MARYLAND DEPARTMENT OF NATURAL RESOURCES

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PPRP

Electricity in MARYLAND

FACT BOOK

2014

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"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

Maryland's electricity industry is functionally separated into three lines of business: generation and supply, transmission, and distribution (see Figure 1). While customers are billed for each of these three separate functions, most only receive one consolidated electric bill. The generation and supply of electricity is not regulated in Maryland, and prices are set by competitive wholesale and retail electricity markets. The distribution of electricity is a regulated monopoly function of local utilities and is therefore subject to price and quality-of-service regulation by the Maryland Public Service Commission (PSC). The high-voltage bulk electric transmission system is also a monopoly function and is regulated by the Federal Energy Regulatory Commission (FERC).

Retail competition for power supply provides Maryland consumers with an opportunity to choose their own electricity suppliers. For more information about electric choice, visit the Maryland PSC website (http://webapp.psc.state.md.us).

Figure 1. *Maryland's Electricity Market*

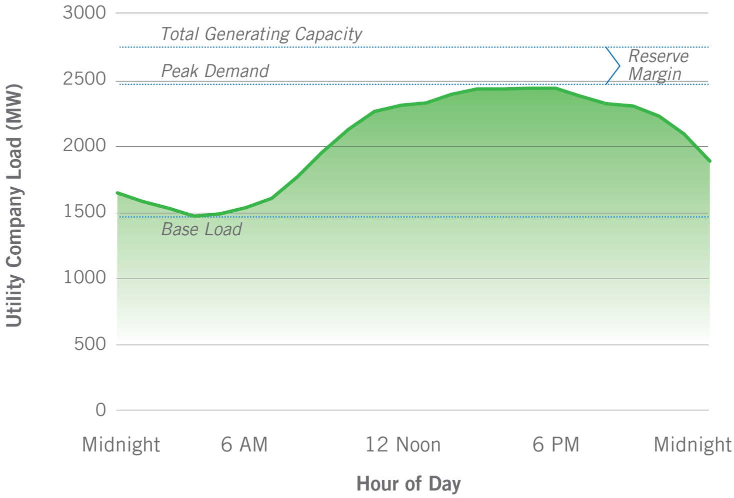
- **Generation** companies produce power to be sold in the wholesale marketplace. Generation of electricity is a competitive industry in Maryland (i.e., is not subject to price regulation). Retail power supply to end–use customers is also competitive, allowing consumers to choose their own supplier.
- **Transmission** is the high–voltage, long–distance movement of power, while **distribution** is the low–voltage, local delivery of power.
- **Transmission** and **distribution** of electricity continue to be provided by local utilities within their various franchised service territories.

Note on Terminology: The ***generating capacity*** of a power plant is the maximum amount of power it can instantaneously supply to the grid and is measured in megawatts (MW). ***Electricity generation*** is the amount of power supplied through time (energy) and is measured in megawatt-hours (MWh).

Maryland is part of PJM Interconnection (PJM), a regional transmission organization (RTO) that is responsible for balancing electricity demand and supply across the Mid-Atlantic region.[1] PJM administers the markets for energy, capacity, and ancillary services, but it does not direct the construction of new generation capacity. As conditions change throughout the day, PJM tells generators when to send electricity out into the grid based on the electricity prices bid by the generators. The power plants that are the least expensive to run operate almost continuously in order to meet the minimum level of electricity that is demanded by a system, which is typically overnight. These plants are considered "base-load" generators. These base-load plants have traditionally been coal and nuclear; however, natural gas has become increasingly more predominant. While base-load generators are expensive to construct, they are relatively inexpensive to operate, and they perform more efficiently and cost effectively when running at a constant level. The typical level of demand that must be met by these base-load plants can be seen in the low-electricity demand hours of Figure 2.

When consumers demand more electricity, the power plants with the ability to quickly send electricity out onto the grid to meet peak demand are put into operation. Peaking power typically comes from smaller fossil fuel units. These units can be more expensive to operate, but they are relatively inexpensive to construct and can start up and shut down quickly. Intermediate or mid-merit plants—which can fill the gap between peak load and base load generators—have become more prevalent in recent years. Intermediate plants typically provide most or all of their energy during the day when energy demand increases, and

Figure 2. *Typical Load Profile*



[1] For more information on regional transmission organizations, see the Transmission Section on page 16; for more information on PJM specifically, see the PJM Interconnection callout box on page 3.

they can either turn off or cycle to a low minimum run level at night so they can match the diurnal demand patterns. Although some coal plants can provide this capability, it is typically natural gas, oil, or hydropower plants that act as mid-merit plants.

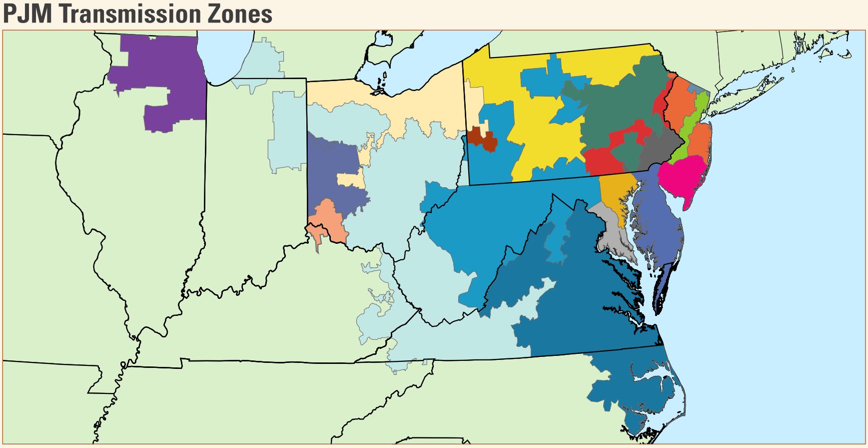
Another resource that PJM can utilize to meet peak demand is demand response (DR), which is achieved when customers voluntarily shut down some of their electricity-using systems, thereby reducing demand for electricity at that time (curtailment). In PJM, thousands of customers participating in DR programs are aggregated by curtailment service providers to create significant savings during times of peak demand. Alternately, customers can use distributed generation (DG) and use small, local generators to switch some local electricity use to those generators.

Retail end-use customers—including residential, commercial, and industrial customers—may purchase electricity from licensed competitive suppliers (i.e., non-utility electricity suppliers) participating in Maryland's retail electricity market. If a customer does not (or cannot) choose a competitive supplier, then that customer will be served by the regulated electric distribution company under a tariff rate, which differs among the various customer classes. A residential or small commercial customer would be placed on the utility's Standard Offer Service rate. A larger customer, such as an industrial establishment, would be placed on a different rate, in which the price of energy varies hourly based on the zonal wholesale market for electricity.

PJM Interconnection

PJM Interconnection, which serves Maryland and several nearby states, is one of eight regional transmission organizations and independent system operations with territory covering the United States. It is the largest regional transmission organization, serving more than 61 million people.

PJM Transmission Zones



Source: Transmission Zone, *pjm.com/documents/%7E/media/about-pjm/pjm-zones.ashx*.

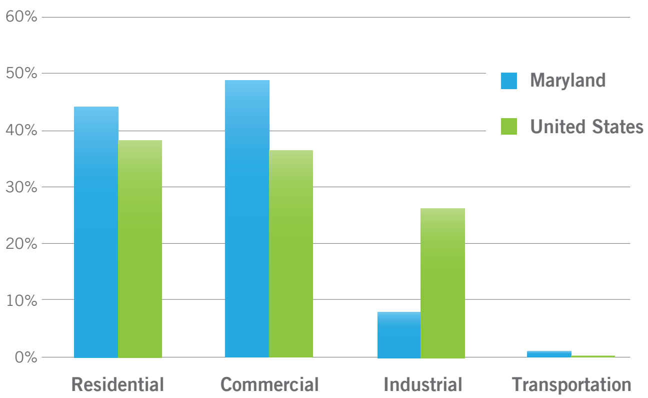
Electricity Sales in Maryland

At the beginning of 2009, only 2.8% of residential customers were being served by competitive suppliers (i.e., non-utility electricity suppliers), but by June 2014, 25% of residential customers had signed with competitive suppliers. By comparison, 34% of small commercial and industrial (C&I) customers were receiving competitive supply, while the majority of medium-to-large C&I customers were already purchasing electricity from competitive suppliers. About 60% of medium C&I customers and 87% of large C&I customers had signed with competitive suppliers by June 2014.

In 2013, Maryland's electricity users consumed approximately 62 million megawatt-hours (MWh) of electricity. Figure 3 shows the percentage of state retail electric sales by customer class. As shown in the figure, Maryland has a larger percentage of sales to residential and commercial customers than the Untitled States as a whole. Recent reductions in electricity consumption in Maryland have been outpacing those in the United States across all sectors.[2]

In 2013, electricity supply (i.e., generation) accounted for approximately 62% of electricity costs for Maryland's residential customers, 68% for commercial customers, and 71% for industrial customers. Transmission costs represented approximately 5% of the state's total costs for all customer classes. The remaining costs component (33% for residential, 27% for commercial, and 24% for industrial) was related to distribution charges. Figures 4 and 5 and Table 1 provide data on electricity rates in Maryland and the PJM region. Figure 5 shows that Potomac Edison, which serves customers in Western Maryland, has lower electricity prices as compared to the rest of the State's utilities. This price differential is mainly due to congestion between the western region of PJM, where abundant low-cost generation is located, and PJM's Mid-Atlantic region, where the large load centers are located.

