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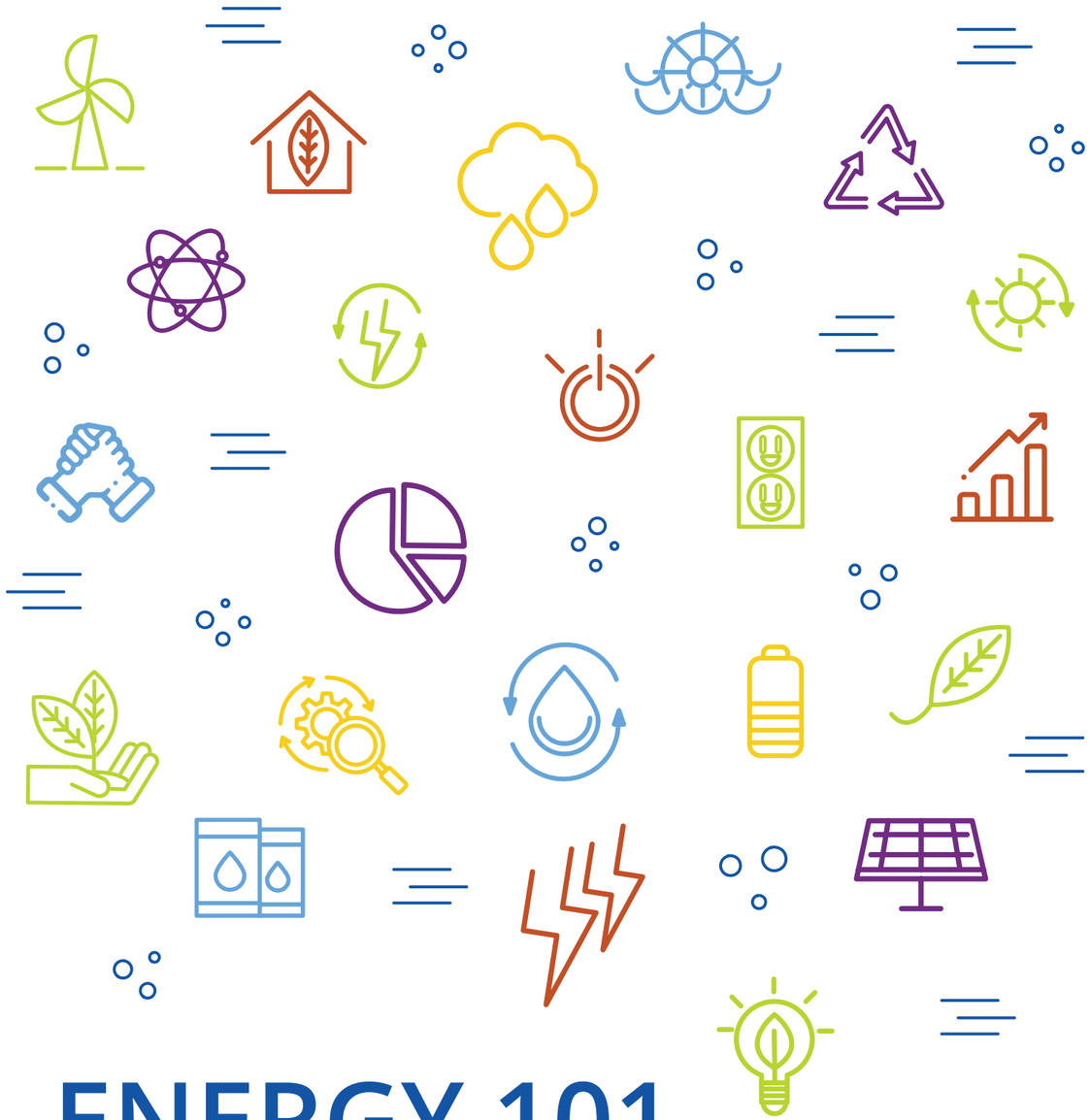

ENERGY 101

A Resource Guide for Maryland's Advanced Energy Network

MARYLAND
CLEAN ENERGY CENTER

INTRODUCTION

What is Energy 101?

Energy 101 describes the key entities involved in energy generation, transmission, distribution, and regulation, as well as how they interact with each other. This publication also contains summaries of energy technologies currently available in Maryland, an energy policy history timeline, and milestone goals that frame the market, along with a helpful glossary of industry-related terms (page 51) and a list of resource and reference links (page 56).

Why do you need this information?

The energy landscape is complicated. This resource contains valuable information for a better understanding of the energy sector in Maryland. Energy 101 has been designed to enable Maryland consumers, policy makers, and stakeholders - as well as their colleagues and constituents - to make effective personal and public policy decisions about managing energy supply, delivery, consumption, and costs.

Who provided this resource?

Energy 101 is brought to you by the Maryland Clean Energy Center (MCEC). As an active voice of industry and a resource for both consumers and policy makers, MCEC acts as a trusted third-party source of information and technical support.

MCEC was created as an instrumentality of state by the Maryland General Assembly in 2008. The Center serves as a statewide green bank with a mission to transform the energy economy in Maryland by increasing clean energy jobs, driving commercialization of technological innovations, and enabling consumer adoption of clean energy products and services. MCEC facilitates access to capital through leveraged or direct investment and operates financing programs targeted to serve various consumer audiences and underserved communities. The Center provides specialized procurement and technical support in order to facilitate and expedite project implementation.

The energy sector is rapidly evolving in Maryland. Energy 101 is viewed as a living document that will be updated and improved as circumstances dictate. The most current version of the guide, and related resources, can be found online at mdcleanenergy.org.

The Maryland Clean Energy Center

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MARYLAND POLICY ADVANCING CLEAN ENERGY

The Maryland legislature has a long track record with energy-related policy and regulation. In past sessions, the Maryland General Assembly has established goals related to energy consumption and supply, as well as the associated emissions:

- Reduce statewide greenhouse gas emissions by 60% from 2006 levels by 2031
- Achieve net–zero statewide greenhouse gas emissions by 2045
- Renewable Portfolio Standard (RPS) minimum of 50% from Tier 1 sources, including 14.5% from solar by 2030

This timeline highlights some of the most significant energy-related policy decisions, but it is not a complete record of past policy activity.

Additional Policy Watch resources are available online at mdcleanenergy.org/policy.

2004	Electricity Regulation - Renewable Energy Portfolio Standard and Credit Trading - Maryland Renewable Energy Fund
2008	EmPOWER Maryland Energy Efficiency Act of 2008 **Maryland Clean Energy Center** *Enabled the creation of the Maryland Clean Energy Center in statute as a corporate instrumentality of the state to promote economic development and jobs in the clean energy industry sector, promote the deployment of clean energy technology in the state and serve as an incubator for its development; collect, analyze and disseminate industry data; and provide outreach and technical support to further the clean energy industry in the state.* Regional Greenhouse Gas Initiative - Maryland Strategic Energy Investment Act
2009	Greenhouse Gas Emissions Reduction Act
2011	Income Tax – Tax Credit for Electric Vehicle Recharging Equipment Maryland Quiet Vehicles and Pedestrian Safety Task Force - Reconstitution Renewable Energy Portfolio - Waste-to-Energy and Refuse-Derived Fuel Renewable Energy Portfolio Standard - Renewable Energy Credits - Solar Water Heating Systems

2013	Offshore Wind Act
2014	Clean Energy Loan Programs - Private Lenders - Collection of Loan Payments Electric Vehicles and Recharging Equipment – Rebates and Tax Credits Maryland Clean Energy Center - Green Bank Financing Study
2015	Electricity - Community Solar Energy Generating System Program Environment - Hydraulic Fracturing Maryland Commission on Climate Change
2016	Greenhouse Gas Emissions Reduction Act – Reauthorization Local Government - Clean Energy Loan Programs - Commercial Property Owners - Renewable Energy Projects
2017	Clean Cars Act of 2017 Renewable Energy Portfolio Standard
2019	Clean Energy Jobs Plug-In Electric Drive Vehicle Excise Tax Credit Public Safety - Solar Photovoltaic Systems - Lockout Tag Requirement
2021	Clean Cars Act of 2021 Electricity - Renewable Energy Portfolio Standard - Qualifying Biomass Renewable Energy Portfolio Standard - Wastewater, Thermal, and Other Renewable Sources Utilities - Net Energy Metering
2022	Clean Cars Act of 2022 Climate Solutions Now Act of 2022 Electricity - Community Solar Energy Generating Systems - Generating Capacity Public Utilities - Electric School Bus Pilot Program Renewable Energy Portfolio Standard and Renewable Energy Credits - Offshore Wind

BUILDING A FOUNDATION TO UNDERSTAND ENERGY

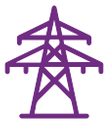
Creating electricity involves a complex energy extraction and use process. The system is composed of four fundamental parts:

Resources

The energy extraction process begins with the resources, or fuel, from which usable energy is derived. These resources include fossil fuels such as coal or natural gas, nuclear fuel, or renewable resources such as wind, sunlight, geothermal, or water for hydropower.

Generation

Generation is the process of refining raw resources into usable electricity. Natural gas, coal, wind, and solar energy are converted into electricity by combustion, reactive processes, or physical motion. Electricity is then sent to the electric transmission system. Electricity generation may occur at a large, centralized facility or distributed generation, whereby electricity is used nearby.



Transmission

Transmission is defined differently by various entities, but involves the movement of large quantities of electricity, gas, or liquid fuels over a long distance at high rates (high voltage, in the case of electricity, or high pressure, in the case of natural gas). A limited number of high-capacity transmission lines feed into many distribution lines and networks.

Distribution

Distribution systems take the transmitted energy and distribute it to homes and businesses. The high-voltage and high-pressure energy is stepped down, or transformed, to more usable voltage or pressure on the distribution system so that it can be consumed by individuals and commercial businesses.

FRAMING THE MARYLAND ENERGY MARKETPLACE

The electricity used by Maryland consumers is diverse. In 2020, slightly over 39% was generated by natural gas power plants and almost 42% from nuclear power.

Coal use has decreased, representing 9% of the electricity fuel source. This percentage will decrease as several coal fired power plants will be retiring or switching fuel. **Renewable energy generation comprises about 9.5% of Maryland's diverse energy portfolio.**

Increasing the percentage of clean energy generation from renewable sources will help Maryland reduce its dependence on imported electricity from other states, create more Maryland jobs in a growing industry, and improve the environment. More renewable energy in the portfolio will help protect Marylanders from some cost variability in the marketplace and contribute towards the **goal of generating 50% of electricity from renewable sources by 2030 and 100% by 2040. Of the 50% goal, 12.5% shall be from solar energy by 2030. There is also a goal for offshore wind generation to generate 1,200 Megawatts (MW) by 2030.**

Maryland's Energy Challenges

Maryland is part of the Mid-Atlantic regional electricity transmission grid, PJM Interconnection. **PJM is a regional transmission organization that coordinates the movement of wholesale electricity across thirteen states and D.C.** Marylanders consume more than five times as much electricity than is generated from in-state sources. Therefore, about two-fifths of the power consumed in Maryland comes from resources outside the state through the PJM grid. The transportation sector comprises about one-third of the state's energy consumption. As of 2022, the state was a net importer of about 82% of its energy and 44% of its electricity. With an aging fleet of generation plants and little utility-scale generation added since 1999, Maryland must explore options to continue to meet consumer demand.

