinated discharge. Chlorine is highly toxic to aquatic life, particularly larval fish (PPER 1991). Although chlorine is still the most commonly used biocide

in power plants across the United States, a number of facilities recently have conducted trials with alternative biocides, such as sodium bromide, and are exploring new techniques to minimize the amounts of chlorine used. A recent PPRP study evaluated the use of alternative biocides at U.S. power plants and tracked the results of trials conducted in Maryland (Pinkney 1992).

4.2.2.2 *Metals*

In addition to chlorine and other components of biocides, power plants can also discharge trace amounts of metals into the environment. The sources of the metals are wastewaters from cooling operations, boiler cleaning, ash generation, and disposal. Runoff from coal piles can also release toxic substances into the environment. Under the 1987 Clean Water Act (CWA) Amendments, the U.S. EPA developed lists of waterways that have been impacted by toxic chemicals, as well as discharges to these waterways. Ten power plants across the U.S. were included on the CWA's list of toxic dischargers.

The power plants were listed primarily because metal concentrations in their water discharges exceeded established levels. Two Maryland power plants — Brandon Shores and Vienna — were included on the list because concentrations of copper in their discharge water exceeded state standards (Pinkney *et al.* 1992). Control strategies are being developed to reduce these concentrations.

PPRP has recently examined the contribution of power plant discharges to copper levels in surface waters (Pinkney *et al.* 1991). It has been recognized that condenser tubing in power plant systems corrodes and releases copper into the environment. Copper/nickel tubing is used at 10 of the 13 Maryland power plants examined in the study. An alternative to copper/nickel tubing is tubing made of titanium, which is much more resistant to corrosion than copper and so should release smaller amounts of metals into the environment. The settlement of a lawsuit between MDE and a group of industries addresses the issue of pollutant discharges in excess of standards due to corrosion and erosion of condenser tubes. MDE's proposed regulations now provide for a one-time allowance for these discharges if the discharger commits to replacing the tubes with noncorrosive materials within five years. It is likely that new power plants will use all titanium in the future.

4.2.2.3 *Coal Piles and Ash*

Toxic substances can be released into the environment by leaching from coal storage piles or from ash landfills. Toxics can also enter the environment from historical releases of substances no longer used, such as

PCBs. PPRP has monitored potential impacts of toxic releases from ash storage facilities in a number of projects.

In the mid-1980s, PPRP sponsored research on the effects that arsenic and selenium released from ash landfills could have on striped bass (Klauda 1986). These metals may enter aquatic systems as airborne fly ash or in runoff from coal and ash piles. This study found that selenium levels near discharge points may be high enough to cause adverse effects from long-term exposure.

PPRP also investigated past reports of declines in the numbers of yellow perch in Zekiah Swamp Run in Charles County, which is near PEPCO's Faulkner Ash Storage Facility. Monitoring studies indicated that ground water collected from wells near the facility was contaminated with heavy metals, but that contamination was limited to an area within about 1,500 feet from the landfill (Price and Keating 1991). The chemical monitoring studies did not indicate surface water contamination of Zekiah Swamp; however, other tests conducted in Zekiah Swamp indicated that yellow perch larvae had difficulty surviving in areas of the swamp within and outside of the range of possible influence of the Faulkner facility (Burton *et al.* 1990). The study concluded that many factors are responsible for the poor larval survival and that the ash facility did not contribute to the observed mortalities.

4.3 *GLOBAL CLIMATE CHANGE*

The **greenhouse effect** is a naturally occurring phenomenon in which clouds and certain gases found in relatively minute amounts in the atmosphere trap heat emitted by the earth's sun-warmed surface, and warm the atmosphere near the ground. In recent years, there has been a realization that the release of greenhouse gases from human activity, including burning of fossil fuels, could be enhancing the greenhouse effect. The potential for dramatic climate change (global warming) due to emissions of greenhouse gases such as carbon dioxide (CO_2) has spurred intense scientific investigation and prompted response on a world-wide scale. Because fossil fuel combustion, by utilities and other sources, is a significant source of CO_2, any efforts to reduce CO_2 emissions could affect utility operations.

4.3.1 *Reasons for Concern*

Based on estimates from complex mathematical computer models, many prominent researchers believe that global warming can be expected as atmospheric concentrations of greenhouse gases rise. In addition to CO_2, there are several other important greenhouse gases, including

chlorofluorocarbons (CFCs), methane (CH_4), and nitrous oxide (N_2O). These other gases are more effective at trapping the earth's infrared energy, or have greater **radiative forcing effect**, than CO_2 (Table 4-1). For example, methane, molecule for molecule, absorbs 25 times more long-wave radiation than CO_2. Nevertheless, CO_2 has been the main focus of greenhouse gas reduction policies because it is significantly more abundant in the atmosphere (see Table 4-1). CO_2 also contributed almost as much to the increase in absorption of infrared energy during the 1980s as all the other greenhouse gases combined (Hansen *et al.* 1988) (Figure 4-3). It is estimated that without controls, the concentration of all greenhouse gases in the atmosphere will be equivalent to a doubling of the preindustrial level of CO_2 by the middle of the next century (NAS 1991).

