PPRP-CEIR-10

PPRP

Maryland Power Plants and the Environment

A review of the impacts of power plants and transmission lines on Maryland's natural resources

January 1999

MARYLAND POWER PLANT RESEARCH PROGRAM

The Maryland Department of Natural Resources (DNR) seeks to preserve, protect and enhance the living resources of the State. Working in partnership with the citizens of Maryland, this worthwhile goal will become a reality. This publication provides information that will increase your understanding of how DNR strives to reach that goal through its many diverse programs.

John R. Griffin
Secretary
Maryland Department of Natural Resources

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Foreword

The Maryland Department of Natural Resources (DNR) Power Plant Research Program (PPRP) is required by Maryland law to review and evaluate the potential impacts to Maryland's environment from the construction and operation of electric power generating and transmission systems. PPRP summarizes these evaluations every other year in a document known as the Cumulative Environmental Impact Report (CEIR).

This volume represents the tenth edition of CEIR (CEIR-10), and it summarizes the current state of knowledge which PPRP has gained from more than 25 years of continuous monitoring of power plant impacts in Maryland. PPRP conducts a range of research and monitoring projects on the topics addressed in this CEIR and many other issues as well. In fact, PPRP publishes a Bibliography every year that lists the general and site-specific power plant related reports that PPRP has produced since the early 1970s. PPRP also issues periodically the *Power Plant Update* newsletter, highlighting current projects and emerging topics related to power generation and the environment.

If you want more information on the impacts of power plants in Maryland, you can request a copy of the Bibliography, past CEIRs, and other documents from:

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Introduction

Power plants affect the environment in various ways, as do all industrial facilities. For example, power plants emit air pollutants that affect local air quality and can contribute to worldwide problems such as acid rain and global warming. Some power plants in Maryland draw in large volumes of water from the Chesapeake Bay and local rivers, use it, and then discharge it back into the Bay and rivers, potentially affecting local fish and shellfish stocks. Ash from Maryland's coal-fired power plants is collected and landfilled at various places in the state, which can degrade local ground water resources.

All of these activities affect the environment to some degree. Even though we acknowledge that we need power plants and transmission lines, we must still be concerned with how power plants affect the environment. What impacts *do* power plants have on the environment? Are the impacts significant? What are the costs to minimize these impacts?

The Maryland Department of Natural Resources (DNR) **Power Plant Research Program (PPRP)** investigates how power plants impact Maryland's air, water, land, and cultural resources. In this role, PPRP is required by the Maryland Power Plant Research Act (§3-304 of the Natural Resources Article of the Annotated Code of Maryland) to prepare the **Cumulative Environmental Impact Report (CEIR)** every other year. The purpose of this report is to summarize the information available on impacts to Maryland's environment from electric power generation and transmission.

This report is the tenth CEIR (CEIR-10) published by PPRP. As in past CEIRs, this document presents a comprehensive overview of how electricity is generated and distributed in Maryland; this discussion is included in Section 2. Section 3 includes detailed results from a variety of environmental and economic studies that PPRP has conducted to evaluate impacts to Maryland's air, water, and land. In addition to these environmental impact issues, Section 4 of CEIR-10 provides an update on several power plant related issues of special interest to Maryland, such as deposition of air pollutants, ash management, nuclear power, and biodiversity. Section 5 addresses developments in the structure of the electric industry that affect how power is generated and distributed in Maryland and nationwide.

The Role of PPRP

Legislative Mandate and Overview of Activities

The Maryland legislature created the Power Plant Siting Program, precursor to the current PPRP, in 1971 as a result of extensive public debate regarding the potential effects on the Chesapeake Bay from the Calvert Cliffs Nuclear Power Plant. Calvert Cliffs was a source of concern because the plant uses a once-through cooling system that withdraws 3.5 billion gallons of water per day from the Bay and discharges the water back to the Bay with a temperature elevation of about 12°F. The magnitude and diversity of potential environmental impacts that came to light during the licensing of Calvert Cliffs prompted the creation of PPRP to ensure a complete evaluation and resolution of environmental and economic issues before future decisions were made regarding whether and where to build other generating facilities.

Today, PPRP continues to conduct research on power plant impacts to the Chesapeake Bay, one of Maryland's greatest natural resources. In addition to surface water concerns, PPRP's evaluations consider impacts to Maryland's ground water, air, land, and human resources. PPRP examines all of these areas in its review of proposed power facilities, including new plants, expansions of existing plants, and transmission lines. To construct any of these facilities, a company must obtain a **Certificate of Public Convenience and Necessity (CPCN)** from the Maryland Public Service Commission (PSC). As part of this licensing process, applicants must address a full range of environmental, engineering, socioeconomic, planning, need, and cost issues.

PPRP is responsible for managing the consolidated review of CPCN applications. This is the only process within the state regulatory framework that allows a comprehensive review of all electric power issues. The goal of the consolidated review is to ensure that adequate electricity is provided to Maryland users at a reasonable cost while minimizing the impacts on the environment.

As part of its comprehensive review, PPRP coordinates the involvement of the Departments of Natural Resources, Environment, Agriculture, Business and Economic Development, and Transportation; the Office of State Planning; and the Maryland Energy Administration. PPRP consolidates the recommendations of those agencies and represents them before the PSC in the CPCN hearing process. The general goals of the comprehensive licensing review are to:

- *Assess the suitability of sites in the state that utilities identify as potential locations for construction or modification of power plants or transmission lines.*
- *Evaluate potential environmental impacts of proposed power plant facilities and transmission lines on air, surface water, ground water, terrestrial, and cultural and historic resources.*
- *Analyze the need for new power plants or transmission facilities, taking into account cost and energy conservation alternatives for reducing energy demand.*
- *Coordinate the development of recommendations, using the evaluations outlined above, that become conditions of the CPCN to ensure that impacts are minimized or mitigated.*

As part of the CPCN process, the PSC holds a series of public hearings. On the basis of background information presented by the applicant, the state agency evaluations coordinated by PPRP, and input from local governments, environmental groups, and citizens' groups, the PSC decides whether to grant a CPCN. When the PSC grants a license, it also determines what conditions it will place on the license to ensure that the new or modified facility operates in an environmentally acceptable way.

Another important function of PPRP is to assist the PSC in evaluating the utilities' long-range plans for meeting electricity demand. Through its research and informal interaction with the state's utilities, PPRP has been working to expand the role that load management and conservation programs play in meeting customer power demands in a reliable and cost-effective manner. Also, in past years, PPRP has sponsored independent load forecast studies for each of Maryland's major electric utilities.

The proposed introduction of retail competition and customer choice in Maryland over the next few years will make long-range load forecast studies of individual utilities less useful and feasible. In a world of retail competition, alternative suppliers of electricity will compete to serve part of the load that is today served by Maryland utilities; at the same time, Maryland utilities will serve new customers in other states. Thus, the power supply requirements of individual utilities could change from year to year, perhaps dramatically, as customers choose among competing suppliers. The need remains, however, for a state-wide understanding of electrical needs, independent of any one utility. For this reason, PPRP is working with the PSC and other state agencies to prepare a single, state-wide forecast of energy demand.

Recent Application of Innovative Technologies

Over the past year, PPRP's role as technical lead in State projects where power plant expertise is required, has become increasingly significant. PPRP has conducted several projects that use new technology, or that promote innovative applications, to address environmental concerns associated with power generation. The remainder of this introductory section highlights some important examples of PPRP's ongoing work in innovative technology applications.

Combustion of Poultry Litter for Power Generation (Eastern Shore)

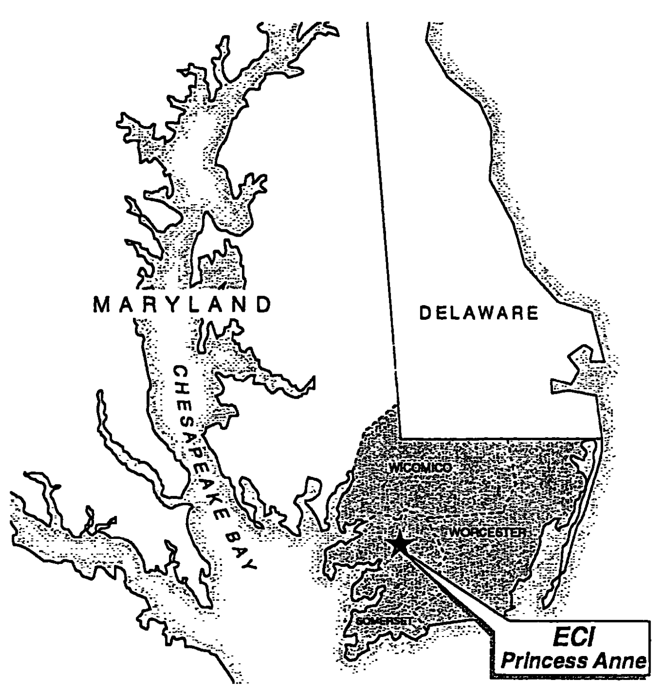
PPRP has been involved for several years in evaluating operational alternatives for the boilers at Eastern Correctional Institution (ECI), a correctional facility in Somerset County on Maryland's Eastern Shore. The Maryland Environmental Service (MES) operates the prison's cogeneration facility—a type of power plant that produces both electric power and steam for process or heating purposes. The ECI cogeneration facility consists of two boilers, each rated at 2 MW, firing wood wastes. The existing boilers provide hot water for the prison's thermal requirements as well as steam for the turbines. The facility also supplies most of the prison's electrical needs with supplemental power provided by Delmarva Power & Light Company.

Since 1995, MES has been considering alternatives for expanding capacity because the existing boilers are not capable of meeting the electric and thermal demands of the prison. PPRP assisted MES with evaluating the use of alternative fuels, such as shredded tires, but the alternatives were determined to be too expensive at that time. MES recently utilized PPRP's expertise again, this time to evaluate the use of poultry litter as a potential fuel source.

Poultry litter is a term that refers to the mixture of manure and bedding material removed periodically from brooding houses. Historically, farmers have utilized poultry litter as a soil fertilizer either on-site or on nearby farms. Farmers typically determine how much litter to apply based on the nitrogen content of the litter and nitrogen requirements of the soils and crops. However, poultry litter has a higher phosphorus to nitrogen ratio in comparison to commercial fertilizers. As a result, application of poultry litter has resulted in an accumulation of phosphorus in the soils of the lower Eastern Shore in excess of what can be used by crops or attenuated by the soils. The dissolution and runoff of this excess phosphorus from soils can cause surface water eutrophication, and may have contributed to the recent outbreaks of the toxic microorganism *Pfiesteria piscicida*, with resultant adverse impacts to human health and fisheries in several rivers and creeks on the lower Eastern Shore.

Chicken farms on the Eastern Shore are concentrated in three counties—Wicomico, Somerset, and Worcester (corresponding to the shaded area in Figure 1-1). The ECI facility is ideally situated as a collection point for poultry litter, located within an approximate 25-mile radius of all poultry growers in the tri-county area. The possible causal link between poultry litter management practices and water quality concerns, together with ECI's need for additional generating capacity, led the State to investigate the technical feasibility, costs and impacts of burning poultry litter as a primary fuel at the cogeneration facility. PPRP's depth of technical resources and expertise on power plants issues has allowed the State to perform an in-house study of the feasibility of this approach.

Figure 1-1
Location of Eastern Correctional Institution



PPRP evaluated the suitability of poultry litter for use as a fuel and determined that the material has sufficiently high energy content and sufficiently low moisture content to allow it to be used as a fuel at the ECI facility. Depending upon the litter's physical and chemical characteristics, and the operating parameters of the modified boilers, the ECI units could burn on the order of 50,000 tons of poultry litter annually. By comparison, the poultry farms within a 25-mile radius of ECI generate an estimated 150,000 tons of litter per year beyond what is needed to satisfy phosphorus-based fertilizer requirements. Thus, it appears that nearby farms generate more than enough poultry litter to provide a reliable fuel supply.

PPRP assessed three alternative technologies currently available to accommodate the use of poultry litter as a fuel—direct combustion, fluidized bed combustion, and gasification. Because poultry litter is a relatively moist fuel, gasification may be the most efficient means of extracting its fuel energy. However, for the ECI cogeneration plant, direct combustion was found to be more cost effective.

The analysis of air quality issues indicates that potential emissions may be high enough to trigger Prevention of Significant Deterioration or nonattainment New Source Review if no pollution controls or limitations are implemented. However, emissions estimates are preliminary and will need to be re-evaluated. Toxic metals concentrations in the litter ash, a residue of the combustion process, should be well below the thresholds at which the ash would be classified as a hazardous waste, and it is likely the ash would have value as a fertilizer or fertilizer supplement.

Based on the technology and environmental assessments, PPRP considered various scenarios, including constructing a new litter-fired combustion unit or retrofitting the existing wood-fired facility to burn poultry litter instead. Life-cycle cost estimates were developed for each scenario based on projections of usage, capital costs, fuel costs, labor costs, and other relevant factors. PPRP's economic and engineering analyses indicate that it may be feasible and cost effective to retrofit the existing boilers at ECI to burn poultry litter, and in fact, the operating costs in such a case could be lower than present operations.

Following completion of the preliminary feasibility study, the State determined that it was reasonable to conduct a more detailed and comprehensive investigation of firing poultry litter at ECI. PPRP is currently coordinating this investigation. Its objectives are to identify all process modifications (equipment and operational) necessary to successfully burn poultry litter, and to develop detailed cost estimates for making those modifications. PPRP is also conducting a socioeconomic component of the evaluation, focusing on the economic implications for farmers and the current wood chip supplier for ECI. Other issues to be addressed will include impacts of truck traffic on residents, and tax revenue and employment effects on the local and State economy.

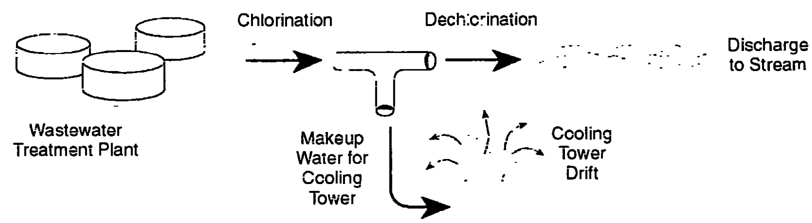
The comprehensive investigation is underway and is to be completed during the fall of 1998. At its completion, the State will have the necessary information to decide whether to proceed with modifying the existing boilers at ECI.

Treated WWTP Effluent as Cooling Water (Southern Maryland)

For most power plants, the availability of water for cooling purposes is a critical requirement. Large generating stations can require several million gallons per day of cooling water. Instead of using ground water or surface water sources to supply cooling water, power generators and other industries have begun considering the use of treated effluent from domestic wastewater treatment plants (WWTPs).

In the fall of 1996, a new power plant began operating in Maryland, using WWTP effluent for cooling water. The 248-MW Panda-Brandywine facility, near Brandywine, Prince George's County, is the first large power plant in the state to use treated effluent as cooling water (see schematic in Figure 1-2). The reuse of WWTP effluent was first suggested by PPRP and adopted by Panda because of the State's policy against permitting the use of potable ground water for industrial cooling when suitable lower quality water is available. This is particularly important with the increasingly high demand being placed on ground water resources in southern Maryland, where the Panda facility is located.

Figure 1-2
Schematic of Treated Effluent Reuse as Cooling Tower Makeup Water



PPRP conducted an independent evaluation of the feasibility and potential impacts of using Mattawoman WWTP effluent as cooling water. The technical feasibility was examined, and the quality of the treated WWTP effluent was compared to two other alternative sources: ground water and municipal potable water. Based on the technical evaluation, PPRP concluded that the most appropriate means of meeting the water supply need of the Panda-Brandywine facility was to combine the routine use of wastewater treatment plant effluent for cooling water with the use of ground water for the remainder of the plant's water needs.

The State also completed a review of potential environmental and human health impacts from the proposed use of treated WWTP effluent. This review focused on impacts to soil and vegetation due to salt deposition, and potential releases of pollutants, including pathogens, dissolved in water vapor emitted from the tower ("cooling tower drift"). PPRP estimated the human health risks associated with emissions from the cooling tower, considering both inhalation and potential residential exposures to soils affected by deposition. The risk assessment concluded that the use of Mattawoman WWTP effluent for cooling water poses no unacceptable human health risks. Chlorination can control concentrations of bacteria and viruses at safe levels.

As a result of the above studies, a CPCN was issued in 1996 for the Panda facility. The CPCN included conditions to ensure effective disinfection and suitable water quality, such as requirements to control residual chlorine concentration, contact time, and turbidity of the effluent prior to entering the plant's cooling towers. PPRP has maintained an active role in reviewing the monitoring data from Panda's cooling water system, to ensure that public health and environmental risks are minimal.

PPRP also evaluated the feasibility of using treated effluent as cooling tower makeup for a proposed combined cycle unit at the Perryman plant in Harford County, operated by Baltimore Gas and Electric Company (BGE). The utility requested a CPCN to add capacity at the site in a two-part application submitted to the PSC in 1989 and 1990. BGE received its license for the first component of the project, a new simple cycle turbine which is currently operating at the site. A following phase would involve adding a steam cycle at Perryman, as the need for additional capacity arises in the future.

To supply water for the steam cycle of such a combined cycle operation, BGE proposed two alternative water sources: treated effluent from the Sod Run WWTP adjacent to the Perryman site, or water purchased from the City of Baltimore. PPRP conducted an analysis of the quantity, quality, environmental issues, regulatory issues, and cost associated with each water supply alternative. The State concluded that Sod Run WWTP effluent was the preferred source of cooling water for the future needs of the Perryman plant. The Sod Run plant discharges enough water to provide a reliable supply; reuse of treated effluent would provide environmental benefits and conserve fresh water resources; and the costs would be similar to those for purchasing municipal water from Baltimore City. BGE agreed to reevaluate the use of treated effluent when the time comes to obtain the CPCN for this future phase.

Because of the constraints on ground water resources and the concerns about water availability around the state, PPRP expects that any new generating station proposed in Maryland will need to consider the use of WWTP effluent as cooling water.

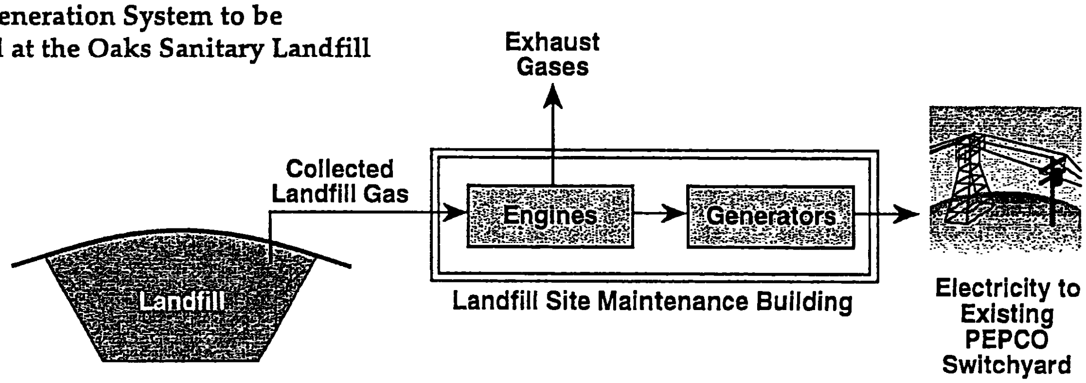
Licensing of Landfill Gas Combustion Units (Montgomery County)

The PSC recently issued a CPCN for construction of new turbines for the combustion of landfill gas (methane, commonly generated at landfill sites) at the Oaks Sanitary Landfill in Montgomery County. Most of the methane from the Oaks Landfill is currently being collected and combusted in an open flare. The landfill reached capacity and was closed in 1997. The County is planning to install a new system in which the collected landfill gas can be used to generate electricity through combustion in gas turbines, rather than flaring the gas.

Two engines will be installed within the Maintenance Building at the landfill, generating a total of up to 4 MW of electricity for purchase by Potomac Electric Power Company (PEPCO). Figure 1-3 depicts the generation project. Construction is scheduled to begin during the fall of 1998.

Due to the relatively small scale of the proposed system, PPRP worked directly with the County and its turbine system contractor, the Bentech Group, to develop an environmental review report for the project. This collaborative approach enabled PPRP to involve the appropriate regulatory agencies early in

Figure 1-3
Electrical Generation System to be Constructed at the Oaks Sanitary Landfill



the licensing application process, and resulted in a more streamlined CPCN preparation and review. The landfill gas combustion project had a particularly urgent timetable due to a very limited opportunity to interconnect with PEPCO's transmission system. Through cooperative efforts on the part of the applicant, PPRP, the PSC, and regulatory agencies (both state and county), the licensing process was completed within a six-month period. The PSC Hearing Examiner issued an order in May 1998 incorporating all of the State's recommended conditions.

The key environmental issues covered in the licensing review were associated with air and noise emissions from the proposed units. Due to the location of the Oaks Sanitary Landfill in an ozone nonattainment area, PPRP worked with the Maryland Department of the Environment (MDE) and Bentech to ensure that the engines' operation will limit emissions of volatile organic compounds and nitrogen oxides, precursors of ozone. MDE's involvement was essential to develop operating limits that will protect air quality in Maryland while allowing sufficient operation to make the project economically viable.

PPRP also examined potential noise levels produced by the engines. Personnel from the Montgomery County Department of Environmental Protection worked with PPRP and Bentech to identify noise abatement techniques that could be integrated into the system design. PPRP recommended licensing conditions that will ensure the operation of the engines will comply with Montgomery County noise regulations.

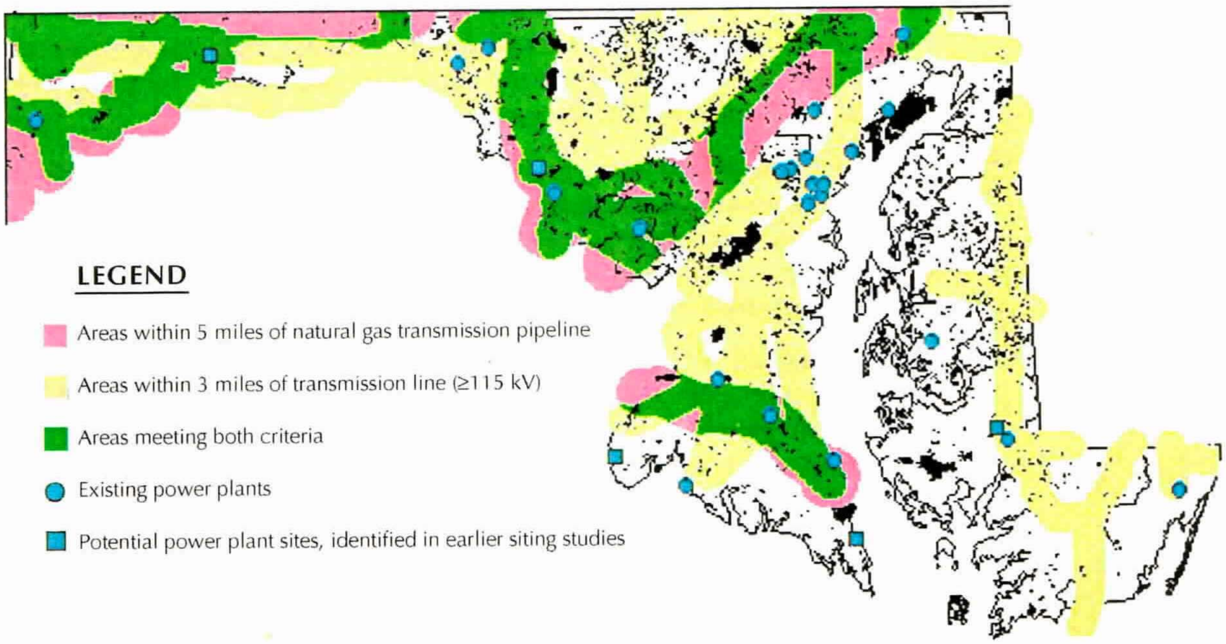
PPRP Smart Siting Project (State-wide)

Competition in the energy industry could change the siting of new power plants in Maryland. Competition may result in new plants being built by power developers other than utilities. Furthermore, future capacity may be added not at the major existing power plant sites presently owned by utilities, but at dispersed "greenfield" sites around the state.

With the need for new power plant sites comes the need for information to support the responsible siting of these facilities. To meet this need, PPRP initiated the PPRP Smart Siting Project. Its primary goal is to conduct a statewide assessment identifying regions of the state more favorable for power plant development. Although focused on power plant development, this project will also provide enhanced visibility for Maryland's industrial potential and promote economic development opportunities in a balanced framework.

The Smart Siting Project is designed to highlight potential regional areas for development as opposed to specific sites that are suitable or unsuitable for facility development. Using the results from the Smart Siting Project, a developer could identify areas of the state on which to focus when seeking a good plant site. The developer would still need to get more detailed information from the local level, and go through all applicable licensing activities.

PPRP is conducting this statewide assessment using a Geographic Information System (GIS) siting model. The GIS allows the project team to link a tremendous amount of information on various features (roads, railroads, waterways, transmission lines, etc.) to their locations on a map, and to provide electronic access to all the data sets. The GIS user can also view information in different combinations, depending upon the type of facility under consideration.



Example of Siting Scenario Results from PPRP Smart Siting Project

One of the siting scenarios examined in the Smart Siting Project resulted in identifying those areas within 5 miles of a natural gas transmission pipeline, and within 3 miles of a transmission line (115 kV or greater). These criteria address the infrastructure that would be needed to support a new simple cycle combustion turbine facility. The green areas in the adjacent map represent those areas of the state meeting both the natural gas pipeline and transmission line criteria. The blackened areas are protected lands, such as federal properties, parks, private conservation lands, and DNR-owned lands, where power plant development would be excluded.

PPRP worked with other State agencies to integrate existing GIS data into this project. All the siting factors, or **data layers**, incorporated into the project are listed below:

- *Transmission lines*
- *Natural gas transmission pipelines*
- *Industrially zoned areas*
- *Wastewater treatment plants*
- *Existing power plants*
- *Surface water availability*
- *Property tax assessment rates and land value*
- *Incentive areas (enterprise/empowerment zones)*
- *Protected lands (e.g., parks)*
- *Railroads*
- *Ozone nonattainment areas*
- *Major roads*

At the outset of the project, PPRP formed a Smart Siting Advisory Group to provide guidance and input to the project team. The Advisory Group includes representatives from interested state, county, regional, and local agencies as well as electric utility companies and non-utility generators. The group was extremely helpful in determining which siting factors to include.

After developing the data layers, PPRP then evaluated **power plant engineering requirements**—the resources or infrastructure that are needed at a site to support a particular type of power plant. For example, rail lines would be a desirable infrastructure feature for a coal-fired power plant, since it would be an economic benefit to have coal delivered to the site by rail.

From the identified engineering requirements, PPRP created typical power plant siting scenarios reflecting different types of power plants that could be proposed in Maryland. In addition, a user can develop unique scenarios by listing a series of questions which the user is seeking to answer through the Smart Siting GIS tool. For example, one siting scenario might ask, "What areas of Maryland are located . . .

- *within five miles of a natural gas transmission pipeline?*
- *and within five miles of a one-million-gallon-per-day water supply?*
- *and within five miles of a transmission line?*
- *and within an industrially zoned area?"*

The Smart Siting Project has generated statewide screening results for eight siting scenarios. PPRP created composite maps for each siting scenario, using the GIS tool to overlay portions of data layers meeting the criteria of each scenario. The Smart Siting report, which PPRP is currently developing, will contain maps of all siting scenarios, as well as maps of each individual data layer and a full description of the project methodology and results.

Electronic versions of each data layer, the composite maps, and associated descriptive information are stored on CD-ROM, and are available as part of DNR's Technology Toolbox. The maps and data layers can be viewed with ArcView® or other GIS software. With ArcInfo® or the Spatial Analyst extension of ArcView GIS software, the user can construct new siting scenarios to fit specific plant requirements, and explore different combinations of siting factors depending upon the user's particular interests or constraints.

PPRP expects the Smart Siting GIS tool to be a dynamic, ongoing project that will improve the efficiency and minimize the environmental impact of plant development within Maryland.

Electric Power Generation in Maryland

This section describes the companies and facilities that make up the power generation and transmission system in Maryland. It also discusses electricity demand among the state's consumers and how demand is changing over time.

Maryland's Electricity Suppliers

Electricity in Maryland is supplied principally by investor-owned utilities (IOUs). IOUs are large, vertically integrated firms that generate electricity, transport it over high voltage transmission lines to population centers and then distribute it to ultimate consumers. Three other types of companies also supply electric power in Maryland:

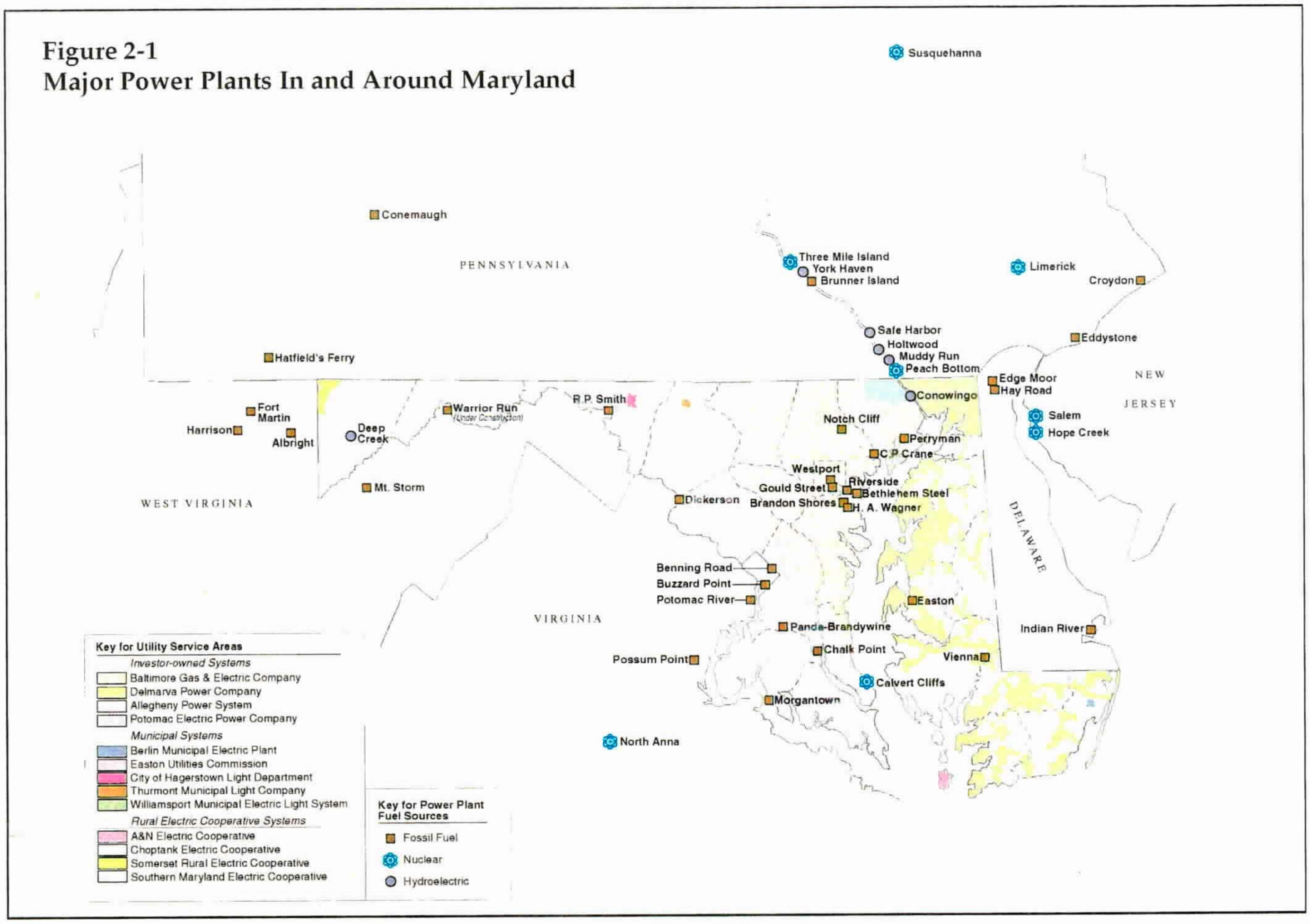
- *municipal utilities;*
- *rural electric cooperatives; and*
- *non-utility generators (NUGs).*

A municipal utility owns the local distribution facilities in a specific town or city, generates electricity itself or buys wholesale power from another utility, and distributes it to local citizens. Rural cooperatives are customer-owned utilities, which were established during the 1930s to provide electricity to rural America. These cooperatives serve larger areas than do municipal utilities, are located in less populated portions of the state, and in some cases borrow most of their investment funds from the federal Rural Utilities Service. NUGs generate electric power and sell it wholesale to utilities, or in some cases, consume it on site. Unlike utilities, NUGs do not serve a franchise service area.

The amount of electricity generated by power plants in Maryland is not sufficient to meet the total power demands of the state's electricity consumers. Therefore, Maryland utilities import more than 25% of the state's electricity from power generating facilities located in neighboring states. These imports come both from power plants owned by Maryland utilities but located in other states and from long- and short-term power purchases from IOUs in other states. Because of the complex power operating agreements in the region, some of the energy generated in Maryland is actually exported to other states. For example, although Maryland on balance is a net importer of power, Maryland power plants serve the power demands of customers in the District of Columbia and, occasionally, Pennsylvania.

The service areas of Maryland's electric utilities, and major power plants in the state, are shown in Figure 2-1.

Figure 2-1
Major Power Plants In and Around Maryland



Investor-Owned Utilities (IOUs)

There are four major IOUs that generate, distribute, and sell electricity in Maryland:

- *Allegheny Power System (APS);*
- *Baltimore Gas and Electric Company (BGE);*
- *Delmarva Power & Light Company; and*
- *Potomac Electric Power Company (PEPCO).*

Each of these companies was involved in merger negotiations during the last several years. This merger activity is discussed further in Section 5 of this report.

Two other IOUs operate generating facilities in Maryland but sell no electricity at retail in Maryland:

- *Susquehanna Electric Company, a wholly owned subsidiary of PECO Energy, which operates the hydroelectric facility at the Conowingo Dam; and*

- *Pennsylvania Electric Company (Penelec), a subsidiary of General Public Utilities (GPU), which operates a small hydroelectric facility on Deep Creek Lake in Garrett County.*

Baltimore Gas and Electric Company

BGE is a combination gas and electric utility serving the metropolitan Baltimore area. The electric service is provided to a 2,300-square-mile area with an estimated population of 2.6 million and more than one million customers. In 1996, industrial customers accounted for 50% of total sales, residential 40% and small commercial 10%. BGE's system peak in that year occurred during the winter, in February, and was 5,966 MW. To meet this demand, BGE had 6,804 MW of installed capacity resources. The 1996 winter peak demand reflected very cold weather. Moreover, because high generating capacity in the region was adequate at the time of the winter peak, BGE did not find it necessary to request load reductions from curtailable customers as sometimes occurs at the time of the annual peak. The weather-normalized peak during 1996 of 5,482 MW was a summer peak and included the impact of reductions in all curtailable loads and other peak reduction programs. BGE estimates that its peak demand will grow to 6,103 MW by the year 2006. This would require the company to increase its supply-side resources by 398 MW, to 7,202 MW, to maintain an adequate reserve margin.

In 1996, approximately 45% of the electricity BGE supplied to its customers was from nuclear energy (the Calvert Cliffs Nuclear Power Plant). Of BGE's total customer requirements, 28% of the energy was imported from resources outside of the state, including non-Maryland plants owned by BGE.

