MARYLAND DEPARTMENT OF NATURAL RESOURCES

PPRP – CEIR – 17
DNR Publication No. 12-1222015-745

PPRP

Maryland Power Plants and the Environment

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

Summary Document

December 2014

MARYLAND POWER PLANT RESEARCH PROGRAM

Martin O'Malley, Governor
Anthony G. Brown, lt. Governor

"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."

Joseph P. Gill, *Secretary*
Maryland Department of Natural Resources

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Introduction

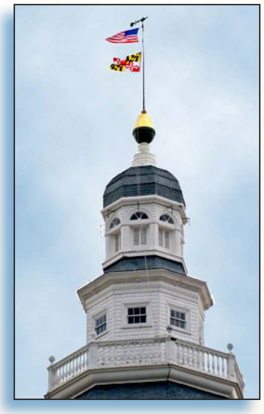
The Maryland Department of Natural Resources (DNR) Power Plant Research Program (PPRP) evaluates how the design, construction, and operation of power plants and transmission lines impact Maryland's environmental, socioeconomic, and cultural resources. PPRP's legislative mandate seeks to ensure that the citizens of Maryland can continue to enjoy reliable electricity supplies at a reasonable cost while minimizing impacts to Maryland's resources. The program plays a key role in the licensing process for power plants and transmission lines by coordinating the State agencies' review of new or modified facilities and developing recommendations for license conditions.

PPRP is directed by the Maryland Power Plant Research Act (§3-304 of the Natural Resources Article of the Annotated Code of Maryland) to prepare a biennial Cumulative Environmental Impact Report (CEIR). The intent of the CEIR is to assemble and summarize information regarding the impacts of electric power generation and transmission on Maryland's natural resources, cultural foundation, and economic situation.

This document serves as a summary of CEIR-17. The complete online report contains more detailed background on many topics and can be accessed from the PPRP website at pprp.info/ceir/17/HTML/Chapter1.html.

Key Technical Issues Addressed by PPRP 1971 - 2014

1971



Power Plant Siting Act was passed by the Maryland legislature in 1971 to address potential effects on the Chesapeake Bay from the Calvert Cliffs Nuclear Power Plant as well as several major proposed coal-fired power plants. PPRP was created to ensure a comprehensive, objective evaluation, based on sound science, to resolve environmental and economic issues associated with building power generating facilities.

1975

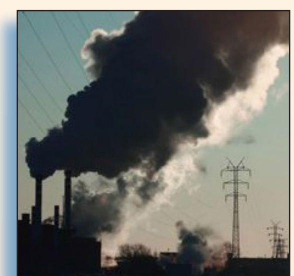
Aquatic impacts of power plants were identified due to entraining fish eggs, larvae, and/or prey organisms into their cooling systems, impinging adult and juvenile fish and crabs on intake screens, and discharging heat and chemicals into receiving waters. PPRP began testing intake designs that discourage fish congregation and determined in 1988 that impingement and entrainment could be reduced to acceptable levels, not adversely affecting aquatic biota in Maryland's surface water bodies. PPRP later evaluated methods such as barrier nets and wedge-wire screens that have become widely used for reducing impingement and entrainment levels at power plants.

1975

PPRP established the radioecology program and initiated radiological assessment of Calvert Cliffs Nuclear Power Plant. In the aftermath of the Three Mile Island accident in 1979, the U.S. Nuclear Regulatory Commission requested PPRP's assistance in evaluating impacts to human health and the environment from radioactivity released during the event and its cleanup. The ongoing monitoring program expanded to cover Peach Bottom Atomic Power Station in Pennsylvania, just upstream from Conowingo Dam on the Susquehanna River, in 1981. Over the past 40 years, the radioecology program has developed a valuable long-term database of radionuclide fate and transport throughout the Bay ecosystem.

1978

Clean Air Act Amendments of 1977 included provisions for the Prevention of Significant Deterioration (PSD) and non-attainment areas. PPRP recommended forming a policy board, establishing an offset bank exchange, and creating a multi-state planning council to share information and resolve disputes between states. On an ongoing basis, continuing with the Clean Air Act Amendments of 1990 and Maryland's Healthy Air Act of 2006, PPRP has analyzed compliance alternatives for the state's power plants and helped provide State agencies and lawmakers with technical background to support policy decisions.



1970s

1982

Coal-fired power plant operations create large quantities of solid combustion products, primarily fly ash, which need to be managed. While reuse is desired, some quantity of waste must be landfilled. PPRP conducted the first survey of CCB management methods across the state, a landmark first step in developing a thorough technical basis for evaluating, minimizing, and mitigating potential adverse impacts.

1984

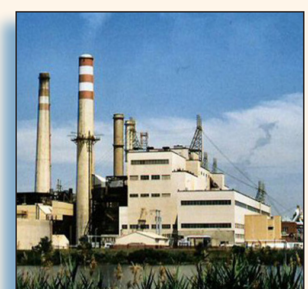
Sulfur and nitrogen emissions generated by power plants were identified as a large contributor to the formation of acid rain in the Northeast and Maryland. PPRP funded significant research to determine the extent of the problem and to identify remedial actions.

1985

Aquatic impacts such as denied access of anadromous fish to upstream spawning areas were observed at main stem Susquehanna hydroelectric dams. As the State lead, PPRP worked with Pennsylvania agencies, federal agencies, and private intervenors to address both fish passage and water quality in the federal relicensing of Conowingo and other dams on the Susquehanna. The first fish passage facility on the Susquehanna began operating in 1985. An additional stretch of more than 400 miles of the river is now open to migratory fish as a result of these settlement agreements reached with power companies seeking to renew their federal licenses.

1992

As an outcome of PPRP's evaluation of aquatic impacts from large- volume water withdrawals at all of Maryland's power plants, BGE and PEPCO were required to conduct additional studies on long-term impacts at the Calvert Cliffs, Chalk Point, Dickerson, and Wagner power plants. In addition, PEPCO established a fish hatchery operation on the Patuxent River estuary. From 1992 to 1997, the hatchery produced 3.5 million juvenile striped bass and 750,000 shad to mitigate losses caused by the power plant's intake of cooling water. PEPCO also provided the State with $100,000 per year for five years to fund environmental education and support projects to remove passage obstructions for anadromous fish.



1993

The effects of electromagnetic fields (EMFs) associated with generating, transmitting, distributing, and using electric power were evaluated and studies revealed conflicting results. PPRP reviewed all EMF studies and provided annual summary reports to the PSC on significant findings. Utilities constructing transmission lines have agreed to protocols for EMF measurements as well as utilization of conductor configurations resulting in the lowest EMF field strengths.

1980s and 1990s

1995

PPRP and MDE Bureau of Mines initiated an extensive program to address the problems of acid mine drainage as well as disposal of coal combustion by-products. The Winding Ridge project demonstrated the feasibility of using 100 percent waste products — fly ash plus by-product from sulfur dioxide removal —to seal an abandoned underground mine and minimize acidic discharges to surface water ecosystems.

1996

PPRP joined the Maryland Geological Survey and the U.S. Geological Survey in operating ground water monitoring programs to track water levels in affected aquifers over time, in response to increasing public awareness of ground water withdrawal by Maryland power plants from several coastal aquifers.

1997

As part of the CPCN licensing process, Panda Energy agreed to use treated effluent from the Mattawoman Wastewater Treatment Facility as a source of 1.5 million gallons per day of cooling water at its combined cycle plant in Brandywine. This approach, the first use of treated effluent for power plant cooling water in the state, conserves groundwater sources in Southern Maryland, and has helped generate operational data for other Maryland power plant proposals.

1999

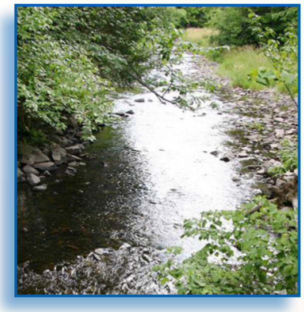
In response to water quality concerns in Maryland streams, apparently linked to agricultural runoff and the overuse of poultry litter as fertilizer, PPRP evaluated the suitability of using poultry litter as fuel. Three alternative technologies were identified that could accommodate the use of litter as a fuel: direct combustion, fluidized bed combustion, and gasification.

2000

The Maryland legislature introduced electricity competition. PPRP studied the potential environmental and economic impacts of restructuring and, over the next few years, observed that low utility rate freezes were limiting the development of a competitive retail market in Maryland.

1995-2000

2001

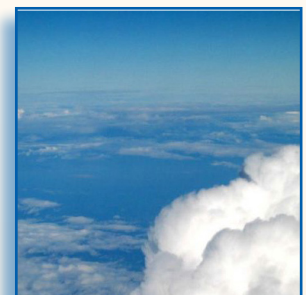


Through the CPCN licensing review process, Old Dominion Electric Cooperative agreed to support stream buffer restoration efforts, mitigating the effects of nitrogen deposition from the proposed Rock Springs power plant.

2003

Initial federal regulations came into force, under Section 316(b) of the Clean Water Act, intended to minimize aquatic impacts from large-volume surface water withdrawals at power plants. New requirements for power plant cooling water withdrawals were phased in over several years, and legal challenges have also affected the timing of implementation. PPRP followed these regulatory developments closely and evaluated how the new rules would impact Maryland power plants.

2006



Maryland passed the Healthy Air Act, a comprehensive regulatory program to reduce emissions and improve air quality in the state and the region. During 2006-07, PPRP completed expedited licensing reviews of substantial emission control projects at Maryland's coal-fired plants.

2008

Increasing concerns about the long-term reliability of the electricity supply in the state and surrounding region resulted in numerous proposals for transmission line projects. These included two major interstate transmission lines — PATH and MAPP — that would have traversed parts of Maryland, as well as many new or upgraded transmission lines located within the state. PPRP was actively involved in evaluating potential environmental and socioeconomic impacts of these proposed linear facilities. While the PATH and MAPP interstate projects were later canceled due to changing economic conditions (and a slowdown in electricity demand growth), significant evaluations were conducted regarding the potential undersea cable crossing of the Chesapeake Bay and other project elements.

2009

Maryland's Public Service Commission granted a CPCN to UniStar for the construction of Calvert Cliffs Unit 3, a 1600 MW nuclear power plant proposed for the existing Calvert Cliffs site. PPRP coordinated the State's review of all relevant environmental and socioeconomic issues associated with the Calvert Cliffs expansion, and assisted the U.S. Nuclear Regulatory Commission (NRC) in its evaluation as well. The proposed expansion did not ultimately receive NRC approval. Over the past four decades, PPRP has carried out several important technical projects related to Calvert Cliffs, including review of the NRC operating license renewal for existing Units 1 and 2; assessment of risks posed to Calvert Cliffs by expanded operations at the nearby Cove Point LNG terminal; and participation in license renewal evaluation for the existing on-site storage facility for spent nuclear fuel.

2000s

2010

Maryland's first wind turbines came online - the Criterion and Roth Rock projects, both located along the western Maryland ridgeline known as Backbone Mountain. PPRP took an active role in reviewing plans for both these facilities, especially the potential for adverse impacts to bird and bat populations in the vicinity of these two sites.

2010

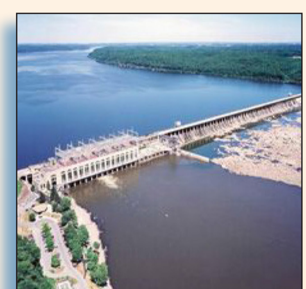
Governor Martin O'Malley directed PPRP to prepare a comprehensive report evaluating approaches to meet Maryland's long-term electricity needs. PPRP conducted a thorough assessment under an array of alternative future economic, legislative, and market conditions, considering such variables as natural gas prices and climate change impacts (among many others). A final report was submitted to the Governor and the PSC in December 2011; PPRP also updated the base case assumptions in 2013 to reflect evolving economic conditions.

2011

PPRP coordinated the State's review of Maryland Solar's proposed 20 MW project in Hagerstown. The PSC granted a CPCN for this project, the first utility-scale solar electrical generating facility in the state. The project is located on approximately 250 acres of State-owned land at the Maryland Correctional Institution. Maryland's aggressive goal of supplying 2 percent of the state's electricity from solar resources by 2022 has spurred increased activity. As of January 2015, there is more than 65 MW of utility-scale solar generating capacity in operation, with an additional 70 MW currently proposed within Maryland.

2012

Exelon filed its application to renew its federal license for Conowingo Hydroelectric facility operations on the Susquehanna River. PPRP is participating in the scoping of necessary studies and analysis of the findings, as well as providing technical support regarding fish passage and downstream flows. These efforts build upon the long-term collaborative work PPRP has done to support enhanced fish passage at Conowingo and other Susquehanna hydroelectric facilities (see timeline entry for 1985). The current license renewal evaluation is also addressing new impact issues, most notably the buildup of sediment behind the Conowingo Dam and the implications for natural resources and dam operations.



2010 and Beyond

2013

Maryland PSC received new or modified applications for five proposed gas-fired power plants, reflecting the predominant shift across the power industry toward natural gas as a primary fuel for generation. Dominion also applied for PSC approval to construct 130 MW of generating capacity as part of its plans to begin exporting LNG from its Cove Point terminal. PPRP utilized its technical expertise and coordinated effectively with other State agencies to provide thorough and rigorous technical review of all these applications.

2013

Source: National Renewable Energy Laboratory. Artist: Josh Bauer

With the passage of the Maryland Offshore Wind Energy Act by the General Assembly, the State took a major step toward harnessing ocean winds as a renewable energy resource. The law's implementation has led to the leasing of an offshore wind area in federal waters off the coast of Maryland with the federal Bureau of Energy Management serving as lead permitting agency. State agencies have been undertaking geotechnical, environmental, archaeological, and socioeconomic assessments of the site and associated onshore infrastructure needs. PPRP is providing assistance in natural resource impact assessment.