PJM regional transmission area

Reliance on imported power supply may affect businesses and consumers in terms of reliability and cost. While building new nuclear power generation capacity could offset carbon emissions from fossil fuel sources, a significant portion of the construction expense could also impact

ratepayers. Maryland is transitioning away from fossil fuel generation to an array of renewable generation sources that will meet energy demand and keep future carbon at reduced levels.

Stability and grid resilience represent additional challenges. Because a large portion of consumed electricity is generated outside the state, distant storms or other outage events can impact the availability of electricity in Maryland. On-site generation, known as distributed generation, reduces the distance from the point of generation to the point of consumption, decreasing the chance of interruption. In addition, localized grids on campuses, neighborhoods, or large facilities (called microgrids) represent enclosed systems that can be isolated from the rest of the grid, if needed, further increasing reliability and resilience.

Maryland's Greenhouse Gas Reduction Goals

The Climate Solutions Now Act of 2022 is considered to be one of the most ambitious state laws to address climate change.

The Act establishes a greenhouse gas (GHG) reduction goal of 60% by 2031, using a 2006 baseline. As of 2022, no other state has established a similar reduction by such an early date. The Act also sets a policy goal for the Maryland economy to have net zero emissions by 2045. The Maryland Department of Environment (MDE) is required to submit a draft plan for achieving the 2031 goal by June 30, 2023. A final plan is to be adopted by December 31, 2023. A final plan for achieving the net zero emission goal is required by December 31, 2030.

Maryland Electricity Profile 2021

Primary Energy Source **Nuclear**

Item	Value	Rank
Net Summer Capacity (MW)	**13,006**	**32**
Electric Utilities	1,058	41
IPP & CHP	11,947	9
Net Generation (MWh)	**38,235,713**	**37**
Electric Utilities	3,470,291	41
IPP & CHP	34,765,422	12
Emissions		
Sulfur Dioxide (Short Tons)	5,047	35
Nitrogen Oxide (Short Tons)	6,484	42
Carbon Dioxide (Thousand Metric Tons)	12,040	37
Sulfur Dioxide (lbs/MWh)	0.3	36
Nitrogen Oxide (lbs/MWh)	0.3	44
Carbon Dioxide (lbs/MWh)	693	38
Total Retail Sales (MWh)	**59,303,974**	**25**
Full Service Provider Sales	30,885,118	35
Energy-only Provider Sales	28,418,856	8
Direct Use (MWh)	**154,960**	**44**
Average Retail Price (cents/kWh)	**11.48**	**14**

*Sources: U.S. Energy Information Administration, Form EIA-860, **Annual Electric Generator Report,** U.S. Energy Information Administration, Form EIA-861, **Annual Electric Power Industry Report,** U.S. Energy Information Administration, Form EIA-923, **Power Plant Operations Report** and predecessor forms.*

THE REGULATORY STRUCTURE

The energy market is highly regulated with state, regional, and federal agencies or authorities overseeing many aspects of its operations. These regulators impact the shape, size, and rules governing the market.

In Maryland, distribution is regulated separately from generation and transmission. This structure allows consumers to purchase electricity and natural gas from a variety of suppliers (generators), but the delivery of those commodities is provided by regulated utilities.

The following are descriptions of the relevant regulatory entities:

Public Service Commission (PSC)

The PSC regulates Maryland's utilities, including natural gas and electric service providers with a mission to "ensure safe, reliable, and economic public utility and transportation service to the citizens of Maryland." The most relevant duties of the PSC to the electric industry are to:

- License retail electricity suppliers and ensures they uphold consumer protection standards
- Set electric distribution rates and oversees the utilities' procurement of Standard Offer Service (SOS) electricity and natural gas for Maryland ratepayers, which sets the price that customers pay for the electricity and gas commodity if they do not choose an alternative supplier
- Provide information to assist consumers in choosing alternative suppliers
- Oversee the EmPOWER Maryland energy efficiency initiative, which is run by the major electric distribution companies to provide technical support and grants to encourage customer energy efficiency measures

Federal Energy Regulatory Commission (FERC)

FERC is an independent federal agency responsible for regulating interstate transmission of electricity, natural gas, and oil. FERC regulates interstate issues in the electricity and natural gas supply industries. FERC also reviews proposals to build liquefied natural gas (LNG) terminals and interstate natural gas pipelines, as well as licenses for hydro-electric plants.

PJM Interconnection

PJM Interconnection is the regional transmission organization (RTO) that is responsible for ensuring the safety, reliability, and security of the electric power grid in our region, and administering the wholesale electricity market. PJM coordinates the movement of electricity through all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio,

Pennsylvania, Tennessee, Virginia, West Virginia, and the District of Columbia. PJM is regulated by FERC.

PJM has three main priorities: ensuring reliable grid operations, buying and selling energy, and planning for the future.

PJM also:

- Monitors the grid system, changes in electricity use, equipment problems, weather conditions, and other factors to keep electricity flowing
- Administers competitive wholesale markets for large volumes of electricity that is then sold through retail electricity providers to consumers
- Ensures that electricity will be available in the future by analyzing multiple factors, such as expected growth in demand for electricity, shutdowns of existing power plants, governmental energy policy initiatives, and planning for new power lines and other equipment upgrades that may be needed in the future

Other Government Agencies and Related Entities

Maryland Office of People's Counsel (OPC) is an independent state agency that serves as a residential ratepayer advocate for consumer interests in the regulatory and policy processes for energy, as well as in other utility and public service matters.

Maryland Energy Administration (MEA) is part of the Office of the Governor. The mission of MEA is to promote affordable, reliable, and cleaner energy for Maryland. MEA's programs and policies are intended to help lower energy bills, fuel the creation of "green collar" jobs, address environmental and climate impacts, and promote energy independence.
The MEA operating budget and several of its programs are funded by a portion of the Strategic Energy Investment Fund (SEIF), which is financed by proceeds from the sale of carbon allowances in Regional Greenhouse Gas Initiative (RGGI) Auctions, Renewable Portfolio Standard (RPS) Alternative Compliance Payments (ACP),

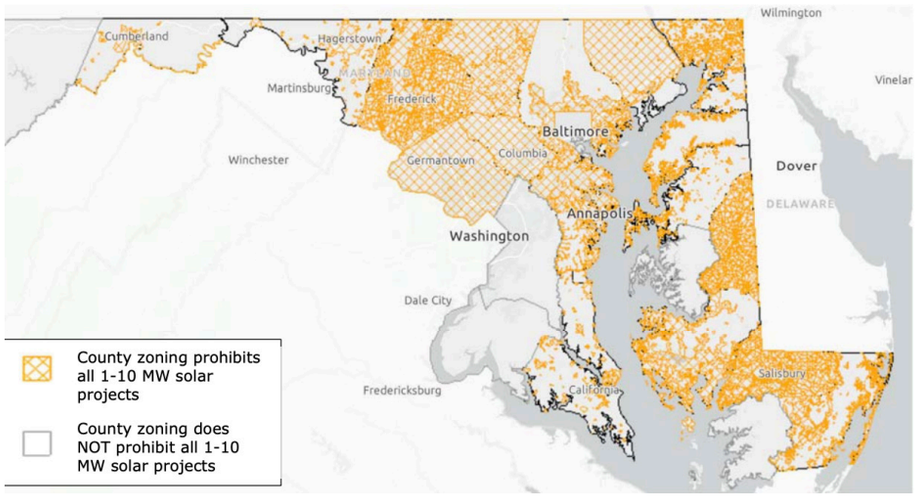
compliance fees paid under PSC orders, and other sources as defined in the law.

The Maryland Department of the Environment (MDE) manages the permitting process for environmental regulation and Maryland's participation in RGGI. The Secretary of the Environment is the Chair of the Maryland Commission on Climate Change (MCCC), responsible for advising the Governor and General Assembly "on ways to mitigate the causes of, prepare for, and adapt to the consequences of climate change." The MCCC includes representatives of the legislature, state agencies, local government, business, environmental non-profit organizations, organized labor, philanthropic interests, and the State University system. MDE administration and programs are funded by the State General Fund, federal grants, and regulatory fees.

The Power Plant Research Program (PPRP) was established under the Power Plant Siting and Research Act of 1971. This legislation provided a model that several other states have adopted for addressing power plant licensing issues. The enabling legislation established an Environmental Trust Fund to support PPRP. Funding is provided through an environmental surcharge that is assessed on all electricity used in the state. The surcharge adds between 10¢ and 20¢ per month to the average residential customer's electric bill.

PPRP is housed within the Maryland Department of Natural Resources and provides a continuing program for study and evaluation of electric generation issues to recommend responsible, long-term solutions. It functions to ensure that Maryland meets its electricity demands at reasonable costs while protecting the state's valuable natural resources.

The Maryland Department of Human Services (DHS) is the state's primary social service provider, assisting people in economic need, providing preventive services, and protecting vulnerable children and adults in Maryland. DHS manages the Low-Income Home Energy Assistance Program (LIHEAP).



Source: Final Report Concerning the Maryland Renewable Portfolio Standard. Maryland Power Plant Research Program, December 2019

Land Use Considerations

Land use in Maryland is regulated by the state's 23 counties and Baltimore City. With the recent increase in the number of utility-scale solar facilities in the state and the need for additional solar capacity to meet requirements of state law, consideration of land use impacts has become increasingly important in the siting of larger facilities. Public concerns about the loss of prime agricultural or forest land and visual impacts of large solar photovoltaic (PV) installations have led local governments to adopt zoning regulations that limit or prohibit the development of utility-scale solar projects in every county in Maryland. Although the Maryland PSC has the statutory authority to preempt county zoning decisions for projects greater than 2 MW, the PSC is legally required to give consideration to the recommendations of local and county governments.

Maryland's Renewable Portfolio Standard (RPS) sets a goal in state law that requires a minimum of 50% renewable and/or clean energy to be sold by electricity suppliers in the state from Tier 1 sources, including 14.5% from solar, by 2030. Analysis by Maryland's PPRP has indicated that if the entire 14.5% solar goal were to be met by new utility-scale PV systems located solely on farmland, about 1.3% of Maryland's agricultural land would be required. This estimate represents an upper bound on the percentage of agricultural land that could be impacted since not all new PV installations will be by utilities on farmland. A significant proportion will be residential and non-residential rooftops, brownfields, landfills and other vacant non-agricultural land. Based on its analysis, PPRP concluded that 50% of new solar on agricultural land would be a more reasonable estimate and would result in impacting only about 0.6% of agricultural land.

Land use and visual impact of wind farms is also a concern in the state. Public opposition to siting of wind turbines on mountain tops, offshore locations within sight of land and other "viewsheds" that are of interest to the public has resulted in siting challenges for both on land and offshore wind projects. These challenges are not new for the utility sector and are generally faced by nearly all power supply installations of all types. Local land use ordinances and land use considerations have always been an important part of the regulatory structure.

REGIONAL GREENHOUSE GAS INITIATIVE & THE STRATEGIC ENERGY INVESTMENT FUND

The Regional Greenhouse Gas Initiative (RGGI)

RGGI is a cooperative effort by eleven (11) Northeast and Mid-Atlantic states to reduce carbon dioxide (CO_2) emissions from electricity generating plants.

The first program of its kind in the U.S., RGGI is a regional, multi-state emissions cap and trade program with a market-based emissions trading system designed to steadily reduce CO_2 (a greenhouse gas) while maintaining electricity affordability and reliability. Since the start of the program, RGGI member states have seen a GHG reduction 16% deeper than that of non-RGGI states during the same period. The program also directly funds energy efficiency and cleaner energy programs that will lower greenhouse gas emissions.