Delmarva Power & Light Company (Conectiv)

Delmarva Power is a combination gas and electric utility providing electric service to most of the Delmarva Peninsula. This is an area covering 5,700 square miles with a population of 800,000, consisting of the entire state of Delaware; portions of Maryland's nine Eastern Shore Counties; Cecil County and a portion of Harford County; and the two Virginia Eastern Shore Counties, Accomack and Northampton. Delmarva Power serves approximately 440,000

How is Electricity Generated in Maryland?

In Maryland, four types of generation technologies provide the bulk of electricity generation:

- steam turbines (both fossil fuel-fired and nuclear-powered boilers);
- combustion turbines;
- combined cycle units; and
- hydroelectric units.

Steam turbine power plants are the most common generation technology in Maryland. A steam turbine is an enclosed rotary device in which the energy of high-temperature, high-pressure steam is converted to mechanical energy. This mechanical energy is used to drive generators that produce electricity. Steam turbine plants in Maryland use either fossil fuels (coal, oil, or natural gas) or nuclear fission to produce steam. Steam electric stations in Maryland burn mostly pulverized coal, reflecting the national trend during the 1970s and 1980s toward coal and away from oil or nuclear fission as the primary fuel.

Combustion turbines are the second most common power generation technology in use in Maryland. Combustion turbines use compressors to draw air from the atmosphere and pressurize it. The compressed air is then directed to the combustor where it is mixed with either oil or natural gas and ignited. The energy of the combustion product is converted to mechanical energy by expansion in a turbine. Due to the relatively high cost of oil and gas, combustion turbines are primarily used to provide peaking power, that is, to help meet short-term demands for electricity when demand is highest.

Combined cycle units, a hybrid of combustion turbines and steam units, should become more common in the future. This technology directs the waste heat from a combustion turbine to a heat recovery steam generator; the steam drives a turbine generator to produce electricity. Typically, about two-thirds of the electric output of a combined cycle unit is produced by the combustion turbine and one-third by the steam turbine generator. Utilities are looking to this type of unit as the resource of the future because of dramatic increases in overall efficiency that have been achieved recently. Moreover, where retail competition is permitted, the combined cycle unit is likely to be the generating technology most often used by alternative suppliers of electricity.

Hydroelectric power, the fourth major generation technology in Maryland, uses the energy of moving water to produce electricity. Potential energy in the form of stored water behind a dam is converted to kinetic energy when drawn by gravity through the dam's conduits. The amount of electricity generated depends upon how far the water "falls" (head) and how much water is flowing. In a hydroelectric system, flowing water pushes against turbine blades to drive generators and produce electricity.

customers (residences and businesses), and its retail sales in Maryland account for 30% of the company's total electric sales.

In 1996, Delmarva's peak was 2,510 MW, compared to generating resources of 2,990 MW. Delmarva estimates that it must add 116 MW of resources by the year 2006. Most of Delmarva's generating units are coal-fired and are located in Delaware. As of May 1998, Delmarva has been operating as a subsidiary of Conectiv, a holding company formed by the merger of Delmarva Power and neighboring Atlantic Energy (see further discussion in Section 5).

Allegheny Power System

The three operating utilities of APS function as a single integrated utility. They serve approximately 1.4 million customers in a 29,000-square-mile service territory with a population of 2.9 million. In Maryland, APS serves 205,000 customers in a 2,500-square-mile area.

Industrial sales account for more than 50% of APS' retail sales in Maryland, in large part due to the electricity requirements of Eastalco Aluminum Company. APS also serves three Maryland municipal electric distribution systems—the cities of Hagerstown, Thurmont, and Williamsport—at wholesale. APS' system peak for the winter of 1996/1997 was 7,423 MW. The 1996/97 peak demand of APS' Maryland customers was 1,657 MW.

Potomac Electric Power Company

PEPCO provides service in metropolitan Washington, D.C. to more than 650,000 customers in a 640-square-mile area with a population of 1.9 million. This service area includes the entire District of Columbia, and most of Prince George's and Montgomery Counties in Maryland. PEPCO also sells electricity at wholesale to Southern Maryland Electric Cooperative (SMECO), which serves an area of 1,150 square miles in Calvert, Charles, St. Mary's and a small portion of Prince George's Counties in southern Maryland. PEPCO is unique among Maryland IOUs in that it has no major industrial customers. In 1996, PEPCO's system peak demand was 5,288 MW and it had 6,805 MW of capacity resources available to meet this demand. The peak demand is expected to increase to 6,404 MW by the year 2006, requiring the company to add 723 MW of additional resources.

Publicly Owned Utilities

Two types of publicly or member-owned utilities operate in Maryland—municipal electric systems and rural electric cooperatives. Municipals include the systems operated by the cities of Hagerstown, Thurmont and Williamsport, which buy their electricity from APS; the Town of Berlin, which buys most of its electricity from Delmarva Power and generates some electricity as well; and the Town of Easton, which is interconnected with Delmarva Power but has its own generating capacity. Rural electric cooperatives include SMECO, which owns one generating unit at PEPCO's Chalk Point site; A&N and Choptank, which buy power from Delmarva Power; and Somerset, whose energy is supplied by the Allegheny Electric Cooperative in Pennsylvania. A&N and Somerset serve only a few hundred Maryland customers and operate mostly in neighboring states.

Non-Utility Generators (NUGs)

A small but expanding portion of Maryland's electric power supply comes from NUGs—power generation facilities owned and operated by major industrial firms or private third-party developers. The power from these projects is either consumed on site (if, for example, the facility is located at an industrial plant) or sold at wholesale to the local electric utility.

Since the early to mid-1980s, there has been a growing realization that new electric power resources need not be provided by traditional utilities. It is now generally accepted that the function of electric power generation is no longer a "natural monopoly" and is subject to competition. Section 5 of this report discusses competitive restructuring in more detail.

Non-utility generation has been modest in Maryland compared with surrounding states and some other regions of the United States. Presently, there are approximately 550 MW of installed NUG capacity in Maryland from more than a dozen projects. Table 2-1 provides a list of all current NUG facilities in Maryland with generating capacities greater than 10 MW. These five projects listed in the table account for nearly all the state's NUG capacity. Although there are several other NUGs operating in Maryland, they are all very small and produce only modest amounts of energy.

Table 2-1 Current NUG Facilities in Maryland With Capacity Greater Than 10 MW

Facility	Location	Purchasing Utility	Type of Facility/Fuel	Capacity (MW)
BRESCO	Baltimore City	BGE	Municipal Waste	57
Bethlehem Steel	Baltimore County	BGE	Natural Gas/ Blast Furnace Gas	169
Westvaco	Allegany County	Self/AP	Manufacturing Waste	50
Montgomery County Resource Recovery Facility	Montgomery County	PEPCO*	Municipal Waste	32
Panda-Brandywine	Prince George's County	PEPCO	Natural Gas	230
			Total	**538 MW**

* PEPCO purchases energy only until 2002.

The only other NUG project under construction in Maryland is the AES-Warrior Run facility, with a capacity of 180 MW. That facility is expected to enter service in 1999.

The Maryland PSC has ruled that NUG projects that sell electricity off site are generally subject to the same power plant licensing rules as utilities. This means that any NUG facility built in Maryland must first undergo the same comprehensive environmental review that utility-built power plants undergo during the licensing process.

Electric Generating Capacity of Maryland Utilities

Maryland utilities own and operate more than 11,000 MW of generating capacity in Maryland. In addition, they own all or shares of generating units in other states. BGE and Delmarva Power own shares of the large Conemaugh and Keystone coal plants in Pennsylvania; PEPCO also owns a share of the Conemaugh plant. Delmarva Power owns shares of the Peach Bottom nuclear unit in Pennsylvania and the Salem nuclear unit in New Jersey, and operates coal plants in Delaware. Most of APS' power plants are located in West Virginia and Pennsylvania. BGE has an entitlement to the Safe Harbor hydroelectric plant in Pennsylvania, and PEPCO is the sole owner of the Potomac River coal-fired plant in Alexandria, Virginia, and several oil-fired units in the District of Columbia. In total, this comes to almost 18,000 MW of capacity owned by Maryland utilities.

Table 2-2 lists the power plants owned by Maryland utilities and the rated capacity at each plant. This table includes existing NUG plants (over 10 MW) whose total net output is purchased by a utility.

Table 2-2 Current Generating Capacity in Maryland Utility Systems

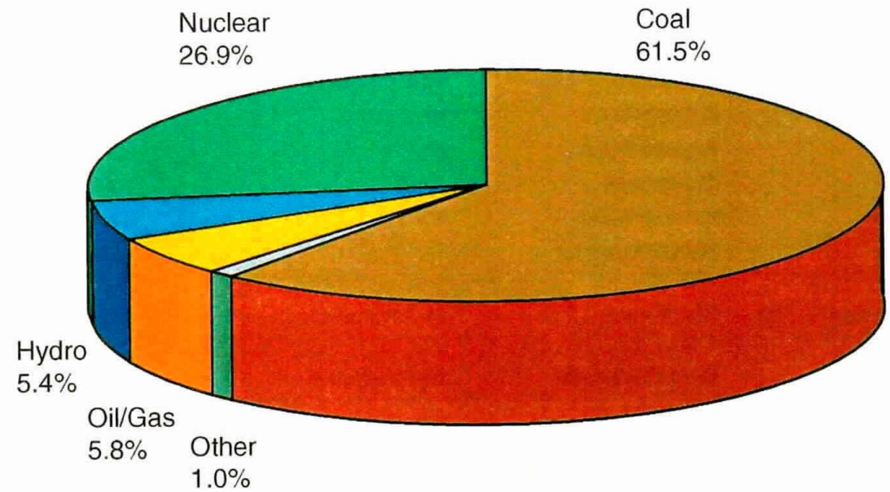
Utility	Plant Name	Major Fuel Type	Capacity (MW)
BGE In-State	Brandon Shores	Coal	1,298
	Calvert Cliffs	Nuclear	1,721
	C.P. Crane	Coal	397
	Gould Street	Oil/Natural Gas	104
	Notch Cliff	Natural Gas	132
	Perryman	Oil/Natural Gas	244
	Riverside	Oil/Natural Gas	251
	H.A. Wagner	Coal/Oil	1,011
	Westport	Natural Gas	134
	Philadelphia Road	Oil	68
	Bethlehem Steel	Natural Gas/ Blast Furnace Gas	169
	BRESCO	Waste	57
BGE Out-of-State	Conemaugh	Coal	181
	Keystone	Coal	358
	Safe Harbor	Hydroelectric	277
	BGE Subtotal		6,402

Table 2-2 Current Generating Capacity in Maryland Utility Systems (continued)

Utility	Plant Name	Major Fuel Type	Capacity (MW)
PEPCO In-State	Chalk Point	Coal/Natural Gas	2,350
	Dickerson	Coal/Natural Gas	913
	Morgantown	Coal	1,491
	SMECO	Natural Gas	84
	Montgomery County	Waste	32
	Panda-Brandywine	Natural Gas	230
PEPCO Out-of-State	Benning Road	Oil	554
	Buzzard Point	Oil	271
	Conemaugh	Coal	179
	Potomac River	Coal	484
	PEPCO Subtotal		**6,588**
PECO (Susquehanna)	Conowingo	Hydroelectric	512
Penelec	Deep Creek Lake	Hydroelectric	19
APS In-State	R.P. Smith	Coal	114
	AES-Warrior Run	Coal	
APS Out-of-State	Albright	Coal	76
	Harrison	Coal	629
	Hatfield's Ferry	Coal	332
	Pleasants	Coal	375
	Bath County	Pumped Storage	235
	VA & WV Hydro	Hydroelectric	11
	APS Subtotal		**1,772**
Delmarva Power In-State			
	Vienna	Oil	168
	Dorchester	Coal	
	Crisfield	Oil	10
Delmarva Power Out-of-State			
	Christiana	Oil	45
	Conemaugh	Coal	63
	Edge Moor	Coal/Oil	708
	Indian River	Coal	781
	Keystone	Coal	63
	Peach Bottom	Nuclear	157
	Salem	Nuclear	167
	Hay Road	Natural Gas	511
	Diesels	Diesel Oil	77
	Delmarva Power Subtotal		**2,750**
Easton	Easton	Oil	47
Berlin	Berlin	Oil	4
Total			**18,095**

The principal fuel burned at power plants located in Maryland is coal, which in 1996 accounted for roughly 61 percent of the generation in Maryland. Figure 2-2 illustrates the generation in Maryland in 1996, by fuel. Nuclear generation, represented by BGE's Calvert Cliffs plant, accounted for 26% of total generation in the state in 1996.

Figure 2-2
Fuel Used to Generate Electricity in Maryland in 1996



Power Pooling

Maryland utilities have combined their operations to gain the efficiency and reliability benefits of inter- and intra-state coordination through membership in power pools. APS operates as a single, large multi-state utility that integrates the operation of generating resources in several states to gain such advantages. BGE, Delmarva, and PEPCO are members of the Pennsylvania-New Jersey-Maryland Interconnection (PJM), the nation's oldest power pool, which includes many of the utilities in Pennsylvania, New Jersey, and Delaware as well as Maryland. The PJM pool has recently completed a restructuring, which was required by the Federal Energy Regulatory Commission (FERC) under its open access transmission orders (see further discussion in Section 5).

In 1997, the PJM utilities placed into effect on an interim basis a new operating agreement that supersedes the original PJM agreement. FERC has approved a slightly different version of that agreement, which became effective on April 1, 1998. The new agreement establishes an **Independent System Operator (ISO)** to assume responsibility for assuring members that the transmission grid is operated reliably and generating units are dispatched efficiently. The ISO arrangements establish new governance procedures to open membership to different segments of the industry and assure that no one segment can dominate decisions of the pool. Further, the ISO will operate a **Pool Spot Energy Market (PX)** that is expected to approximate the central dispatch provisions of the previous PJM agreement. The new agreement also provides for reserve sharing similar to that in the previous PJM agreement and non-discriminatory transmission service to all eligible utilities at a single rate, with that single rate depending upon where power is delivered, for transactions within and through the pool.

Under the old PJM arrangement, generating resources within PJM were operated under a method called **economic dispatch**. Under that approach, PJM used hourly cost information on all generation within the pool and used this to schedule generation within the pool from the lowest cost unit available to meet increments of load. The central dispatch of PJM resources produced significant operating cost savings for member utilities and their customers over the years.

Under the new PJM ISO agreement, the ISO administers a PX energy market (instead of economic dispatch) to minimize the pool's operating costs. Under this approach, generating resources within the pool submits a cost-based bid to the PX on a day-ahead basis. In each hour, the highest bid needed to serve loads becomes the market clearing energy price and utilities purchasing energy from the PX pay this market clearing price. Similarly, all generating units selected to supply power in a given hour receive the market clearing price established for that hour. A more complicated set of prices are paid whenever the transmission grid is congested. The PX prices under this approach should provide all utilities in the pool with the proper economic incentives so that the operation of generating resources within the pool is similar to that of the previous economic dispatch system.

The PJM ISO agreement also provides for members to achieve desired reliability levels at a lower cost using methods virtually identical to those in the original PJM agreement. Such benefits in PJM have been realized through long- and short-term, pool-wide planning for the adequacy of reserves. Reserves required for the pool as a whole are determined by assuring that generation resources are sufficient to satisfy demand on all but one day in 10 years. Once the appropriate level of reserves is computed, the reserves are allocated among PJM members on the basis of members' load shapes and the reliability of their generating units. During the past few years, under this procedure BGE and Delmarva used 18% reserve margins for planning purposes, while PEPCO used a 16% reserve margin.

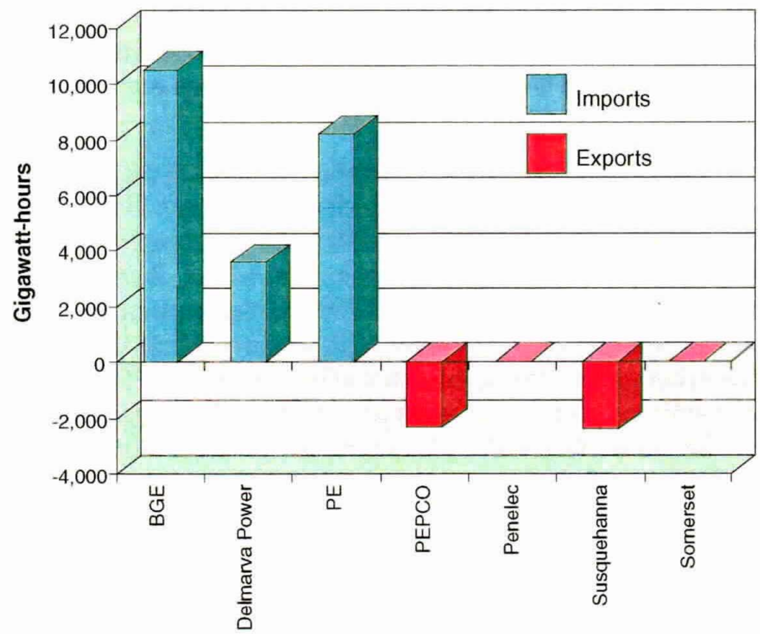
Energy Imports and Exports

Electricity demand in Maryland exceeds the amount of electricity generated within the state; therefore, retail suppliers must import a substantial quantity of energy from neighboring states. Three utilities—BGE, Delmarva Power, and PEPCO—import energy from the Conemaugh and Keystone plants in western Pennsylvania (plants in which the three utilities hold partial ownership interests). Delmarva Power also imports electricity from both the Peach Bottom nuclear plant in southern Pennsylvania and the Salem nuclear plant in southern New Jersey. PEPCO and BGE import substantial amounts of power from utilities in Ohio and Pennsylvania under long-term contracts. Table 2-3 compares energy sales in the state, adjusted for losses, with the amount of energy generated in the state. The difference is the energy imported. The amount of electricity imported to and exported from Maryland in 1996 is also illustrated in Figure 2-3.

Table 2-3 Exports and Imports of Energy into Maryland in 1996 (GWH)

	BGE	Delmarva Power	APS	PEPCO	Other	Totals
Retail/Wholesale Sales in MD	37,667	3,785	8,490	13,246	6	63,194
MD Generation	27,165	207	260	15,547	2,469	45,647
Imports (Exports)	10,502	3,579	8,230	(2,301)	(2,463)	17,547
Imports as Percent of Sales	27.9%	94.5%	96.9%	-17.4%	NA	27.8%

Figure 2-3
Electricity Imports to Maryland and Exports from Maryland, 1996



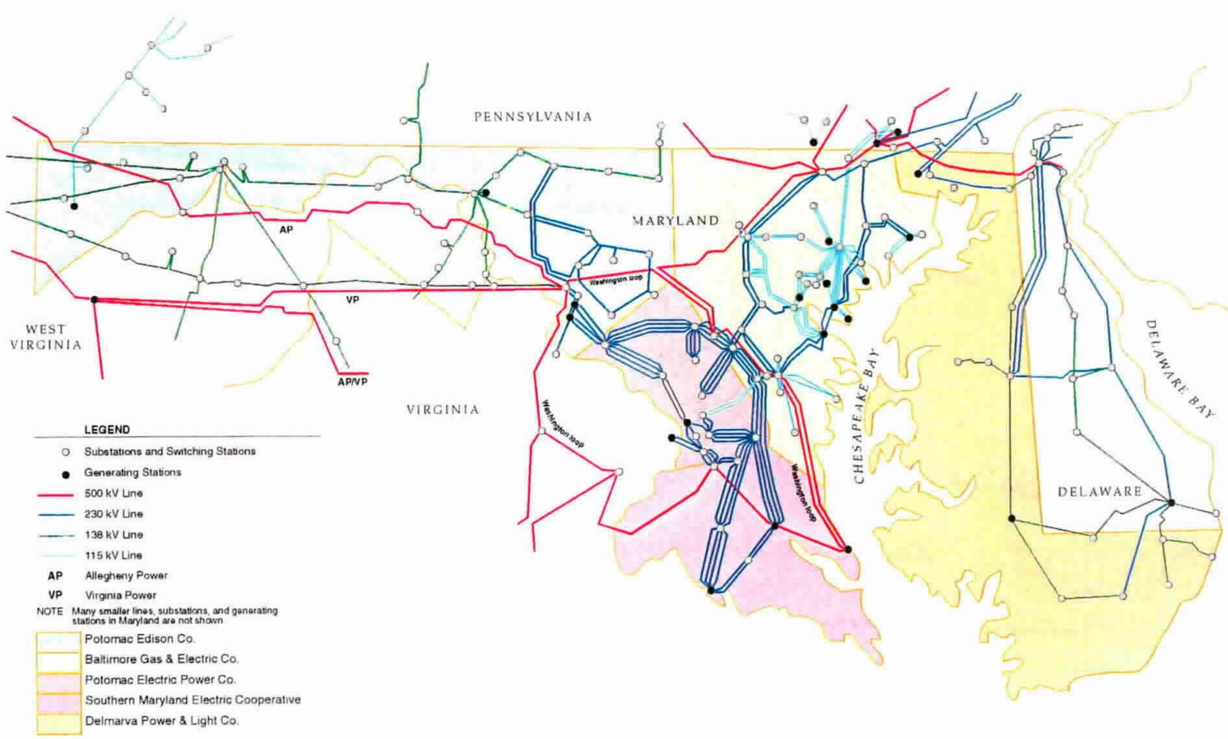
The Role of Transmission

Transmission facilities, consisting of high-voltage lines and transformers, play an integral role in providing electricity to Maryland consumers. Transmission serves at least four functions. First, the use of transmission enables utilities to locate power plants in remote locations near inexpensive sources of fuel. The high-voltage system allows Delmarva, BGE, and PEPCO to import their ownership shares of the Keystone and Conemaugh coal units in western Pennsylvania; BGE to import its share of the Safe Harbor hydro units in central Pennsylvania; and Delmarva to import its share of the Peach Bottom and Salem nuclear units in central Pennsylvania and southern New Jersey, respectively.

Another important function of transmission is to permit utilities to purchase power from others when that is less expensive than operating their own units. PEPCO is able to use the high-voltage system in western Maryland and western Pennsylvania to deliver its 20-year, 450 MW purchase from Ohio Edison. BGE uses the high-voltage system in Maryland and Pennsylvania to purchase power from Pennsylvania Power and Light Company's Susquehanna nuclear unit. The transmission system also enhances reliability by allowing access to available capacity resources in other systems in the event of an emergency. Finally, in conjunction with their membership in the PJM power pool and through the integration of APS's entire mix of generating resources, Maryland utilities can reduce operating costs by purchasing economy energy through the transmission network.

Figure 2-4 shows the high-voltage transmission grid in Maryland. The 500 kilovolt (kV) system is shared by all Maryland utilities, by other PJM members in Pennsylvania and New Jersey, and by APS. Figure 2-4 illustrates the connections between generating stations and load centers in and around Maryland. BGE's Calvert Cliffs nuclear plant is connected by two 500 kV lines to the Baltimore-Washington metropolitan area. PEPCO's major generating facilities at Chalk Point, Dickerson, and Morgantown are connected to the Washington, D.C. metropolitan area through 230 kV lines. Delmarva Power's load on the Eastern Shore is connected to its generation resources through 230 and 115 kV lines. Finally, APS' system is connected to company facilities located in other states through the 500 kV and lower voltage lines from the APS system in West Virginia and Pennsylvania.

Figure 2-4
Major High Voltage Transmission Lines in Maryland and Nearby Areas, 1997



Electricity Usage in Maryland

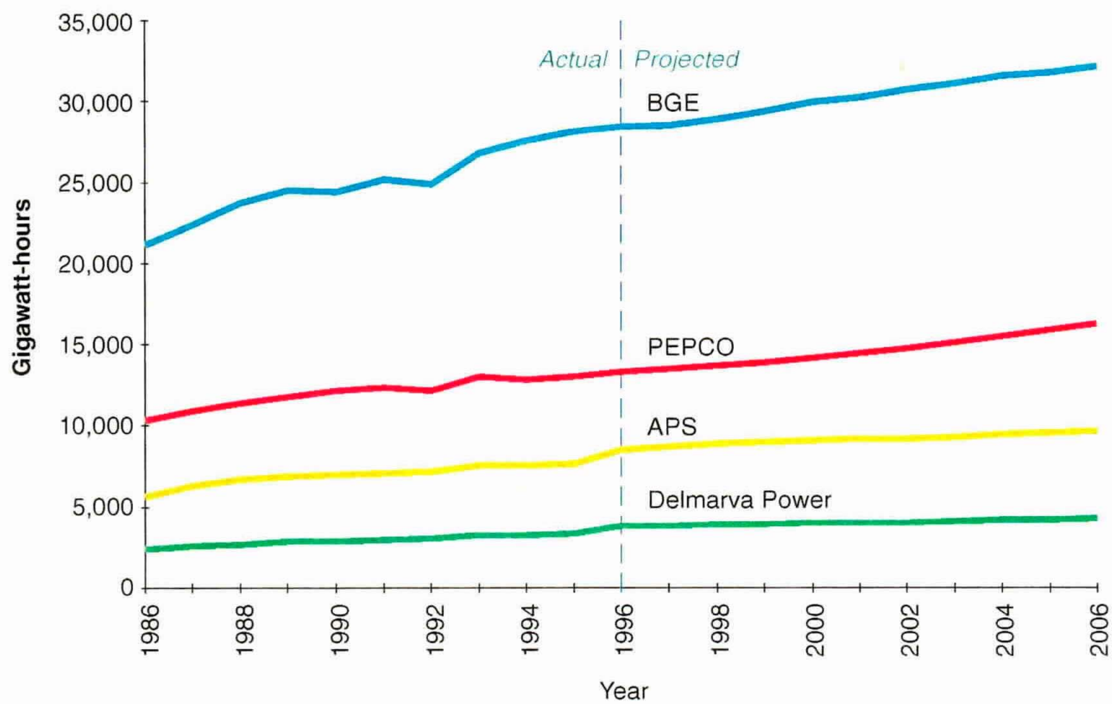
Maryland's Electricity Users

Users of electricity in Maryland are generally classified as residential, commercial, industrial, or governmental. Overall, total usage of electricity in Maryland is 60% non-residential and 40% residential, although each utility's customer base is different. Municipalities and rural cooperatives tend to sell a somewhat larger percentage of their total energy to households than do the larger IOUs.

Since most of Maryland's manufacturing industry is located in the service territories of BGE and APS, a higher proportion of these two utilities' sales are to industrial customers. In fact, most of the total sales for these two utilities are to the primary metals industry in Maryland, because APS provides service to Eastalco Aluminum Company and BGE serves the Bethlehem Steel Company.

Energy sales in Maryland are expected to continue to grow, but at a slower rate than recently. From 1985 to 1995, the growth in energy sales in Maryland by Delmarva Power, BGE, APS, and PEPCO (which account for more than 90% of all retail energy sales in the state) ranged from 3.8% to 5.7% per year, and averaged 4.8%. Over the 10 years from 1996 to 2006, the annual rate of growth in energy sales is projected to range from 1.0% to 1.9%, for an average of 1.5%. Figure 2-5 illustrates the actual retail sales of electricity from 1986 through 1996, for each of the four major Maryland utilities, as well as their projected sales through the year 2006.

Figure 2-5
Retail Sales Within Maryland of Major Utilities, 1986 - 2006



Many parts of Maryland experienced rapid increases in population, income, and employment during the late 1980s—some of the most significant factors causing electricity demand growth. Such increases are not projected for the 1990s and beyond. Appendix A of this report discusses some of the key factors that contribute to forecasted energy demand across the state.

Conservation and Demand-side Management

Since the mid-1980s, Maryland utilities have been actively engaged in promoting **demand-side management** (DSM) programs as a means of deferring power plant construction and meeting growing customer demands. DSM programs fall into two basic categories: 1) load management, and 2) conservation.

The first category, load management, refers to utility programs designed to reduce customer's electricity usage at the peak hours of the year or to shift demand from the high-usage peak hours to the low-usage off-peak hours. If successful, load management allows utilities to defer building or buying new generating capacity (which is driven by peak demand growth) and to use existing baseload units more efficiently. While reducing peak hour demand, load management programs have little or no effect on total electric energy usage.

The second category, conservation, refers to utility-sponsored programs that meaningfully reduce customers' total energy demands. Such programs usually, but not always, are intended to achieve peak hour demand savings as well. In general, conservation programs can help defer new power plant construction and also reduce fuel consumption.

In the mid-1980s, an acceleration in load growth prompted Maryland utilities to heavily emphasize load management, which was viewed as a cost-effective tool for reducing the large power plant construction burdens that utilities were facing at the time. The most important programs introduced or expanded at that time included interruptible or curtailable service to large business customers, time-of-day pricing for both residential and non-residential customer groups, and air conditioner/water heater cycling. Most of these programs could be introduced at relatively low cost, with participating customers receiving attractive rate discounts.

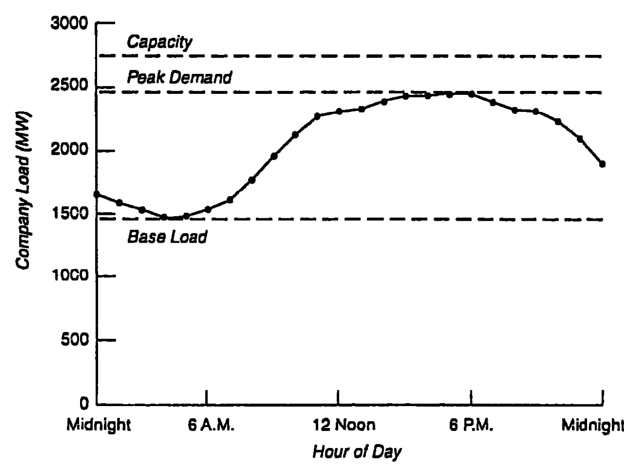
Electricity Supply and Demand

Capacity is the maximum rate at which electrical energy can be supplied (in watts). It is necessary for a system to have reserve generating capacity in case of equipment failure or maintenance shutdowns. Electrical energy is produced by using a portion of the capacity over a period of time (in watt-hours or kilowatt-hours).

Peak demand occurs when consumers use the greatest amount of electricity. Over the course of a year, electricity usage typically is highest on hot summer afternoons and cold winter evenings. The figure below shows how electricity demand on a utility's system may change during a summer day.

During a period of peak demand, generating units called peaking units (combustion turbines or diesel engines) are put into operation. These units can be started up quickly, but are expensive to operate for extended periods of time. Using less electricity during peak periods helps reduce overall electricity generation costs.

A system's **base load** is the minimum level of demand. Base load units are less expensive to operate, and run around-the-clock to meet at least that minimum demand.



Utilities placed comparatively less emphasis at that time on conservation programs. Programs undertaken during the 1980s consisted mainly of home energy audits, conservation advertising, new home energy efficiency certifications, low income weatherization, and providing technical advice to customers. Approximately five years ago, utility sponsorship of conservation began to expand substantially, with the major change being the introduction of financial incentives in the form of customer rebates and financing assistance to encourage the purchase of high-efficiency equipment and appliances.

While substantial conservation and load management has been achieved since the mid-1980s, there is evidence that utilities are considering cutbacks in DSM program investments in the future. As market prices for electric energy fall, it becomes more difficult for DSM programs to pass economic cost-effectiveness tests. A further impetus for the reduction in utility DSM programs stems from the expectation of retail competition in Maryland. In a competitive environment, some observers question whether utilities can continue to fund DSM efforts as they have in the past. In addition, an active market for energy efficiency services is emerging (at least for large business customers), which should reduce the need for utility-sponsored programs. However, it is not clear that a market exists to serve small utility customers' energy efficiency needs.

The Maryland PSC has established a Roundtable Working Group on DSM to determine the proper role for utility conservation programs during and after a transition to retail competition. The Working Group has been asked to examine the issues and to seek consensus concerning general policies to support DSM. The group is scheduled to complete its work by the end of 1998.

DSM Trends in Maryland

Maryland utilities' DSM efforts are projected to make a substantial contribution toward meeting peak demands over the next 10 years. For Maryland's four major electric utilities, Table 2-4 shows the projected energy and peak demand growth over the next 10 years and the contribution of DSM programs in meeting this growth. Figure 2-6 illustrates the percentage of power demand over the next 10 years to be met by DSM savings. Although there is considerable variation among the four utilities, in each case DSM is expected to meet a substantial portion of the 10-year demand growth. For peak demand, DSM savings range from 0% to 42%, with the average for the four utilities at 32%. Utility conservation programs will meet a somewhat smaller percentage of the energy growth, ranging from 0% to 23% over the next 10 years. However, as competitive pressures increase, utilities may seek to reduce their conservation program investments.

Considerable caution must be exercised in making cross-utility comparisons. Differences in DSM growth projections in Table 2-4 may be due to a number of utility-specific factors including the projected rate of growth in power demands (without DSM), inherent conservation or load savings opportunities, utility cost structures and other features. For example, since APS is winter-peaking, programs which primarily reduce summer peak demands might not be applicable.

The projected savings from DSM programs for Maryland utilities are shown on Figure 2-7. That figure shows the projected growth in peak demand over the next 10 years with and without DSM, with the savings from DSM divided between load management and conservation programs. The middle growth path shows what projected peak demand would be if only load management programs were included in the projections, while the bottom growth path subtracts out all planned DSM. Hence, the vertical difference between the middle and bottom paths is the estimated peak demand savings from utility conservation programs.