Table 4-1 ***Concentrations of the Major Greenhouse Gases, Their Growth Rates, and Radiative Forcing Effects (Relative to that for CO_2)***

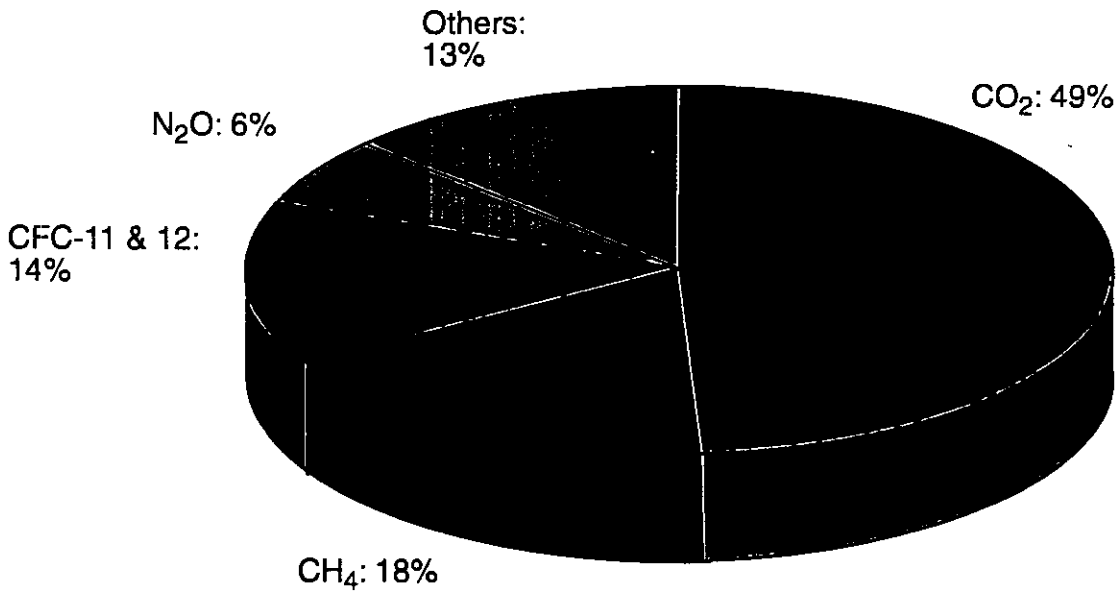
Greenhouse Gas	Pre-Industrial Concentrations[a]	1990 Concentrations[b]	Annual Growth Rate[b]	Radiative Forcing Effect[c]
CO_2	280 ppmv	353 ppmv	0.5%	1
CH_4	0.8 ppmv	1.72 ppmv	0.9%	25
N_2O	290 ppbv	310 ppbv	0.25%	200
CFC-11	0	0.28 ppbv	4%	10,000
CFC-12	0	0.48 ppbv	4%	10,000

[a] Ramanathan 1985
[b] IPCC 1990
[c] USEPA 1990
ppmv = parts per million by volume
ppbv = parts per billion by volume

The Intergovernmental Panel on Climate Change (IPCC) originally reported in 1990 that without limits on greenhouse gas emissions, the earth's temperature could warm about 2°F by 2025 and 5.5°F by 2100 (IPCC 1990). In a 1994 update, the IPCC found no new evidence to contradict its findings, and thus reaffirmed its conclusions from the 1990 assessment (Monastersky 1994).

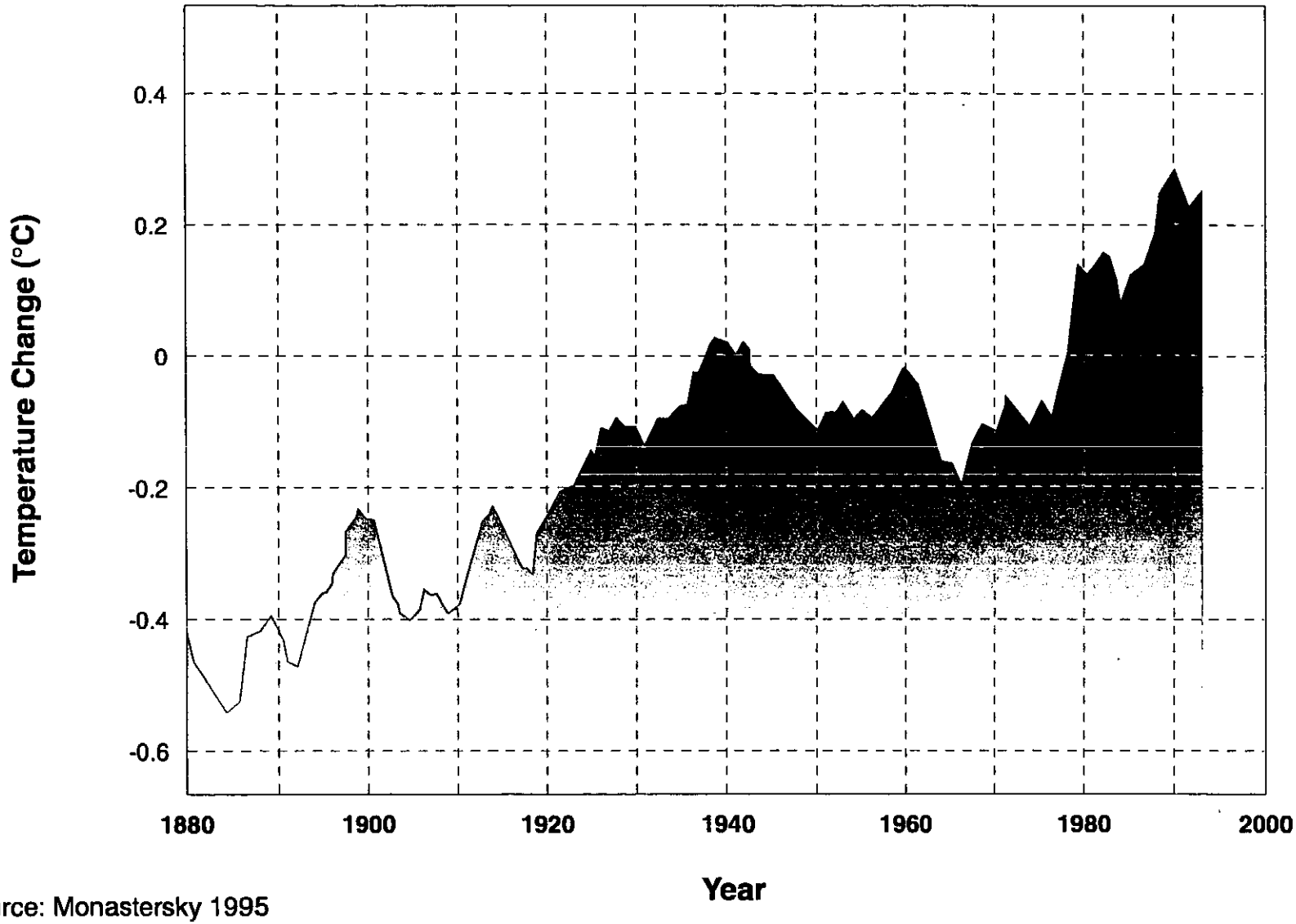
Studies of the global temperature record of the past 100 years indicate an increase of about 0.7°C or 1.2°F (see Figure 4-4). Most experts feel that this