Figure 3. *Distribution of Retail Electricity Sales in Maryland and the United States, 2013*



Source: U.S. Energy Information Administration.

[2] Maryland Power Plant Research Project, Cumulative Environmental Impact Report-17.

Maryland Electricity Imports

Although the exact percentage varies slightly from year to year, Maryland imported about 40% of its electricity supply in the past two years. Maryland's decreased level of in-state generation in recent years, relative to the earlier parts of the decade, can be partially attributed to record low prices for natural gas which have made imported electricity generated from gas more competitive than in-state generation from coal. As discussed in the generation section, Maryland's share of generation capacity from natural gas is relatively small compared to the rest of the United States.

Electricity (thousand MWh)

	Retail Sales (Consumption)	Sales + T&D Losses	Generation	Net Imports	Percentage of Sales Imported
2000	60,620	65,470	51,145	14,325	22%
2005	68,365	73,834	52,662	21,172	29%
2007	65,391	70,622	50,198	20,424	29%
2008	63,326	68,392	47,361	21,031	31%
2009	62,589	67,596	43,775	23,821	35%
2010	65,489	70,728	43,613	27,115	38%
2011	63,581	68,667	41,913	26,754	39%
2012	61,814	66,759	37,810	28,949	43%

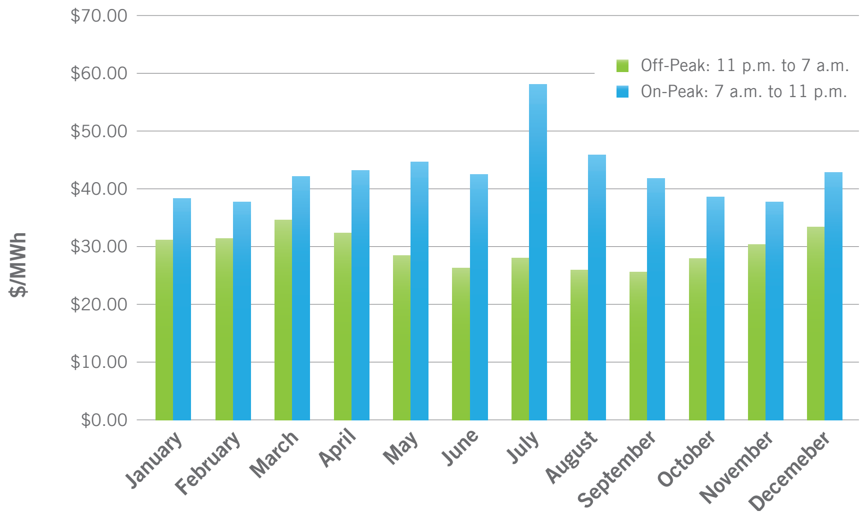
Source: U.S. Energy Information Administration.

Table 1. *Typical Prices for Electric Service, 2013*

	Residential	Commercial	Industrial
Typical usage billed (kWh/month)	1,000	10,000	50,000
Average per-kWh cost in Maryland (cents/kWh)	13.3	11.1	10.7
Average per-kWh cost in the Mid-Atlantic (cents/kWh)	15.5	13.8	8.6
Average per-kWh cost in the U.S. (cents/kWh)	12.4	10.5	6.9

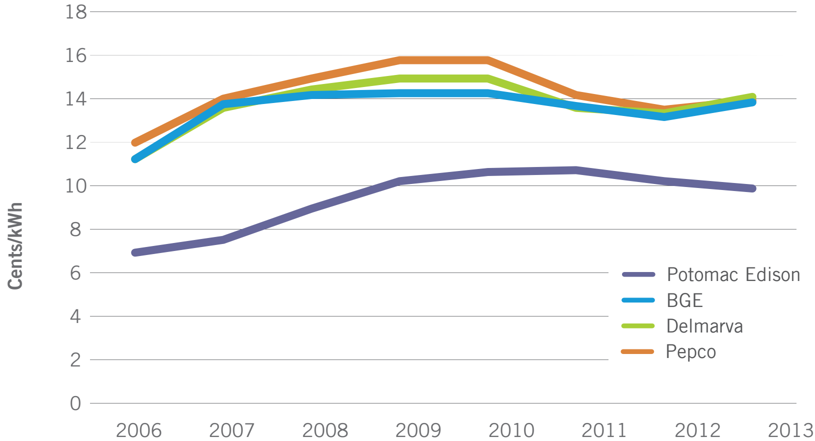
Source: *Edison Electric Institute, Typical Bills and Average Rates Report.*

Figure 4. *PJM Representative Peak and Off-Peak Wholesale Power Prices, 2013*



Source: Calculated from 2011 PJM hourly day-ahead locational marginal prices (LMPs) and hourly load data.

Figure 5. *Maryland Summer Electric Rates for Residential Standard Offer Service Customers*



Note: Includes generation, transmission, and distribution charges.

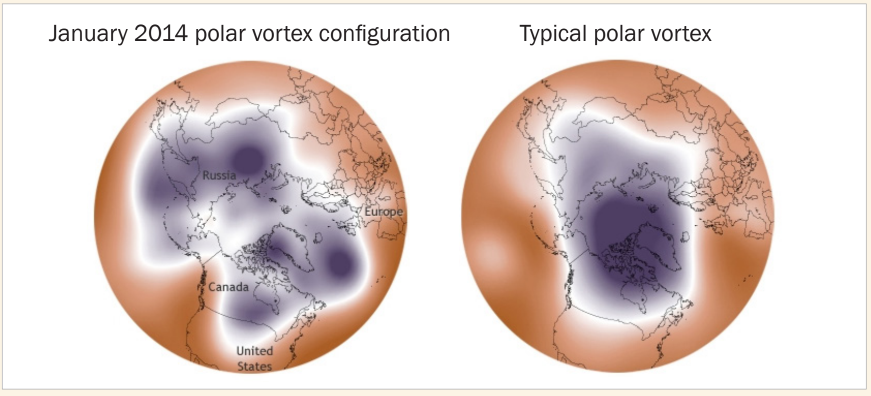
Source: *Edison Electric Institute, Typical Bills and Average Rates Report.*

Generation, Transmission, and Distribution

Currently in Maryland, 45 power plants with generation capacities greater than 2 megawatts (MW) are interconnected to the regional transmission grid. In aggregate, Maryland power plants represent more than 13,400 MW of operational capacity. The largest portion of Maryland's generating capacity comes from fossil fuels, with the remainder attributed to nuclear and renewables. In Maryland, there are more than 2,000 miles of transmission lines operating at voltages between 115 kilovolts and 500 kilovolts. There are 13 electric distribution utilities in Maryland serving about 2.5 million customer accounts. About 90% of these customer accounts are served by Maryland's four investor–owned utilities.

Electricity Price Spikes during the January 2014 Polar Vortex

The polar vortex is a high altitude low-pressure system that hovers over the Artic during winter (see figure below). From January 6–8, 2014, a polar vortex weather event brought prolonged, deep cold temperatures to the entire PJM region. System operators had to contend with record-high electricity use and significantly higher than normal generator outages. Because of heating needs, PJM demand for electricity set a new winter peak record of 141,846 MW the evening of January 7, but during the peak demand hour, 22% of generation capacity—including coal, gas, and nuclear—was out of service. Although power supplies were maintained without interruption, electricity prices increased significantly due to the generation shortage. On January 7, 2014, wholesale electricity prices in PJM exceeded $1,800 per MWh. This price was set by emergency DR offers, which meant that DR participants responded to calls for emergency energy and high prices to voluntarily curtail their use of electricity in exchange for curtailment payments. Due to the extreme weather during January 2014, the average wholesale electricity price in PJM was more than $110/MWh that month. By comparison, the average wholesale electricity price in PJM during January 2013 was only about $35/MWh— approximately one-third of the January 2014 average.



Source: National Oceanic and Atmospheric Administration.

Generation

In states with restructured markets, such as Maryland, electricity is generated by power companies that are separate from the entities responsible for transporting and delivering the resource to end-use customers. In order for a power company to construct or modify a generating facility (or transmission line) in Maryland, it must receive a Certificate of Public Convenience and Necessity (CPCN) from the PSC prior to the start of construction.

Maryland's CPCN Process for Generation

An approved CPCN constitutes permission to construct the facility and incorporates several, but not all, additional permits required prior to construction (such as air quality and water appropriation). Applications for a CPCN are reviewed before a Public Utility Law Judge in a formal adjudicatory process that includes written and oral testimony, cross examination, and the opportunity for full public participation. Parties to a CPCN licensing case include the applicant, PSC Staff, the Office of People's Counsel (acting on behalf of the Maryland ratepayers), and interveners such as Power Plant Research Program (PPRP) (acting on behalf of the Department of Natural Resources (DNR) and six other State agencies). Other groups, such as federal agencies and private environmental organizations, as well as individuals, also have a right to participate as interveners in these hearings. The broad authority of the PSC allows for the comprehensive review of all pertinent issues and was designed in 1971 to be a "one-stop shop" for power plant licensing. In recent years, PPRP has been involved in numerous CPCN cases representing several thousand megawatts of potential generating capacity at existing facilities and green field sites (see Table 2).