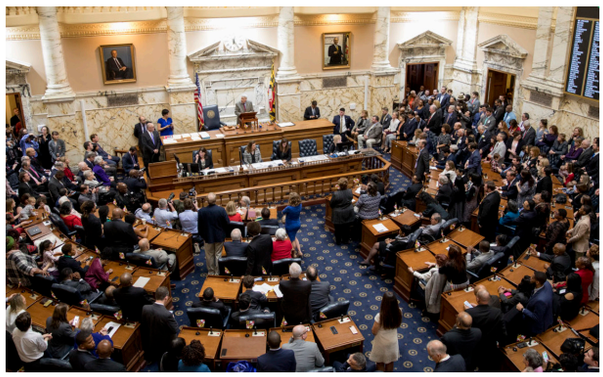
RGGI includes Maryland, Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Virginia, and Vermont. Maryland joined RGGI in 2006, as part of the Healthy Air Act. Since power generation and demand for power overlaps between states throughout the northeast United States, this initiative seeks to mitigate impact on air quality from coal fired power generation, and reduce greenhouse gas emissions throughout the region with the investment of carbon offset or alternative compliance payments into clean energy and energy efficiency solutions.

Strategic Energy Investment Act (SEIF)

In 2008, this Act created the SEIF as a special, non-lapsing fund financed by revenue from multiple sources, including proceeds from the sale of carbon allowances in Regional Greenhouse Gas Initiative (RGGI) Auctions, Renewable Portfolio Standard (RPS) Alternative Compliance Payments (ACP), compliance fees under Public Service Commission (PSC) orders, money appropriated in the State budget, and other sources as defined in the law.

The Maryland Department of the Environment (MDE) provides management & oversight of the RGGI auction program of allowances and the Maryland Energy Administration (MEA) administers the SEIF.

The first RGGI auction was held on September 25, 2008 and since then quarterly auction proceeds for Maryland and SEIF as of June 1, 2022 have totaled $931,958,502.18.



Source: WAMU

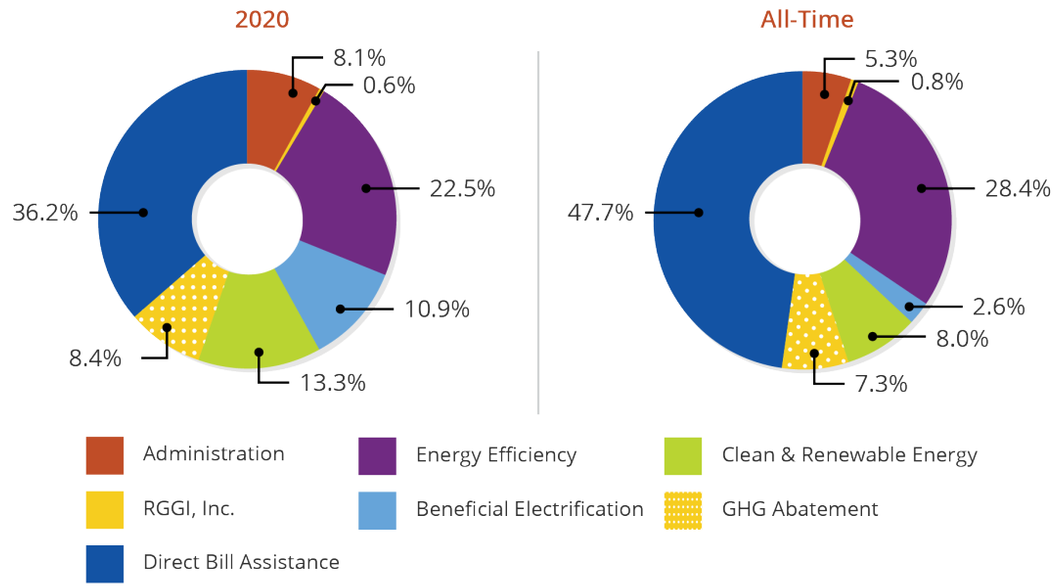
SEIF Revenues by Source

Source	FY 19	FY 20	FY 21
RGGI Auction Revenue	51,388,456	54,804,407	77,812,461
RGGI Set Aside Allowance Revenue	3,529,000	2,963,293	3,096,825
Cove Point Settlement	8,000,000	0	0
Alternative Compliance Payment Revenue	68,869	41,089	52,240
Fund Interest Revenue	3,844,103	3,077,621	728,892
Altagar Merger Revenue	30,320,000	0	0
Total	**97,141,428**	**60,886,410**	**81,690,418**

Over the last three State Fiscal Years (2019 – 2021), RGGI auction proceeds for Maryland have provided 81% of SEIF revenues:
FY 19: $51,388,456
FY 20: $54,804,407
FY 21: $77,812,461

The SEIF currently provides ratepayer assistance with household energy bills as well as grant and loan programs to promote affordable, reliable, and clean energy solutions in Maryland. Programs funded by SEIF have also helped create new green collar jobs, address global climate change, and promote energy independence. A portion of the fund also supports the administration of the SEIF by MEA.

2020 Maryland RGGI Investments by Category



Maryland received $736.8M in proceeds from 2008 – 2020. RGGI investments represent $55M in 2020, and $711.3M cumulatively. $25.5M is committed to 2021 and future programs.

POWER SUPPLY CHOICE AND THE RETAIL ENERGY MARKET

Utilities across the United States ensure safe and reliable delivery of electricity and natural gas to customers. Regardless of the entity from which a customer purchases the commodity, the utility always delivers the energy.

In states like Maryland, with competitive energy markets, customers have the choice of purchasing energy from a variety of companies, although the local utility continues to deliver the energy and respond to emergencies and outages.

Most consumers have the right to switch to an alternative electricity or natural gas supplier. As in other states, Maryland utilities continue to serve as one option among many from which consumers can purchase their energy This is often called "default service," or, as in Maryland and other states, **"Standard Offer Service" (SOS).**

Some states have taken a different approach. Texas and Georgia, for electricity and gas, respectively, have done away with utility provided default service – all customers take supply from competitive suppliers. In all states, whether customers purchase from a supplier of their choosing or from a designated supplier, the utility serves in the delivery role.

Utility Distribution Rates Versus Utility Default Service Rates

Typically, in a competitive energy market, investor-owned utilities' profits come from the delivery of energy, not from the supply of energy. The delivery rate is usually referred to as a "distribution charge" on a utility bill, and this rate is controlled by a state's public service commission.

When the utility also provides the actual energy commodity under a SOS, this is generically referred to as a "supply charge" or "generation charge" on a bill. In most cases, the utility is passing along the cost of the energy commodity itself directly to the customer, without markup. In Maryland, utilities' standard offer service supply is typically set at two levels - summer rates and non-summer rates. Alternative suppliers may change electric commodity rates on a monthly basis or fix rates for a set period. Unlike electricity, the natural gas standard offer service pricing can fluctuate monthly in Maryland. Alternative gas suppliers may alter pricing monthly or fix prices for a set period.

Power Supply Choice in Action

The Baltimore Regional Cooperative Purchasing Committee combines the purchasing power of local government agencies to procure energy on a large scale. This approach leverages Maryland's competitive energy market and seeks to procure better energy pricing than individual agencies could achieve on their own.

Availability of Choice in Maryland

Electricity choice is available in the following utility territories:

- Baltimore Gas and Electric (BGE)
- Choptank Electric Cooperative
- Delmarva Power and Light
- Potomac Edison
- Potomac Electric Power Company (Pepco)
- Southern Maryland Electric Cooperative (SMECO)

Natural gas choice is available in the following utility territories:

- Baltimore Gas and Electric (BGE)
- Washington Gas Light (WGL)
- Chesapeake Utilities
- Eastern Shore Gas
- Elkton Gas
- Columbia Gas

Why Would Customers Switch Their Energy Supplier?

Customers may choose to switch energy suppliers to save on the commodity cost, to purchase from renewable generation suppliers, to receive additional benefits a supplier offers, to leverage a different rate structure (fixed, variable, indexed, green, etc.), or because they prefer one supplier. The ability to choose a supplier provides consumers with options previously unavailable to them in fully regulated markets.

There are various reasons a natural gas or electricity supplier might encourage consumers to switch, such as home and business energy efficiency audits, warranty products, equipment repair services for heating, ventilating, and air conditioning (HVAC) systems, rebates for appliances and smart thermostats and energy credits. Some plans may also include different incentives for switching, ranging from hotel savings to airline vouchers.

Renewable Energy Products

Many suppliers offer renewable energy products, specifically for electricity, that range from partially to 100% renewable.

Similarly, a few suppliers offer natural gas coupled with carbon offsets to balance the environmental impact of burning the fossil fuel.

When customers choose to purchase a renewable energy product from a competitive supplier, because of the physical properties of electricity, there is no way to know whether the electricity delivered to their home is the exact same electricity that was produced from a renewable source. What happens, instead, is that the renewable energy generator delivers the electricity to the grid on the customer's behalf - electricity that would have otherwise been produced by a coal, natural gas, or nuclear plant. The net effect of increasing renewable energy is the same as if there were a direct transmission line between the renewable energy source and the customer's home.

Variable Rate Structures

can change in price from month to month with no price floor or price cap. Variable rate products typically do not have cancellation fees.

Fixed Rate Structures provide a firm, fixed price for a specified term, usually one or two years. There can be a cancellation fee associated with these products.

Retail Energy Market Players

The retail energy market in Maryland consists of many players at all levels of the sales and marketing process.

Investor-Owned Utilities (IOUs) are the regulated utilities that maintain the infrastructure of the distribution grid or pipelines, provide service to customers who don't switch to an alternative supplier, and administer billing and collection of fees or taxes. The Maryland Public Service Commission (PSC) oversees the auctions that set the price of standard offer service of electricity or natural gas. IOUs do not own any significant generation. The EmPOWER Maryland program is run through the IOUs.

Electricity Suppliers purchase electricity on the wholesale market and sell it to customers on the retail market at rates that are not subject to government approval. They do not typically own any generation. Electricity suppliers are licensed by the PSC.

Natural Gas Suppliers purchase natural gas on the wholesale market and sell it to customers on the retail market at rates that are not subject to government approval. Natural gas suppliers are licensed by the PSC.

Energy Cooperatives, (or co-op) act as the energy supplier, the utility, and the owner of generation, for some parts of Maryland. There is not robust consumer choice in these markets.

Brokers are licensed by the PSC, brokers don't take ownership of energy commodity and resell it, but match buyers with sellers. They are often the primary point of contact for commercial entities.

Aggregators are companies, often web-based, that bring groups of customers together in order to approach a supplier with a larger volume of business. Aggregators are licensed by the PSC and share many similarities with brokers.

Telemarketers and Other Agents such as direct mail agencies, and door-to-door groups are used to approach potential customers in both the retail and commercial spaces. These groups often, but not always, work for only one supplier at a time.