Figure 4-3
The Contribution to Increased Absorption of Infrared Energy by Greenhouse Gases During the 1980s



Source: Hansen *et al.* 1988

Figure 4-4
Global Average Surface Air Temperature Change
(5-Year Running Mean)



Source: Monastersky 1995

THE 1992 EARTH SUMMIT

World leaders from over 160 nations met for 12 days in June 1992 in Rio de Janeiro, Brazil, at the United Nations' Conference on the Environment and Development. This Earth Summit was convened to discuss pressing global environmental issues. Discussions focused on two major areas: biodiversity, or the protection of plants, animals, and natural resources; and the control of CO_2 emissions, those emissions primarily responsible for global warming.

The Framework Convention on Global Climate Change, more informally referred to as the Global Warming Treaty, was signed by almost all of the countries in attendance, including the United States. However, for the treaty to officially take effect, it needed to be ratified by 50 countries; the U.S. ratified the agreement in October 1992. The Framework Convention on Climate Change entered into force on 21 December 1993, when it was ratified by the fiftieth nation (CAR 1994b). This agreement is now binding on all parties to the Convention that had previously signed the accord. The treaty states that the ultimate aim of the ratifying nations is to return to their 1990 emission levels of CO_2, but no timetable is mentioned for reaching such levels. The only binding language in the treaty requires each ratifying nation to issue detailed action plans for stabilizing greenhouse gas emissions. The first meeting of the parties to the Convention was scheduled in late March 1995. The Clinton Administration has developed the Climate Change Action Plan as the United States global warming strategy in response to the requirements of the Convention.

warming trend is not conclusive evidence of greenhouse warming because the magnitude of uncertainty concerning this observation masks the true trend. Some researchers have found the warming observed over the past few decades to be primarily a result of an increase in minimum (nighttime) temperature, while the maximum (daytime) temperature has remained fairly steady (Karl *et al.* 1991). Most experts believe that if there is a real warming trend, it will become apparent within the next 10 to 15 years.

Several plausible effects may be observed, especially in Maryland, during the next century if a substantial warming trend develops. Sea-level rise could adversely affect significant portions of Maryland's Chesapeake Bay wetlands in the next century. Hotter and drier summers with accompanying stagnant weather conditions could worsen Maryland's ozone air pollution problem. Hotter summers also could increase electricity demand in Maryland, as well as in the entire northeast region.

Major questions exist regarding the reality, magnitude, and timing of potential greenhouse-induced climatic effects. These questions are generated by the uncertainties in the greenhouse gas emissions data and atmospheric loading estimates, and the global climate prediction models. Adding to the uncertainties in model predictions is a recent finding that the cooling effect of sulfur emissions, not accounted for in recent models, may have offset a significant part of the greenhouse warming in the northern hemisphere during the past several decades (IPCC 1992).

4.3.2 *CO_2 as a Greenhouse Gas*

Without CO_2 in the atmosphere, life as we know it would not exist on this planet. The natural atmospheric level of CO_2 is the reason why the Earth's temperature averages about 59°F globally instead of about 0°F.

CO_2 is emitted by natural and human sources. CO_2 from human sources is generally believed to be the prime contributor to CO_2 buildup in the atmosphere (OTA 1990). Ice core samples from Antarctica and Greenland and direct atmospheric CO_2 measurements made in Hawaii since 1958 indicate that CO_2 levels have been increasing since about the time of the Industrial Revolution (OTA 1990). These increases have been attributed to emissions from industrial, utility, and transportation-related sources. The oceans and plants act as CO_2 sinks, removing approximately half of the CO_2 emissions from human sources from the atmosphere (IPCC 1990). Deforestation increases atmospheric CO_2 by removing a natural sink for CO_2 emissions.

Additionally, human activities have resulted in increased emissions of other more potent greenhouse gases, such as CH_4, N_2O, and CFCs. CO_2 is

CFCs AND OZONE DEPLETION

The stratospheric ozone layer helps to shield the Earth from the sun's harmful ultraviolet radiation. In the mid-1980s, scientists discovered that portions of the protective ozone layer above Antarctica were destroyed each year, resulting in a phenomenon known as the "Ozone Hole." This layer of ozone has been thinning slowly since the late 1970s (Monastersky 1993). Over the past few years, the depletion of ozone has reached record proportions. The extent of stratospheric ozone depletion observed in 1994 was similar to the record-setting values of 1992 and 1993. Scientists expect that ozone depletion will peak around 1998. Then, ozone levels will gradually rebound as a result of international agreements to reduce the use of ozone-depleting chemicals.