2014

Southern Maryland Electric Cooperative (SMECO) completed the Southern Maryland Reliability Project, a 30-mile, 230 kV transmission system upgrade. One of the most significant components of the project was the crossing under the Patuxent River — 4,800 feet of horizontal directional drill installation under the river from the Naval Recreation Center in Calvert County to Town Creek in St. Mary's County. To ensure protection of the river's resources, PPRP, in coordination with other State agencies, utilized its technical expertise to review all aspects of the drilling project.

2014

Final federal 316(b) rules came into effect for aquatic resource protection – addressing technical issues that PPRP has been working on since 1975. These new requirements for power plant cooling water withdrawals were issued after several years of legal challenges. PPRP participated in these regulatory developments and is working with MDE and Maryland power plants to implement the new regulations.

2014

The U.S. EPA released new regulations addressing the management of coal combustion by-products (CCBs). The rule establishes minimum federal requirements for both existing and new CCB landfills and surface impoundments, including expansions of any existing unit. PPRP and MDE are examining the new rules, which take effect in early 2015, to determine whether they will impact the landfilling and beneficial use of CCBs in Maryland.

2010 and Beyond

See Chapter 2 of CEIR-17

Power Generation, Transmission, and Use

In Maryland, electrical power is provided to its residents through a variety of fossil fuel sources, which account for the largest portion of the state's generating capacity, in addition to nuclear and renewable sources such as solar photovoltaics, wind turbines, and biomass. Currently in Maryland, 44 power plants with generation capacities greater than 2 megawatts (MW) are interconnected to the regional transmission grid. For more information on electricity in Maryland and full content of the Electricity in Maryland Fact Book for 2014, go to http://pprp.info/factbook/factbook.htm.

Electricity Demand

Maryland end-use customers consumed about 62 million MWh of electricity during 2012. Between 1997 and 2012, the annual average growth rate in electricity consumption in Maryland was lower than in the U.S. as a whole—0.76 percent in Maryland versus 1.32 percent in the U.S. A key factor for this growth is Maryland's population growth, which slowed significantly between 2001 and 2007 but accelerated between 2007 and 2012. Despite the varying growth rates, per capita income and employment has grown more rapidly than the national average over the last 16 years. In general, as more people live and work in Maryland, and as incomes grow, they collectively use more electricity.

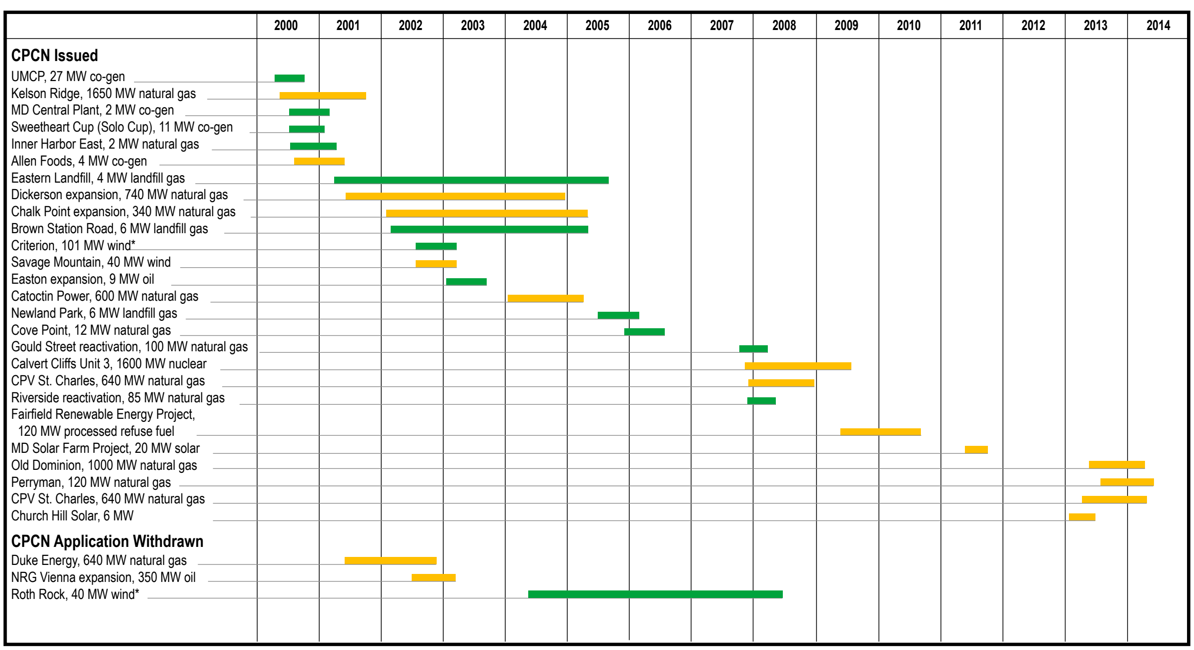
The economic recession that began in 2008 resulted in a downward trend on electricity consumption in Maryland. While Maryland was not as seriously affected by the recession as many other states, Maryland was not immune to the higher unemployment levels and lower levels of economic activity. Electricity sales in 2009 were about 1 percent below 2008 levels, largely explained by the recession-induced declines in economic activity. As the economy began to recover in 2010, electricity consumption also increased in Maryland by 4.4 percent compared to 2009. However, since 2010, electricity consumption has been falling again largely due to the impact of the EmPOWER Maryland legislation. This law targets a 15 percent reduction in per capita electricity consumption by 2015 from 2007 levels. (For more information about EmPOWER Maryland, refer to Section 5.1.2. Electricity consumption data can be found in Section 2.5.)

Power Plant Licensing Activity

The Maryland Public Service Commission (PSC) has received 28 CPCN applications for new generation since 2000, representing several thousand megawatts (MW) of potential generating capacity at existing facilities and at greenfield sites (see Figure 1).

While the majority of these proposed plants did obtain a CPCN, only 11 are now in operation, with the remainder being delayed or abandoned because of various financial or commercial reasons, compounded by the reduction in electricity demand resulting from the economic recession and regional energy efficiency initiatives. Several projects, however, are still considered viable. For example, in 2007 the Kelson Ridge site was purchased by CPV Maryland with plans to develop the site as a new generation facility. The project, a 640 MW natural gas fired facility, received a CPCN in October 2008. An amended and modified CPCN and construction deadline extension was approved in October 2012, including the use of newer, more efficient natural gas turbines; associated slight changes to stack and cooling tower parameters; and an increased nameplate capacity of the proposed CPV St. Charles facility to 725 MW. In September 2009, in Case No. 9214, the PSC opened an investigation into whether it should exercise its authority to order electric distribution companies to enter into long-term contracts to support new generation or to construct, acquire, or lease, and operate, new electric generating facilities in Maryland. In December 2011, the PSC ordered Baltimore Gas and Electric Company, Potomac Electric Power Company, and Delmarva Power & Light Company to issue a PSC-approved RFP for generation capacity resources under long-term contract. CPV Maryland submitted a bid proposal for 661 MW of such capacity (later increased to 725 MW), and the PSC ordered the distribution companies, in April 2012, to enter into a contract with CPV Maryland to enable the construction of the CPV

Figure 1 CPCN Requests



Bar length indicates the duration of the CPCN process from the time the application was filed to the time it was withdrawn or a PSC order was filed. Bar coloring indicates whether the project is now in operation:

= Project is operational

= Project is not operational

* Project was subsequently reconfigured, granted a CPCN exemption, and is now operational. See Section 2.1.5 for more information.

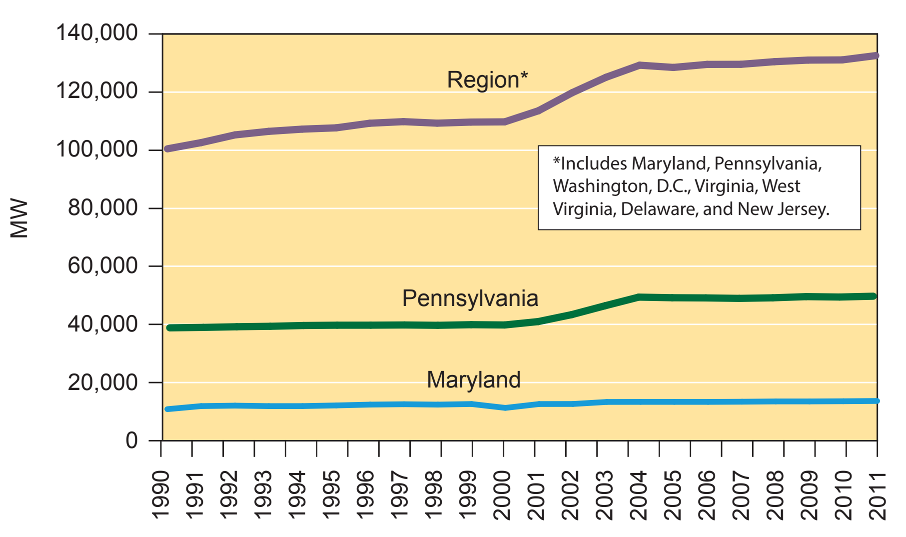
Chart does not reflect CPCN cases ongoing at time of publication: Keys Energy Center, Mattawoman Energy Center, OneEnergy Cambridge Solar, Rockfish Solar.

St. Charles plant with an in-service date of June 1, 2015. Financing and construction of the plant were delayed due to various legal battles, but developers eventually closed on a financing deal in August 2014, and construction finally began in December 2014. CPV estimates that the plant will come online sometime between June 2016 and June 2017.

The process by which new power plants are proposed and developed in Maryland has changed as a result of the move to retail competition and electric utility restructuring. Maryland's regulated utilities are no longer responsible for building new generation. Resource planning resides with the competitive electricity market, driven by economics and price signals. High prices that result from tight supply markets are expected to attract investors, developers, and demand response providers; low prices that result from over-supplied markets are projected to discourage new generation development and demand response providers. However, substantial and sustained price differentials are required to elicit such market behaviors. The up-and-down movement of wholesale prices in PJM has resulted in a "boom-bust" cycle in the development of new generating plants in PJM. This trend produces a situation where many power plants are proposed and built in a short time frame followed by a period where few plants are built. Figure 1 demonstrates the recent increase in the number of CPCN requests in Maryland after a multi-year period with relatively few open applications. The PJM region experienced a boom in power plant development between 1999 and 2003. Figure 2 shows the amount of capacity on-line for Maryland, Pennsylvania, and the region.

New generation projects seeking to connect to the PJM grid must submit a generator interconnection request. PJM performs the requisite studies for generator interconnection in clusters grouped together based on a six-month queue cycle. The aggregate list of dated interconnection requests is referred to as the generation interconnection queue. As of the end of 2012, the PJM interconnection queue consisted of projects totaling 58.5 GW of capacity (stated as winter net capacity). Natural gas is the dominant resource, followed by wind. Renewable energy projects accounted for around 30 percent of the total capacity in the PJM interconnection queue. Although the majority of generation projects in the interconnection queue are not developed, the interconnection queue provides an initial estimate of the potential new generation capacity in PJM.

Figure 2 Maryland and Regional Capacity



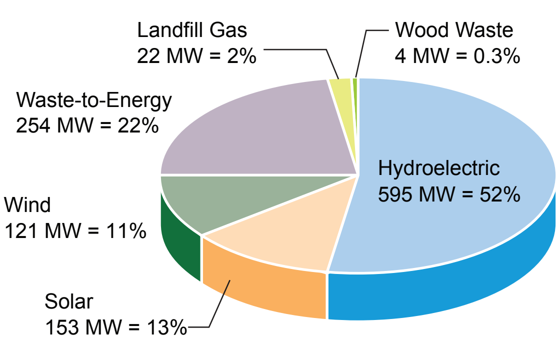
Renewable Energy

Presently, there are four main types of renewable energy resources in use in Maryland: wind, biomass, solar, and hydropower. Approximately 1,150 MW of generation capacity in Maryland comes from these resources, with hydroelectric accounting for the largest share (see Figure 3).

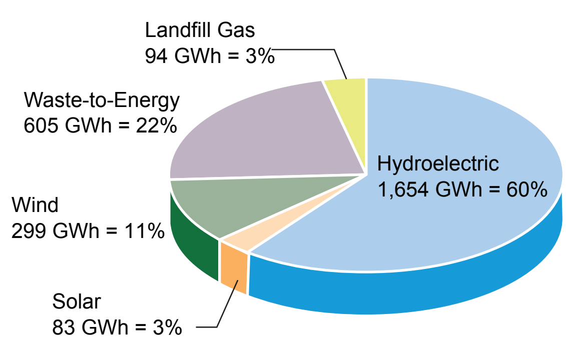
The Maryland Renewable Energy Portfolio Standard (RPS) became law in May 2004. The RPS requires an electrical supplier to provide a certain percentage of its electricity resources from Maryland-certified Tier 1 and Tier 2 renewable resources. The PSC determines the list of certified renewable resources, and these are not limited to renewable energy facilities physically located within Maryland. Every MWh generated by qualified renewable resources is equivalent to one Renewable Energy Credit (REC). The 2004 RPS law was modified by legislation enacted in 2007, 2008, 2010, 2011, 2012 and 2013. The current RPS law contains these provisions:

- *Tier 1 renewable resources include fuel cells that produce electricity from other Tier 1 renewable fuel resources, geothermal, hydroelectric facilities under 30 MW, methane, ocean, poultry litter-to-energy, qualifying biomass, solar, wind, waste-to-energy, and refuse-derived fuel. The Tier 1 requirement began at 2 percent and increases annually; in 2013 it was 7.95 percent, and will reach its 18 percent maximum in 2022.*
- *The solar energy set-aside requires that a certain percentage of energy supply must come from in-state solar facilities. This requirement increases annually to reach 2 percent in 2020.*
- *Existing hydroelectric facilities over 30 MW qualify to meet the Tier 2 standard. Tier 1 resources may also be used to meet the 2.5 percent Tier 2 standard. Tier 2 will sunset in 2018.*
- *The Maryland Offshore Wind Energy Act, which was passed in 2013, created a new set-aside for offshore wind facilities. Each year, the PSC will set the percentage of offshore energy to be mandated in the RPS based on the projected annual output from qualified offshore wind projects. This percentage may not exceed 2.5 percent of total retail sales.*

Figure 3 Renewable Energy in Maryland



Installed Renewable Energy Capacity (MW) in 2013



Renewable Energy Generation (GWh) in 2012

Figure 4 illustrates the renewable sources that are required under the RPS law, shown as a percentage of total energy sales over time.