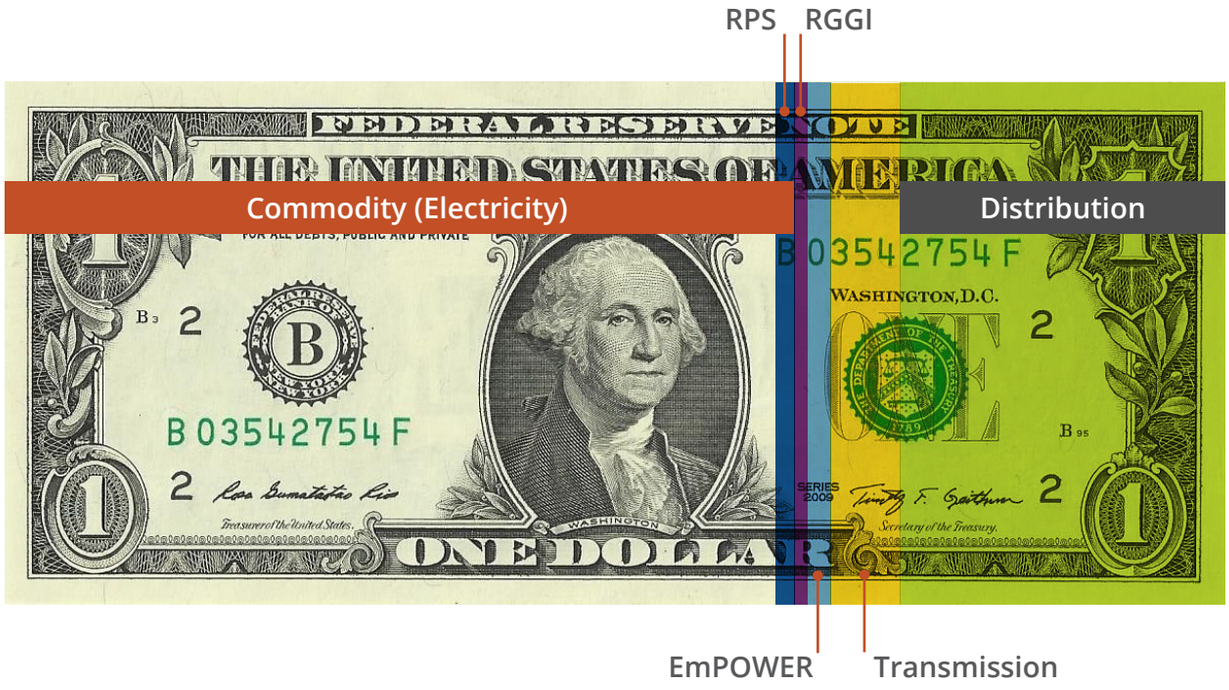
Individuals Who Are Part of a Multi-Level Marketing (MLM) Model are used by some suppliers to sell their products.

How It Works

In this sales channel, a person signs up to be an agent for the supplier, though not an employee, and sells the supplier's products to consumers, usually in the residential space for residential accounts.

Consumers who sign up for the service can then become agents themselves and sell the product to others. The agents in an MLM program typically do the work part time as a way to supplement their incomes.

Our Utility "Bill"



This represents an overview of the breakdown for the components that are included in electric bills for Maryland consumers.

General Current Issues

Consumer Education

When a consumer is entering into an energy supply contract, they should first understand supplier rates versus the cost of Standard Offer Service, switching and contract termination fees, penalties, and other specific contract terms.

Consumer Protection

The PSC investigates whether consumers have enough protection in the retail energy market. Consumers should be careful of false or misleading market claims, advertising, and contracts that are confusing.

Municipal Aggregation

Some states, such as Illinois, Massachusetts, New Jersey, and Ohio, have adopted "opt-out" municipal aggregation as a way to automatically have many residential ratepayers switch to an alternative supplier. In these cases, a municipality or group of municipalities negotiates with a competitive supplier on behalf of all its residents; residents are automatically enrolled in the plan unless they take the extra step to affirmatively "opt out."

Maryland's Energy Landscape

Third-Party Energy Supply Market

In 2018, the Abell Foundation found that the third-party energy supply market doesn't benefit residential consumers and is especially harmful to low-income households. "From 2014 to 2017… Maryland households have been losing money by using third-party suppliers – paying about $255 million more in all than if they had stayed with their regulated utility's supply offer."

The Impact of Third-Party Energy Supply Markets

In late 2021, The Baltimore Fishbowl reported that Maryland's third-party energy supply markets had not had the positive effect lawmakers were hoping for. They found that "Marylanders who switched paid about $621 million more to turn on lights, run microwave ovens and charge their cell phones between 2014 and 2021 than those who stayed with Baltimore Gas and Electric (BGE) and Potomac Electric Power (Pepco)."

Maryland's Energy Supply Reform Bill

In May 2021, the Maryland General Assembly passed the Energy Supply Reform Bill, which protects income qualifying families from bad suppliers and exorbitant prices by making curtain that third-party suppliers don't charge more than standard utility rates. This is to be effective Jan. 2023.

Climate Solutions Now Act of 2022

This landmark legislation aims to achieve net-zero carbon for the state by 2045 and involves environmental justice and decarbonization.

MD Public Service Commission: Retail Energy Supplier Complaint Reports

The Maryland Public Service Commission issues a report of complaints regarding energy suppliers every year. They also provide a link for Maryland energy users to file an online complaint.

TRADITIONAL FOSSIL FUELS & NUCLEAR ENERGY GENERATION

Coal-fired power plants generate a small portion of the electricity produced within the state of Maryland (9% in 2020), although many of these plants also generate electricity from both natural gas and oil. Chalk Point Generating Station, which is located in Aquasco, Maryland retired their coal-fired units in 2021. The station still produces 1,600 MW using other non-coal powered units.

Remaining Coal-Fired Plants in Maryland

- Brandon Shores Generating Station (1,370 MW) Baltimore, Anne Arundel County (Scheduled closure 2025)
- Herbert A. Wagner Generating Station (359 MW) Baltimore, Anne Arundel County (Scheduled closure 2025)
- Warrior Run Generating Station (229 MW) Cumberland, Allegany County

Five coal-fired plants in Maryland have closed over the past 5 years.

Electricity From Coal

Coal is a fossil fuel formed from the decomposition of organic materials that have been subjected to geologic heat and pressure over millions of years. Coal is considered a nonrenewable resource because it cannot be replenished within a reasonable time frame. While there are coal deposits in western Maryland, most of the coal used to generate electricity within Maryland comes from neighboring states, such as West Virginia.

The activities involved in generating electricity from coal include mining, transporting to and burning the coal at power plants. There, the coal is commonly burned in a boiler to produce steam, which runs through a turbine to generate electricity.

Environmental Impacts

Although power plants are regulated by federal and state laws to protect human health and the environment, there is a wide variety of environmental impacts associated with power generation technologies. When coal is burned, dangerous chemical compounds are released. For that reason, coal-fired boilers are required to have control devices to reduce the amount of emissions.

If the coal burning process is not properly handled, other environmental impacts can include contaminated water discharged from cooling and boilers at significantly higher temperatures than the ambient environment, contaminated rainwater runoff from coal stored outside at power plants, and a solid waste called fly ash – a byproduct of burning coal (primarily metal oxides and alkali, about 10% of coal). Much of this solid waste is deposited in landfills and abandoned mines, although some amounts are now being recycled into useful products, such as cement and building materials. Maryland has made significant progress in eliminating the use of coal.

Natural Gas

Natural gas, a fossil fuel, provides a source of energy for consumers throughout Maryland. More than 1,160,000 customers are served via natural gas pipelines in Maryland for home heating and other household appliances. Natural gas is also used to produce electricity. As of 2020, about 38% of the state's electricity came from natural gas. Numerous Marylanders rely on propane supply as a source of energy, especially in rural areas of the state where pipeline infrastructure does not exist.

Natural gas prices have been fluctuating over the past four years, with prices hitting a 14-year high of $9.28 per million British thermal units in early June, 2022. The increased price of natural gas is due to many factors including increased cooling demand due to rising temperatures, Russian sanctions, higher demand for US produced natural gas, and gas storage shortages. The United States produces the most natural gas, with 37,011,455 cubic feet being produced in 2021 and enjoys the lowest natural gas prices of any developed nation.

Maryland ranks among the 10 states with the lowest per capita natural gas use. The electric power sector has become the state's top natural gas-consumer. Maryland also produces very little natural gas, exacerbated by the statewide ban on fracking effective October 2017. Fracking is a process in which pressurized water, sand, and chemicals are injected into a rock, causing it to break apart and release the gas inside.

By nature of the physical properties of the commodity, natural gas is ready to be used by the consumer whenever they need it. All of the commodity put into the transmission and distribution network is utilized by customers. This is a theoretical 100% utilization. In reality, a small amount of natural gas commodity is lost in the system due to leakage and waste. Unlike the electric power plant generation system, there is no wasted generation or capacity by having an excess supply of energy available at every customer meter to meet instantaneous demand.

Natural gas emits less carbon than other fossil fuels when burned, though it does emit additional emissions when extracted and transported. In addition, there are considerable environmental concerns regarding its extraction process.

Natural Gas at Cove Point, Maryland

The United States has been producing natural gas at a lower price compared to international prices. This has increased US natural gas exports, causing Cove Point LNG Terminal at Cove Point, Maryland to become the second largest LNG export facility in the continental United States, and is the first such facility on the East Coast. It is recognized as one of the most technically advanced and environmentally sensitive LNG facilities in the world.

Source: The Baltimore Sun

Nuclear Energy

Calvert Cliffs

Maryland has only one nuclear power plant – the Calvert Cliffs facility located in Lusby is owned and operated by Exelon Corporation. Calvert Cliffs Unit 1 began generating electricity in 1975, and Unit 2 joined the system in 1977. In 2020, nuclear power accounted for 41% of electricity generation in Maryland.

The plant is built on a 1,500-acre site, located on the western shore of the Chesapeake Bay, about 50 miles southeast of Washington, D.C. Its two units are capable of generating more than 1,700 net MW annually, enough to power more than 1 million average sized American homes, each year.

Calvert Cliffs Energy Snapshot

- Number of units: 2
- Total site net generation: 1,756 MW
- 2016 net generation: 14.76 million MW-hours
- Customers served: more than 1 million homes
- 2016 capacity factor: 95.6%

Natural Gas Pros and Cons

Pros:

- Fossil fuel with the least greenhouse gas emissions
- Extensive North American shale gas supply
- The US enjoys lower natural gas prices compared to other developed nations

Cons:

- Still a fossil fuel and therefore adds CO_2 to atmosphere
- Extraction process (including hydraulic) may have considerable environmental impacts
- Transmission infrastructure has not yet been fully developed in light of relatively new supplies

Nuclear Energy Pros and Cons

Pros:

- Nuclear facilities do not produce greenhouse gases when producing energy
- The Calvert Cliffs facilities have been operating safely for nearly 40 years, and will continue to produce clean energy

Cons:

- No new nuclear power plants have been constructed since 1977, and the time required to bring new generation facilities on-line in Maryland is enormous
- The cost of new plants makes new sources of nuclear energy less cost competitive than other generation sources

ZERO CARBON & ADVANCED CLEAN ENERGY GENERATION

A zero carbon energy source produces no carbon emissions during production or service and includes solar, hydro, and nuclear.

Traditional energy sources like coal and gas produce carbon dioxide, along with other gases, when they are burned for electricity. These gases act like a blanket, preventing heat from leaving our atmosphere.

Zero Carbon vs. Net Zero Carbon

Net zero carbon means that carbon emissions created during the production of power are balanced or canceled out by removing, from the atmosphere, the same amount of carbon that was emitted. A nation, municipality, or business can claim to be net zero carbon if they remove the amount of carbon they produce.