Chlorofluorocarbons (CFCs) and halons, two types of inert gases, have been clearly implicated in the depletion of stratospheric ozone. After being released, CFCs are long-lived in the atmosphere, eventually reaching the stratosphere to contribute to the destruction of the ozone layer. Worldwide, CFCs have been used primarily for refrigeration, foam production, and aerosol propellants (Wuebbles and Edmonds 1988). Their use as an aerosol propellant has been banned in the United States since the 1970s. In responses to the findings that CFCs were destroying stratospheric ozone, 35 countries, including the United States, signed the 1987 Montreal Protocol, committing to reduce production of CFCs and halon gases drastically. In a 1992 revision to the Montreal Protocol, the countries agreed to phase out CFC production by the end of 1995 (Rose 1994). Recently, scientists have reported that the rapid increase in CFC concentrations has fallen off substantially (ES&T 1993).

Electric utilities are very minor contributors of atmospheric CFC emissions. However, domestic and commercial use of less effective and less energy-efficient CFC substitutes could increase the demand for electricity. This increased demand could potentially increase the emissions of other greenhouse gases, such as CO_2.

about 100 times more abundant than the other gases combined; however, because of the recent rapid growth in emissions of these more potent greenhouse gases, the relative importance of CO_2 is somewhat reduced. CO_2 levels are thought to be increasing at a rate of about 0.5% per year (see Table 4-1) (IPCC 1990).

4.3.3 *The Utility CO_2 Contribution*

The primary manmade CO_2 emission sources are fossil fuel combustion, and biomass burning and decay (IPCC 1990). Combustion of fossil fuels accounts for most of the CO_2 emissions. On a per-energy-unit basis, coal burning generates the most CO_2, and natural gas burning generates the least. In the United States, the utility industry accounts for roughly 35% of fossil fuel-derived CO_2 emissions (Figure 4-5) (Perhac 1989). The United States contributes approximately 25% of the worldwide fossil fuel-derived CO_2 emissions, the most of any country (Marland 1989); therefore, utilities in the United States account for about 8% of the worldwide fossil fuel-derived CO_2 emissions.

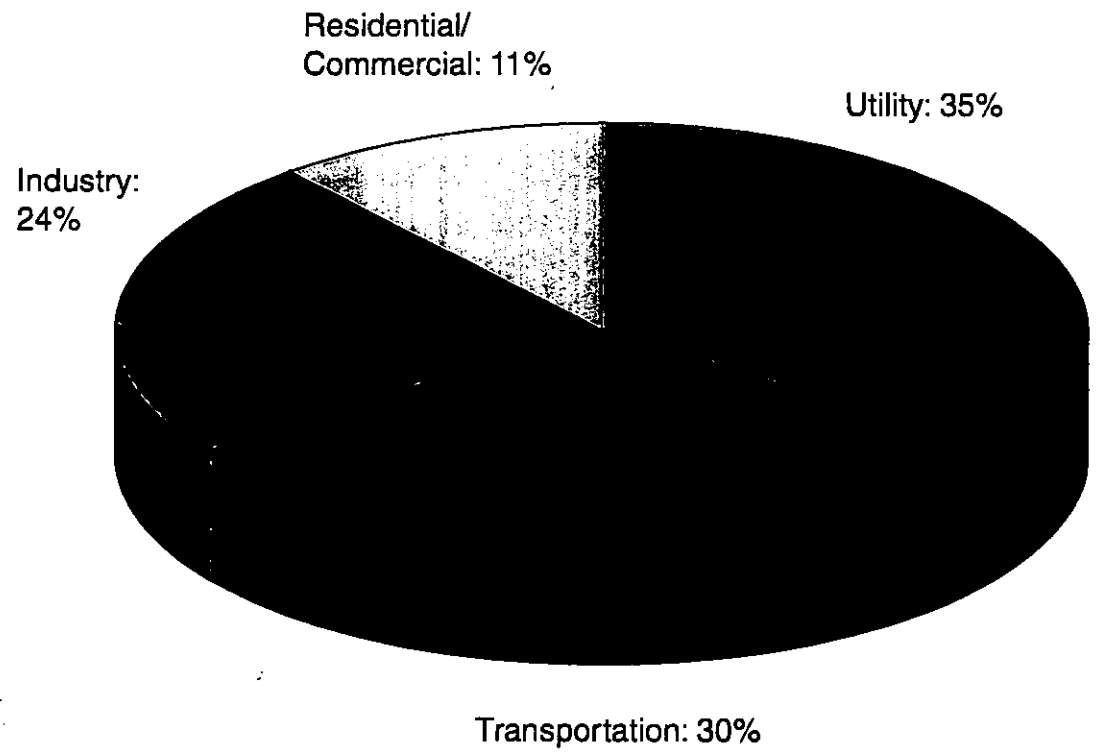
4.3.4 *Recent Governmental Responses*

The federal government recently has taken steps to reduce the United States' greenhouse gas emissions directly, especially CO_2, through the Climate Change Action Plan (CCAP). In addition, greenhouse gas emissions should be reduced indirectly through the Energy Policy Act of 1992. These two programs, as well as policies Maryland has enacted that should help to reduce greenhouse gas emissions, are discussed in this section.