Table 2-4 The Role of DSM in Meeting the Growth in Power Demands for Maryland Electric Utilities (1997-2006)

Projected Energy Use w/o DSM to be met				DSM Savings			
Utility	**1997**	**2006**	**Growth**	**1997**	**2006**	**Increase in DSM**	**% of Growth**
			Energy Usage (GWH)				
BGE	30,833	34,866	4,033	619	771	152	3.8%
Delmarva Power	13,172	14,030	857	18	18	0	0%
PEPCO	27,947	35,316	7,369	1,430	3,154	1,724	23.4%
APS	13,591	15,558	1,967	481	613	132	6.7%
Total	**85,543**	**99,770**	**14,227**	**2,548**	**4,556**	**2,008**	**14.1%**
			Peak Demand (MW)				
BGE	6,259	7,037	778	765	934	169	21.7%
Delmarva Power	2,906	2,909	3	270	270	0	0%
PEPCO	6,326	7,761	1,435	749	1,357	608	42.4%
APS	2,707	3,128	421	212	272	60	14.3%
Total	**18,198**	**20,835**	**2,637**	**1,996**	**2,833**	**837**	**31.7%**

Figure 2-6
Percentage of Power Demand Growth Over the Next Ten Years to be Met by DSM Savings for Maryland Utilities

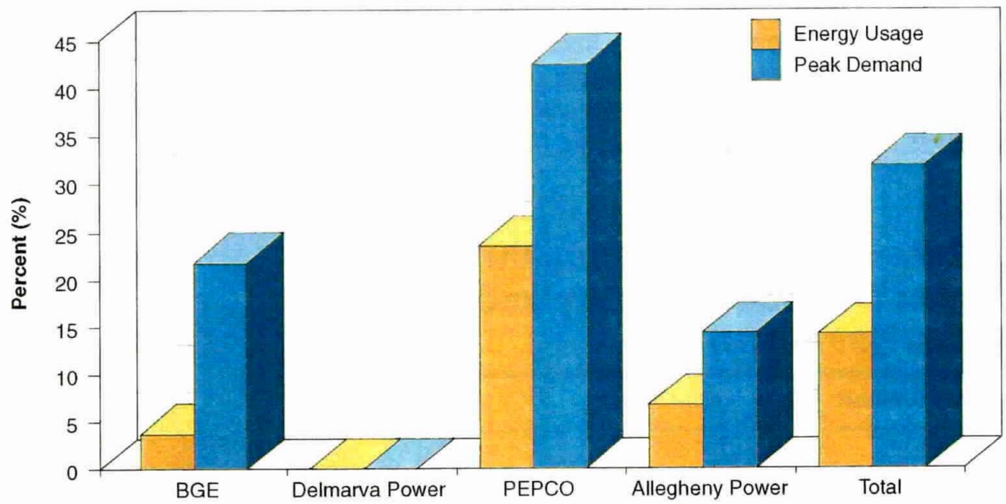
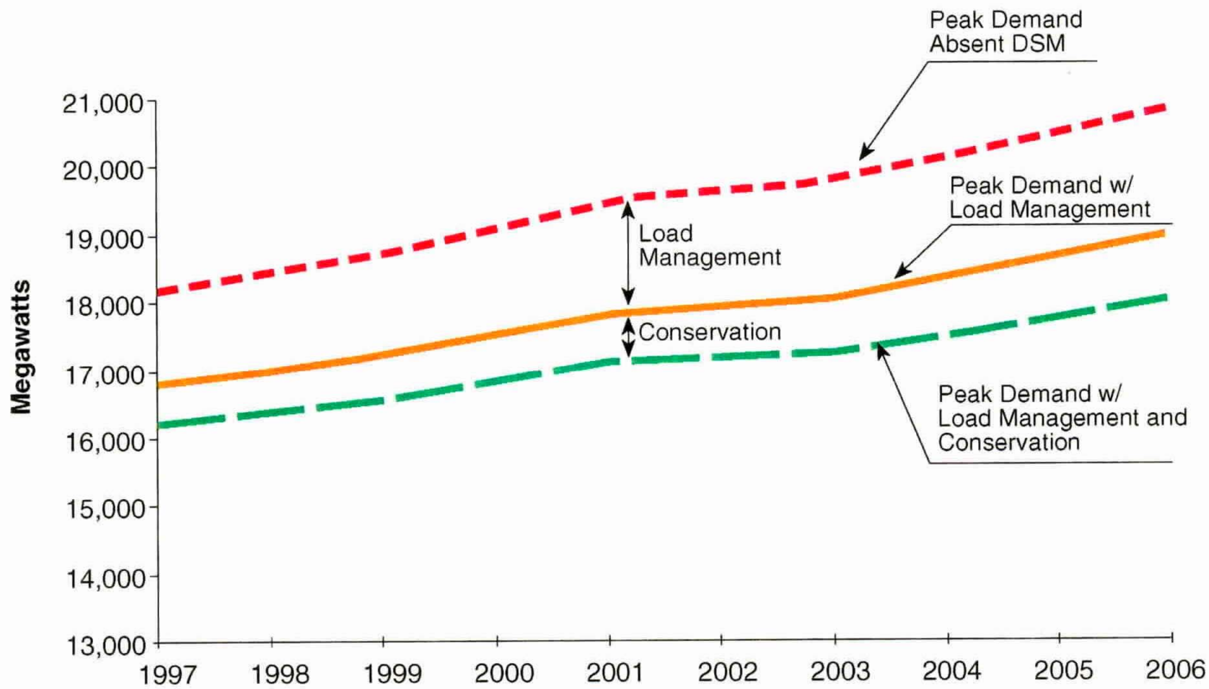


Figure 2-7
Projected Peak Demand for Maryland Utilities With and Without DSM Savings *



*Based on the sum of projected peak demand and DSM peak demand savings of BGE, Delmarva Power, PEPCO, and Allegheny Power.

Environmental Impacts of Power Generation

Most environmental impacts can be classified into those that primarily affect our air, water, or land. For example, emissions of nitrogen oxides (NO_x) from power plant stacks may affect smog levels; discharges of heated water into rivers and the Chesapeake Bay affect fish populations.

Some activities at power plants can affect air, water, and land resources simultaneously. Acid rain, for example, arises partially from air pollutants that are released from power plant stacks, transformed in the atmosphere and then fall to the ground affecting lakes, rivers, and forests. Radiological releases from nuclear power plants enter the air, water, and river sediments. Each of these topics, as well as other environmental impacts of concern, are discussed in this chapter.

Air Impacts

The combustion of fossil fuels to generate electricity at power plants in Maryland results in the release of air pollutants that can potentially degrade air quality, both locally and regionally. Since the 1970s, the U.S. Environmental Protection Agency (U.S. EPA) has taken action through provisions of the Clean Air Act (CAA) to monitor and control the effects of air pollutants from power plants and other sources. The first comprehensive CAA was passed in 1970. It has been amended twice, once in 1977 and again in 1990.

The U.S. EPA has established **National Ambient Air Quality Standards (NAAQS)**, which are maximum ambient air concentrations of six pollutants known as criteria pollutants. NAAQS have been established to protect human health (primary standards) and welfare (secondary standards).

Currently in Maryland, measured ambient levels of the criteria pollutants sulfur dioxide (SO_2), nitrogen dioxide (NO_2), particulate matter (PM), lead, and carbon monoxide (CO) are within the standards set by the U.S. EPA. Regions of the state in which the criteria pollutants are within standards are said to be "attaining the NAAQS," and are thus known as attainment areas. On the other hand, many areas of Maryland are not meeting the NAAQS for ozone, making ozone one of three air quality issues of particular concern in Maryland. The ozone issue and the other two key issues—acid rain and toxic air pollutants—are discussed in the following sections.

Ozone Pollution and NO_x Emissions

Of the major pollutants for which the U.S. EPA has set NAAQS, the most pervasive problem continues to be **ozone**, an important component of urban smog. One of the main goals of the CAA is to bring areas that are not attaining the NAAQS into attainment with the standard. In the past, ozone reduction strategies focused on controlling emissions of certain hydrocarbons, such as volatile

Air Standards for Criteria Pollutants

National Ambient Air Quality Standards

Criteria Pollutant	Averaging Period	Primary NAAQS ($\mu g/m^3$)	Secondary NAAQS ($\mu g/m^3$)
PM10 (Particulate matter <10 microns)	Annual	50	50
	24-hour	150	150
PM2.5 (Particulate matter <2.5 microns)	Annual	15	15
	24-hour	65	65
SO_2 (Sulfur dioxide)	Annual	80	—
	24-hour	365	—
	3-hour	—	1,300
NO_2 (Nitrogen dioxide)	Annual	100	100
Ozone*	8-hour	157	157
	1-hour	235	235
CO (Carbon monoxide)	8-hour	10,000	40,000
	1-hour	10,000	40,000
Lead	Quarterly	1.5	1.5

*EPA is phasing out and replacing the previous 1-hour primary ozone standard (0.12 parts per million, ppm) with a new 8-hour standard (0.08 ppm) to protect against longer exposure periods.

Since the early years of air quality management, air quality rules and regulations in the United States have been based on a set of air quality standards known as the National Ambient Air Quality Standards, or NAAQS. The NAAQS represent a maximum concentration or "threshold level" of a pollutant in the air above which humans or the environment may experience some adverse effects. The actual threshold levels are based on years of epidemiological, health, and environmental effects research conducted by EPA. There are two types of NAAQS: primary standards, which are set at levels that are designed to protect the public health; and secondary standards, which are designed to protect the public welfare (such as vegetation, livestock, building materials, and other elements of the environment).

EPA has established NAAQS for six pollutants since the concept of NAAQS was established in the CAA Amendments of 1970. Each has been reviewed periodically, and several have been revised; however, no new pollutants have been added to the list.

organic compounds (VOCs). However, recent studies indicate the need to control both VOC and NO_x emissions to attain the ozone NAAQS. Combustion sources, such as fossil fuel-fired power plants, are among the largest category of stationary sources of NO_x.

Ozone Levels in Maryland

Maryland's ozone air pollution is a significant concern. The ozone problems in the Baltimore and Washington, D.C. areas, along with other major metropolitan areas of the United States, are among the worst in the nation. The Maryland Department of the Environment (MDE) monitors ozone at various locations in Maryland to identify areas of concern and develop appropriate ozone pollution control strategies.

Figure 3-1
Number of Monitored One-hour Ozone Exceedances in Maryland, 1983-1996

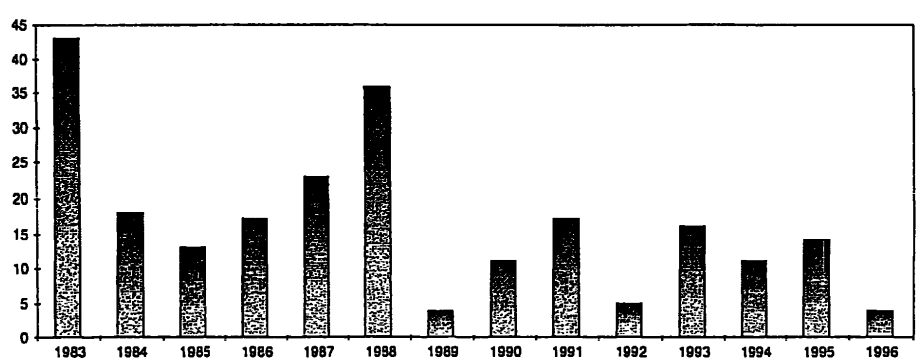
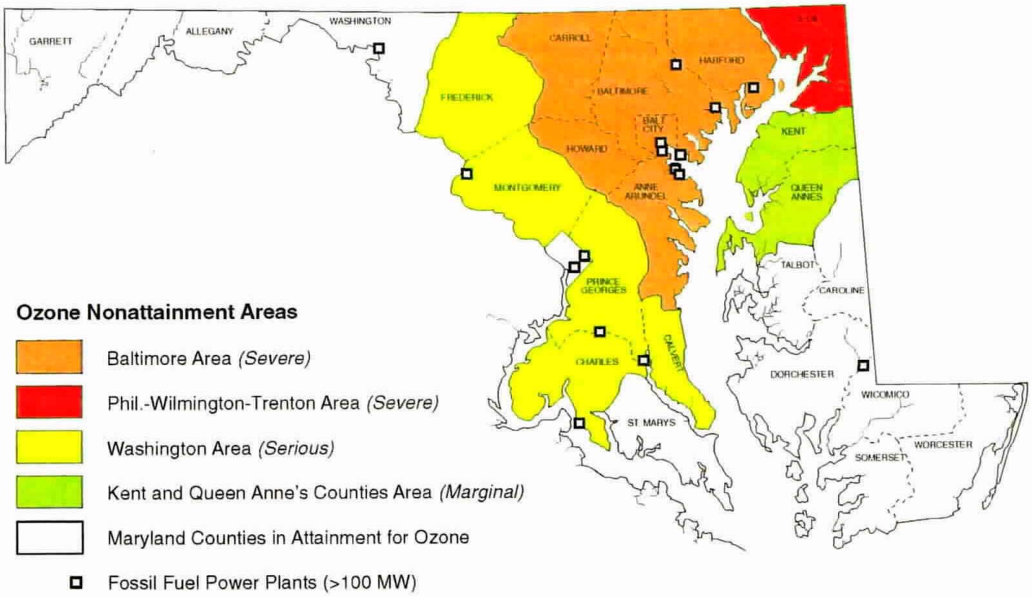


Figure 3-1, based on MDE's ozone monitoring program, indicates the number of monitored "exceedances" of the ozone NAAQS in Maryland over the last few years. Under the U.S. EPA's classification system for indicating the magnitude of ozone pollution, the Baltimore area is designated a "severe" ozone

Figure 3-2
Ozone Nonattainment Areas in Maryland



nonattainment area, and the Washington, D.C. area is designated a "serious" ozone nonattainment area (Figure 3-2). The rest of the State of Maryland, and much of the East Coast from Virginia to Maine, is classified as the "Northeast Ozone Transport Region." The entire Region is treated as an ozone nonattainment area in recognition of the fact that ozone pollution is a regional phenomenon that is affected not only by emissions of NO_x and VOCs, but also by weather conditions—wind patterns affect the transport of the precursor pollutants throughout the Region, while the amount of sunlight available largely governs the rate of ozone formation in the air.

Under the CAA, the U.S. EPA is required to review all NAAQS every five years. If the U.S. EPA's risk assessments show that existing standards are not protecting the public health adequately, the agency may revise the standard. In July 1997, in response to its extensive review of the existing NAAQS, the U.S. EPA revised the NAAQS for both ozone and particulate matter. The revisions make the NAAQS substantially more stringent than the current standards. Many areas of the country that have been meeting the existing ozone standard will be classified as nonattainment areas because monitored ozone levels are above the new, more stringent ozone NAAQS.

Figure 3-3
VOC Emissions Contribution in the Baltimore Area During the 1990 Baseline Year

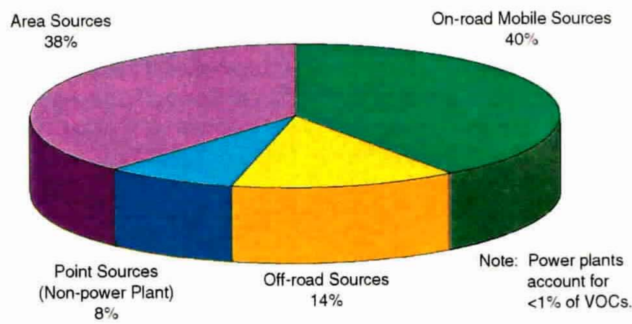
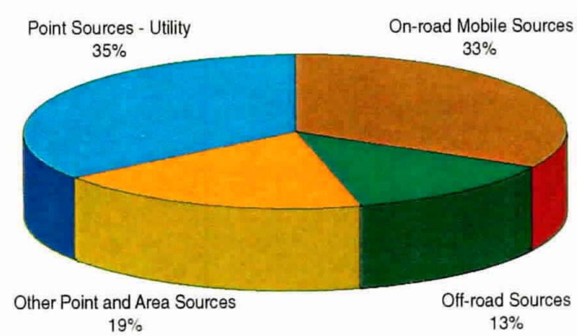


Figure 3-4
NO_x Emission Contribution in the Baltimore Area During the 1990 Baseline Year



Power Plant Contributions to Ozone Pollution

The two most important pollutants to the formation of ozone are VOCs and NO_x, known as **ozone precursors**. Each year, as part of its program to address the ozone problem in Maryland, MDE collects information on VOC and NO_x emissions from all types of sources in the state, including power plants. The emissions information, along with monitored ozone levels, is used to develop strategies to reduce ozone levels in Maryland.

As shown in Figure 3-3, MDE's emissions inventory indicates that mobile sources (accounting for about 54%) are the largest source of VOC emissions. Power plants are responsible for less than 1% of the total VOC emissions. On the other hand, power plants are significant emitters of NO_x, which is formed mainly by high-temperature chemical reactions during the combustion of fuels. These emissions consist primarily of nitric oxide (NO). Some of the NO converts to NO_2 in the atmosphere. NO_x (pronounced "nox") refers to the combined amounts of NO and NO_2 in the atmosphere.

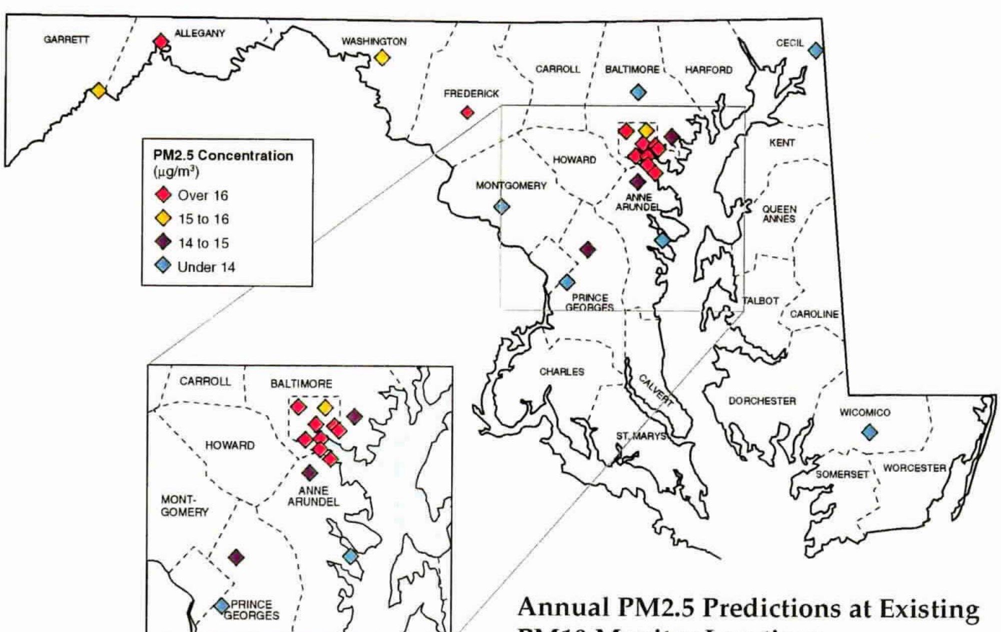
Power plant emissions account for about 35% of the total NO_x emissions in Maryland, depending on the particular area of the state (Figure 3-4). Power plants are the largest point source contributor of NO_x in Maryland. However, mobile sources (automobiles, trucks, construction and farm equipment, etc.) account for as much or more of the NO_x in the state.

Particulate Matter NAAQS Revision

On 17 June 1997, the U.S. EPA published its new National Ambient Air Quality Standards (NAAQS) for both ground-level ozone (smog) and particulate matter (PM) pollution based on scientific health risk assessment studies. The "PM NAAQS" sets new standards for very fine particulate matter, known as PM2.5 (dust and aerosol particles less than 2.5 microns in diameter). There is a new daily standard (65 $\mu g/m^3$ on a 24-hour average basis) and an annual standard (15 $\mu g/m^3$). PM2.5 has not been regulated in the past, and so there is very little information available anywhere on PM2.5 pollution.

In 1997, PPRP conducted a study to evaluate PM2.5 emissions in Maryland and to predict areas of the state in which monitoring may show exceedances of the new PM standards. Sixteen individual locations in Maryland were predicted to experience exceedances of the annual standard; there were no projected exceedances of the new daily standard.

In this study, PPRP conducted modeling to predict PM2.5 levels, but did not monitor actual PM2.5 levels in the air. Under the NAAQS regulations, MDE must establish a monitoring network across Maryland to identify potential PM2.5 problem areas in the state.



Annual PM2.5 Predictions at Existing PM10 Monitor Locations

Regulatory Approaches to Reducing NO_x Emissions

The CAA Amendments of 1990 address the ozone problem by requiring reductions in emissions of ozone precursors. The CAA requires all states, including Maryland, to submit plans, known as State Implementation Plans (SIPs), to the U.S. EPA that demonstrate the measures the states will take to meet the ozone NAAQS. Beginning in mid-1995, the SIPs had to include both VOC and, for the first time, NO_x emissions control and reduction as part of the solution to the ozone problem. This was significant for utilities, because their combustion units are relatively large sources of NO_x emissions but minor sources of VOC.

Among other measures to reduce ozone pollution, the SIPs outline specific pollution controls or emission limits, representing a level of pollution control known as **Reasonably Available Control Technology** (RACT), to reduce NO_x and VOC emissions from existing facilities. Most utilities and many other large combustion sources in the Northeast were required to implement NO_x RACT programs in 1995. Proposed new facilities whose NO_x and VOC emissions will exceed certain levels are subject to even stricter control requirements, known as **Lowest Achievable Emission Rate** (LAER) technology. Additionally, a proposed new source must identify a means to offset its new NO_x and VOC emissions with reductions from other sources in the area. The offset ratio must be greater than 1 to 1—there must always be a larger quantity of emissions reduced than the amount of new emissions added. Depending on the severity of the ozone nonattainment area, different offset ratios are imposed. For example, in the Baltimore area, the required offset ratio is 1.3 to 1.

Air Pollution Modeling

One of the most difficult aspects to understand about air pollution is how pollutant emissions from specific smokestacks affect overall air quality. In fact, it is surprisingly difficult to relate air emissions from a specific stack directly to concentrations of pollutants in the ambient air. The two fundamental approaches to the problem are to use mathematical air quality dispersion models that predict concentrations, or monitoring systems that measure pollutant concentrations in the air. Computerized air quality dispersion models are the most commonly used tools for predicting pollutant concentrations because they are much less expensive to maintain, and they allow users to ask questions such as "What will happen to the air quality if I reduce emissions from this stack?"

PPRP has a number of air quality modeling projects underway that attempt to determine the air quality impacts of pollutants emitted from power plant smokestacks. In one project, PPRP sponsored a detailed evaluation of the new AERMOD model that will soon become the U.S. EPA's primary model for determining impacts to air quality from all stationary smokestack sources in the U.S., including power plants.

The results of PPRP's findings on draft versions of the model have been communicated to the scientists involved with the development of AERMOD. In fact, the final version of AERMOD will include revisions suggested by PPRP's work with the draft model. It is anticipated that the use of AERMOD for assessing the impacts of power plants in Maryland will increase the accuracy of the predictions and the confidence that the State's impact evaluations are based on the best scientific information available.

Ozone Smog Pollution Modeling: Developing a Screening Tool

Scientists and regulators use computer air quality dispersion models to predict the level of ozone pollution (or smog). These models account for the transport of pollutants from thousands of individual pollution sources, such as power plants, industrial facilities, and automobiles, over large distances and simulate the complex chemical reactions that lead to ozone formation. One major drawback to most models commonly used to predict ozone concentrations is that they require enormous amounts of computer resources. These models are so large and complex that it is impossible to evaluate more than just a few ozone "episodes" (periods of time with high levels of measured ozone concentrations, ranging from a few days to a few weeks) to determine the effect of different pollutant control strategies.

In response to this drawback, PPRP has been sponsoring the enhancement of a screening tool, known as the Simplified Ozone Modeling System (SOMS), which estimates ground-level concentrations of ozone. SOMS, originally developed by the Electric Power Research Institute, runs on a personal computer and requires significantly less computer time than other existing models. Therefore, even though SOMS is not intended to replace the more sophisticated ozone models, such as "UAM" that MDE and other state agencies use, it is useful for evaluating a range of different pollutant control strategies for addressing the ozone pollution problem.

PPRP's initial evaluations of SOMS have revealed that even with its simplified approach to complex atmospheric phenomena, ozone concentrations predicted by SOMS compare quite well to observed ozone concentrations and to the predictions of more complex computer models. The encouraging results of the SOMS evaluations have prompted PPRP to continue in its effort to establish SOMS as an acceptable tool to help determine the most effective and efficient approaches for Maryland power plants to participate in the ozone attainment effort.

Under Maryland's NO_x RACT program, affected "major" facilities were required to achieve RACT by 31 May 1995. The designation of major is based on the location of the facility and the facility's potential NO_x emission rate. The eight Maryland power plants subject to RACT include all seven of the state's coal-fired plants, plus Delmarva Power's oil-fired Vienna facility (see Figure 3-5).

Ozone Attainment Programs

Ozone attainment demonstrations are made through the use of computer modeling that predicts ozone concentrations in the ambient air. The models use information on projected future emissions from stack sources (including power plants) and from mobile and area sources, as well as information on photochemistry and meteorology to predict ground-level ozone concentrations. Recent U.S. EPA ozone modeling for the entire eastern portion of the country indicates that even considering reductions in NO_x and VOCs from the implementation of RACT in 1995, additional reductions are needed throughout the region to attain the ozone standard.

To help address the regional aspects of ozone pollution, the U.S. EPA, 37 states, various industry representatives, and environmental groups recently participated in a two-year cooperative effort known as the Ozone Transport Assessment Group (OTAG) process. In its final report published in June 1997, OTAG presented recommendations on precursor pollutant reductions from different type of soiurces required to reduce ozone levels in the eastern United States.

Using information developed by individual states, through the OTAG process, and by the Agency itself, the U.S. EPA just imposed significant new NO_x reduction requirements to improve ozone pollution. The new Regional NO_x Emissions Reduction rule, signed on September 24, 1998, will affect sources in 22 Midwestern and Eastern states and the District of Columbia. Under the rule, all affected states will have to develop new, more stringent plans to reduce NO_x and implement those plans by May 2003. The rules require summertime reductions in NO_x emissions of about 28% (1.2 million tons of NO_x) across the 22 states and Washington, D.C.

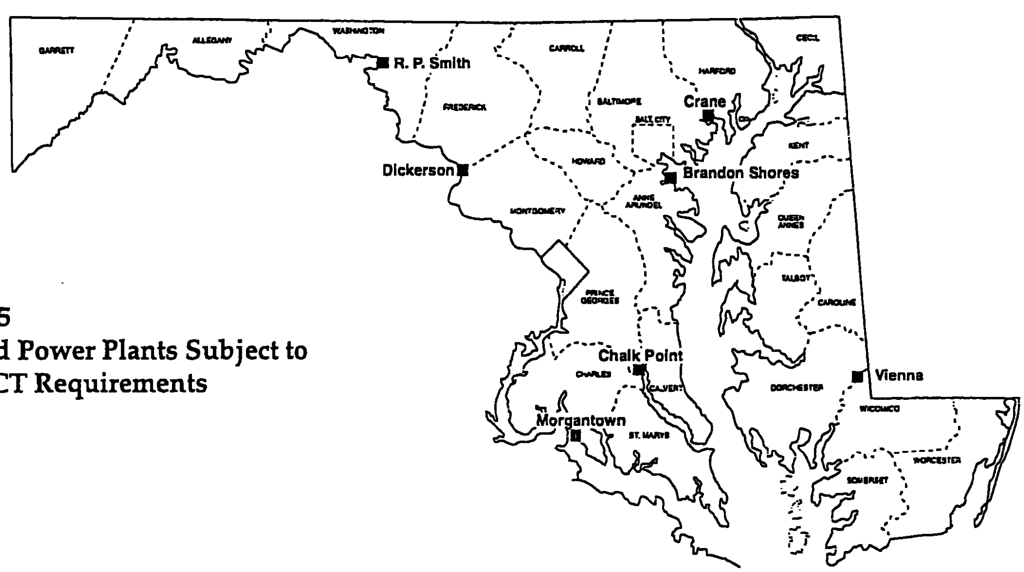


Figure 3-5
Maryland Power Plants Subject to NO_x RACT Requirements

To provide an opportunity for more cost-effective compliance, the new rule allows states to establish NO_x pollutant trading programs. In addition to individual state trading programs, the U.S. EPA is working with states to establish a multi-state "cap and trade" program for utility and other large combustion sources to reduce NO_x. As part of its trading program, the U.S. EPA will allow facilities that "over-control" to sell emission reductions to other facilities that cannot reduce as quickly or as cost-effectively. The program will provide "bonus" credits to sources that reduce pollutants early. States are now developing their NO_x reduction plans in response to the new rule, and are required to submit their SIPs to the U.S. EPA in September 1999.

Concurrent with U.S. EPA efforts, ozone modeling studies are being conducted by states, including the State of Maryland. The goal of the state studies is to identify specific areas where NO_x and VOC reductions will help achieve the ozone standard. In Maryland, MDE, PPRP and the University of Maryland are working cooperatively to conduct additional, state-of-the-art regional ozone modeling studies as part of the State's ozone control efforts. These results will be critical for designing appropriate control plans for the various source categories, including power plants, and for determining areas where NO_x emissions control would help in attaining the ozone NAAQS.

Power Plant NO_x Control Options

The combustion of fossil fuels generates NO_x in two ways: 1) thermal NO_x formation; and 2) fuel NO_x formation. Thermal NO_x results from the high-temperature reaction of nitrogen and oxygen in the air used for combustion. As the combustion temperature increases, the amount of thermal NO_x that is formed increases. Fuel NO_x results from the oxidation of nitrogen bound in the fuel during combustion. Increasing amounts of fuel-bound nitrogen will result in higher NO_x emissions.

In 1995, power plants in Maryland emitted approximately 110,000 tons of NO_x into the atmosphere. Nearly 80% of these emissions come from fossil fuel steam boilers, as opposed to combustion turbines and other generating units. Most of the boilers in Maryland burn coal as their primary fuel. On the other hand, combustion turbines burn relatively clean fuels, such as natural gas and distillate oil, and operate for shorter periods than boilers. The majority of combustion turbine capacity in Maryland has been constructed since 1990, and therefore is also subject to New Source Performance Standards (NSPS). Consequently, the greatest NO_x reductions from stationary sources will be realized by controlling pre-NSPS utility boilers.

There are generally three ways that NO_x emissions from boilers can be reduced:

- ***Fuel conversions**, which reduce NO_x emissions by burning fuels with lower nitrogen contents—for instance, changing from coal to oil or natural gas, co-firing natural gas with oil, or switching to a lower nitrogen content coal or oil;*

- ***Combustion modifications**, which reduce the amount of NO_x that is formed during the combustion process, including such techniques as low-NO_x burners or overfire air; and*

- ***Post-combustion control equipment**, which reduces NO_x after it has formed by injecting a reagent (e.g., ammonia) into the exhaust gas to convert NO_x into atmo-*

spheric nitrogen and water. Add-on pollution control devices such as selective catalytic reduction (SCR) and selective non-catalytic reduction (SNCR) are examples of post-combustion controls.

Power Plants and Acid Rain

Power plant emissions contribute to another regional air quality problem — the formation of **acid rain.** Acid rain is produced by the reaction of precursor compounds, SO_2 and NO_x, with water in the atmosphere to form sulfuric and nitric acids.

The majority of SO_2 emissions, and a significant but smaller percentage of NO_x emissions, arise from the burning of fossil fuels in power plants and other combustion sources. In Maryland, power plant emissions account for 35-40% of the total NO_x emissions, by far the largest point source contributor. Maryland power plants are responsible for roughly 85% of the total SO_2 emissions.

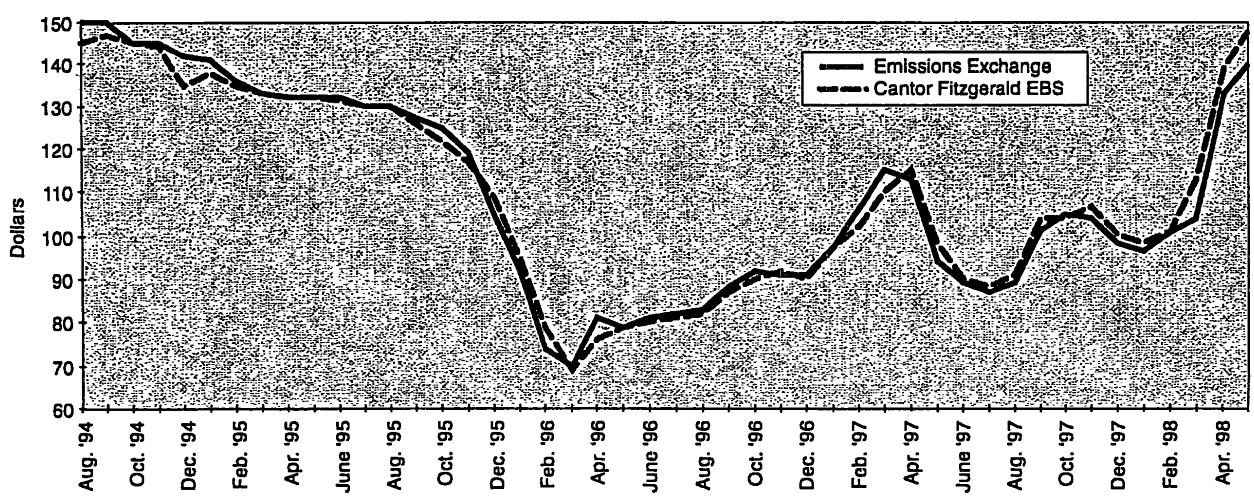
From 1960 until 1970, nationwide SO_2 emissions increased by approximately 40%. Emissions of NO_x steadily increased by nearly 50% between 1960 and 1980. However, emissions of both precursors have generally declined during the past decade.

Regulatory Approaches to Reducing Acid Rain

Title IV of the CAA Amendments of 1990, the **acid rain program,** sets forth an innovative plan to control acid rain precursor emissions. The program is directed primarily toward coal- and oil-burning utility plants, because of the magnitude of their SO_2 and NO_x emissions.

The acid rain program mandates significant SO_2 and NO_x reductions. Power plants must meet a national emissions cap of 8.9 million tons of SO_2 per year from all electric utilities across the United States, a reduction of 10 million tons per year compared to 1980. These reductions will be achieved in two phases. In Phase I, which began in 1995, the 110 largest utility plants located in 21 eastern

Figure 3-6
Monthly Average Price of SO_2 Allowances, 1994 - 1998



and midwestern states, including six units at three power plants in Maryland, were required to meet an intermediate SO_2 emissions limitation. In Phase II, beginning in the year 2000, the annual emission limits imposed on the Phase I plants will be tightened, and the number of plants subject to the limits will be greatly expanded.

The acid rain program also calls for a reduction of approximately two million tons per year of NO_x emissions below 1980 levels. Utility coal-fired boilers will be required to meet new emissions standards based on the installation of low-NO_x burner technologies. Because parts of Maryland are classified as ozone nonattainment areas, and all of Maryland is part of the Northeast Ozone Transport Region, utility boilers here will have to comply with RACT emission limits for NO_x that may be more restrictive than those under Title IV.

The centerpiece of the acid rain program for SO_2 control is a pollution trading system based on the use of marketable **emission allowances.** An allowance is effectively a permit to emit one ton of SO_2. Existing electric utility units are granted annual allowances based on their historic fuel use and the emission limitations specified in the acid rain program. Beginning in 1995, each utility must ensure that SO_2 emitted from its Phase I units does not exceed the total number of allowances held by those units. Under Phase II, which begins in the year 2000, virtually all units will have to hold allowances to cover their emissions, and utilities must demonstrate compliance on a system-wide basis. New generating units (units starting commercial operation after 15 November 1990) must obtain allowances before beginning operation.

The market-based allowance approach is designed to allow utilities to meet their emission control requirements in the most cost-effective manner possible. As part of its compliance strategy, a utility may install SO_2 emission controls, switch to fuels that contain less sulfur (either lower-sulfur coals or oil or natural gas), or purchase allowances from another utility. Utilities may purchase allowances from distant utilities, even ones that are out of state. For example, an early SO_2 allowance trade involved Wisconsin Power selling 10,000 allowances to the Tennessee Valley Authority. The rationale behind such long-distance trading is that acid rain is a regional problem, caused by emissions over a large area, not by sources concentrated in a particular location. Consequently, the specific location in which the emission reductions actually occur is unimportant, assuming the total regional reductions are achieved.

In addition to individual private sector trades, Title IV mandates that the U.S. EPA establish a special allowance reserve containing allowances to be offered for auction or direct sale. The auction and sales programs are intended to stimulate the market in allowance trading and help establish an early market price for allowances. In the fall of 1992, the U.S. EPA delegated the administration of the auctions and sales to the Chicago Board of Trade, which has been holding routine allowance auctions since.

Between early 1994, when allowance trading began, and September 1997, the U.S. EPA reports that 44.4 million allowances have been traded. The vast majority of the transfers of allowances, more than 90%, were transfers *within* organizations,

SO_2 Control Technologies

Emissions of SO_2 from combustion sources result from the oxidation of sulfur and sulfates contained in the fuel. There are basically three ways to reduce SO_2 emissions from combustion sources:

Fuel Switching — A common way to limit the sulfur contained in the fuel is to simply switch to a fuel that contains less sulfur. Most often this involves changing from a higher to a lower sulfur content coal. In general, fuel switching options involve relatively low capital investment and can be implemented in a short time frame. A potential risk with fuel switching, however, is the uncertainty in the future cost and availability of low-sulfur fuels.