Zero Carbon Energy Examples

Synthetic Non-carbon Fuels

Hydrogen is a clean fuel that only produces water when consumed in a fuel cell. It can be produced from a variety of domestic resources, such as natural gas, biomass and renewable power like solar and wind. It can be used in cars, in houses, for portable power, and in many more applications. Today, hydrogen fuel can be produced through several methods. The most common methods are natural gas reforming (a thermal process), and electrolysis. Other methods include solar-driven and biological processes.

Carbon Sinks

Carbon sinks are natural systems that use and store carbon dioxide. The 3 biggest carbon sinks are the oceans, plants, and soil. Oceans absorb carbon that lands on the surface and sinks. Next, the carbon is used by marine life and can even dissolve into the sea water. Plants use carbon for photosynthesis, creating clean oxygen as a result. Soil gets its carbon from decomposing plants and animals.

Ammonia is a viable option for clean energy, despite being known as a smelly and toxic household cleaner. It is easier to ship and distribute ammonia compared to hydrogen and contains nearly double the amount of energy. Ammonia power is a very new concept and is still being tested and developed by several chemical companies and other firms.

Source Power

Nuclear energy is produced by the use of nuclear reactions from nuclear fission, nuclear decay and nuclear fusion reactions. Presently, the vast majority of electricity from nuclear power is produced by nuclear fission of uranium and plutonium.

Wind is derived from wind spinning a turbine that produces electricity. Wind power generation does not produce emissions and has been a proven, efficient technology for decades.

Solar is produced by utilizing the Sun. Solar technology can either convert the Sun's energy to electricity (photovoltaics / PV), use it to heat fluids for indirect electric power generation (concentrated solar power), or use it to heat water (solar thermal or solar hot water).

Hydropower is one of the oldest and largest sources of renewable energy, which uses the natural flow of moving water to generate electricity.

Wave Energy is electricity generated by harnessing the up-and-down motion of ocean waves. Most wave energy technology uses floating turbines that rise and fall with the swells. The energy density of shoreline ocean waves can be 40 kW for every meter of wave.

For more information on hydropower in Maryland, see Renewable Energy Solutions: page 31. For more information on nuclear energy in Maryland, see Traditional Fossil Fuels and Nuclear Energy Generation: page 20. For more information on wind in Maryland, see Renewable Energy Solutions: page 28. For more information on solar in Maryland, see Renewable Energy Solutions: page 27.

Carbon Capture and Storage (CCS)

CCS is the process of catching and storing carbon dioxide from industrial operations, like the burning of fossil fuels or cement and steel production, before it is released into the atmosphere. Once captured, the carbon dioxide is compressed into a liquid and stored underground in empty oil and gas reservoirs, saline aquifers, or coal beds.

Carbon Capture and Utilization (CCU)

This type of capture and utilization is similar to CCS, the difference being that the carbon dioxide is used in further industrial practices. The most common use for this carbon dioxide is for enhanced oil recovery, where the carbon is injected into oil and gas reservoirs to help with the extraction process.

Advanced Clean Energy Generation

Clean energy generation is an ever-evolving industry that is crucial to the longevity of our species and planet. This section will explore clean energy generation that is still being developed or is not yet being utilized in a large format.

Concentrating Solar Power (CSP)

This technology involves the use of mirrors, focusing sunlight onto receivers or other devices that capture and convert or use the enhanced solar energy.

CSP Has Been Around Since the 1980s.

However, it has re-emerged in recent years, leading to new and innovative energy solutions.

Current CSP systems:

- **Trough systems** are U-shaped mirrors reflect sunlight onto oil-filled pipes which heat up surrounding water, creating steam for electricity generation.
- **Power Tower CSP system** use large flat mirrors called heliostats to focus sunlight onto a receiver where fluid such as molten salt can absorb the heat to make steam for electricity generation.
- **Dish/engine system** use mirrored dishes to concentrate sunlight towards a device at the center of the dish. That device is connected to a combustion engine which generates electricity.

Bioenergy

Renewable energy derived from biological sources, known as biomass, to be used for heat, electricity, or vehicle fuel, bioenergy is one of the most rapidly growing renewable energy technologies.

Ethanol is in around 98% of U.S. gasoline. E10 ethanol contains (10% ethanol, 90% gasoline), to oxygenate the fuel and reduce air pollution. Ethanol is also available at E85 (flex fuel), which is a mix of up to 83% ethanol and can be used in flexible fuel vehicles.

Biodiesel is a renewable and biodegradable fuel, biodiesel is typically made from vegetable oils, recycled restaurant grease or animal fats.

Biodiesel Use

Just like petroleum diesel, biodiesel is used in fuel compression-ignition engines.

Enhanced Geothermal Systems

Natural geothermal systems generate power by circulating liquids through hot rocks that are underground. Sometimes these systems are insufficient due to the limited pathways for the liquid to flow. Enhanced Geothermal systems solve that problem by injecting fluid underground, creating more permeable pathways for the liquid to flow through.

Near-Field Thermophotonics (TPX-Power project)

Most industries, transportation systems, data processing, practices, and other energy intensive processes generate waste heat that is sometimes difficult to dispose of and often goes unused. Systems and methods that utilize this waste heat for energy exist but are costly and inefficient.

New Technologies Are Underway

The EU-funded TPX-Power project is working toward developing new waste heat systems by harnessing the thermodynamics of electroluminescence.

In short, the project seeks to improve the efficiency of any waste heat producing process by reconverting some of the waste heat energy to electricity. These systems could almost double the efficiency of combustion engines and be pollution-free. The project is currently underway and has a planned end date of Dec. 2024.

Artificial Intelligence and Big Data

Energy grids and infrastructure are very large and complex, requiring quick decisions from human workers or advanced computer programs.

Algorithms Are Impacting Grid Efficiency

AI algorithms and big data are currently being implemented to improve energy grids by conducting grid management and analytics.

These tools also forecast power consumption and generation, predict maintenance, and conduct autonomous trading and pricing. As big data and AI technologies improve, the efficiency and productivity of standard and renewable energy sources will grow as well.

RENEWABLE ENERGY SOLUTIONS

Renewable energy and clean technology companies in Maryland are generating employment and tax revenue for the state. This section describes various renewable energy technologies and how they may be applicable in the Maryland energy landscape.

About 14.4% of the state's total net electricity generation came from renewables in 2022, compared to the U.S. average of 26.7%. Maryland's total renewable energy net summer capacity was 1,319 MW.

Solar Energy

Solar energy is energy produced by utilizing the Sun. Solar technology can either convert the Sun's energy to electricity (photovoltaics), use it to heat fluids for indirect electric power generation (concentrated solar power), or use it to heat water (solar thermal or solar hot water).

Photovoltaics (PVs)

PV systems do not have the moving parts or steam production found in most other electricity generation systems. Instead, the sunlight shines on a solar cell and causes an electric current to be generated directly. Common uses are to generate power in a grid-connected system for use on-site (e.g., residential, commercial, and other buildings, or groundwater remediation); other (larger) systems generate power that is provided directly to electric utilities.

Solar Thermal

Solar thermal is also known as "solar hot water" because it uses heat from the Sun to heat water. The primary components of a typical residential solar water heating system are one or two panels, a solar water heater tank with a heat exchanger, a small system controller and circulator pump known as the pump control module, some insulated piping, and a nontoxic antifreeze for the heat transfer fluid. All systems include some form of backup energy, but electric backup is the most common and allows for a single water tank.

Solar thermal is also frequently deployed at a commercial scale to provide solar water heating for multi-family housing, military installations, retail and industrial applications, and any other system that requires a significant, daily, hot water demand.

Concentrated Solar Power

Solar thermal technologies can also be used in large utility-scale power generation systems. Most of these applications involve focusing the sun's rays via rotating mirror arrays (called Heliostats) to a central tower core, where the intense heat creates steam that runs turbines to generate electricity.

Solar Power Statistics

Maryland had 1,250 MW of total solar generating capacity installed by mid-2021, which is 7 times the State's capacity in 2013.

Solar is a Growing Source of Jobs in Maryland

According to the 2022 United States Energy and Employment Report (USEER), 6,104 professionals are employed by the solar industry in the state. There are 176 solar-related companies including 12 Manufacturers, 100 Installers/Developers and 64 Others.

The Maryland 2013 Offshore Wind Energy Act expanded the RPS to include a "carve-out" of a maximum of 2.5% of electricity sold in Maryland for offshore wind starting in 2017. In 2017, the PSC approved 368 MW of offshore wind capacity.

The Clean Energy Jobs Act of 2019 added a minimum of 1200 MW additional offshore wind capacity and the PSC acted on this by approving 1654 MW of additional offshore wind capacity in 2021.

Wind

Wind power is derived from wind spinning a turbine that produces electricity. Wind power generation does not produce any emissions and has been a proven, efficient technology for decades across the globe.

Maryland has plenty of wind to generate power, from onshore and offshore areas. The Eastern Shore and the mountains of Western Maryland have the best wind exposure for onshore generation.

Solar Power Pros and Cons

Pros:

- Renewable resource, no fuels required, abundant supply
- Greenhouse gas reductions – non-polluting (post-construction)
- Available at varying scales, from utility to consumer

Cons:

- Variable resource due to changing seasons and weather
- Loss of agricultural or forest land due to the large surface area needed to collect enough energy
- Visual impact at installation site
- Manufacturing process can result in pollution

Wind Power Pros and Cons

Pros:

- Renewable resource, abundant supply
- Significant greenhouse gas reduction
- Wind prediction models improving for better site selection

Cons:

- Intermittent resource
- Visual impact of turbines, localized noise pollution
- Wildlife impact of land-based wind due to bird and bat strikes
- Offshore impacts on navigation and marine life

Land-Based Wind

In 2020 Maryland had 190 MW of land-based wind capacity, which provided about 13% of renewable electricity generation.

Large land-based wind farms use wind turbines that have a capacity of 2–3.5 MW. In our region, wind farms typically have 10 to 50 turbines, which are usually sited on high ridge lines. Most of Maryland's land-based wind sites are located in the mountains of western Maryland.

Offshore Wind

Maryland's greatest wind potential is offshore because the turbines are larger and the wind is more consistent over the water. Four major wind projects have been approved by the PSC and are in development off Maryland's Atlantic coastline. The first two, approved in 2017 and located about 17 miles offshore in federal waters, are expected to generate up to 368 MW of electricity. The second two projects are located 15-20 miles offshore and are expected to generate more than 1600 MW. All four projects are expected to come online by 2026.

Biomass and Waste to Energy (WTE)

Biomass is plant and animal matter – including crops such as corn and soybeans – as well as wood, grasses, algae, vegetable oils, municipal waste, and certain agricultural byproducts, such as poultry litter and animal manure, that can become workable feedstocks, or raw materials, for energy production.

Biomass was used to generate almost one-tenth of Maryland's renewable electricity in 2020, including facilities that use landfill gas, municipal solid waste, wood and wood waste.

Woody biomass includes wood chips from forestry operations, arborist trimmings, recycled pallets, fuel wood for space heating, and residues from lumber, pulp/paper, and furniture mills. Maryland is rich in raw biomass material from farming, fishing, aquaculture, and forestry.