4.3.4.1 *Energy Policy Act of 1992*

The Energy Policy Act of 1992 (EPACT), enacted by Congress to enhance competition in the electric power industry and to improve efficiency in energy use, should indirectly help to reduce emissions of the most important greenhouse gas, CO_2. The Act is considered to be a supplement to existing state policies regarding energy planning. Through the use of tax incentives, EPACT endeavors to make renewable sources of energy, such as wind and solar power, more cost-competitive with traditional fossil fuel sources (Burmeister and Sikkema 1992). Funding opportunities exist for research, development, and commercialization improvements in energy efficiency, renewable energy, clean coal technologies, alternative fuels, electric vehicles, and demand-side management programs. In addition, awards are authorized for electric utilities that conduct exceptional or innovative energy efficiency programs. EPACT strives to influence pricing such that investments in energy efficiency are "at least as

Figure 4-5
Relative Contributions of Manmade Fossil Fuel CO_2 Sources in the U.S.



profitable" as building new generation, transmission, and distribution facilities (Burmeister and Sikkema 1992).

EPACT is expected to foster competitiveness within, and hasten restructuring of, the utility industry (NRRI 1993). The Act includes amendments to the Public Utility Holding Company Act of 1935 that lift barriers on the development of wholesale power facilities by both traditional utilities and independent power producers. In addition, EPACT expands the Federal Energy Regulatory Commission's authority to order "wheeling", or distribution of power from utility to utility, under a wide range of conditions (NRRI 1993). Therefore, electric utilities will compete with each other, as well as independent power producers, to supply electricity to the ratepayers in markets outside of their traditional retail service areas.

4.3.4.2 *Climate Change Action Plan*

The goal of the CCAP, made public in October 1993, is to return greenhouse gas (mainly CO_2) emissions to 1990 levels by the year 2000 (Clinton and Gore 1993). This greenhouse gas emission reduction strategy is a response to the Framework Convention on Climate Change agreed upon by attending nations at the 1992 Earth Summit. The action plan that is required by the Framework Convention will be based on the CCAP, or an update, if necessary. The keys to implementing this plan are numerous public-private partnerships, and cooperation among the participating governmental agencies (Clinton and Gore 1993).

The CCAP proposes adopting, expanding, or reinforcing innovative and successful greenhouse gas emissions reduction programs, such that the reductions can occur quickly enough to meet the year 2000 goal (Clinton and Gore 1993). The Administration's main strategy is to accelerate the deployment of existing energy efficient technology, and hasten the introduction of more advanced technology. The use of renewable energy is encouraged through increased funding, and utilization of incentives contained in the Energy Policy Act of 1992. The Administration has requested that the U.S. Department of Energy (DOE) assist states, utilities, and other interested firms with collective purchases of renewable energy technology (Clinton and Gore 1993).

The *Climate Challenge* program is one example of the partnerships created through the CCAP. This voluntary program partners DOE with a multitude of electric utility companies to study and develop cost-effective ways to reduce, avoid, or sequester (absorb) greenhouse gas emissions, while considering the potential ramifications to ratepayers. Representatives from DOE and the power industry signed a Memorandum of Understanding on 20 April 1994 that establishes the

AES's GREENHOUSE GAS OFFSET PROGRAM

In the mid-1980s, Applied Energy Services (AES) initiated a corporate policy of social responsibility with regards to global warming. AES's goal is to preserve coal and natural gas as fuel options at its non-utility generating facilities, while mitigating the effects on global climate that burning such fuels may cause. As part of this effort, AES investigated the least-cost ways to reduce its CO_2 emissions. They found that tree planting could provide an economical and effective solution for mitigating CO_2 emissions from its newly built power plants (Sturges 1993).

The idea is that by planting trees, enough CO_2 will be absorbed by the trees that it will "offset" the emissions from the power plants. Preventing deforestation can also conserve carbon, which is stored by trees and released when the trees are cut down and burned. Moreover, forest conservation can be supplemented by additional tree plantings as a longer term offset project.

AES began its voluntary CO_2 mitigation measures in the late 1980s through tree planting and land preservation programs in Guatemala, Paraguay, Peru, Ecuador, and Bolivia. It is estimated that through these projects about 45 million trees will be planted and over one million acres of forest will be protected from deforestation. As a result, these efforts will prevent roughly 100 million tons of CO_2 from being released to the atmosphere. AES's associated cost for these efforts is about $7 million, which is funded mostly through endowments (Sturges 1993).

The AES Warrior Run power plant is under construction in Cumberland, Maryland, and scheduled to go on line in 1999. Potential programs addressing social responsibility are usually made once a plant is operational. Thus, no decision has been made yet regarding potential conservation or mitigation projects associated with Warrior Run (Murtlow 1995).

framework for the *Climate Challenge* program (Forrister 1994). Overall, the utilities providing 80% of the total electricity generated in the U.S. have signed on to participate in the program. Any participant in the *Climate Challenge* program may withdraw without penalty, because emissions reductions are not mandated by law (Forrister 1994).

The Maryland utilities that are participating in the *Climate Challenge* program include BGE, Delmarva Power, PE, and PEPCO (USDOE 1994; Molzahn 1995). PEPCO has made a commitment to DOE to reduce its greenhouse gas emissions to below 1990 levels by the year 2000. The company plans to achieve this reduction primarily through conservation programs, but it has also included programs involving electric vehicles and other electrotechnologies, and the use of renewable energy (Potts 1995). BGE has also committed to reducing its greenhouse gas emissions by 2000 and plans to achieve reductions primarily through supply-side management programs. Furthermore, BGE participates in several programs aimed at reducing greenhouse gas emissions through demand-side energy management, the advance of cleaner alternatively fueled vehicles, forest management, and investments in new electrotechnologies (Bauereis 1995).