Add-on Pollution Control — SO_2 emissions can be reduced by add-on pollution control devices called flue gas desulfurization systems, otherwise known as scrubbers. Scrubbers are commercially proven pollution control systems that can remove SO_2 very efficiently. However, potential drawbacks of scrubbers include additional capital and operating costs, some loss of generating efficiency of the power plant, and the production of relatively large amounts of by-product, which may present a costly disposal problem.

Combustion Technologies — Some advanced combustion technologies, such as fluidized bed combustion (FBC), achieve SO_2 removal in the combustion zone as it is being created. FBC technology results in high generating efficiency, but retrofitting requires significant capital expenditure, so this technology is considered mostly for new power plants. FBC boilers also create a large amount of solid by-product.

which means that utilities were "banking" and trading pollutants internally. Of the 10% of the transactions that were *between* organizations, about 65% were transactions between utilities and independent brokers. As Figure 3-6 illustrates, the average cost of an allowance over time has decreased from about $150 per allowance at the outset of the program in 1994, to a low of less than $80 in early 1996. In September 1997, the average price of an allowance was back up to over $100. It is expected that as the Phase II, year 2000 deadline approaches, the demand for allowances will increase, causing an increase in their price.

SO_2 Control Plans for the Maryland Utilities

Two electric utilities have generating units in Maryland that are now subject to acid rain controls under Phase I: PEPCO's Chalk Point Units 1 and 2 and Morgantown Units 1 and 2, and BGE's C.P. Crane Units 1 and 2. Under Phase II (beginning in 2000), virtually all fossil fuel generating units in Maryland will be affected.

Both PEPCO's and BGE's strategy for Phase I included substantial SO_2 emission reductions at the Conemaugh plant located in Pennsylvania, a plant in which both utilities (in addition to others) share ownership. The owners of the Conemaugh units elected to install high-efficiency SO_2 scrubbers on two generating units. This measure reduced emissions beyond the level required in Phase I, thereby generating excess allowances that could be applied elsewhere or sold. PEPCO and BGE have been using some of these excess allowances and have burned lower sulfur fuels (lower sulfur coals and/or natural gas) to comply with Phase I.

Generally, Maryland utilities have emphasized flexibility in their acid rain compliance plans. To date, no utility has proposed a scrubber to achieve SO_2 reductions for any existing generating units in Maryland. The cost of lower-sulfur coal, which will likely increase due to increased demand, and the market price of allowances will have a large impact on the future compliance actions taken by Maryland utilities. PPRP has had continuing contact with the utilities on the status of their compliance plans, and participated in hearings before the PSC on PEPCO's Phase I proposal. PPRP is tracking the progress of the utilities in addressing acid rain requirements by ensuring that all facets of compliance alternatives are considered.

Air Toxics

The State of Maryland, the U.S. EPA, and other federal agencies and groups, such as the Department of Energy and the Electric Power Research Institute (EPRI), are actively involved in evaluating the emissions, deposition, and impacts of toxics from power plants. Although fossil fuel-fired power plants emit toxic air pollutants, power plants have not been considered among the more significant sources of air toxics nationwide. Until passage of the CAA Amendments of 1990, emissions of toxic substances from power plants had not been regulated specifically either by the federal government or by most states, including Maryland.

Many of the new federal toxics initiatives driven by the CAA may result in the regulation of toxics from power plants at the federal level. The next few sections provide a brief summary of these U.S. initiatives. In addition to the federal programs, PPRP has initiated a number of air toxics programs involving the

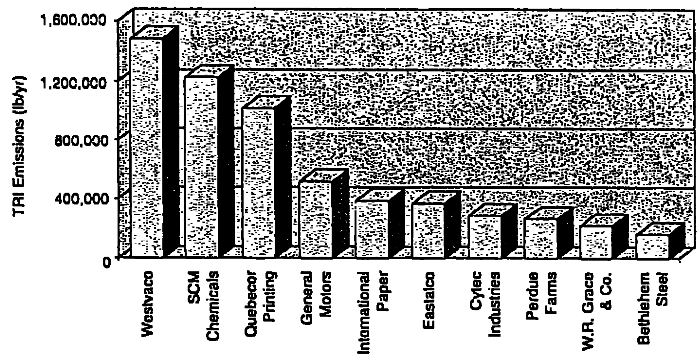
Power Plants and Toxic Chemical Release Inventory Reporting: HCl Emissions

Beginning in 1999, many coal-fired electric utility power plants will begin reporting on releases of toxic chemicals under the national Toxic Chemical Release Inventory (TRI) program. Because coal often contains naturally high levels of chlorides, and large portions of the chlorides are converted to hydrochloric acid (HCl) when the coal is burned, utilities may end up reporting large emissions of HCl to the atmosphere.

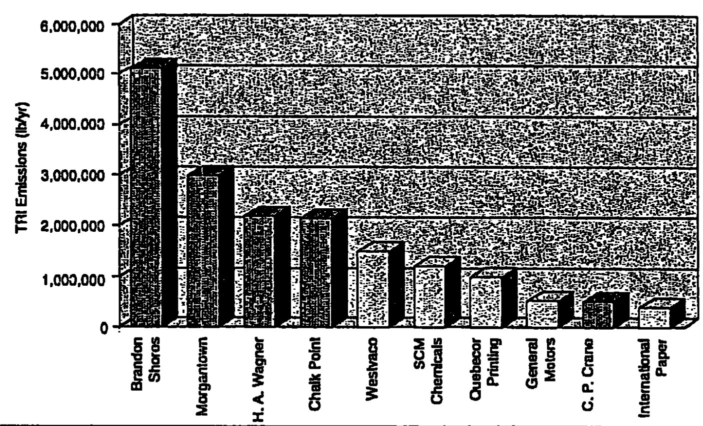
The first graph to the right shows the top ten Maryland companies in terms of TRI chemical emissions in 1995. The second graph illustrates how power plants may move into the category of top ten emitters, based on PPRP's preliminary estimates of potential HCl emissions.

Even though potential HCl emissions to air may be large, HCl is highly water soluble, and readily transforms into relatively harmless inorganic salts soon after leaving a power plant smokestack. For this reason, emissions of HCl may not pose a health risk. Utilities may be faced with a public relations challenge beginning in 1999 when they will be required to start publishing the TRI emissions information, including HCl information.

Top Ten TRI Emitters in Maryland (Without Utilities)



Top Ten TRI Emitters in Maryland (With Utilities)



evaluation of both the emissions of air toxics, especially mercury, and the deposition of and impacts to Maryland natural resources. Deposition monitoring is discussed further in Section 4 of this report.

U.S. EPA's "Utility HAP Report to Congress"

Because of the uncertainties in the health impacts of power plants, Congress specifically mandated the U.S. EPA under the CAA Amendments of 1990 to perform studies to evaluate toxic emissions from fossil fuel-fired electric utilities, and provide its findings in a Report to Congress. The results of the report will eventually be used to formulate federal regulations for controlling **hazardous air pollutants (HAPs)** from power plants. HAPs include a specific list of 189 toxic chemicals that Congress has elected to regulate under the CAA.

After some delays, the U.S. EPA published its draft Report to Congress, referred to as the *Utility HAP Report,* in June 1995 and its final version in February 1998. For the Utility HAP report, the U.S. EPA conducted extensive studies to estimate HAP emissions from utility generating units across the country. Using the emissions estimates, EPA conducted a series of screening level hazard/risk assessments of 67 HAPs. Based on the screening assessment, EPA identified 14 "priority HAPs" (including metals, such as arsenic, mercury, and nickel; acids, such as hydrogen chloride and hydrogen fluoride; dioxins; and radionuclides) that merited further study. The U.S. EPA evaluated the priority HAPs in more detail, primarily through inhalation and multipathway risk assessments. The Agency's summary and conclusions presented in the Utility HAP Report to Congress indicate that mercury is the HAP of greatest concern. Mercury was the subject of a separate U.S. EPA study (see the discussion of mercury beginning on Page 38). A few other HAPs, including dioxins and arsenic from coal-fired units, and nickel from oil-fired units, were identified as HAPs of potential concern. In all instances, the U.S. EPA indicated that there are significant data gaps and uncertainties in the risk assessments that suggest HAPs from utility generating units require additional study.

Although the goal of Utility HAP Report to Congress, under the CAA mandate, was to identify control strategies for toxic emissions from utilities, the U.S. EPA concluded that it did not have sufficient information at this time on which to base toxic air pollutant standards. The U.S. EPA was scheduled to present additional utility HAP information in November 1998; however, it does not appear that additional information will be presented this year.

New Federal Toxic Chemical Reporting Requirements

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.

Most manufacturing industries in the United States have been reporting emissions of toxic chemicals to the environment under a SARA program known as the **Toxic Chemical Release Inventory (TRI)** since 1988. Electric utility power plants were exempt under the initial regulations. However, under a new regulation effective for calendar year 1998, power plants that handle toxic chemicals above threshold amounts will now also be required to report toxic chemical releases to air, water, and land. Affected facilities must report annual toxic releases, in pounds per year, of any of the more than 650 substances on the list of regulated TRI chemicals that the power plant uses, produces, or emits in certain minimum quantities.

Among the substances on the list of regulated TRI chemicals are several metals, such as lead, manganese, nickel, arsenic, vanadium, and cadmium, that are commonly emitted by coal-fired and oil-fired power plants. Other substances that coal-fired power plants emit that may be reported under TRI include hydrochloric acid and hydrogen fluoride.

Mercury

The concentration of mercury in the atmosphere has been increasing at least since the Industrial Revolution. Elemental mercury vapor can circulate in the atmosphere for months, and can thus be dispersed globally over time. After mercury is emitted to the atmosphere, it is deposited to the ground and to surface waters in rainwater and possibly through dry deposition. Mercury is readily emitted back to the atmosphere, as either dust or vapor, and can be re-deposited elsewhere over time. As mercury cycles through the environment, it undergoes physical and chemical reactions, so that most of the mercury in surface waters, soils, and fish and other wildlife is in the form of inorganic mercury salts and organic mercury (such as methylmercury).

Mercury is of particular concern, and has been the subject of intense study internationally, because it accumulates efficiently in the food chain and can cause toxic effects on the nervous systems of people and wildlife that eat contaminated food. Methylmercury, in particular, is the species of most concern for health risks. Fish consumption is the dominant pathway for mercury exposure for humans. Because of mercury contamination of fish, the U.S. EPA's Office of Water has issued advisories in 39 states against consumption of certain types and amounts of fish.

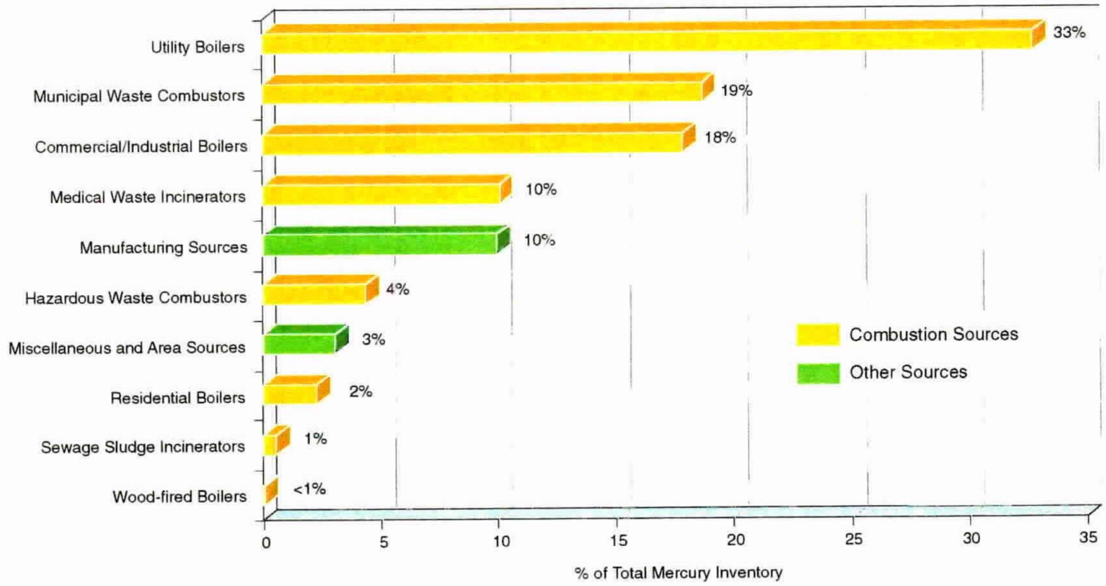
There are many unanswered questions about the environmental fate and effects of mercury. They include questions about how much mercury is released during combustion, the chemical and physical properties of the released mercury, the transformations that occur after it is released to the environment, and the toxicological effects on people and wildlife. In response to the growing concern, the CAA Amendments of 1990 required 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.

The U.S. EPA published its *Mercury Study Report to Congress*, as required by the CAA, in December 1997. The Agency identified three types of mercury sources—natural sources, anthropogenic sources (e.g., boilers and incinerators), and re-emitted mercury (deposited mercury compounds, either from natural or anthropogenic sources, that re-enter the atmosphere). The report indicates that there are still great uncertainties in mercury emissions estimates. However, it appears that emissions from anthropogenic sources of mercury in the United States totaled about 160 tons in 1995, accounting for between 50 and 75% of the total annual mercury input to the atmosphere. Among the various types of anthropogenic sources, combustion sources (utility, commercial, and residential boilers; and hazardous, medical, and municipal waste incinerators) account for about 87% of the total mercury emitted. As Figure 3-7 illustrates, utility boilers are the largest single source of anthropogenic mercury emissions, at 33% of the total amount emitted. Coal-fired boilers account for nearly all of the utility boiler mercury emissions.

The U.S. EPA investigated potential mercury emission control strategies as part of the *Report to Congress*, and identified three techniques that may be applicable to utility boilers. These techniques vary in their removal efficiencies, costs, and other considerations.

- ***Coal cleaning*** — *Coal cleaning can reportedly reduce mercury emissions from 0 to 65%, depending on the type of coal and the cleaning process employed. The mercury removed from the coal prior to combustion ultimately ends up in waste slurries, which are disposed of on land; the fate of mercury compounds in the slurries is not fully understood.*

Figure 3-7
Manmade Sources of Mercury Emissions, 1994 - 1995



Source: U.S. EPA Mercury Study Report to Congress

- ***End-of-pipe control systems*** — *Some pollution control systems, such as wet scrubbers, have been shown to be technically feasible and effective on utility boilers. Scrubbers can be 90% efficient in removing some types of mercury compounds, but have no effect on other types of mercury (for instance, elemental mercury). Other control technologies are undergoing testing before installation on actual operating units. Bench-scale tests of an activated carbon injection system indicate mercury removal efficiencies of between 50 and 90%. The carbon injection systems have the added benefit of removing other pollutants as well as mercury. However, these systems significantly increase the amount of particulate matter that must be collected from the flue gas and disposed of elsewhere, usually in landfills.*

- ***Co-control*** — *Utility boilers are subject to regulations that require control of a variety of pollutants, including* SO_2 *and particulate matter. The devices installed to control these and other pollutants in some instances also control mercury ("co-control"). The U.S. EPA estimates in its* Report to Congress *that by installing scrubbers or switching from coal to natural gas to meet new particulate matter NAAQS, electric utilities will coincidentally reduce mercury emissions by 11 tons per year (compared to the 52 tons per year that coal-fired utility boilers emitted in 1995).*

Add-on pollution control systems are typically capital intensive. The U.S. EPA evaluated the costs of potential mercury control strategies, and found that application of activated carbon injection systems on coal-fired boilers in the United States could result in potential annual costs for mercury control of about $5 billion. This represents about $70,000 per ton of mercury removed.

PPRP has initiated its own studies to determine whether mercury is a significant toxic chemical issue in Maryland, and to analyze atmospheric mercury emissions in the state. PPRP determined that three major sources contribute 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. This is consistent with the U.S. EPA's estimated anthropogenic mercury contributions (Figure 3-7). PPRP's studies indicated 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.

There are gaps in the available data on mercury emissions, speciation, and deposition, which limit our ability to understand and effectively control risks from mercury in the environment. In part, the data gaps are due to the fact that mercury presents unique sampling and analytical problems. In 1997, PPRP initiated an innovative study to characterize mercury emissions from two significant types of emission sources: a coal-fired power plant and a municipal waste combustion unit. The goal of the study is to determine types and quantities of mercury compounds potentially emitted by these two classes of emissions sources. PPRP's study is using state-of-the-art sampling equipment and analytical techniques. Results of the study, expected in early 1999, will provide valuable data to assist in the evaluation of mercury pollution.

Water Impacts

Nearly all modes of electric power generation may cause or contribute to adverse effects on water resources. Hydroelectric power plants require that water be impounded by damming to create the hydraulic capacity to generate electricity. Impacts of damming include the inundation of riverine habitats, blockage of rivers to movement of aquatic biota, and changes in surface water quality both upstream and downstream from these facilities. Steam generating power plants use large volumes of surface water for cooling. In Maryland, the Chesapeake Bay and its major tributaries are the primary sources of this water. The Bay also receives most of the effluents (wastewater discharge) from the state's power plants. Both withdrawal and discharge of water at power plants can adversely affect surface water quality and the biota that reside in these waters. Finally, power plant withdrawals of ground water, and releases of pollutants to aquifers, have the potential to adversely affect ground water resources.

This section focuses on the nature and extent of these types of impacts attributable to Maryland power plants. Because they have distinct modes of impact on water resources, this section discusses hydroelectric facilities and steam electric plants separately.

Hydroelectric Facility Impacts

Nine hydroelectric projects are operating in Maryland. The largest facility is the Conowingo Hydroelectric Station, with a capacity of 512 MW. The second largest is Deep Creek Station, with a capacity of 19.2 MW. Seven smaller projects around the state have a combined capacity of 3 MW. Development and operation of hydroelectric facilities can cause three types of impacts—alteration of water quality, fluctuations in water level and flow, and direct adverse effects on fish populations.

- *Alterations of water quality*—Impoundments created by the construction of hydroelectric dams and modifications of river flow implemented for the purpose of generating electricity can result in changes in natural water clarity, dissolved oxygen (DO) concentration, and water temperature upstream and downstream of the dam.
- *Fluctuations in water level and flow reductions*—Operating hydroelectric facilities in a peaking mode (that is, not continually but in response to peak demand for electricity) produces unnatural, and frequently extreme, water level fluctuations in impoundments and in aquatic habitats downstream of dams. Small-scale hydroelectric projects may also divert some streamflow away from the natural streambed. Fluctuations in water level and flow may reduce fish abundances and the abundance of food important to fish growth and survival.
- *Direct adverse effects on fish populations*—Dams constructed for electricity generation may prevent the natural upstream and downstream movement of both resident and anadromous (migrating) fish species. Entrainment of fish attempting to move downstream past the dam may result in mortality in the turbines. The type of turbine, the proportion of flow diverted through the turbine, and the size of fish affect mortality.

Each of these modes of impact has been found to be significant at hydroelectric facilities in Maryland. The following discussion presents three case studies, describing the impacts caused by these facilities and the manner in which these impacts have been mitigated through the cooperative efforts of PPRP, other state and federal agencies, and the facility operators.

Case Study—Anadromous Fish Passage on the Susquehanna River

Historically, the Susquehanna River supported large spawning runs of **anadromous species** such as American shad, river herring, and striped bass. However, the massive anadromous fish runs that generated migrations extending as far upstream as Binghamton, New York were eliminated with the construction of four major hydroelectric facilities on the lower Susquehanna River in the early 1900s (Maryland's Conowingo Dam, and Holtwood, Safe Harbor, and York Haven dams in Pennsylvania).

The Federal Energy Regulatory Commission (FERC) is the federal agency that licenses hydroelectric facilities throughout the country. PPRP is the lead agency for the State of Maryland with regard to FERC licensing of hydroelectric facilities

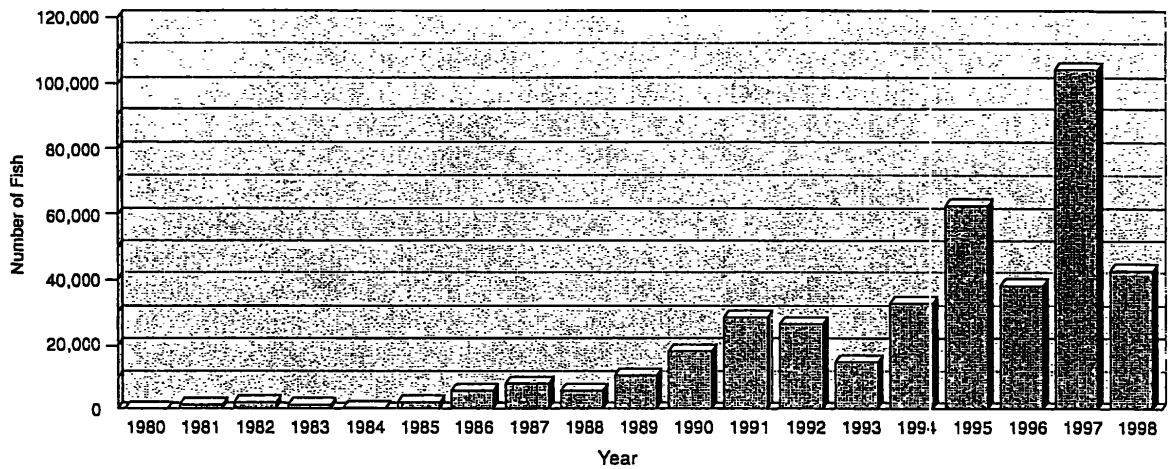
Hydropower and Eels

The American eel is a species common to estuarine and fresh waters throughout Maryland. This species is unique in its life history, growing and maturing in fresh and brackish waters, then migrating to the Sargasso Sea in the equatorial Atlantic Ocean to spawn, with the larvae migrating from the ocean into the inland waters. This migratory behavior differs from that of other important species in Maryland, such as striped bass and American shad, that grow and mature in the ocean and return to inland waters to spawn.

Eels have become an increasingly important commercial fisheries resource, with adults being harvested for sale in Europe, and juveniles (elvers) being harvested and shipped to Japan to support aquaculture operations. In recent years, apparent declines in eel populations along the east coast of North America have caused concern among scientists and fisheries managers.

The Atlantic States Marine Fisheries Commission is in the process of developing an interstate management plan for eels that will likely recommend stricter harvest regulations and mitigation for hydroelectric impacts. Because of eels' migratory nature within river systems, hydroelectric dams have come under increasing scrutiny as a potential major source of impacts to both adult and juvenile eels. FERC has recently required project licensees in Virginia and Maine to study eel turbine entrainment and mortality and to install eel passage facilities. The Susquehanna, Patuxent, and Potomac Rivers in Maryland host both hydroelectric dams and eel populations. Thus, PPRP will be addressing means of ensuring that impacts to the populations of this important commercial species are minimized.

Figure 3-8
Shad Collected at Conowingo, 1980 - 1998



in the state. Restoration of anadromous fish to the Susquehanna River was a major issue that arose when the FERC licenses for the four Susquehanna River hydroelectric facilities came up for renewal in the early 1970s. Participants in the FERC license proceedings have included PPRP, on behalf of the State of Maryland; the State of Pennsylvania; the U.S. Fish and Wildlife Service; and several non-governmental organizations (NGOs). The ultimate goal of the resource agencies and NGOs is the restoration of anadromous fish populations to the entire Susquehanna River drainage system. The primary means for achieving this goal include the installation of fish passage at all four dams, the implementation of an active restoration program involving trapping and transport upstream of adult fish, and hatchery production of young fish for stocking.

Construction of an experimental fish lift at Conowingo Dam in the early 1970s provided an opportunity to evaluate the potential effectiveness of lift facilities for restoring American shad and other species and for gathering extensive information on fish populations and passage behavior. Stock restoration activities began at about the same time. These activities included: 1) transporting adults from other east coast rivers and releasing them into the Susquehanna River; 2) trapping adults at Conowingo, trucking, and releasing them upstream of the dams; and 3) using shad eggs from many different shad stocks to propagate larvae and juveniles, and releasing them into the Susquehanna River and its tributaries. These different approaches were monitored for their effectiveness, and the findings from the monitoring were used to modify existing programs and develop new programs.

Perhaps the most significant development in the Susquehanna restoration was a 1988 settlement on fish passage at Conowingo reached by PECO Energy, which operates the hydroelectric plant at Conowingo, and the resource agencies. In accordance with this agreement, a permanent east side fish lift was completed in the spring of 1991, in time for the spring shad run. A further breakthrough in achieving the fish restoration goal was reached in October 1992, when the State of Maryland, the U.S. Fish and Wildlife Service, the Pennsylvania Fish and Boat Commission, NGOs, Safe Harbor Water Power Corporation, and Pennsylvania Power and Light (which owns Holtwood) agreed on construction and operation of fish passage facilities at Holtwood and Safe Harbor by 1997.

Growth of the Susquehanna River shad stock in response to the restoration efforts and fish passage construction to date has been dramatic, culminating in 1997 in the largest number of American shad to ever be passed over Conowingo Dam, 104,000 (Figure 3-8). Numbers of shad passed at Holtwood and Safe Harbor in 1997, their first year of operation, were 28,000 and 21,000 respectively, representing the first shad to swim upstream to Pennsylvania's portion of the Susquehanna River since before 1900.

The total number of fish passed in 1998 was somewhat smaller than in previous years, with about 46,000 American shad passing through the Conowingo lift, 8,000 through Holtwood, and 6,000 through Safe Harbor. This decrease is attributed to a compressed spawning season caused by higher than normal precipitation (and resultant river flows), coupled with unusually warm temperatures. These factors, rather than a decline in returning stock, resulted in a reduced ability to attract fish and operate lifts at Conowingo. As evidence of the compressed season, 92 percent of Conowingo's total shad passage occurred on 20 days in May. In fact, the single-day record at Conowingo was set on 21 May, when 9,151 shad passed through the lifts.

GPU, which operates the York Haven Dam upstream of Safe Harbor, has agreed to construct a passage facility that will be operational by the year 2000. Construction of its facility on the east side of the river is scheduled to begin in the summer of 1998. With its completion, the entire Susquehanna River will be open to migratory fish for the first time since the dams were constructed, creating the potential for shad and other species to move as far upstream as New York State.

Case Study—Water Quality and Flow Regulation at Conowingo Hydroelectric Station

PPRP has devoted substantial effort for more than 20 years to addressing the impacts of the Conowingo Hydroelectric Station on water quality and aquatic habitat in the downstream portion of the Susquehanna River. Operation of the Conowingo facility controls water levels and flows to downstream aquatic habitats, thereby affecting fish abundance and the amount and type of food organisms available for fish. During peak electricity demand periods in the summer, river water upstream of the dam, if released unconditioned, often has low DO, which can cause poor water quality downstream of the dam. These issues were addressed together with fish restoration in the negotiations and litigation discussed above for fish passage. In the 1988 agreement, the State of Maryland and PECO Energy resolved most water quality and flow issues through implementation of the following actions:

- ***Water Quality***—During the 1960s, large fish kills occurred downstream of Conowingo Dam as a result of fish being exposed to water discharged from the generating turbines that contained very low levels of DO. From the early 1970s through the 1980s, PECO Energy evaluated several different means of improving the DO levels in water released from Conowingo generating turbines:
    - *bubbling of air through the water column in front of the turbine intakes,*
    - *the injection of oxygen into the water column in front of the turbine intakes, and*

- *turbine venting, a procedure in which an intake is constructed that allows air to be entrained into the water passing through a turbine to increase the oxygen content of the water.*

Studies conducted by PPRP in cooperation with PECO Energy to establish the effectiveness of turbine venting led to the adoption of this measure to correct the low DO problem. To date, venting has proven effective in providing water below the dam that meets Maryland's DO standard.

- *Water Flow and Downstream Habitat*—Another issue addressed in the 1988 settlement agreement was the level of minimum flow that should be released from the Conowingo Dam throughout the year to protect and enhance aquatic biota. The flow releases specified in the agreement are seasonal, varying from a high of 10,000 cubic feet per second (cfs) in the spring to as low as 3,500 cfs in the winter. At the time of the settlement agreement, there was a consensus of all parties that existing data were insufficient to select an appropriate permanent flow regime for winter months (December through February). As a result, PPRP conducted additional studies of winter flow regimes from 1988 through 1993. The alternative flows studied were:
  - *a continuous flow of 3,500 cfs,*
  - *an intermittent regime that allowed PECO Energy to shut off the 3,500 cfs flow for up to 6 hours at a time, and*
  - *a peaking flow regime that allowed the operator to shut off the 3,500 cfs flow for unlimited time periods, depending on generation needs.*

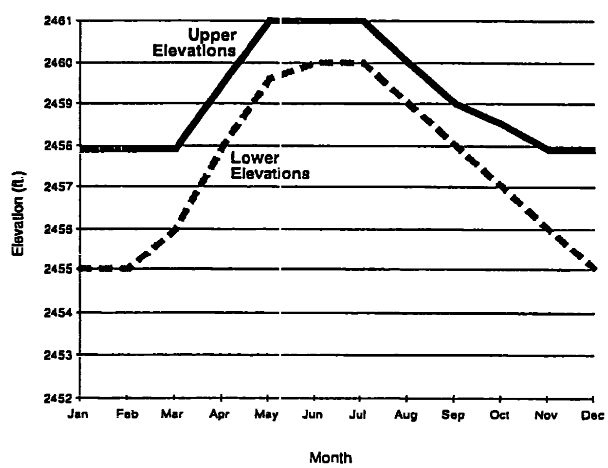
Results of the 5-year study showed that the intermittent flow regime did not harm communities of aquatic invertebrates, but that the peaking regimes did adversely affect some organisms. These findings will lead to a modification in the FERC license to permit an intermittent flow regime during the winter.

The extensive studies and monitoring work performed by PPRP in cooperation with PECO Energy, its contractors, and other agencies have significantly enhanced water quality and aquatic habitat below Conowingo Dam relative to conditions that existed following construction of the dam.

Case Study—Water Quality and Recreational Use Conflicts at the Deep Creek Hydroelectric Project

The 3,900-acre Deep Creek Lake was formed in 1925 by construction of a rock-wall dam across Deep Creek, a tributary of the Youghiogheny River. The Deep Creek Hydroelectric Project includes two turbines that have a combined generating capacity of 19.2 MW. When both turbines are operating, the hydroelectric project discharges water to the Youghiogheny at a rate of 630 cfs. Power generation has the potential to affect lakeside recreation through changes in the lake's water level, as well as the downstream environments of the Youghiogheny River due to discharge from the hydroelectric project. The Youghiogheny is

Figure 3-9
Operating Rules Guiding Maximum and Minimum Lake Levels at Deep Creek Lake



Maryland's only designated "wild" river—it supports a developing trout fishery and one of the most challenging kayak-ing and rafting runs in the country.

Penelec, the owner-operator of Deep Creek Station, received an operating license for the Deep Creek Hydroelectric Project from FERC in the 1960s. In 1988, Penelec initiated the operating license renewal process with FERC. PPRP participated in the FERC relicensing process as the lead agency for the State of Maryland. The State sought to ensure that the operation of the hydroelectric plant minimized potential impacts to Maryland's natural and recreational resources while still allowing for the economical generation of electricity.

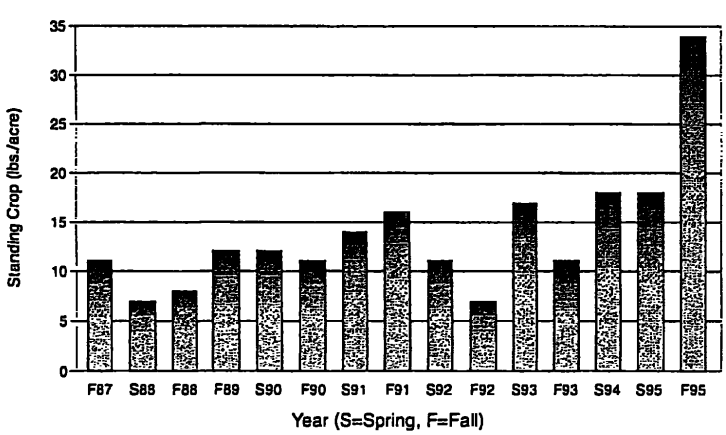
Subsequent to working with Penelec on the conditions for the FERC license, the Deep Creek Hydroelectric Project was found to be outside FERC's jurisdiction. Penelec and the State then agreed to integrate the discussions and negotiated conditions that had been part of the FERC relicensing effort into a Maryland water appropriations permit administered by MDE. This permitting process afforded the State an opportunity to develop a plan that controlled the timing and quantity of water released from the hydroelectric project. The conditions attached to the water appropriations permit, issued to Penelec in 1994, were designed to achieve two objectives: 1) provide a reliable and economical source of electricity; and 2) enhance Deep Creek Lake's and the Youghiogheny River's natural and recreational resources.

Environmental and Recreational Issues

Because the interests of various users of Deep Creek Lake's resources are often conflicting, it was a difficult task to develop an operational plan to balance the following complex environmental and recreational issues with economical operation of the plant.

- ***Lake Levels***—Recreational lake users wanted minimal and consistent drawdown of the lake during summer, and a higher than historic level in the fall to extend the boating season. Historically, Penelec lowered the water level in the fall and winter to prevent ice damage to the spillway, resulting in an annual water level change of about 9 feet.

Figure 3-10
Trout Population in the Upper Youghiogheny, 1987 - 1995



- ***River Fisheries***—High water temperatures in the Youghiogheny River and low DO levels in the hydropower project's discharge historically limited trout habitat. The discharge from the hydroelectric project is cooler than the river because it draws cold water from the bottom of the lake. The timing and volume of cool water discharges from the hydroelectric project could be manipulated during periods of high temperatures in the Youghiogheny to improve trout habitat and assure that the growing trout population would not be subjected to lethal temperature extremes.

- *Whitewater Recreation*—The Youghiogheny River is an exceptional whitewater recreation resource almost totally dependent upon releases from the Deep Creek Project in most summer months. Whitewater boaters need certain flow volumes and timed, dependable releases from the hydroelectric facility to plan trips in advance. The "Upper Yough," which runs from Sang Run to Friendsville, is the key section of the river for whitewater boating that is affected by the Deep Creek Project. During dry periods, the Upper Yough may be the only whitewater resource in the area available to boaters.

Deep Creek For Sale

As part of its corporate restructuring plan, GPU Energy announced in October 1997 its intention to divest its non-nuclear generating facilities. These 26 fossil fuel and hydroelectric operating stations are owned by three GPU Energy companies, one of which is Penelec, the operator of the Deep Creek Lake hydroelectric project. The sale of these assets, including Deep Creek is expected to be completed by the end of 1998. GPU will offer to prospective bidders the hydroelectric station, the dam, and the intake and discharge structures and property. The State of Maryland has entered into an exclusive bargaining agreement with GPU to purchase the lake buffer strip. Maryland's purchase and continued management of the lake property will ensure that this valuable natural resource will be protected and preserved regardless of who becomes the new owner of the generating facility. PPRP and MDE will assist in assuring that future project operation continues to provide an appropriate balance among economic interests and recreational and natural resource benefits.

Resolution of Issues

PPRP and Penelec developed the following measures as part of the water appropriations permit that best balance fishery and recreational interests with the need to maintain reliable and economical power generation.

- *Lake Levels*—A computer model of historical lake inflow, storage, and generation was developed to simulate historical operation and to evaluate alternative operating strategies. Using the results from the model, Penelec and PPRP developed monthly operating rules for the Deep Creek Hydroelectric Project that balanced providing reliable electricity with enhancing lake and river resources. Figure 3-9 illustrates the new rules for operating the project to maintain the desired lake levels and thus accommodate the needs of recreational lake users.