If a supplier does not provide the required amount of renewable electricity to its customers, it must pay a non-compliance penalty, referred to as an alternative compliance payment (ACP). These payments amount to $0.04 for each kilowatt-hour (kWh) short of the Tier 1 resource requirement and $0.015 for every kWh short of the Tier 2 requirement. The penalties for the solar energy set-aside started at $0.45/kWh in 2008, decrease to $0.40/kWh for 2009 through 2014, to $0.35/kWh in 2015 and 2016, to $0.20/kWh in 2017, and then by $0.05/kWh every other year to $0.05/kWh in 2023.

Table 1 shows the aggregate supplier obligation, the RECs retired, and the ACPs submitted from 2006 to 2011. The total cost of compliance with the 2011 RPS requirements was $14.6 million, with ACPs accounting for only $98,520 (0.6% of the total).

Figure 4 Maryland RPS Summary

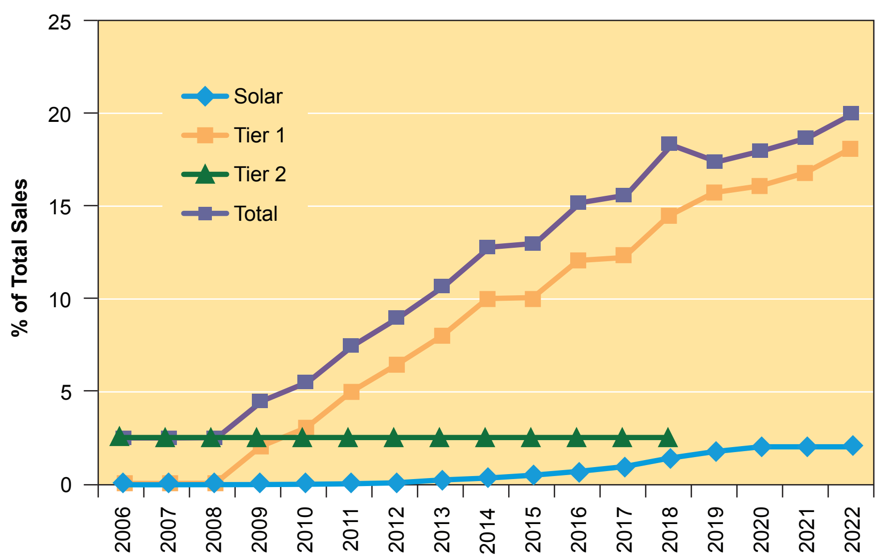


Table 1 Maryland RPS Compliance

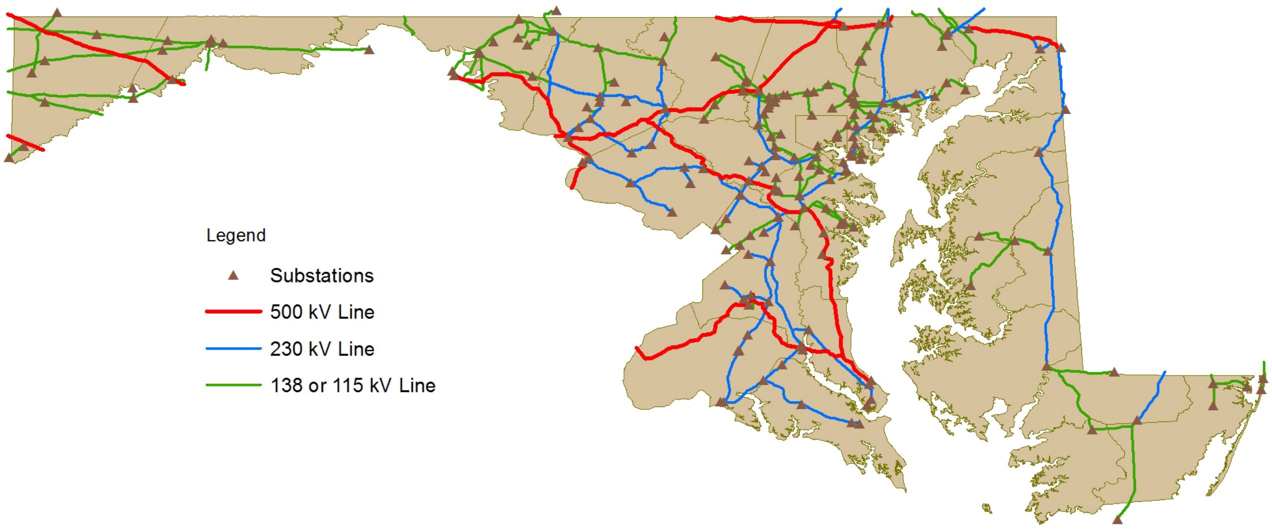
RPS Compliance Year		Tier 1 Solar	Tier 1 (non-solar)	Tier 2	Total
2006	RPS Obligation (MWh)	---	520,073	1,300,201	1,820,274
	Retired RECs (MWh)	---	552,874	1,322,069	1,874,943
	ACP Required	---	$13,293	$24,917	$38,209
2007	RPS Obligation (MWh)	---	553,612	1,384,029	1,937,641
	Retired RECs (MWh)	---	553,374	1,382,874	1,936,248
	ACP Required	---	$12,623	$23,751	$36,374
2008	RPS Obligation (MWh)	2,934	1,183,439	1,479,305	2,665,678
	Retired RECs (MWh)	227	1,184,174	1,500,414	2,684,815
	ACP Required	$1,218,739	$9,020	$8,175	$1,235,934
2009	RPS Obligation (MWh)	6,125	1,228,521	1,535,655	2,770,301
	Retired RECs (MWh)	3,260	1,280,946	1,509,270	2,793,475
	ACP Required	$1,147,600	$395	$270	$1,148,265
2010	RPS Obligation (MWh)	15,985	1,920,070	1,601,723	3,539,778
	Retired RECs (MWh)	15,451	1,931,367	1,622,751	3,569,569
	ACP Required	$217,600	$20	$0	$217,620
2011	RPS Obligation (MWh)	28,037	3,079,851	1,553,942	4,661,830
	Retired RECs (MWh)	27,972	3,083,141	1,565,945	4,677,058
	ACP Required	$41,200	$48,200	$9,120	$98,520

Electricity Transmission

The network of high-voltage lines, transformers, and other equipment that connect power generating facilities to distribution systems are part of an expansive electric transmission system. In Maryland, there are more than 2,000 miles of transmission lines operating at voltages between 115-kV and 500-kV. Figure 5 shows a map of this high-voltage transmission grid in Maryland.

While the economic and environmental effects of generation are substantial, transmission also has major environmental and socioeconomic implications in Maryland, particularly since Maryland is a net importer of electricity. Building new transmission facilities is costly with significant environmental impacts and ratepayer costs. Upgrading existing heavily used facilities must be done quickly, often in short windows of time, while minimizing environmental impacts. Shortages of transmission capacity or congestion can lead to higher priced out-of-merit generation dispatch and extremely high energy and capacity prices over peak time periods.

Figure 5 Transmission Lines in Maryland (>115 kV)



The transmission of electricity in Maryland is almost completely dependent on the PJM planning process. As a principal responsibility, PJM must ensure that there is sufficient transmission system capacity to meet all North American Electric Reliability Corporation (NERC) standards. In addition, PJM routinely examines many other proposed transmission projects to determine if they are economically justified and would produce an overall system benefit. To the extent PJM determines a need for a transmission project and includes it in the Regional Transmission Expansion Plan (RTEP), there is an expectation that the transmission owner will file for a CPCN and build the transmission requirement.

Most recently, PJM participated in the DOE-funded interconnection-wide plans as part of the 2009 economic stimulus effort. Planners selected three scenarios and analyzed the transmission systems of each in the year 2030. The Eastern Interconnection Planning Collaborative submitted its plan to the U. S. Department of Energy in late April 2013 that included estimates of transmission operations and maintenance in 2030, along with the cost to build new facilities that may be required to meet the multi-policy future. (This plan is detailed in Section 3.3.)

The PSC has received 9 CPCN applications for new and modified transmission line projects since early 2012, representing over 70 miles of new, expanded, or rebuilt transmission lines in Maryland. Additionally, two projects previously filed with the PSC were withdrawn and reissued as a new combined project. Table 2 presents a summary description of all these recent transmission cases. Transmission planning and regulatory drivers, as well as oversight, are described in Section 3.3.

Table 2 In-State Transmission Line Projects 2012 – 2014

Line	Owner	Size (kV)	Approx. Length in MD (miles)	Affected MD Counties	Status
PSC Case Number 9239: Monocacy-Ringgold-Carroll (MRC) – Modification (Rebuild)	Potomac Edison	230	12.7	Washington, Frederick, Carroll	CPCN issued April 2011; modified in 2012 to include only the Catoctin to Carroll segment. New CPCN issued July 2012.
PSC Case Number 9246: Conastone-Graceton (Upgraded single to double circuit)	BGE	230	1.5	Harford	Project withdrawn by BGE on 5 April 2013, became a part of Case No. 9323
PSC Case Number 9251: Bagley-Graceton (Rebuild to double circuit)	BGE	230	14	Harford	Project withdrawn by BGE on 5 April 2013, became of part of Case No. 9323
PSC Case Number 9282: Northwest-Deer Park (Construction of single circuit)	BGE	115	3.1	Baltimore, Carroll	CPCN issued April 2012
PSC Case Number 9290: Church-DE/MD State Line (Rebuild)	DPL	138	10.86	Queen Anne's	CPCN issued January 2013, construction began February 2014
Case Number 9309: Mt. Storm to Doubs (Rebuild)	Potomac Edison	500	2.8	Frederick	CPCN issued June 2013
PSC Case Number: 9312: Church-Wye Mill (Construction of new single and double circuit)	DPL	138	25.9	Queen Anne's	CPCN issued October 2013
PSC Case Number 9321: Cecil to MD/DE State Line (Rebuild)	DPL	138	2.05	Cecil	CPCN issued April 2014
PSC Case Number 9323: Northeast Transmission System – replace Case #s 9246 and 9251 (Upgrade of single to double circuit)	BGE	230	21.25	Harford, Baltimore	CPCN issued November 2013
PSC Case Number: 9329: Burtonsville to Takoma (Rebuild)	Pepco	230	9.5	Montgomery	CPCN issued April 2014

Reliability

Historically, transmission infrastructure enabled utilities to locate power plants near inexpensive sources of fuel, and transmit electricity over long distances to consumers. By interconnecting different utilities' transmission systems, utilities were able to access additional sources of generation and back up each other's generating capacity, thus improving reliability. Ultimately, the power grid grew into an interstate system subject to both federal and state regulation. Under the federal Energy Policy Act of 1992 and Order 888 issued by the Federal Energy Regulatory Commission (FERC) in 1996, any generator, independent or utility-owned, may request access to the transmission grid at rates and terms comparable to those that the owner-utility would charge itself. This access to the transmission grid led to the growth of wholesale power markets. Power generators were able to use the transmission system to send power to one another as needed to serve the loads of their customers, creating larger, more regional transmission networks. With the creation of regional transmission systems and competitive wholesale markets, utilities in many areas transferred the functional control of their transmission lines to independent system operators (ISOs) or regional transmission organizations (RTOs), such as PJM, while maintaining ownership and maintenance responsibilities over their lines. Utilities retain sole control over their distribution systems.

