Chapter 4 – Energy Policy and Technology for a Sustainable Future

Ere many generations pass, our machinery will be driven by a power obtainable at any point of the universe.

– Nikola Tesla
"Experiments with Alternate Currents of High Potential and High Frequency," 1892

Our energy future is complex; it is interrelated with a variety of environmental and social issues. This chapter discusses a wide variety of issues related to sustainable energy and how Maryland is seeking to craft a more sustainable energy future. It also puts these sustainable energy efforts within the context of federal initiatives and technological advances.

4.1 Electricity Policies for Sustainability

Presently, only a small amount of Maryland's electricity comes from renewable energy sources. Fossil fuels are a finite resource and continuing to rely on fossil fuel generation almost exclusively is unsustainable in the long run. Technological advancements and the use of renewable sources are necessary to support sustainable electricity generation. Equally important is the implementation of effective energy efficiency and conservation measures that reduce the need for additional generation resources. The State continues to evaluate policies that encourage energy innovation, energy efficiency, conservation, and renewable resource development.

4.1.1 Maryland RPS

The Renewable Portfolio Standard (RPS) became Maryland law in May 2004. Electricity suppliers are required to purchase a certain percentage of their electricity resources from Maryland-certified Tier 1 and Tier 2 renewable resources.

- *Tier 1 renewable resources include fuel cells that produce electricity from other Tier 1 resources, geothermal, hydroelectric facilities under 30 MW, methane, ocean, poultry litter-to-energy, qualifying biomass, solar, and wind.*
- *Tier 2 resources include municipal waste-to-energy projects and existing hydroelectric facilities over 30 MW. Tier 1 resources can be used to meet the 2.5 percent Tier 2 standard.*

In April 2007, Governor Martin O'Malley signed House Bill 1016 revising the RPS to include a specific solar energy requirement. This requirement starts at 0.005 percent in 2008 and grows to 2 percent by 2022. The new legislation increased the total annual Tier 1 renewable requirement by an amount equal to the solar energy component each year — for instance, 2 percent Tier 1 plus 0.005 percent additional solar requirement for the 2008 compliance year. House Bill 375 passed during the 2008 legislative session amended the RPS regulations by accelerating the renewable requirement, increased the Tier 1 non-compliance penalty, and decreased the eligible facilities geographic footprint (effective 2011). The total Tier 1 renewable energy requirement now increases steadily to reach 18 percent (without solar) by 2022 and facilities can be in PJM adjacent control areas if the electricity is delivered to the PJM region.

Figure 4-1 Maryland RPS Summary

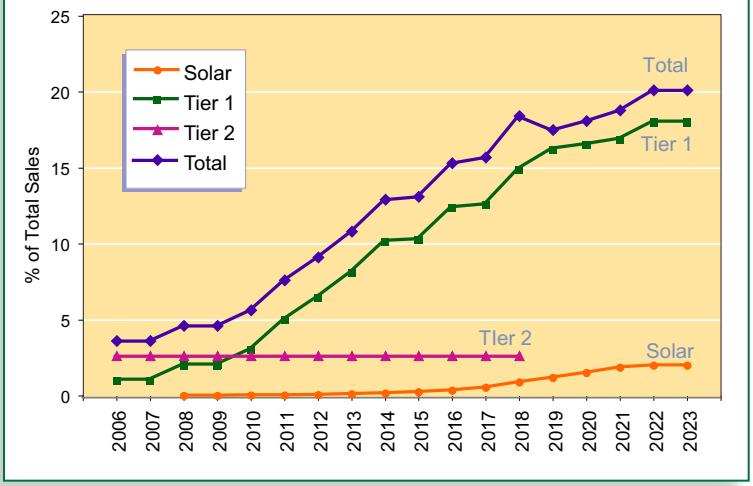


Figure 4-1 illustrates the renewable shares that are required, shown as a percentage of total energy sales and increasing over time. If a supplier does not provide the required amount of renewable electricity to their customers, it must pay $0.04 for each kilowatt-hour (kWh) short of the Tier 1 resource requirement and $0.015 for every kWh short of the Tier 2 requirement. The noncompliance penalties for the solar energy component of the RPS started at $0.45 per kWh in 2008 and decrease $0.05/kWh every other year to be $0.05/kWh by 2023. Owners of Maryland solar power facilities must first offer their renewable energy credits for sale to a local electricity supplier, for a minimum contract term of 15 years, under the solar RPS legislation. Facilities with generating capacity of 10 kW or less will receive upfront a lump sum payment for the estimated output over the life of the contract.

The PSC is charged with ensuring compliance with the RPS and certifying eligible facilities. Certifying a renewable energy facility requires due diligence in determining whether each facility meets the standards set forth in the Maryland RPS Program. To qualify, the facility must operate within the PJM footprint, a PJM adjacent state, or a PJM adjacent control area if the electricity is delivered into PJM, and must be classified as a either a Tier 1 facility or Tier 2 facility. As of the end of 2008, there were 174 renewable energy facilities certified with the Maryland RPS Program providing over 5,700 MW of capacity in 13 states (see Table 4-1).

Table 4-1 Maryland RPS Certified Capacity in MW

	Tier 1						Tier 2		
Facility Location	**Biomass (Black Liquor)**	**Biomass (Wood)**	**Landfill Gas**	**Hydro**	**Solar**	**Wind**	**Hydro**	**Municipal Solid Waste**	**Total**
Maryland	65		6.7	9.6	0.03		474	223.2	778.6
Delaware									0
Illinois			78.3			518.4			596.7
Michigan	67.1	109.3	36.2						212.6
New Jersey			34.5					59	93.5
New York			40	494.5			150.9		685.4
North Carolina		50	5.3	5			112		172.3
Ohio	92.8	16.5							109.3
Pennsylvania	109.7	16.2	108.2	42.7		198.5	352.1		827.3
Tennessee			3.2					84.7	87.9
Virginia	89.6	94.9	14.2	7.5				60	266.2
West Virginia				6		494	168.8		668.8
Wisconsin			27.7						
Iowa			705			200			905
Indiana						300			300
Total	424.2	286.9	1,059.3	565.3	0.03	1,710.9	1,257.7	426.9	5,703.6

The first compliance year was 2006 and electricity suppliers were required to submit the compliance reports by April 1, 2007. For all years thereafter, compliance reports must be submitted by April 1 of the following year. For 2006 and 2007 almost all Maryland electricity suppliers were in compliance. Table 4-2 shows the aggregate supplier obligation and the REC or fees submitted.

The 2008 RPS compliance year is the first year with a solar energy requirement (0.005 percent). As can be seen from Table 4-2, most suppliers opted to pay the solar compliance fees, resulting in revenues to the state of $1.236 million. This was partly due to a lack of available solar RECs as very few solar facilities had made it through the RPS approval process. Several new solar facilities have been approved by the PSC recently and the pace of solar development has been increasing in the area, which may increase the availability of solar RECs for the 2009 compliance year.

Table 4-2 Maryland RPS Compliance

	RPS Obligation			RPS Compliance Submissions			
Utility	Tier 1		Tier 2	Tier 1 RECs		Tier 2 RECS	Compliance Fee
2006	520,073		1,300,201	552,874		1,322,069	$38,209
2007	553,612		1,384,029	553,374		1,382,874	$6,374
		Solar			Solar RECs		
2008	1,183,400	2,900	1,479,300	1,184,500	227	1,569,000	$ 1,236,000

Federal RPS Proposals

For several years, federal legislators have been expressing interest in creating a national RPS where a set percentage of all electricity produced and sold in the U.S. will be required to come from federally mandated renewable resources. Most recently, three bills have been introduced in 2009 aiming to establish a national-level renewable energy requirement.

In January 2009, Natural Resources Committee Chairman Jeff Bingaman (D-NM) released draft discussion legislation that would require utilities to obtain 20 percent of their electricity generation resources from renewables by 2021. In February 2009, Representatives Markey (D-MA) and Platts (R-PA) introduced H.R. 890, the American Renewable Energy Act, which would require electric utilities to obtain 25 percent of electric energy needs from renewable sources by 2025. Later in February 2009, Senator Tom Udall (D-NM) introduced a third RPS bill (S.433) that also requires utilities to obtain 25 percent of their electricity requirements from renewables by 2025. Senator Udall's legislation, however, exempts all municipal retail electric suppliers and rural electric cooperatives. And, on April 1st, Chairman Henry Waxman of the Energy and Commerce Committee and Chairman Edward Markey of the Energy and Environment Subcommittee and Select Committee on Global Warming released a discussion draft of the American Clean Energy and Security Act of 2009 (ACESA). ACESA is primarily a climate change bill that aims to create a national greenhouse gas cap-and-trade program but also contains an RPS provision. In June 2009, the House passed the ACESA. Table 4-3 outlines the main points of the bills being considered.

These bills set requirement amounts similar to the existing Maryland RPS legislation. The Maryland RPS requires that retail suppliers of electricity provide 18 percent from Tier 1 renewable resources and 2 percent solar by 2022. The federal legislation however, does not

Table 4-3 Federal RPS Legislation in the 111th Congress

Provision	Bingaman S. 1462	Markey-Platts H.R. 890	Udall S. 433	Waxman-Markey H.R. 2454
Required Annual Percentage of Renewable Generation	4% in 2011 8% in 2015 16% in 2020 20% in 2021-2039	6% in 2012 8.5% in 2015 17.5% in 2020 25% in 2025-2039	6% in 2012 8.5% in 2015 17.5% in 2020 25% in 2025-2039	6% in 2012 9.5% in 2015 20% in 2020 20% in 2021-2039
Regulated Entities: minimum generation threshold	All electric utilities that sell more than 4 million MWh annually. Hawaii is exempt.	All electric utilities that sell more than 1 million MWh annually.	Privately owned utilities that sell more than 1 million MWh annually. Hawaii is exempt.	All electric utilities that sell more than 1 million MWh annually.
Eligible Renewable Energy Sources	Wind, solar (not solar thermal), geothermal, biomass, landfill gas, ocean energy, and incremental hydropower.	Wind, solar (not solar thermal), geothermal, biomass, landfill gas, marine and hydrokinetic, and qualified hydropower.	Wind, solar (not solar thermal), geothermal, biomass, landfill gas, ocean, tidal, other hydrokinetic, and incremental hydropower.	Wind, solar, geothermal, biomass, landfill gas, marine and hydrokinetic, fuel cells.
Alternative Compliance Payment	3 cents/kWh (adjusted for inflation)	The lesser of 200% of the average market value of a renewable energy credit or 5 cents/kWh (adjusted for inflation).	The lesser of 200% of the average market value of a renewable energy credit or 3 cents/kWh (adjusted for inflation).	The lesser of 200% of the average market value of a renewable energy credit or 5 cents/kWh (adjusted for inflation).

Source: Solar Energy Industry Association and NREL, "Federal RPS Bill Comparison," Webinar presentation, April 7, 2009.

contain a solar set-aside and would not include the small retail suppliers currently included in the Maryland RPS. Additionally, the federal definition of biomass would exclude the use of black liquor, a resource category that is substantially utilized by Maryland retail suppliers to meet their RPS compliance obligations.

Federal RPS legislation has been introduced in past sessions and faced considerable opposition. Some of the issues being expressed with respect to this year's legislation include:

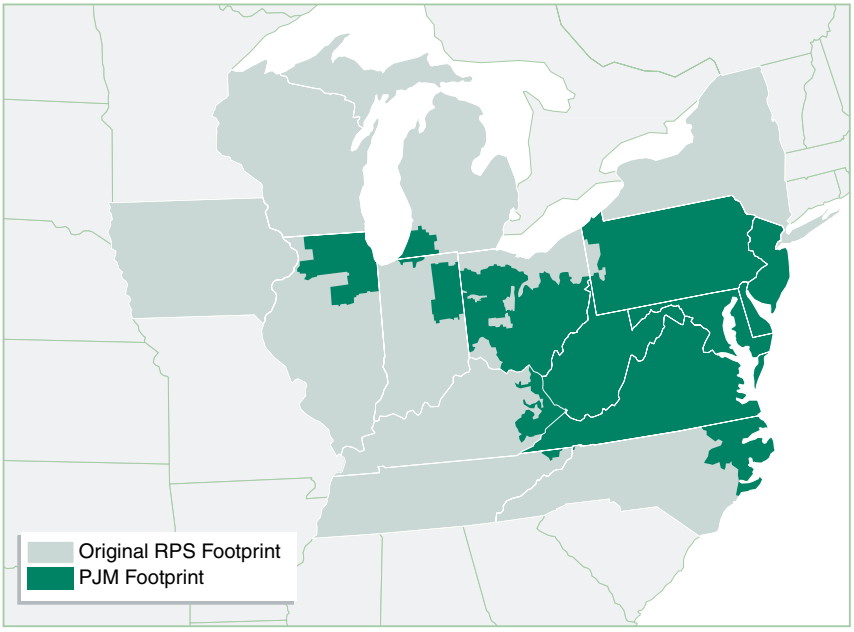
- *The bills give the U.S. DOE full control over the RPS and do not require cooperation with state-level agencies.*
- *The bills do not address the differences between states with respect to the amount and quality of renewable resources available in their respective jurisdictions. Some states do not have adequate renewable resources to meet a federal RPS and will be forced to rely on renewable energy credit purchases from other jurisdictions, a situation that could create winning and losing states.*
- *The nation's transmission grid will need significant upgrading to be able to integrate such large amounts of variable renewable resources. The bills do not discuss how adequate transmission infrastructure will be enabled to allow the federally mandated level of renewable resources on the grid.*
- *Existing state-level RPS programs vary greatly in their requirements. The federal bills do not discuss how the federal requirements would be harmonized with states that have a renewable energy requirement in excess of the level contained in federal legislation.*

4.1.2 Demand Side Resources

With the move to retail competition and electricity restructuring, Maryland investor-owned utilities phased out nearly all of the demand side management programs that characterized utility resource plans throughout the late 1980s and early to mid-1990s. The view of most utilities and the PSC was that the newly developed retail electricity supply market would include a range of energy efficiency and demand side management initiatives as part of suppliers' competitive service offerings. However, below-market retail electricity prices and low rates of customer switching provided few incentives for the development of demand side service offerings on the part of retail electricity suppliers. The rise in electricity prices and increasing concerns over electric supply adequacy has spurred new interest

How the RPS Footprint Will Change Starting in 2011

The Maryland RPS defines an eligible resource as renewable energy facilities located in the PJM Interconnection region or in a state that is adjacent to the PJM Interconnection region. This broad geographic footprint includes 16 states and the District of Columbia. The Maryland General Assembly made changes to the Maryland Renewable Energy Portfolio Standard in 2007 to shrink the geographic footprint to include resources located within the PJM Regional Transmission Organization. This change comes into effect on January 1, 2011. This policy is more consistent with the RPS policies of other PJM states and serves to better direct investment in renewable energy resources to those facilities located within the electricity network serving Maryland. Resources outside of PJM may still contribute to the RPS policy, but only if the electricity is delivered into the PJM system. The map to the right demonstrates the impact of the change to the RPS statute which becomes effective January 1, 2011.



in developing demand side resources in Maryland. Maryland utilities, the PSC, and State agencies have been actively pursuing demand side strategies for the last two years. As a result, demand side management has been utilized as a resource in the PJM auctions (see Appendix B for further information).

EmPOWER Maryland

In July 2007, Governor Martin O'Malley announced a new energy initiative called EmPOWER Maryland with a goal of reducing Maryland's per capita energy consumption and peak demand by 15 percent by 2015. This initiative was encoded into law in 2008 with House Bill 374, the EmPOWER Maryland Energy Efficiency Act of 2008 (EPM Act). The EPM Act requires the utilities to develop and implement cost-effective energy efficiency and conservation measures and demand response plans to achieve electric consumption and peak demand reductions on the following schedule:

- *Per capita electricity consumption: five percent reduction by the end of 2011 and 10 percent by the end of 2015, from 2007 levels.*
- *Per capita peak demand: five percent reduction by the end of 2011, 10 percent by the end of 2013, and 15 percent by the end of 2015, from 2007 levels.*

The EPM Act requires that programs contained in the utility plans be cost effective and for the impact of programs on "low-income communities" and "low-to moderate-income communities" to be specifically considered and evaluated. The EPM Act directs utilities to develop plans for all customer sectors — residential, commercial, and industrial. The PSC is directed to consider whether each program is cost-effective and adequate to achieving the EMP goals, and also to assess the program's potential impacts on electricity rates, jobs, and the environment. The PSC and utility programs are responsible for 10 percent of the consumption goal, with the remaining five percent reduction in per capita electricity consumption to be achieved through the State-administered programs and changes to codes and standards. Additionally, the initiative contains several measures to help State

EmPOWER Maryland at the Department of Agriculture

In September 2008, the Maryland Department of General Services (DGS) announced an energy efficiency performance contract that will save the Maryland Department of Agriculture (MDA) more than $4.36 million over 14 years. The project for the Wayne A. Cawley, Jr. headquarters building in Anne Arundel County will include lighting retrofit upgrades, water conservation retrofits, building envelope improvements, renewable technology, HVAC upgrades, direct digital controls, facility maintenance services, and measurement and verification services.