- *River Fisheries*—PPRP developed a protocol for the Deep Creek Hydroelectric Project operators that predicts maximum daily river temperature during the summer. The protocol uses river flow and temperature changes, and available predictions of maximum air temperature and cloud cover for the region. During low flow conditions in the late summer, plant operators follow the protocol in the morning and afternoon to predict river temperature. The goal is to make sure the river temperature never exceeds 25°C. Based on the temperature predictions, the operators decide whether to make a release to cool the river and thus enhance temperature habitat for trout. If the operators decide to make a release, they make this information available to the public on a telephone recording so that whitewater boaters can also take advantage of the release. The trout population has been increasing since Penelec implemented the protocol in 1994 (Figure 3-10). In addition to enhancing trout habitat through water temperature regulation, Penelec also installed structures to provide a continuous minimum flow to the Youghiogheny River and aerate discharge water to alleviate the low-DO problem.

- *Whitewater Recreation*—Penelec now schedules generation of electricity to provide: 1) whitewater boating whenever possible; 2) at least three-hour periods of release particularly during low river flow conditions during the whitewater boating season (April 15-October 15); 3) suitable flow for boating at fixed times on all Fridays and Mondays during the whitewater recreation season, except when lake levels are too low; and 4) suitable boating flow on at least one Saturday per month and during other special events on a prearranged schedule.

The Future

The impending sale of the Deep Creek Project creates some uncertainty with respect to future stewardship of natural and recreational resources of the lake and the Youghiogheny River. However, Maryland is fully committed to preserving this invaluable Western Maryland treasure for future generations and will take all steps necessary to ensure that future operation and ownership are in the best interest of its citizens.

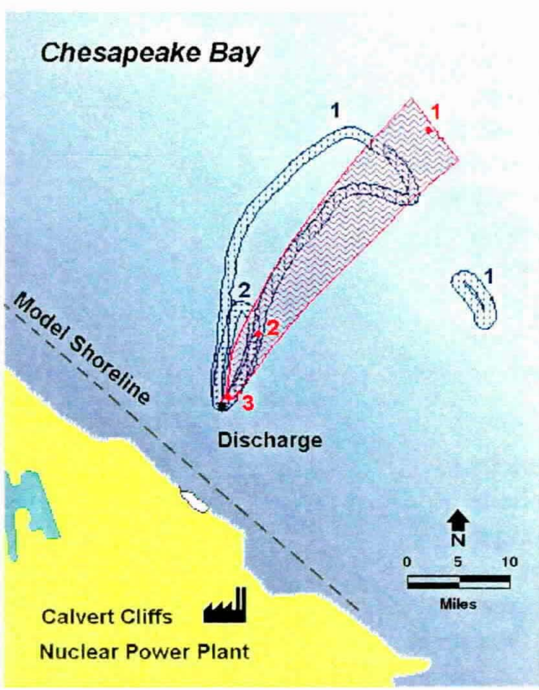
Steam Electric Facility Impacts

Power plants that incorporate a steam cycle must have some means of cooling and condensing their steam after it passes through the turbines so it can be recirculated as boiler feedwater. The steam cycle thus gives rise to cooling water requirements, typically served by surface water withdrawals, and boiler makeup requirements, frequently served by ground water withdrawals. Some steam electric facilities may affect water resources by discharging toxic substances to surface or ground water. Generating facilities that burn fossil fuels (which can be either simple cycle combustion turbines or steam electric plants) also contribute to varying degrees to the formation of acid rain, with its associated impacts to surface water and aquatic biota. Finally, oil- and coal-fired power plants have the potential to degrade ground water quality through the storage and handling of fuel oil, coal, and coal combustion by-products (CCBs). The following section

Mixing Zone Model Evaluation

Thermal dischargers must comply with a complex set of mixing zone criteria to protect aquatic life. Historically, expensive and time-consuming thermal plume studies were used to determine the mixing zone. Mixing zones may need to be reevaluated due to changes in operating conditions or for new power plants.

PPRP co-funded development of the U.S. EPA model CORMIX (CORnell MIXing Zone Expert System) and sponsored studies using historical measured thermal plume data from several Maryland power plants to provide data for testing the model and demonstrating its utility and limitations. Results for Calvert Cliffs show reasonable agreement with the plume direction and centerline temperature values, for both the ebb and flood tide cases.



Map of thermal plume at Calvert Cliffs at an ebb tide in May 1978. Blue lines show 1 and 2°C measured temperature increases, while red area shows modeled plume and centerline temperature increases.

discusses all of these types of impacts and describes PPRP's work aimed at understanding, preventing, and mitigating them.

Cooling Water Withdrawals

In a steam electric power plant with a once-through cooling system, water is drawn continuously from a source water body to cool the condensers. The heated cooling water is then discharged into a receiving water body (usually the same as the source). Once-through cooling systems require large volumes of water; a fossil fuel-fired plant with once-through cooling uses about 1.4 million gallons of cooling water per day for each MW of electricity produced. Nuclear power plants, such as the Calvert Cliffs plant, generate more waste heat than fossil fuel plants and therefore use more water per MW for once-through cooling.

Three major Maryland power plants, Brandon Shores, Chalk Point, and Vienna, use closed-cycle systems for all or part of their cooling water requirement. These systems recycle cooling water and typically require only 2 to 25% of the water needed for once-through cooling systems. However, as much as half the water withdrawn is consumed (used and not returned) due to evaporation. Steam electric plants in Maryland consume nearly 70% of the total freshwater consumed in the state by all sources.

In Maryland, most cooling water is drawn from the Chesapeake Bay or one of its tributaries. Although there is ample water available for cooling purposes, adverse environmental effects can result from withdrawing, heating, and discharging large volumes of water. The ways in which power plant operations can impact aquatic organisms include:

- ***Entrapment****—accumulation of fish and crabs (brought in with cooling water) in the intake region;*
- ***Impingement****—trapping of larger organisms on barriers such as intake screens and nets;*
- ***Entrainment****—drawing in of plankton and larval or juvenile fish through plant cooling systems; and*
- ***Discharge Effects****—adverse impacts of exposure to heated effluents and toxic discharges.*

PPRP and Maryland's utilities have evaluated impacts at 12 major power plants in the state over the last two decades, conducting several dozen studies on the nature and extent of entrainment, impingement, and discharge effects. These studies were used to evaluate the relative impacts of power plant operations on the aquatic environment in the state, with special emphasis on the Chesapeake Bay. Some studies were also used as the basis for modifying operating procedures at the plants to reduce impacts and to provide quantitative cost estimates of unavoidable losses in aquatic biota.

Results of these studies show that while operations of individual power plants impact various ecosystem elements in various ways, those impacts, taken together, have had no identifiable substantive cumulative impact on Maryland's aquatic resources to date. Although large entrainment losses of some types of aquatic organisms have been measured frequently, no consistent depletions in numbers of organisms have been found, or the loss is being mitigated. For example, at Chalk Point, PEPCO has initiated a program to rear and stock fish in the Patuxent River and to remove blockages to migratory fish as mitigation for mortalities of bay anchovy populations in the river. At Wagner (located in Baltimore's outer harbor), data from field studies revealed that actual entrainment impacts are substantially less than projected by computer screening models, and PPRP concluded that mitigative measures at this facility are not warranted.

In addition, intake technologies and modifications to operating practices have been developed to reduce entrainment or impingement impacts at steam electric power plants. However, few can reduce both entrainment and impingement impacts. PPRP has investigated the applicability of several intake technologies to Maryland's power plants and ecosystems and found the following:

- Physical barriers, such as screens or nets, are the most successful and economical for reducing both entrainment and impingement. Wedge-wire screens keep entrainment low and essentially eliminate impingement. Such screens are likely to be included in the design of any new proposed facilities that would use Bay water for cooling.

- Collecting and releasing organisms after impingement is only partially effective at reducing impingement losses. Some of the collected organisms, particularly those in early life stages and juveniles, are sensitive to handling and abrasion. If they are returned to the receiving water body near the intake structure, they may be susceptible to reimpingement. As a result, Morgantown power plant redesigned its system to return fish to either side of the intake structure depending on the direction of the tide. Similarly, the fish return system installed at BGE's Wagner power plant places impinged fish into a channel leading away from the intake screens.

Modification of plant operations is also a cost-effective approach for reducing many aquatic impacts. Two operating practices previously evaluated by PPRP were modifying intake screen wash cycles and discontinuing the use of auxiliary tempering pumps. Intake screens at Maryland power plants are rotated on a frequency of anywhere from once per day to continuously. Increasing the frequency of rotation does not alter the rate of impingement, but it can reduce the time organisms are exposed to scavengers and conditions leading to suffocation. Auxiliary tempering pumps withdraw surface water to mix with the plant's discharge and reduce thermal impacts. However, studies by PEPCO and PPRP showed that discontinuing their use would reduce entrainment and impingement and not significantly increase downstream mortalities.

Sometimes an adverse environmental effect cannot be minimized or eliminated through procedural or engineering modifications. In such cases it may be appropriate to employ other types of mitigation to offset certain impacts from power plants. Although mitigation with resources similar to those lost is most desirable (in-kind mitigation), situations arise where mitigation using different resources (out-of-kind mitigation) is the only possible or practical alternative. In-kind mitigation means providing or managing substitute resources that are physically and biologically similar to those lost due to plant construction or operation. Out-of-kind mitigation means providing or managing substitute resources that are physically and biologically different from those lost. Both in-kind and out-of-kind mitigation have been applied at PEPCO's Chalk Point facility and have been included as a license condition to the Dorchester power plant on the Nanticoke River.

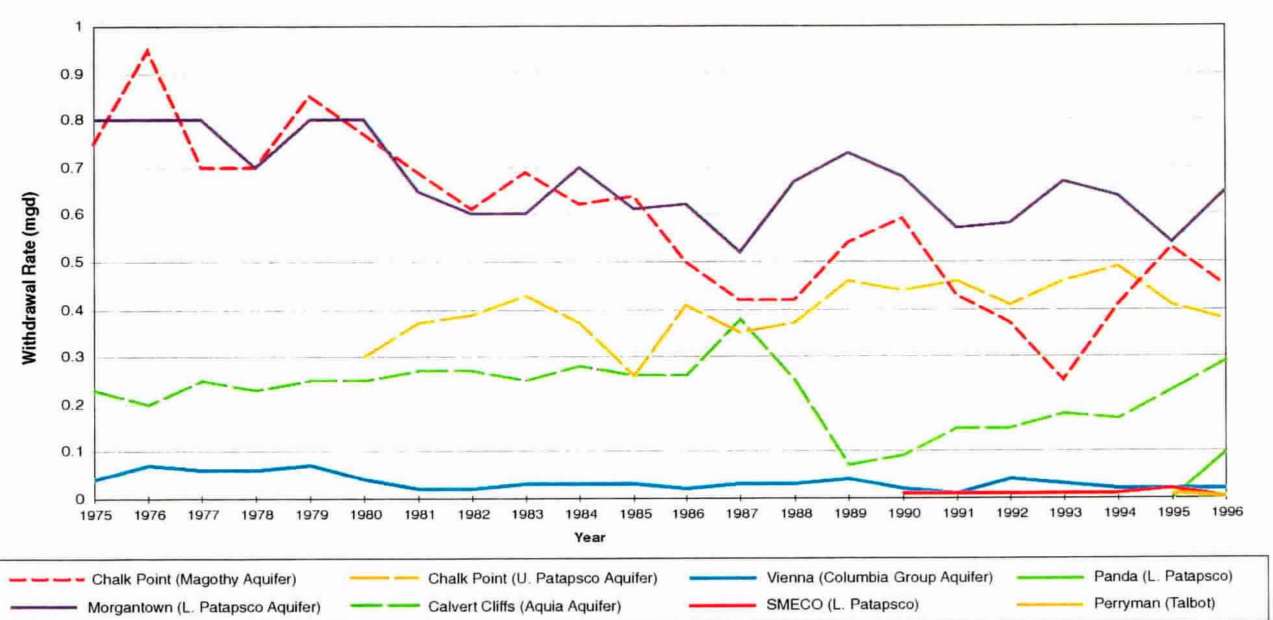
PPRP is also encouraging the use of treated wastewater as cooling tower makeup. This type of water reuse conserves surface water resources and minimizes withdrawals, thus reducing aquatic stresses. The Panda-Brandywine cogeneration plant in Prince George's County uses treated effluent as cooling water, and PPRP has also determined it to be feasible for BGE's Perryman site. See Section 1 of this report for more information on these examples.

Ground Water Withdrawals

High-volume ground water withdrawals have the potential to lower the water level in an aquifer or cause intrusion of salt water into the aquifer. The impact of these withdrawals is a key issue in southern Maryland, where there is a significant reliance on ground water. Maryland's power plants withdraw ground water from Coastal Plain aquifers in southern Maryland. Although large volumes of ground water are available in the Coastal Plain aquifers, withdrawals must be managed over the long term to ensure that adequate ground water supplies are available in the future.

Currently, seven power plants in Maryland use ground water for plant operations. These plants include BGE's Calvert Cliffs Nuclear Power Plant and Perryman combustion turbine, PEPCO's Chalk Point and Morgantown power plants, Delmarva Power's Vienna power plant, SMECO's combustion turbine (located at PEPCO's Chalk Point plant), and Panda-Brandywine's combined

Figure 3-11
Average Daily Ground Water Withdrawal Rates at Maryland Power Plants



cycle power plant. All of these power plants are located in the Coastal Plain of Maryland, and with the exception of the Perryman and Vienna facilities, all are located in southern Maryland. The five power plants located in southern Maryland withdraw ground water from three critical aquifers: the Aquia, the Magothy, and the Patapsco. Three government agencies—the Maryland Geological Survey, the U.S. Geological Survey, and PPRP—jointly operate ground water monitoring programs to measure the water levels in these critical aquifers.

Figure 3-11 shows the ground water withdrawal rates of each of the seven power plants from 1975 to 1996, expressed as daily averages. There are limited data for the SMECO, Perryman, and Panda-Brandywine power plants because they came on line in the past few years. The power plants typically withdraw amounts of ground water well below their appropriation permit limits. For example, the average withdrawal for all seven power plants in 1996 was 1.9 million gallons per day (mgd) compared to a combined daily appropriations limit of 2.8 mgd.

Two significant trends in power plant withdrawal rates are evident.

- ***BGE's Calvert Cliffs Plant***—The withdrawal rates have increased since 1989 and 1990 when the plant was shut down. The withdrawal rates have risen back up to pre-shut down levels.
- ***PEPCO's Chalk Point Plant***—This facility's withdrawal rate from the Magothy Aquifer between 1986 and 1995 has decreased by almost 40 percent compared to the period before 1980. The MDE Water Resources Administration has required industrial users of the Magothy Aquifer to use deeper aquifers like the Patapsco to allay concerns over water level declines in the Magothy. Chalk Point's withdrawal from the Patapsco Aquifer has remained constant since 1980.

Long-term monitoring indicates a steady decline in water levels in the Aquia, Magothy, and Patapsco aquifers. However, these declines are considered negligible compared to the amount of water available in the aquifers. The amount of water available is expressed as the aquifer's "available drawdown," which is defined in MDE Water Resources Administration regulations as 80 percent of the historic pre-pumping level in the aquifer. Also, although the power plants have contributed to the decline in the water levels in these aquifers, increased withdrawals from municipal well fields in southern Maryland have caused most of the recent declines. Water quantity impacts to each of the three aquifers are summarized below.

- ***Aquia Aquifer at Calvert Cliffs***—Water levels in the Aquia at Calvert Cliffs have declined 40 feet over the period 1982 to 1995, with most of the decline occurring since 1990. This acceleration in water level declines is due to withdrawal from municipal well fields at Lexington Park in St. Mary's County and Solomons Island in Calvert County. The water levels at Lexington Park and Solomons Island have declined 30 feet since 1990. The impacts from the water level decline are considered negligible compared to the 315 feet of drawdown currently estimated to be available in the Aquia Aquifer at Calvert Cliffs.
- ***Magothy Aquifer at Chalk Point***—Water levels in the Magothy Aquifer at Chalk Point have declined by about 20 feet from 1975 to 1995. The rate of decline has been slower since 1990 due to PEPCO's decreased withdrawal. PEPCO's withdrawals have not seriously affected the available drawdown in the Magothy Aquifer.

- *Upper Patapsco Aquifer at Chalk Point*—The water level surface of the Upper Patapsco Aquifer declined five feet at Chalk Point from 1990 to 1995. These declines will not impact the approximately 740 feet of water available in the Upper Patapsco Aquifer.

- *Lower Patapsco Aquifer at Morgantown*—The water level surface of the Lower Patapsco Aquifer in the vicinity of the Morgantown power plant remained stable between 1982 and 1995. Recent water level data, however, suggest that the water level declined by five feet during the period 1995-1996. The significance of this trend will become more evident after two additional years of water level data are available. By comparison, water levels in the Lower Patapsco Aquifer have declined 60 to 70 feet since 1990 in the Waldorf and LaPlata area.

Wastewater Discharges

In addition to withdrawing water for various plant needs, power plants generate wastewater from cooling operations, boiler cleaning, ash handling, and equipment maintenance. Power plants 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. Although chlorine is still the most commonly used biocide in power plants across the United States, a number of facilities have recently conducted trials with alternative biocides, such as sodium bromide, and are exploring new techniques to reduce the amounts of chlorine used.

Power plant discharges can also contain toxic metals. Under the 1987 Clean Water Act (CWA) Amendments, the U.S. EPA developed lists of waterways 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. Control strategies are being developed to reduce or otherwise address these concentrations.

BGE recently requested a permit modification for Brandon Shores, based on use of a mixing zone and **chemical translator** as provided in state regulations for discharge of a toxic substance (copper in this case). A chemical translator is a mechanism for establishing the relationship between dissolved concentrations, which may affect aquatic life, and total recoverable metals concentrations, which are the basis of NPDES permit limits. The permit limit applies at the edge of a legal mixing zone and therefore the chemical translator is also based on the dilution that occurs at the edge of the mixing zone. PPRP reviewed BGE's mixing zone study and the proposed use of a chemical translator to aid the evaluation of these methods.

A major issue for utilities in complying with toxic discharge limits is that the permit limits established to protect aquatic life may not be easily or economically measured by standard laboratory methods. EPRI has submitted a proposal to the U.S. EPA to establish an alternative approach to determining detection and quantitation levels for permit limits. PPRP held a workshop with Maryland utilities, state regulators, and EPRI scientists to facilitate communication about the new approach. PPRP is also making an independent assessment of the strengths and weaknesses of EPRI's approach and recommended methodology for determining minimum levels.

Coal Piles and Coal Combustion By-product Storage Piles

Inorganic constituents, such as iron and sulfate, may enter the environment from coal storage piles or fly ash landfills, particularly via leaching into water which passes through the stored material and into ground or surface waters. PPRP has monitored such releases and their potential impacts from CCB storage facilities in a number of projects. Section 4 of this report also discusses PPRP activities regarding alternative management methods for CCBs.

PPRP has assessed the potential for coal piles to impact ground water quality at Maryland's seven coal-fired power plants. All of the power plants have placed low permeability material beneath the pile, and collect and treat the coal pile runoff to prevent ground water impacts. Several power plants, such as PEPCO's Dickerson and Morgantown power plants and APS' R.P Smith power plant, did not have liners or other low permeability material beneath the coal piles when the power plants began operation. PEPCO recently installed a low permeability layer at the Morgantown plant that consists of compacted CCBs and Portland Cement.

Water quality data indicate that coal pile runoff at several Maryland power plants has caused localized degradation of ground water quality. The ground water quality degradation occurred prior to placement of the liners beneath the coal piles. Shallow ground water beneath and downgradient of the coal piles contains elevated levels of iron, manganese, aluminum, zinc and sulfate relative to background. The concentrations of these constituents in ground water decrease downgradient of the coal piles, resulting in no adverse impacts to ground water users or surface water downgradient of the site.

PPRP has also evaluated ground water quality impacts associated with three PEPCO CCB storage sites and two BGE structural fill sites. The water quality data collected from PEPCO's Faulkner, Brandywine, and Westland coal ash storage sites and BGE's Brandon Woods site indicate that shallow ground water and surface water quality have been degraded with iron, manganese, nickel, zinc and sulfate relative to background water quality. No adverse impacts to ground water users or surface water downgradient of these sites is expected because, in all cases, these impacts have been confined within the site boundaries. In addition, ground water quality data collected over the past 10 to 15 years indicate that these constituents have reached maximum concentrations in ground water and the levels will decrease over time.

PPRP investigated reports of yellow perch declines in Zekiah Swamp Run in Charles County, which is near PEPCO's Faulkner Ash Storage Facility, to assess whether the reductions in populations might be attributable to impacts from ash storage runoff. Monitoring studies showed 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. The chemical monitoring studies did not indicate surface water contamination of Zekiah Swamp. Other tests conducted in Zekiah Swamp, however, indicated that yellow perch larvae had difficulty surviving in areas of the swamp within and outside the range of possible influence of the Faulkner facility. 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.

Effects of Acid Deposition

PPRP has conducted a substantial amount of research over the past 20 years on the generation and effects of **acid deposition** in Maryland. PPRP designed these projects to complement deposition research conducted at the national level by focusing on resources unique to Maryland or on topics that are not being studied elsewhere.

Studies have shown that the deposition of acidified materials can affect aquatic and terrestrial resources. The magnitude and type of impact of the acid deposition, however, depends on a variety of complex factors. These factors include the amount of materials deposited, the relative ability of the water body or soils to buffer the effects of the acidity, the sensitivity of organisms to pH changes, and the types and amount of vegetation. The goal of much of Maryland's acid rain research is to generate information needed for effective management, including mitigation, of the acid deposition problem in Maryland.

The statewide, multi-year Maryland Biological Stream Survey (MBSS) was initiated in the 1990s to assess the status and trends of biological resources. The MBSS collects information on aquatic biota (fish and macroinvertebrates), physical habitat, and water quality to assess the fishability and biological integrity of Maryland streams. The MBSS will yield a comprehensive assessment of the extent to which acidic deposition may be affecting critical biological resources within streams of the state. The Survey is using the **Index of Biotic Integrity (IBI)** approach to characterizing stream health, which takes into account water quality, physical habitat, land uses, and watershed area in interpreting biological data. Initial results have begun to answer key questions about impacts to biological resources. For the statewide assessment currently in progress, the IBI will serve as a useful tool for assessing the impacts of acid deposition, particularly in the context of other cumulative impacts.

Maryland has conducted a number of research projects to investigate the effectiveness of liming applications to mitigate acidification of Maryland surface water bodies. A series of Maryland studies investigated the use of automated stream liming devices to neutralize acidic episodes in several Coastal Plain streams. In these projects, researchers operated **dosers** in study streams, which automatically release liming materials at intervals into the streams. Although the dosers were able to mitigate acidic pulses during storm events, the devices experienced mechanical breakdowns and power failures during long-term use.

Maryland has recently investigated two innovative mitigation designs: **diversion wells** and **constructed wetlands**. Diversion wells have been successful in Sweden, but have only been implemented at a few sites in the United States.

They involve diverting the acidic water from the stream into a cylindrical concrete well with limestone on the bottom; neutralized water is then returned to the stream. Constructed wetlands have never been attempted as a mitigation for acid deposition, but they could provide an economical means of raising stream pH, while at the same time contributing wildlife habitat and other benefits to the landscape. If successful, these methods can be added to the repertoire of potential mitigation alternatives for acid streams in Maryland.

PPRP is currently developing a demonstration project for the constructed wetland method in the Murley Run watershed in Garrett County. An ecological characterization of the streams identified it as a candidate for acid mitigation owing to the absence of fish but the abundance of suitable habitat and benthic organisms. PPRP prepared a conceptual plan for the project that consists of constructing a limestone wetland on an upstream tributary of the mainstem Murley Run. In the second phase of the project, PPRP demonstrated the feasibility of the concept by confirming that passing actual stream water through columns of the proposed construction materials would provide enough alkalinity in the system to allow fish to return. DNR is currently seeking funding sources to implement this project as the first demonstration of constructed wetlands for mitigation of acid deposition impacts.

Terrestrial Impacts

Vegetated, natural terrestrial ecosystems in Maryland include forests, tidal and non-tidal wetlands, grasslands, and other habitats. Agricultural land, residential development, and commercial development have replaced some of Maryland's natural terrestrial ecosystems. A variety of wildlife inhabit Maryland's terrestrial ecosystems. Construction and operation of power plants and their related linear facilities (transmission line rights-of-way, pipelines, access roads, etc.) can affect terrestrial resources and the wildlife they support in a variety of ways, including: 1) physical change or elimination of existing habitats; 2) disturbance and displacement of wildlife; 3) deposition of particulate matter or gaseous emissions to the atmosphere; and 4) inadvertent spills and permitted release of toxic materials.

Forest resources are protected under the 1991 Forest Conservation Act (FCA). Under the FCA, tree conservation, replanting, and other environmental parameters must be considered before any development disturbs forest resources. An exemption for rights-of-way and land for construction of electric generating facilities can be given if a CPCN is issued. A project may lose its exemption status if the developer of a site or its linear facilities cannot demonstrate that cutting or clearing of forest will be minimized.

Power plant construction and operation can adversely affect nontidal and tidal wetlands. In the 1780s, Maryland included about 1,650,000 acres of wetlands (24.4% of its surface area); as of 1989, Maryland included only about 440,000 acres of wetlands (6.5% of its surface area). These figures represent a 73% loss of wetlands in the state. The State is concerned with such losses, and now protects these resources. Through regulations developed under Maryland's 1991 Nontidal Wetlands Protection Act, many activities in nontidal wetlands are regulated under a policy of no net loss. Similarly, activities in tidal wetlands in Maryland are regulated under the 1994 Tidal Wetlands Regulations.

Compared with residential and commercial construction, power plant construction has caused minimal direct wetlands impacts since the implementation of Maryland's nontidal wetlands law. Relatively small losses of wetlands were associated with recently licensed Perryman and Panda-Brandywine facilities. Wetlands losses were minimized through the CPCN process, requirements of the Nontidal Wetlands Protection Act, and cooperation from the utilities. To compensate for wetland losses and to meet the state's no net loss goal, mitigation is being required for these projects. Wetlands mitigation is also underway at PEPCO's Station H facility.

This section on terrestrial impacts focuses on the various ways power plants and their related maintenance and operation impact Maryland's natural terrestrial ecosystems, as well as the methods used by the state and utility operators for reducing these impacts.

Steam Electric Power Plants

Fifteen steam electric power plants in Maryland have a capacity greater than 100 MW; 10 are located in rural or semi-rural areas and five are in urban, developed areas. The total area of all rural sites is approximately 5,500 acres, most of which lies within the Coastal Plain province. This acreage amounts to less than 0.1 percent of Maryland's total land area (more than six million acres).

Depending on the location of the facility and its design, the project footprint (buildings, structures, roads, etc.) makes up only a small portion of the total acreage of a plant site. From surveys of land use patterns at the 15 steam electric facilities, PPRP found that the footprints of all of the sites combined average about 54% of the total acreage, with a range of about 7% at Calvert Cliffs to 100% at Westport. The remaining land at the facilities comprises forests, wetlands, grassland/oldfield, and agricultural land.

As new power plants are sited and constructed in Maryland, it is likely that the footprint acres/total site acres ratio will become larger than in the past (i.e., footprints will be a larger proportion of smaller sites). This can be attributed primarily to technological changes in the design of new steam plants, making them more efficient per unit size than old plants. In addition, more stringent environmental regulations such as the Nontidal Wetlands Protection Act and the FCA limit the number of suitable large sites and can increase development costs.

Hydroelectric Facilities

Nine hydroelectric facilities are currently active in Maryland. Terrestrial habitats that are typically displaced by the impoundments created by dams are nontidal wetlands and riverine forests, which support a diverse and valuable group of flora and fauna. The impoundment areas associated with eight of the facilities (not including Conowingo Reservoir, which is partially in Pennsylvania) total about 7,000 acres, representing a small percentage of the total land area of Maryland. The loss of existing terrestrial habitats by inundation is accompanied by the formation of new habitats along the peripheries of the impoundments. Open water habitats, suitable for a variety of wildlife, including waterfowl, have also been provided by the impoundments.

The impoundments created by the hydroelectric facilities have not eliminated a significant portion of Maryland's total riparian habitat, which is about half a million acres. Unaltered rivers, however, are increasingly valuable for recreational and educational purposes. Electricity is generated by peaking operations at three of the nine hydroelectric facilities in Maryland, and by run-of-river operations at the other six. Peaking refers to the storage and release of water from the impoundment to the turbines during high demand periods. Peaking operations involve rapid fluctuation of impoundment and river water levels that may have adverse effects on wetlands vegetation and wildlife. Rapid water level fluctuations can expose and freeze plant roots in the winter, strand bird hatchlings on mudflats, and increase streambank and impoundment erosion. Run-of-river operations are generally less ecologically harmful than peaking operations because they simulate natural river flow by passing a minimum flow through the facility at all times, and do not involve rapid, severe changes in water levels.

Combustion By-Product Landfills

Five active CCB landfill sites in Maryland occupy a total of about 1,000 acres. There are more than 30 inactive, smaller ash landfill sites around the state. The smaller sites are typically 50 to 100 acres in size, but vary depending on the type of coal used and the generation facility. The capacity of some of these sites may be 20 years; others may possess only a 5- to 10-year capacity. Over the next 40 years, Maryland's coal-fired plants could require between 1,100 and 2,300 acres for ash disposal. With several landfill sites near capacity, either additional landfill space or new uses for combustion by-products need to be identified. Several candidate landfill sites next to existing sites are being considered as potential new landfill areas. Ash utilization techniques that may reduce the amount of landfill space required are discussed in Section 4 of this report.

Terrestrial impacts of ash landfills are prolonged by the fact that landfills are rarely managed for habitat restoration purposes after closure. These sites are designed to be dry and elevated above the water table. Owing to the operation of the landfills, the fly ash and other materials are usually highly compacted, which tends to inhibit deep root growth; this precludes establishment and survival of woody vegetation. One closed landfill site in Anne Arundel County has been partially developed into a business park and has been landscaped, but this is an exception to the rule.

Transmission Line and Pipeline Rights-of-Way

Electric transmission line and pipeline rights-of-way are located throughout the state. Both temporary and permanent impacts can arise from transmission line and pipeline corridor construction and maintenance. Forested communities are particularly prone to impacts from construction of rights-of-way, especially where fragmentation of large parcels occurs. To construct these corridors, land must be cleared of vegetation, and sometimes graded. Once the linear facilities have been installed, the rights-of-way are typically maintained in herbaceous or shrubby vegetation, resulting in permanent impacts to forest, wildlife, and wetlands resources.

With appropriate planning and construction techniques under ideal conditions, nontidal wetlands (excluding forested systems) can recover from linear facilities construction in as little as two years. Recent investigation by PPRP has shown that construction of electric transmission line rights-of-way has had relatively little impact on nontidal wetlands in Maryland. Transmission line construction accounted for only 1 of the 92 wetlands permits and about 7 of the 682 Letters of Authorization approved by DNR from January 1991 (when State nontidal wetlands permitting activities began) to May 1994. In the same period, the construction of new transmission line rights-of-way has permanently impacted only about one acre of nontidal wetlands and temporarily impacted about eight acres. Many of these impacts represent conversion of one type of vegetation to another; for example, forest is converted to a scrub/shrub habitat. To put these numbers into context, permanent nontidal wetlands impacts for all projects in Maryland authorized from January 1991 through December 1993 totaled 76.9 acres. Temporary impacts authorized during that time totaled 93.6 acres.

Under Maryland's nontidal wetlands regulations, permanent impacts to nontidal wetlands must be mitigated (i.e., new wetlands created, other disturbed wetlands restored, or payment made to the Wetlands Compensation Fund) at various ratios depending on the type of wetlands affected. A ratio of 3:1 is applied to scrub/shrub and forested wetlands of special state concern, a 2:1 ratio to scrub/shrub and forested wetlands and to herbaceous wetlands of special state concern, and 1:1 for emergent wetlands. Mitigation ratio requirements are similar for state tidal wetlands. Temporary impacts and impacts to wetlands buffers do not usually have to be mitigated.

When transmission line corridors go through forested areas, individual trees are lost, and the natural forest community is often fragmented. Fragmentation of forest habitats may affect biodiversity. Forest-dwelling species that require large tracts of intact forest—such as migratory songbirds—may be eliminated through predation or parasitism by edge species that invade the corridor. While the total number of species in the local area may increase as a result of the invasion of common species with an affinity for brushy or oldfield habitats, the regional diversity will usually decrease as rarer forest-interior species are eliminated.

PPRP recognizes the importance of reducing forest fragmentation caused by transmission line corridors and is working with utilities to encourage management practices that reduce edge effects, such as fostering of shrubby, low-growing communities. Such communities will help to provide a more natural transition into the remaining forest adjacent to the right-of-way. It is also hoped that such low-growing communities will help prevent colonization of rights-of-way by invasive species. Section 4 of this report describes in more detail the methods PPRP is developing to evaluate and promote biodiversity.

PPRP is also developing a siting model for new transmission lines that takes into account the need to preserve large tracts of intact forest. This model uses GIS map overlay techniques to "grade" points on the landscape as to their suitability for construction of power facilities. Sensitive resources (including intact forest) at each location combine to produce higher avoidance scores, while existing infrastructures produce favorable siting scores. Following the appropriate algorithm, multiple transmission line routes can be drawn and evaluated. This model will provide an effective tool to assist siting decisions, once the model is validated and economic factors are included.

Right-of-Way Maintenance

Growth of woody vegetation on transmission line and other rights-of-way (such as natural gas pipelines) can present public safety hazards. Trees or branches that grow too close to power lines (**danger trees**) could fall on the lines and deep roots jeopardize the integrity of underground pipes. Utilities manage vegetation through a combination of mechanical and chemical treatments. State regulations permit the utilities to use only U.S. EPA-approved herbicides. These herbicides pose little danger to the terrestrial environment if properly applied.

The herbicides most commonly used by Maryland utilities, those with glyphosate as the active ingredient, persist in the environment for less than two months and are generally not toxic to wildlife when applied appropriately. Improper use of chemical herbicides, however, can result in excessive amounts being carried by runoff or wind transport into areas outside the right-of-way, and may damage untargeted vegetation and wildlife.

Several of Maryland's electric utilities have initiated maintenance programs to improve wildlife habitats in rights-of-way. Under these programs, stable oldfield (i.e., weedy, shrubby) habitats are established with tree species that do not have the potential for becoming danger trees. This is typically accomplished by spot treating potentially undesirable trees with glyphosate herbicide every three to five years, instead of annual mowing or broadcast spraying of herbicides. Results provided by the utilities indicate that such selective programs have created better, more stable habitats for wildlife, and have saved thousands of dollars in annual maintenance costs.

Mechanical cutting of vegetation in rights-of-way is not necessarily benign; it can disturb and kill wildlife, and has the potential for polluting surface waters, depending on the type of equipment used. Right-of-way management, whether it is accomplished by mowing or by herbicides, often affects wildlife by altering the original vegetative community. Most Maryland utilities indicate that they use a combination of selective herbicide application and mechanical cutting rather than exclusively one or the other.