Maryland's strong agricultural industry combined with federal research facilities and significant biotech industry presence position the state to be a national leader in biomass innovation. Major facilities such as the Beltsville Agricultural Research Center

and the University of Maryland Energy Innovation Institute, along with state university research and large agri-business, provide the knowledge, research and development (R&D), and workforce required to produce promising new biomass technologies.

WTE involves recovering energy from waste by converting refuse materials into usable heat, electricity, or fuel through a variety of processes, including combustion (incineration), gasification, anaerobic digestion, and landfill gas (LFG) recovery. Maryland currently has two large-scale municipal solid waste (MSW) to energy plants (61 MW in Baltimore and 54 MW in Montgomery County). Projects are also under development on WTE technologies as a part of mitigation strategies to deal with excess poultry waste from agricultural production operations.

Geothermal

Geothermal technologies utilize a constant ground temperature beneath the surface of the earth or thermal heat from hot spots near the surface in heating and cooling applications or for commercial or utility-scale energy generation.

The Western United States, Alaska, and Hawaii are the literal "hot spots" for utility-scale geothermal energy. The geology of Maryland makes large- scale geothermal energy production unviable.

Geothermal heat pumps for residential and commercial heating, cooling, and hot water using "ground source" energy to reduce the need to regulate temperatures from one extreme to the other are now commonly adopted by consumers and business operators. A closed loop geothermal system contains a non-toxic fluid, like glycol, as the medium to transfer the constant ground temperature to a heat pump for space heating and cooling, and hot water heating.

Biomass/WTE

Pros:

- Renewable, extensive supply of biomass available
- Modern biomass heating and cooling can reach efficiency levels of up to 80 – 90% of the BTU content of the fuel
- Lower greenhouse gas emissions than fossil fuel
- WTE offers space management solutions for landfills

Cons:

- Releases "captured" greenhouse gases and other harmful pollutants into atmosphere
- Transportation of feedstock to electricity production plant requires energy

Conowingo Dam
Source: Chesapeake Bay Magazine

Hydroelectricity

At a utility scale, hydropower in Maryland is used to generate electricity. This hydroelectricity is derived from harnessing the energy of falling and running water. Hydropower generated about 40% of Maryland's renewable energy in 2020.

The largest hydroelectric plant in the state is the Conowingo Hydroelectric Generating Station, a run-of-the-river hydroelectric power plant owned and operated by Exelon Power, a business unit of Exelon Generation. The generation units are collocated with the Conowingo Dam on the Susquehanna River in northern Maryland between Cecil and Harford counties. With 11 turbines, the plant has an installed capacity of more than 570 MW.

Because a constant flow of water is used to turn the turbines, Conowingo can be used to "jump start" the electric distribution system in the event of a widespread system outage of the PJM region.

Wave and Tidal Hydropower

Wave and tidal power hydropower generation offer high potential. The energy density of shoreline ocean waves can be 40 kW for every meter of wave. Yet, this technology has not been developed at a large commercial scale.

Hydroelectricity

Pros:

- Renewable resource, no greenhouse gas emissions
- Reliability – base load generation that requires no startup electricity to recover from blackout
- Relatively safe – no combustion, requirements for spent fuel disposal
- Reservoirs are popular recreation assets

Cons:

- Alters river flow, fish and wildlife habitats, reservoirs trap sediment, debris and pollutants that can be released downstream in storms
- Expensive to develop new plants
- Resource availability limited during droughts
- Impact downstream availability of water for irrigation, transportation, or other uses

RENEWABLE ENERGY CREDITS

A Renewable Energy Credit/Certificate (REC) is a tradable instrument that represents proof of 1 MW hour of electricity that has been generated from a renewable energy resource. RECs separate the benefit of renewable energy from the electricity itself, which allows for the creation of markets.

These credits are bought and sold separately from the underlying physical electricity commodity associated with renewable-based generation. An owner of a REC can claim to have bought renewable energy. The REC program allows consumers or producers who would not otherwise have access to renewable energy, or sufficient quantities of renewable energy, to support renewable generation. Ultimately, the purchase of a REC supports renewable generation by subsidizing its development and operation. RECs are registered by the green energy generator and then sold into the market, often via a broker.

Compliance RECs Versus Voluntary RECs

RECs come in several types, depending on the fuel source and their use. All RECs are either compliance RECs or voluntary RECs. Compliance RECs are further categorized by two renewable tiers. **Tier 1 renewables include: solar, wind, qualifying biomass, methane from a landfill or wastewater treatment plant; geothermal; ocean; certain fuel cells; small hydroelectric power; poultry litter-to-energy; waste-to-energy; refuse derived fuel; thermal energy from thermal biomass; and wastewater used for heating or cooling systems. Tier 2 renewables include hydroelectric power, other than pump-storage generation.**

Starting in 2006, electricity suppliers were required to provide 1% of retail electricity sales from Tier 1 renewables and 2.5% from Tier 2 renewables. By 2022, the Tier 1 requirement increased to 30.1%, while the Tier 2 requirement remains at 2.5%.

Measuring Compliance

RECs are at the heart of the Maryland Renewable Portfolio Standard (RPS) and are used to measure compliance. They can also be sold as part of a voluntary purchase by consumers.

To provide some ceiling protection to the electricity suppliers, an Alternative Compliance Payment (ACP) cap has been implemented. This ceiling effectively ensures that compliance RECs will stay manageably priced. For example, for Tier 1 compliance other than required solar energy, in 2022 the ACP is $30/MWh through 2023 and then steps down each year to $23.50/MWh in 2030 and beyond. It would make no sense for a company to pay more for a compliance REC if it can just pay the ACP at a lower cost. In 2021 according to the PSC, RECs were selling for $14/MWh.

REC Sales

Voluntary RECs closely follow the prices of compliance RECs because of the competitive and open-market relationship between the two types of RECs.

REC generators will sell at the highest price, which is typically driven by REC supply and demand in the compliance market. REC buyers will likewise buy at the cheapest price, which ensures voluntary REC pricing will not exceed that of compliance RECs.

REC generators will sell at the highest price, which is typically driven by REC supply and demand in the compliance market. REC buyers will likewise buy at the cheapest price, which ensures voluntary REC pricing will not exceed that of compliance RECs.

Types of RECs Based on Fuel Source

Within these two categories, RECs can differ based on their fuel source:

Solar RECs (SRECs) are produced by a solar PV or thermal system. SRECs have their own trading value because Maryland's RPS requires each supplier to have a certain percentage of solar in its mix. This is called the "solar carve-out." (A generic Tier 1 REC would not qualify for compliance with this carve-out.)

SREC Requirements

To qualify for an SREC, a solar generator must be located in Maryland, thus keeping the benefits of the solar carve-out local.

SRECs in 2022 are set at $60/MWh and step down each year to $22.50/MWh in 2030 and later. In 2022, SRECs were selling for $59/MWh.

Offshore wind RECs (ORECs) are produced by generating electricity from an offshore wind facility. ORECs will have similar attributes to an SREC because the Maryland RPS has an "offshore wind carve-out" that acts like the solar carve-out.

Current offshore wind project details can be found on page 29.

TRECs

Like other renewable resources, biomass used for heating, cooling and combined heat and power (CHP) in Maryland helps to reduce greenhouse gas emissions, decreases our dependence on foreign fossil fuels, and creates jobs. Allowing the Renewable Portfolio Standards to include Thermal Renewable Energy Credits (T-RECs) would encourage the use of biomass for heating and cooling.

Biomass Technologies

Modern and commercially viable biomass heating, cooling, and cogeneration technologies can reach efficiency levels of up to 80-90% of the BTU content of the fuel.

Biomass generation is currently included as a part of Maryland's RPS, but biomass-enabled thermal energy involves technologies that are not specifically included in Maryland's Renewable Energy Credit (REC) program. T-RECs, if adopted, could encourage greater use of biomass for heating and cooling.

Renewable Energy Credits

Come in several types, depending on the fuel source and their use.
All RECs are either compliance RECs or voluntary RECs.

Types of RECs

RECs are equivalent to 1,000 kilowatt-hours of energy. This generic classification may be given to all renewable power sources outside of solar and offshore wind. The most common energy sources for these generic RECs are land-based wind, biomass, and hydropower.

Compliance RECs are used to meet the Maryland RPS is a compliance RECs.

Voluntary RECs are different than compliance RECs since they are purchased by end users who are not mandated or regulated to do so. Some retail customers in Maryland may choose to purchase a percentage of their electricity supply as renewable. In doing this, the customer is typically participating in a voluntary REC purchase.

Within these two categories, RECs can differ based on their fuel source.

SREC are a Solar REC, which is a REC produced by a solar system, whether it is a PV or a thermal system.

OREC are an Offshore Wind REC, which is a REC produced by an offshore wind facility.

TREC are a Thermal REC. This credit is equal to the environmental attributes of 3,412,000.

BTUs (British Thermal Units) are Thermal energy generated by a Tier I or Tier II thermal renewable source. 3,412,000 BTUs are equivalent to displacing the need for 1 MW of power generated otherwise from nonrenewable sources.

ENERGY EFFICIENCY

Energy efficiency is defined as using less energy to achieve the same results. For example, an energy-efficient light bulb can produce the same amount of light as a non-efficient bulb, but it uses a fraction of the electricity to do so.

An energy-efficient house can be just as warm in the winter or just as cool in the summer as a typical house, but it uses less energy to achieve those results. Energy efficiency is one of the easiest and most cost-effective ways to address climate change, reduce energy costs and improve the environment.

There are many technologies that improve energy efficiency, Here are just a few:

Insulation – Installing super insulation is the most cost-effective way to reduce energy use in homes, residential and commercial buildings.

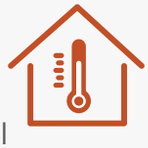
Windows – Heat gain and heat loss from windows are responsible for 25% to 30% of residential heating and cooling energy use.

Lighting and Appliances – Compact fluorescent light (CFL) bulbs and light-emitting diode (LED) light bulbs use significantly less electricity than traditional light bulbs. New ENERGY STAR® appliances use less energy and water.

Smart Thermostats – Enables more efficient energy management by reducing energy use during periods of low demand.

Geothermal HVAC – Geothermal heat pump systems are viable in just about any location in the state and can provide a consistent, reliable, and largely clean source of energy for residents. These systems are 400% more efficient than traditional heat pump systems.

Geothermal Heat Pumps



The U.S. Environmental Protection Agency estimates that geothermal heat pumps can lower energy bills by 30% – 40%.

EmPOWER Maryland

EmPOWER Maryland, which is overseen by the Public Service Commission (PSC), is the state's signature program to promote energy efficiency. The 2008 EmPOWER Maryland Act set a goal for the state to reduce energy use by 15% and reduce peak demand per capita by 15% by 2015 (based on 2007 levels) through energy efficiency programs. This goal was met statewide. In 2017, the law was updated with a new annual energy savings goal of 2% of gross energy sales through 2023. The programs are funded through ratepayer surcharges, and they must be cost effective for ratepayers in aggregate, meaning that ratepayers must receive more savings benefits than the fees they pay. Residential ratepayers only pay the residential surcharge, and commercial ratepayers only pay the commercial surcharge. The funds do not mix across account types.

Investor-Owned State Utilities

Within EmPOWER Maryland, programs are run through each of the four largest investor-owned state utilities (BGE, Pepco, Delmarva Power, and Potomac Edison) and SMECO. Natural gas programs are available from BGE and Washington Gas. EmPOWER programs generate about $1.40 of benefits for every $1.00 spent. content of the fuel.