4.3.4.3 *State Initiatives*

Many states have adopted legislation in recent years to respond to the global warming issue. These responses mainly have taken the form of programs to study greenhouse gas emissions and energy use, and to recommend possible courses of future action. In addition, numerous states have developed programs to increase efficiency in energy use; these projects indirectly decrease net greenhouse gas emissions by reducing CO_2 emissions from various sectors.

In Maryland, the PSC Integrated Resource Planning (IRP) group endeavors to provide the same consideration to conservation programs (demand side) as to new electricity generation, distribution, and transmission projects (supply side) (Black 1993). Utility conservation and energy efficiency programs are formulated and implemented through collaborative arrangements that include the PSC, utilities, DNR, and conservation groups. These collaborative develop cost-effective conservation programs, some of which include cost recovery plans for the utilities' expenditures (Black 1993).

Maryland is actively involved in the effort to reduce, through indirect means, CO_2 emissions to the atmosphere. Maryland has developed a State Strategic Energy Plan that makes recommendations for energy efficiency programs involving State government, industry, commercial, and residential projects (Mason 1994). The Governor approved the plan in

late 1993, and five of the recommendations were put on the "fast track" for implementation. Maryland also has established a reforestation program that could indirectly affect net CO_2 emissions. The Forest Conservation Act is a State mandated program that requires replacement of trees lost during development or alternatively, payment of specific fees in lieu of replanting (Burroughs 1993).

The Center for Global Change, a nationally recognized research group located at the University of Maryland at College Park, provides up-to-date information about the CO_2 emissions reduction efforts ongoing throughout the United States, and other greenhouse gas emissions issues. In addition, PPRP actively collects and reviews new information regarding CO_2 emissions and potential global warming effects, with special attention given to utility emissions.

4.4 *NATIONAL PARKS AND FORESTS IMPACTS*

4.4.1 *Current Adverse Impacts*

Utilities in Maryland and surrounding states in recent years have had to address the effects of their new power plant emissions on the following federal areas: Shenandoah National Park in Virginia, Brigantine National Wildlife Refuge (NWR) in New Jersey, Dolly Sods Wilderness in West Virginia, and Otter Creek Wilderness in West Virginia (both Dolly Sods and Otter Creek are within the Monogahela National Forest) (see Figure 3-12). These areas are referred to as Prevention of Significant Deterioration (PSD) Class I areas. Each Class I area has its own Air Quality Related Values (AQRVs), special attributes of a Class I area that may be adversely affected by deterioration of air quality. AQRVs include visibility, odor, flora, fauna, and geological resources, archaeological, historical, and other cultural resources, and soil and water resources (Bunyak 1993) unique to that site.

Section 165 of the CAA states that the Federal Land Manager (either the National Park Service (NPS) park superintendent, the Fish and Wildlife Service refuge manager, or the Forest Service wilderness area manager) is responsible for the protection of the AQRVs of his/her respective Class I area. The responsible Federal Land Manager and the established AQRVs for the four Class I areas near Maryland are listed in Table 4-2.

INTERAGENCY WORKGROUP ON AIR QUALITY MODELING

The Interagency Workgroup on Air Quality Modeling (IWAQM), consisting of representatives from the U.S. EPA and the agencies responsible for managing the wilderness and national park resources, was formed to provide a focus for developing technically sound, regional air quality models for regulatory assessments of air pollutant source impacts at Federal Class I areas. These assessments include effects on air quality related values (AQRVs), as well as compliance with air quality standards. To this end, the IWAQM developed a multi-year work plan which is to be implemented in three phases. Phase 1, completed in October 1992, consisted of a review of U.S. EPA guidance and issuance of recommendations for "off-the-shelf" modeling techniques to meet the immediate need of the permitting community. During Phase 2, the IWAQM will augment Phase 1 with a review of other available models and make a recommendation of the most appropriate modeling techniques. In Phase 3, the IWAQM will add more advanced modeling techniques to its consideration and recommend a more permanent modeling solution, probably representing a greater level of scientific and computer hardware sophistication.

Table 4-2 ***Responsible Federal Land Managers and AQRVs of Class I Areas Near Maryland***

Class I Area	Federal Land Manager	AQRVs
Shenandoah National Park	National Park Service, Dept. of the Interior	Visibility, aquatics (streams and the life in the streams), soil (including organisms living in the soil), vegetation, and human health[1]
Dolly Sods Wilderness Area	U.S. Forest Service, Dept. of Agriculture	Scenic beauty (including visibility), vegetation, odor, and wildlife[2]
Otter Creek Wilderness Area	U.S. Forest Service, Dept. of Agriculture	Scenic beauty (including visibility), vegetation, odor, and wildlife[2]
Brigantine National Wildlife Refuge	U.S. Fish and Wildlife Service, Dept. of the Interior	Vegetation and wildlife[3]

[1] Thomas 1994
[2] Murtlow 1994a
[3] Lambertson 1994

Once AQRVs have been established at a Class I area, the Federal Land Manager must determine whether or not the AQRVs are being adversely affected. The criteria for determining whether or not an AQRV is being adversely affected are: 1) diminishment of the national significance of the area, 2) impairment of the quality of the visitor experience, or 3) impairment of the structure and functioning of ecosystems. In September 1990, the Federal Land Manager declared that AQRVs at Shenandoah were being adversely affected. Table 4-3 lists various items of concern noted by the NPS with regards to Shenandoah (USEPA 1990).