Figure 3-12
Estimated Effective Radiation Dose from Natural and Manmade Sources

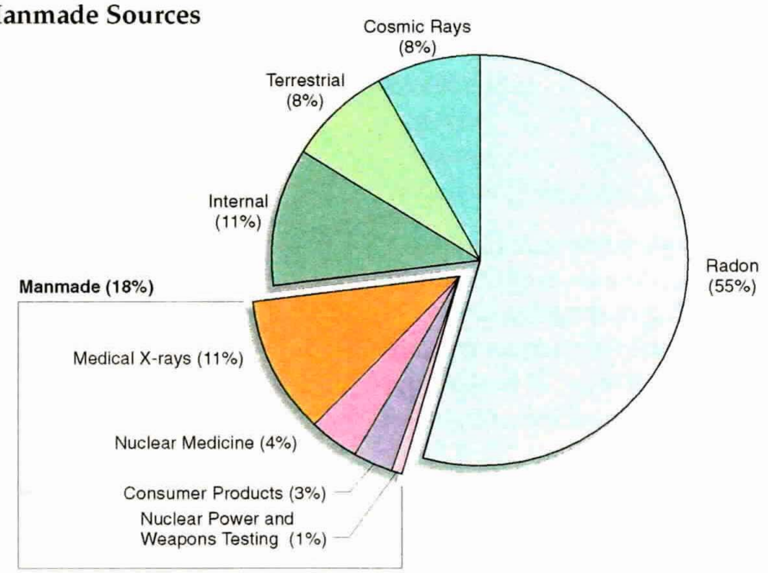
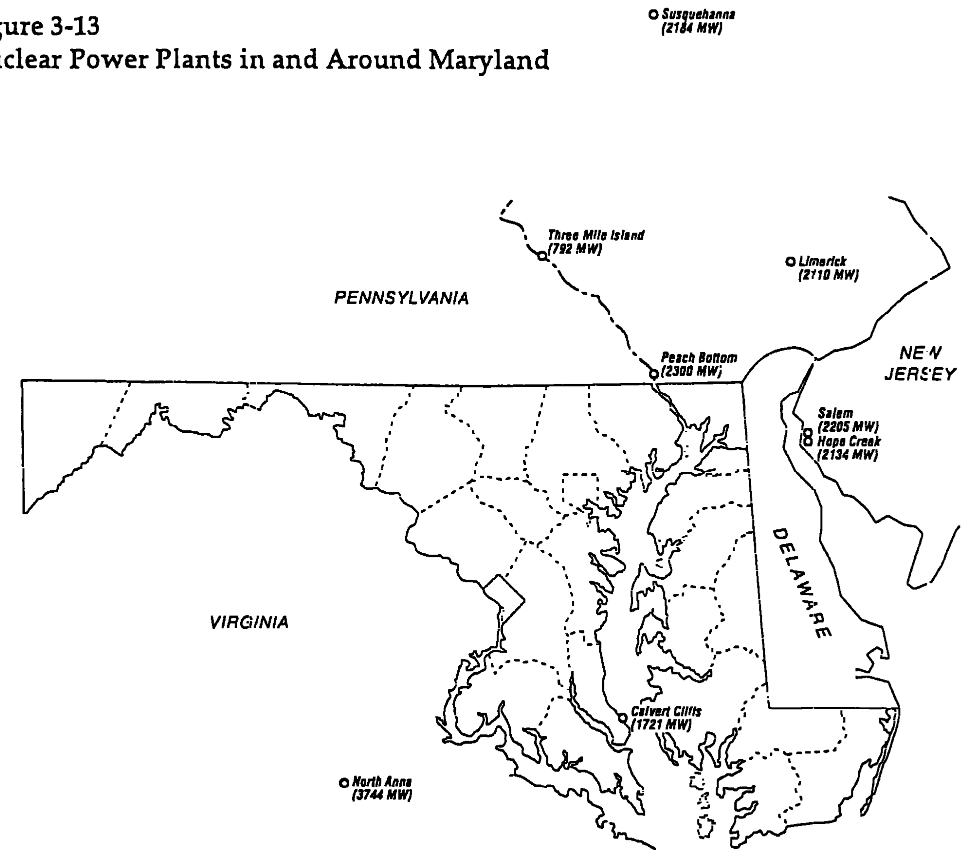


Figure 3-13
Nuclear Power Plants in and Around Maryland



Radiological Impacts

Production of nuclear power in the United States is licensed, monitored, and regulated by the U.S. Nuclear Regulatory Commission (NRC). Provisions in the operating licenses of each plant allow utilities to discharge low levels of radioactive material to the environment. The kind and quantity of releases are strictly regulated and must fall within limits defined in federal law. The NRC regulates releases from power plants according to the principle that radiation exposure to the environment and humans be kept "as low as reasonably achievable."

Pathways of exposure to radioactive material in the environment are similar to those for other pollutants. An aqueous pathway dose (water dose) is received by ingesting radioactive water and seafood and by exposure to contaminated sediments and water. An atmospheric pathway dose results from exposure to or inhalation of radioactive gas or airborne particles or ingestion of radionuclides deposited on or assimilated by terrestrial vegetation and animals.

Nuclear power plants are minor contributors to radiation exposure in the United States. As Figure 3-12 illustrates, natural radiation sources account for more than 80% of the average radiation dose. Of the approximately 18% of radiation doses arising from manmade sources, only 1% is attributed to nuclear power plants.

Figure 3-13 shows the locations of nuclear power plants in and near Maryland. Calvert Cliffs Nuclear Power Plant, in Calvert County, is the only nuclear station in the state. The next closest plant, Peach Bottom Atomic Power Station, is on the

Calvert Cliffs License Renewal

On April 10, 1998, BGE filed an application with the NRC for a 20-year renewal of the operating licenses for both units at Calvert Cliffs. This filing has been anticipated for several years. PPRP has been involved extensively with BGE and the NRC in both the rulemaking related to the license renewal process and the development of BGE's application. Calvert Cliffs will be the first nuclear power plant to be considered by the NRC for license renewal.

BGE decided to pursue relicensing and replacement of the steam generators following an eight-year evaluation of options for safely and competitively maximizing the life of Calvert Cliffs. The power generated at the plant makes up a large portion of the electricity used by Maryland residents—it supplies 40% to 50% of the power generated by BGE, and in 1996 generated 27% of the power produced in the State of Maryland. During the same year, coal-fired generators produced about 62% of the power generated in Maryland. While it seems that the expiration of the licenses for Calvert Cliffs' two units are a long way off (16 and 18 years), BGE must have sufficient time to get through the license renewal process and to pursue alternative sources of power to replace the plant if that should become necessary.

In accordance with NRC regulations, BGE's application for license renewal has two parts: 1) a safety analysis that describes the procedures for managing the effects of aging on plant components; and 2) an environmental report that analyzes environmental impacts of renewal, with an emphasis on 22 issues or resources that the NRC has determined must be evaluated for each relicensing application. The NRC has determined that BGE's application is complete, and is in the process of preparing a supplemental environmental impact statement (SEIS). The SEIS presents the NRC's independent analysis of the environmental impact of license renewal, and compares these impacts to the environmental impacts of the alternatives. In its application, BGE evaluated alternatives to relicensing Calvert Cliffs, which include constructing new coal- or gas-fired generation and purchasing power generated elsewhere.

The NRC will draft an SEIS and solicit comment and input from other federal agencies, state agencies, and the interested public, following a process established by the National Environmental Policy Act. PPRP will continue to coordinate Maryland's input to this process, interacting with both BGE and the NRC. The NRC will integrate comments received in the draft SEIS into a Final EIS. On the basis of the environmental impact statement and the safety analysis information, the NRC will determine whether to issue a license renewal; this decision is expected in the year 2000.

Susquehanna River just north of the Pennsylvania/Maryland border. These two facilities both release radionuclides into Maryland's environment. PPRP, MDE, and the utility operators conduct environmental monitoring programs near both plants. These monitoring programs are used to assess the radiological effects on the environment attributable to each of the power plants.

Calvert Cliffs Nuclear Power Plant

BGE owns and operates the Calvert Cliffs facility, on the western shoreline of the Chesapeake Bay. Each of its two units is a pressurized water reactor with a generating capacity of approximately 860 MW. The units began service in May 1975 and April 1977.

Calvert Cliffs routinely releases low-level gaseous and liquid radioactive effluents into the atmosphere and the Chesapeake Bay. The level of radioactivity of these effluents at any given time depends on many factors, such as plant operating conditions and conditions of the nuclear fuel. Since Calvert Cliffs has been in operation, releases of radioactivity to the environment have been well within the regulatory limits.

Radioactive noble gases, primarily xenon, krypton, and argon, constitute most of the radioactive material released to the atmosphere from Calvert Cliffs. Noble gases are chemically inert, are not readily incorporated into biological tissues, and are not bioconcentrated. They are readily dispersed in the atmosphere, and most have short half-lives decaying rapidly to stable forms. For these reasons, the noble gases do not represent a significant threat to human or ecological health. The most recently compiled results from environmental monitoring (for the years 1994 and 1995) indicate that releases of radioactivity to the atmosphere by the Calvert Cliffs plant were not detectable in air, precipitation, or vegetation.

In the plant's aqueous releases to the Chesapeake Bay, the environmentally significant radionuclides are primarily forms of radioactive cesium, cobalt, and silver. These radionuclides are notable because biota, such as oysters, accumulate them readily. They also can be trapped in sediments at the bottom of the Bay. Through the food chain, these radionuclides in sediments may ultimately contribute a radiation dose to human populations. However, the quantities of environmentally significant radionuclides released and subsequently detected in fish and Bay sediments were quite small (approximately 1% of all radioactivity includes historic fallout and naturally occurring radionuclides).

Bay oysters are ideal indicators of environmental radionuclide concentrations because they do not move and they readily ingest and concentrate metals. Oysters are commercially harvested near Calvert Cliffs, and they have the greatest potential for providing a human radiation dose through seafood consumption. PPRP routinely monitors the uptake of radionuclides in test oysters placed on platforms on the Bay floor, in the vicinity of the Calvert Cliffs discharge. The oysters are collected at scheduled time intervals and analyzed for radionuclide content in tissues. Radiosilver continues to be the principal plant-related radionuclide accumulated by oysters; it has consistently been detected in test oysters as well as oysters on natural beds.

Chesapeake Bay sediments are also useful indicators of environmental radionuclide concentrations because they serve as natural sinks for both stable and radioactive metals. Sediment samples are collected seasonally by PPRP from eight transects extending bayward north and south of the Calvert Cliffs plant. Cobalt-60 was the plant-related radionuclide detected most frequently in Bay sediments during the 1994-1995 reporting period. Radiosilver was also detected sporadically during this period, but generally less frequently and at less concentrations than in previous years.

As part of the surveillance program, PPRP estimates doses of radiation to individuals consuming seafood. The doses are calculated based on maximum or worst-case estimates of the amount of plant-related radioactive materials potentially available. Results indicate that radiation doses attributable to operations at Calvert Cliffs are well below federally mandated limits.

A comparison of radionuclide concentrations in environmental samples collected between 1994 and 1995 with levels detected since 1978 shows the following:

- *The levels of plant-related radionuclides detected during 1994 and 1995 are slightly less than the range of concentrations detected over the previous decade.*
- *Although radionuclide concentrations fluctuate seasonally and annually, no long-term accumulation of plant-related radioactivity in Bay aquatic life and sediments is evident.*
- *The radioactivity introduced into the environment by Calvert Cliffs is small compared with background radioactivity from natural sources and weapons test fallout.*
- *Atmospheric and aqueous releases and radiation doses to humans are well within regulatory limits.*
- *Environmental, biological, and human health effects of releases of radioactivity from Calvert Cliffs are insignificant.*

Peach Bottom Atomic Power Station

Peach Bottom Atomic Power Station, located on Conowingo Reservoir just north of the Pennsylvania/Maryland border, is owned jointly by PECO Energy, Public Service Gas and Electric Company, Delmarva Power, and Atlantic Electric Company. PECO Energy operates the plant. Its two operating units are boiling water reactors, each with a currently licensed capacity of approximately 1,150 MW, and have been in service since 1974.

Like Calvert Cliffs, Peach Bottom routinely releases low-level gaseous and liquid radioactive effluents into the atmosphere and the Susquehanna River. Since the plant has been in operation, all liquid and atmospheric releases of radioactivity have been well within regulatory limits.

Information from monitoring programs shows that in recent years radionuclides of xenon and krypton accounted for nearly all of the radioactivity released to the atmosphere by the plant. These particular radionuclides are chemically inert and, therefore, are of little environmental concern. Based on environmental monitoring from 1994 and 1995, no radioactivity attributable to atmospheric releases by Peach Bottom was detected in air samples collected from the plant site and distant locations.

Of the radionuclides released by Peach Bottom to the Susquehanna River in 1994 and 1995, 99% was tritium (a radioactive form of hydrogen) in a form that is not bioaccumulated and is of limited environmental concern. Very small quantities of radioactive cobalt, zinc, and cesium accounted for most of the remaining radioactive material released in liquid effluent. These particular radionuclides are environmentally significant because they can be readily accumulated by aquatic life such as mussels and finfish.

Finfish collected from the Conowingo Reservoir area contained both plant-related and fallout-related radionuclides. Peach Bottom plant-related radioactivity was also detected in sediments collected down-river of the plant, at slightly lower levels than in previous years. Concentrations of radiocobalt and radiocesium were highest in the Conowingo Reservoir area, as they have been in previous years. It is estimated that less than 20% of the radioactivity released in Peach Bottom water discharge is found in sediments of the Conowingo Reservoir. The remaining radionuclides are transported downstream to the Chesapeake Bay.

Estimates of radiation doses to individuals consuming fish were calculated using the maximum plant-related radionuclide concentrations, similar to the studies at Calvert Cliffs; however, because the Susquehanna River is a source of drinking water, its ingestion, in addition to fish consumption, may potentially contribute to a human radiation dose. The annual total body doses associated with the consumption of finfish and drinking water are well below federal limits.

Comparing PPRP's radiological monitoring of Peach Bottom-related radioactivity of aquatic life and sediments collected from 1994 to 1995 with monitoring results since 1978 shows the following:

- *The low levels of plant-related radioactive material detected in aquatic life and sediments represent a small portion of the radioactive material in the Susquehanna River-Chesapeake Bay system compared with that from natural sources and weapons test fallout.*
- *No long-term accumulation of plant-related radioactive material in river biota is evident.*
- *Long-term operation of Peach Bottom has not caused significant accumulation of radioactive material within the Conowingo Reservoir.*
- *Atmospheric and aqueous releases and radiation doses to humans are well within regulatory limits.*
- *Environmental, biological, and human health effects of releases of radioactivity from Peach Bottom are insignificant.*

Update on Natural Resource Issues

Since its inception, PPRP has undertaken projects addressing the myriad environmental impacts discussed in the previous section. This section describes some of PPRP's current studies that are focusing on emerging environmental and natural resource issues related to power plants. Although some aspects of these concerns have been recognized for many years, PPRP's work continues to evolve to take advantage of new technology, to incorporate new scientific findings, and to respond to changes in the power industry.

Power Plants and Pollutant Deposition to the Chesapeake Bay Watershed

PPRP has been involved in monitoring, modeling, and literature studies since the 1970s to characterize the effect of power plant air emissions on water quality in the Chesapeake Bay. The following discussion outlines two areas of ongoing PPRP research that examine power plant impacts on deposition to the Bay: 1) emission and deposition of nitrogen compounds, and 2) impacts of toxic pollutants in the watershed.

Nutrient Deposition to the Chesapeake Bay Watershed

Recent studies performed by the U.S. EPA have shown that NO_x emitted from air pollution sources, including power plants, could be a significant component of the total nitrogen loading to the Bay watershed. These studies suggest that NO_x can travel from sources as far away as the Midwest, over hundreds of miles, and still be an important contributor to nitrogen loading in the Bay. In the free atmosphere, NO_x is converted into nitrates, a common plant nutrient. The atmospheric processes by which this nutrient is deposited on the ground or on the surface of a water body are collectively referred to as **deposition**. Pollutants in the air can reach the ground by either wet deposition—in which pollutants wash out of the air in rain—or by dry deposition—in which pollutant particles or gases impinge onto a surface. Nitrogen deposition onto the water surface is the most direct pathway for airborne nutrients to affect water quality. An indirect pathway involves deposition onto the land surface and subsequent runoff into the waterways.

PPRP initiated the **CALPUFF modeling** project to help assess the relative impacts of local Maryland power plants and distant sources, and to assist in evaluating the potential effectiveness of control measures for reducing nitrogen loadings to the Chesapeake Bay. This work is investigating long-range transport and nitrogen deposition to the Bay using the U.S. EPA's new CALPUFF model.

The U.S. EPA originally developed the CALPUFF model for the California Air Resources Board, and recently released it for public use. The model uses a "puff" approach to modeling pollutant releases—that is, it simulates the release of pollutants from a stack or other type of emission source as a series of discrete puffs. This model is useful for deposition research because it allows modelers to track pollutants over hundreds of miles and can differentiate between wet deposition and dry deposition.

It is known that emissions of nitrogen compounds can travel hundreds of miles with winds in the atmosphere before being deposited to the ground. However, researchers have not yet fully characterized the magnitude and extent of this "regional transport" and deposition. To improve our understanding of regional transport issues, PPRP conducted an initial study using CALPUFF to evaluate the potential impacts to the Bay watershed from various types of NO_x emissions sources. These sources included power plants, other industrial stack sources, mobile sources (cars and trucks), and area sources, located throughout the eastern half of the United States. Figure 4-1 illustrates the location and relative magnitude of power plant NO_x sources modeled in the study. Each circle on the map corresponds to a power plant, while the relative sizes of the circles indicate each plant's comparative NO_x emissions. The largest circle on the map represents daily emissions of 452 tons of NO_x.

Figure 4-1
Location and Relative Magnitude of Power Plant NO_x Sources Modeled to Assess Deposition Impacts in Maryland

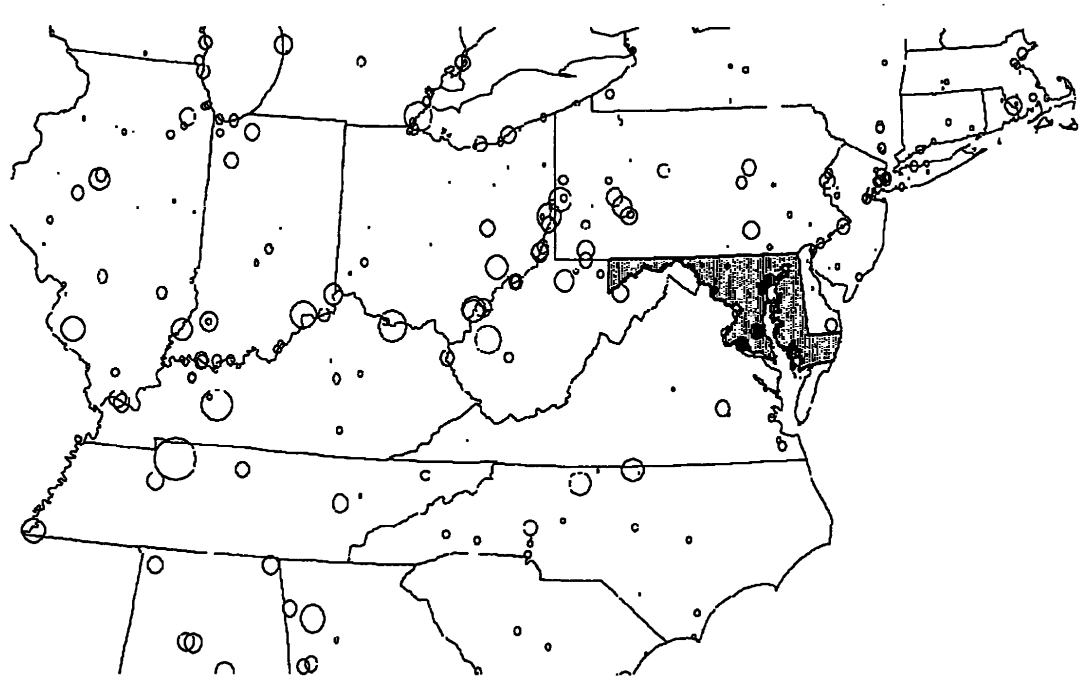
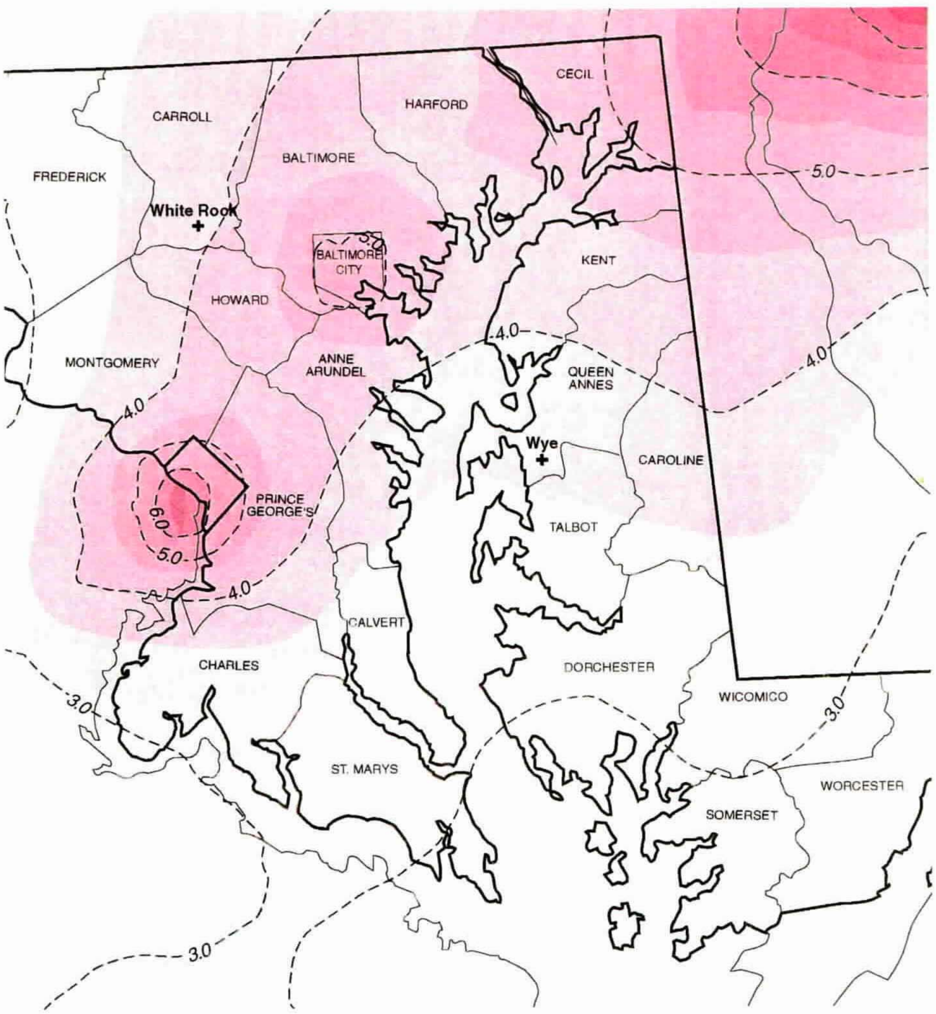


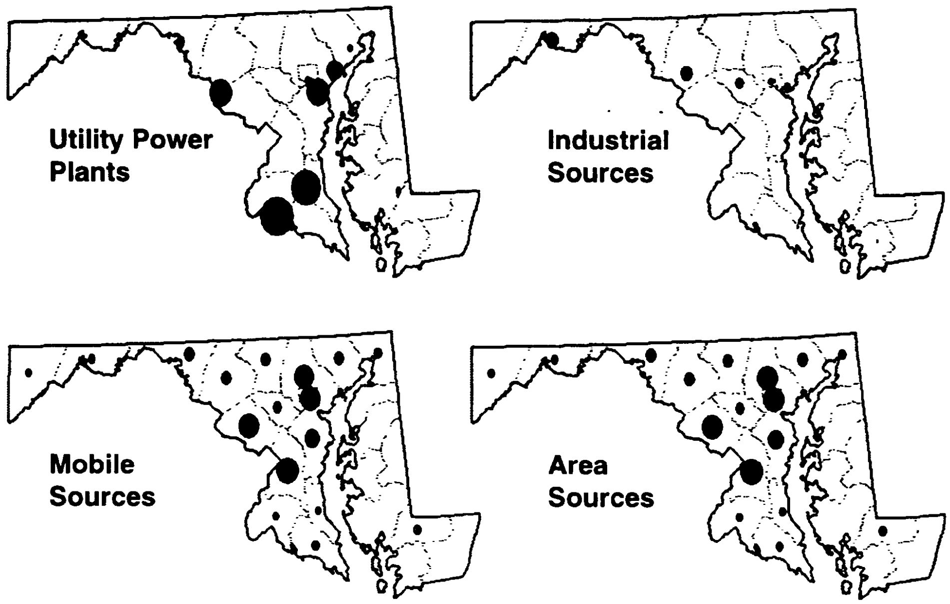
Figure 4-2
Total Nitrogen Deposition (kilograms of nitrogen/hectare/year)



Results of initial CALPUFF modeling runs reveal some interesting spatial patterns of NO_x deposition. Figure 4-2 shows the spatial distribution of total predicted nitrogen deposition around the northern Chesapeake Bay. The areas of higher deposition (darker shaded areas) around urban centers illustrate the important role that mobile sources of NO_x (i.e., cars and trucks) play in deposition. The impact from power plants is significant as well, but tends to be less concentrated and extends over a wider area than the impact from mobile sources.

In a second study, PPRP focused locally, and used CALPUFF to determine the contribution that NO_x emissions sources in Maryland have on nitrogen deposition in the Chesapeake Bay watershed. Figure 4-3 shows the location and relative magnitudes of Maryland sources of NO_x emissions.

Figure 4-3
Location of Maryland NO_x Emissions Sources



- Source symbol sized to annual NO_x emissions
- Largest symbol = 22,463 tons/year
- Based on OTAG National Emissions Inventory - 1990

As Table 4-1 indicates, Maryland sources of NO_x of all types combined accounted for only about 3% of the overall total NO_x emitted in the eastern half of the United States. However, CALPUFF predicts that Maryland sources of NO_x account for about 16% of the nitrogen deposited to the Baltimore portion of the Bay watershed (see Table 4-2).

Table 4-1 Comparison of Maryland to Eastern U.S. 1990 NO_x Emissions

	Annual NO_x (Tons)			Annual NO_x (% of Overall Total)		
	Non-Maryland	Maryland	TOTAL	Non-Maryland	Maryland	TOTAL
Utilities	4,240,095	106,204	4,346,300	47.5	1.2	48.7
Industry	1,047,259	27,410	1,074,669	11.7	0.3	12.0
Mobile Sources	1,778,164	66,991	1,845,155	19.9	0.7	20.7
Area Sources	1,606,391	60,731	1,667,122	18.0	0.7	18.7
Total	**8,761,907**	**261,337**	**8,933236**	**97.1**	**2.9**	**100.0**

Table 4-2 Comparison of Maryland to Eastern U.S. 1990 Nitrogen Deposition in the Baltimore Area Receptor Grid

	Annual Nitrogen Deposition (Tons)			Annual Nitrogen Deposition (% of Eastern U.S. Total)		
	Non-Maryland	Maryland	TOTAL	Non-Maryland	Maryland	TOTAL
Utilities	6,937	747	7,684	37.7	4.1	41.7
Industry	1,910	279	2,189	10.4	1.5	11.9
Mobile Sources	3,357	1,076	4,433	18.2	5.8	24.1
Area Sources	3,249	859	4,107	17.6	4.7	22.3
Total	15,453	2,962	18,414	83.9	16.1	100.0

A number of other observations can be made about nitrogen deposition patterns from this CALPUFF study:

- *Approximately 63% of Maryland sources' nitrogen deposition in the entire watershed occurs in the Baltimore area.*

- *Mobile source deposition quantities are a substantial part of the overall total for Maryland sources, and are due primarily to dry deposition. Highest deposition rates occur quite close to the emissions sources.*

- *Deposition from utility sources in Maryland tends to occur over a wider area and maximum long-term deposition rates tend to be less than for ground-level mobile and area sources. Utility deposition quantities are dominated by wet deposition.*

- *Industry contribution to overall totals is small, although deposition rates are high in a relatively small area close to Baltimore.*

PPRP continues to use the CALPUFF model in assessments of the impact of NO_x emissions on water quality in the Chesapeake Bay. The assessments are being improved based on evaluations against measured data. This work promises to provide important insights into current and future trends in airborne nutrients and their water quality impacts.

Western Maryland Toxics Deposition Study

Much of PPRP's deposition work over the years has focused on nitrogen deposition and nutrient loadings, because power plants are recognized as significant contributors of nitrogen compounds. However, power plants also contribute to loadings of toxic pollutants (metals, organics, etc.) in the Bay watershed.

Research conducted in the early 1990s under the Chesapeake Bay Atmospheric Deposition Study suggested that an accurate assessment of trace metal loadings to the Bay would require data from additional sites throughout the Bay watershed, especially in western Maryland. To obtain some of this critical data, PPRP initiated the Western Maryland Metals Deposition project in 1996 to extend the spatial coverage of wet deposition monitoring to the western portion of the Bay watershed. The study is a cooperative effort sponsored by PPRP, being con-

The National Emissions Inventory for 1990

One of the most important aspects of conducting air quality modeling is the development of an emissions inventory. Inventories used for modeling contain data on pollutant emissions, and also identify the location and configuration of the sources being modeled. Different types of source "configuration" may include large industrial stacks, the tailpipes of cars and other mobile sources, and widely spread sources such as wintertime residential space heating or a collection of many smaller industrial facilities.

The Ozone Transport Assessment Group (OTAG), an organization of regulatory agencies in the eastern half of the U.S. charged with investigating the effect of long-range transport on attainment of air quality standards for ozone (smog), devoted substantial resources to developing and improving an emissions inventory of several pollutants, including NO_x. The result of this effort was the National Emissions Inventory (NEI) for 1990, which established a baseline of NO_x emissions that was used in the OTAG effort to examine ozone impacts. The NEI has proven to be useful in PPRP's own efforts to analyze ozone issues in Maryland, and also served as the basis for PPRP-sponsored modeling of nitrogen deposition in Maryland.

ducted by PPRP and researchers from the Appalachian Laboratory of the University of Maryland's Center for Environmental Science, the University of Delaware, and the Chesapeake Biological Laboratory.

Phase I of the Western Maryland deposition study gathered trace metal deposition data. The sampling program for Phase I included the collection of wet deposition, stream water, and **throughfall** (precipitation that has fallen through forest or other vegetative cover). PPRP sampled at two sites in Garrett County: the Piney Creek reservoir for the collection of wet deposition samples, and a tributary to Herrington Creek for the collection of throughfall and stream water samples. Sampling of wet deposition, stream water, and throughfall started in May 1996 and continued through the end of May 1997. Analysis of the data collected during the study is underway.

Although researchers have identified the atmosphere as an important potential source of both nitrogen and certain trace metals entering the Chesapeake Bay (parameters being measured in Phase I of the study), estimates of these atmospheric loadings are uncertain. Recognizing this knowledge gap, PPRP initiated Phase II of the Western Maryland deposition project in the fall of 1997. The goal of Phase II is to quantify the retention of atmospheric nitrogen and trace metals by two forested watersheds in western Maryland—the unnamed tributary to Herrington Creek and Black Lick. To accomplish this objective, PPRP will quantify atmospheric inputs (wet deposition and throughfall) and watershed outputs (stream water and soil gases) over the 1998 water year (October 1997 through September 1998). Using the data collected during the study, PPRP will develop a "watershed input-output budget" by calculating watershed retention of major ions and selected trace metals as the difference between atmospheric inputs and stream water outputs, plus soil gas emissions. The input-output budget will constitute a first step in quantifying pollutant loadings to the Bay watershed. Results from the study should be available in early 1999.

Coal Combustion By-Product Management

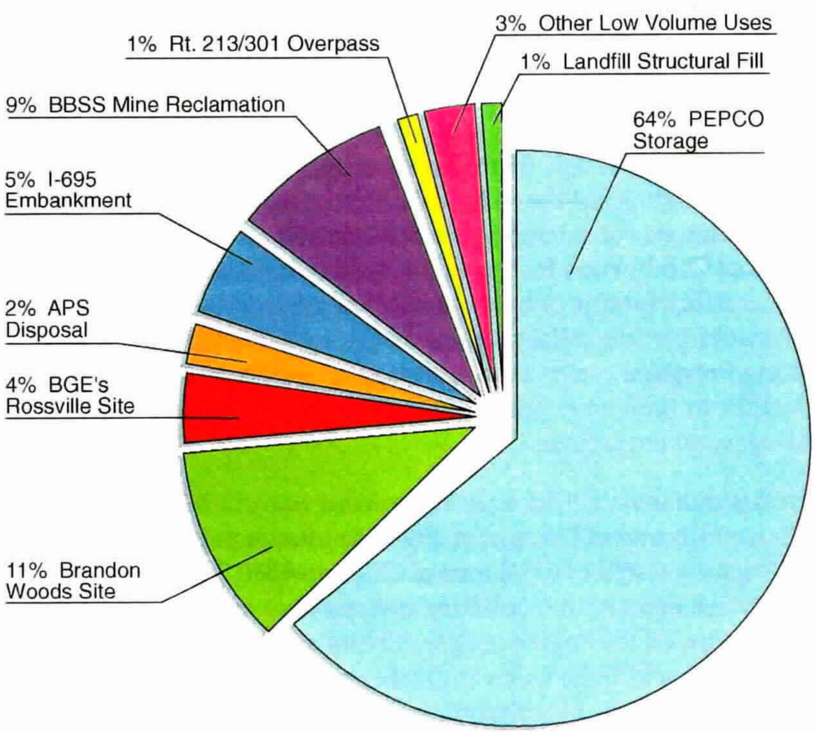
Maryland power plants generate about 1.2 million tons of **coal combustion by-products** (CCBs) annually, primarily fly ash and bottom ash. The majority of the CCBs generated in Maryland are placed in captive fill areas. However, fill areas consume valuable land and are quite costly when engineered to minimize adverse environmental impacts. Without adequate controls, CCBs have the potential to affect Maryland's terrestrial, aquatic and ground water resources. Alternative uses are available and some may provide options that are economically feasible and yet more environmentally friendly than fill placement.

The term **beneficial use**, pertaining to CCB utilization, applies to an environmentally friendly alternative for a material that would otherwise be placed in a captive fill area. CCBs can be economical for users by replacing more costly raw materials, and they can also provide technical advantages over some materials due to their uniform physical and chemical makeup. With assistance from BGE and PEPCO, PPRP is conducting a series of integrated projects designed to assess and promote the beneficial use of CCBs generated in Maryland. This section discusses four key elements of PPRP's efforts to increase public awareness and eliminate some of the uncertainty associated with using CCB materials.

Beneficial use of CCBs generated by Maryland's seven coal-fired power plants has been limited. Since 1993, 80% of the approximately 1.2 million tons per year of CCBs generated in Maryland has been placed in captive fill areas operated by the utilities that generated them. The remaining 20% has replaced raw materials in a variety of applications, including highway embankments, structural fills, low strength grouts, and cinder block manufacturing (Figure 4-4). In 1996, approximately 30% of the fly ash and bottom ash generated in the U.S. was utilized in beneficial applications.

Environmental and economic benefits can be associated with alternative uses for CCB materials; however, potential users are generally unaware of the State's position regarding their acceptability and the regulatory approval process associated with CCB use. Through the activities described below, PPRP is trying to improve knowledge about CCB utilization and to disseminate that knowledge to potential users.

Figure 4-4
Disposition of CCBs in Maryland, 1993 - 1997



LEGEND

PEPCO Storage - Dedicated fill sites owned and operated by PEPCO.

Brandon Woods, Rossville - Dedicated structural fill sites owned and operated by BGE.

APS Disposal - Slurried under Potomac River to West Virginia CCB disposal site.

I-695 Embankment, Rt. 213/301 Overpass - BGE supplied CCBs for use in constructing highway embankments.