Residential Energy Efficiency in Maryland

There are various programs available Maryland's utility companies, state agencies, and local governments.

Some of the most popular residential programs include:

The Clean Energy Advantage (CEA) Loan Program offers convenient and affordable financing for qualified home energy improvement projects in Maryland and Washington, D.C.

The Weatherization Assistance Program is managed by the The Department of Housing and Community Development. which focuses on low income home households with the installation of energy conservation materials.

Lighting and Appliance Rebates are available when a customer uses high-efficiency CFL and LED bulbs. These products are discounted at the point of sale to encourage customers to buy these bulbs instead of standard or halogen incandescent bulbs. Further, ENERGY STAR® - rated appliances such as refrigerators or clothes washers have mail-in rebates to encourage people to buy higher-efficiency equipment.

HVAC Upgrades are for customers who replace their air conditioner, furnace, or other HVAC equipment can obtain rebates for buying higher-efficiency appliances. Lists of qualifying models are based on ENERGY STAR® ratings or Consortium of Energy Efficiency (CEE) ratings.

Quick Home Energy Check-Up (QHEC) is a brief energy assessment for residential ratepayers that is provided at no cost. It also includes free CFLs, smart power strips, and other items. A QHEC is positioned as the first step for many residents to learn about their homes and how they can participate in EmPOWER Maryland programs.

Home Energy Audits or assessments are a comprehensive analysis of a home's energy usage. It looks at the entire building structure and all its energy uses, which typically takes several hours. A home energy audit is a necessary step for a resident to access the Home Performance rebate program. To encourage participation, energy audits are subsidized.

Home Performance rebates are available for homeowners who make significant improvements to their home's building envelope (the physical barrier between the conditioned and unconditioned space), or who add insulation. These improvements permanently enhance the comfort of homes, which enables homeowners to reduce heating and cooling equipment usage.

Commercial Property Requirements and Resources

Energy Analysis/Audits are available for companies or cooperatives managing the EmPOWER Maryland program offer services to assess current energy usage and recommendations for efficiencies.

Lighting and HVAC Incentives are offered to small and large businesses for upgrading to LED lighting or for replacing older fluorescent technology with new technology. Business who choose to do so receive a large rebate. Because many businesses keep their lights on 12–24 hours a day, the incentives are even larger than residential incentives. Some utilities even offer small financing programs directly on their bills to help companies pay for the amount that is not rebated.

HVAC Incentives

To motivate compaies to upgrade their chillers, boilers, and fans, among other components, HVAC incentives are available.

Custom Programs capture savings from projects that do not fall into the standard, prescriptive approaches. In these cases, businesses may apply for a flat dollar rebate amount per kilowatt-hour saved. These programs allow customers to flexibly accomplish their goals.

Building Energy Performance Standards (BEPS)

Recognizing that energy efficiency has a direct benefit to reduced greenhouse gas (GHG) emissions, the Climate Solutions Now Act set a new policy goal for broader

electrification of existing buildings and new construction. Buildings covered are commercial or multi-family residential housing that are over 35,000 square feet (excluding parking garage).

Receiving Recommendations

The Building Codes Administration is required to provide a final report with recommendations to the Public Service Commission (PSC) and the General Assembly by December 1, 2023.

Recommendations are expected to address having a building code that would require most new buildings to rely solely on electricity for internal use.

Buildings covered by the Act must report their GHG emissions to MDE beginning in 2025. MDE is required to develop “energy performance standards” for covered buildings that will achieve a 20% reduction in direct emissions by January 1, 2030 and net zero emissions by January 1, 2040.

THE SMART GRID

"Smart grid" refers to an electricity delivery system that uses digital communications technology allowing for two-way communication between energy consumers and the entities that deliver energy. Electricity usage can be monitored and controlled from the point of generation to usage in real time or near real time.

Managing the transmission, distribution, and consumption of energy has become much easier as a result of evolving technological developments. The smart grid will facilitate the use of electric vehicles. Maryland is one of the top states in modernizing the electric grid.

Integrating smart grid technologies may bring numerous benefits for everyone, such as:

- Giving consumers more information and control over their energy use
- Providing more effective management for distributors during peak times
- Improving utility grid operational efficiency and reliability, including quicker restoration after disruptions
- Better integration of distributed generation, especially large-scale renewable energy systems
- Making the grid more resilient and improved system security
- Facilitate increased use of energy storage systems and microgrids

Elements of the Smart Grid

Smart meters are digital meters, installed at the customer's home, that provide detailed and exact measurements of electricity, gas, or water use, and detect outages. Smart meters can communicate remotely and frequently with the utility.

A Continuous Effort

Maryland utilities have been working for several years to install smart meters in every home to provide consumers with more information to manage their energy use.

Transmission and Distribution Intelligence

This refers to the part of the smart grid that applies to the wires, switches, and transformers that connect the utility transmission, substations, and distribution systems. A key component of distribution intelligence is faster and improved outage detection and response. These technologies permit rerouting of power around trouble areas, managing power quality, and proactively monitoring key components, such as transformers, to predict potential failures.

Advanced Components

These entities play an active role in determining the electrical behavior of the grid. They can be applied in stand-alone applications or connected to create complex systems such as microgrids. These components are based on fundamental R&D gains in power electronics, superconductivity, materials, chemistry, and microelectronics.

Examples of advanced components include the Flexible AC Transmission System (FACTS), smart meters, and solid-state transfer switches.

Smart Meters

Digital electricity meters are linked to the utility company through the grid and provide real time data on power usage, outages, and other information.

Advanced Control Methods

This type of technology uses devices and algorithms that analyze, diagnose, and predict conditions in the modern grid. These technologies utilize the advanced components of an intelligent transmission and distribution system to enable grid managers to determine and take appropriate corrective actions to eliminate, mitigate, and prevent outages and power quality disturbances.

These methods also manage both real and reactive power across state boundaries.

Sensing and Measurement

This technology acquires and transforms data into information and enhance multiple aspects of power system management. These technologies evaluate equipment health and the integrity of the grid. They support frequent meter readings, eliminate billing estimations, and help prevent energy theft. They also help relieve congestion and reduce emissions by enabling consumer choice and demand response and by supporting new control strategies.

Examples of sensing and measurement technologies include transformer load monitoring, components of the advanced metering infrastructure, wide area monitoring systems, and outage monitoring and management systems.

Improved Interfaces and Decision Support

This technology converts complex power-system data into information that can be understood by human operators at a glance. Animation, color contouring, virtual reality, and other data display techniques are parts of improved user interfaces for systems that help operators identify, analyze, and act on emerging problems.

Examples of improved interfaces and decision support technologies include distributed energy resource interfaces, phasor measurement analysis, voltage optimization systems, scenario analyses, and customer gateways.

Integrated Communications

Create an interactive infrastructure for real-time information exchange, allowing users to interact with various intelligent electronic devices, to fully deploy smart grid technologies.

DISTRIBUTED GENERATION, MICROGRIDS, AND STORAGE CAPACITY

Microgrids are small, local electric grids that can disconnect from the traditional grid and generate electricity using distributed energy resources such as natural gas turbines, solar PVs, and batteries. Generally, the microgrid is "islanded" from the electricity grid within a geographically defined area.

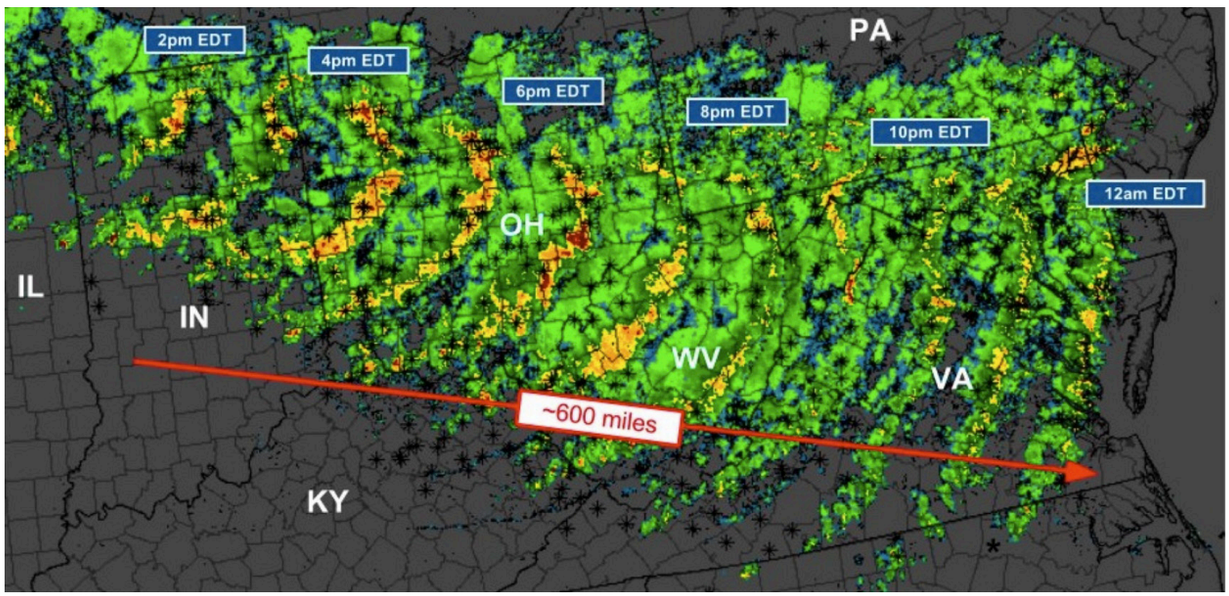
A microgrid can disconnect from the traditional grid and operate autonomously. This strengthens grid resilience and helps to mitigate disruptions or outages in the electricity grid. A microgrid can help alleviate grid congestion by providing more efficient management of power supply and demand.

These systems have been shown to provide power for critical community services during extreme weather events such as Hurricane Sandy and the June 2012 derecho storm.

Microgrid Technologies

Microgrid technologies are increasingly cost-effective, especially in situations where uninterruptible quality power is required 365 days per year.

Governments are partnering with businesses to strategically deploy microgrids where they can best benefit



June 29, 2012 Midwest to East Coast derecho radar imagery composite summary 18-04 UTC. ~600 miles in 10 hours with an average speed of ~60 mph.

communities during an emergency. Many of these systems are privately financed with revenues from selling energy services into the regional energy market. As energy project developers continue to create new business models and value streams – such as energy efficiency or renewable energy generation projects, or energy pricing based on reliability factors – microgrids will increase in popularity as an option for local electricity distribution.

The Maryland Energy Administration's Resilient Maryland Program provides competitive grants that can offset the costs of analyzing, planning and designing resilient microgrids and energy hubs.

The U.S. Department of Energy maintains a Combined Heat and Power and Microgrid Installation database to locate microgrids installed across the U.S.

Energy Storage

Storing and distributing power as effectively as possible is important because energy supply (generation) and demand (consumption) are never constant and rarely equal. Excess energy is produced during periods of low demand, but it is lost if it can't be stored for use during peak demand. Similarly, electricity produced in one location might go unused because of low demand, while another location is underserved by supply because too little energy is produced. Energy storage systems facilitate the expansion of renewable energy generation and the potential to accelerate the de-carbonization of the electric grid.

The Maryland Energy Storage Pilot Project Act was passed in 2019. The Act requires each investor owned utility to solicit two energy storage pilot projects. The PSC has established an Energy Storage Pilot Program. To facilitate energy storage, Maryland has an Maryland Energy Storage Tax Credit Program.