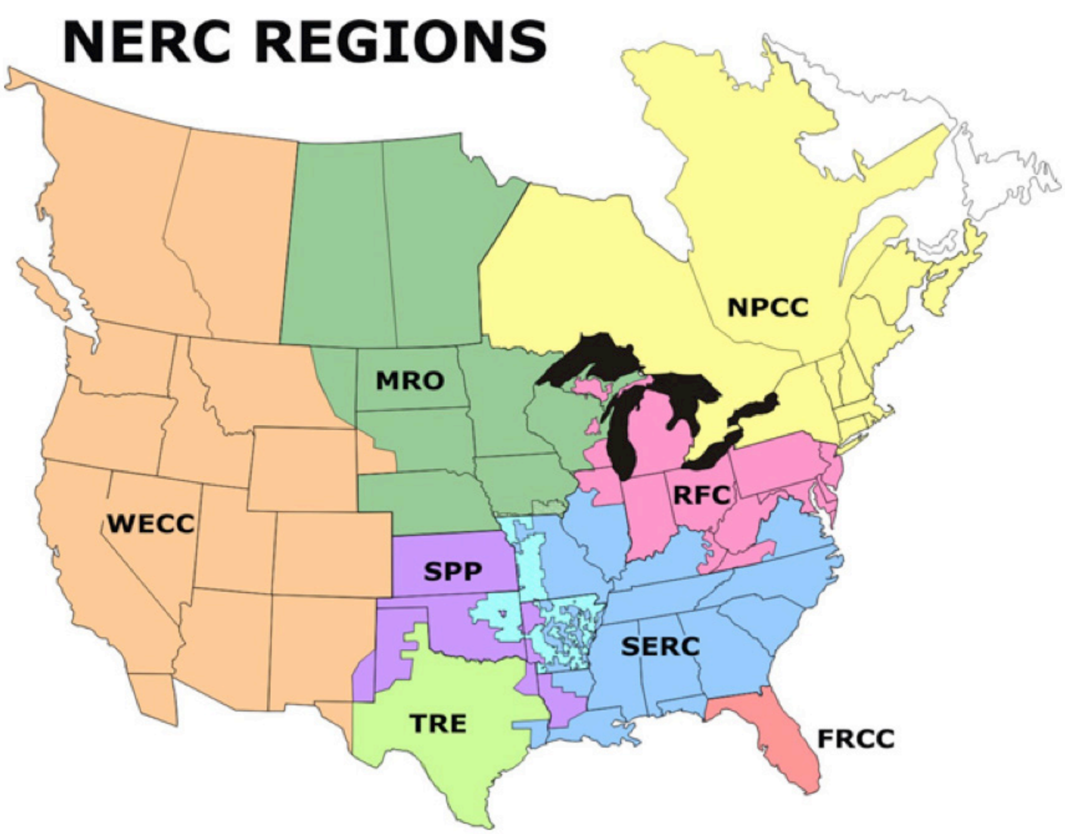
The North American Electric Reliability Corporation (NERC) is charged with developing and implementing reliability standards and periodically assessing the reliability of the bulk power system. NERC, which is governed by a 12-member independent board of trustees, develops mandatory reliability standards that are reviewed and ultimately approved by FERC. The Energy Policy Act of 2005 requires electricity market participants to comply with NERC reliability standards, or be subject to fines of up to $1 million per day per violation. NERC delegates enforcement authority to eight regional reliability councils, including the Reliability*First* Corporation that serves the PJM RTO (see Figure 6).

One of the NERC reliability standards applicable to PJM is the Resource Planning Reserve Requirement. The standard requires that each load-serving entity (LSE) participating in PJM have sufficient resources such that there is no loss of load more than one day in ten years. In order to maintain compliance under this reliability standard, PJM conducts annual resource planning exercises to ensure all LSEs have sufficient generation resources to supply their peak electricity load, plus a specified annual reserve margin of approximately 15 percent.

Following several incidents of storms and outages in Maryland during 2010 and 2011, the PSC initiated Rulemaking 43 (RM43) to consider revisions to State regulations in regard to electric company reliability and service quality standards, “including, but not limited to: service interruption, downed wire repair and service quality standards; vegetation management standards; annual reliability reporting; and the availability of penalties for failure to meet the standards.” In April 2012, the new regulations were adopted including the following:

- *A requirement that utilities submit a Major Outage Event Report within 3 weeks following the end of the event. A “major outage” is defined as affecting more than 10 percent of a utilities customers or 100,000 customers total, whichever is less.*
- *A set of reliability standards and a requirement to collect data.*
- *Service interruption standards that require utilities to restore service within a defined amount of time.*
- *Downed wire standards that require utilities to respond within 4 hours of notification by a fire department, police department, or 911 emergency dispatcher at least 90 percent of the time.*

Figure 6 NERC Reliability Councils



Legend

FRCC - Florida Reliability Coordinating Council
MRO - Midwest Reliability Organization
NPCC - Northeast Power Coordinating Council
RFC - Reliability*First* Corporation
SERC - SERC Reliability Corporation
SPP - Southwest Power Pool
TRE - Texas Reliability Entity
WECC - Western Electricity Coordinating Council

Source: NERC, 2006 Long-Term Reliability Assessment, October 2006.

- *A communications standard that requires utilities to answer calls within a certain amount of time.*
- *Vegetation management standards that aim to keep power lines clear of potential falling hazards.*
- *A requirement for periodic equipment inspections.*

Utilities must submit an annual report outlining their performance with respect to these regulations. In addition, the utilities are required to have a Major Outage Event Plan on file with the PSC providing a description of and procedures for its response to major events, and performance measures associated with the assessment of the implementation of the Major Outage Event Plan.

Being able to detect outages during storms or during normal operations has been a challenge for utilities. Historically, utilities have relied on customers to report local outages. With the advent of new technologies, being able to "see" conditions on the distribution grid in real-time is becoming a reality. Maryland utilities are installing advanced metering infrastructure (AMI) in their service territories. While AMI allows for electronic reading of customer meter information, the communication network created by the advanced meters also serves to provide much needed information on the current status of the distribution grid. (For more information on AMI and smart grid capability see Section 5.5.3).

See Chapter 3 and Appendix B of CEIR-17

Markets and Pricing

PJM uses a uniform price auction based upon locational marginal prices (LMPs), which vary across PJM zones and time of day, to establish energy prices. Electricity generators bid in the amount of energy they would like to sell at a particular time and price.

Energy prices in PJM are based upon the bids designating a price and quantity at which a generator is willing to sell electricity. PJM stacks these bids from lowest price to highest price until it is able to satisfy the quantity required to meet energy requirements in the zone. It is the price of the last resource—the marginal price—that becomes the zone-wide energy component of the hourly LMP for the next operating day.

PJM must also account for congestion costs. Congestion occurs between two delivery points on the transmission system when the transmission grid cannot accommodate the power flows between these specific locations. When congestion occurs, higher priced local resources are used instead of lower cost electricity that would otherwise be used to meet load by being transported into the area via transmission lines. During periods of congestion, PJM must dispatch generation resources that are located at or near the load zone even if those resources are not the most economic resources available to meet load. The cost of congestion refers to the incremental cost of dispatching these more expensive location-specific resources.

Traditionally, coal plants were the least-cost generators due to the long-term availability of low-cost coal as a fuel and the economies of scale arising from the construction of large coal plants. As natural gas supplies have become more abundant due to shale gas discoveries, leading to sharp decreases in wholesale natural gas prices, natural gas has increasingly been used in place of coal for baseload generation. This has led to reductions in wholesale electricity prices and, therefore, in the resulting retail electricity prices. As a result of lower wholesale electricity prices coupled with other factors, such as stricter environmental regulations for fossil-fuel plants and the aging of the coal fleet, some companies have opted to either retire older, less efficient coal plants or convert them to natural gas firing. PJM expects that 14,000 MW of coal, oil, and older natural gas plants will retire within its territory by 2016.

However, PJM does not expect this to result in reliability issues as there is currently excess capacity in PJM.

The distribution of electricity continues to be a regulated monopoly function of the local utility, and hence continues to be subject to price regulation by the Maryland PSC at the retail level. The fundamental objective of the 1999 Maryland Electric Customer Choice and Competition Act was to foster retail electric competition as a means of achieving favorable retail electricity prices for customers, stimulating an array of alternative supply products (for example, supply of green power), and giving customers a choice in their electric power supplier. By mid-2013, 26.1 percent of residential customers had signed with competitive suppliers. The majority of medium to large commercial and industrial customers are currently purchasing electricity from competitive suppliers (see Table 3).

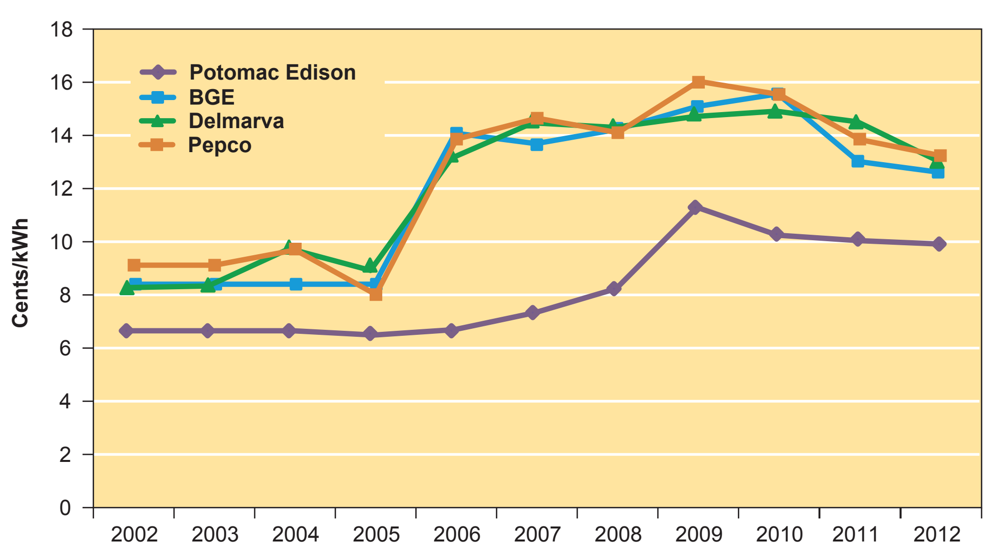
Table 3 Percentage of Customers Served by Competitive Suppliers

Residential	Small Commercial & Industrial	Mid-size Commercial & Industrial	Large Commercial & Industrial
26.1%	36.3%	59.0%	89.8%

Source: Maryland PSC, Electric Choice Enrollment – July 2013.

Wholesale market prices rose significantly between 2005 and 2009, and residential customers saw substantial increases in their electric bills. However, retail prices declined from 2009 to 2012 as wholesale energy prices have decreased. Figure 7 shows the average residential rates in effect in summer of 2002 and for each subsequent year.

Figure 7 Average Summer Retail Electricity Rates for Residential Customers, 2002-2012 (cents/kWh)



See Section 4.1 of CEIR-17

Air Quality

Emissions

Power plants in the U.S. are a major source of air emissions. According to the report *Benchmarking Air Emissions of the 100 Largest Electric Power Producers in the United States*, power plants in the U.S. contribute about 16 percent of all NO_x, 64 percent of SO_2, 68 percent of mercury, and about 40 percent of CO_2 emissions emitted by the industrial sector, including transportation. Emissions generated by the industrial sector are often discussed in terms of three classes of pollutants: criteria pollutants, hazardous air pollutants (HAPs), and greenhouse gases (GHGs).

The Clean Air Act authorized EPA to develop ambient air quality standards for six common air pollutants, or criteria pollutants: nitrogen dioxide (NO_2), sulfur dioxide (SO_2), particulate matter (PM), carbon monoxide (CO), lead, and ozone (O_3). Of the criteria pollutants, SO_2 and NO_x are among the most stringently regulated by EPA because they are the principal pollutants that react with water vapor and other chemicals in the atmosphere to create ozone smog, cause acid precipitation, and impair visibility. Recently, there has also been an increased focus on PM (both PM10 and PM2.5) emissions, as EPA has recognized that particulates are associated with adverse health effects, including premature mortality, cardiovascular illness, and respiratory illness. EPA continually attempts to better understand which attributes of particles may cause these health effects, who may be most susceptible to their effects, how people are exposed to PM air pollution, how particles form in the atmosphere, and what the contributions are from various sources in different regions of the country. This research has allowed EPA to hone its focus over time from regulating emissions of total suspended particulates to PM10, and most recently to PM2.5 (fine particulates, diameter less than 2.5 microns).

Power plants, specifically coal-fired units, are significant contributors of SO_2, NO_x, PM10, and PM2.5 emissions nationwide and in Maryland. Figures 8 through 11 show trends in emissions from power plants with coal-fired units in Maryland during the years 2008 to 2012.

Reducing Emissions from Coal-Fired Generation

Most coal-fired power plants in Maryland have installed state-of-the-art pollution control systems to meet requirements of the Maryland Healthy Air Act (HAA). Use of add-on control technologies, with efficient combustion and limits on sulfur content of fuels, have contributed to a decline in SO_2 and PM emissions since 2009.

Annual emissions of NO_x also depend on the types and amounts of coal burned and pollution control systems in place. However, unlike SO_2 and PM emissions, NO_x emissions have been regulated more stringently and for a longer period of time. NO_x emissions from power plants have been declining in recent years, in part, due to installation of control equipment and process changes.

Output from coal-fired plants in Maryland and throughout the region is declining, and this has contributed significantly to the observed decrease in emissions.