Table 2. *Recent CPCNs for Generation in Maryland*

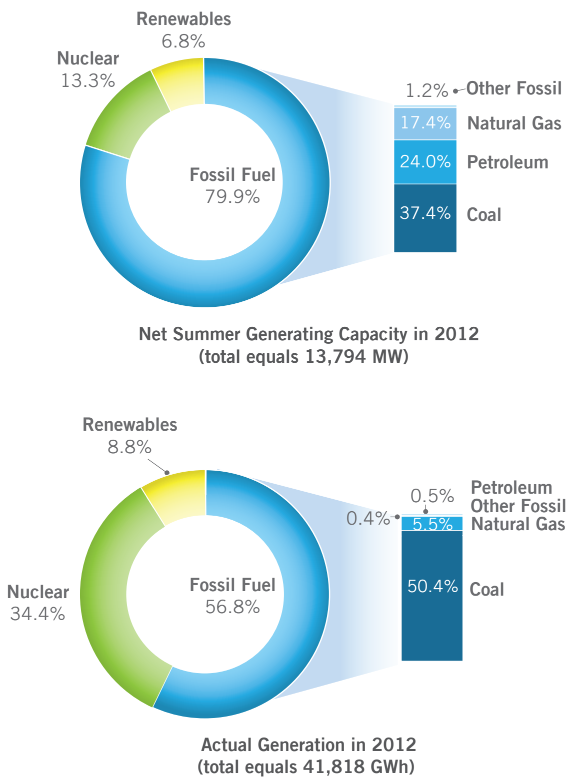
Facility Name	Proposed Size (MW)	CPCN Status	PSC Case Number*
Church Hill Solar	6	granted	9314
Cove Point Natural Gas	130	granted	9318
CPV St. Charles Natural Gas	725	granted	9280
Keys Energy Center Natural Gas	755	granted	9297
Maryland Solar	20	granted	9272
Mattawoman Energy Center Natural Gas	859	pending	9330
Old Dominion Natural Gas	1,000	granted	9327
OneEnergy Cambridge Solar	4.2	pending	9348
Perryman Natural Gas	120	granted	9136
Rockfish Solar	10	pending	9351

* More information regarding each application can be found by using the PSC's case seach tool on its website http://webapp.psc.state.md.us.

Generation Resources in Maryland

The largest new generation project recently issued a CPCN in the state is a 1,000 MW natural gas power plant that Old Dominion Electric Cooperative (ODEC) is building in Cecil County. In April 2013, ODEC asked the PSC for expedited approval of a CPCN for the project so that it could bid into PJM's May 2014 capacity auction (see page 15 for a description of PJM's capacity market). The project, which is called the Wildcat Point power plant, was approved by the PSC in March 2014, began construction in late 2014, and is expected to be online by June 2017.

Figure 6. *Power Plant Capacity (MW) and Generation (GWh) in Maryland by Fuel Category*

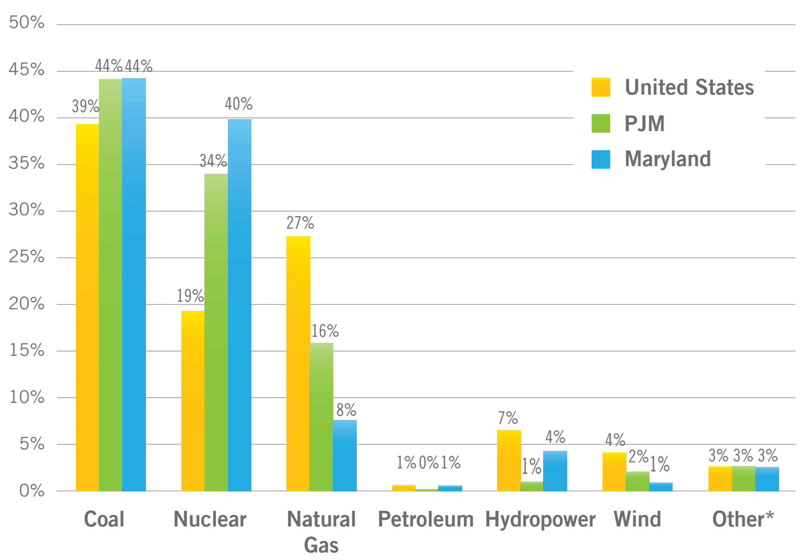


Source: U.S. Energy Information Administration.

Coal is the primary fuel used to generate electricity in Maryland, with nuclear power being the second-largest generation source. Maryland's coal-fired power plants typically supply about half of the state's annual electricity generation, while power from the state's only nuclear plant—the dual-unit Calvert Cliffs facility—typically supplies about one-third of annual generation. Much of the remaining generation is supplied by natural-gas-fueled plants, hydropower plants, and other renewable resources (see Figure 6).

Several major pipelines from the Gulf Coast region supply natural gas to Maryland markets. As shown in Figure 7, Maryland generates a larger portion of its electricity from coal and nuclear fuel than the United States as a whole, while natural gas is used to a larger extent by power plants in other areas of the country compared to Maryland. This is expected to change in the coming years as older coal-fired generators are retired and new natural gas-fired generators, such as the ODEC plant discussed above, come online. Maryland has less renewable generation than the United States as a whole due to the geographic nature of the State. The heartland of the United States has much better wind resources than Maryland, and there are limited opportunities to utilize hydroelectric resources in Maryland.

Figure 7. *Electric Generation by Fuel Type for the United States, the PJM Region, and Maryland, 2013*



*"Other" includes both fossil and renewable fuels, including: solar, blast furnace gas, biomass, methane, tired derived fuels, and other fuels not otherwise explicitly represented in the figure.

Source: U.S. Energy Information Administration.

Note: Totals may not add up to 100% due to independent rounding.

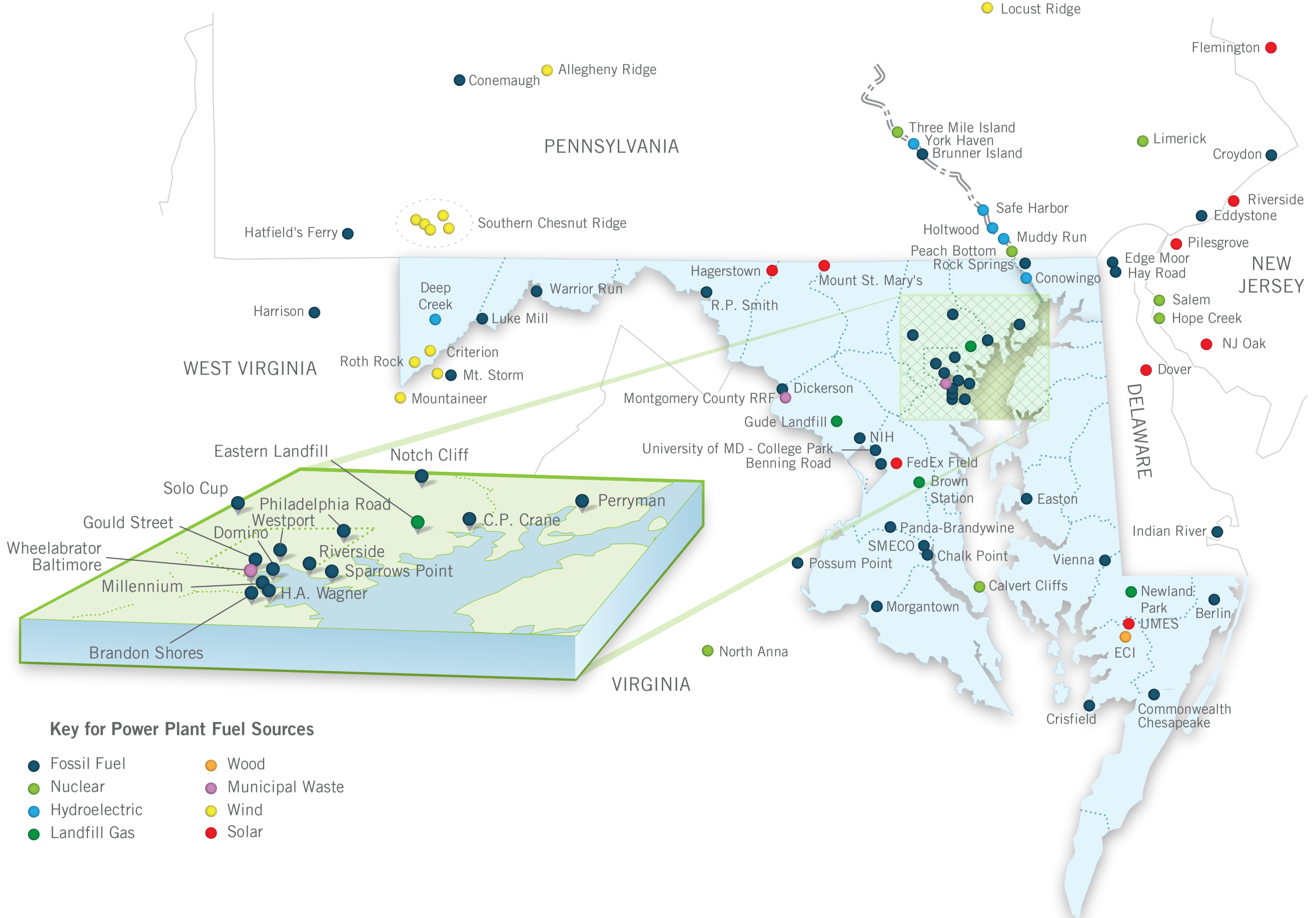
Table 3. *Operational Generating Capacity in Maryland (>2 MW)*