BBSS Mine Reclamation - BGE supplies CCBs to a sand and gravel mine for reclamation.

Landfill Structural Fill - BGE supplied CCBs to regrade a landfill cell in Anne Arundel County.

Other Low Volume Uses - Includes flowable fill, cement manufacturing, block manufacturing, and deicing.

- ***Survey of Regulations.*** One of the barriers to increasing CCB use is the uncertainty users may have regarding the State's regulatory approval process. PPRP compared the regulatory framework for CCB utilization and management in Maryland with that in neighboring states to evaluate the need for regulations or written guidance to encourage CCB use. The survey found that some states, like Pennsylvania and Virginia, have codified programs that provide clear direction on the regulatory requirements associated with CCB use. Other states, like Delaware and New Jersey, have unwritten policies to direct CCB use projects.

- ***Information on CCBs.*** Another effort undertaken by PPRP to promote CCB use is to provide information regarding the availability, quality, and environmental effects of CCBs. PPRP, with assistance from BGE and PEPCO, is preparing a technical report to describe CCB generation, disposition and beneficial use in Maryland. The report's purpose is to assist potential CCB users with evaluating whether CCBs represent a viable alternative material. The report will document the source, type, amount, chemical and physical properties, and potential environmental effects of CCBs generated in Maryland. The report will also highlight some of the technical advantages of using CCBs over other raw materials, such as its light weight and consistent quality.

- ***Promising Uses in Maryland.*** PPRP is conducting a literature search to identify beneficial uses for CCBs that are suitable for implementation in Maryland. This evaluation is addressing the important issue of how CCBs compare with other raw materials that they can replace in terms of transportation and design costs, environmental effects and engineering feasibility. The beneficial use technologies being evaluated include: "manufactured" topsoil by mixing CCBs with compost, biosolids, or dredge spoils; use of hardened CCBs as the core material in oyster beds; use as compacted pavement base during highway construction; and beneficiation of CCBs using chemical or physical separation techniques. It is hoped that this research will identify new uses for CCBs in Maryland in which the cost of hauling the CCBs to the user does not overrun the market value of the material.

- ***Demonstration Projects.*** The final element employed to promote CCB use involves demonstrations of the technical and economic feasibility of beneficial CCB use applications considered to be viable in Maryland. The Western Maryland Coal Combustion By-Products/Acid Mine Drainage (AMD) Initiative is a successful example of a demonstration carried out through a joint private and public sector collaboration. PPRP, with participation from the MDE Mining Program, coal mining companies, and electric utilities, has undertaken the initiative to evaluate the use of alkaline CCBs to abate AMD from underground coal mines.

  As part of this initiative, a field scale experiment was put in place at the Frazee Mine in Garrett County in November 1996. Approximately 5,600 cubic yards of grout, which consisted of 6,000 tons of CCBs and 520,000 gallons of acidic mine water, were injected into both dry and submerged mine conditions. The project demonstrated the engineering feasibility and logistics of using 100 percent CCBs and acid mine water to create a grout that can be used to seal underground coal mines. No other project in the U.S. has included the use of 100% CCBs and mine water to create a flowable, cementitious grout.

The State is monitoring the mine to evaluate the effectiveness of the grout to seal the mine and abate AMD, and to make sure ground water is not adversely impacted. The experience gained from the demonstration project will allow for a more streamlined and economical approach that can be applied to larger AMD sources. The ultimate goal of the initiative is to use CCBs to address the 6-square-mile underground Kempton mine complex, which discharges approximately 6 million gallons per day of AMD into the Chesapeake Bay watershed in Maryland.

PPRP will continue its efforts to expand the beneficial use of CCBs by reducing regulatory uncertainties around CCB use and increasing the understanding of the physical, chemical, and environmental attributes of CCBs. PPRP is also considering other possible demonstration projects with BGE and PEPCO to evaluate technologies that may be feasible for CCBs generated in Maryland.

Radioactive Waste Management

High-level Waste

Civilian high-level radioactive waste (HLW) comprises mainly spent fuel from nuclear power plants. Historically, nuclear power facilities stored their spent fuel on site in large, specially designed cooling pools. For most nuclear power facilities, this practice has continued to the present because there are no regional off-site repositories within the U.S. to permanently warehouse spent fuel. At the same time, nuclear power facilities have a finite amount of space in which to temporarily store spent fuel on site.

Over the last decade, utilities have become increasingly interested in wet or dry storage of HLW in independent spent fuel storage installations (ISFSIs) on site. Dry cask has become the principal option for utilities needing additional storage capacity. The NRC approved storage casks in response to the Nuclear Waste Policy Act of 1982. Dry casks are intended as an interim solution to alleviate storage problems until a permanent national repository can be authorized.

Dry casks receive spent fuel which has resided in the reactor spent fuel pool for at least five years. The spent fuel is in airtight steel and/or concrete containers or casks that provide both structural strength and shielding. Casks are placed either horizontally or vertically on a concrete pad above-ground, depending on cask design. Casks are designed to withstand acts of nature, remove heat, and effectively contain radiation. Currently, 10 nuclear power plants, including Calvert Cliffs, use dry storage. PECO Energy recently contracted for construction of an ISFSI at Peach Bottom Atomic Power Station, with operation expected in 2000.

The U.S. government has enacted several policies to address the lack of permanent high-level radioactive waste repositories. The most recent policy statement, the Energy Policy Act of 1992, specified that HLW will be placed in an underground repository. At present, only Yucca Mountain, Nevada is being considered as a permanent repository. It must pass extensive field and laboratory tests to determine its suitability.

Calvert Cliffs Independent Spent Fuel Storage Installation

Spent nuclear fuel from Calvert Cliffs is currently covered with water in pools near the reactors. In the mid-1970s when Calvert Cliffs received its operating license, it was envisioned that nuclear fuel assemblies used in the generation of electricity would be transported off site for reprocessing or storage. Because spent fuel reprocessing was banned in 1977 and no interim or final spent fuel repositories are expected to be immediately available, BGE began, in the mid-1980s, exploring options for on-site storage of its spent fuel.

That evaluation culminated in 1989 with an application before the NRC for a license to construct and operate a spent fuel facility at Calvert Cliffs. PPRP intervened in this licensing proceeding to ensure that there existed "a forum for resolution of issues related to the facility's potential impacts on the State, its environs and the health, safety and welfare of its citizens." PPRP, the NRC, and BGE ultimately reached formal agreement whereby PPRP was provided all pertinent information related to the facility and was accorded review and decisionmaking input privileges. After extensive evaluation by PPRP and the NRC of BGE's application, supporting documentation, and subsequent information submittals, the NRC issued a materials license in December 1992, authorizing BGE to operate the facility for 20 years.

The $24 million state-of-the-art facility is designed and licensed to hold 2,880 spent fuel assemblies in dry-shielded canisters, housed in 120 concrete modules. Two of the five licensed phases, a total of 48 modules, have been constructed. As of April 1998, 19 of the 48 modules had been loaded with 456 spent fuel assemblies. The facility design and 20-year license will accommodate all of the spent fuel that Calvert Cliffs will generate during its 40-year licensed life.

Three federal agencies will conduct the site selection, assessment, and licensing for the repository. The U.S. Department of Energy (DOE) will determine the suitability of, construct, and operate the facility. The U.S. EPA is responsible for developing environmental standards for its operation. The NRC will license the repository once it is determined that the facility meets NRC and U.S. EPA regulatory requirements.

Since 1994, DOE has excavated several tunnels to characterize the geology of the mountain and in 1998 will submit its Viability Assessment. This assessment will include design of the facility, a license application plan, projected costs, and timetables for completion of the site. If the NRC is satisfied with the assessment, the current schedule calls for a decision on site suitability in 1999, a recommendation to the President of the U.S. in 2001, and submission of a construction license application in 2002. After construction, DOE will apply to the NRC for a license to receive and possess spent fuel and other HLW. Even with a "fast track" schedule, the repository will probably not be available to receive spent fuel until about 2010.

Low-level Waste

Low-level wastes (LLW) are generally defined as radioactive wastes other than high-level (spent fuel) and wastes from uranium recovery operations (reprocessing). LLW is produced in thousands of institutions nationally, but primarily nuclear power plants, universities, hospitals, laboratories, and manufacturers of various products. It can include general refuse, protective clothing and gloves, testing equipment, machinery parts, and other items that may have become contaminated by radioactive particles.

The Low-Level Radioactive Waste Policy Act of 1980 charged states with the responsibility for the disposal of commercial and some federal waste. It also encouraged the states to form regional groups or compacts and to site, in a central location, regional LLW repositories by 1986. Progress on new LLW disposal facilities has been slow. Congress extended the deadline another 10 years by passing amendments to the original act. Several compacts plan to open sites in the first decade of the 21st century. There are currently nine compacts, representing 42 states.

Nationwide, LLW is stored locally where it is produced or is shipped to near-surface shallow trenches at privately operated facilities in Barnwell, South Carolina; Hanford, Washington; and Clive, Utah. Disposal in the Hanford facility is restricted to the 10 states which make up the Northwest and Rocky Mountain Compacts. Since South Carolina is not a member of a regional compact, Barnwell has authorized all states except North Carolina to ship LLW to its facility since 1995. The facility in Utah only accepts a limited type of waste—the

Peach Bottom Spent Fuel Storage Facility

In 1997, PECO Energy initiated the process of establishing dry cask interim storage for spent fuel from its two boiling water reactors at Peach Bottom Atomic Power Station. As was the case with Calvert Cliffs some years ago, the absence of a federal repository necessitated the action. Peach Bottom projected it would fill existing storage in fuel pools by the year 2000. However, unlike BGE's Calvert Cliffs, which licensed its facility under an NRC site-specific license, PECO Energy will pursue the NRC's general license, an option unavailable to BGE in 1989.

Under such a license an applicant is required to contract with an NRC-approved vendor for storage and transportation casks. Approved vendor designs have undergone extensive technology and safety reviews by the NRC for certification. The licensee is responsible for reviewing the Safety Analysis Report (SAR) issued for the storage cask, and ensuring that the construction and operation of the storage facility are consistent with the limitations identified in the SAR. The general license option reduces the complexity of the licensing process.

PECO Energy selected Transnuclear Inc. of Hawthorne, New York, to provide the licensing support and fabrication of casks for storage and, later, transport to a repository. Nine casks were ordered for delivery over the period 1999 to 200[illegible]. A "dry run" loading is scheduled for 1999 and the first loading expected in 2000. The company has started construction of the site, located within the controlled area on the western shore of the cooling water discharge canal, about one-quarter mile south of the power block. PPRP continues to monitor and participate in this licensing, interacting with the NRC and PECO Energy as the project progresses.

large amounts of waste with low levels of radiation resulting from closing and cleanup activities.

The Appalachian Compact, comprising Maryland, Pennsylvania, Delaware, and West Virginia, was established in February 1986 and ratified by Congress in May 1988. Pennsylvania is the host state and has been selected to construct the compact's regional disposal facility. The LLW disposal facility in Pennsylvania was scheduled to be operational by 2002, however, Pennsylvania has announced that it is considering suspending siting activities. The Compact supported Pennsylvania's decision, due primarily to the amount of disposal capacity available at Barnwell and to implementation of LLW reduction measures on the part of waste generators.

Conserving Biodiversity Through Integrated Assessments

PPRP recognizes that, although the State has made great progress in minimizing the impacts of specific power plant activities on individual resources, it has not yet fully addressed the cumulative effects of these activities on Maryland's ecosystems. To do this, we need an integrated approach to the assessment of ecological condition and change, based on watersheds or other ecological regions. This approach will become even more important as the electric utility industry changes into a more decentralized and less structured business. New technologies, such as GIS, will play a central role in integrating assessment information across geographic locations and in developing comprehensive solutions.

This section addresses three PPRP initiatives that support this integrated approach: 1) biodiversity conservation; 2) landscape analysis; and 3) indicator development. GIS plays an important role in this approach by integrating remotely sensed land cover information with ecological measurements from comprehensive field surveys (see Figure 4-5). In addition to addressing the indirect and cumulative impacts of power plants, this approach will further collaborative efforts on ecosystem protection within DNR (e.g., the Integrated Natural Resource Assessment), with MDE (e.g., watershed-based permitting), and with the U.S. EPA (e.g., regional assessments and priority setting).

Biodiversity Conservation

Biological diversity, or **biodiversity**, is defined as the "variety of life and its processes," and includes diversity at the levels of genes, species, ecosystems, and landscapes. Scientific and public concern for biodiversity is based on the fact that projections of the loss of species are great (even in the United States) and that environmental degradation continues in the face of attempts to regulate impacts on a resource-by-resource basis. The loss of biodiversity carries with it the diminution of utilitarian values (e.g., medicinal uses of plants, agricultural gene stocks, fisheries as a food source); indirect utilitarian values (e.g., ecosystem services such as air quality, climate amelioration, flood regulation, soil building, waste assimilation, pest control, crop pollination); recreational and aesthetic values; and intrinsic, spiritual, and ethical values. The solution to conserving biodiversity is to preserve and restore natural ecosystems with enough native components to sustain themselves over time.

DNR recognizes that addressing biodiversity is critical to meeting the goals of 1) understanding ecosystem processes and their relationships to Maryland's natural resources; and 2) evaluating the effectiveness of restoration, enhancement, and protection activities for Maryland's natural resources. The DNR Ecosystem Council has embraced the conservation of biodiversity as a key objective.

PPRP is also part of the larger electric industry effort to address this issue. PPRP participated in a recent conference on biodiversity, sponsored by the Electric Power Research Institute, and is pursuing partnership opportunities so that utilities can better manage their land for biodiversity, avoid biodiversity impacts, and mitigate unavoidable impacts.

Components of Biological Diversity

Biodiversity exists on many levels, from broad regional patterns down to the variations within individuals of the same species. Assessing impacts to biodiversity requires an understanding of the various levels. In its guidance on incorporating biodiversity considerations into impact analysis, the U.S. Council on Environmental Quality defined four general components of biological diversity:

Regional ecosystem diversity - the pattern of local ecosystems across the landscape. Sometimes referred to as "large ecosystem diversity" or "landscape diversity."

Local ecosystem diversity - the diversity of all living and non-living components within a given area and their interrelationships. Ecosystems are the critical biological/ecological operating units in nature. A related term is "community diversity" which refers to the variety of unique assemblages of plants and animals (communities). Individual species and plant communities exist as elements of local ecosystems, linked by processes such as succession and predation.

Species diversity - the variety of individual species, including animals, plants, fungi, and microorganisms.

Genetic diversity - variation within species. Genetic diversity enables species to survive in a variety of different environments, and allows them to evolve in response to changing environmental conditions.

PPRP is currently pursuing three biodiversity conservation initiatives:

- ***Fostering biodiversity and utility partnerships***—PPRP will hold an initial partnering roundtable with Maryland electric utility companies to learn about their biodiversity programs and identify ways PPRP can facilitate biodiversity conservation on utility properties and in other utility activities.

- ***Holding a DNR biodiversity conference***—PPRP played a key role in planning and implementing the DNR-sponsored conference, "Conservation of Biological Diversity: A Key to the Restoration of the Chesapeake Bay Ecosystem and Beyond."

- ***Mapping biodiversity hotspots***—PPRP is currently undertaking a biodiversity hotspots project to locate and map areas of high species diversity and areas supporting rare species, using existing data from large-scale field surveys. Identification of these biologically rich or unique areas is consistent with the DNR Ecosystem Council recommendations for identifying core and buffer areas for conservation and restoration. Initial results indicate that hotspots of species diversity vary among organism groups even within aquatic ecosystems (e.g., fish versus benthic macroinvertebrates).

Landscape Analysis

Although PPRP has considerable information on the volume and variety of potential impacts to Maryland's environment from the construction and operation of electric power plants and transmission systems, a fully integrated assessment of the cumulative effects of these activities on the natural resources of Maryland is needed. It can be difficult, however, to study power plant effects in the context of effects from other anthropogenic stressors. To assess power plant impacts effectively, PPRP is developing a methodology that focuses on individual resources and whole ecosystems, and on the thresholds of stress beyond which they become degraded. This methodology consists of the following components:

- *Needs assessment for the methodology;*

- *List of cumulative effects issues related to power plants;*

- *GIS with natural airshed, watershed, and ecoregion boundaries at the scales needed to meet the study goals;*

- *Practical land use-based relationship as a surrogate for nonpower-related stresses that can be applied across the state;*

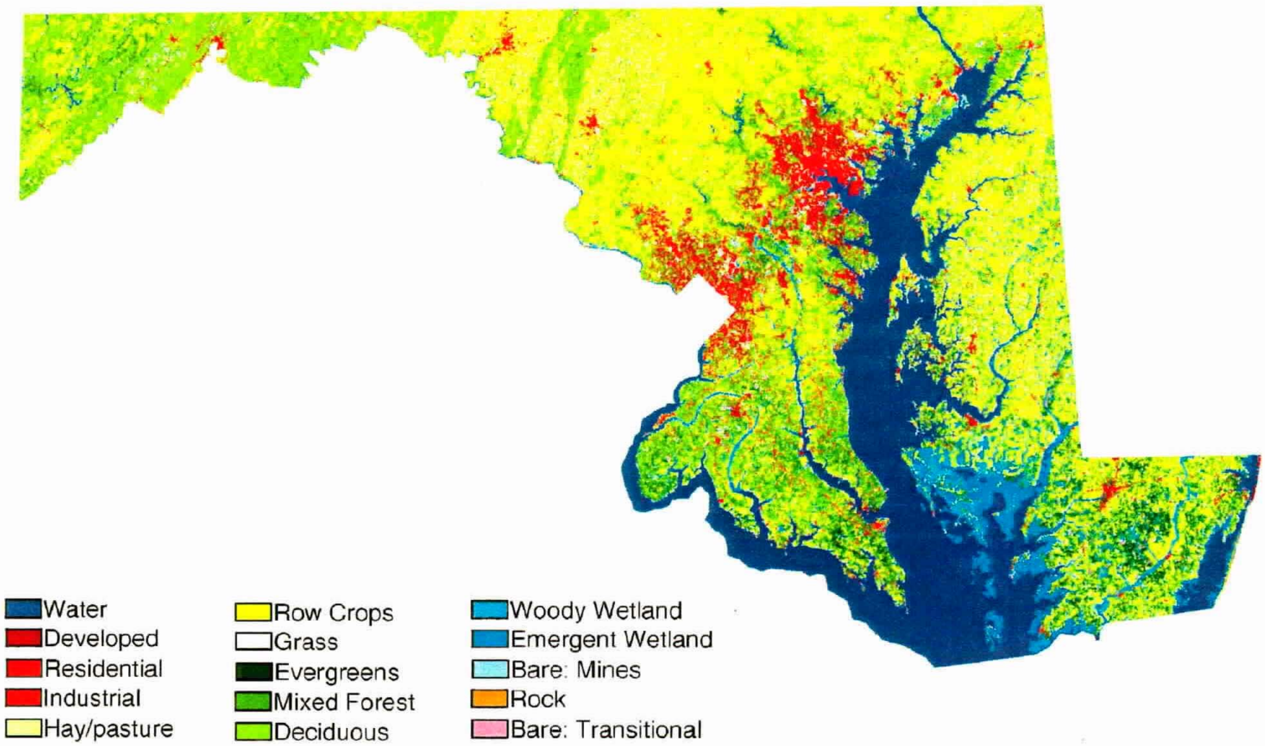
- *More and better indicators of ecological condition using Maryland reference conditions;*

- *Baseline of current ecological condition across the state;*

- *Inventory of power plant activities statewide; and*

- *Basic research on cause-and-effect relationships.*

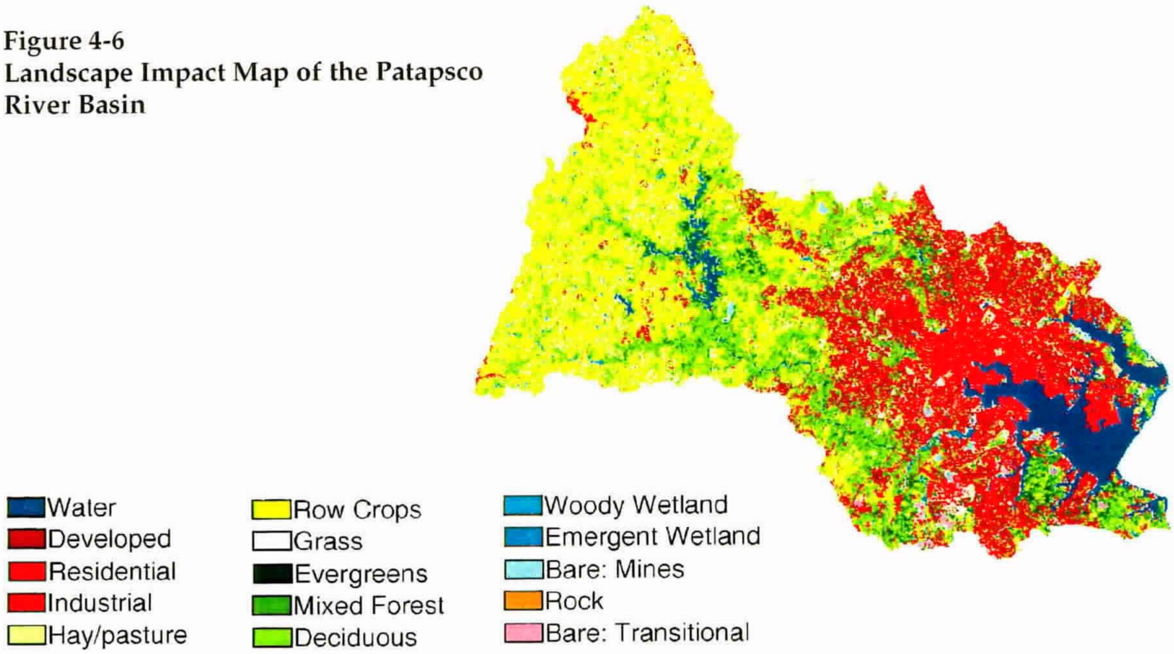
Figure 4-5
Maryland Land Use

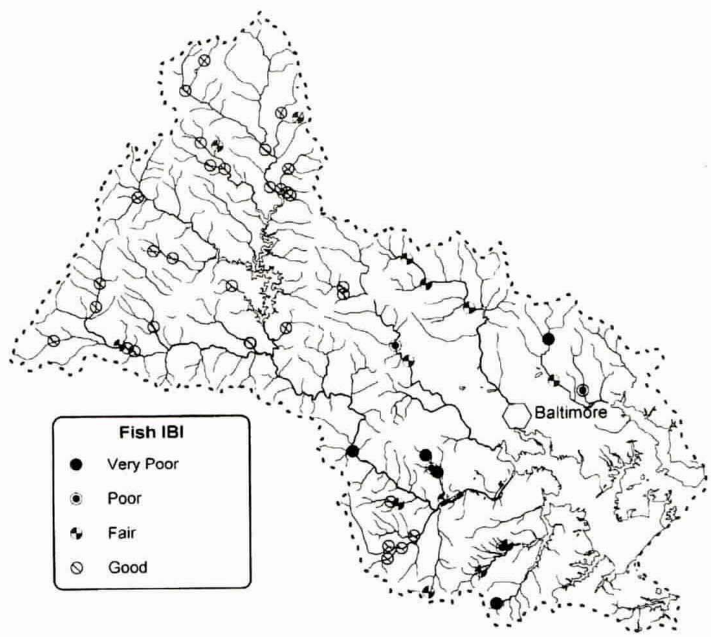


One of the components listed—practical land use-based surrogate for nonpower-related stresses that can be applied across the state—is a major focus of PPRP activity. PPRP is developing a landscape-ecological condition relationship based on the correlation between land use and an integrated indicator of stream condition, the Maryland Index of Biotic Integrity (IBI) for fish. Using the IBI values derived for Maryland Biological Stream Survey sites, PPRP is determining the best fit of these values with Multi-Resolution Land Char-acteristics (MRLC). These MRLC data have recently been developed for the mid-Atlantic region as the first step in a national effort by a consortium of federal agencies, including the U.S. EPA and the U.S. Geological Survey, to provide 30-meter resolution land cover/land use from Landsat imagery.

PPRP's efforts are aimed at determining: 1) the best land cover data and resolution to use; 2) what unit of the landscape should represent the area of influence; and 3) what specific metrics quantifying landscape condition are most useful. Landscape areas of influence that PPRP is considering include the watershed or catchment upstream of each sample site, the riparian corridor upstream of the sample site, and a circular area representing the local land use. Initial results in the Patapsco River basin indicate that such relationships may be useful for inferring the ecological condition of streams where instream measures do not exist (Figure 4-6).

Figure 4-6
Landscape Impact Map of the Patapsco River Basin





If this surrogate relationship is validated for use in other regions, PPRP will be able to identify areas where additional stresses may cause streams in marginal condition to become degraded, or where restoration may alleviate cumulative adverse effects. This relationship can also be used to determine the incremental contribution of existing and proposed power plants to the cumulative effects on resources of concern.

Integrated Indicators of Ecological Condition

Understanding the status and trends in the condition of natural resources is critical to evaluating the cumulative effects of power generation and transmission. PPRP believes that using environmental indicators is the most cost-effective way of assessing power-related impacts to the environment. Specifically, validated indicators that are based on reference conditions can best determine the status of the resource relative to all other stresses. Integrated indicators that describe the integrity of biological communities are needed to address biodiversity and ecosystem-level impacts.

Indicators can assess either the condition of the resource or its exposure to stressors. They can both evaluate current baseline conditions and detect trends over time. Proper calibration is needed, using reference conditions as a yardstick to measure the degree of impact at specific sites while also accounting for natural variation in ecological conditions. The use of standard indicators and appropriate reference conditions provides an accurate and scientifically defensible means of evaluating impacts. Such indicators can serve as the basis for evaluating power-related impacts, such as acid deposition or mine drainage, in the context of other cumulative effects. They are useful diagnostic tools for comparing the relative influence of other, multiple stressors, including physical habitat degradation and urban development. Integrated indicators of ecological condition will make possible comprehensive, integrative assessments of the relationships between environmental stressors and a broad range of resources.

PPRP is currently investigating many kinds of indicators for addressing power-related impacts, including physical indicators, chemical indicators, biological indicators, and landscape indicators using GIS. At the same time, PPRP is working with other agencies and organizations to develop indicators through programs such as DNR's Maryland Biological Stream Survey and Integrated Natural Resources Assessment. Recent program accomplishments include the development and application of the IBI, a reference-based indicator that has undergone rigorous testing and calibration for use in Maryland streams. The fish IBI is being used in assessments of conditions in freshwater streams across the state. Ongoing work includes validation of the fish IBI with additional data to ensure proper consideration of special habitats, such as coldwater trout streams. Efforts are currently underway to develop indicators of physical habitat and benthic macroinvertebrate communities in streams, using a similar reference-based approach. GIS-based landscape indicators are also being developed to represent the cumulative impacts of human activities on a watershed scale. PPRP continues to review current state and federal initiatives in indicator development to identify the best indicators and techniques for evaluating the effects of power generation and transmission.

Competition in the Electric Utility Industry

Introduction

Over the last few years, competition among electric utilities at the bulk power level has increased, spurred significantly through the efforts of the Federal Energy Regulatory Commission (FERC). In the early 1990s, FERC used its authority over mergers and bulk power pricing to encourage voluntary open access to transmission. The Energy Policy Act of 1992 (EPACT) codified FERC's power to order transmission access. Because EPACT authorized FERC to act on a case-by-case basis, an approach that would open the transmission grid to competition over several years, in 1996 FERC issued an industry-wide rule requiring utilities to provide wholesale open access transmission. This has led to important competitive changes in wholesale markets.

The introduction of retail competition is also actively under consideration in most states, including Maryland. The Maryland Public Service Commission (PSC) issued an order in December 1997 that provides a framework for retail competition for generation services in Maryland. The Maryland General Assembly established a Task Force in 1997 to study retail competition. During 1998 the PSC has begun a series of roundtables considering specific implementation issues associated with the start of retail competition. Also, the PSC began its consideration of utility stranded costs.

Federal legislation proposals are under review that would mandate (or facilitate) competition over the next few years. While details vary, these pieces of legislation identify timetables for the introduction of retail competition. Some also include provisions that address stranded cost recovery.

The remainder of this section discusses the general issues associated with transmission open access and retail competition. Changes specific to Maryland utilities and the operating systems that serve Maryland customers are then described.

Transmission Issues

The transmission grid of vertically integrated utilities has been considered a bottleneck that could serve as a barrier to new competition. Transmission service on the high voltage grid, which is essential to effectuate many bulk power transactions, could be difficult to obtain if the transmission owner had reserved transmission capacity for other purposes or if the owner simply refused to provide transmission to third parties. Beginning in the mid-1980s, FERC sought to increase competition in bulk power markets by requiring utilities to provide access to their transmission grids to third parties. Initially, FERC required utilities seeking merger approval to provide transmission access, later extending this to include utilities seeking to sell power at market-based rates. With the passage of EPACT, Congress amended the Federal Power Act to confer on FERC the right to order transmission service upon request of an eligible wholesale entity, which included other utilities, nonutility generators, and qualified power marketers. EPACT specifically prohibits FERC from issuing any transmission order that would require transmission service to an ultimate consumer.

FERC's efforts to open the transmission grid culminated with its open access orders issued in April 1996 and May 1997. In these orders, FERC required all utilities under its jurisdiction to file open access transmission tariffs in order to make their grids available to other wholesale market participants on non-discriminatory terms. The open access orders also specified filings that would be required by power pools (such as PJM) to comply with the open access rules.

FERC's Open Access Orders

Under the open access orders, FERC required utilities to file non-discriminatory, open access transmission tariffs. Among other things, these orders require utilities to:

- *File non-discriminatory, open access point-to-point and network transmission tariffs; and to charge themselves under the same open access transmission rates that they make available to third parties;*
- *Expand capacity of the transmission system if that is necessary to respond to a request for transmission service; and*
- *Provide ancillary services of the kind that are normally required to effectuate transactions over the grid.*

Under these orders, utilities may reserve their own transmission capacity for the future use of their "native load" or franchise customers over a reasonable planning horizon. These orders also established separate procedures applicable to members of power pools with varying degrees of coordination.

Open Access Tariffs

The open access orders require utilities to offer access to their transmission grids to all eligible entities in order to eliminate undue discrimination in the provision of transmission service. FERC found that utilities must offer both **point-to-point** and **network service** whether or not the utility provides such service to itself. In reaching this conclusion, FERC found that since utilities had the flexibility to offer that service to themselves, to be non-discriminatory, an open access tariff must offer the same flexibility to others.

Firm point-to-point service requires the transmission owner to provide firm deliveries of power from designated points of receipt to designated points of delivery. The amount of capacity reserved at points of receipt and delivery would be spelled out in service agreements. Network service permits a transmission customer to integrate and economically dispatch its resources to serve its load in a manner comparable to the way that the transmission provider uses the transmission system to integrate its generating resources to serve its native load. However, network service cannot be used by utilities for sales to other utilities. Point-to-point service must be used for that purpose.

Expansion of the Grid

The open access orders require utilities to expand the capacity of the grid if that is necessary to satisfy a request for transmission service. Whether the cost of the expansion would be assigned directly to the entity requesting service, or allocated among all transmission users, would depend upon the circumstances. Such issues would be decided when the utility sought to recover the cost of the new facilities in a filing at FERC.

Ancillary Services

Ancillary services are those elements of **bundled transmission** service that are required to effectuate transactions on the grid. Historically, these were not sold separately because the transmission provider included these as part of bundled retail or wholesale service. In a competitive environment, a market could emerge to supply such ancillary services in lieu of their being provided by the transmission grid owner. In its open access orders, FERC identified six ancillary services that transmission customers must purchase.

Transmission customers were required to purchase the following three ancillary services from the transmission provider:

- *Scheduling, system control, and dispatch service;*
- *Reactive supply and voltage control from generation sources; and*
- *Regulation and frequency response service.*

Regulation and frequency service were only required for transmission customers serving entities within the transmission provider's control area.

Three additional ancillary services could be obtained either from the transmission owner or from alternative sources. These include:

- *Energy imbalance service,*
- *Spinning reserves, and*
- *Supplemental reserves.*

Energy imbalance service is needed to correct for any mismatch between a customer's sources of supplies and its load during a given hour. Spinning reserves refers to generating capacity available instantaneously to meet load in the event of an emergency. This service is usually provided by generating units that are not operating at full capacity. Supplemental reserves are additional operating reserves that could be called upon in the event of an emergency, but unlike spinning reserves, not instantaneously. Generally, such capacity should be available in a short period of time, around 10 minutes.

How Will Open Access Affect Maryland's Environment?

There appear to be a number of potential environmental implications arising from FERC's open transmission access rule and PJM restructuring. One effect concerns the likelihood that, over time, open transmission access would lead to increases in generation from under-utilized Midwest coal-fired generating units. This would increase NO_x emissions that could be transported to downwind Northeast states, including Maryland. If this hypothesis is correct, the long-range transport of increased NO_x emissions could worsen Maryland's ozone problem, making compliance with federal ozone standards more difficult and costly. Second, the transport of increased Midwest NO_x emissions into Maryland could increase nitrate deposition to the Chesapeake Bay, adversely affecting Bay habitat.

FERC addressed some of these concerns by preparing an Environmental Impact Statement (EIS), which concluded that there would not be any significant environmental impact stemming from the adoption of the open access transmission rule. The U.S. EPA, however, continued to express concern and referred the matter to the Council on Environmental Quality for further review. At some point in the future, if the U.S. EPA and state actions to mitigate potentially adverse effects are not successful, FERC agreed to open a Notice of Inquiry to investigate possible mitigation measures. In fact, the U.S. EPA recently imposed significant new NO_x reduction requirements to improve ozone pollution (see Section 3) that may mitigate some of these NO_x concerns.

Following release of the FERC EIS, PPRP began researching to more accurately determine the full environmental impacts to Maryland of electric utility restructuring. PPRP's ongoing work in this area uses economic dispatch models and air quality dispersion models to assess the impacts of various restructuring scenarios. The results of this study will assist the State in evaluating potential impacts to the Chesapeake Bay and other natural resources.

Transmission Pricing

Utilities have used a variety of pricing mechanisms to establish the terms and conditions under which they provide transmission services to third parties. Many simply compute the average cost of their transmission facilities, divide those costs by their annual peak demand (as a proxy for the capacity of the grid), and charge the resulting dollars per kilowatt transmission rate. This was normally a "postage stamp" rate that reflected neither the distance of specific transactions nor the impact on the grid of actual power flows.

Other transmission pricing schemes used by utilities include the "contract path" and "MW-mile" methods. The contract path method is based upon a presumed electrical path associated with a specific transaction. The MW-mile method reflects the fact that power flows over all parallel paths in an interconnected transmission grid. The MW-mile method compensates all utilities whose facilities are used in a given transaction in proportion to that use.

Pricing problems arise when capacity on the grid is constrained. FERC, in approving open access transmission rates filed during the past few years, has used the so-called "or" policy to set transmission rates. This is designed to protect native load customers from any increased costs of providing transmission to third parties. If such third-party transmission can be provided only through the construction of new facilities, FERC will permit transmission rates to reflect the greater of average embedded cost *or* the incremental cost of the new transmission facilities. If transmission can be provided at lower cost by redispatching existing generation, or by foregoing discretionary off-system transactions, then these "opportunity costs" should be recoverable through transmission rates. This approach is intended to protect utility customers from rate increases from expensive grid expansions necessitated by third-party use of the transmission system.