The project will be funded through energy-related savings as MDA's headquarters building implements measures to provide approximately a 31 percent reduction in utility costs. In addition, the project will reduce green house gases including 2.98 million pounds of carbon dioxide or the same amount of CO_2 emitted by powering 120 homes, within the life of the contract. Energy Performance Contracts provide another tool in meeting the requirements of the State Buildings Energy Efficiency and Conservation Act (2006-Senate Bill 267) which requires DGS, in cooperation with the Maryland Energy Administration, to set specified energy performance standards requiring a five percent reduction of energy consumption in State buildings by 2009 and 10 percent by 2010.

government reduce its own power consumption 15 percent by 2015, such as improving building operations, expanding the use of Energy Performance Contracting, purchasing ENERGY STAR products, and expanding the State Agency Loan Program and the Community Energy Loan Program to provide additional loans for state and local agencies to fund energy efficiency and conservation activities.

EmPOWER Maryland Utility Energy Efficiency and Conservation Programs

The utilities have been developing energy reduction plans and submitting them for approval with the PSC. The PSC has conducted an extensive review of these plans to ensure they are cost effective and contain methods for reducing impacts on low-income customers. The first programs were approved in August 2008, with most of the others gaining approval in December 2008. A few additional programs are still under consideration as the utilities continue to conduct cost and impact analyses. The programs being offered by utilities mainly take the form of rebates for ENERGY STAR products, energy audit and retrofit assistance, and incentives for energy efficient new construction. All of the utilities offer some form of rebate program for purchasing CFLs, energy efficient refrigerators, and room air conditioners. Some of the programs include rebates for other appliances such as water heaters, clothes washers, and heat pumps. Rebate programs for central heating and cooling systems are also being offered. All of the utilities have been directed to include a series of programs targeting low-income consumers. Low-income programs generally include most of the residential programs offered to all customers but are delivered to low-income consumers on a reduced or no-cost basis. Table 4-4 shows the programs being offered by the utilities and the percentage of each utility's EMP Act energy reduction goals the programs are expected to achieve.

EmPOWER Maryland – Maryland Energy Administration Programs

The Maryland Energy Administration is also sponsoring several programs to help meet the EMP Act goals. MEA's administers the following programs:

- *Home Performance with ENERGY STAR program – trains and certifies contractors to perform energy audits and install whole-house energy improvement;*
- *Green Building Tax Credit – provides a tax credit of up to eight percent of the total cost for constructing a certified green building;*
- *State Agency Loan Program – provides loans to State agencies for cost-effective energy efficiency improvements in State facilities; and*
- *Jane E. Lawton Conservation Loan Program – provides loans to local governments, nonprofits, and businesses in the state to install energy conservation improvements.*

EmPOWER Maryland Utility Demand Response Programs

Demand response activities can change how energy is utilized in order to make more efficient use of existing resources. This can involve installing automated control systems to turn out lights, power down equipment when it is not in use, and cycling air conditioners and heaters on and off. This can also consist of changing the patterns of energy use, such as shifting some activities from peak times to a time when energy is less in demand overall

Table 4-4 Maryland Utility Energy Efficiency and Conservation Programs

Residential Programs:	Allegheny Power	BGE	Delmarva Power	Pepco
CFL Rebates	✔	✔	✔	✔
ES Refrigerator Rebates	✔	✔	✔	✔
ES Appliance Rebates	✔	✔		
ES Water heater Rebates			✔	✔
Room Air Conditioner Rebates	✔	✔	✔	✔
Heat Pump Rebates	✔			
HVAC Rebates		✔	✔	✔
Home Energy Audits		✔		
Home Performance with ES	✔	✔	✔	✔
New Construction		✔		
Low Income Program	✔	✔	✔	✔
General Awareness Program	✔	✔	✔	✔
Commercial and Industrial Programs:				
Lighting Fixture Rebates	✔	✔	✔	✔
AC Rebates	✔		✔	✔
Heat Pump Rebates	✔		✔	✔
Building Re-Commissioning Incentives		✔	✔	✔
Retrofit Incentives		✔		
Small Business, Audits & Incentives		✔		
Motor & Equipment Rebates	✔		✔	✔
Custom Business Flexible Rebates	✔	✔	✔	✔
2011 EMP Energy Target Projected to Achieve	90%	52%	55%	67%
2015 EMP Energy Target Projected to Achieve	93%	63%	61%	66%

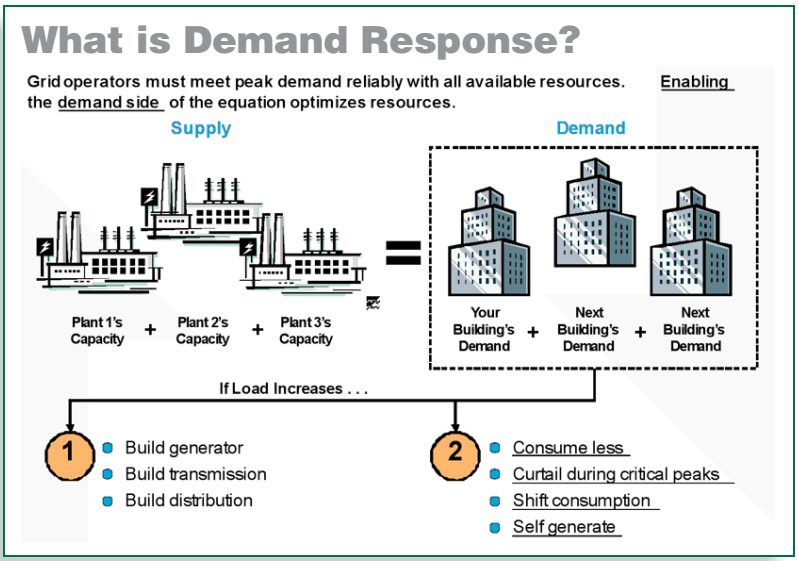
Source: Maryland PSC, Utility EmPOWER Maryland filings.
Note: ES = ENERGY STAR

(off-peak periods). A survey of U.S. demand response programs completed by FERC in 2008, indicates that approximately 8 percent of electricity customers in the country are participating in some kind of demand response program. FERC estimated that the total potential contribution from demand response programs was 41,000 MW, about 5.8 percent of U.S. peak demands.[1]

PJM Interconnection runs several demand response programs that provide incentives for customers to reduce their load. Demand response in PJM is utilized as a supply resource in the same way generators are. PJM members that act as demand response providers are called curtailment service providers (CSP). Customers can act as their own CSP or sign with another CSP that can bid load reductions into PJM markets. CSPs can participate as a capacity resource in the capacity markets and can bid load reductions into the energy markets, both for reductions needed during emergency events or reductions in response to high prices (economic events). There has been substantial growth in the participation of demand response resources in PJM programs. On June 9, 2008, the 2008 peak demand day, the following demand response resources were available:

- *4,440 MW were eligible for capacity credits;*
- *1,900 MW were eligible for energy payments in the emergency program; and*

[1] FERC, "Assessment of Demand Response & Advanced Metering," Staff Report, December 2008.



- *2,290 MW were bid into the economic program.*

The successful implementation of demand response initiatives will help to reduce the peak demand of the PJM electricity markets, reducing hours with high spot market prices and contributing to an overall reduction in wholesale and retail electricity prices. Additionally, reducing peak demand in Maryland, and system-wide, may reduce the need for investments in power plants primarily used during peak demand. The EMP Act directed utilities to reduce per capita peak demand by 15 percent by the end of 2015, from 2007 levels. The utilities have been implementing the following programs to meet these goals.

Baltimore Gas & Electric (BGE):

- *Peak Rewards – an automatic air conditioner and/or heat pump cycling program for residential customers.*
- *Interruptible Load for Reliability – a program where BGE acts as the CSP for large customers to participate in PJM regional demand response programs.*
- *Time of Use Rates – commercial and industrial customers can sign up for rates that vary by time of day, week, and season.*
- *Advanced Metering Infrastructure Pilot was completed in 2008, and full deployment is now under consideration.*
- *BGE has estimated it will achieve 232 percent of the 2011 EMP Act peak demand reduction goal and 138 percent of the 2015 goal.*

Potomac Electric Power Company (Pepco) and Delmarva Power:

- *Residential Air Conditioner Direct Load Control – air conditioner cycling for residential customers.*
- *Non-Residential Air Conditioner Direct Load Control (pending) – air conditioner cycling for small commercial, government, and institutional customers.*
- *Internet Platform Program – where Pepco or Delmarva act as a CSP for large customers to participate in PJM demand response programs.*
- *Advanced Metering Infrastructure deployment and Smart Community Program are under consideration.*
- *Pepco estimates it will achieve 151 percent of the 2011 EMP peak demand reduction goal and 108 percent of the 2015 goal.*
- *Delmarva will achieve 125 percent of the 2011 EMP Act peak demand reduction goal and 99 percent of the 2015 goal.*

Allegheny Power:

- *Advance Utility Infrastructure Program – a combined advanced metering and demand response program still under consideration by the PSC.*
- *Allegheny estimates it will achieve 72 percent of the 2011 EMP Act peak demand reduction goal and 53 percent of the 2015 goal.*

4.1.3 Distributed Generation

Distributed generation (DG) is defined as generating resources located close to or on the same site as the facility using the power. This includes both facilities that are not connected to the grid, and those that are tied into the grid to allow the sale of electricity in excess of on-site requirements. On-site generators with capacity less than 373 kW are not required to apply to the PSC for a CPCN. In addition, certain generators are eligible to seek a CPCN exemption:

- *Facilities with a capacity of less than 70 MW, consuming at least 80 percent of the electrical output on-site; and*
- *Facilities less than 25 MW in capacity, consuming at least 10 percent of the electrical output on-site.*

Distributed generation resources can include renewable resources such as small wind installations, small hydro, and increasingly, solar PV facilities. The Maryland RPS solar power requirement along with the incentives offered by MEA is increasing the number of small-scale PV facilities being constructed in the state. Small-scale PV can help the State meet its energy supply needs and provide significant co-benefits through reduced air and carbon emissions. Solar resources in Maryland are discussed in greater detail in Section 2.1.3 (on page 21).

At present, the majority of distributed generation facilities are diesel-fired emergency back-up generators, and they are mostly too small to require CPCNs. An examination of MDE and PSC data on permitting and CPCN exemption applications, along with regional surveys and market studies suggest that there may be upwards of 3,000 emergency generators in Maryland. Locations include government facilities, hospitals, colleges and universities, commercial and industrial facilities, telecommunications installations, and farming operations. The generators range in size from 20 kW to multi-unit 40,000 kW installations, though most seem to fall in the 100 kW to 2,000 kW range.

Most on-site systems are used to supply emergency power, but there are instances where these emergency units can be operated as part of load management and load response programs, which has led to concerns that this might adversely affect air quality in Maryland. Most of Maryland is still a non-attainment area for the regional 8-hour ozone standard and the Maryland State Implementation Plans for bringing Maryland into compliance by 2009 do not specifically target distributed generation resources. Ozone-forming nitrogen oxides (NO_x) and volatile organic compounds (VOCs) come from a variety of sources classified as point sources, area sources, on-road mobile sources, or non-road mobile sources. Distributed generation resources are too small to be classified as point sources and would therefore be captured as parts of area sources if they are counted at all.

PJM Interconnection offers opportunities for DG owners to participate in demand response programs, which is often done through CSPs (often their local utility) that aggregate many small DG units under one demand response bid. Some facilities, mainly government buildings, universities, and hotels are participating in PJM demand response programs, but mostly they reduce load rather than use their emergency generators. Some poultry farms and large telecommunications facilities, however, are participating in demand response programs by utilizing their generators. PJM demand response data indicates that in 2008 only a relatively small number of DG sites (Table 4-5) were involved and called upon by PJM to curtail load only a few times.

Table 4-5 PJM Demand Response Participants, 2008

Zone	Demand Response Sites and Sizes		
	Number of Sites	Total MW of DR	Avg. Size of Each (MW)
APS	23	43.6	1.9
BGE	322	522.7	1.6
DPL	40	27.3	0.7
Pepco	110	52.7	0.5
Total	495	646.3	1.3

Source: PPRP, Distributed Generation in Maryland

The majority of emergency generators seem to be used for true emergencies, when the power supplied from the electric grid is unexpectedly interrupted due to inclement weather or other uncontrollable circumstances. These engines are likely to be used only a few times each year as required to provide emergency power supply and for maintenance and servicing of the engine. However, there is growing interest among generator-owners to capitalize on their investment by participating in one or more demand response programs where use of emergency generators may be more regular.

Net Metering and Interconnection Standards

Net metering refers to a billing arrangement where 1 kWh generated by a customer's on-site DG system is worth the same amount as 1 kWh of grid electricity consumed by the customer. When the customer's DG facility is producing more electricity than the customer is using, that excess electricity is fed back into the grid. At the end of each month, a customer's bill will reflect the net electricity use, which equals electricity consumed minus electricity fed to the grid. Interconnection standards are the technical rules a customer must follow to connect a generation facility to the electric grid. FERC has jurisdiction over large generation facilities that connect to the transmission system, which are generally those over 20 MW in capacity. Smaller DG facilities, however, generally connect to the distribution system and are therefore regulated by the State. Net metering is also regulated by states and most often restricted to facilities with a capacity of 2 MW or less.

The Energy Policy Act of 2005 (EPAct 2005) directed state utility commissions to consider and determine whether it was appropriate or not to implement a set of interconnection standards that were set forth in Section 1245. In response, the PSC initiated Case No. 9060 to develop a set of interconnection standards appropriate for Maryland. In April 2007, the Maryland Legislature enacted Senate Bill 595, Electricity – Net Energy Metering – Renewable Energy Portfolio Standard – Solar Energy (SB 595). Among other things, SB 595 revised net- metering rules and required the PSC to devise interconnection standards for DG. As a result, the interconnection standards already in development due to EPAct 2005 were finalized and subsequently adopted in March 2008.

Maryland's net metering rule has the following characteristics:

- *Facilities eligible for net metering must use the following resources: PV, wind, biomass, anaerobic digestion;*
- *All customer classes can participate but individual facility size is limited to 2 MW;*
- *Statewide enrollment is limited to 1,500 MW at any one time;*
- *Net energy generated is rolled over to the next billing period, but any excess remaining at the end of a 12-month period is granted to the utility; and*

- *Customers retain possession of the RECs generated by their facility.*

Maryland's interconnection standards are as follows:

- *The standard interconnection agreement applies to all technologies and resources for all customer classes up to a capacity limit of 10 MW for each individual system.*
- *Contains four levels of standards based on facility size, with expedited and simplified reviews available for smaller systems with capacities of 10 kW or less, and 2 MW or less, conditional on their meeting certain technical requirements.*[2]

4.1.4 Green Power Programs

In recent years, Maryland has purchased green power resources as part of its electricity procurement process. The motivation for the initial green power procurement came as a response to a 2001 executive order to set a goal of six percent green electricity for state facilities. In July 2006, the goal was revised and the State committed to obtaining 10 percent of its electricity supply from Tier 1 resources. From 2002 to 2007, the Maryland Department of General Services (DGS) obtained a portion of their energy supply from green power sources through their competitive auctions (see Table 4-6). For the 2009 auction the DGS relied on the winning suppliers meeting their renewable RPS requirements. On December 8, 2009 Governor Martin O'Malley announced that in partnership with the University System of Maryland, the state would be purchasing renewable energy from four projects being awarded contracts through the Generating Clean Horizons initiative. The University System of Maryland's Board of Regents and the DGS recently approved the awards for the renewable energy projects, which will provide almost 23 percent of the institutions and state agencies annual electricity needs. The awards, in the form of 20-year power purchase agreements, are for the following:

- *All of the output from a 55-MW wind facility being planned near Keyser, West Virginia by US WindForce of Greensburg, Pennsylvania.*
- *Most of the output (13.5 MW) of a 14.5-MW solar project that Constellation Energy Group is planning to build on the Mount St. Mary's University campus near Emmitsburg, Maryland. The $60 million project will consist of thin-film photovoltaic cells on 100 acres leased from the university, which will be buying the remaining capacity.*
- *Up to 55 MW from an offshore wind facility that Bluewater Wind, a unit of Princeton, New Jersey-based NRG Energy Inc., plans to build off the coast of Delaware. Bluewater Wind has indicated this project could potentially be built up to 600 MW total capacity.*

Table 4-6 State Green Power Purchases

Contract Start Date	Length (months)	Territory	Total MWh/year Purchased	MWh/year of Green Power	Percent of Total
July 2002	24	BGE	1,600,000	96,000	6
October 2003	29	Conectiv	106,000	6,400	6
July 2004	24	BGE	862,000	112,000	13
January 2007	24	All	1,479,000	3,900	0.3
June 2009	36	BGE, Pepco	950,000,000	*	*
June 2009	24	Allegheny, BGE, Delmarva, Pepco	500,000,000	*	*

* For the 2009 auction, DGS required only that the suppliers meet their Maryland RPS obligations.

Source: Communications with Maryland Energy Administration and Department of General Services, August 2009.

[2] For more information on interconnection standards see Maryland Standard Small Generator Interconnection Rule, available on the PSC website.