Owner	Plant Name	Fuel Type	Nameplate Capacity (MW)
Independent Power Producers			
AES Enterprise	Warrior Run	Coal	229
BP Piney & Deep Creek, LLC	Deep Creek	Hydroelectric	20
Calpine Corporation	Crisfield	Oil	10
Eastern Landfill Gas	Eastern Landfill	Landfill Gas	3
Exelon Generation	Calvert Cliffs	Nuclear	1,829
	Conowingo	Hydroelectric	572
	Criterion Wind Park	Wind	70
	Gould Street	Natural Gas	104
	Mount Saint Mary's	Solar	16
	Notch Cliff	Natural Gas	144
	Perryman	Oil/Natural Gas	404
	Philadelphia Road	Oil	83
	Riverside	Oil/Natural Gas	244
	Westport	Natural Gas	121
First Solar, Inc.	Hagerstown	Solar	20
INGENCO	Newland Park Landfill	Landfill Gas	3
Montgomery County	Resource Recovery Facility (RRF)	Waste	68
Northeast Maryland Waste Disposal Authority	Gude & Oaks Landfills	Landfill Gas	3
NRG Energy	Chalk Point	Coal/Oil/ Natural Gas	2,563
	Dickerson	Coal/Oil/ Natural Gas	930
	FedEx Field Solar Facility	Solar	2
	Morgantown	Coal/Oil	1,548
	Vienna	Oil	183
Panda Energy	Brandywine	Natural Gas	289
Pepco Energy Services	National Institutes of Health	Natural Gas	23
Prince George's County	Brown Station Road	Landfill Gas	6

Owner	Plant Name	Fuel Type	Nameplate Capacity (MW)
Gestamp Wind	Roth Rock Wind Facility	Wind	50
Raven Power Holdings, LLC	Brandon Shores	Coal	1,273
	C.P. Crane	Coal/Oil	399
	H.A. Wagner	Coal/Natural Gas/Oil	976
Suez Energy North America	Millennium Hawkins Point	Oil/Natural Gas	11
	University of Maryland – College Park	Oil/Natural Gas	27
SunEdison	University of Maryland - Eastern Shore	Solar	2
Wheelabrator Technologies	Wheelabrator Incinerator (formerly BRESCO)	Waste	65
Publicly Owned Electric Companies			
Town of Berlin	Town of Berlin	Oil	9
Easton Utilities	Easton	Oil/Biodiesel	69
Old Dominion Electric Cooperative	Rock Springs	Natural Gas	770
Southern Maryland Electric Cooperative (SMECO)	SMECO Solar	Solar	5
	Chalk Point Turbine	Natural Gas	84
Self-Generators			
American Sugar Refining Co.	Domino Sugar	Oil/Natural Gas	18
Hilco Industrial	Sparrows Point	Natural Gas/Blast Furnace Gas	120
Maryland Department of Public Safety and Corrections	Eastern Correctional Institution (ECI) Cogeneration Facility	Wood	4
New Page	Luke Mill	Coal	65
Solo Cup	Solo Cup – Owings Mills	Natural Gas	11

Source: Maryland Power Plant Research Project, *Cumulative Environmental Impact Report-17.*

Figure 8. *Location of Power Plants In and Around Maryland*



Key for Power Plant Fuel Sources

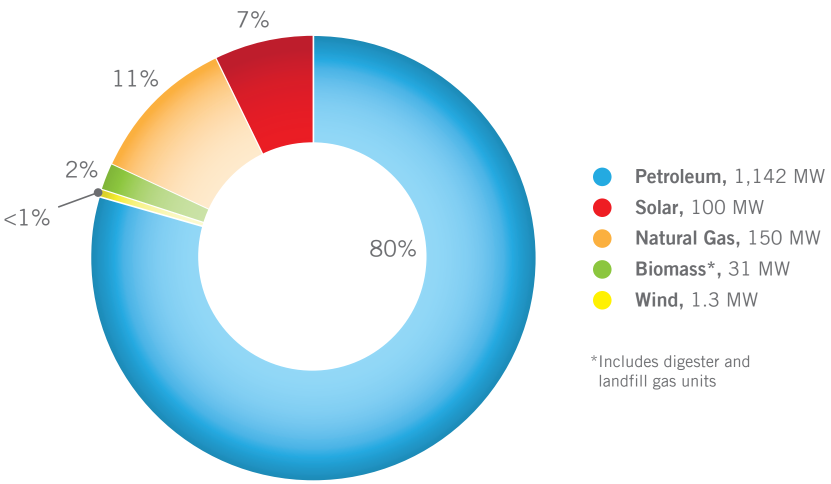
- Fossil Fuel
- Nuclear
- Hydroelectric
- Landfill Gas
- Wood
- Municipal Waste
- Wind
- Solar

Distributed Generation

It is difficult to accurately estimate the total amount of DG in Maryland, as the majority of DG units are diesel-fired, emergency back-up generators. However, an increasing share of this capacity comes from solar energy, which is predominantly grid-tied for the purposes of net metering and generating solar renewable energy credits (SRECs) for sale or trade. Net metering is a billing mechanism that allows DG owners to be credited for excess electricity that is added to the grid. In other words, under a net metering arrangement, a DG customer's electric meter can run backwards when the DG system is generating more electricity than the customer is consuming. SRECs are used to comply with Maryland's Renewable Energy Portfolio Standard (RPS), which is described on page 22.

Onsite generators with capacity less than 1,500 kilowatts (kW) are not required to apply for a CPCN through the PSC. Certain generators, including most solar DG, that have a capacity of 1,500 kW to 70 MW are eligible to seek a CPCN exemption. As of the end of 2013, a total of about 1,575 MW of generation capacity had been granted CPCN exemptions in Maryland, including 61.8 MW of solar capacity and 190 MW of onshore wind power. Under net-metering arrangements, 100 MW of solar DG and 1.3 MW of small wind facilities had been installed in Maryland by mid-2013 (see Figure 9).

Figure 9. *Distributed Generation Capacity in Maryland, 2013*



Source: Maryland Power Plant Research Project, Cumulative Environmental Impact Report-17.

PJM Capacity Market

PJM operates a forward capacity market, in which an auction is conducted three years in advance of the need for generation capacity, where load serving entities (LSEs, for example, Baltimore Gas and Electric) purchase supply-side and demand-side capacity resources.[3] Each LSE is required to have available its share of the PJM system peak plus a reserve margin of an additional (approximately) 15% of peak load. This means that the system as a whole must always have more generation capacity available than what is expected to be required to meet peak loads so that extra electricity generation can be brought into use if needed, e.g., in the event of an unplanned outage of one or more large generating plants or extreme weather conditions.

The current PJM capacity market is based on PJM's Reliability Pricing Model (RPM), implemented in 2007 as a means to provide power plant developers with price signals to influence decisions on whether (and where) to construct new power plants and to provide owners of existing generation with price signals to influence decisions on whether to retire existing plants. The RPM is an approach developed by PJM and used to provide a market price for capacity that is aligned with PJM's assessment of the cost of new entry, i.e., the level of revenue that a power plant developer would require in order to make the decision to develop peaking resources economically feasible. The approach also recognizes and accommodates higher capacity prices when PJM is capacity short and lower prices when excess capacity exists.

The RPM establishes capacity prices that are determined through an auction three years in advance of the need for generation capacity resources. The most recent auction, which occurred in May 2014 for the 2017/2018 delivery year (i.e., June 1, 2017 through May 31, 2018), cleared 167,004 MW of unforced capacity in the PJM region.

Fundamentally, capacity market prices are determined through the intersection of a demand curve and a supply curve (i.e., the equilibrium market clearing price):

The Demand Curve–the downward sloping demand curve, referred to by PJM as the Variable Resource Requirement (VRR), is developed for the PJM region and also for the locational delivery areas (LDAs). This curve is plotted on a graph with dollars per MW-day on the vertical axis and MW of capacity (or percentage of reliability requirement) on the horizontal axis.

The Supply Curve–the supply curve is obtained by PJM through the capacity bids offered by the capacity owners. Eligible capacity includes existing and new capacity, demand-side resources (e.g., load response), and qualified transmission upgrades. The capacity offers from the auction are stacked (lowest cost to highest cost), resulting in an upward sloping supply curve. The auction clearing price is determined by the intersection of the VRR and the supply curve (the auction bids).

[3] An LSE is any entity that (a) serves end-users located in PJM, and (b) is granted the authority or has an obligation pursuant to state or local law, regulation, or franchise to sell electric energy to end-users located in PJM.

Transmission

The transmission grid conveys electricity over a system of high-voltage electric lines that extend between electric generators and distribution companies. Proper coordination and planning of the transmission system is critical to maintaining electric reliability and providing adequate power supplies at reasonable prices. The map in Figure 10 illustrates the extent of Maryland's existing transmission network. FERC regulates the transmission of electricity, natural gas, and oil in the United States. In regard to the electricity industry, FERC is responsible for regulating the transmission system and wholesale sales of electricity, ensuring the reliability of high-voltage transmission systems, and monitoring and investigating the energy markets. For more information, visit FERC's website (www.ferc.gov).