Figure 8 Annual SO_2 Emissions from Coal-fired Power Plants in Maryland

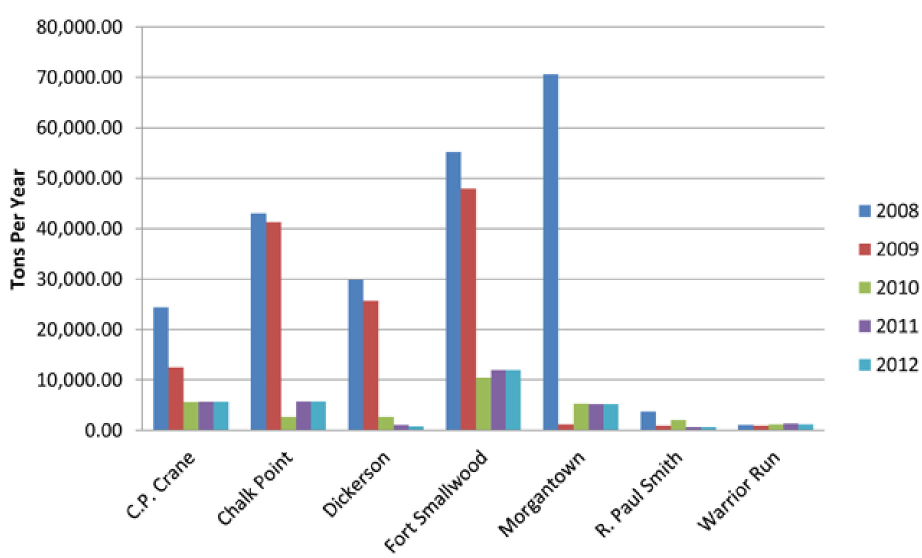
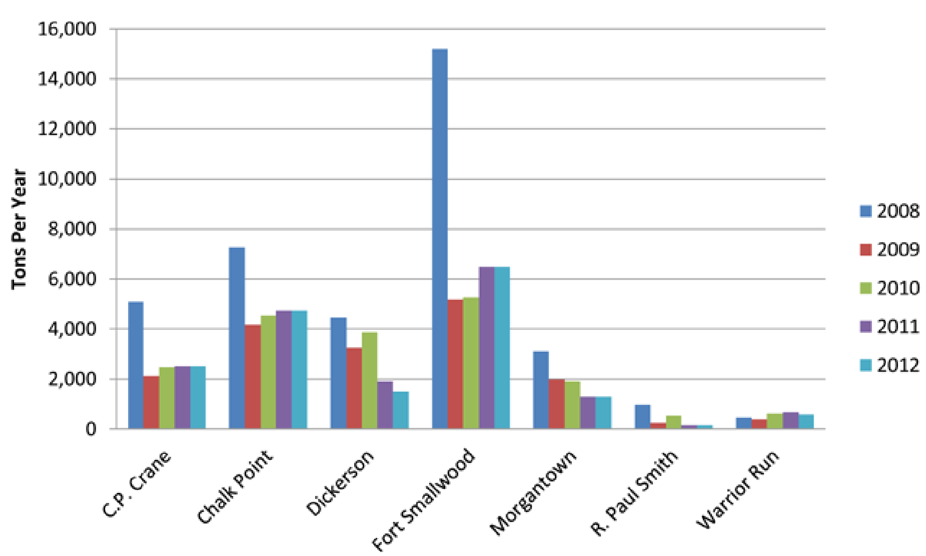


Figure 9 Annual NO_x Emissions from Coal-fired Power Plants in Maryland



Note: Fort Smallwood consists of Brandon Shores and Wagner plants.

Figure 10 Annual PM10 Emissions from Coal-fired Power Plants in Maryland

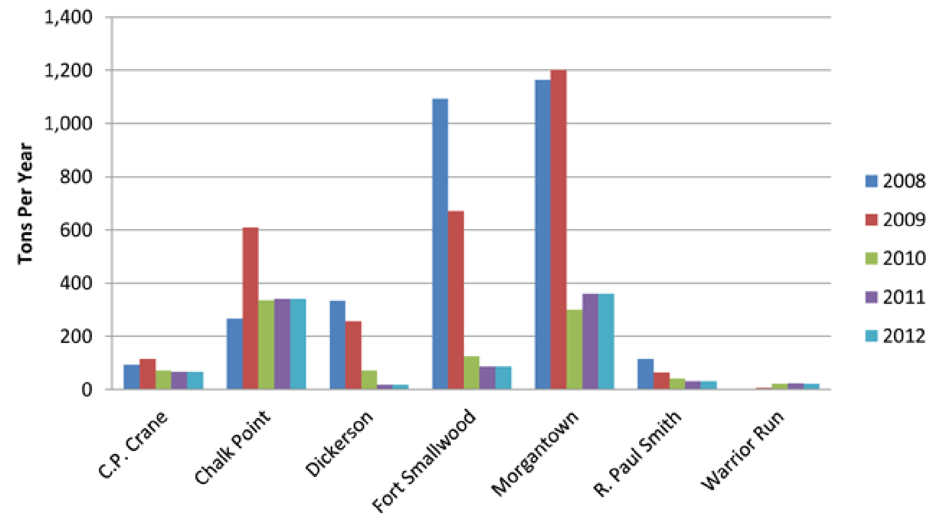
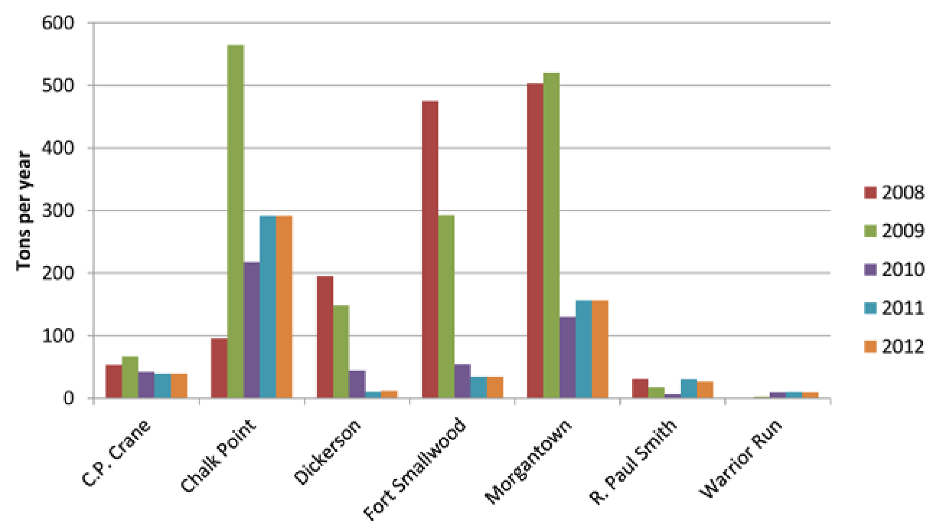


Figure 11 Annual PM2.5 Emissions from Coal-fired Power Plants in Maryland



Impacts

Air emissions from power plants affect the environment in a number of ways; some of the most significant are listed below. PPRP has worked over the past several decades to study these air quality issues, and continues to support research to improve our understanding of these impacts in Maryland.

- ***Acid Rain*** *– Occurs when precursor pollutants, NO_x and SO_2, react with water and oxidants in the atmosphere to form acidic compounds. These acidic compounds are deposited with precipitation ("acid rain") or as dry particles ("dry deposition"), acidifying lakes and streams, harming forest and coastal ecosystems, and damaging man-made structures.*

- ***Ozone*** *- An invisible and reactive gas that is the major component of photochemical smog. It is not emitted directly into the atmosphere in significant amounts but instead forms through chemical reactions in the atmosphere. Ground-level ozone is formed when the precursor compounds — NO_x from both mobile and stationary combustion sources (such as automobiles and power plants, respectively), and VOCs from industrial, chemical, and petroleum facilities and from natural sources — react in the presence of sunlight and elevated temperatures.*

- ***Visibility and Regional Haze*** *– Conditions that can facilitate, or impair, the appreciation of natural landscapes. The national visibility goal, established as a part of the CAA Amendments of 1977, requires improving the visibility in federally managed "Class I areas." These areas include more than 150 parks and wilderness areas across the United States that are considered pristine air quality areas. Four of these areas are located in states surrounding Maryland. PM2.5 is the principal air pollutant associated with visibility impairment.*

- ***Nitrogen Deposition*** *– Contributes to excess nutrient loadings to the Chesapeake Bay. The Chesapeake Bay Program estimates that approximately 30 percent of the nitrogen load to the Bay comes from atmospheric deposition and subsequent transport of nitrogen through the watershed. Much of this loading comes from NO_x emissions from power plants, industrial sources, and mobile sources. Excess nitrogen stimulates excessive plant growth, which reduces the dissolved oxygen content in the water and limits the oxygen available for use by aquatic organisms.*

- ***Mercury*** *- A pollutant of particular concern because of its significant adverse health effects. Power plants contribute approximately 75 percent of the total mercury emissions in Maryland, and PPRP plays a significant role in supporting scientific research on this topic. PPRP has been actively involved in the study of regional sources of mercury emissions and their impacts on the Chesapeake Bay. In cooperation with the University of Maryland, PPRP has sponsored several deposition monitoring programs and continues to evaluate the impacts of toxic emissions from power plants in Maryland, as well as measures to reduce emissions and mitigate the impacts.*

Recent regulatory developments have focused on controlling emissions of hazardous air pollutants such as mercury and other compounds from power plants. More information on these rulemakings can be found in Section 4.1.5.

See Section 5.2 of CEIR-17

Climate Change

A greenhouse gas (GHG) is broadly defined as any gas that absorbs infrared radiation in the atmosphere. The pollutant "GHG", as defined in federal air regulations (40 CFR Part 51.21), is the aggregate of six greenhouse gases: carbon dioxide (CO_2), methane, nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6). EPA recently issued a Greenhouse Gas Reporting Rule and other regulations that address GHGs. The principal GHGs that enter the atmosphere above natural levels due to human activities are:

- ***Carbon dioxide (CO_2):*** *Carbon dioxide enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement).*

- ***Methane (CH_4):*** *Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and agricultural processes and from the decay of organic waste in municipal solid waste landfills.*

- ***Nitrous oxide (N_2O):*** *Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste.*

- ***Fluorinated gases:*** *HFCs, PFCs, and SF_6 are synthetic, powerful GHGs that are emitted from a variety of industrial processes. Fluorinated gases are sometimes used as substitutes for ozone-depleting substances (i.e., chlorofluorocarbons (CFCs), hydrochlorofluorocarbon (HCFCs), and halons). These gases are typically emitted in smaller quantities, but because they are potent GHGs, they are sometimes referred to as High Global Warming Potential gases.*

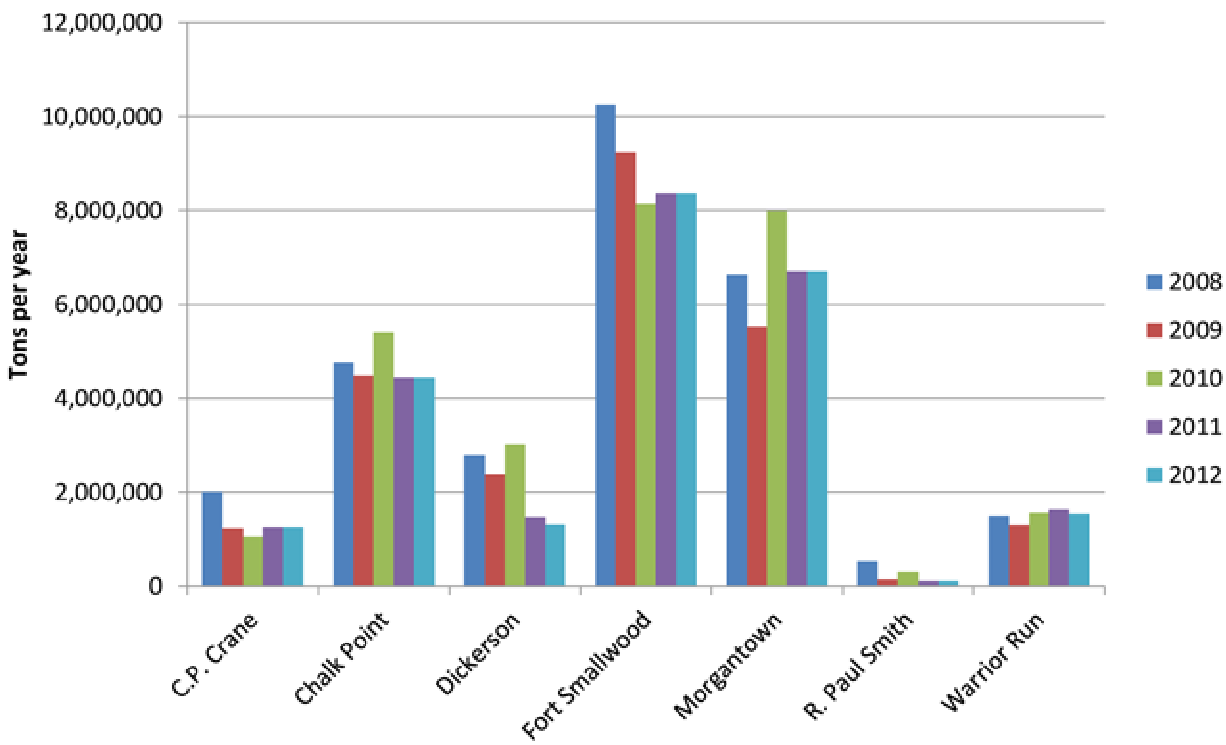
Maryland has been working to reduce the State's impact on the climate. The Maryland Climate Change Commission was formed in 2007 to develop a state-wide Climate Action Plan, which was published in 2008. This plan contained 61 policy options, programs, and measures to reduce GHG emissions in Maryland and to help the State respond and adapt to the impacts of climate change. Maryland has implemented the Greenhouse Gas Emissions Reduction Act of 2009, a key recommendation of the Climate Action Plan. The law commits the State to reduce GHG emissions by 25 percent below 2006 levels by 2020 while also promoting new "green" jobs, protecting existing jobs, and positively influencing the State's economy. The State also participates in the Regional Greenhouse Gas Initiative (RGGI) with the objective of reducing CO_2 emissions specifically from the electricity generation sector.

Emissions of GHGs are reported on a "carbon dioxide equivalent" (CO_2e) basis under the GHG Reporting Rule. CO_2e emissions are determined by multiplying the mass amount of emissions in tons per year (tpy), of each of the six individual greenhouse gases by each gas's global warming potential (see table in EPA's regulations).

Figure 12 presents GHG emissions from coal-fired power plants in Maryland, as reported to MDE, for the years 2008 through 2012. Similar to other regulated pollutants, fluctuations in emissions are seen throughout the years as a result of changes in fuel consumption caused by power demand. Note that prior to the year 2010 (the first reporting year under the Mandatory Reporting Rule), GHG emissions reported to MDE may only include emissions of carbon dioxide, and not total GHG emissions as currently defined by the EPA.