- *A separate award under a small business provision will be made to Annapolis-based Synergics Group for 10 MW of its 50-MW Roth Rock wind facility planned atop Backbone Mountain in Garrett County, Western Maryland.*

County Green Power Purchases

In January 2004, Montgomery County issued a Request for Proposals (RFP) for the "Supply of Electricity and Related Services for Montgomery County and County and Bi-County Agencies and Jurisdictions." In addition to addressing electricity supply for most county facilities, the RFP covered several local towns and cities, the Washington Suburban Sanitary Commission, and the Maryland National Park and Planning Commission. The County specified that the successful bidder must deliver wind generation to the PJM grid. The RFP also required that all environmental attributes related to the wind power, including any NO_x certificates or allowances, be transferred to Montgomery County and its partners. Washington Gas Energy Services was selected as the winning bidder, sourced from the 66 MW Mountaineer Wind Energy Center in Thomas, West Virginia. In 2006, the County increased its share of wind energy to 10 percent, now purchasing approximately 35 percent of Mountaineer's yearly output, and set a goal of reaching 20 percent wind power by 2010. In March 2009, Montgomery County issued an RFP for RECs for the Group (Table 4-7) for years 2008 and 2009. RECs can be generated in the United States from the following eligible resources – wind, solar, geothermal, tidal ocean energy, and other clean renewable energy resource which produces zero emissions and meets the definition of a Tier 1 Resource under the Maryland RPS. Table 4-8 shows the Montgomery County purchasing group's aggregate wind energy and REC purchases.

Table 4-7 Montgomery County Group Participants and Desired RECs from RFP

Participant	2008 RECs	2009 RECs
Montgomery County, Maryland	26,422	27,950
Montgomery County Public Schools	32,250	32,250
Montgomery College	5,258	5,420
Maryland-National Capital Park and Planning Commission	7,995	8,100
Prince Georges County Community College	1,813	2,719
Member Towns & Cities	3,851	4,456
Total RECs Purchased	77,589	80,895

Source: Montgomery County RFP.

Table 4-8 Montgomery County Group Wind Purchases

Contract Start Date	Length (months)	Total MWh/year	MWh/year Wind Power	Percent of Total
July 2004	12	768,000	38,412	5 percent
August 2005	12	817,000	40,845	5 percent
September 2006	24	860,000	55,578	10% for Montgomery County and some other participants, 5% for others

Montgomery County has also created an incentive mechanism for consumers to purchase green power called the Clean Energy Rewards program. This program offers a rebate of 1 cent per kWh to residents and 1.5 cents per kWh to businesses and organizations for purchases of eligible renewable energy.

Water Agency Purchasing Green Power

In mid-2008, the Washington Suburban Sanitary Commission (WSSC), which supplies water and sewer services to Montgomery and Prince George's County customers, began using wind power to run one-third of its water and wastewater operations. Presently, this consists of 70,000 MWh of power per year, purchased from a wind project running fourteen turbines in Somerset County, Pennsylvania. This purchase agreement is particularly notable, as the WSSC is buying power directly from the wind farm, rather than purchasing renewable energy certificates. They have negotiated a ten year contract with Constellation Energy Projects & Services Group, Inc. to obtain a fixed price per MWh for 85 percent of the wind farm's output during that period, which will amount to a projected savings of $20 million in energy costs over the course of the contract.

Apart from serving as a hedge against price volatility, the WSSC also notes the arrangement's environmental impact is substantial — comparable to removing 100,000 cars from service over the contract time span, as the wind power will be reducing the WSSC's greenhouse gas emissions by around 90 million pounds annually.

4.1.5 Transmission Planning and Renewable Resources

Renewable energy sources are typically located in areas of significant distance from the populated load centers with high energy demand. Because of this, the transmission of renewable energy is a particularly controversial issue in the U.S., and especially in the Mid-Atlantic region.

In April 2009, 17 bulk power planning authorities in eastern North America, including the regional transmission organizations in the Eastern Interconnection (PJM, Midwest ISO, ISO New England, Southwest Power Pool, and New York ISO) met in Atlanta, Georgia, to discuss coordinated transmission planning for the entire Eastern Interconnection. The participants agreed to jointly form an Eastern Interconnection Planning Collaborative (EIPC) that will function in a manner similar to the Western Electric Coordinating Council, which coordinates regional planning for the Western Interconnection. Among the topics discussed at the meeting was the development of transmission systems to link remote regions rich in renewable resources to urban and industrial areas with high electricity demand. This could include developing a high-voltage transmission overlay consisting of multiple 500-kV or 765-kV AC or DC transmission lines that would transmit electricity through multiple states. Proposed projects that the EIPC could potentially help facilitate include:

- *Joint Coordinated System Plan: a conceptual regional transmission and generation system plan for a large portion of the Eastern Interconnection that includes a scenario where twenty percent of the energy demand is met with wind energy by 2024.*
- *Southwest Power Pool's Extra-High Voltage Overlay Plan: a transmission plan designed to tap into approximately 20 GW of wind energy in Kansas, Oklahoma, Missouri, New Mexico and Texas with plans to export renewable energy into neighboring systems such as PJM and the Midwest ISO.*
- *Green Power Express: proposal to build approximately 3,000 miles of 765-kV transmission lines across North Dakota, South Dakota, Minnesota, Iowa, Wisconsin, Illinois, and Indiana.*
- *Pioneer: a proposed 240 mile, 765-kV line that will interconnect PJM and the Midwest ISO facilitating the interconnection of wind power facilities in central Indiana and the transfer of wind power to Midwest load centers such as Indianapolis. FERC approved incentive rates, including a 200 basis-point adder to the return on equity, for the Pioneer Project in March 2009, prior to the project's approval in the regional transmission planning process.*

Federal Legislation for Transmission to "Renewable Energy Zones"

Congress is considering two bills that would encourage interconnection-wide transmission planning and would allow for federal siting of transmission facilities. under certain conditions. The House-passed American Clean Energy and Security Act of 2009 would direct the FERC to institute grid planning principles for regional transmission development to facilitate the deployment of renewable and other zero-carbon energy sources for generating electricity to reduce greenhouse gas emissions while enhancing reliability, reducing conges-

tion, ensuring cyber-security, and providing for cost-effective electricity services. The FERC can require regional planning entities to submit regional electric plans consistent with the FERC grid planning principles. The Act would authorize the FERC to site a high priority interstate transmission line in the Western Interconnection if the proposed transmission line is identified in an regional or interconnection-wide plan, any conflict among regional plans concerning the need for the transmission facility is resolved, the regional plans are consistent with FERC grid planning principles, and the transmission project is identified as necessary to meet demand for renewable energy in a regional or interconnection-wide plan. The Act would exempt the Western Interconnection from being subject to the FERC backstop transmission siting authority under EPAct 2005.

The Senate Energy and Environment Committee approved The American Clean Energy Leadership Act of 2009 in June 2009. This bill would require the FERC to coordinate the establishment of interconnection-wide transmission plans with plans developed by other transmission planning entities. Transmission planning entities have up to two years from enactment to develop and submit regional transmission plans to the FERC, and to update these plans every three years. States have one year to site transmission projects that are over 345 kV and identified as high priority national transmission projects, after which the FERC may take over siting if the state is unable to site the facility or denies the application. The FERC is also charged with setting cost allocation methodologies for high priority national transmission projects that are just and reasonable and not unduly discriminatory or preferential. The FERC may not allocate transmission costs to a region or sub-region unless the costs are reasonably proportionate to measurable economic and reliability benefits for that region or sub-region.

Separately, two U.S. courts issued opinions that are may have an impact on transmission policy and planning. In February 2009, the U.S. Court of Appeals for the Fourth Circuit ruled that the FERC incorrectly interpreted its transmission backstop siting authority to consider interstate transmission applications that had previously been denied by state regulatory commissions. In August 2009, the U.S. Court of Appeals for the Seventh Circuit overturned the FERC's previous approval of PJM's transmission cost allocation methodology that spread the costs of new transmission facilities over 500 kV to all PJM load-serving entities. The Court remanded the case back to the FERC, stating that the FERC must quantify the benefits to justify broadly spreading the costs.

As described in Section 2.1.3, a promising source of renewable energy for Maryland is from proposed land-based and offshore wind power projects. Accordingly, in May 2009, Governor O'Malley joined the governors of nine other states in signing a letter addressed to several members of Congress requesting that they support "strong new federal policies to promote wind resources." These ten governors were concerned that recently proposed energy bills involving selective federal subsidies and incentives to build new transmission lines would create financial hindrances for both land-based and off-shore wind power projects. The letter also described minimum qualifications for fair, equitable, and efficient renewable energy legislation, which included the following:

- *Creation of strong, federal energy efficiency and renewable energy incentives that are simple, transparent, and technology neutral, which capitalizes on more than a decade of successful direct experience by many states in developing robust efficiency and renewable energy markets;*
- *Consideration of new market mechanisms, such as regional procurements for renewable energy in the form of long-term power purchase agreements, which allows all renewable generation interests to compete on the basis of total cost of power delivered to load centers;*
- *Encouragement of state and regional planners along the Atlantic coast to develop a plan within and across regions to accommodate the growing availability of onshore wind resources and to*

establish an offshore wind transmission regime, including new FERC policies tailored to the special circumstances of offshore wind and expedited siting review for offshore transmission lines in federal waters and their interconnection to coastal load centers with appropriate state involvement;

- *Encouragement of FERC and NERC to support and facilitate robust planning within regional transmission organizations that provides and promotes local renewable resources integration and preserves local oversight and review; and*
- *Evaluation of whether expanding the federal Investment Tax Credit would be a more effective, simpler, and technology neutral mechanism for promoting renewable energy development across the country than a focus on transmission, which tends to support remote onshore wind, but disadvantage nearby offshore wind.*

4.2 Greenhouse Gas Policies

Indications are that the average global temperature is rising, and may be due to carbon dioxide and other greenhouse gases (GHGs) released into the atmosphere from human activities, such as industrial processes, fossil fuel combustion, changes in land use, and deforestation.

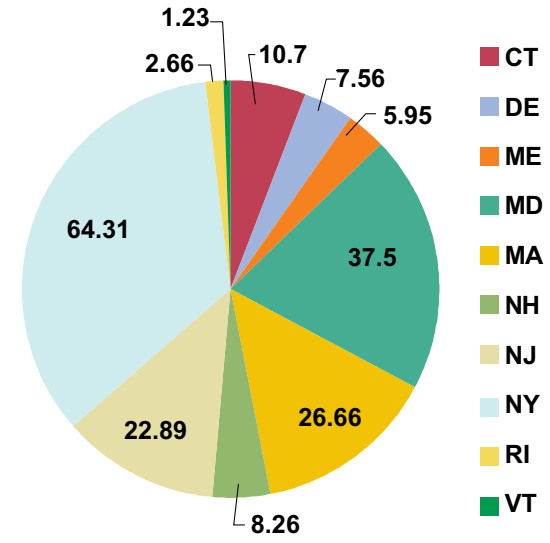
Current projections from the U.N. Intergovernmental Panel on Climate Change point to a global increase of 2.0°F to 11.5°F by 2100. This warming will have real consequences such as additional sea-level rise that will gradually inundate coastal areas and increase beach erosion, flooding from coastal storms, changes in precipitation patterns, increased risk of droughts and floods, threats to biodiversity, and a number of potential challenges for public health.

Maryland has implemented several policies in the last few years to reduce GHG. In 2007, the State joined RGGI, which is aimed at reducing CO_2 emissions from the electricity sector. Also in 2007, Governor O'Malley established the Maryland Climate Change Commission which released its comprehensive Climate Action Plan in summer 2008. During the 2009 legislative session the Maryland Legislature passed the Greenhouse Gas Emissions Reductions Act of 2009, committing the State to reducing GHG emissions by 25 percent from 2006 levels by 2020, a key recommendation of the Climate Action Plan.

4.2.1 Regional Greenhouse Gas Initiative

In 2005 the Governors of Delaware, Connecticut, Maine, New Hampshire, New Jersey, New York, and Vermont signed the RGGI Memorandum of Understanding (MOU) creating the first cap-and-trade program for CO_2 in the United States. In January 2007, Massachusetts and Rhode Island joined and, as required by the Healthy Air Act of 2006, on April 20, 2007 Maryland also signed the MOU joining RGGI. RGGI caps CO_2 emissions from fossil-fuel fired electricity generating units with nameplate capacities of 25 MW or greater at a level roughly equal to projected 2006-2007 emissions levels from 2009 through 2014 then mandates a 10 percent reduction (2.5 percent per year) by 2019. This phased approach to CO_2 emissions reductions is designed to provide regulatory certainty for electricity generators to begin planning for and investing in lower-carbon alternatives without creating dramatic electricity price impacts. There are 17 power plants in Maryland that are subject to the RGGI cap.

Figure 4-2 RGGI Allocations (million tons of CO_2)



The RGGI MOU outlines the CO_2 allowance allocations for each member state. These budget allocations, shown in Figure 4-2, were negotiated in 2005, based on actual annual 2000 to 2002 emission rates and including expected capacity additions and demand growth to create an estimate of 2006-2007 emissions. Maryland's annual budget starts at 37.5 million tons of CO_2 per year for the first five years then reduces 2.5 percent per year to about 33.8 million tons in 2019. This is approximately 20 percent of the total regional budget of 188.1 million tons.

Table 4-9 RGGI-Covered Entity CO_2 Emissions (in Millions of Short Tons)

State	2000	2001	2002	2003	2004	2005	2006	2007	2009 Allocated Budget
Connecticut	11.97	10.99	9.84	9.26	9.98	11.32	10.76	10.05	10.70
Delaware	7.31	7.61	7.62	7.63	7.88	8.30	7.56	8.74	7.60
Massachusetts	25.45	25.40	25.28	27.22	26.37	26.64	23.45	25.37	26.67
Maryland	38.45	36.98	37.08	37.06	36.28	37.26	35.23	35.70	37.50
Maine	3.16	5.52	5.78	5.52	5.19	4.59	3.37	3.53	5.95
New Hampshire	5.18	4.86	5.56	8.48	8.81	8.97	7.57	7.31	8.62
New Jersey	21.95	20.18	21.15	2.54	21.13	22.07	20.79	21.85	22.89
New York	69.81	65.55	61.37	62.13	62.61	62.72	53.64	55.72	64.31
Rhode Island	2.96	1.78	3.25	2.67	2.22	2.69	2.63	3.16	2.66
Vermont	0.024	0.022	0.052	0.012	0.015	0.0078	0.0063	0.0061	1.23
10 State Total	186.26	178.90	176.93	180.52	180.50	184.57	165.00	171.44	188.08

Source: RGGI, Inc. website. http://www.rggi.org/states/historical emissions

Allocation of the Strategic Energy Investment Fund

Program	2008 Strategic Energy Investment Fund Allocation (%)	2009 Budget Reconciliation and Financing Act Allocation (%)	RGGI – Strategic Energy Investment Fund ($ millions)	
			FY 2010 Budget	Auction Revenue to Date*
Department of Human Resources: Bill Assistance	17	50	$53.2	$36.2
Public Service Commission: Electricity Rate Relief	23	23	$24.4	$16.7
MEA/ Department Housing and Community Development: Low & Moderate Income Energy Efficiency**	23	8.75	$9.3	$6.3
MEA/ Department of General Services: Non-Low Income Energy Efficiency**	23	8.75	$9.3	$6.3
MEA / Maryland Department of Environment: Renewable and Clean Energy	10.5	6.5	$6.9	$4.7
MEA: Administration	3.5	3.0	$3.2	$2.2
Total	**100**	**100**	**$106.3**	**$72.4**

*Reflects revenue to Maryland from the first four RGGI auctions which occurred over a nine month period in September 2008, December 2008, March 2009, and June 2009. A portion of these revenues were allocated to the FY 2009 Budget.

**The statute requires that 46 percent of the revenues be allocated to energy efficiency efforts and that half of the 46 percent be dedicated to support programs and activities targeting low and moderate income households. This information reflects the split of energy efficiency funds between low and moderate income programs and non-low income programs.

Contrary to what was expected when the CO_2 state apportionments were negotiated, emissions in the power sector have fallen in the last few years (see Table 4-9), and as a result, emissions from RGGI covered power plants are below the negotiated apportionment amounts. Coupled with the economic slowdown reducing energy demand, 2009 CO_2 emissions are expected to be approximately 10 percent below the established RGGI budget.

A RGGI "model rule" issued in August 2006 details the operating rules for the RGGI cap-and-trade program. The model rule stipulates that a minimum of 25 percent of each state's emissions allowances are to be used for consumer benefit and/or strategic energy purposes. The member states have decided to auction nearly all of their allowances in quarterly regional auctions. Maryland's proceeds will go to the Maryland Strategic Energy Investment Fund (SEIF), which will be used to benefit Maryland residents (see sidebar at left).