Under Maryland regulations, an electric company that is planning to construct a transmission line greater than 69 kilovolts (kV) in Maryland must receive a CPCN from the PSC prior to the start of construction. The PSC considers impacts on Maryland's resources (e.g., land use impacts) and requires a thorough environmental and socioeconomic impact evaluation as part of the CPCN approval process for transmission projects in Maryland. Table 4 summarizes the recent projects for which CPCN permits have been obtained.

Table 4. *Recent CPCNs for Transmission in Maryland*

Line Name	Developer/ Owner	Size (kV)	Approximate Length in MD (miles)	Affected MD Counties
Monocacy-Ringgold-Carroll Modification	Potomac Edison	230	13	Washington, Frederick, Carroll
Northwest-Deer Park	BGE	115	3	Baltimore, Carroll
Conastone-Graceton	BGE	230	2	Harford
Church-DE/MD State Line	Delmarva	138	11	Queen Anne's
Bagley-Graceton	BGE	230	14	Harford
Church-Wye Mill	Delmarva	138	26	Queen Anne's
Cecil to MD/ DE State Line	Delmarva	138	2	Cecil
Northeast Transmission System	BGE	230	21	Harford, Baltimore
Mt. Storm to Doubs	Potomac Edison	500	3	Frederick
Burtonsville to Takoma	Pepco	230	10	Montgomery

Source: Maryland Power Plant Research Program, *Cumulative Environmental Impact Report-17*.

Regional transmission organizations are responsible for operating and controlling transmission assets, providing equal-access wholesale transmission services, and administering the wholesale electricity and ancillary services market within a geographic region. Independent system operators (ISOs) perform similar functions; however, in contrast to RTOs, they have not sought formal RTO status from FERC, or they do not meet one of FERC's characteristic or functional RTO criteria. The concept and regulatory construct governing these organizations was created by FERC as a mechanism to facilitate the many transactions that take place when states, like Maryland, introduce competitive electricity supply.

PJM is the FERC-regulated RTO that dispatches and coordinates the flow of bulk power across the District of Columbia and all or parts of the following 13 states: Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, and West Virginia. PJM routinely examines proposed transmission projects to determine if they are economically justified and would produce an overall system benefit. Authorized transmission upgrades to improve system reliability could potentially alleviate congestion costs in Maryland. PJM's 2013 Regional Transmission Expansion Plan authorized 10 transmission upgrades for Maryland and the District of Columbia, with each costing more than $5 million. Together, the upgrades cost approximately $179.2 million. Also, Edison Electric Institute highlighted six ongoing transmission upgrades within Maryland totaling approximately $469 million. According to the Public Service Commission of Maryland's *Ten-Year Plan (2014-2023) of Electric Companies in Maryland*, there are 45 identified transmission enhancement accounting for more than 239 miles of upgrades.

PJM zones are organized according to the service territories of the distribution utilities. To establish energy prices, PJM uses a uniform price auction based on locational marginal prices (LMPs), which vary across PJM zones and time of day. Electricity generators bid the amount of energy they would like to sell at a particular time and price. In the wholesale electricity market, LMPs vary because of physical system limitations, congestion, and loss factors. Table 5 shows the average annual LMPs for 2013.

Table 5. *Average Annual LMPs, 2013*

Maryland	$43.59	Pennsylvania	$39.15
Delaware	$41.01	Washington D.C.	$43.27
Ohio	$36.34	West Virginia	$36.19

Source: U.S. Energy Information Administration.

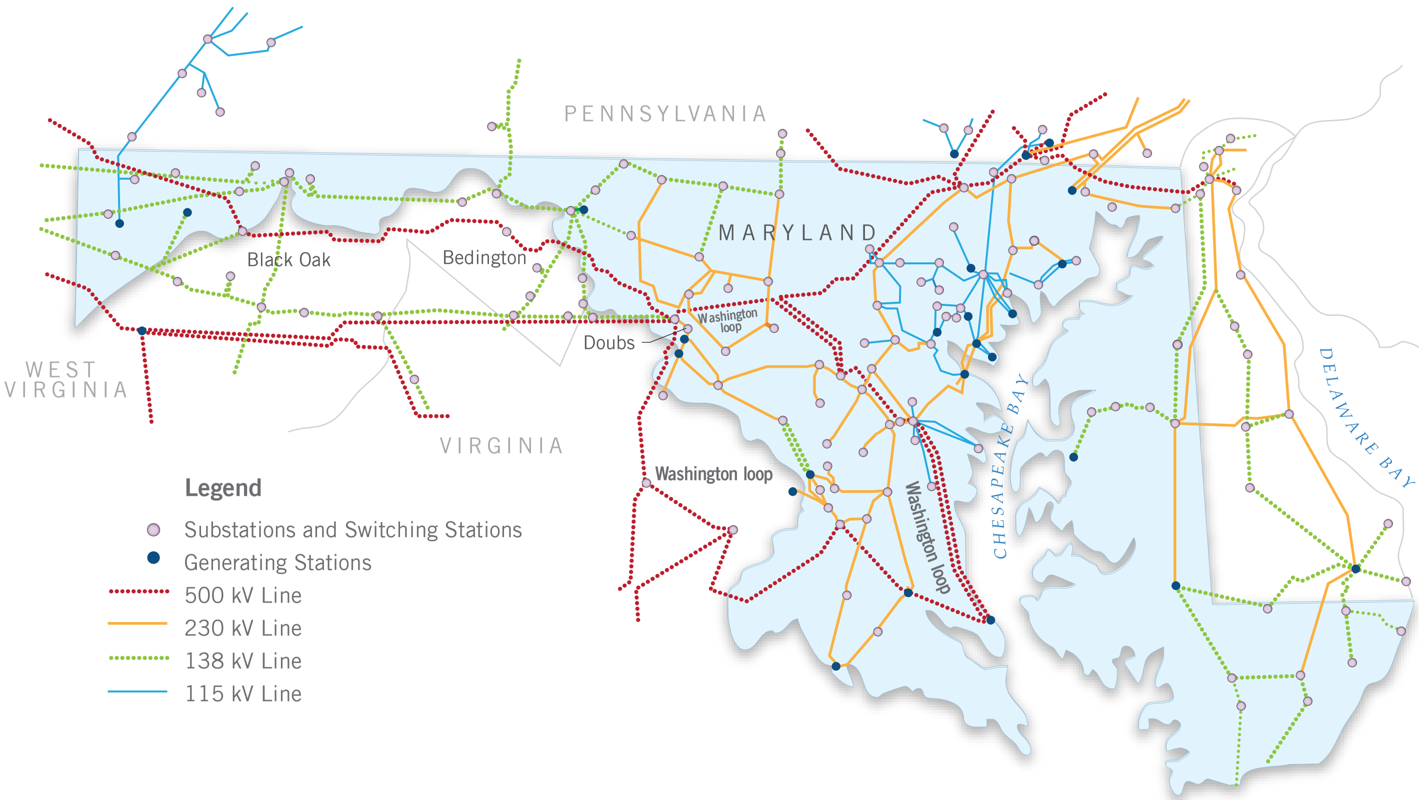


Figure 10. *Transmission Lines in Maryland*

Distribution

Distribution is the process by which electricity is physically delivered to end users. The Maryland PSC regulates and recognizes electric companies' monopoly franchise function to deliver electricity to all customers within their respective service areas. As part of the monopoly franchise arrangement, distribution companies are subject to price and other regulations by the PSC.