In October 1994, FERC issued a policy statement concerning transmission pricing. FERC concluded that flexibility with respect to pricing methods was required to accommodate the evolving needs of transmission owners and users in an increasingly competitive era. Under FERC's policy statement, transmission pricing proposals must adhere to five principles:

1. *Allow recovery of transmission embedded cost of service but not allow monopoly profits;*
2. *Provide comparable service for all grid users;*
3. *Promote economic efficiency;*
4. *Promote fairness; and*
5. *Be practical.*

Any transmission pricing proposal failing to adhere to the first two of these would be rejected. FERC expected that it would be difficult to fashion transmission pricing proposals consistent to the same extent with all of the last three principles. FERC therefore must judge the extent to which a particular pricing proposal, on balance, was consistent with the principles. The policy statement also concluded that the "or" policy provides sufficient incentives for utilities to provide additional transmission.

Retail Competition

During the last few years, there has been increasing activity both by the states and the federal government to restructure the electric utility industry at the retail level. The federal open access transmission initiatives, while limited to permitting wholesale service, has led to the reexamination of the desirability of permitting retail customers to shop for electric power in much the same way that they are able to select among long-distance telephone suppliers. During the transition from the regulated system of providing electric service to competitive retail choice, one of the more daunting issues that regulators must face is that of **stranded cost recovery**. This issue involves determining to what extent utilities should be allowed to recover from customers the cost of assets that may no longer be economic under a competitive industry structure.

Restructuring at the Federal Level

At the federal level, four bills have been introduced in Congress that would entail comprehensive restructuring of the industry:

- *HR 655, The Electric Consumers' Power to Choose Act of 1997;*
- *HR 1230, The Consumer Act of 1997;*
- *HR 1960, The Electric Power Competition and Consumer Choice Act of 1997;*
- *S 237, The Electric Consumers Protection Act of 1997; and*
- *the Administration's proposal, the Comprehensive Electricity Competition Act.*

Many proponents of retail competition have most actively supported HR 655 as the primary restructuring legislation. This bill would require full retail competition for all customers in the United States by December 15, 2000. While implementation is left to the states, FERC would be empowered to impose a plan if one is not developed by a state within six months of the bill's passage. This bill does include a two-year grace period to allow states time to amend their constitutions or pass other legislation that may be required to permit retail competition. HR 655 is silent about stranded cost recovery, apparently leaving this issue to the states.

HR 1230 would require full retail access for all customers across the United States by January 1, 1999. This bill is controversial because it prohibits all utility stranded cost recovery and exit fee charges. HR 1960 requires states to open their electricity markets to competition but does not specify a deadline, nor does it provide an implementation plan or guidance on stranded cost recovery. Finally, S 237 mandates full competition in the electric utility industry by December 15, 2003. This legislation is the only one that explicitly provides for full stranded cost recovery. Action on any of these restructuring proposals is unlikely during 1998. There is little consensus among members of either party whether Congress should enact any kind of restructuring legislation and, if so, the form that such legislation should take.

The Clinton Administration also submitted a bill to Congress calling for the restructuring of the electric utility industry. Among other things, this legislation would require retail open access no later than January 1, 2003 and would require states to consider a mechanism for the recovery of retail stranded costs. This legislation, however, allows states not to permit retail competition if they find that implementation could have a negative impact on a class of customers, and that the negative impact cannot be mitigated reasonably.

Restructuring at the State Level

The federal restructuring of wholesale markets impelled most state legislatures and public utility commissions to investigate electric utility restructuring at the retail level. Most notable are the restructuring efforts in California, where retail competition for all customer classes was to commence on March 31, 1998. California utilities were encouraged to divest a portion of their non-nuclear generating resources under the state's restructuring plan, but were assured the ability to recover all stranded costs through a non-bypassable competitive transition charge. Some Middle Atlantic states have established phase-in schedules for retail competition; retail customer choice will begin in Pennsylvania on January 1, 1999 and in New Jersey in early 1999.

The Maryland PSC considered retail competition and customer choice in 1995, but concluded that only wholesale, not retail competition was in the public interest at that time. The PSC noted, however, that the rapidly changing nature of the electric utility industry would require further inquiry into the issue. In October 1996, the PSC determined that changed circumstances required a further investigation of the issue. On December 3, 1997, following the issuance of a PSC Staff report and generic hearings, the PSC issued an order establishing a framework for implementing retail customer choice in Maryland. The PSC's framework contemplates a gradual phase-in of retail access to all customer classes over a period of three years beginning in July 2000. However, before customer choice can be made available, there are numerous technical, policy, and practical implementation issues which should be addressed, including rate unbundling, stranded cost recovery, universal service, and competition in metering.

The legislature established a task force to investigate these and other issues. A January 1998 draft report by the Task Force indicated that the legislature was responsible for establishing policy on electric restructuring and that it should establish implementation benchmarks to protect all stakeholders during the transition to retail competition.

Stranded Cost

One of the more complex issues confronting regulators overseeing the introduction of retail competition and customer choice is stranded cost. Stranded costs are the legitimate, prudent, and verifiable costs incurred by a utility which would be recoverable under regulation but not recoverable in a competitive market. The fact that market prices for generation are below regulated prices is attributable to a confluence of factors. Among those contributing to the high cost of utility generation is the cost of some base load power plants, such as nuclear units, and high fixed costs of power purchase contracts with cogenerators that had been entered into many years ago. Market prices for generation, on the other hand, have declined in part because of technological advances for new generation facilities that have increased the fuel efficiency by 15 to 20 percent. In addition to increased efficiency, the installed capital costs of those generating units have also declined significantly.

The introduction of competition presents the problem that utilities would be unable to recover the cost of "uneconomic" assets and other commitments acquired or entered into under regulation. FERC and some state utility commissions have determined that utilities should be afforded an opportunity to recover the costs that were "stranded" as a result of the move toward retail and wholesale competition, subject to certain conditions.

If stranded costs are to be recovered, regulators face the difficult task of quantifying those economic losses from a competitive retail market which does not yet exist. In some states, the quantification problem is being resolved by permitting the utility to divest or auction its generation assets. Once quantified, a recovery mechanism must be identified.

Each of Maryland's major electric utilities has submitted a stranded cost filing to the PSC as part of the State's ongoing restructuring proceeding. The PSC is scheduled to make a determination by the fall of 1999 concerning the appropriate level of stranded costs that each utility will have an opportunity to recover, and the time period over which such recovery will be allowed.

PJM Restructuring

Background

The Pennsylvania-New Jersey-Maryland Interconnection (PJM) is the nation's oldest power pool. Its members include utilities in Pennsylvania, Maryland, New Jersey, and Delaware. Three of Maryland's major utilities—BGE, Delmarva, and PEPCO—are members.

In July 1996, seven of the eight PJM utilities (the Supporting Companies) and, in a separate filing, PECO Energy, submitted alternative Independent System Operator (ISO) proposals to FERC to restructure the operation of PJM. The restructuring was necessitated—in fact mandated—by FERC's open access order.

In broad terms, the two proposals were similar with the following significant modifications to the PJM Agreement being included in both proposals.

- *Control over the integrated operation of the grid would be vested in an ISO. The ISO would be charged with ensuring the reliable operation of the grid, and would be vested with responsibility for transmission planning.*

- *A Power Exchange (PX) would be established to allow members to sell and purchase energy at market prices.*

- *A mechanism would be created to determine the installed capacity reserve requirements of the Pool and to devise an approach for assigning shares of such reserve requirements to all load serving entities within the Pool.*

- *A uniform system of transmission rates would become effective for point-to-point and network service. The Supporting Companies proposal called for the establishment of zonal rates with surcharges for service that extended beyond a zone. The PECO Energy proposal called for uniform pool-wide rates.*

In November 1996, FERC rejected both restructuring proposals. Among other things, FERC held that these restructuring proposals precluded meaningful representation by all non-PJM stakeholders and that this was unduly discriminatory. The governance procedures included in the filings would perpetuate the existing members' dominance. With respect to other features of the proposal, FERC ruled that insufficient evidence had been presented to allow a determination as to whether these were just and reasonable. The proposal to establish a PX energy market, for example, could not be approved until a market power study had been prepared. Further, the Supporting Companies failed to provide any cost support for their transmission pricing proposals.

Subsequent to this rejection, the PJM Supporting Companies and PECO Energy met with all stakeholders to resolve their differences. While narrowing many of the issues, competing proposals were presented to FERC for final resolution in mid-1997. A FERC order approving the final form of the PJM ISO was issued in late 1997, and the revised ISO began operations on January 1, 1998. The effective date of the PJM open access tariff, which includes congestion pricing provisions, was deferred until April 1, 1998.

The FERC PJM ISO Order

In November 1997, FERC issued an order adopting in all important respects the restructuring proposals submitted by the Supporting Companies. The final form of the ISO addresses many of the concerns that gave rise to FERC's rejection of earlier proposals. In particular, the ISO governance procedures were revised to provide that existing members would be unable to dominate ISO decisionmaking. Open access transmission rates were revised so that a single rate was applicable for service throughout the pool. In this regard, FERC required PJM to file a new rate by July 2002 that would provide a uniform charge for delivery of power anywhere in the pool. This would implement PJM's commitment to adopt a uniform rate within five years. With respect to the energy exchange, the ISO is required to submit a market power study to justify the use of market prices.

Finally, FERC asked the parties to file briefs addressing the pool's proposal to continue to reserve 3,500 MW of transmission interface capability with other systems as a capacity benefit margin to reduce the reserve requirements of the pool as a whole. According to FERC, the continuation of this proposal would not be consistent with the terms and conditions of the open access tariff. Further, continuation of the practice in the short run benefits the existing utility members of the pool, most of whose capacity resources are located within PJM.

Potential Impact of the ISO

Because the ISO has been in operation only a few months, it is difficult to determine its long term effects on the operation of the PJM high-voltage transmission grid. As users gain experience with new institutional protocols, modifications will undoubtedly be required. Some effects upon transactions and power flows on the grid have already emerged. BGE's and PEPCO's purchased power accounts reveal, for example, the emergence of power brokers and marketers as new participants in the market. Since many of these marketers do not actually own any generating resources, they must assemble resources from numerous utilities and compete with the energy sales that these firms have traditionally made from the PJM energy market or from Midwestern utilities and other systems. While many of these transactions are small, some are fairly sizable. For example, almost 30 percent of BGE purchases in 1996 were from LG&E Marketing, the power marketing subsidiary of Louisville Gas and Electric Company. Moreover, since pool-wide open access transmission rates became effective only in the latter half of 1996, transactions of this kind may be expected to grow in the future.

Another effect of the PJM ISO is the entry of Virginia Power (VP) as a significant supplier. Prior to the adoption of the ISO, VP was connected to PJM only through its interconnection with PEPCO and would have had to incur multiple transmission charges for sales to other PJM utilities. Under the pool-wide ISO open access tariff, VP is effectively connected to the entire pool and can sell energy for only a single transmission charge. In 1996, VP sold roughly 1,500 gigawatt-hours to PJM utilities other than PEPCO.

FERC has also questioned PJM's reservation of 3,500 MW of transmission interface capability. PJM regards the 3,500 MW as a capacity benefit margin that lowers reserve requirements for all members of the Pool. If FERC finds that this practice is no longer warranted, the availability of 3,500 MW of transfer capability for firm transactions with other systems could make it easier for new market entrants to import capacity into PJM to compete for retail load. However, utilities in the pool may be required to increase their reserve margins in order to achieve the same level of reliability as before.

Environmental Impacts of Utility Mergers

In reviewing the electric utility merger activity that has taken place in Maryland and the mid-Atlantic region, there is no evidence that mergers will adversely affect environmental quality. For the PJM companies, power plants will be dispatched and operated in accordance with the PJM energy exchange administered by the ISO. This means that a merger is not likely to change the ways in which plants are dispatched. In addition, mergers have no effect on the laws, standards, regulations, and permit or licensing conditions to which the companies must adhere. Information supplied by companies involved in merger cases indicates no material change in environmental compliance activities or planning.

It is unlikely that mergers will cause electricity consumption to grow substantially. Although the mergers provide cost savings and rate reductions, the reductions are too small (about 1% to 3%) to significantly increase customer power demands. As discussed in Section 2 of this report, demand-side management and conservation programs may become less important in a competitive industry, because they are often not cost-effective for an electricity supplier to implement. It is possible that this will lead to an increase in power demand with the attendant environmental implications.

Merger Activity Among Maryland Utilities

The industry-wide movement to introduce competition, which has been described in previous sections, has been accompanied by a corresponding merger movement. During the past two years, no state has seen more electric utility merger activity than Maryland. During 1997, all four of Maryland's investor-owned electric utilities were involved in pending mergers. The largest was the merger between BGE and PEPCO, creating Constellation Energy Corporation. Constellation would have been the ninth largest electric utility in the U.S. and would have served approximately 75 percent of Maryland households and businesses, along with the District of Columbia. The Constellation merger received key regulatory approvals but with certain ratemaking conditions which the companies contested. The Maryland PSC approval was the subject of court challenges brought by the International Brotherhood of Electrical Workers. In December 1997, BGE and PEPCO announced their cancellation of merger plans—nearly two years after publicly announcing the merger. However, it would not be surprising to see either PEPCO or BGE, or both, be involved in new merger activities in the near future.

Delmarva Power & Light Company, which serves Maryland's Eastern Shore and Delaware, has merged with neighboring Atlantic Energy, which provides electric utility service to southern New Jersey. Delmarva Power and Atlantic Energy will continue to operate as separate utility subsidiaries of the new holding company created by the merger, "Conectiv." The merger was completed in May 1998.

In August 1997, the Allegheny Power System (parent of Potomac Edison Company which serves Western Maryland) announced its merger with DQE (parent of Duquesne Light Company), the electric utility serving the Pittsburgh area. The merger will produce a new holding company, Allegheny Energy. In July 1998, the Pennsylvania Public Utilities Commission approved the merger with certain conditions relating to the mitigation of potential market dominance. The Maryland PSC's investigation of the merger was resolved earlier in 1998 in a settlement among the parties. In September 1998, FERC approved the merger subject to certain conditions, including the divestiture of a DQE power plant. DQE has stated that it intends to cancel the merger due to what it believes are adverse regulatory rulings.

There are several reasons why impending competition drives the merger movement. First, competition creates an imperative for cutting costs, and utilities see mergers as a potential source of administrative efficiencies. For example, the

Constellation merger projected net cost savings totaling $1.3 billion over the next 10 years. In a competitive environment, such cost savings will contribute to the business success of the companies.

Merger benefits, however, can go beyond mere savings in administrative costs. Success in the newly emerging competitive retail market will require a large marketing effort, name recognition and a market presence. Electric utilities will seek to exploit new growth opportunities and sell power far beyond their present local service areas. This will require extensive financial, human and power supply resources. Utilities believe that they must become substantially larger if they are to succeed in the competitive market, and merging allows them to achieve this larger size quickly.

The difficult public policy question is how far should this merger and consolidation movement go. While competition motivates mergers and may provide cost saving efficiencies, if the merger movement extends too far, it may end up threatening the viability of competition itself as markets become more and more concentrated. As electric restructuring emerges, the challenge will be to find the appropriate balance that permits the exploitation of scale economies while preserving the benefits of competition.

Appendix A Determinants of Electricity Demand Growth in Maryland

The Power Plant Research Program (PPRP) conducts a program of independent electric load forecasts as part of its efforts to both monitor the adequacy of future power supplies and to independently evaluate the potential for excess generating capacity.

The PPRP forecast studies use economic theory as the organizing principle to model the demand for electricity, and rely on econometric methods for estimation and projection. The econometric data that are used to run these models involve historical and projected data on variables assumed *a priori* to significantly affect the demand for electricity. Some of these variables are economic and some are non-economic in nature. Economic variables include income, the price of electricity, employment, and output; non-economic variables include population and weather. Historical information is required for estimation purposes, while projected data are necessary to forecast the demand for power econometrically.

This appendix provides an overview of the theoretical foundations upon which these forecast studies rest and an analysis of the trends of some of the economic and non-economic determinants of the demand for electricity. The Maryland data presented here have been obtained from the Maryland Office of Planning. For comparison, some nationwide data from the U.S. Departments of Labor and Commerce are also included.

This appendix is composed of five sections. Section A.1 presents a brief discussion of the theoretical foundations for modeling the demand for electricity econometrically. This section sets the stage for the rest of the appendix, which examines economic and demographic trends for Maryland by region. The Maryland Office of Planning divides the state into six regions, defined in Table A-1, for statistical purposes. Section A.2 discusses trends in per capita income. Section A.3 discusses trends in employment. Section A.4 discusses trends in population and the number of households. Finally, Section A.5 presents a brief summary.

Table A-1 Principal Regions in Maryland

Region	Counties	Predominant Electric Utility
Baltimore	Anne Arundel Baltimore City Baltimore County Carroll Harford Howard	Baltimore Gas and Electric Company
Lower Eastern Shore	Dorchester Somerset Wicomico Worcester	Choptank Electric Cooperative
Southern Maryland	Calvert Charles St. Mary's	Southern Maryland Electric Cooperative
Upper Eastern Shore	Caroline Cecil Kent Talbot Queen Anne's	Delmarva Power (Conectiv) and Choptank Electric Cooperative
Washington	Frederick Montgomery Prince George's	Potomac Electric Power Company
Western Maryland	Allegany Garrett Washington	Allegheny Power

Theoretical Foundations for Econometrically Modeling the Demand for Electricity

The PPRP forecast studies use economic theory as the organizing principle to econometrically model the demand for electricity. The body of theory upon which these studies rely, in particular, focuses on the demand faced by a company, such as an electric utility, for its goods or services.

The demand for any commodity (good or service) faced by a firm depends on the size of the market demand, the form of industrial organization, and the number of producers in the market. Market demand size involves the aggregation of individual choice, while the form in which the industry is organized and the number of participating firms relate to market structure. In econometrically modeling the demand for electricity, the PPRP forecast studies treat the electric utility as a sole producer of a commodity. This assumption rests on the fact that under the present and historical regulatory environment, utilities operate in franchised service areas as regulated monopolies. The utility in each franchised service area thus represents the industry and faces the aggregate (or market) demand for electricity.

Because market demand and firm demand are the same, factors that drive the demand faced by the utility are precisely the factors that drive market demand. If electricity is for residential use, then market demand will be driven by factors to which individual consumers are sensitive. If electricity is for commercial or industrial use, conversely, then market demand will be driven by factors to which producers are sensitive. What these factors are and how they relate to the market demand for electricity is, for the most part, postulated by economic theory.

Consider first the residential demand for electricity. Here electricity forms part of the basket of goods and services purchased by the consumer. In the PPRP forecast studies, demand for electricity is assumed to result from the exercise of choice by which the consumer maximizes his/her welfare subject to a budget constraint. Consumer demand for a commodity is taken to be a function of its price, consumer income, weather, and the price of related commodities (i.e., substitutes and complements).

For commercial and industrial customers, electricity is a factor of production—an input. In the PPRP forecast studies, the demand for electricity is assumed to result from an exercise of choice by which the producer seeks to maximize profits. For the profit-maximizing producer, demand for a commodity (including electricity) is driven by its price, the price of related inputs, and the level of output. Producer demand is also driven by other factors, including weather.

Both the residential and non-residential demand for electric power is discussed above in terms of the individual consumer or producer. The market demand for electric power in a given franchised area is also dependent on the number of consumers (households) and the level of goods and services produced in the region. Residential demand is therefore forecasted on a per-customer basis which, when multiplied by the projected number of residential customers, provides a forecast of total residential sales. Commercial and industrial electric sales are projected per employee, which are then multiplied by the number of forecasted employees to project total commercial and industrial electric sales. Employment is used in lieu of output since no satisfactory time series of output data is available at a suitably disaggregated level.

Per Capita Income Trends

Income is an important determinant of the demand for residential electricity. The relationship between income and the demand for electricity is important because changes in income will affect the quantity of electricity purchased. Changes in income affect electric power consumption in two ways. First, a change in income will induce a change in the intensity of use of the existing stock of electricity-consuming appliances. Second, an income change will induce changes in the stock of electricity-consuming appliances. As income changes, therefore, the demand for electricity will rise or fall. The PPRP forecast studies demonstrate a positive and, typically, statistically significant relationship between income and the residential demand for electricity.

The PPRP forecast studies use real per capita income as an explanatory variable. Real figures are used to control for inflation in the time series. Real per capita income figures are reported in Table A-2 for the Maryland regions defined by the Maryland Office of Planning. Table A-2 summarizes historical and projected data as well as average annual growth rates for the period 1980 through 2010. As shown by the historical data, all regions within the state experienced a substantial slowing in the growth of real per capita income during the 1990 to 1995 period in comparison to the 1980 to 1990 period. For the state as a whole, growth in real per capita income declined to 0.36% per year between 1990 and 1995 compared to an average annual growth rate of 2.64% between 1980 and 1990.

The projections for growth in real per capita income for the 1995 to 2000 period exceed the growth experienced over the first five years of the 1990s, but are smaller than the growth experienced during the 1980s. Between 1995 and 2000, real per capita income is expected to increase at an average annual rate of 1.35% for the state as a whole, compared to the 2.64% growth rate experienced in the 1980s. The most rapid increases in real per capita income are expected in the Southern Maryland region (1.89% per year), with the slowest growth over the 1995 to 2000 period projected for Western Maryland (1.17% per year).

Per capita real income is expected to grow at a slower rate in the 2000 to 2010 period relative to the projections for the 1995 to 2000 period, with average annual growth for the state as a whole projected to be 0.96%. As was the case for the 1995 to 2000 period, growth in real per capita income for the 2000 to 2010 period is expected to be most rapid in the Southern Maryland region. Growth in real per capita income is expected to be slowest in the Western Maryland and Washington regions.

Table A-2 Per Capita Income in Maryland, 1980-2010 (1992 Dollars)

Region	1980	1990	1995	2000	2010	Annual Rate of Growth (%) 1980-1990	1990-1995	1995-2000	2000-2010
Baltimore	18,459	23,203	23,751	25,390	27,919	2.31	0.47	1.34	0.95
Lower Eastern Shore	13,172	18,154	18,623	20,137	22,661	3.26	0.51	1.58	1.19
Southern Maryland	15,032	20,407	20,603	22,630	26,144	3.10	0.19	1.89	1.45
Upper Eastern Shore	15,665	20,998	21,203	22,861	25,586	2.97	0.19	1.52	1.13
Washington	21,109	28,237	28,548	30,433	33,122	2.95	0.22	1.29	0.85
Western Maryland	14,333	16,793	17,052	18,074	19,720	1.60	0.31	1.17	0.88
State of Maryland	18,680	24,236	24,677	26,390	29,040	2.64	0.36	1.35	0.96

Employment Trends

The non-residential demand for electricity is largely driven by the level of output. The PPRP forecast studies, however, do not use output as an explanatory variable because output data at the county level are not available on a consistent basis. Because the electric sales forecasts rely on quarterly county-level data, a proxy for output must be used. Non-farm employment has typically been used for this purpose. It is a sound alternative and it is not subject to data consistency problems. Employment data by major employment sector are reported in Table A-3 and Table A-4.

Table A-3 Structure of Non-agricultural Employment in Maryland and the U.S., 1980 and 1995 (Percentages)

	Maryland		United States	
Sector	1980	1995	1980	1995
Mining	0.15	0.10	1.02	0.52
Construction	6.11	6.26	6.48	6.31
Manufacturing	11.88	6.72	22.87	16.87
Transportation and Public Utilities	4.73	4.54	6.80	7.17
Wholesale Trade	4.55	4.17	4.09	4.11
Retail Trade	17.53	17.63	16.96	17.36
Finance, Insurance, and Real Estate	7.33	8.29	6.25	6.57
Services	24.43	34.96	29.97	36.19
Government	23.30	18.34	5.57	4.90

Totals may not sum to 100 due to rounding.

Table A-3 reports sectoral shares for Maryland and the United States for 1980 and 1995. Sectoral distribution within Maryland has been subject to important changes over time. This is particularly so for the shares reported for government, services, and manufacturing. These changes are consistent with recent developments in both the local and the national economy. Government, for example, has become a less significant source of employment largely as a result of downsizing at the federal level. Services have become the largest source of employment as the local economy continues to move away from manufacturing and heavy industry. Manufacturing employment as a proportion of total employment declined in Maryland, mirroring the decline nationally, which reflects movement towards a service-based economy. The distribution of employment in the state continues to resemble that for the country as a whole.

Table A-4 Regional Non-agricultural Employment for Maryland and the U.S., 1980-2010 (thousands)

						Annual Rate of Growth (%)			
Region	1980	1990	1995	2000	2010	1980-1990	1990-1995	1995-2000	2000-2010
Baltimore	1,120.8	1,383.1	1,379.3	1,446.8	1,554.4	2.13	-0.06	0.96	0.72
Lower Eastern Shore	67.0	91.6	97.6	104.2	116.8	3.18	1.28	1.32	1.15
Southern Maryland	47.0	90.4	100.6	121.4	141.6	6.76	2.16	3.83	1.55
Upper Eastern Shore	53.3	75.7	78.8	86.5	96.6	3.57	0.81	1.88	1.11
Washington	648.9	954.2	970.3	1,066.9	1,234.5	3.93	0.34	1.92	1.47
Western Maryland	93.3	113.7	118.2	123.8	134.2	2.00	0.78	0.93	0.81
State of Maryland	2,029.9	2,708.1	2,741.5	2,949.6	3,278.1	2.92	0.25	1.47	1.06
United States	95,939.0	115,570.0	121,460.0	122,238.3	138,648.3	1.88	1.00	0.13	1.27

Sectoral changes are expected to continue as a result of not only a horizontal migration of workers across sectors, but also as a result of increases in the workforce. As shown in Table A-4, every region of the state is expected to experience employment growth. Growth is projected to be most rapid in the Southern Maryland region and slowest in Western Maryland and Baltimore. For the state as a whole, average annual growth in employment for the 1995 to 2000 period is expected to exceed the growth over the 1990 to 1995 period (1.47% per year compared to 0.25%). The projections for all of the regions in Maryland during the 1995 to 2000 period are projected to be below the rates of growth experienced between 1980 and 1990.

Population and Household Trends

Population is an important causal variable in the PPRP sales forecast models because population trends are used to project the number of residential customers. Two demographic concepts closely related to population are the number of households and average household size. These concepts can be important since the number of households affects the number of residential customers of an electric utility, and changes in average household size can affect usage per customer. Population growth and the rate of household formation are closely related, and both affect the residential use of electricity. Increases in population lead to increases in the number of households (and hence residential customers) although rates of change need not coincide due to changes in the size of households. Population and household data are reported in Table A-5 and Table A-6.

Table A-5 Regional Population for Maryland and the U.S., 1980-2010 (thousands)

						Annual Rate of Growth (%)			
Region	1980	1990	1995	2000	2010	1980-1990	1990-1995	1995-2000	2000-2010
Baltimore	2,174.0	2,348.2	2,433.3	2,485.6	2,618.1	0.77	0.71	0.43	0.52
Lower Eastern Shore	145.2	163.0	173.1	182.1	197.1	1.16	1.21	1.02	0.79
Southern Maryland	167.3	228.5	255.8	288.9	350.4	3.17	2.28	2.46	1.95
Upper Eastern Shore	151.4	180.7	195.5	208.8	229.3	1.78	1.59	1.33	0.94
Washington	1,358.9	1,635.8	1,746.5	1,839.9	2,035.0	1.87	1.32	1.05	1.01
Western Maryland	220.1	224.5	230.5	239.3	247.8	0.20	0.53	0.75	0.35
State of Maryland	4,216.9	4,780.8	5,038.6	5,244.5	5,677.6	1.26	1.04	0.82	0.80
United States	227,225	249,440	262,761	270,002	297,716	0.94	1.05	0.55	0.98

Table A-6 Historical and Projected Number of Households and Average Size of Households in Maryland by Region, 1980-2010

						Annual Rate of Growth (%)			
Region	1980	1990	1995	2000	2010	1980-1990	1990-1995	1995-2000	2000-2010
	Number of Households (thousands)								
Baltimore	757	868	918	955	1,042	1.38	1.13	0.79	0.88
Lower Eastern Shore	53	62	67	71	79	1.58	1.56	1.17	1.07
Southern Maryland	51	75	87	100	127	3.93	3.01	2.82	2.42
Upper Eastern Shore	53	67	73	80	90	2.37	1.73	1.85	1.18
Washington	469	593	639	685	776	2.37	1.51	1.40	1.26
Western Maryland	78	85	88	91	96	0.86	0.70	0.67	0.54
State of Maryland	1,461	1,750	1,872	1,982	2,210	1.82	1.36	1.15	1.09
	Average Household Size								
Baltimore	2.80	2.64	2.58	2.53	2.44	-0.59	-0.46	-0.39	-0.36
Lower Eastern Shore	2.69	2.50	2.45	2.42	2.34	-0.73	-0.40	-0.25	-0.34
Southern Maryland	3.24	2.97	2.90	2.84	2.71	-0.87	-0.48	-0.42	-0.47
Upper Eastern Shore	2.81	2.65	2.60	2.57	2.48	-0.58	-0.38	-0.23	-0.36
Washington	2.84	2.71	2.69	2.69	2.63	-0.47	-0.15	0.00	-0.23
Western Maryland	2.70	2.52	2.47	2.44	2.37	-0.69	-0.40	-0.24	-0.29
State of Maryland	2.82	2.67	2.63	2.59	2.52	-0.55	-0.30	-0.31	-0.27

Population data at regional, state, and national levels are reported in Table A-5. The table summarizes historical and projected data, as well as average rates of growth for the period 1980 through 2010. The rates of growth in population have been positive since 1980 for every region of Maryland. Between 1980 and 1995, population growth in Maryland has been about 1% per year on average. The growth in population for the state is projected to slow to approximately 0.9% between 1995 and 2000, and further slow to approximately 0.8% between 2000 and 2010. The pattern of slowing growth for the state as a whole also characterizes the expected pattern of growth in most of the six separate regions. Exceptions are Western Maryland and Southern Maryland. In Western Maryland, growth in population is expected to increase to an average annual rate of 0.75% between 1995 and 2000 before slowing to an average annual growth of 0.35% between 2000 and 2010. These growth rates compare to the 0.53% rate that the region experienced between 1990 and 1995. Similarly, the growth in population in Southern Maryland is expected to increase at an average annual rate of 2.46% between 1995 and 2000 compared to a rate of 2.28% between 1990 and 1995. Between 2000 and 2010, the average annual rate of growth in population is expected to decline to 1.95% in Southern Maryland. Together, Southern and Western Maryland represent approximately 10% of the population in the state. Consequently, the population growth rate trends for these two regions do not significantly affect the trend expected for the state as a whole.

Projected growth in the Baltimore region shows a different pattern of expected change. Between 1990 and 1995, population in the Baltimore region grew at an average annual rate of 0.71%; the growth rate is projected to decline to 0.43% per year between 1995 and 2000. Growth in Baltimore region population is expected to be 0.52% per year between 2000 and 2010, a slight increase from the 1995 to 2000 projection period.

As suggested by the discussion of population growth in Southern and Western Maryland and the Baltimore region, the rates of growth in population are uneven across the state. Historically, the largest growth rates are reported for Southern Maryland and the smallest rates for Western Maryland. In the 1980s, the population growth rate for Southern Maryland was approximately 4 times that of Western Maryland. Disparities such as this are expected to continue in the future.

Household data for the state and for regions within the state are shown in Table A-6. The table shows a summary of historical and projected data, as well as average rates of growth for the period 1980 through 2010. Average annual growth in the number of households was 1.82% during the 1980s, declined to 1.36% between 1990 and 1995, and is expected to further decline to approximately 1.1% through 2010. The pattern of slowing growth in the number of households for the state also characterizes the pattern of growth in each of the six regions of Maryland. As was the case for population, growth in the number of households is projected to be most rapid in Southern Maryland and least rapid in Western Maryland.

Since 1980, household size in each of the six Maryland regions has been declining, though the rate of decline is forecasted to moderate. For the state, the average household size of 2.82 people in 1980 declined to 2.63 in 1995, representing an average rate of decline of about 0.5% per year. The rate of decline is expected to be approximately 0.3% per year between 1995 and 2010. The largest declines in household size are projected for Southern Maryland and the smallest for the Washington area.

Summary

This appendix provides a review of the theoretical foundations used for modeling the demand for electricity econometrically in the PPRP forecast studies. In doing so, emphasis is placed on some of the key determinants of the demand for electric power. The determinants of demand are classified into residential and non-residential, as well as into economic and non-economic for purposes of exposition. Per capita income is an explanatory economic variable that influences the residential demand for electricity; population, the number of households, and average household size are non-economic explanatory variables affecting residential electricity consumption. This appendix also shows trends in employment, which affect the non-residential demand for electricity. Selected data on these determinants of demand are reported and trend analyses presented. The broad conclusion to emerge from these trends is that the demand for electricity should continue to grow in Maryland. Growth rates, however, should moderate from those in the past.

Appendix B
Internet Resources

PPRP's home page includes links to various Program publications and project descriptions. It can be found at ***http://www.dnr.state.md.us/bay/pprp.***

- PPRP Program Activities
- Featured Projects:
  - Biodiversity in Maryland
  - AERMOD Evaluation
  - The Deep Creek Project
- PPRP Updates:
  - Spring 1997
  - Winter 1998
  - Summer 1998
- Scientific Data
- Abstracts of Recent Reports
- Eastern Correctional Institute Chicken Litter Study
- Publications Available for Download

PPRP reports can also be obtained from the National Technical Information Service. Their internet website can be found at ***www.ntis.gov.***

Winding Ridge Demonstration Project

- *www.mde.state.md.us/wma/minebur/wrs.html*

Other websites that contain information on PPRP projects, or general power plant-related topics, are listed below.

Maryland Utilities

- Baltimore Gas & Electric Co.: *www.bge.com/*
- Delmarva Power & Light Co.: *www.delmarva.com/*
- Potomac Edison: *www.alleghenypower.com/*
- Potomac Electric Power Co.: *www.pepco.com/*
- The Easton Utilities Commission: *www.eastonutilities.com/*
- Choptank Electric Cooperative, Inc.: *www.choptankelectric.com/*
- Southern Maryland Electric Cooperative, Inc.: *www.smeco.com/*

Maryland State Agencies

- Department of the Environment: *www.mde.state.md.us/*
- Department of Agriculture: *www.mda.state.md.us/*
- Department of Natural Resources: *www.dnr.state.md.us/*
- Department of Business & Economic Development: *www.dbed.state.md.us/dbed/*

- Department of Housing & Community Development: *www.dhcd.state.md.us/*
- Department of Transportation: *www.inform.umd.edu/MDOT*
- Office of Planning: *www.op.state.md.us/*
- Public Service Commission: *www.psc.state.md.us/psc/*
- Energy Administration: *www.energy.state.md.us/*

U.S. Government Data

- Environmental Protection Agency: *www.epa.gov*
  - Environmental Protection Agency AIRS Database: *www.epa.gov/docs/airs/airs.html*
- National Oceanic and Atmospheric Administration Climate Monitoring and Diagnostics Laboratory: *www.cmdl.noaa.gov*
- Department of Energy: *www.doe.gov*
  - Energy Information Administration: *www.eia.doe.gov*
  - U.S. Dept. of Energy - Environmental Management: *www.em.doe.gov*
- Federal Energy Regulatory Commission: *www.ferc.fed.us*
- National Low-Level Waste Management Program: *www.inel.gov/national/national.html*
- U.S. Nuclear Regulatory Commission: *www.nrc.gov*

Other Sites

- PJM Interconnection: *www.pjm.com*
- Electric Power Research Institute: *www.epri.com*
- Edison Electric Institute: *www.eei.org*
- Environmental Resources Management: *www.erm.com*
- Versar, Inc.: *www.versar.com*