RGGI Allowance Auctions

RGGI allowances are sold at auction, quarterly, in lots of 1,000. Initially, the auction format is a single-round, uniform price, sealed-bid format. The states may transition to a sealed bid, discriminatory price; a multiple round, ascending-price; or a multiple round, descending price format at a later time if evolving market conditions warrant it. Allowances will be identified with a vintage for the year they are issued, with up to 50 percent of future vintage allowances offered for sale in advance of their annual allocation. Any type of entity may apply to participate in the auction but the rules limit any one participant (an organization and its affiliates) from purchasing more than 25 percent of the total available allowances in any one auction. A reserve, or minimum, price is set for each auction starting with $1.86 per allowance for the first auction held in September 2008. For all subsequent auctions, the reserve price will be the higher of $1.86 (adjusted for inflation) or 80 percent of the current market price for each vintage allowance being auctioned. The participating states have retained Potomac Economics as the independent market monitor to report on whether or not the auction was conducted in accordance with the regulations established by participating states.

In the first auction, the clearing price was $3.07 each and all of the 12,565,387 allowances offered were sold, mainly going to covered entities (see Table 4-10). According to Potomac Economics, the CO_2 allowance auctions raised no material concerns regarding the auction process or its results. Thus far, there is no evidence

Regional Greenhouse Gas Initiative: RGGI Allowance Auctions

The Regional Greenhouse Gas Initiative CO_2 Allowance Tracking System (RGGI COATS) is a system that follows data regarding states' CO_2 Budget Trading Programs. Specifically, RGGI COATS contains historical emissions data, and tracks present emissions data, which is updated quarterly. It also includes data regarding CO_2 allowance transactions and allowance ownerships, which facilitates market participation, as it allows account holders to receive and/or transfer CO_2 allowances. Further, each state's compliance data is housed in RGGI COATS; and there is a Special Approvals module, which is responsible for following each state's set-aside account applications. Finally, an offsets module is included, which can be used for offset project registration, and to track the offset project applications, report submittals, and regulatory status.

RGGI COATS is not only used by offset project sponsors, regulated entities and other market participants; it is also used by the public. RGGI COATS permits the general public to view a number of program and market data reports, including: account representatives report, owner/operator report, transaction price report, CO_2 budget source report, account report, special approvals, offsets, and emissions. Reports regarding compliance will be available beginning in the spring of 2012.

Table 4-10 RGGI Allowance Auctions

Auction Date	Allocation Year	Quantity Sold	Reserve Price	Clearing Price	Maryland Allowances Sold	Maryland Revenues
9/25/2008	2009	12,565,387	$1.86	$3.07	5,331,781	$16.4 million
12/17/2008	2009	31,505,898	$1.86	$3.38	5,331,781	$18.0 million
3/18/2009	2009	31,513,765	$1.86	$3.51	5,331,783	$19.9 million
	2012	2,175,513	$1.86	$3.05	399,884	
6/17/2009	2009	30,887,620	$1.86	$3.23	5,331,782	$18.0 million
	2012	2,172,540	$1.86	$2.06	399,884	
9/9/2009	2009	28,408,945	$1.86	$2.19	5,331,782	$12.4 million
	2012	2,172,540	$1.86	$1.87	399,884	

Source: RGGI, Inc., website. http://www.rggi.org/co2-auctions/results

of collusion or manipulation by bidders and the vast majority of bids were submitted in line with competitive expectations.

Maryland has incorporated a safety trigger value set at $7.00 per CO_2 allowance. If the auction clearing price reaches $7.00, up to 50 percent of the allowances allocated to the Consumer Energy Efficiency Account will be made available for direct sale to Maryland CO_2 budget sources at $7.00 per ton of CO_2.

RGGI 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 but that amount can be increased under the following circumstances:

- *The 12-month rolling average spot price for allowances is $7.00 or greater. Then the source can cover up to 5.0 percent of emissions using offsets.*
- *The 12-month rolling average spot price for allowances is greater than $10.00 for two consecutive 12-month periods. Then the source can cover up to 10.0 percent of emissions using offsets.*

Offset projects[3] that qualify under the RGGI model rule are:

1. *Landfill Methane Capture and Destruction – projects that capture and destroy methane from landfills that are not subject to the New Source Performance Standards (NSPS) for municipal solid waste landfills.*
2. *Reduction in Emissions of Sulfur Hexafluoride (SF_6) – projects that prevent the release of SF_6 to the atmosphere, through capture and storage, recycling, or destruction, can qualify for offset credits.*
3. *Sequestration of Carbon due to Afforestation – projects that sequester carbon through the conversion of land that has been in a non-forested state for at least 10 years to a forested condition.*
4. *Reduction or Avoidance of CO_2 Emissions from Natural Gas, Oil, or Propane End-use Combustion due to End-use Energy Efficiency – projects that reduce CO_2 emissions by reducing on-site combustion of natural gas, oil, or propane in either an existing or new commercial or residential building by improving the energy efficiency of fuel usage and/or the energy-efficient delivery of energy services.*
5. *Avoided Methane Emissions from Agricultural Manure Management Operations – projects destroy methane generated by anaerobic digesters and the uncontrolled anaerobic storage of manure or organic food.*

4.2.2 Maryland Commission on Climate Change

The Maryland Commission on Climate Change (MCCC) was established via Executive Order in April 2007 and charged with developing a Maryland Climate Action Plan (CAP). The MCCC consists of the leaders of 16 State agencies and six members of the General Assembly and is supported by the following Working Groups:

1. *Scientific and Technical Working Group (STWG) – chaired by the University of Maryland Center for Environmental Science and MDE. The STWG provides advice on the scientific and technical aspects of climate change, and developed a Comprehensive Climate Change Impact Assessment for the CAP.*
2. *Greenhouse Gas & Carbon Mitigation Working Group (MWG) – chaired by MDE and MEA. The MWG evaluated and recommended a GHG reduction goal, developed policy options to*

[3] Offset project details and protocols are available on the RGGI and MDE websites: www.rggi.org/offsets and www.mde.state.md.us/Air/RGGI.asp

reduce GHG emissions, and created a Comprehensive Greenhouse Gas and Carbon Footprint Reduction Strategy for the CAP.

3. *Adaptation and Response Working Group (ARWG) – chaired by DNR and the Maryland Department of Planning. The ARWG examined strategies for reducing the vulnerability of the State's coastal, natural and cultural resources and communities to the impacts of climate change and developed a Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change for the CAP.*

In August 2008, the MCCC released the final version of the Maryland CAP. The CAP contains the comprehensive assessments and strategies developed by each of the working groups, which include sets of policy options, programs, and measures. The MWG and its

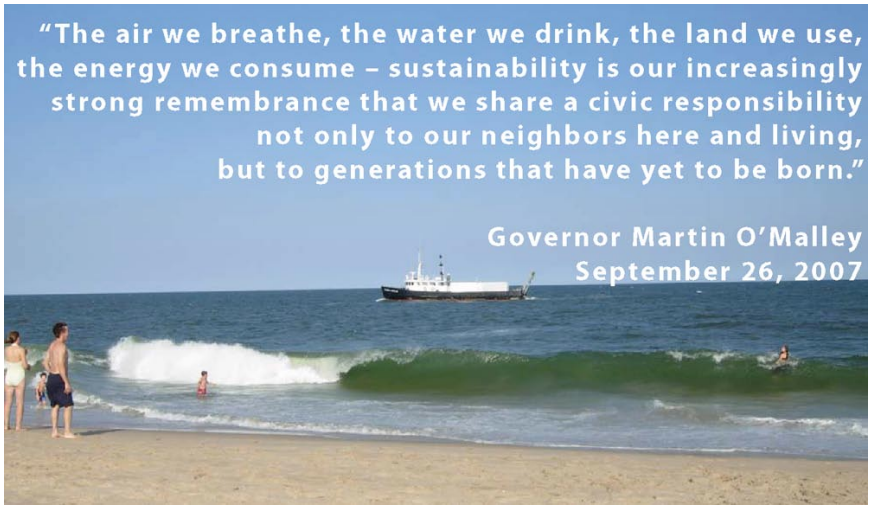
Table 4-11 Climate Action Plan Energy Supply GHG Mitigation Policy Options

		GHG Reductions ($MMtCO_2e$)					
	Policy Option	2012	2020	Total (2008–2020)	Net Present Value 2008– 2020 (Million $)	Cost-Effectiveness ($/tCO$_2$e)	Level of Support
ES-1	Promotion of Renewable Energy (Zoning and Siting Incentives for Centralized Facilities)	0.2	0.5	3.3	$100	$30.3	Unanimous
ES-2	Technology-Focused Initiatives for Electricity Supply (Biomass Co-Firing, Energy Storage, Fuel Cells, Landfill Gas, Clean Energy Incentives)	U	U	U	U	U	Unanimous
ES-3	GHG Cap-And-Trade (C&T) (With a Hypothetical Allowance Auction Price At $7/tCO$_2$e); Account for All Reduction Under an Auction-Based C&T (Note: Quantification Represents Current Regional Greenhouse Gas Initiative [RGGI] Program	U	16.96	U	-$235	U	Unanimous
ES-4	Combined Capture, Storage, and Reuse (CCSR) Incentives, Requirements, and Enabling Policies (Administration, Regulation, Liability, Incentives)	Study presented for informational purposes only.					N/A
ES-5	Clean Distributed Generation (DG): Standards, Incentives and Barrier Removal for DG, Including Combined Heat and Power (CHP), District Heating and Cooling, Landfill Gas, Solar, and Other Forms of Renewable Energy						Unanimous
	ES-5a Distributed Generation (DG)	0.3	1.1	6.7	$250	$37.5	
	ES-5b Combined Heat and Power (CHP)	0.3	1.0	6.3	$90	$14.4	
ES-6	Integrated Resource Planning (IRP) With or Without Re-Regulation or State Energy Plan	U	U	U	U	U	Unanimous
ES-7	Renewable Portfolio Standard (RPS)	5.2	13.8	100.7	$2,589	$25.7	Unanimous
ES-8	Efficiency Improvements and Repowering Existing Plants	1.2	2.0	17.9	$389	$21.8	Unanimous
	ES-8a Biomass Component						
	ES-8b Repowering Component	Study presented for informational purposes only.					N/A
ES-9	Carbon Tax	Study presented for informational purposes only.					N/A
ES-10	Generation Performance Standards (GPS)—1,125 pounds CO_2e/MWh	4.9	6.6	62.6	$2,659	$42.4	Unanimous
	Sector Total After Adjusting for Overlaps*	11.9	24.6	194.2	$5,977	$30.8	
	Reductions From Recent Actions	4.8	12.2	88	$2,329	$26.5	
	Sector Total Minus Recent Actions	7.1	12.4	106.2	$3,648	$34.3	

GHG = greenhouse gas; $MMtCO_2e$ = million metric tons of carbon dioxide equivalents; $/tCO$_2$e = dollars per ton of carbon dioxide equivalent; U = Unquantified; N/A = not applicable; ES = Energy Supply; CO_2e/MWh = carbon dioxide equivalents per megawatt-hour.

*See explanation below:

Recent actions include those GHG reductions and costs associated with the Maryland renewable portfolio standard (RPS). ES-7 proposes an RPS policy that results in GHG reductions in excess of the current Maryland RPS. The net differences between the proposed ES-7 policy and the current Maryland RPS are included in the "Sector Totals Minus Recent Actions" results.



Source: Maryland Climate Action Plan, August 2008.

Technical Working Groups developed 42 GHG reduction policy options covering a broad range of areas: energy supply; transportation and land use; agriculture, forestry, and waste; residential, commercial, and industrial; and cross-cutting issues. The MWG also quantified as many of the policy options as possible, including GHG reduction potential and cost-effectiveness. Table 4-11 outlines the policy options for reducing energy supply GHG emissions. As can be seen in the table, the largest impact in terms of GHG and greatest net benefit is gained from a RPS Program and a Generation Performance Standard of 1,125 pounds CO_2 equivalent (CO_2e) per MWh.

4.2.3 Maryland Climate Change Legislation

Over the last several years, Maryland has enacted several pieces of legislation that will help the State, both directly or indirectly, meet its climate change goals. These bills target emissions from power plants and vehicles, spur development of renewable energy, and set energy efficiency and conservation goals (see Table 4-12).

During the 2009 session, the legislature passed the Greenhouse Gas Emissions Reduction Act of 2009, House Bill 315/Senate Bill 278. The main points of this legislation include the following:

- *Requires the State to reduce GHG emissions by 25 percent below 2006 levels by 2020.*
- *Directs MDE to develop and adopt a GHG reduction plan by 2012 that will not adversely impact the economy.*
- *Requires that MDE update its GHG emission inventory every three years.*
- *Contains a provision where the manufacturing sector is only subject to federal and RGGI regulations. (Emissions from this sector are small, constituting on 4 percent of Maryland's total GHG emissions.)*

An analysis conducted by MDE shows that programs already underway will achieve a 12.5 percent reduction in GHG emissions by 2020 and implementation of the cost-effective CAP measures will result in actually exceeding the 25 percent target (see Figure 4-3).

Table 4-12 Maryland Legislation to Reduce GHG Emissions

Legislation	Description
Renewable Energy Portfolio Standard (HB 1308), 2004, Revised 2007 & 2008.	Established a renewable portfolio standard for electricity supply. RPS was accelerated to 20 percent by 2022.
Healthy Air Act of 2006 (HB 189)	Established a ceiling on NO_x, SO_2, and mercury emissions from power plants and directed the State to join RGGI.
The Clean Cars Act of 2007 (HB 44)	Adopts California's stringent vehicle emissions standard beginning in model year 2011.
EmPOWER Maryland Energy Efficiency Act of 2008 (HB 374)	Sets a target of reducing the State's per capita electricity consumption and peak demand by 15 percent by 2015.
Regional Greenhouse Gas Initiative – Maryland Strategic Energy Investment Program (HB 368)	Created a fund using RGGI proceeds to invest in energy efficiency and renewable energy.
Several Bills for Renewable Energy Grant and Incentive Programs (HB 714-2004, SB 361-2005, SB 314-2006, HB 377-2008, SB 565-2008)	Provides tax incentives and/or grants for renewable energy resources, including solar, geothermal, biofuels, and wind.
Maryland Clean Energy Center, 2008 (HB 1337)	Established the Maryland Clean Energy Center as in information clearing house and to lead collaborative efforts to promote clean energy development.
Greenhouse Gas Emissions Reductions Act of 2009 (HB 315/SB 278)	Codifies the GHG goals from the MCCC Climate Action Plan and authorized MDE to pursue the recommended measures.

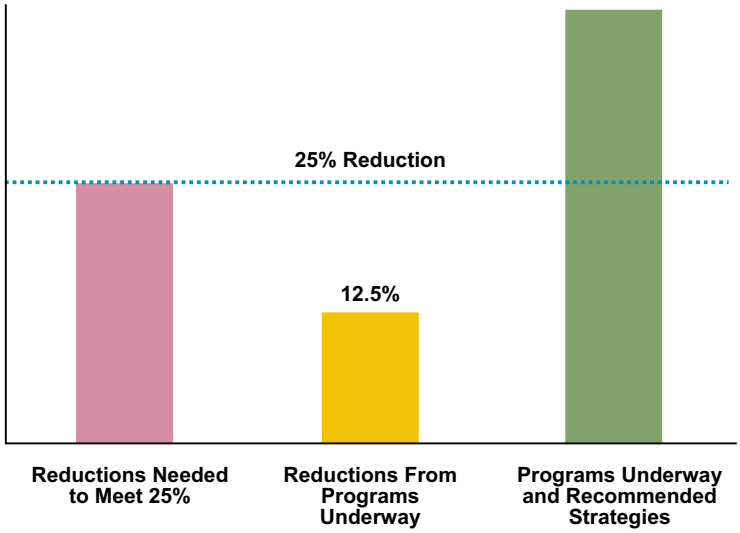
Source: Maryland General Assembly, Bill Indexes and Information

4.2.4 Federal Greenhouse Gas Initiatives

President Obama, throughout his campaign and during his time in office, has openly supported a national cap-and-trade program for the reduction of GHG emissions. It is expected that a federal GHG reduction program will be in place prior to the end of 2010.

As a stepping stone to GHG emissions reduction legislation, in September 2009, the U.S. Environmental Protection Agency (EPA) finalized the first comprehensive national system for reporting emissions of CO_2 and other GHGs produced by major sources in the United States. This reporting rule was developed, as required, by the consolidated Appropriations Act of 2008.

Figure 4-3 Maryland GHG Reduction Potential



Source: MDE, HB 315, The Greenhouse Gas Reduction Act of 2009, presentation by Shari Wilson, Secretary, February 27, 2009.