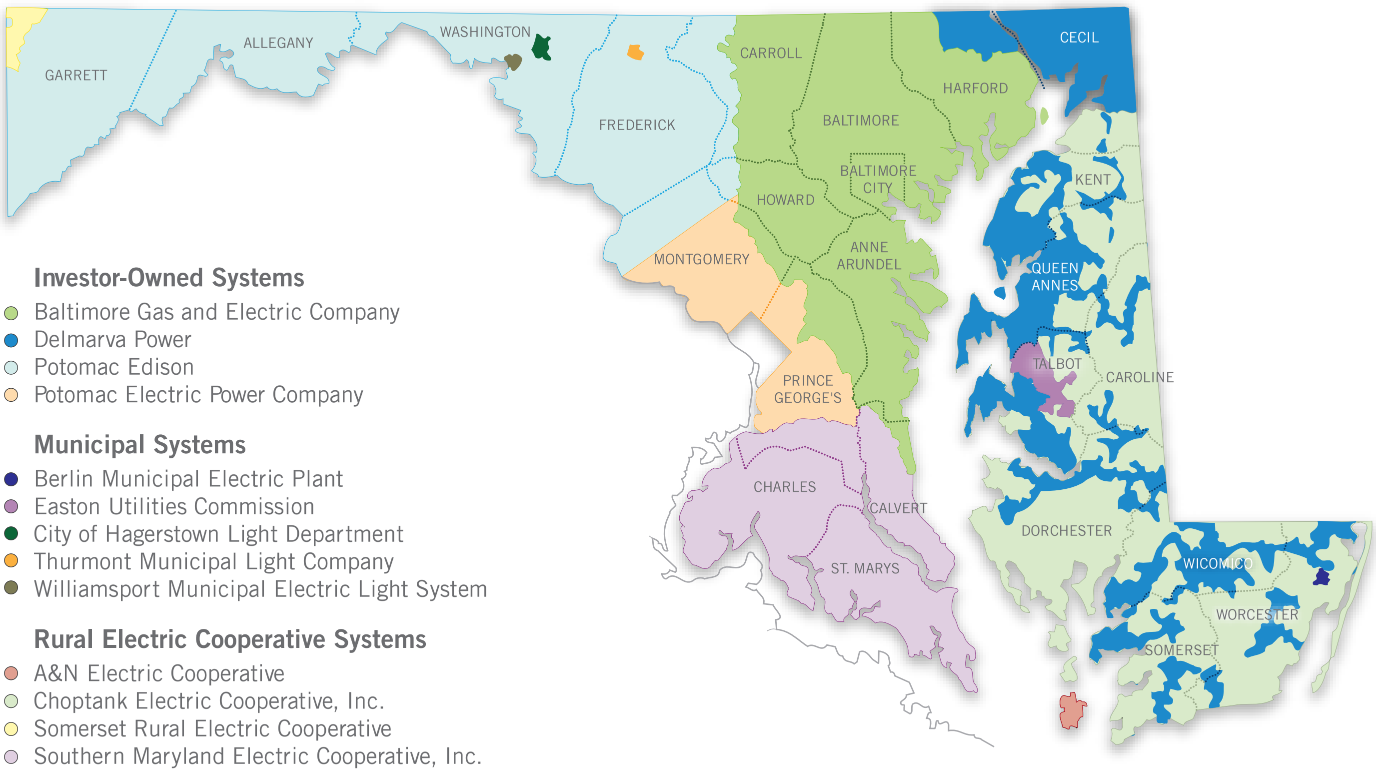
There are 13 electric distribution utilities in the State of Maryland (see Figure 11) that serve about 2.5 million electricity customer accounts. Of these, four are investor-owned systems, five are municipal systems, and four are electric cooperatives. As shown in Table 6, about 90% of Maryland's electric service is provided by the four investor-owned utilities. The remaining customers are served by municipal systems and rural electric cooperatives.

Table 6. *Maryland Electric Distribution Companies*

Company	Approximate Number of Maryland Customers
Investor-Owned Systems	**90.3%**
Baltimore Gas and Electric Company	1,240,300
Delmarva Power	199,400
Potomac Edison	252,800
Potomac Electric Power Company	531,200
Municipal Systems	**1.4%**
Berlin Municipal Electric Plant	2,400
Easton Utilities Commission	10,500
City of Hagerstown Light Department	17,400
Thurmont Municipal Light Company	2,800
Williamsport Municipal Electric Light System	1,000
Rural Electric Cooperative Systems	**8.3%**
A&N Electric Cooperative	300
Choptank Electric Cooperative	52,000
Somerset Rural Electric Cooperative	800
Southern Maryland Electric Cooperative	151,700
Total	2,462,700

Source: Maryland Power Plant Research Program, *Cumulative Environmental Impact Report-17.*

Figure 11. *Maryland Electric Distribution Service Territories*



Microgrids and Resiliency in Maryland

On June 23, 2014, the Maryland Energy Administration released the *Resiliency through Microgrids Task Force Report*, charting a path forward for microgrid deployment in Maryland. The report is the result of roundtable meetings with representatives from Maryland's government agencies, sister states, project developers, utilities, and non-profit think tanks, as well as ratepayer advocates, regulatory lawyers, and university and law school professors. As defined by the Task Force, a "microgrid" is a collection of interconnected loads, generation assets, and advanced control equipment installed across a defined geographic area that is capable of disconnecting from the macrogrid (i.e., the utility scale electric distribution system) and operating independently. The Task Force focused on microgrids serving the public good, termed "public purpose microgrids", and recommended that Maryland pursue the development of public purpose microgrids for uninterrupted electric service to critical community assets such as community centers, commercial hubs, and emergency service complexes. The Task Force also recommended that Maryland create a Grid Transformation Program to help facilitate its recommendations, and that Maryland launch three new grant programs for public purpose microgrid projects, advanced controls, and energy storage.

Maryland's Efforts to Improve Grid Resiliency

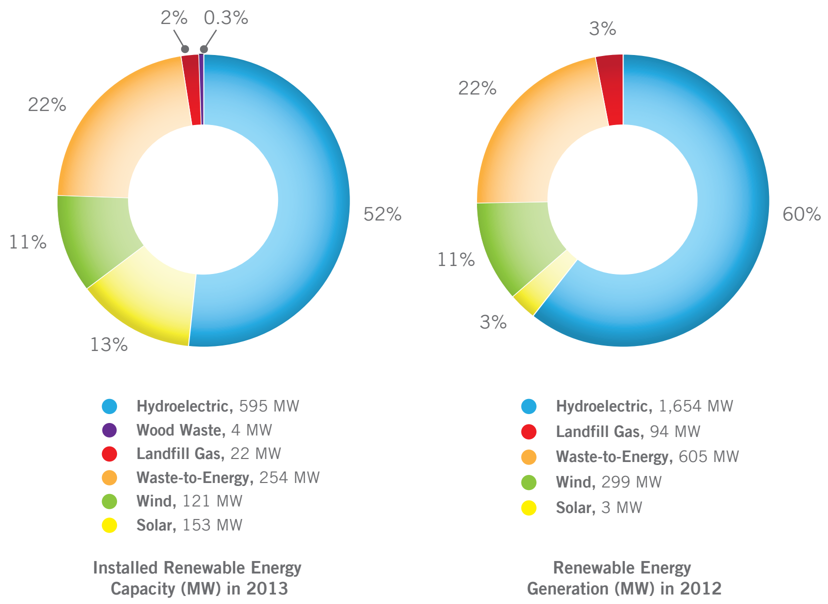
Following several incidents of storms and outages in Maryland during 2010 and 2011, the PSC initiated Rulemaking 43 to consider revisions to state regulations in regard to electric company reliability and service quality standards. On April 17, 2012, regulations were adopted to include new requirements and stricter standards. Examples include 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% of the time; 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; and a requirement for periodic equipment inspections.

Shortly after the 2012 derecho, Maryland issued a comprehensive report, *Grid Resiliency Task Force: Weathering the Storm*, and published interactive maps of both the Pepco and BGE service territories. The maps display those areas that experienced outages after major storms from 2010–2012. In addition, the report details a list of specific technology, infrastructure, regulatory, and process recommendations to improve the resiliency of Maryland's electric distribution grid.

Renewable Energy and Energy Efficiency

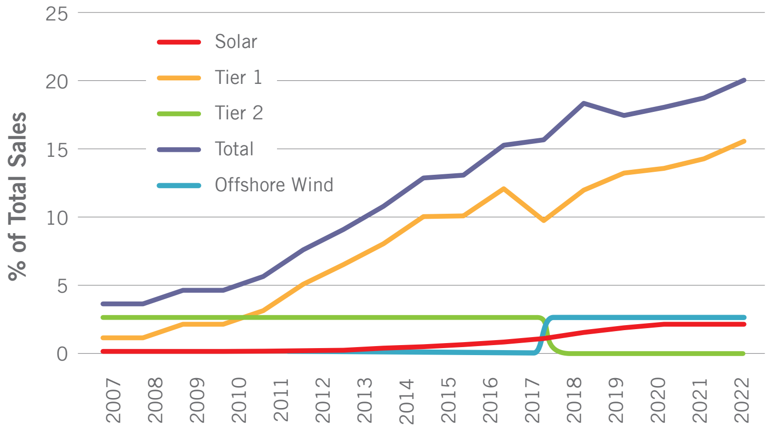
There are four main types of renewable energy resources in use in Maryland: wind, biomass, solar, and hydropower. Approximately 1,150 MW of generation capacity in Maryland comes from these resources, with hydroelectric accounting for the largest share (see Figure 12). In 2004, Maryland's State Legislature established the Maryland Renewable Energy Portfolio Standard (RPS), which requires electricity suppliers to obtain an increasing percentage of their power from renewable energy sources (see Figure 13). The RPS has been amended numerous times over the past decade; the most recent significant legislation affecting the RPS was passed in 2013 to include a carve-out specifically for offshore wind energy. For more information about Maryland's renewable resources, as well as their eligibility for inclusion in the RPS, follow the Program Activities link on the Maryland Power Plant Research Program website (www.pprp.info).

Figure 12. *Renewable Energy in Maryland*



Source: Maryland Power Plant Research Project, *Cumulative Environmental Impact Report-17.*

Figure 13. *Maryland RPS Requirements*



Source: Maryland Offshore Wind Energy Act of 2013; Maryland House Bill 226; 2013.

Notes: The Tier 1 line represents the remaining portion of the Tier 1 requirement after netting out the solar and offshore wind carve-outs. The offshore wind carve-out does not come into effect until 2017, coinciding with the time that the Tier 2 requirement declines to zero.

Solar

Maryland has several policies in place that encourage the deployment of solar energy systems. One such policy is the state's RPS, which calls for 20% renewable energy by 2022, with 2% coming from solar energy sources by 2020. Solar systems must be connected to the distribution grid in Maryland to be eligible. Load-serving entities can self-generate solar power, purchase SRECs, or pay the solar alternative compliance payment of up to $400 per MWh (declining through time)—providing a financial incentive to homeowners, businesses, and independent developers to install solar renewable energy systems.