Table 4-3 NPS-Stated Concerns Regarding AQRVs at Shenandoah National Park

1. Visibility is impaired by anthropogenic pollution more than 90% of the time; the average reduction from the natural visual range (150 kilometers) is approximately 60%.
2. Ambient SO_2 levels are in the range known to have contributed to the absence of *Ramalina americana* (lichen) in Canada.
3. Sulfur loadings at Shenandoah are greater than background levels and are within the range known to cause morphological changes in some species of lichens.
4. Shenandoah National Park streams continue to acidify over time.
5. Foliar injury and significant growth and yield reductions in sensitive species results from ozone concentrations less than the National Ambient Air Quality Standard.

4.4.1.1 *Visibility Impairment*

Visibility degradation due to regional haze is perhaps the AQRV of most concern at many Class I areas, especially Shenandoah. It is commonly believed that this haze is the result of the cumulative effect of emissions from numerous SO_2-emitting facilities near the park. (SO_2 does not directly impair visibility, but acts as a precursor for the formation of fine particle sulfates, which scatter visible light quite effectively.) The daily "average" visibility at Shenandoah has degraded over time to one-tenth to three-fourths of estimated natural conditions (i.e., 150 km visual range), averaging approximately 40% of natural conditions on an annual basis. Visibility at the park is poorest during the summer when visitation is the highest.

4.4.1.2 *SO_2 Concentrations*

The physical characteristics of lichens make them susceptible to the effects of air pollution; as a result, they are often used as a monitor of air pollutant levels, especially SO_2. In the areas of Shenandoah with high SO_2 concentrations, the sensitive species of lichens are either growing poorly or not growing at all. For example, one study showed an absence of lichens from an area with a mean SO_2 level of 170 micrograms per cubic meter ($\mu g/m^3$). It should be note that SO_2 levels as low as 30 $\mu g/m^3$ have been shown to injure sensitive species of lichen, including *Ramalina* (NPS 1990).

4.4.1.3 *Acid Deposition*

Acid deposition is comprised of two components: dry and wet deposition. Dry deposition occurs when sulfates (mainly in particulate form) and nitrates (either gaseous or particulate form) drift along, contact,

and then stick to water, vegetation, soil, or other materials. Wet deposition, commonly referred to as "acid rain," involves pollutants that are deposited on objects after having been "washed out" or "rained out" by precipitation. Wet deposition primarily affects lakes and trees (Stern *et al.* 1984).

Shenandoah receives one of the highest acidic deposition loads of any national park, with anthropogenic sources accounting for approximately 90% of the sulfate in this precipitation. While some basins in Shenandoah are not currently experiencing elevated sulfate levels in the stream waters, the NPS has established that all of the park's basins have been acidified to some extent by atmospheric deposition. Furthermore, certain areas, such as Deep Run and White Oak Run, have been extensively monitored and are showing chronic acidifications (NPS 1990). Stream water quality monitoring conducted by the NPS at Shenandoah indicates that the acidity of some streams has increased three-fold over a six-year period.

In addition, precipitation data collected near both the Dolly Sods and Otter Creek Wilderness by the Forest Service indicate that the precipitation that falls in this area is among the most acidic in the United States. Within the two wilderness areas, the majority of the perennial streams are acidic and unproductive, resulting from both natural and deposition-derived acidity. Furthermore, water quality monitoring conducted in Dolly Sods and Otter Creek between 1991 and 1993 suggests that aquatic resources may be stressed by the acidity of the water (Marita 1994).

4.4.1.4 *Ozone Concentrations*

The NPS has monitored ozone concentrations at Shenandoah for several years. Despite its rural location, exceedances of the federal ozone standard have been recorded at Shenandoah. The NPS has determined that the elevated ozone levels that occur within the park cause damage to trees (USEPA 1990). In addition to addressing the biological effects (i.e., tree mortality, decreased growth, etc.) on trees, the NPS currently is studying the ecological effects of ozone pollution at the park (O'Leary 1988).

4.4.2 *Recent Power Plant Assessments*

As mentioned previously, the Federal Land Manager for Shenandoah has declared that AQRVs are being adversely affected at Shenandoah. As a result, all new power plants recently undergoing PSD review in Virginia have been subject to considerable scrutiny by the NPS. For example, a cogeneration project proposed by Patowmack Power Partners, Inc., for Loudoun County, Virginia, was the focus of extensive and in-depth

evaluations of impacts to the AQRVs at Shenandoah. None of the recently permitted power plants in Virginia have been shown to have any adverse impact at Shenandoah. The Federal Land Manager has agreed with these conclusions.

In Maryland, Applied Energy Services, Inc. (AES), as part of its PSD permit application for the coal-burning Warrior Run power plant in Cumberland, assessed potential impacts to the AQRVs at Shenandoah, Dolly Sods Wilderness, and the Otter Creek Wilderness. AES determined that since insignificant amounts of SO_2 would reach Shenandoah, no adverse impact to the AQRVs at the Park will occur (Murtlow 1994a). For the two wilderness areas, AES used a new screening approach developed by the Forest Service which allows it to determine potential impacts of new emissions sources on AQRVs for the Class I areas in question (AES 1992). This analysis indicated that only minimal effects on terrestrial and aquatic ecosystems would be realized (Murtlow 1994a). Furthermore, the visibility analyses conducted by AES showed no adverse impact. The NPS and the Forest Service agreed with the results of these Class I AQRV analyses.