The new reporting requirements apply to suppliers of fossil fuels and industrial chemicals, manufacturers of motor vehicles and engines, as well as large direct emitters of GHGs with greater than or equal to 25,000 metric tonnes CO_2e emissions per year, which covers all of Maryland's coal-fired power plants. This new program will cover approximately 85 percent of the nation's GHG emissions and will apply to roughly 10,000 facilities. The first annual reports for the largest emitting facilities are to be submitted to EPA in March 2011 for calendar year 2010 data, with the exception of vehicle and engine manufacturers, who are to begin reporting for model year 2011. Sources that are covered under the rule are

Table 4-13 Sources Required to Report GHG Emissions Under EPA's Reporting Rule

General Sources	Specific Sources
A facility that contains any of the source categories listed to the right in any calendar year starting in 2010	Electricity generating facilities that collectively emit 25,000 metric tons of CO_2e or more per year
	Adipic acid production
	Aluminum production
	Ammonia manufacturing
	Cement production
	HCFC–22 production
	HFC–23 destruction processes that are not collocated with a HCFC–22 production facility and that destroy more than 2.14 metric tons of HFC– 23 per year
	Lime manufacturing
	Nitric acid production
	Petrochemical production
	Petroleum refineries
	Phosphoric acid production
	Silicon carbide production
	Soda ash production
	Titanium dioxide production
	Municipal landfills that generate methane in amounts equivalent to 25,000 metric tons CO_2e or more per year
	Manure management systems that emit CH_4 and N_2O in amounts equivalent to 25,000 metric tons CO_2e or more per year
Any facility that emits 25,000 metric tons CO_2e or more per year in combined emissions from stationary fuel combustion units, miscellaneous use of carbonates, and all of the source categories listed to the right that are located at the facility in any calendar year starting in 2010	Electricity generation
	Ferroalloy production
	Glass production
	Hydrogen production
	Iron and steel production
	Lead production
	Pulp and paper manufacturing
	Zinc production
Any facility that in any calendar year starting in 2010 meets all three of the conditions listed to the right. For these facilities, the GHG emission report would cover emissions from stationary fuel combustion sources only.	The facility does not contain any source in any source category designated in the above two categories.
	The aggregate maximum rated heat input capacity of the stationary fuel combustion units at the facility is 30 mmBTU/hr or greater.
	The facility emits 25,000 metric tons CO_2e or more per year from all stationary fuel combustion sources.
Any supplier of any of the products listed to the right in any calendar year starting in 2010	Coal-based liquid fuels
	Petroleum products
	Natural gas and NGLs
	All producers of industrial GHGs and importers and exporters of industrial GHGs with total bulk imports or exports that exceed 25,000 metric tons CO_2e per year
	All producers of CO_2 and importers and exporters of CO_2 or a combination of CO_2 and other industrial GHGs with total bulk imports or exports that exceed 25,000 metric tons CO_2e per year
Manufacturers of mobile sources and engines would be required to report emissions from the vehicles and engines they produce, generally in terms of an emission rate. These requirements would apply to emissions of CO_2, CH_4, N_2O, and, where appropriate, HFCs. Manufacturers of the vehicle and engine types listed to the right would need to report.	Manufacturers of passenger cars, light trucks, and medium-duty passenger vehicles
	Manufacturers of highway heavy-duty engines and complete vehicles
	Manufacturers of nonroad diesel engines and nonroad large spark-ignition engines
	Manufacturers of nonroad small spark-ignition engines, marine spark-ignition engines, personal watercraft, highway motorcycles, and recreational engines and vehicles
	Manufacturers of locomotive and marine diesel engines
	Manufacturers of jet and turboprop aircraft engines

detailed by source category in Table 4-13. Some source categories that were included in the proposed rule, such as electronics manufacturing, ethanol production, oil and natural gas systems, industrial landfills, wastewater treatment, and suppliers of coal, are currently not required to report their emissions; however, are still under review by EPA and may be required to do so in the future.

Transitioning from State/Regional Initiatives into a Federal Program

As described in Section 4.3.1, Maryland is a signatory to the RGGI MOU. This agreement incorporates provisions for transition into a federal GHG reduction program. It also includes encouragement for the federal program implementers to reward the signatory states for early action. The federal program must be determined to be comparable to RGGI by the signatory states for them to willingly transition into the new program.

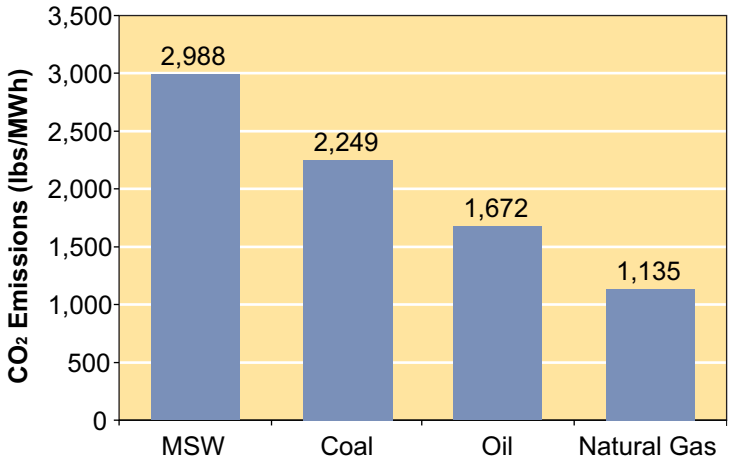
When drafting the proposed reporting rule, EPA referred to existing climate registries and regional initiatives, such as RGGI, to ensure many of the reporting rule requirements were comparable, providing for a smooth transition into a federal program.

4.3 Coal-Fired Generation and CO_2

Coal-fired power plants make up a large part of the power generation portfolio in many countries, but have the disadvantage of relatively high levels of CO_2 emissions (see Figure 4-4). A number of solutions, both short-term and long-term, have the ability to place coal-derived power on a similar performance level as other advanced generation technologies. In a well balanced energy generation portfolio comprised of renewables, nuclear, and fossil fuels, coal still has a significant role to play in the future to meet growing U.S. energy demand and to exploit domestic energy resources. Some of the attractive features of coal-derived power generation include the following:

- *Coal is very abundant, particularly in the United States;*
- *Coal is relatively easy to store and transport; and*
- *Coal-fired power plants offer unique load-carrying flexibility, are particularly useful in meeting peak demand, and can compensate for the intermittency of renewable energies like wind power.*

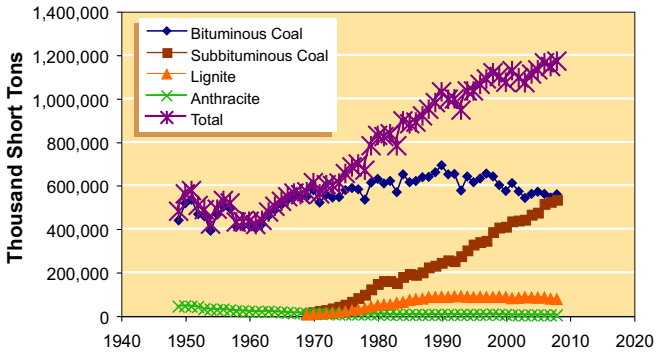
Figure 4-4 CO_2 Emissions by Fuel Type



Peak Coal

The concept of peak coal refers to the point in time when global coal production rates reach their maximum and thereafter begin an inevitable decline. Coal is a finite, and therefore non-renewable, resource that will eventually run out.

Annual U.S. Coal Production Rates, 1949 - 2008



Coal provides about 40 percent of the worlds primary energy needs, about 50 percent of the electricity generation in the U.S. (which holds the world's largest reserves) and was 62 percent of the energy supply in Maryland in 2007. Between 2000 and 2005, coal extraction in the U.S. increased by an average of 4.8 percent per year, which compares to 1.6 percent per year for oil over the same time period.* According to the World Coal Institute, proven global coal reserves will last 155 years at current production levels. However, the U.S. Department of Energy predicts that annual global coal consumption will continue to increase by 2.5 percent per year through 2030, at which time, world consumption will be nearly double that of today. Many analysts who are concerned about future oil and gas supply constraints foresee a compensatory shift to lower-quality fuels. Coal can be converted to a gaseous or liquid fuel, and coal gasification and coal-to-liquid plants are being constructed at record rates.

The Energy Watch Group, an independent group of scientists, published a study in 2007 that claims the U.S. surpassed the peak of high-quality coal (anthracite) in 1990. However, during that time, production of sub-bituminous coal in Wyoming more than compensated for the decline. This trend may continue for 10 to 15 more years, but thereafter, it is likely that a decline in total coal production will be experienced. The study also explained that U.S. coal production, in terms of energy content, peaked in 2002 and in terms of volume, is expected to peak sometime between 2020 and 2030.

* Richard Heinberg, 2007. Peak Coal: Sooner Than You Think. Energy Bulletin.

Carbon Capture at AES Warrior Run

In Cumberland, Maryland, the AES Warrior Run cogeneration plant is currently the only coal-fired facility using carbon capture technology. This 180-MW generating facility utilizes circulating fluidized bed combustion technology, which apart from producing electricity, also supplies approximately 400 tons/day of steam to its adjacent CO_2 production unit. CO_2 is removed from a slip-stream of 2 – 3 percent of the plant's total flue gas stream using an ABB Lumus MEA flue gas scrubber system. The extracted CO_2 is then purified to a 99.99 percent purity level using carbon filters and molecular sieves. The purified CO_2 is stored under pressure in large, steel storage tanks, as shown in the adjacent photo, until it can be shipped off-site for use in fire extinguishers, dry ice production, and in food-related processes. The facility currently captures the majority of the CO_2 emissions in the slip-stream, which is 14 percent CO_2 by volume, and there is on-going discussion regarding the capturing of additional CO_2 at this facility for possible use in a geologic sequestration pilot test.

Source: EPRI, 2008

Aside from these advantages, energy conversion from coal generates the highest level of CO_2 emissions of all the fossil fuels available. CO_2 emissions from conventional combustion technologies generally amount to approximately 1 ton per MWh of electricity generated. For coal to have an environmentally acceptable future, CO_2 emissions from new and existing coal-fired power plants will need to be mitigated to as low a level as feasibly possible. CO_2 mitigation for coal-derived power is a highly debated topic; however, there are several options that can be effective:

- *Improving generation efficiency (providing a reduction in overall CO_2 emissions per megawatt of electricity generated), either through the development of new plants or upgrading existing facilities;*
- *Substituting a fraction of the coal with a carbon-neutral fuel such as biomass (biomass co-firing). Modern coal-fired boiler designs are currently capable of accommodating up to 20 - 30 percent biomass co-firing, with a corresponding reduction in CO_2 emissions; and*
- *CO_2 capture and geological storage (federal programs are beginning to provide support to validate this option).*

Currently, three general methods are available to capture CO_2:

- *Post-combustion capture, in which CO_2 is separated from flue gases;*
- *Pre-combustion capture, in which CO_2 is captured prior to combustion (generally involving a shift reaction to convert synthesis gas to CO_2 and hydrogen); and*
- *Oxyfuel firing, in which the fuel is fired with an oxygen/CO_2 mixture, thus producing a CO_2-rich flue gas that is easier for CO_2 capture. Oxyfuel firing methods have been demonstrated in several projects abroad. Several feasibility studies are currently underway for options using advanced supercritical plants.*

4.3.1 Clean Coal Technologies

More than 50 percent of the U.S. electricity supply comes from coal-fired generation facilities. The U.S. Department of Energy (DOE) has been engaged in researching and developing more efficient and environmentally sound ways to utilize coal for more than 20 years. The aim of clean coal technologies is to reduce the environmental effects of coal as a fuel source by using multiple innovative technologies to wash coal and/or contain its emissions. Clean coal technologies include the installation of scrubbers and other exhaust system equipment that remove harmful emissions and particulates before they reach the open air and pre-treating or cleaning the coal to remove harmful substances before the combustion cycle.

Though coal use in the electricity industry has increased by 83 percent since 1980, total industry SO_2 emissions have decreased by 39 percent and total NO_x emissions by 42 percent. In Maryland, the Healthy Air Act (HAA) of 2006 directed coal-fired facilities in the state to reduce emission of SO_2, NO_2, and mercury by installing state of the art pollution control technology. The HAA is expected to result in significant reductions of emission making coal-fired plants much cleaner in the coming years (discussed in greater detail in Section 3.1.1 on page 61).

Clean coal technologies also include advanced coal power systems, such as integrated gasification combined cycle (IGCC). In IGCC systems, coal is superheated to a gaseous state, or gasified, creating a synthetic gas that is then combusted in a turbine. The system also captures waste heat that is used to create steam to power a second turbine. Conventional coal plants are about 35 percent energy efficient, while IGCC facilities are currently about 50 percent efficient, and expected to reach nearly 80 percent efficiency in the future. Because the coal is gasified, IGCC plants achieve dramatic reductions in harmful emissions, creating up to 99 percent less SO_2 and particulates, and 90 to 95 percent less mercury. Additionally, the synthetic gas can be reduced to hydrogen and CO_2, making IGCC plants ideal for the addition of carbon sequestration systems. The DOE currently has two "super clean" IGCC demonstration plants in operation: Tampa Electric IGCC Power Plant in Mulberry, Florida, and the PSI Energy Wabash River IGCC Power Plant in West Terre Haute, Indiana.

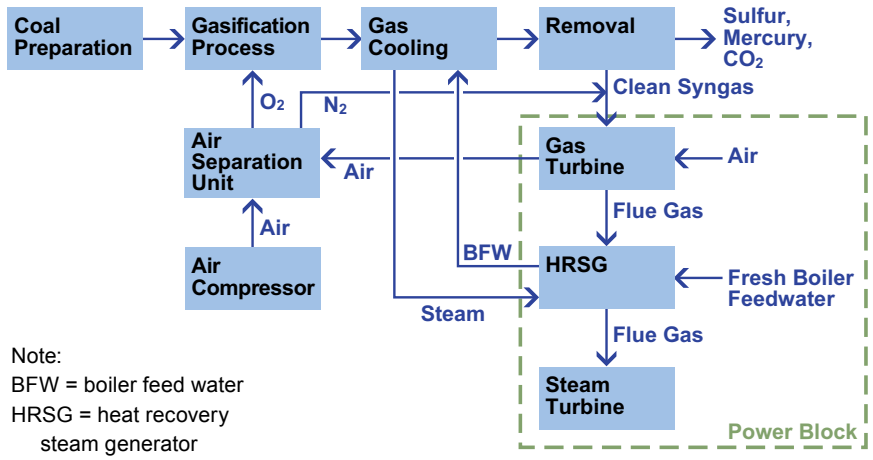
Table 4-14 shows a direct comparison of uncontrolled CO_2 emissions from IGCC and combustion-based power generation technologies.

In October 2008, the National Energy Technology Laboratory launched a program to develop an IGCC with carbon capture simulator to be used for research and training. The facility will be located in Morgantown, West Virginia. IGCC with carbon capture is considered the most promising technology for achieving high-efficiency and near-zero emissions from coal-fired power plants of the future. Dynamic simulation offering a real-time operational experience of IGCC has been used on a limited basis, but the Morgantown facility will be the first full-scope, real-time research and training facility offering operation and control simulation of IGCC with carbon capture. Figure 4-5 shows the IGCC reference plant for the generic dynamic simulator, a 746 MW (gross size) plant consisting of dual train entrained-flow gasifiers producing synthetic gas (syngas) for combustion in two advanced combustion turbines with a combined net output of 464 MW.

Table 4-14 Comparison of IGCC and Combustion-based Power Generation Technologies

Power Generation technology	Facility Heat Rate (Btu/kWh)	CO_2 Emissions (lb/kWh)	CO_2 Emissions (Ton/MWh)
Conventional Pulverized Coal Plant with Flue Gas Desulfurization Scrubber (FGD)	9,800	2.0	1.0
Polk Power IGCC Plant (U.S., Indiana)	9,350	1.87	0.94
Wabash River IGCC Plant (U.S., Tampa FL)	8,900	1.78	0.89
Advanced Integrated Gasification Fuel Cell Plant (IGFC)	6,000	1.20	0.6
Pressurized Fluidized Bed Combustion Plant (PFBC)	8,700	1.81	0.91
Natural Gas Combustion Turbine Plant	11,000	1.27	0.64
Natural Gas Combined Cycle	7,500	0.86	0.43

Figure 4-5 Integrated Gasification Combined Cycle System



4.3.2 Carbon Sequestration

Terrestrial Sequestration

As introduced in Section 3.2.5, carbon sequestration is the intended permanent storage of CO_2. There are multiple types of carbon sequestration, including geologic sequestration in subsurface rock or aquifer formations and terrestrial sequestration, which involves the storage of CO_2 in vegetation via the creation of a new sustainable forest or agricultural area.

In Maryland, two specific types of sequestration are being explored as potential GHG offset projects under either RGGI or a new GHG reduction program administered at the federal level. The first type focuses on the restoration of salt marshes. 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 in conditions of rising sea levels. Marsh decline, however, is becoming more prevalent throughout the region, which corresponds to a decrease in carbon storage. It is possible through the placement of artificial sediment to restore these marshes, allowing them to rebound and promote carbon sequestration, which is the goal of this type of offset project. In order for the salt marsh restoration to be successful, the new marsh surface must accrete with sea level rise. PPRP and the University of Maryland have been working together to establish project guidelines and accounting methods.

The second type is terrestrial sequestration through urban forestry. Urban forestry projects involve the implementation of programs within urban communities to plant and grow trees. This program provides two means for reducing CO_2 emissions. First, carbon is sequestered in the growing of trees due to an increase in biomass. Secondly, there is an associated avoidance of emissions through energy conservation, as the trees

Blackwater Project

PPRP, DOE, and several other partners are collaborating with the University of Maryland on the Blackwater Project to learn more about carbon sequestration in tidal marshes. There are potentially as much as 20,000 acres available for this project, which would not only sequester thousands of tons of CO_2 annually, but would also provide increased habitat for birds, terrestrial animals, and aquatic life that live in the area or use it for stopovers during their annual migrations. Wetlands can store up to 2.5 tons of carbon per acre. The team will examine three tidal marsh cells -- one newer 5-acre cell; one older cell, created in 1983; and a third that is a natural marsh cell. Researchers will establish approximately 50 field plots per cell and will conduct annual soil analyses, including organic carbon content, bulk density, active carbon (particulate, chemically labile), nutrients, pH, and other selected samples, such as particle size, sulfides, and metals. These tests will be used to determine the rate of carbon sequestration and the total amount of carbon that can be sequestered in restored versus natural marshes. Additionally, restoration efforts include rebuilding the marshland using clean, dredged material from the Chesapeake Bay shipping channel, which has the added benefit of helping to counter sea level rise. Maryland has great potential for reducing greenhouse gas emissions through sequestering carbon in restored wetlands and marshlands around the Chesapeake Bay.