As of late 2013, there were more than 5,400 in-state solar projects representing more than 150 MW of generating capacity in the state. While most of the facilities are smaller than 10 kW, at least seven systems larger than 1 MW have come online. Maryland's solar RPS resources generated 82,610 MWh of renewable electricity in 2012. Based on expected electricity consumption in 2020, about 1,150 MW of solar capacity is required to be operational in Maryland to meet the 2020 solar requirement, meaning that Maryland's solar generation must grow by about 30% per year.

Wind

Wind power is one of the most affordable, scalable, and deployable renewable energy sources in the region. There are seven land-based wind turbine projects under development in the State of Maryland—each in various stages of permitting, construction, and operation. The Backbone Mountain ridge line in Garrett County already supports two utility-scale wind facilities: the 70 MW Criterion Wind Park and the 50 MW Roth Rock Wind Energy Farm. Their combined power capacity of 120 MW is estimated to represent less than 10% of Maryland's onshore wind resource potential. The five other projects—representing about 420 MW of wind-power capacity—are currently in the planning and development stages. For more information about renewable wind energy, visit MEA's website (http://energy.maryland.gov).

Offshore Wind Energy

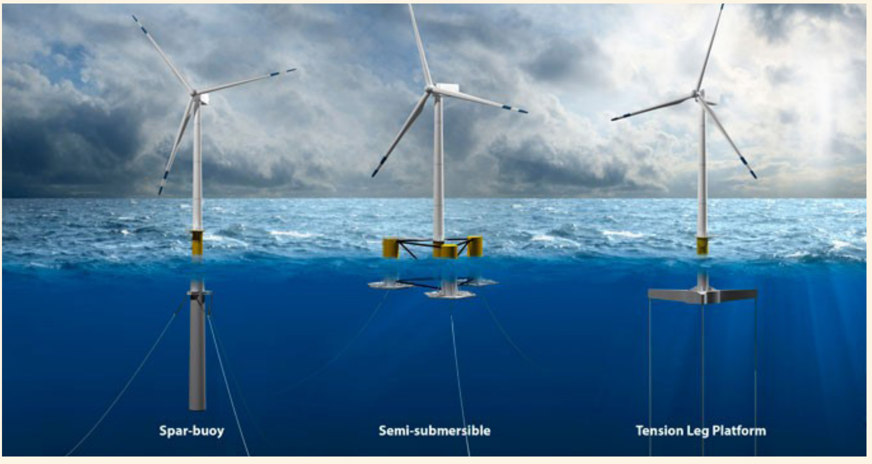
According to the National Renewable Energy Laboratory (NREL), the United States may have a usable offshore wind resource capacity of more than 4,000 GW, with approximately 480 GW to 570 GW of that potential in the Mid-Atlantic region. NREL estimates that Maryland alone has an unrestricted offshore wind power capacity in excess of 25 GW. A report prepared by the University of Delaware suggests that after accounting for possible conflict areas, Maryland's wind resource potential is likely closer to 13 GW.

The Maryland Offshore Wind Energy Act of 2013 (the Offshore Wind Act) creates a mechanism to incentivize the development of up to 500 MW of offshore wind capacity, at least 10 nautical miles off of Maryland's coast. The Offshore Wind Act creates a "carve-out" for energy derived from offshore wind within the state RPS. The carve-out requires that a portion of state electricity sales must come from offshore wind power facilities beginning in 2017 and for every following year. The amount of offshore energy required each year is set by the PSC, is based on the projected annual creation of "offshore wind renewable energy credits" by qualified offshore wind projects, and may not exceed 2.5% of total retail sales. The Offshore Wind Act establishes an application and review process for the PSC for proposed offshore wind projects and limits rate impacts to both residential and nonresidential electric customers. The electric bills of residential customers are limited to a $1.50 per month increase, while commercial customers are limited to a 1.5% increase.

Under the Energy Policy Act of 2005, the U.S. Department of the Interior's Bureau of Ocean Energy Management (BOEM) is the lead federal agency responsible for issuing leases in federal waters (greater than 3 nautical miles from shore) for ocean energy technologies. BOEM held a lease sale (i.e., a competitive auction) on August 19, 2014, for the Wind Energy Area (WEA) identified off Maryland's coast. The WEA shown in Figure 14 covers approximately 80,000 acres and is located about 10 nautical miles off the coast of Ocean City, Maryland. BOEM auctioned the Maryland WEA as two leases—referred to as the North Lease Area (32,737 acres) and the South Lease Area (46,970 acres).

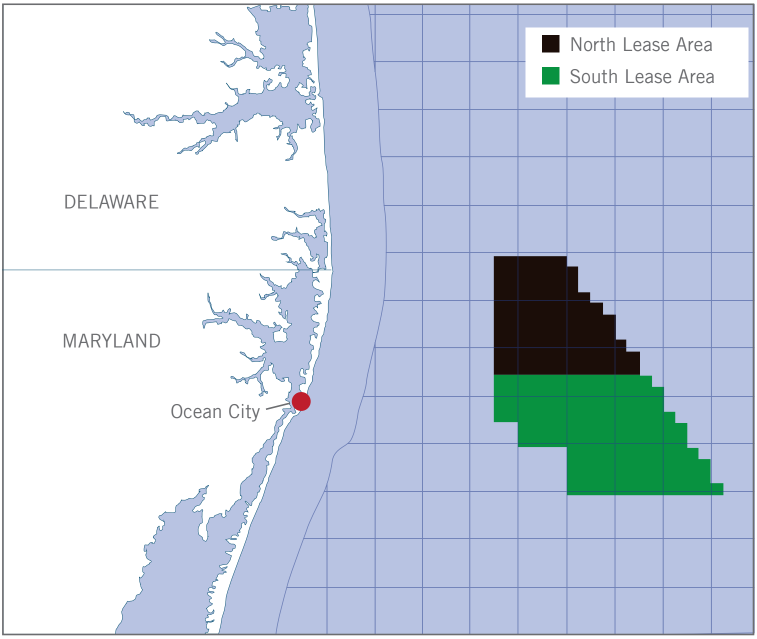
Engineering Concepts for Offshore Wind Turbines

Manufacturers are currently working to develop large wind turbines capable of generating significantly more electricity than traditional onshore wind turbines. Modern land-based, commercial-scale wind turbines typically have a rated capacity between 1.5 MW and 3 MW, but offshore turbines are projected to be in the 10 MW–20 MW range. Support structure designs for large offshore wind turbines are still in the research and development stage and continue to evolve over time. Offshore turbines have historically been installed primarily in relatively shallow water (up to 30 meter [~100 ft] depth) on a mono-pile structure that is essentially an extension of the tower. Other concepts that are more appropriate for deeper water depths include fixed-bottom, space-frame structures (such as jackets and tripods); floating platforms (such as spar-buoys and semi-submersibles); and tension-leg platforms.



Source: Josh Bauer and National Renewable Energy Laboratory.

Figure 14. *Map of the Maryland Wind Energy Area*



Source: U.S. Department of the Interior, Bureau of Ocean Energy Management.

Energy Efficiency and Demand Response

Reductions in energy usage by Maryland electricity consumers can come from energy efficiency, conservation, or demand response. Energy efficiency means using less energy to accomplish the same work. Conservation means making conscious changes in behavior in order to use less energy (or other resources). Demand response means reducing the demand for electricity when prices are high by using efficiency, conservation, or alternative sources of electricity.

In July 2007, the state introduced EmPOWER Maryland, which aims to cut Maryland's per capita energy consumption and peak demand by 15% by 2015. By the end of 2013, the EmPOWER Maryland utilities' portfolio of energy efficiency, conservation, and direct-load control programs have resulted in energy savings of 61% of the 2015 EmPOWER Maryland goal, while peak-demand reductions accounted for 73% of the 2015 EmPOWER Maryland goal. Overall, these programs have achieved 1,538 MW in reported peak-demand reductions and more than 3.3 million MWh in reported energy savings.

Plug-In Electric Vehicles in Maryland

Over the next couple of decades it is expected that increasing electrification of the transportation sector in the form of plug-in electric vehicles (PEVs) will have a significant effect on the electricity system. As discussed in *Maryland Power Plants and the Environment* (CEIR-17), integrating PEV charging into the electric grid comes with both costs and benefits. For more information related to the impact of PEVs on the electric grid, please visit: http://pprp.info/ceir17/HTML/Chapter5-5-4.html.

As the EmPOWER Maryland legislation did not set goals beyond 2015, the state is actively coordinating with various utility, environmental, and industry stakeholders to plan for the next phase of EmPOWER Maryland. In September 2014, the state's utilities submitted plans to the Maryland PSC for achieving EmPOWER Maryland targets for the next three years.

Demand response allows end-use customers to reduce their energy consumption during periods of high demand (and high prices). Voluntary usage reductions can come from customers of all sizes. Large industrial customers may choose to shift some high-energy-intensity processes to lower-cost hours. Small residential consumers can cycle air conditioning and electric water heaters. When aggregated across thousands of customers, these residential energy-use reductions can create significant savings during times of peak demand. For more information, visit the MEA website (http://energy.maryland.gov/).