A PSD permit was recently issued for Delmarva Power's proposed new coal-burning Dorchester power plant near Vienna, Maryland. Delmarva Power examined SO_2 effects at the Brigantine NWR, 160 km away. Delmarva Power found that the SO_2 levels predicted to occur at the Brigantine NWR were below the PSD Class I significance levels; therefore, impacts to AQRVs are not anticipated. Also, Delmarva Power, using conservative U.S. EPA-approved modeling methodologies, showed no adverse visibility impact at Brigantine (PPRP 1994c). The U.S. EPA Region III did not dispute these findings.

4.4.3 *Ramifications for Utilities*

In recent years, the NPS and Forest Service have been requiring more extensive and in-depth AQRV impact evaluations for new source permit applications in the region around Shenandoah, as well as other Class I areas in the Northeast United States. In addition, the NPS has established emissions offset requirements for certain new construction projects. The NPS requires an applicant to obtain an emissions decrease (or offset) at another facility equal to the emissions increase associated with the proposed project if an applicant's impact on AQRVs is above the NPS significance level. Also, the NPS requires a demonstration of a net AQRV benefit to the Class I area.

Overall, as the NPS has increased its scrutiny of impact analyses for new source permit applications, the amount of time required to obtain a permit

has increased. Recently, this review process has taken as long as three years because of increased requirements.

4.5 *WESTERN MARYLAND COAL MINING ISSUES*

4.5.1 *Maryland Coal Industry*

The coal mining industry is a significant factor in Western Maryland's economy. Located on the extreme eastern edge of the Appalachian Basin, Garrett and Allegany Counties account for all of Maryland's coal production. In 1993, roughly 3.4 million tons of coal were mined in Maryland, and an average of 441 miners were employed in the industry. Approximately 21 active mines were operating in Maryland as of 1993. Only four of the operating mines are deep mines; the remainder are strip/surface mines. Deep-mined coal accounts for roughly 75% of all of the coal mined in Maryland, with virtually all (99%) of the deep-mined coal being produced from the Mettiki mine in Garrett County. According to the latest available data, Maryland has roughly 664 million tons of underground coal reserves and approximately 86 million tons of surface coal reserves (PEPCO 1995).

In 1993, Virginia Power's Mount Storm plant purchased nearly half of the coal produced in Maryland. The other major utility purchasers were PEPCO, which purchased 25% of the total Maryland coal production in 1993, and Monongahela Power Company, which purchased 15%. Relatively small amounts were purchased by PE, Delmarva Power, and New England Power Company. The balance of the coal produced was either exported, sold to other mining companies for blending with other coals, or used by industrial sources (PEPCO 1995).

The potential use of Maryland coal is influenced by its characteristics. Maryland coal is generally described as having a low to medium volatile content, a medium sulfur content, and relatively high ash content and ash fusion temperature (USGS/MGS 1981). From a technical perspective, two characteristics of Maryland coal limit its use in existing Maryland utility boilers: relatively high ash fusion temperature and the low volatile content.

Coal-fired boilers that employ a wet ash removal system (wet bottom boilers) require coal with low ash fusion temperatures to maintain the ash as a liquid. Because most Maryland coals have relatively high ash fusion temperatures, they are not suitable for use in wet bottom boilers. For example, BGE's C.P. Crane units are wet bottom cyclone boilers, and could not burn Maryland coal.

Coals with low volatile content, such as most Maryland coal, are more difficult to ignite and require specially designed combustion systems to sustain combustion (Stultz and Kitto 1992). In addition, a high, stable burning rate is required to use low volatile coal; variations in burning due to load shifts would likely result in operational problems. For example, the design and operation of BGE's H.A. Wagner Unit 4 and PEPCO's coal-fired Dickerson units, preclude the use of Maryland coal.

In addition to technical feasibility, environmental regulations and transportation issues also constrain the use of Maryland coal. From an environmental perspective, the sulfur content of Maryland coal limits its use in some Maryland utility boilers such as BGE's Brandon Shores and H.A. Wagner plants. Economic and transportation issues also impact the use of Maryland coal. For example, although Western Maryland is well served by existing rail lines, transporting Maryland coal to utilities in the eastern part of the state is more expensive and complicated than transporting Pennsylvania-mined coal to these destinations due to the need to contract with both CSX and Conrail (EIA 1991; Graves 1993).

4.5.2 *Environmental Issues*

4.5.2.1 *Sulfur Dioxide Emissions*

The medium sulfur content of Maryland coal precludes its use at some coal boilers without extensive emissions control. Maryland coal at BGE's Brandon Shores and H.A. Wagner units could not meet currently imposed federal and state SO_2 emissions requirements without post-combustion controls. The sulfur content of Maryland coal will also constrain its future use because of SO_2 limitations in 1995 (Phase I) and 2000 (Phase II) required by Title IV of the 1990 CAA Amendments. The sulfur content of most Maryland coal is being reduced by state-of-the-art cleaning methods. These methods will result in CAA compliance for Phase I, but cleaning alone will not meet Phase II SO_2 standards.

The SO_2 reductions mandated by the CAA could significantly affect the use of Maryland coal at PEPCO's Chalk Point and Morgantown boilers. To comply with these requirements under Phase I, PEPCO plans to use an optimum mix of low-sulfur coal and natural gas co-firing at Chalk Point and to burn low-sulfur coal, possibly with some oil firing, at Morgantown. Although Maryland coal is capable of meeting the Phase I SO_2 standards, if a significant amount of natural gas is used in the Chalk Point boilers, the amount of Maryland coal used in these boilers would be reduced. PEPCO is currently evaluating options to achieve Phase II standards. Because the sulfur content of Maryland coal will not meet Phase II standards without expensive air emissions control such as scrubbing, the use of Maryland coal at Chalk Point and Morgantown could be discontinued altogether.