There are 17 power plants in Maryland that are covered by RGGI. Maryland's annual RGGI budget through 2013 is 37.5 million tons of CO_2, or just under 23 percent of the annual budget for the region of 165 million tons. Contrary to what was expected when the CO_2 state apportionments were negotiated, emissions in the power sector have fallen over the last several years due to the economic downturn, mild weather patterns, shifts to natural gas-fired generation, increased generation from renewable energy sources, and increases in conservation and demand response. As a result, state-wide emissions from power plants subject to RGGI, with the exception of Rhode Island, continued to remain below

Figure 12 Annual GHG Emissions from Coal-fired Power Plants in Maryland



Notes: Emissions reported in MDE Emission Summary Reports.
GHG Emissions prior to the year 2010 may only include carbon dioxide emissions, not total GHGs as currently defined by the EPA.
Fort Smallwood consists of Brandon Shores and Wagner plants.

the negotiated apportionment amounts in 2012 (for those states reporting data; RGGI data for Connecticut and Delaware remain incomplete). Maryland's 2012 CO_2 emissions were 41 percent below its initial annual cap.

A comprehensive program review was conducted in 2012 by member states via a regional stakeholder process. An updated RGGI Model Rule was published in February 2013, resulting in, among other program clarifications, a 45 percent reduction in the regional emissions cap to 91 million tons starting in 2014. Other revisions include the establishment of interim control period requirements, cost containment reserves to help alleviate spikes in allowance prices, and changes in the handling of offsets.

The RGGI program allows covered entities to use qualifying offset projects to reduce the total number of allowances they are required to secure. Offset projects or emission credit retirements will be awarded one CO_2 offset allowance for every ton of CO_2 reduced or sequestered. A source may cover up to 3.3 percent of its CO_2 emissions with offset project allowances. Currently, no offset projects have been awarded to offset allowances under RGGI.

In Maryland, two offset project categories are being pursued, specifically terrestrial sequestration through urban forestry and the restoration of salt marshes. Maryland is promoting the development of programs within urban communities to plant and grow trees, which reduces GHG emissions in two ways. First, CO_2 is removed from the atmosphere during the growing of the trees due to an increase in biomass. Second, GHG emissions are avoided through energy conservation, as the trees can provide shade with a natural cooling effect for residences and other buildings in the community. Several State agencies and community groups are interested in pursuing urban forestry projects as an alternative or supplement to other more traditional afforestation projects.

Salt marshes are prevalent in Maryland and are of critical importance for estuarine ecosystems, such as those associated with the Chesapeake Bay, by serving as habitats for wildlife and buffers to large storms. In addition, salt marsh soils have the capacity to sequester large amounts of CO_2 through organic and mineral accretion. Marsh decline, however, is becoming more prevalent throughout the region due to the increase in water levels. Raising the elevation of the marsh beds via supplementation of natural sediment (e.g., depositing clean dredged material) can restore the tidal fluctuations required to support the marsh systems and promote carbon storage. Over the last several years, PPRP has assisted with an effort by Restore America's Estuaries to develop a formal offset protocol for salt marsh systems.

Water Resources

See Section 4.2 of CEIR-17

All steam electric power plants in Maryland are located in the Chesapeake Bay watershed. Power plants are significant users of water in Maryland, and their operation can affect aquatic ecosystems as well as the availability of water for other users. This section describes the surface and groundwater withdrawals, consumption and discharges in Maryland from power plant operations. It also describes potential resource impacts and methods for minimizing any adverse impacts.

Cooling Water Supply

Most electricity produced in Maryland is generated by one of four types of generating technologies: steam-driven turbines, combustion turbines, combined cycle facilities (a combination of steam and combustion turbine units), and hydroelectric facilities. Power plants utilizing steam have larger water withdrawals compared to simple cycle combustion turbines because of the need to cool and condense the recirculating steam. Typically, a power plant will obtain cooling water from a surface water body. The other, much smaller water needs of the power plant, such as boiler makeup water, are typically met by on-site wells or municipal water systems. (Hydroelectric facilities also have significant surface water impacts; see discussion on page 31.)

Four steam power plants in Maryland – AES Warrior Run, Brandon Shores, Panda Brandywine, and Vienna – use closed-cycle cooling (cooling towers) exclusively instead of once-through cooling. (Chalk Point has multiple steam boilers; two that use once-through cooling and two that use closed-cycle cooling.) Closed-cycle systems recycle cooling water and withdraw less than one-tenth of the water required for once-through cooling; however, depending on plant design and operating parameters, 50 to 80 percent of the water evaporates from the cooling tower and does not return to the source, thus representing a consumptive use. Closed-cycle cooling systems consume 1.5 to 2 times more water per MWh than once-through systems.

Nuclear power plants also fall within the steam generating category; however, they use nuclear reactions instead of fossil fuel combustion to create thermal energy. The typical nuclear power plant operating today requires 10 to 30 percent more cooling water, on a per-MWh basis, compared to a fossil fuel plant. Nuclear stations generally operate at a lower steam temperature and pressure compared to fossil fuel-fired generating plants, which causes a somewhat lower efficiency in the conversion of thermal energy to mechanical and, ultimately, electrical energy. Consequently, more waste heat is created per MWh generated than would occur in a fossil fuel plant, and more cooling water is needed to absorb that waste heat.

Maryland has one nuclear power plant operating on the western shore of the Chesapeake Bay, Calvert Cliffs, which withdraws an average of 3.2 billion gallons per day from the Bay. This is the largest single appropriation of water in Maryland, and 13 times more than the municipal supply for the Baltimore City metropolitan area of 250 million gallons per day (mgd). While the majority of this water is returned to the Bay, an estimated 18 mgd of Bay water is lost to evaporation as a result of the heated discharge (see Table 4).

In addition to cooling systems, air pollution control systems at power plants can also require substantial amounts of water. As a result of the Healthy Air Act, Maryland's four largest coal-fired power plants – Brandon Shores, Chalk Point, Dickerson, and Morgantown – have begun operating wet flue gas desulfurization (FGD) systems. Typically, about 85 percent of the water used in these systems is consumptively lost through evaporation out of the stack. Operation of the FGD systems at Maryland's coal-fired power plants results in an additional evaporative loss of approximately 8 mgd combined. This additional loss is not significant in the tidal estuarine environments at Brandon Shores, Chalk Point, and Morgantown. NRG, the operator of the Dickerson plant, is required to provide on-site water storage to minimize the potential impacts of its FGD system's water use on other users of the Potomac River.

Groundwater Withdrawals

The use of groundwater for process cooling is severely restricted in Maryland, although some of Maryland's power plants are significant users of groundwater for other purposes. Groundwater is used for boiler feedwater in coal-fired power plants, inlet air cooling, emissions control in gas- and oil-fired combustion turbines, and potable water throughout the power plants. High-volume groundwater withdrawals have the potential to lower the water table of an area, thus reducing the amount of water available for other users. Excessive withdrawals from Coastal Plain aquifers can also cause intrusion of salt water into the aquifer. Although large volumes of groundwater are available in the Coastal Plain aquifers, withdrawals must be managed over the long term to ensure adequate groundwater supplies for the future.

The impact of these withdrawals has been a key issue in southern Maryland, where there is a significant reliance on groundwater for public water supply. Currently, five power plants withdraw groundwater from southern Maryland coastal plain aquifers for plant operations: Exelon's Calvert Cliffs Nuclear Power Plant, NRG's Chalk Point and Morgantown power plants, Southern Maryland Electric Cooperative's (SMECO's) combustion turbine facility (located at the Chalk Point plant), and Panda Brandywine's combined cycle power plant. These five plants have historically withdrawn groundwater from three aquifers in Southern Maryland: the Aquia, the Magothy, and the Patapsco. The Chalk Point power plant began withdrawing groundwater from the deeper Patuxent Aquifer in 2010. Two additional power plants utilize groundwater: Perryman, located in Harford County northeast of Baltimore, and Vienna, located in Dorchester County on the Eastern Shore. Figure 13 shows the groundwater withdrawal rates expressed as daily averages from 1975 to 2012 for each of these power plants. Power plants typically

Table 4 Surface Water Appropriations and Use at Maryland Power Plants with Steam Cycles

Power Plant	Surface Water Appropriation (average, mgd)	2011 Actual Surface Withdrawal (average, mgd)	2012 Actual Surface Withdrawal (average, mgd)	Estimated Consumption (mgd)	Water Source
Once-Through Cooling					
Calvert Cliffs	3,500	3,315	3,180	18	Chesapeake Bay
Chalk Point[a]	720	622	398	2.1	Patuxent River
C.P. Crane	475	301	312	2.1	Seneca Creek
Dickerson	401	258	248	1.0	Potomac River (non-tidal)
H.A. Wagner	940	285	307	1.7	Patapsco River
Morgantown	1,503	1,258	1,066	2.5	Potomac River
Riverside	40	4.04	5.56	0.04	Patapsco River
R. Paul Smith[b]	70	12.4	19.1	0.15	Potomac River (non-tidal)
Wheelabrator (Baltimore RESCO)	50	14.5	21.6	0.10	Gwynns Falls
SUBTOTAL	7,699	6,070	5,558	27	
Closed-Cycle Cooling					
AES Warrior Run[c]	None	2.07	1.91	1.5	City of Cumberland
Brandon Shores	35	14.6	16.9	12	Patapsco River (Wagner discharge)
Montgomery Co. Resource Recovery Facility	1.342	0.75	0.78	0.57	Potomac River (Dickerson Station's discharge canal)
Panda Brandywine[c]	None	N/A	N/A		Mattawoman WWTP
Vienna	2	0.009	0.002	--	Nanticoke River
SUBTOTAL	41.4	0.76	0.78	12.6	
TOTAL	**7,740**	**6,071**	**5,559**	**40**	

Source: MDE WMA

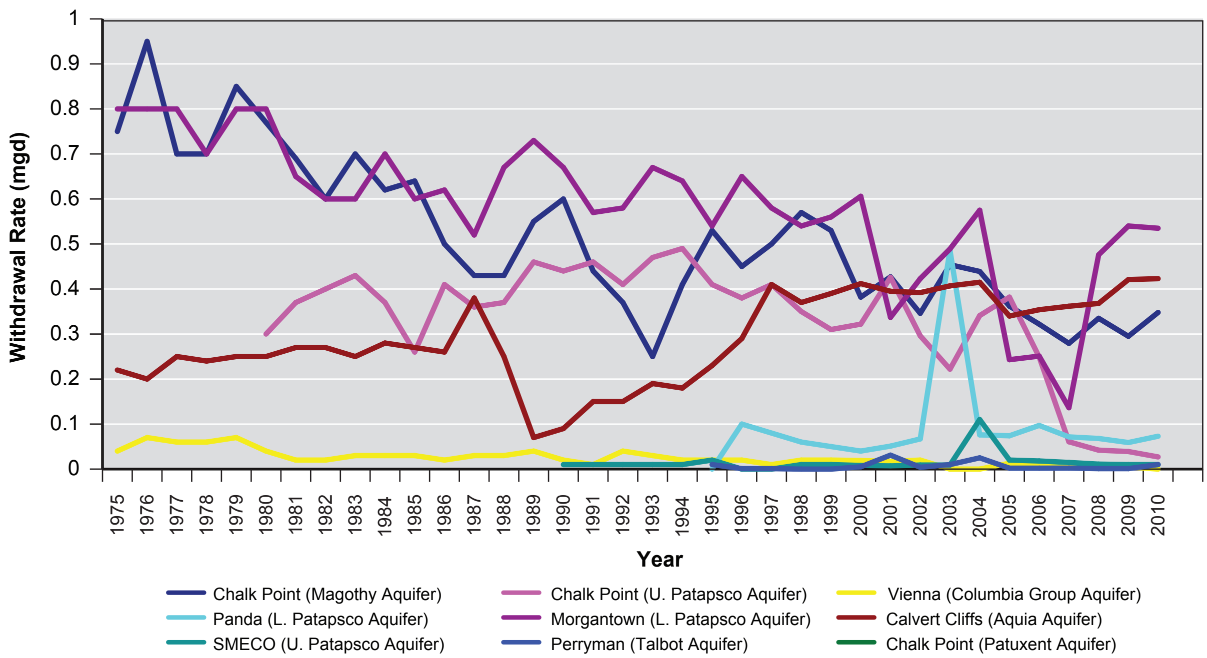
mgd = million gallons per day

(a) Chalk Point has two units on once-through cooling and two on closed-cycle cooling. The appropriation of 720 mgd covers all four steam units; data on each cooling system individually are not available.

(b) R. Paul Smith ceased operations on September 1, 2012. The use data for 2012 covers January 1 through September 1, 2012. The plant's surface water appropriation permit has since been inactivated.

(c) AES Warrior Run and Panda Brandywine do not have direct surface water appropriations for their total water use, since their cooling water needs are met indirectly through third parties (the City of Cumberland and the Mattawoman wastewater treatment plant, respectively). Data for Panda Brandywine's water use for 2011 and 2012 are not available. AES Warrior Run has a surface water appropriation of 0.021 mgd for back-up water use only. Warrior Run used an average of 2.07 mgd of purchased municipal water in 2011 and 1.91 mgd in 2012.

Figure 13 Average Daily Ground Water Withdrawal Rates at Maryland Power Plants



withdraw groundwater at rates well below their appropriation permit limits. The average withdrawal for all seven power plants in 2012 was 2.1 mgd compared to a combined daily appropriations limit of 3.8 mgd. The amount of groundwater withdrawn by power plants has fluctuated between about 0.9 and 2.4 mgd over the past 38 years.

Three government agencies – the Maryland Geological Survey, the USGS, and PPRP – jointly operate a groundwater monitoring program to measure the water levels in the Coastal Plain aquifers of Southern Maryland to ensure the long-term availability of groundwater. MDE Water Management Administration (WMA), the permitting authority for all groundwater appropriations, uses the data from this joint monitoring program to assess the significance of impacts to aquifers when reviewing additional appropriation requests.