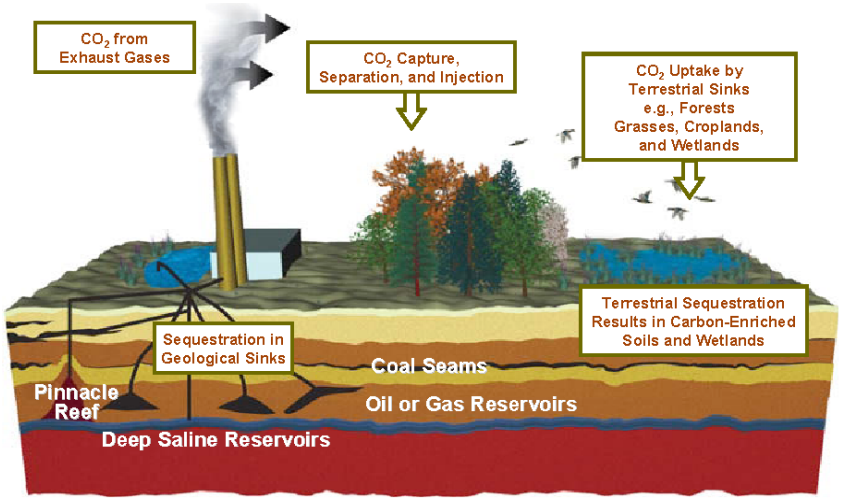
can provide shade with a natural cooling effect for residences and other buildings in the community. There is an interest among various State agencies and community groups to pursue urban forestry projects as an alternative to other, more traditional afforestation projects.

Geologic Sequestration

Carbon capture and storage technologies can be employed to reduce emissions by sequestering CO_2, either terrestrially or geologically. Terrestrial sequestration options include eroded and non-eroded cropland, marginal land, mineland, and wetlands and marshlands. Restoring these areas allows carbon to be sequestered in the soil and in plant matter that develops on these lands. Geological sequestration involves pumping CO_2 into underground storage reservoirs. The primary types of geological reservoirs are depleted oil and gas fields, unmineable coal seams, and deep saline formations. A co-benefit to geological sequestration is that when used in oil and gas fields the pressurized CO_2 displaces residual oil and gas allowing more of the resource to be extracted. The U.S. is already a world leader in enhanced oil recovery through CO_2 injection, sequestering about 32 million tons of CO_2 per year. A similar technique is being developed to utilize CO_2 injection into unmineable coal seams to displace and recover coal bed methane. Another potential sequestration option involves injecting CO_2 into (otherwise unused) deep saline reservoirs. Deep saline reservoir injection has two important benefits – potential storage capacity in the U.S. is very large and many are close to existing large CO_2 point sources.

The Midwest Regional Carbon Sequestration Partnership (MRCSP) was established by the U.S. Department of Energy to assess the technical potential, economic viability, and public acceptability of carbon sequestration within an eight state region – Indiana, Kentucky, Maryland, Michigan, New York, Ohio, Pennsylvania, and West Virginia. The MRCSP region has great potential for sequestration in geological and terrestrial sinks. Depleted or nearly depleted natural gas reservoirs and unminable coal seams in Garrett and Allegany counties are suitable for geological carbon storage. Terrestrial sequestration opportunities especially relevant to Maryland are wetlands and marshland. Table 4-15 outlines the MRCSP estimates of the regional sequestration storage capacity.

Carbon Dioxide Storage Options



Source: Block diagram provided from the Plains CO_2 Reduction (PCOR) Partnership Regional Atlas (2005). Modified from Oak Ridge National Laboratory (2000). Original rendering by LeJean Hardin and Jamie Payne.

Table 4-15 MRCSP Estimates of the Regional Sequestration Storage Capacity

Terrestrial Sequestration Potential		Geological Sequestration Potential	
Marginal Land	100 $MMTCO_2$/yr	Deep Saline Formations	475,000 $MMTCO_2$
Wetland/Peatland	15 $MMTCO_2$/yr	Depleted Oil & Gas Fields	1,400 $MMTCO_2$
Mineland	5 $MMTCO_2$/yr	Unmineable Coal Seams	350 $MMTCO_2$
Cropland	25 $MMTCO_2$/yr		

Source: Battelle, "Managing Climate Change and Securing a Future for the Midwest's Industrial Base," presentation by David Ball, MRCSP Project Manager, February 14, 2006.
Note: $MMTCO_2$/yr = million metric tons of carbon dioxide per year.

4.4 Generation Technology and Innovation

As detailed in Chapter 2, historic methods of generation in Maryland have been mainly fossil fuel combustion-based, with some non-combustion methods, such as hydroelectric and nuclear generation. In recent years, however, there has been an emphasis within the state on the development of renewable energy sources (see Section 2.1.3 for more information). Fossil fuel energy sources generally have greater impacts on the environment than their renewable counterparts. Although the timeframe for when the demand for coal, oil, and natural gas will outweigh economically feasible supply (often also referred to as the "peak") is widely debated, these resources are indisputably finite.

In general, electricity in the United States is generated by large centralized power stations (typically 300 – 3,000 MW) and is delivered to load centers by the regional transmission and distribution networks. An alternative to this traditional system is distributed generation, which is small-scale energy generation (typically 1 kW – 5 MW) that is located close to the point of use. Home-based solar, wind, and geo-thermal installations are examples of distributed generation that are gaining in popularity.

4.4.1 Current Generation Technologies

The Healthy Air Act (HAA) has had a significant effect on existing generation facilities in Maryland (see discussion in Chapter 3, page 61). Many power companies have installed selective catalytic reduction (SCR) and selective non-catalytic reduction (SNCR) systems on their existing plants to reduce SO_2 emissions; FGD systems to lower NO_x emissions; and electrostatic precipitators (ESPs) and baghouses to reduce particulate matter and mercury emissions in order to comply with the limits set forth in the HAA. However, the most recent new generation projects have been designed to utilize cleaner-burning fuels, such as pipeline-quality natural gas and ultra-low sulfur diesel fuel.

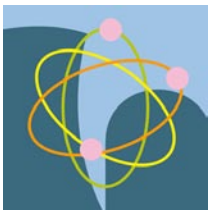
For example, CPV Maryland was granted a license by the Maryland PSC in November 2008 to build and operate a new natural gas-fired electric generating station near St. Charles in Charles County, Maryland. The proposed CPV St. Charles facility incorporates state-of-the-art natural gas CTs and HRSGs and will have a maximum electric output of 640 MW, or enough to power approximately 160,000 homes. The CTs will utilize an advanced dry, low- NO_x burner technology and the HRSGs will be equipped with SCR systems to control emissions of NO_x. To reduce the emissions of carbon monoxide (CO) and volatile organic comounds (VOCs), oxidation catalyst systems will be employed. An additional shared steam turbine generator, fed by the HRSGs, will be capable of generating an additional 170 to 304 MW (nominal). Due to its use of natural gas as a primary generating fuel, this

facility will qualify for the Clean Generation Set-Aside under RGGI (discussed in Section 4.3.1), which awards CO_2 allowances equal to actual CO_2 emissions for up to the first six years of plant operation.

In addition, as described in Section 2.2.1, the Calvert Cliffs Nuclear Power Plant is currently going through the licensing process for an additional reactor that will effectively double its current generation capacity. As proposed, this third reactor will provide 1,600 MW of new, nuclear generation in the state that can power up to 400,000 homes. Although no new nuclear generation units have been put into service since the Three Mile Island accident in 1979, there has been a resurgence of interest in nuclear power as an alternative to traditional fossil fuel-based generation.

There are also developing plans for fuel-switching in existing power plants to reduce pollutant emissions. Easton Utilities is currently evaluating several biodiesel blends for use at its existing downtown generating station and has received a grant from Maryland Energy Administration (MEA) to support this activity. In addition, the H. A. Wagner and C. P. Crane facilities are evaluating a coal type switch to facilitate compliance with current air emission regulations.

The Role of Nuclear Power in a Sustainable Energy Future



While nuclear power is not a "renewable" energy resource – uranium is a finite resource, just as fossil fuels are – there is increasing recognition that nuclear power generation has a role to play in slowing the rate of climate change. Nuclear reactors can provide large amounts of electricity to meet growing demand while contributing only a small amount of greenhouse gas emissions to the atmosphere, primarily from the use of backup emergency generators.

The U.S. nuclear power industry has been at a standstill since the Three Mile Island accident in 1979 — but that appears to be changing. Higher wholesale market prices combined with improvements in nuclear plant design and increasing concern over greenhouse gases are leading investors and power companies to consider building new nuclear facilities. Furthermore, as part of the Energy Policy Act of 2005, Congress provided $3.1 billion in tax credits for new nuclear facilities, along with liability protection and compensation for legislative delays. UniStar Nuclear, a joint venture that includes Constellation Energy here in Maryland, is one of the companies vying for these tax credits to support the development of its proposed Calvert Cliffs Unit 3 as well as other potential sites out of state.

Critics of nuclear power say that concerns about public safety, security, and long-term radioactive waste disposal outweigh the technology's greenhouse gas benefits. Some believe that climate change issues may be better addressed by building large natural gas-fired facilities to continue to meet demand in the short term while a major national effort is made to strengthen conservation and alternative energy solutions.

4.4.2 The Future of Energy

With federal initiatives focusing on GHG reduction and favoring the development of renewable energy sources and fossil fuels being finite resources, the future of energy production in the U.S. will likely be quite different than the current situation. We are bound to see emerging technologies that employ fossil fuel resources in cleaner, more efficient ways, especially in the near-term. Long-term trends will likely involve a surge in renewable energy project development and technology advancement, such as more efficient solar energy on a utility scale, increasing amounts of wind energy being integrated into the electric mix, and some innovative off-shore generation technologies.

The Role of Natural Gas

Employing natural gas as an energy source results in fewer GHGs (and other emissions) than coal. Coal has traditionally been the cheapest resource for building baseload power generation facilities. Recent new discoveries of unconventional natural gas sources, such as deep shale formations, coupled with advances in extraction techniques, has greatly increased the level of domestic natural gas reserves in the United States. The U.S. Energy Information Administration (EIA) estimated that at the end of 2007 there was up to 1,750 trillion cubic feet of technically recoverable natural gas in domestic sources. This number has increased significantly in the last few years due to new shale gas discoveries (see Figure 4-6). The Marcellus Shale, which extends partly into western Maryland, is now thought to contain up to 500 trillion cubic feet of natural gas.

The increasing supply of natural gas may lead to lower natural gas prices for the foreseeable future. Natural gas has been referred to as a "transitional fuel" in terms of facilitating the transition to a lower carbon profile, and energy companies are increasingly opting to build natural gas baseload generation instead of coal. The large increase in natural gas and

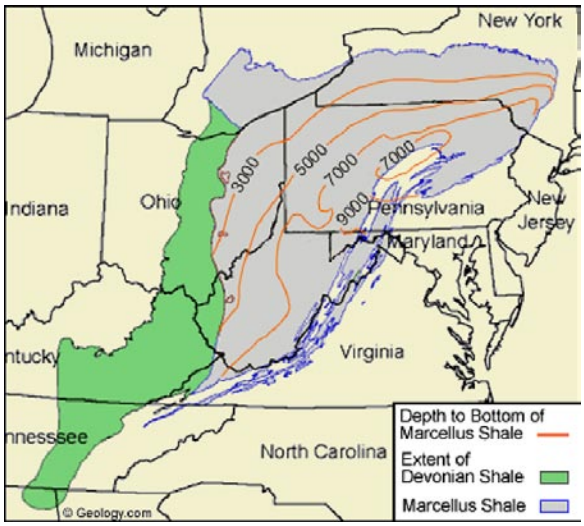
Figure 4-6 Natural Gas Reserves in the U.S.

Source: Energy Information Administration, updated May 28, 2009.

Marcellus Shale

Marcellus Shale has begun drawing attention for gas exploration, as new drilling techniques make the source more economically feasible. A basin extending from New York to West Virginia passes through western Maryland, and in sum is thought to contain the natural gas equivalent of roughly 80 billion barrels of oil. Interest in deposits in western Maryland's Garrett and Allegany Counties has been expressed by energy companies since 2006. The existing data on the land's geology has already been reviewed by companies across the country, with plans forming to drill test wells and lease mineral rights to the area. In Garrett County, there have also already been arrivals of 'land men' – workers who precede the test well drilling to arrange the land's leasing. It will be interesting to see in the future what the impact of this potential resource means for Maryland.

While natural gas does still produce greenhouse gases, it only creates half as much carbon dioxide as coal when burned, and is being looked at as a transitional fuel toward renewable energy. There are some concerns regarding water contamination due to the methods of extraction being employed, namely hydraulic fracturing, however the link between the two has not been conclusively shown and is under study. Added to this is the challenge that the natural gas industry faces by having missed out on taking any substantial gains from the new climate-change bill, Waxman-Markey. This came partly as a result of politics and differences of opinion in the industry regarding climate change, and partly due to the size of the natural gas industry itself, which is primarily made up of smaller to medium-sized businesses who find it difficult to compete in the political realm. One thing is certain, however – with these new technologies, the landscape for the future of energy has once again been changed.



Note: This map shows the approximate depth to the base of the Marcellus Shale. It was prepared using the map by Robert Milici and Christopher Swezey above and adding depth-to-Marcellus contours published by Wallace de Witt and others, 1993, United States Department of Energy Report: The Atlas of Major Appalachian Gas Plays.

Source: http://geology.com/articles/marcellus-shale.shtml

the resultant price decline may lead to natural gas being the near-term fuel of choice for cleaner electricity production as well as transportation.

Windpower and Offshore Resources

Wind energy is becoming increasingly more common throughout the U.S. and more desirable in Maryland. As the best wind resources in the state are found in the western-most counties and off-shore, the need exists for effective ways to integrate these areas with the higher energy demand centers located in the central portion of the state. In addition, the production of wind energy is dependent upon the amount of wind available at any given time, which is widely variable. Because of this, improvements to the transmission system and electricity storage methods will likely be necessary for effective integration into the existing electricity grid (see Section 4.5).

Although more prevalent in European countries, increasing amounts of off-shore wind energy projects are being proposed in the U.S. There are numerous advantages compared to more traditional on-shore wind projects such as steadier and stronger wind resources and typically fewer environmental impacts. Because of this, proposals for off-shore wind projects along the Pacific and Atlantic coasts are gaining traction (see Section 2.1.3, page 18).

Other off-shore technologies, such as underwater and floating ocean turbines, are designed to harness tidal, current, and wave energy resources. These technologies are less common-place than off-shore wind; however, as land resources suitable for renewable energy projects become increasingly scarce, it is likely that off-shore technologies will become an important part of achieving our nation's energy independence. In May 2008, Wavebob Ltd. opened an office in Annapolis, Maryland to serve as the headquarters for its U.S. operations. Wavebob Ltd. is one of only a handful of companies worldwide that has successfully generated electricity using ocean waves. Since Maryland is a coastal state, these issues will need to be followed closely.

Fuel Cells and Hydrogen

Hydrogen is the most abundant element in the universe, making up about 75 percent of all matter. It also contains the most energy of all fuels (Table 4-16). However, hydrogen in its elemental form is very rare on Earth and must be produced from other compounds before it can be utilized as an energy source. There are various ways to produce hydrogen. Hydrogen-rich natural gas and coal can be broken down to harvest the hydrogen. Hydrogen can also be extracted from water and chemical or biological compounds. For example, biohydrogen can be produced from algae that will release hydrogen instead of oxygen in a sulfur-deprived environment, and from certain types of bacteria feeding on wastes in a bioreactor. Table 4-17 outlines the relative merits of each method.

Table 4-16 Energy in Fuels

Fuel Type	Btu/lb
Hydrogen	55,000
Natural Gas	21,148
Gasoline	20,700
Diesel	19,800
Coal	15,000

Hydrogen is an ideal energy carrier. It can be compressed and/or transported through pipelines and stored. Hydrogen can be produced using grid electricity during off-peak periods and then stored for use to make clean, emissions-free electricity during peak

periods. Large-scale hydrogen deployment however, is not without certain challenges. Hydrogen molecules are very small and very flammable, making leakage a significant issue. As can be seen from Table 4-17, the most efficient means of producing hydrogen are still dependent on fossil fuels. More research and development is needed to create clean, efficient, and economical methods for producing hydrogen on a meaningful scale.