Avoided Energy Costs in Maryland

In April 2014, PPRP and MEA released *Avoided Energy Costs in Maryland*, a report that provides a set of estimates of the avoided costs associated with electric energy efficiency and conservation in Maryland implemented through the state's EmPOWER Maryland initiative. The report provides a common framework and methodology that can be used to estimate the value of future energy efficiency and conservation measures in Maryland. The avoidable cost components analyzed in the report include electric energy, electric capacity, renewable energy, transmission and distribution, demand reduction induced price effects, natural gas, other fuels, and water and wastewater.

Policy

There are several state and federal policies with which Maryland must comply in order to help reduce the environmental impacts of the state's electricity sector.

State and federal regulations continue to be developed to address air quality. The Maryland Healthy Air Act of 2006 required 15 coal-fired generating units at seven power plants in Maryland to make substantial reductions in the emission of nitrogen oxides (NO_x), sulfur dioxide (SO_2), and mercury (Hg). In September 2014, Maryland proposed regulations to reduce emissions of NO_x from coal-fired powers further, under the Reasonably Achievable Control Technology (RACT) program. In addition, the Maryland Legislature passed the Greenhouse Gas Emissions Reductions Act of 2009, committing the state to reduce greenhouse gas emissions by 25% below 2006 levels by 2020. To achieve this goal, the state is an active member of the Regional Greenhouse Gas Initiative, a market-based system for reducing carbon dioxide (CO_2) emissions from power plants. Maryland has also committed to other regional initiatives, such as the Low-Carbon Fuel Standard and the implementation of greenhouse gas reporting and control technology regulations.

At the federal level, the U.S. Environmental Protection Agency (EPA) has promulgated numerous regulations targeted at reducing emissions from fossil-fuel-fired power plants. Among the more important federal regulatory initiatives are the Clean Air Interstate Rule (CAIR) which—like the Maryland Healthy Air Act—regulates NO_x and SO_2 emissions, and the Mercury and Air Toxics Standards (MATS), which is targeted at reducing hazardous air pollutant emissions from power plants. In June 2014, the EPA proposed the Clean Power Plan , which calls for a 30% reduction in carbon emissions from 2005 levels by 2030. The proposal provides state-by-state interim CO_2 reduction goals to be achieved by 2030 with the option of achieving interim goals by 2020. In addition to these regulations targeted at reducing emissions, the EPA has proposed stringent revisions to the National Ambient Air Quality Standards (NAAQS) for ozone, which will require further reductions in NO_x and volatile organic compound (VOC) emissions from power plant and other major air emission sources in the state.

Also in 2014, EPA finalized new standards under the Clean Water Act to minimize fish mortality from water withdrawals for cooling at power plants. Under this new rule, existing facilities are required to use additional water withdrawal methods and technologies that reduce fish mortality, and new units at these facilities are required to use technology with withdrawal rates equivalent to closed-loop cooling towers.

Figure 15 illustrates some of the most significant effects associated with nuclear, fossil-fuel-fired, and hydroelectric generation—the technologies that provide the great majority of Maryland's electricity supply. For more information about these topics, as well as the potential impacts from other generating technologies (e.g., wind power), access the Maryland Power Plants and the Environment report (Cumulative Environmental Impact Report-17) on the Power Plant Research Program's website (www.pprp.info).

Figure 15. *Environmental Impacts of Energy-Generating Technologies*

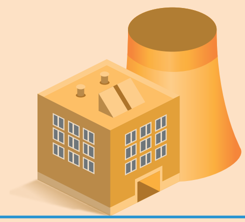
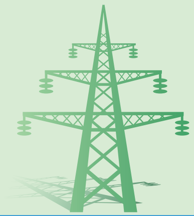
INPUTS

WATER - Surface and ground water withdrawals may reduce the amount available for other users.

Large volume withdrawals of surface water for cooling can affect small fish or other aquatic organisms drawn into cooling systems.

FUEL - Potential impacts to water and land can result from oil and gas drilling, mining for coal and uranium, as well as accidental spills and releases.

LAND USE - The operation of transmission facililities requires no fuel or water, but can consume and/or alter significant land areas.

FOSSIL FUEL PLANT	NUCLEAR PLANT	TRANSMISSION
		

OUTPUTS/EFFECTS

FOSSIL FUEL PLANT

AIR EMISSIONS

- Nitrogen oxides (NO_x)
- Sulfur dioxide (SO_2)
- Mercury
- Greenhouse gases
- Particulate matter

SOLID BY-PRODUCTS

- Ash
- Scrubber sludge

NUCLEAR PLANT

RADIOLOGICAL WASTE

- **High-level waste (spent fuel):** Spent nuclear fuel is stored onsite under stringent Nuclear Regulatory Commission guidelines.
- **Low-level waste:** Solid waste that is contaminated with radiation is trucked offsite for disposal at a licensed radioactive waste-handling site.

TRANSMISSION

Transmission line construction can have significant effects on plants and animals:

- Alteration of wildlife habitat
- Forest fragmentation, especially as it affects bird species
- Disturbance associated with construction that crosses wetlands or streams.

WATER DISCHARGES

Any generating facility with steam turbines likely utilizes water for cooling purposes.

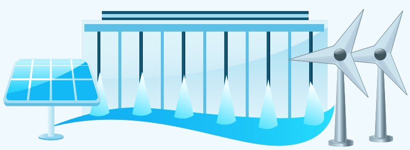
Discharges from once-through cooling systems can create thermal plumes (warm areas) in receiving water bodies. Power plant discharges can also carry small amounts of chlorine or other chemicals used to control biofouling in cooling systems.

LAND USE - The operation of some renewable energy facililities requires no fuel or water, but can consume and/or alter significant land areas.

FUEL - Burning waste or biofuel to generate electricity can help reduce the volume of waste going to landfills and conserve other fuel resources.

INPUTS

HYDROELECTRIC, WIND & SOLAR



Renewable energy facilities can affect plants and animals and their habitats

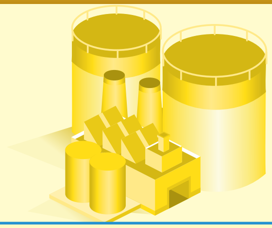
- Alteration of habitat from impounded rivers
- Loss of wildlife habitat from facility installation
- Direct impacts to fish, birds, and bats

WATER DISCHARGES

(from hydroelectric facilities)

Releases from hydroelectric reservoirs can make temperature and dissolved gas levels unsafe for native aquatic species.

WASTE/BIOFUEL PLANT



- Similiar air emissions to those produced from fossil fuel combustion
- Ash (if solid waste is burned)

WATER DISCHARGES

Any generating facility with steam turbines likely utilizes water for cooling purposes.

Discharges from once-through cooling systems can create thermal plumes (warm areas) in receiving water bodies. Power plant discharges can also carry small amounts of chlorine or other chemicals used to control biofouling in cooling systems.

OUTPUTS/EFFECTS

References for Additional Information

Maryland Agencies and Related Publications

Power Plant Research Program (PPRP)– http://www.pprp.info/

Maryland Power Plants and the Environment (CEIR 17th Edition) – December 2014

Provides information on the effects of power generation on Maryland's natural resources.

Avoided Energy Costs in Maryland – April 2014

An assessment of the costs avoided through energy efficiency and conservation measures in Maryland.

Long-Term Electricity Report for Maryland: Reference Case Update – May 2013

Update to the 2011 comprehensive assessment of approaches to meet Maryland's long-term electricity needs, examining sustainable energy challenges and assessing electric energy and peak demand requirements

Maryland Energy Administration (MEA)– http://energy.maryland.gov/

MEA promotes affordable, reliable, and clean energy. MEA's programs and policies help lower energy bills, fuel the creation of green collar jobs, address environmental and climate impacts, and promote energy independence. Visit MEA's website to learn more about Maryland's goals and energy use — and to find out what you can do to make smart energy choices.

Maryland Department of the Environment (MDE)– http://www.mde.state.md.us/

Maryland's Greenhouse Gas Reduction Act Plan – October 2013

Plan to achieve the 25% reduction in greenhouse gasses, as required by the Maryland Greenhouse Gas Emissions Reduction Act, while also creating jobs and improving Maryland's economy.

Maryland Public Service Commission (PSC) – http://www.psc.state.md.us/

Ten-Year Plan (2014 – 2023) of Electric Companies in Maryland – August 2014

Includes a compilation of information pertaining to the long-range plans of Maryland's electric companies.

The EmPOWER Maryland Standard Report of 2014 – March 2014

Contains a summary of energy efficiency/conservation and demand response program achievements; progress on advanced meter infrastructure initiatives; and information on forthcoming milestones.

RPS Report to the General Assembly 2014 – January 2014

Highlights data from Maryland electricity suppliers' 2012 compliance reports and relevant data such as the renewable facilities certified by the State of Maryland.

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

This Fact Book has been prepared by PPRP as a service to electricity users in Maryland. It is intended to provide current information on power generation in the state for the use of state agencies, industrial and residential electricity consumers, and the interested public.

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 biennially produces a Cumulative Environmental Impact Report (CEIR), which provides information on the effects of power generation on the state's natural resources. A bibliography listing the general and site-specific reports that PPRP has produced since the early 1970s is also available.

For more information, or to request a copy of the CEIR, bibliography, or other reports, contact PPRP at (410) 260-8660 or visit its website at www.pprp.info.

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