Long-term monitoring indicates a steady decline in water levels in the Aquia, Magothy, and Patapsco aquifers. However, these declines are not solely due to withdrawal by power plants, and are considered acceptable by MDE WMA when compared to the amount of water available in the aquifers.

Wastewater Discharges

Wastewater discharged from coal ash ponds, air pollution control equipment, and other equipment at power plants can contaminate drinking water sources, impact fish and other wildlife, and create other detrimental environmental effects. Although air emission controls installed to remove pollution from smokestacks have made great strides in cleaning the air people breathe and reducing respiratory and other illnesses, some of the equipment used to clean air emissions does so by “scrubbing” the boiler exhaust with water (“wet” FGD systems), which then can pollute rivers and other receiving water bodies. Treatment technologies are available to remove these pollutants before they are discharged to waterways, but these systems have been installed at only a fraction of the power plants. Types of treatment systems for FGD systems include settling ponds, chemical precipitation, biological treatment, constructed wetlands, and zero-liquid discharge.

In 2009, EPA completed a multi-year study of power plant wastewater discharges and concluded that current regulations, which were issued in 1982, have not kept pace with changes that have occurred in the electric power industry over the last three decades. As part of the multi-year study, EPA measured the pollutants present in the wastewater and reviewed treatment technologies, focusing mostly on coal-fired power plants. Many of the toxic pollutants discharged from these power plants come from coal ash ponds and the FGD systems used to scrub SO_2 from air emissions. In September 2009, EPA announced plans to revise the existing standards for water discharges from coal-fired power plants to reduce pollution and minimize its adverse effects.

Once the new rule for electric power plants is finalized, EPA and states will incorporate the new standards into wastewater discharge permits. EPA issued a proposed rule to amend guidelines and standards for the steam electric power generating industry in 2013 and is scheduled to take final action in late 2015.

In addition to the contaminants covered under EPA’s effluent guidelines, and as a result of the implementation of the Chesapeake Bay Total Maximum Daily Load (TMDL), all dischargers with NPDES permits, including industrial dischargers such as power plants, will have reduced limits on total nitrogen, total phosphorus, and sediment.

Hydroelectric Facility Impacts

While only two large-scale hydroelectric projects (with capacities greater than 10 MW) are present in Maryland, five additional small-scale facilities also generate electricity within the state (see map and table in Section 2.1.5.3). Hydroelectric facilities may present special environmental concerns that are not encountered at steam electric power plants. Development and operation of hydroelectric facilities can cause three main types of impacts:

Changes in water quality – Impoundments created for hydroelectric dams significantly alter river flow from free-flowing streams to deepwater flow. This alteration causes changes in natural water clarity, thermal stratification, and lower dissolved oxygen concentrations upstream of the dam, which, in turn, may result in low dissolved oxygen levels in the water discharged from the dam.

Changes to flow regime – Operating hydroelectric facilities in a peaking mode (in response to peak electrical demand) produces unnatural and frequently extreme water level fluctuations in impoundments as well as downstream from the dams. Additional small-scale projects may also divert some flow away from the natural streambed. Fluctuations in water level and flow may reduce fish abundance as well as important food sources essential to fish growth and survival.

Direct adverse effects on fish populations – Dams prevent the natural upstream and downstream movement of both resident and migratory fish species. Entrainment of fish attempting to move downstream past the dam may cause mortality due to the turbines. Factors that affect fish mortality include the type of turbine, the proportion of flow diverted through the turbine, and the size of fish.

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

The FERC licenses for two of the four lower Susquehanna facilities expired at the end of 2014, and agency consultation on relicensing has been underway since 2009. Fish passage and flow issues are being further studied and addressed as part of this process.

Conowingo Hydroelectric Project Relicensing

Exelon has applied to the Federal Energy Regulatory Commission (FERC) to renew its operating license for the 573 MW Conowingo Hydroelectric Project. FERC has the authority to issue the license for Conowingo, although with significant regulatory input from Maryland (with PPRP as the lead for the State) and other federal agencies. Studies and discussions have been taking place since 2009 between Exelon and various natural resource agencies and other interested parties. Relicensing participants include FERC, Exelon, Maryland (DNR and MDE), Pennsylvania (Fish and Boat Commission and Department of Environmental Protection), U.S. Fish and Wildlife Service, National Marine Fisheries Service, National Park Service, Susquehanna River Basin Commission, The Nature Conservancy, and the Lower Susquehanna Riverkeeper.

PPRP is coordinating all Maryland agency reviews and providing input to FERC on the license application and various studies. Principal issues that have been the subject of multi-year studies based on PPRP recommendations include sediment and debris management, upstream and downstream fish passage (for migratory species such as American shad, river herring and American eel), flow and water level management, dissolved oxygen levels, land conservation, and recreation. Most of these issues were also central when Conowingo went through its previous FERC licensing process more than 20 years ago, although a few issues, most notably sedimentation and eel passage, have only now become significant concerns.

PPRP's goal is to determine appropriate protection, mitigation, and enhancement measures in consultation with MDE and other resource agencies, and ultimately to reach agreement on license conditions prior to issuance of a final license by FERC. Such a license will contain State-mandated license terms contained in the State's Water Quality Certification for the project, as well as fishway prescriptions issued by the U.S. Fish and Wildlife Service.

Terrestrial Impacts

See Section 4.3 of CEIR-17

Maryland's physiographic diversity, geology, and climate have produced a variety of eco-regions that foster numerous, and sometimes unique, habitats ranging from ocean barrier islands in the east through salt marshes, fields and forests of the coastal plain, into rolling piedmont hills, and on to ancient forested mountains with remnant alpine glades to the west. While human activities (agriculture, urban/suburban development, etc.) have altered all of these areas to some extent, the majority of the landscape continues to possess a wide variety of habitats that support diverse communities of flora and fauna. Many of these communities help define their regions, and may contain rare, threatened, or endangered species.

The construction and operation of power generation facilities can have significant effects on terrestrial environments, including wetlands. Power plant infrastructure, including production units, pipelines to transport water, oil, and natural gas, electrical transmission lines, and roadways and railways, can occupy extensive areas on the landscape. Notably, these facilities can:

- *Physically alter or eliminate natural habitats;*
- *Disturb, displace, or result in the loss of wildlife;*
- *Affect landscape ecology through atmospheric emission and deposition of PM and other air pollutants; and*
- *Degrade habitats by the permitted discharge of pollutants or from accidental spills.*

New generation facilities may be constructed entirely within an area that is already developed or may require clearing a significant number of acres of natural habitat. For example, the proposed site for the Keys Energy Center (KEC) combined-cycle, gas-fired plant in Prince George's County is a 180-acre parcel of land formerly used for a sand and gravel mining operation. Approximately 30 acres of the parcel will be used for the permanent electric power generation and support facilities. While the generating station itself will occupy a previously disturbed site, more significant impacts to resources may result from the associated linear facilities. The site is adjacent to PEPCO's existing 500 kV transmission line right-of-way located on the western side of the property. A natural gas pipeline will need to be constructed to obtain fuel for the facility. KEC is proposing to use the vegetated side of the existing 500 kV transmission line for the gas pipeline, which would require clearing many acres of existing forested habitat. The proposed pipeline route crosses sensitive areas such as wetlands and streams, including the headwater streams of Zekiah Swamp. As part of the CPCN licensing review of the KEC project, PPRP recommended conditions to mitigate for loss of forest and impacts to wetlands and streams.

The impacts from new generation projects on Maryland's landscape in the future will also depend on the mode of power production. Power plants that use traditional resources such as coal and natural gas are generally confined to an intensively developed installation, whereas renewable energy projects using wind turbines or solar panel arrays may occupy hundreds of acres. For example, PPRP reviewed a 20 MW solar photovoltaic project that would occupy more than 280 acres surrounding the Maryland Correctional Institution in Hagerstown. More recently, PPRP reviewed the Church Hill Solar Farm in Queen Anne's County, which will be a 6 MW solar photovoltaic project on about 42 acres in Church Hill, Maryland.

More than two thousand miles of electric power transmission line and natural gas pipeline rights-of-way are located throughout Maryland. Constructing and maintaining these rights-of-way creates long, mostly linear, corridors that are often quite different from the surrounding environment. These corridors can affect nearby areas, including terrestrial habitats and wetlands, in a variety of ways, either temporarily during construction or over the long term. To provide public review and to ensure that environmental and other concerns are addressed, a CPCN licensing review is required for new transmission line construction and for modifications in existing corridors.

Transmission line corridors may affect specific environmental features, alter the landscape over long distances, or change the way people use nearby residential, commercial, or agricultural land. For each right-of-way modification or construction proposal, PPRP reviews the potential impacts of the proposed project on streams, floodplains, wetlands, forests, threatened and endangered species, historic and archeological sites, and surrounding land use. Quantitative comparisons of alternative routes are derived from digital maps, aerial photographs, and other data sets, and supplemented by field assessments. The purpose of these comparisons is to identify the types of impacts that may occur along each possible corridor and to determine the route with the lowest overall impact. Where undesirable impacts cannot be avoided, licensing recommendations may include compensating for or mitigating the damage and/or maintaining certain conditions in the corridor after construction.

PPRP's role in the CPCN process is to facilitate compliance with Maryland's environmental regulations and natural resource management objectives. Environmental laws affecting Waterways Construction, Water Quality and Water Pollution Control, and Erosion and Sediment Control require best management practices (BMPs) to eliminate or minimize disturbance in and discharges to Maryland waters. These BMPs are uniformly included as conditions to a CPCN. However, a CPCN can also recommend specific conditions to avoid, minimize, or mitigate impacts on natural resources when the effects of the proposed project are particularly compelling. Under these circumstances, conditions placed on a CPCN to mitigate impacts to wetlands, forests, and sensitive species habitats may often be more stringent than regulatory requirements.

Socioeconomics and Land Use

See Section 4.4 of CEIR-17

Since CEIR-16, the outlook for electricity supply has shifted from interregional transmission to in-state generation and upgrades to existing transmission lines. Furthermore, Maryland's Renewable Portfolio Standard (RPS) and growth of shale gas production nationwide has altered the future in-state generation mix toward solar, wind and other renewable sources and to natural gas among conventional technologies. This is reflected in recent CPCN applications to the Maryland PSC for generation facilities that have included, among other projects, natural gas generation facilities in Prince George's County and Cecil County, and utility-scale solar photovoltaic (PV) facilities in Frederick and Queen Anne's counties. These technologies have distinct socioeconomic impact profiles that must be carefully considered in PPRP environmental reviews.

Natural Gas

In many respects, socioeconomic impacts of natural gas-fired generation plants are similar to other conventional facilities such as coal and nuclear, although construction impacts associated with employment, income, traffic and other metrics are usually smaller and require less mitigation. However, the fuel for natural gas facilities is typically delivered via underground pipeline. While this reduces the facility's impact profile once it is operational, during construction the installation of underground infrastructure can have unforeseen consequences upon local communities and state resources.

The proposed Keys Energy Center (KEC) in Prince George's County is a case in point. Natural gas would be sourced from a Dominion Transmission Incorporated Cove Point interstate pipeline located approximately 8 miles south of the site in Charles County. As currently proposed, the pipeline would be buried along the western edge of a PEPCO 500-kV transmission line ROW. As construction of the pipeline would require trenching, PPRP was particularly concerned about potential adverse effects on undocumented cultural resources. PPRP coordinated its review with the Maryland Historical Trust to ensure that the developer undertook the appropriate surveys so that significant cultural resources were avoided or effects upon them were mitigated.

In addition to cultural resources, KEC's originally proposed non-potable water pipeline route presented another set of concerns related to highway planning. The pipeline, from WSSC's Western Branch WWTP, would have occupied the US 301 ROW for much of its length. US 301 is a major transportation corridor in Southern Maryland and a primary north-south commuter route from fast-growing suburban communities in Prince George's and Charles Counties. Because of increased traffic congestion brought on by rapid suburban growth, improvements to the US 301 corridor have been under consideration for several years. In 1993, for example, Governor Schaefer and Transportation Secretary

Lighthizer appointed a task force to develop recommendations to address transportation and related problems in the US 301 corridor from US 50 to the Potomac River Bridge. Among recommendations addressing land use, jobs, transit, and transportation demand management, the task force recommended converting US 301, from the US 301/MD 5 split at Brandywine to US 50, to a six-lane freeway with service roads by 2020. Additional recommendations were made for US 301 segments in the Waldorf and La Plata areas, and south of La Plata to the Potomac River. US 301 is also the focus of the US 301 Access Management Plan, a collaborative effort between SHA, Prince George's County Department of Public Works and MNCPPC (for the Prince George's County segment), which is used as a guide by Prince George's County and SHA to protect the future US 301 ROW in the review process for development along the corridor until formal studies are complete.

According to SHA's Utility Policy Manual, installation of utilities longitudinally in the ROWs of expressways and highways programmed to be reconstructed as expressways is prohibited in the policy. In addition, the Federal Highway Administration (FHWA) has authority over all highways utilizing federal funds.

But, as the SHA works with utilities to accommodate longitudinal installations in the ROWs of controlled access highways, the non-potable water pipeline could potentially have been permitted. Because of this, PPRP collaborated closely with the SHA to ensure that utility occupancy issues were addressed. Keys' subsequent shift from wet to dry cooling eliminated the issue from further consideration, however. ROW occupancy permitting is currently focused on gas, potable water, and sewer pipelines for the Keys Energy Center.