Table 4-17 Hydrogen Production Methods

Process	Efficiency	Advantages	Drawbacks
Coal Gasification	50-80%	Commercially viable, efficient, cheap, abundant fuel source	Pollutants released unless captured
Steam Reformation (Natural Gas)	80%	Most prevalent, commercially viable	Pollutants released, gas prices unpredictable
Electrolysis	25%	Clean, proven technology	Inefficient, not commercially viable
High-temp. Electrolysis	50%	No pollutants, highly efficient	Generators not ready until 2030
Thermochemical	50%	No pollutants, highly efficient	Not commercially viable, corrodes equipment
Biohydrogen	10%	Clean, renewable	Not yet commercially viable

Source: Clean Coal Technology Foundation of Texas website, accessed April 7, 2009.
http://www.cctft.org

The most efficient use of hydrogen is in fuel cells. Fuel cells create electricity quietly and reliably, and emit only water. Fuel cells are fully scalable, small enough for cell phones and large enough to be a grid-connected utility-sized power plant. The U.S. DOE's Hydrogen Program is conducting extensive research and analysis into safely and efficiency producing, transporting, and storing hydrogen. The program aims to enable commercialization of portable, stationary, and transportation fuel cell applications. Especially promising is the pairing of hydrogen storage and fuel cells in vehicles. DOE reports the following achievements in hydrogen/fuel cell deployment:

- *200 fuel cell vehicles;*
- *20 hydrogen-fueled buses;*
- *60 fueling stations;*
- *9 million metric tons of hydrogen produced annually; and*
- *1,200 miles of hydrogen pipeline.*

Maryland could benefit greatly from deploying hydrogen and fuel cells, especially in the transportation sector, a significant source of both ozone-inducing and climate change emissions.

Fuel cells can be constructed to also utilize other fuels making them useful for many types of applications. For example, molten carbonate fuel cells (MCFCs) are being developed for industrial, military, and utility-scale electricity applications. MCFCs use an electrolyte composed of a molten carbonate salt mixture suspended in a porous, chemically inert ceramic lithium aluminum oxide matrix. They operate at extremely high temperatures (roughly 1,200°F and above) and can reach direct-use efficiencies of up to 60 percent. If the waste heat is utilized in a cogeneration application, efficiencies can reach 85 percent.

A significant advantage of MCFCs is the ability to use fuels other than hydrogen. Due to the high temperature operation, an MCFC can internally convert other fuels to hydrogen by a process called internal reforming. MCFCs are also very resistant to impurities leading scientists to speculate that they may even be capable of internal reforming of coal. The

primary disadvantage of current MCFC technology is the accelerated component breakdown and corrosion caused by the high temperature operation. Research on developing corrosion resistant materials is on-going.

4.4.3 Advances in Energy Generation

Cutting-edge research on energy generation techniques is creating a picture of the future that seems more science fiction than fact. New emerging technologies encompassing biological processes, nanotechnologies, and greater understanding of the properties of magnetism are resulting in innovative and novel methods for creating electricity. This section outlines just a few of the ways in which current research may alter the future of electricity generation.

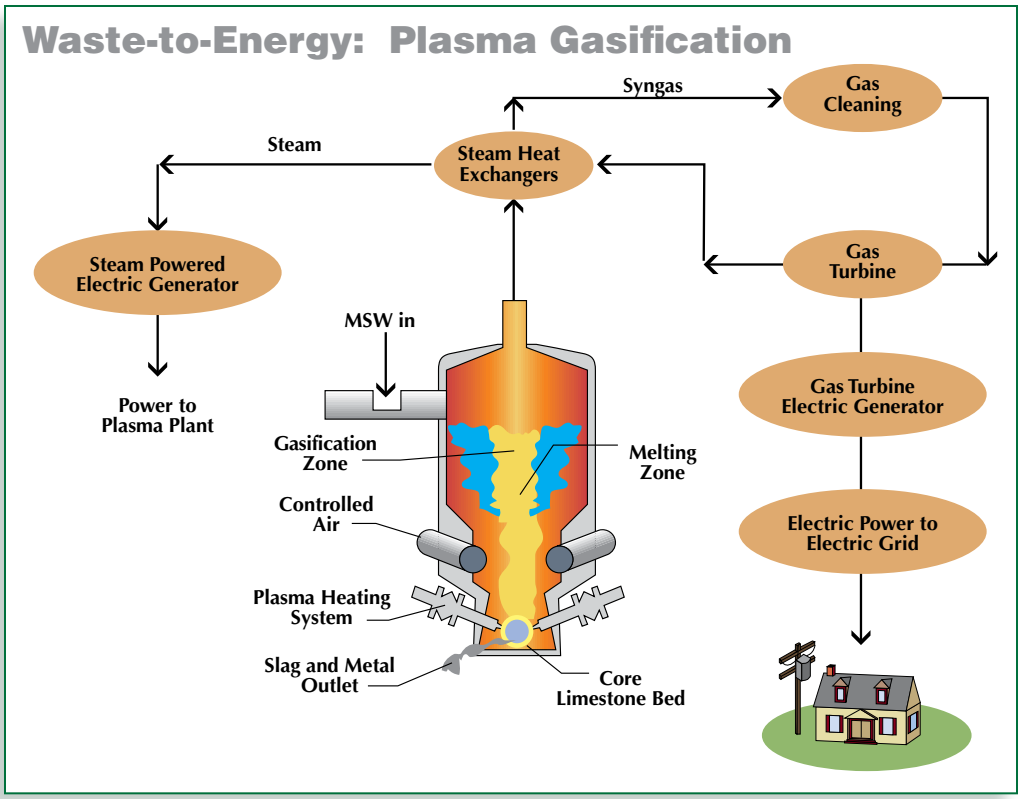
Biotechnology

Biological processes naturally utilize waste materials, including CO_2, as a food source, transforming it to usable fuels. Researchers have been examining various types of algae and bacteria for many years, with the aim of using these organisms to create fuel on an industrial scale. A Maryland company, Zymetis, Inc., is just one of many making significant advances in this field by working with a bacterium, *Saccharophagus degradans*, that was discovered several years ago in the marshes of the Chesapeake Bay. This particular bacterium is very efficient at eating dead plant material and solid waste and breaking them down into glucose, which in turn can be used to make fuel. Researchers have genetically altered the bacterium to produce more of the key enzyme it uses to break down material, and are moving towards being able to use the process on an industrial scale.

Algae are a large and diverse group of simple organisms containing only a nucleus enclosed within a membrane and chloroplasts bound in one or more membranes. Nearly all algae use photosynthesis, consuming CO_2 and producing oxygen as a by-product. Algae grow rapidly, can double their mass several times a day, and can be produced using ocean water and wastewater. Additionally, they can contain high amounts of lipids (oils) and are biodegradable and relatively harmless to the environment. Researchers have been working to create efficient and economical methods for growing and harvesting algae for the purpose of converting them into various fuel sources, including biodiesel, biobutanol, biogasoline, methane, and hydrogen. The first North American commercial algae-to-biofuels facility began operation in April 2008. The facility, located in Rio Hondo, Texas, will produce an estimated 4.4 million gallons of "algal oil" and 110 million pounds of biomass per year using a series of saltwater ponds covering 1,100 acres. The algal oil can be refined into fuel, such as biodiesel or jet fuel, and the biomass can be fed to cattle as a protein supplement or fermented into ethanol.

Plasma Technology

Plasma gasification can use almost any waste material to create electricity, leaving behind an inert slag similar to vitrified glass. Passing electricity through ionized gas (plasma) creates a field of extremely intense, lightning-like energy in a plasma arc. The arc is so powerful that it disintegrates matter by tearing apart molecular bonds. Capable of breaking down just about anything, except nuclear waste, the only by-products are the vitreous slag that can be used as a raw material for numerous applications, including bathroom tiles and high-strength asphalt, and a synthetic gas, or “syngas” — a mixture of primarily hydrogen and carbon monoxide that can be converted into a variety of marketable fuels, including ethanol, natural gas and hydrogen. Over the past decade, half a dozen companies have been developing plasma technology to turn garbage into energy. The first North American plasma facility was initially energized in June 2007 just outside Ottawa, Ontario in Canada. In October 2007, the plant began delivering electricity to the Ontario



grid, converting 85 tons of waste per day. After a successful first year of operation, which included an emissions profile well below permitted amounts, in June 2008, the Ottawa City Council unanimously approved the building of a full-scale facility. When completed, the plant will have a net electrical capacity of 21 MW and process 400 tons of waste per day.

Kinetic Generation Devices

Innovative ways to harness kinetic energy from everyday things is leading to electricity generation from the movement of normal items in our surroundings. A new technology by AEST, Inc. of California is called the Dragon Power Station™ and is activated when heavy duty vehicles drive over plates embedded into the road. The pressure on the plates initiates a hydraulic pumping system that turns a generator to produce electricity. Fluxx-lab, a small New York firm made up of two architectural design graduates, has created the Revolution Door, an adapted revolving door, which can harvest the energy created every time the door spins. The tiny amount of electricity generated can be stored for potential uses such as lighting.

A Burger King franchise has installed a speed bump designed to harness the kinetic energy produced by the hundreds of cars that pass through the drive-thru at its high-traffic restaurant in Hillside, New Jersey each day. Customers waiting for their meals roll through a section of the drive-thru lane lined with metal plates that move down and up as the cars head to the next window. The MotionPower™ technology was developed by Burtonsville, Maryland-based New Energy Technologies, and is designed to make use of the energy from cars, trucks, and heavy vehicles when they slow down or come to a full stop countless times throughout the day, converting this otherwise wasted energy into clean electricity. The company engineers anticipate that MotionPower™ devices could be used to augment or replace conventional electrical supplies for powering roadway signs, street and building lights, storage systems for back-up and emergency power, and other electronics, appliances, and even devices used in homes and businesses.

The David A. Ambler Student Recreation Fitness Center at the University of Kansas recently retrofitted 15 elliptical machines with ReRev devices made by Florida-based SunQuest energy. The devices draw on kinetic energy created by individual's workouts and reroute that energy back into the building's electric grid. SunQuest claims a ReRev device can generate enough electricity from a typical 30-minute workout to power a laptop for an hour, a television for 15 minutes, or a compact fluorescent light bulb for 2.5 hours. The ReRev devices will convert the energy created by the elliptical machines from direct current (DC) power into 240/208 Volt 60 Hertz alternating current (AC) inside a control box mounted near the exercise machines. Users will see the energy their workouts contribute to the building displayed in real time.

Researchers are also inventing ways to harvest energy from simple human motion through knee-mounted devices that can generate energy from a person's stride. One example is the Biomechanical Energy Harvester created by Bionic Power, Inc., which consists of an aluminum chassis and generator mounted on a customized orthopedic knee brace. This technology could potentially be used to help power prosthetic limbs and medical implants, power portable devices such as MP3 players, GPS locators or mobile phones, and provide light-weight portable energy for military personnel, eliminating the need for a heavy backpack battery.

4.5 Innovations in Transmission Technologies

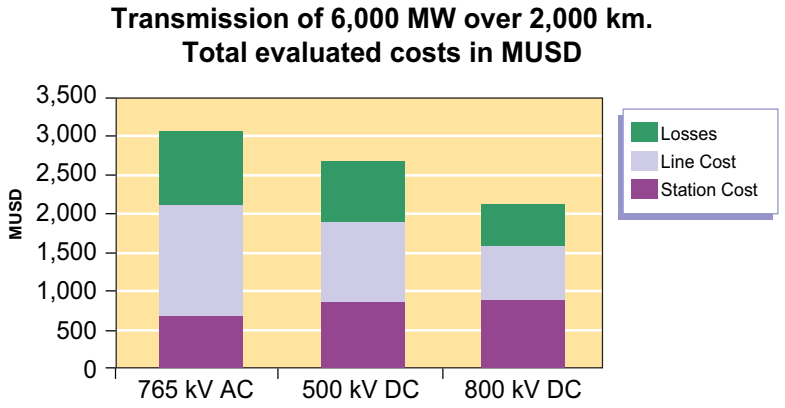
New emerging transmission technologies will enable a new generation of grid equipment that will be able to endure higher electrical and mechanical stresses and provide greater power transfer capacity and greater flexibility. Currently available technologies are already able to provide twice the capacity of similar traditional equipment with half the energy losses.

4.5.1 High-Voltage Transmission Line Technologies

Electricity can be transmitted several ways and at various voltages. The majority of current bulk power transmission systems in the U.S. consist of overhead AC Aluminum Conductor Steel Reinforced (ACSR) transmission lines that are generally rated at 230-kV or higher. Direct current lines comprise only about 2 percent of the total installed high-voltage transmission line mileage. This is mainly due to cost, as DC systems require large power conversion stations at each interconnection with the traditional AC grid, while AC systems only require much less expensive step-down transformers to make the power usable at the consumer end. Direct current systems have mainly been used for large scale one-way bulk power transfers, such as undersea cables. The proposed Mid-Atlantic Power Pathway (MAPP) project (see details in Section 2.6.4) will utilize 500-kV high-voltage direct current (HVDC) for approximately 70 miles, including a 12 - 39 mile submarine crossing of the Chesapeake Bay.

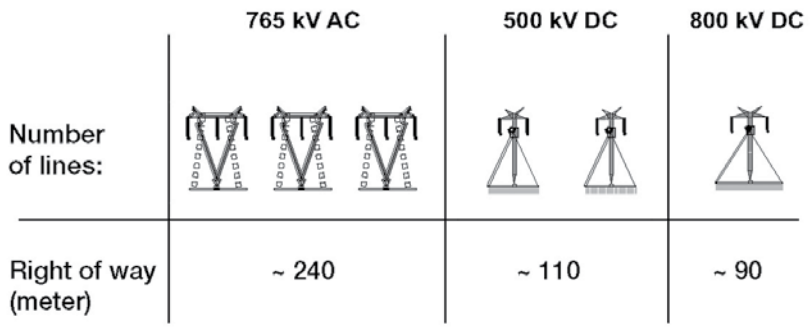
Interest in HVDC has been increasing steadily over the last several years. High-voltage DC systems are capable of carrying significantly more power over longer distances with fewer losses than traditional AC systems. Ultra-HVDC systems are being installed outside the U.S. that operate at 800-kV and can carry 6,000 MW of electricity. Figure 4-7 shows the economic advantage of such a system over longer distances as compared to AC and traditional HVDC systems in millions of U.S. dollars (MUSDs). An additional benefit is a typically smaller environmental footprint as HVDC lines are more compact and may require smaller right-of-ways (see Figure 4-8). Right-of-way widths may vary based on span lengths and terrain conditions.

Figure 4-7 Ultra-HVDC Comparison



Source: The ABB Group website, Brochure: Ultra High Voltage DC Systems

Figure 4-8 Ultra-HVDC Footprint



Source: The ABB Group website, Brochure: Ultra High Voltage DC Systems

Underground and submarine transmission line installations comprise a rather small percentage of the total line miles installed in the U.S. — on the order of approximately 1 percent. Although most utility companies place transmission lines below grade only when there is no feasible overhead route available due to increases in cost and construction and repair times, other reasons for this type of installation becoming increasingly more common include reduced maintenance, less susceptibility to weather damage, fewer traffic accidents involving poles, reduced visual impacts, and less impact to property values compared to comparable overhead transmission lines. Historically, the most common type of underground transmission cable was the "pipe-type" filled with oil as an insulating material. However, there has been a change in recent years from the traditional, oil-filled transmission cables to solid dielectric ones, specifically cross-linked polyethylene (XLPE) cables. This particular type requires little maintenance; is not fluid-filled, and therefore, has no associated leaking risk or pumping stations; can operate at a higher temperature; has the smallest capacitance of any other technology options available; is prefabricated and tested; and can be implemented at longer distances. Going forward, oil-filled cables will likely be phased out completely.

The technology with some of the greatest potential for future transmission grid improvements is high-temperature superconductors (HTS), which will typically be designed for underground installations. Advances in materials sciences are steadily increasing the temperature requirements for superconductivity, which function only in extreme cold. These HTS can potentially carry up to 100 times more power with few, if any, line losses as there is no electrical resistance in superconducting wires. The U.S. DOE's Office of Electric Delivery and Energy Reliability's Superconductivity Program estimates that HTS power cables, fault current limiters, transformers, generators, and motors will be available for full-scale commercial use by 2012.

4.5.2 Electricity Storage Technologies

Electricity storage technologies and facilities might serve to support intermittent renewable resources such as wind and solar. Overall, storage can be used as a system resource, i.e., to help meet load requirements or to provide ancillary services; not to balance individual generating plants. Federal Energy Regulatory Commission (FERC) Order 890 allows for non-generation resources to participate in ancillary services markets. On January 6, 2009, FERC approved the Midwest Independent Transmission System Operator's (Midwest ISO) proposal to use stored energy resources for contingency reserves as well as regulating

reserves.[4] Energy storage devices, including hydroelectric power, flywheels, batteries, and compressed air are among the storage technologies considered for regulation markets and for balancing intermittent renewable resources.

Pumped hydro, which generates electricity by reversing water flow between reservoirs, is the most widespread energy storage system in use today. With an efficiency rate of more than 80 percent, pumped storage provides for approximately 20 GW of storage in the United States.[5] Compressed air energy storage (CAES) makes use of natural and manmade (abandoned gas and oil wells) caverns to store compressed air and recover it for use in a turbine. Excess and inexpensive electricity is used to compress and pump high pressure air into an underground cavern. When electricity is needed, the air is released from the cavern, mixed with natural gas, and combusted leading to the air's expansion prior to running it through a turbine to generate electricity.

Flywheel systems utilize a massive rotating cylinder, and are a good fit for providing regulation services. This technology can be used as a short-term buffer to smooth local output fluctuations from a wind-farm or photovoltaic (PV)-array. Flywheels are commercially available for development as "regulation power plants" providing up to 20 MW of regulation for a 40 MW swing.

Battery storage systems are being evaluated for their ability to control and dispatch electricity as needed to meet demand, or for system stability. Lithium Ion batteries and Sodium Sulfur batteries are already being used to provide 15 to 60 minutes of energy storage as regulation services. A handful of energy companies are beginning to test the use of batteries for grid management and energy storage. AEP installed a 1.2 MW battery system in West Virginia in 2006, to test the storage technology and to help fill capacity gaps and flatten the load in the region.

Use of plug-in all-electric and hybrid vehicles for storage of electricity is another variation on battery storage. The idea of using the batteries of plug-in all-electric and hybrid vehicles as an energy storage resource is called Vehicle to Grid (V2G). The Mid-Atlantic Grid Interactive Car Consortium (MAGICC)[6] interconnected an AC Propulsion "eBox" (a converted Toyota Scion xB, fitted with an AC induction motor, AC-150 electronics and a custom built battery, see Figure 4-9) to the PJM grid and used the control center of PJM to dispatch the battery-stored electricity as a regulation resource.[7] In addition to regulation, the V2G concept would have vehicles providing spinning reserves, back-up power supply service, and peak load management. According to MAGICC, a vehicle plugged in at home and driven sporadically for a total of 2.5 hours might provide regulation electricity services for more than 21.5 hours. In regulation down periods, the car takes in the excess electricity and stores it, then in regulation up periods, the car discharges electricity.[8]

4.5.3 Smart Grid

The smart grid concept embodies the idea of bringing the electric grid into the computer age. Smart grid proponents believe that the electric infrastructure will evolve over the next few decades into a highly automated and interconnected network similar to the internet.

[4] FERC authorizes Midwest ISO Ancillary services market for January 2009 startup, FERC News Release, December 18, 2008, Available: http://www.ferc.gov/news/news-releases/2008/2008-4/12-18-08-E-3.asp

[5] Sullivan, et al, p. 6

[6] Consortium including: Pepco Holdings Inc. (PHI), the University of Delaware, the PJM regional transmission organization, AC Propulsion, and Comverge.

[7] Willet Kempton, et al, A Test of Vehicle-to-Grid (V2G) for Energy Storage and Frequency Regulation in the PJM System, University of Delaware, November 2008, pp. 6-7.

[8] Willet Kempton, et al, A Test of Vehicle-to-Grid (V2G) for Energy Storage and Frequency Regulation in the PJM System, University of Delaware, November 2008, pp. 23-24.

Figure 4-9 MAGICC Prototype

Source: Cathy Atkinson, University of Delaware

The smart grid involves a network of "smart" devices (generally 'smart' means devices contain microprocessor or computer technology) that enable real-time balancing of generation and electric delivery via information flow through intelligent systems. Currently, grid operations are based on the balance of supply and demand between generators and utility customers. Balance is achieved through monitoring demand and adjusting supply. The smart grid of the future will be mutually self-sustaining and self-correcting between energy suppliers and users, and largely self-balancing to ensure reliability in real time.

Utility Advanced Metering Initiatives (AMI)

In April 2007, the PSC approved BGE's AMI pilot project in order to "gather statistically significant, measurable and meaningful information as to the potential positive effect of AMI on reducing peak system demand." In addition to the installation of advanced meters, BGE also conducted a Smart Energy Pricing pilot project to evaluate the impact of time differentiated electricity pricing on customer electricity consumption. There were two pricing options, Dynamic Peak Pricing (DPP) and Peak Time Rebate (PTB). With the DPP program customers would pay more for electricity during higher priced peak periods. Under the pilot program the all-in off-peak rate is $0.09425 per kilowatt hour, the peak rate is $0.14425, and the critical peak rate is $1.30425. Under the PTB customers receive a rebate for using less energy during peak periods. Rebates were provided at a rate of $1.75 per kilowatt hour for peak periods and $1.16 per kilowatt hour during a critical peak day. During the pilot project the typical residential customer rate was at $0.14. Average customer savings ranged between $65 and $170, depending on the program (see Figure 4-10). Customers had day-ahead notification of a critical peak day and were contacted via e-mail, telephone, and text message. A sample of customers also had the Ambient Energy

Orb that signals relative prices through the use of varying colors, as shown in Figure 4-11. BGE is planning a second phase of their AMI pilot project for summer 2009.

Thus far BGE is the only Maryland investor-owned utility to complete an AMI pilot project and to start deploying AMI technology in Maryland. BGE has submitted a proposal to the PSC for full-scale deployment of AMI technology in Maryland, which would include approximately 1.36 million advanced electric meters and 730,000 gas meters installed over 5 years. BGE's has estimated the initial deployment would cost about $482 million and has asked for an expedited proceeding to approve the request. PHI, on behalf of Pepco and Delmarva Power Company, has also requested an expedited proceeding to consider the deployment of advanced meters. Affiliate PHI companies operating in Delaware and the District of Columbia have already completed pilot projects evaluating the economic benefits of advanced meters and have begun deploying advanced meters throughout their service areas. PHI estimates that the cost of full deployment of advanced meters in the Pepco and Delmarva Power service areas is $127.7 million and $51.0 million respectively. The urgency of BGE's and PHI's requests before the PSC are due to the current availability of federal funding for advanced meters and smart grid technology deployment made possible through the American Recovery and Reinvestment Act. Allegheny Power has filed for approval to implement an Advanced Utility Infrastructure (AUI) pilot project in the Urbana area. AP also requested expedited consideration and approval of the pilot so that the company could apply for DOE funding to offset half of the costs. AP's AUI pilot project would include 1,140 customers and demonstrate peak demand reductions and energy savings through direct customer consumption reduction and reduction in system losses associated with the use of AUI technology.

Figure 4-10 BGE Pilot Project Savings

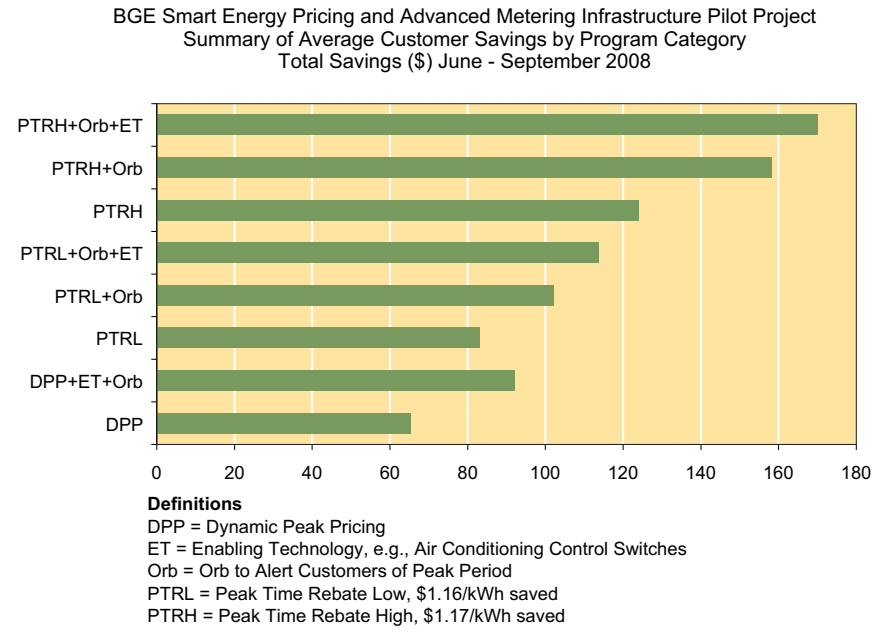
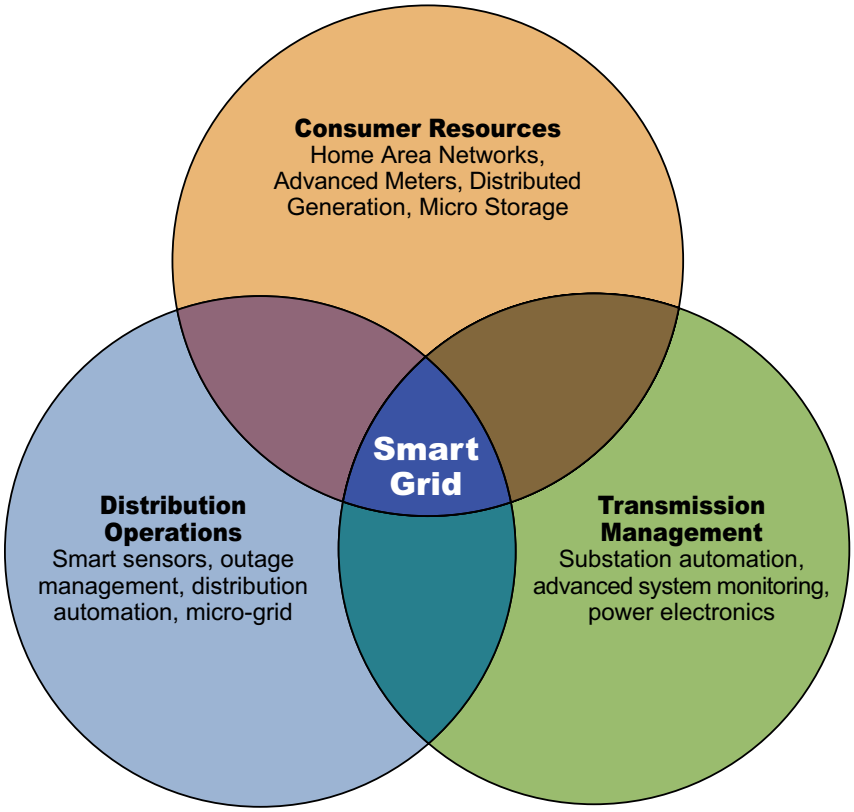


Figure 4-11 Ambient Energy Orb

Smart Grid Integration

"Advanced metering" and "smart grid" are frequently used interchangeably. However, advanced meters are just one component of a smart grid, which would enable a wide array of financial, informational, and "electrical" transactions among consumers and authorized grid users, such as regional transmission operators, distribution utilities and generators. A smart grid integrates advanced technologies and communication by consumer based resources, distribution companies, and transmission systems (see Figure 4-12). Better integration of these traditional elements of electricity may one day serve to reduce utility and power plant operations and maintenance and capital costs by improving load factors, lowering system losses, and improving outage management performance. On the consumer side, the smart grid will provide information, control, and options that enable consumers to engage in new energy markets and better home energy management.

Figure 4-12 Conceptual Illustration of Smart Grid Integration



Smart Grid: reduce O&M costs, more efficient day-to-day operations, improved capacity planning, more efficient resource management, better customer service.

4.6 Federal Stimulus Funding for Energy Research and Development

4.6.1 Generation and Clean Coal

The American Recovery and Reinvestment Act of 2009 (ARRA), signed by President Obama on February 17, 2009, includes funding for research and development of both renewable energy and innovations in conventional energy use. Stimulus funding made available to the DOE Department of Energy, Energy Efficiency, and Renewable Energy (EERE) totals $16.8 billion, of which $11.3 billion is designated to energy efficiency, conservation, and grants to state energy programs. The remaining $5.5 billion will be used at the discretion of EERE to provide additional funding for various technology research programs, including:

1. *Hydrogen Technology Program - $41.9 million to support immediate deployment of nearly 1,000 fuel cell systems for emergency backup power and material handling applications (e.g., forklifts), and to accelerate the demonstration of stationary fuel cells for combined heat and power in the larger residential and commercial markets.*

2. *Biomass Program - $786.5 million to accelerate advanced biofuels research and development and to provide additional funding for commercial-scale biorefinery demonstration projects. The DOE has released funding opportunity announcements for: (a) projects that will address research and development efforts related to intermediate ethanol blends and algal and advanced biofuels; and (b) integrated biorefinery projects that have adequate technical and economic performance data supporting their readiness for scaling up to commercial production levels.*
3. *Solar Energy - $175 million for solar energy, including $30 million for concentrating solar power (specifics to be determined).*
4. *Wind & Hydropower Technologies Program - $12 million to support the research and development of advanced water power technologies; $25 million to Massachusetts to develop a Wind Technology Testing Center that will be able to test blades longer than 50 meters; and $8.5 million for 53 new wind energy projects in 24 states, plus the District of Columbia to support the DOE's 20 Percent Wind Energy by 2030 goal. An additional $93 million is allocated to the National Renewable Energy Laboratory for wind energy programs including:*
    - *$45 million for wind turbine drive-train research, development, and testing;*
    - *$14 million for industry technology development projects;*
    - *$24 million for the development of up to three consortia between universities and industry to examine wind energy deployment challenges; and*
    - *$10 million additional funding for the existing National Wind Technology Center.*
5. *Geothermal Technologies Program - $400 million (specifics to be determined).*

The ARRA also provides $3.4 billion for fossil energy research, including:

- *$800 million for Clean Coal Power Initiatives, which provides government co-financing for new coal technologies that can help utilities reduce power plant emissions of sulfur, nitrogen and mercury.*
- *$1.52 billion for large-scale carbon capture and storage projects from industrial sources, including, but not limited to, cement plants, chemical plants, refineries, steel and aluminum plants, manufacturing facilities, and petroleum coke-fired and other power plants. A second stage will include innovative concepts for beneficial CO_2 reuse and CO_2 capture from the atmosphere. In addition, two previously selected existing projects will be expanded to accelerate scale-up and testing – $20 million for the Ramgen Modification, an advanced CO_2 compression project, and $70.6 million for the Arizona Public Services Modification, an algae-based carbon mitigation project.*
- *$70 million for a combination of geologic site characterizations and research and training related to geologic sequestration of CO_2.*

Additionally, the ARRA makes innovative energy technology research and development funding available through the new Advanced Research Projects Agency – Energy ($400 million increase), and the Innovative Technology Loan Guarantee Program ($6 billion). The loan guarantees are available to projects that commence construction prior to September 30, 2011, and can be used only in support of the following project types:

- *Renewable energy systems, including incremental hydropower, that generate electricity or thermal energy, and facilities that manufacture related components;*
- *Electric power transmission systems; and*
- *Leading edge biofuel projects that will use technologies at the pilot or demonstration scale and will produce transportation fuels that reduce lifecycle greenhouse gas emissions.*

4.6.2 Smart Grid Projects

The ARRA allotted $4.5 billion to DOE's Office of Electricity Delivery and Energy Reliability for investment in a nationwide plan to modernize the electric grid, enhance security of the U.S. energy infrastructure and ensure reliable electricity delivery to meet growing demand. The DOE set aside $3.375 billion for the Smart Grid Investment Grant Program. Funds provided to entities from the grant program are on a cost share basis with a maximum grant of $200 million per project. The DOE issued its solicitation and guidance for smart grid projects on June 25, 2009 with applications for the first round of funding due by August 6, 2009. PHI and BGE submitted proposals to DOE for funding to cover half of PHI's and almost half of BGE's initial costs. On October 27, 2009, President Obama announced the recipients of the smart grid funding. BGE received $200 million and Pepco received $104.8 million to support their smart grid deployment plans.

4.6.3 ARRA in Maryland

Maryland has been allocated $51.8 million of the total $11.3 billion designated to EERE for state energy programs. MEA is proposing to use ARRA funding in the programs outlined in Table 4-18 in fiscal year 2010.

Table 4-18 MEA ARRA Program Funding Allocations

MEA EmPOWERing Maryland Clean Energy Programs	ARRA Funding
Multi-Family Retrofits for Low and Moderate Income Families	$7.5 million
Industrial/Commercial Energy Efficiency Loans and Grants	$3.75 million
State Agency Loan Program	$3.65 million
Residential Renewable Energy Grants	$4.3 million
Renewables on Commercial and Government Buildings	$3.5 million
Alternative Transportation Fuel and Infrastructure Grants	$0.6 million
EmPOWERing Financing Initiative	$4.0 million
Clean Energy Economic Development Initiatives	$5.943 million
Clean Energy Job Training and Building Code Technical Assistance	$1.25 million
Total	**$34.493 million**

Additionally, a total of $2.7 billion in ARRA funding has been allocated to the DOE's Energy Efficiency and Conservation Block Grant (EECBG) Program. The EECBG provides funds to units of local and state government, Indian tribes, and territories to develop and implement energy efficiency and renewable energy projects. Under the EECBG program, states will implement programs that lower energy use, reduce carbon pollution, and create green jobs locally. The EECBG directly allocated $40 million in grants to Maryland's top 10 largest counties and 10 largest cities. In September 2009, the DOE announced Maryland's State energy program was receiving an additional $9.6 million in funding under the EECBG. Eighty-eight percent of this allocation will be passed along to the 13 counties and 147 municipalities that were not eligible for direct EECBG formula funding. The counties will receive up to $417,000 and the municipal governments will receive up to $93,000, depending on population.