Solar Photovoltaic

Solar photovoltaic (PV) generation facilities are land intensive. Maryland Solar, which was permitted in 2011, is a 20 MW solar farm in Washington County that will occupy more than 280 acres. The Church Hill Solar Farm is a proposed 6 MW facility that would occupy 42 acres in Queen Anne's County. Both are sited on land that is currently cultivated for agriculture. While farmland preservation is a goal of Maryland's Smart Growth program, neither project will be sited on protected land, and one is located on farmland leased from the Maryland Department of General Services which administers the land for the Maryland Department of Public Safety and Correctional Services. Still, PPRP's environmental reviews of these projects included detailed assessments of land uses in the project areas, including whether the host or neighboring parcels were protected by easement or other designation. Because a solar generating facility is considered an industrial use, it would be prohibited from properties under most forms of protection in Maryland.

The decommissioning plans of solar generating facilities are also reviewed by PPRP. While there are currently no nationwide or statewide standards for decommissioning, the primary goal of a decommissioning plan is to restore a site to its "original state". A model bylaw developed by the Massachusetts Executive Office of Environmental Affairs defines restoration as the physical removal of all large-scale ground-mounted solar photovoltaic installations, structures, equipment, security barriers and transmission lines from the site; disposal of all solid and hazardous waste in accordance with local, state, and federal waste disposal regulations; and stabilization or re-vegetation of the site. Physical removal of ground-mounted structures includes the removal of all or some of below-ground foundations and supports, although the landowner or operator may leave designated below-grade foundations in order to minimize erosion and disruption to vegetation.

Particularly for agricultural land, the abandonment of below ground structures is a concern. A review of decommissioning plans of proposed or existing solar facilities in North America revealed no consensus with respect to below ground structures, with decommissioning ranging from complete removal without exception to removal to a depth of between two and four feet below grade. Maryland Solar's decommissioning plan proposed to remove below ground portions of supports in their entirety or otherwise at least two feet below ground surface and left in place. Underground collection lines would be cut off two feet below the ground surface and left in place.

To address the issue, PPRP first concluded that to restore a site previously used for agriculture to an "original state," it had to be returned to an agriculturally productive state that allows for safe agricultural practices. It then undertook research on common soil management practices and how below surface structures could affect them.

A recurring problem in agriculture is soil compaction. Intensity of operations and the use of larger equipment used in modern agricultural practice have made soil compaction more common. It has been shown, for example, that the effect of equipment weight can penetrate down to 24 inches when soils are moist. Deep tilling, where soils are ripped at least one foot below the surface, is the primary method for relieving compaction. Although most implements can penetrate to a depth of about 20 inches, tilling depths of two to three feet can be achieved with heavy tracked machinery. Even no-till "rippers" perform tillage to depths of 12 to 18 inches while maintaining a smooth soil surface. Given the potential for deep tillage applications on decommissioned solar farms to restore the land to agricultural use, PPRP concluded that the margin for error provided by removal of below ground structures and cabling to a depth of two feet in Maryland Solar's decommissioning plan was insufficient to ensure safe agricultural operations, recommending instead removal to three feet.

See Section 4.5 and Section 4.6 of CEIR-17

Power Plant Wastes

Radiological

Production of nuclear power in the United States is licensed, monitored, and regulated by the U.S. Nuclear Regulatory Commission (NRC). Calvert Cliffs Nuclear Power Plant, in Calvert County, is the only nuclear power plant in the state of Maryland. The next closest plant, Peach Bottom Atomic Power Station, is on the Susquehanna River just north of the Pennsylvania/Maryland border. Both of these facilities release very low levels of radionuclides into Maryland's environment. Based on data from regular sampling events in the vicinity of Calvert Cliffs and Peach Bottom during 2011-2012 (the most recent period for which data have been compiled), environmental, biological, and human health effects from releases of radioactivity were not significant.

In addition to atmospheric and liquid effluent releases as a by-product of normal power generation operations, both Calvert Cliffs and Peach Bottom generate radioactive waste products which require disposal. Spent nuclear fuel from both Calvert Cliffs and Peach Bottom are presently stored at each site within spent fuel pools for the recently discharged fuel or, in the case of older fuel generated in earlier years of plant operation, at dry storage independent facilities located within the protected plant area. These Independent Spent Fuel Storage Installations (ISFSIs) were originally licensed by the NRC for 20 years; although recent regulatory changes now allow a plant operator to apply for a 40-year license period. Calvert Cliffs just obtained a 40-year ISFSI license renewal from the NRC in October 2014.

ISFSI design and construction must conform to strict NRC specifications (10CFR72) that protect against unauthorized entry, earthquakes, and other natural phenomena such as floods and hurricanes. On-site storage facilities, such as the ISFSI, are currently the only long-term storage facilities for irradiated fuel available.

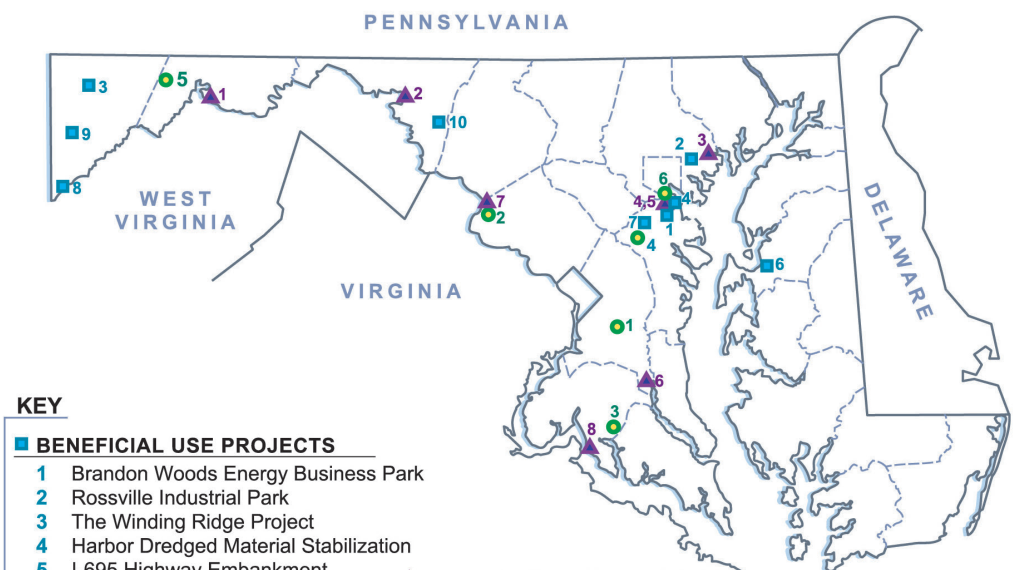
Coal Combustion By-products

In 2012, coal-fired power plants in Maryland generated an estimated 1.3 million tons of coal combustion by-products (CCBs), as reported to MDE. Two primary types of CCBs produced in Maryland, fly ash and bottom ash, are differentiated by their physical characteristics, with particles of bottom ash being much larger than those of fly ash. Fly ash is the finely divided residue that is transported from the furnace along with emission gases. It is captured in electrostatic precipitators or baghouses and has reliable pozzolanic properties. Fly ash is composed of very fine, and generally spherical, glassy particles. Conversely, bottom ash is collected from the bottom of the furnace and is composed of coarser, angular, and porous glassy particles. There is little difference in the chemical makeup of fly ash and bottom ash. During coal combustion, if temperatures are sufficiently high, a portion of the bottom ash will become molten and convert to slag.

The exact chemical nature of CCBs depends upon the nature of the coal burned and the combustion process used. For the most part, power plants in Maryland burn bituminous coal from the eastern United States, which produces predominantly ASTM Class F fly ash. Although Class F ash is primarily composed of silicon, aluminum, and iron oxides, it may also contain trace metals such as titanium, nickel, manganese, cobalt, arsenic, and mercury. For this reason, electric utilities are required to include all applicable constituents of their CCBs when reporting chemical releases to EPA's Toxics Release Inventory (TRI) program, which maintains a database listing the quantities of toxic chemicals released to the environment annually by various industries.

When properly engineered and correctly applied, CCBs can be utilized in civil engineering, mine restoration, and agricultural applications. Beneficial use of CCBs in Maryland has historically included

Figure 15 Distribution of Maryland CCBs in Beneficial Use Projects



KEY

BENEFICIAL USE PROJECTS

1 Brandon Woods Energy Business Park
2 Rossville Industrial Park
3 The Winding Ridge Project
4 Harbor Dredged Material Stabilization
5 I-695 Highway Embankment
6 Route 213/301 Overpass
7 Millersville
8 Kempton Mine Complex
9 Hoyes Run
10 Boonsboro Water Treatment Plant

DISPOSAL SITES

1 Brandywine
2 Westland
3 Faulkner (closed in 2010)
4 BBSS, Inc. (inactive)
5 Mountainview Landfill
6 Lot 15 Landfill

COAL FIRED POWER PLANTS

1 AES Corp. – Warrior Run
2 First Energy – R.P. Smith (closed in 2012)

Raven Power Holdings:

3 C. P. Crane
4 Brandon Shores
5 H. A. Wagner

NRG Energy:

6 Chalk Point
7 Dickerson
8 Morgantown

predominantly large-scale fill applications as in highway embankments and mine reclamation. Figure 15 illustrates the locations of Maryland's coal-fired power plants and the sites where CCBs are beneficially used or disposed around the state.

With the beneficial use of about 84 percent of all CCBs generated, Maryland is well above the national utilization rate of 43 percent, as reported by the American Coal Ash Association for 2011. Since 1994, PPRP has supported research and demonstration projects regarding beneficial use of CCBs, particularly those applications that could use massive quantities of CCBs. This research led to systematic investigation of the severely disturbed mined lands of Maryland to determine how stabilized CCBs, with or without other materials, might be used to return these areas to constructive use, reduce acidic mine drainage, prevent further subsidence, and restore natural drainage patterns.

Morgantown STAR Project

In early 2011, an innovative fly ash beneficiation project was licensed at the Morgantown Generating Station near Newburg, Maryland. The project was designed to thermally process fly ash using a proprietary staged turbulent air reactor (STAR) technology into a low-carbon, mineral admixture product suitable for beneficial use in concrete. The operation of the STAR facility diverts large volumes of unprocessed fly ash from landfills within the state and indirectly reduces greenhouse gas emissions associated with traditional concrete manufacturing.

Since commencing operation in January 2012, the Morgantown STAR facility has processed over 100,000 tons of fly ash from the Morgantown and Chalk Point generating stations. The entirety of the resulting fly ash product has been sold in ready-mix concrete markets in Maryland and Virginia. The STAR facility is continuing its ramp-up to annually process up to 360,000 tons of fly ash generated by the NRG Energy coal-fired power plants (Morgantown, Chalk Point, and Dickerson).

For More Information…

The Power Plant Research Program (PPRP) was established in 1971 to ensure that Maryland could meet its demands for electric power in a timely manner and at a reasonable cost, while protecting the State's valuable natural resources.

PPRP coordinates the State's comprehensive review of new power plants and associated facilities as part of the state and federal licensing process. The Program also conducts a range of research and monitoring projects on existing and proposed power plants. PPRP publishes the Electricity in Maryland Fact Book, which provides information on power generation and use in Maryland. A bibliography listing the general and site-specific reports that PPRP has produced since the early 1970s is also available.

If you want more information, or to request a copy of the Fact Book, bibliography, or other reports, contact PPRP at (410) 260-8660 (toll-free number in Maryland, 1-877-620-8DNR, x8660). You can also visit our website at: www.pprp.info. References are available upon request for all technical topics discussed in this report.

Selected Internet Resources

Federal Agencies

Department of Energy (DOE)	http://www.energy.gov/
Energy Prices & Trends	http://www.energy.gov/public-services/energy-economy/prices-trends
Office of Scientific and Technical Information	http://www.osti.gov
National Renewable Energy Laboratory	http://www.nrel.gov
Energy Information Administration	http://www.eia.gov/
Electricity Statistics	http://www.eia.gov/electricity/
Environmental Protection Agency (EPA)	http://www.epa.gov/
Federal Energy Regulatory Commission	http://www.ferc.gov/
Nuclear Regulatory Commission	http://www.nrc.gov/

Maryland Agencies

Maryland Department of Natural Resources	http://dnr2.maryland.gov/
Maryland Department of the Environment	http://mde.maryland.gov
Maryland Energy Administration	http://energy.maryland.gov/
Maryland Power Plant Research Program	http://pprp.info/
Maryland Public Service Commission	http://psc.state.md.us/

National & Regional Associations

American Nuclear Society	http://www.ans.org/
Edison Electric Institute	http://www.eei.org/
National Association of Regulatory Utility Commissioners (NARUC)	http://www.naruc.org/
National Rural Electric Cooperative Association	http://www.nreca.coop/
North American Electric Reliability Corporation	http://www.nerc.com/
Nuclear Energy Institute	http://www.nei.org/
PJM Interconnection	http://www.pjm.com/

Research

Electric Power Research Institute (EPRI)	http://www.epri.com/
National Regulatory Research Institute (NRRI)	http://www.nrri.org/

Power Industry

AES	http://www.aes.com
Baltimore Gas & Electric Company	http://www.bge.com/
Brookfield Power Corporation	http://brookfieldrenewable.com/
Delmarva Power	http://www.delmarva.com/
Easton Utilities	http://www.eastonutilities.com/
Exelon Corporation	http://www.exeloncorp.com/
FirstEnergy	https://www.firstenergycorp.com
Gestamp Wind	http://www.gestampwind.com/
NRG Energy	http://www.nrg.com/
Old Dominion Electric Cooperative (ODEC)	http://www.odec.com/
Panda Energy International	http://www.pandaenergy.com/
Pepco Holdings, Inc.	http://www.pepcoholdings.com/
Pepco	http://www.pepco.com/
Potomac Edison	https://www.firstenergycorp.com/content/customer/potomac_edison.html
Raven Power	http://raven-power.com/
Southern Maryland Electric Cooperative	https://www.smeco.com/index.aspx