A 100% efficient energy storage device would not lose any energy during the energy storage process – all energy input to the device would be available for output. This level of efficiency remains elusive, but some technologies exist at lower efficiency levels that do capture excess energy to be used when needed.

Advanced Batteries

Lithium-ion batteries, available in varying sizes from utility scale down to consumer electronics sized, are an advanced battery technology. Lithium-ion batteries are the most commonly used advanced batteries.

In general, advanced batteries offer several advantages:

- More efficient than lead-acid batteries
- Provide more energy with a smaller unit than traditional batteries
- Last twice as long as conventional batteries

- Some varieties, such as sodium sulfur batteries, can operate under much higher temperatures
- High-power and high-capacity uses, such as in a power grid
- Charge is circulated through the battery from a rechargeable and portable external unit that can be moved to where it is needed on demand

Compressed Air Energy Storage

Compressed air on a near-utility scale or a utility scale functions similarly to air compressors used in construction applications. Air is compressed into a reservoir, such as a rock cavern or an abandoned mine, relatively slowly during low energy demand periods. When needed as an energy source during high demand times, the air is released rapidly. The released air can turn a turbine to generate electricity.

Superconducting Magnetic Energy Systems (SMES)

This solution provides peak power for short durations, which can be helpful to manage quick fluctuations in power quality. SMES store energy in the magnetic field created by electricity flow through a superconducting coil.

- Used to bridge periods of power instability or short-term interruptions, such as those that may occur while switching from grid electricity to a backup power supply
- Store energy in the magnetic field created when current travels through supercooled conducting material
- SMES produce immediate high power, but for a very short time. New R&D is underway to improve the cooling process, using either liquid helium or liquid nitrogen

Flywheel Energy Storage (FES)

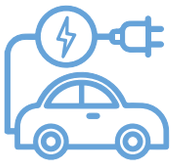
These systems involves bringing a large-sized wheel up to a high rotational speed using available power during low demand times. The flywheel turns on a low friction shaft, so little energy is needed to keep it spinning once it has reached speed. When energy demands increase to peak, the kinetic energy of the flywheel is used to provide power back to the grid quickly.

A Reliable Source

Because flywheels typically remain running and available at a moment's notice, they can be used to meet quick energy demands while grid operators wait for other peaking power systems to spin up to full operation.

Hydrogen Fuel Cells

Hydrogen is the most abundant substance in the universe, but on Earth it is combined with other elements and must be extracted from other sources to be used. This process takes energy. For utility-scale electric production, hydrogen is derived via a natural gas process that can be costly and releases carbon dioxide, albeit at significantly lower amounts than combustion. Fuel cells provide electricity similar to batteries, but unlike batteries, they require a constant input of a fuel source, such as hydrogen. While fuel cells promise high efficiency and use an abundant element, the hydrogen extraction process can be costly and energy intensive, and currently restricts mass adoption of this technology.



ELECTRIC VEHICLES (EVs) AND ALTERNATIVE TRANSPORTATION SOLUTIONS

Just like a conventional car needs gas in its tank, an electric vehicle (EV) needs energy in its battery. The big difference between gas cars and EVs is that gas cars have to be refueled at a gas station while EVs charge when parked at a charging station.

Most EVs require an extensive charging time in order to fully refuel, however, technology is improving to shorten this time. There are three main types of chargers, or electric vehicle supply equipment, each with different availability and charging capacities to match the amount of time an EV is parked. These chargers can be installed in homes or in public places.

There are three main types of EVs:

- **Battery electric vehicles (BEVs)** use only a battery to power the motor, and the batteries are charged by plug-in charging stations
- **Hybrid electric vehicles (HEVs)** are powered by traditional fuels and by electric energy stored in a battery. They use regenerative braking (as the car slows down during braking, energy is absorbed and captured to provide extra power when needed) or the internal combustion engine to charge their battery. HEVs work well for both light-duty and heavy-duty applications
- **Plug-in hybrid electric vehicles (PHEVs)** have internal combustion or other propulsion-source engines and electric motors. Like HEVs, they are powered by either conventional fuels or a battery, but the batteries in PHEVs are larger than those in HEVs. PHEV batteries are charged by a plug-in charging station, regenerative braking, or the internal combustion engine

PHEVs offer longer ranges without the need to stop to charge up. Many hybrid vehicles can travel between 20 and 35 miles on pure electricity before switching to gas. As of April 30, 2022 there are over 47,000 plug-in electric vehicles registered in Maryland. There is an increasing trend toward electrification of off road vehicles such as construction equipment, marine vessels and cargo handling equipment.

The American Council for Energy Efficiency ranks Maryland fourth among all states in having effective transportation electrification programs and policies.

All About Electric Vehicles

Learn about electric vehicles in Maryland at Maryland EV as well as incentive programs, charging station locations, how to choose an EV, and the basics of EV charging.

Marylanders On The Go

On average, Marylanders drive 37 miles per day. Most BEVs can travel close to 75 miles on a fully charged battery, making them a good option for many motorists.

Other EV Resources

Maryland Electric Vehicles

The Electric Vehicle Supply Equipment (EVSE) Rebate Program provides rebates that are calculated on a per charger basis for up to 40% of the cost of equipment and installation for residential (with a $700 cap) and commercial (with a $4,000 cap).

Maryland's electric utilities offer EV programs that provide rebates, and other information for charging on the grid.

- Pepco EVsmart Program
- BGE EVsmart Program
- SMECO EV Guide
- Potomac Edison EV Driven
- Delmarva Power Electric Vehicle Program
- Choptank Electric Choose EV

EVgo s a public EV fast charging network, powered by renewable energy, with locations across the U.S.

Maryland Clean Cars Act of 2022

This legislation establishes a grant program for medium and heavy-duty zero emission vehicles beginning in July, 2023.

ALTERNATIVE FUELS

Biofuels are fuels produced from biomass, such as plant matter. There are several types of biofuel, ranging from traditional biofuels, which are designed to be blended with petroleum products, to more advanced biofuels, which can be a direct replacement for petroleum fuel. Generally, biofuels are used as transportation fuels.

The following are "first generation" types of biofuels:

Ethanol, particularly corn-based, is one of the first biofuels to be widely used in the United States. It is a mandated oxygenate for gasoline meaning that it reduces the emissions of gasoline-powered vehicles. Approximately 98% of all gasoline in the U.S. has some ethanol.

Biodiesel is based on vegetable oil, animal fats, or waste grease from restaurants. Biodiesel is typically blended in diesel fuel at blends of 6% – 20% in transportation vehicles, and of up to 20% for heating applications.

Biofuels Regulation

The Renewable Fuel Standard (RFS) is a federal mandate requiring oil and gas companies to blend biofuel into their traditional, fossil fuels. The RFS is intended to reduce dependence on imported oil, reduce GHG emissions and expand the use of renewable fuels. Companies demonstrate their biofuel use through Renewable Identification Numbers (RINs) and an electronic system established with the U.S. Environmental Protection Agency (EPA). The RFS allows new biofuels to be approved for use via the program, especially fuels that reduce greenhouse gas emissions by 50% or more compared to the petroleum fuel they displace.

Biofuel Availability in Maryland

MEA provides resources for Biodiesel Information and Distribution, as well as a list of Biodiesel Refueling Stations in Maryland. Links for more information are listed in the Resources Guide on page 58.

New Biofuels

Algae is a promising source of new biofuels, especially because other co-products, such as fertilizer and feed, offer other income potential, making the process of turning algae into biofuels cost effective.

Other Fuels

Compressed Natural Gas (CNG) and Liquefied Natural Gas (LNG)

A natural gas vehicle (NGV) is an AFV that uses CNG or LNG as a cleaner alternative to other fossil fuels. NGVs should not be confused with vehicles powered by propane autogas (also known as liquefied petroleum gas, or LPG), which has a fundamentally

different composition. Worldwide, there are over 23 million NGVs. There are over 175,000 NGVs in the United States. Maryland has nine public CNG filling stations and six private CNG filling stations.

Existing gasoline-powered vehicles may be converted to run on CNG or LNG, either in dedicated (running only on natural gas) or bi-fuel (running on either gasoline or natural gas) operation. In the U.S., there are about 50 manufacturers producing 100 light, medium and heavy-duty vehicles and engines.

Despite their advantages, NGVs face several limitations, including fuel storage and a lack of available infrastructure for delivery and distribution at fueling stations.

Propane Autogas

Propane autogas (also known as liquefied petroleum gas or LPG) is an alternative vehicle fuel that reduces some harmful emissions compared to other fuels. LPG costs on average 50% less per gallon than gasoline but it provides less fuel economy. It is almost entirely derived from fossil fuels. Autogas vehicles can be produced by original equipment manufacturers (OEMs), and gasoline vehicles can be converted to run on bi-fuel (either gasoline or LPG). Autogas is the third-most-used vehicle fuel in the world, with approximately 28 million autogas vehicles on the road globally.

Autogas vehicles are ideal for light-to medium-duty, high-mileage fleets. Autogas fueling station installation costs are much lower than for natural gas fueling stations (on-site infrastructure is often installed at little or no cost to autogas fleets), and installation does not require integration with pipeline infrastructure. There are 25 public and 8 private LPG fueling stations in Maryland.

Fleet Diesel-Powered Vehicles

Since 2008 Maryland requires the use of 5% biofuel in state fleet diesel-powered vehicles. Maryland supports all biofuels that have been approved by EPA under the Renewable Fuel Standard (RFS).

Autogas Versus Natural Gas

- Autogas incremental vehicle and fueling infrastructure costs are significantly less than those for natural gas (CNG or LNG); 15 autogas stations can be built for the cost of 1 CNG station
- Autogas vehicles have greater range than CNG vehicles
- The cost of converting two vehicles to autogas is equivalent to the conversion cost of one CNG vehicle
- Autogas distribution is not dependent on building new pipelines

LOW-INCOME RATEPAYER ASSISTANCE PROGRAMS

The Federal Low Income Home Energy Assistance Program (LIHEAP), administered through the U.S. Department of Health and Human Services, offers assistance to low-income households who pay a high proportion of their income for home energy.

Over the past 10 years, LIHEAP services have benefited 60 million Americans, providing them with assistance in managing costs of home energy bills, energy crises, weatherization and energy-related minor home repairs. In addition to this federal program, Maryland offers LIHEAP benefits through additional programs.

Maryland Programs

Maryland Department of Human Services' Office of Home Energy Programs (OHEP)

The OHEP provides bill assistance to low-income households in Maryland to help reduce energy costs, prevent the loss of home energy, and assist in the restoration of home energy service. The program provides four different grants that Maryland residents can apply for.

The Maryland Energy Assistance Program (MEAP) is funded through LIHEAP and provides financial assistance with home heating, cooling and water heating systems. Payments are made to the fuel supplier and utility company on the customer's behalf. This program includes an in-person assessment of the participant's home to determine needed services.

The Electric Universal Service Program (EUSP) provides current electric bill assistance, retirement of certain old bills, and weatherization services to reduce

consumption of electricity. Marylanders who receive EUSP are placed on a budget billing plan with their utility company. The EUSP also includes an arrearage component, which can be used once every 7 years to clear up past bills between $300 and $2,000. Through eliminating old, past due balances, many Marylanders are able to have gas/electric service put back in their name. Eligible customers may receive both EUSP and LIHEAP.

Applying for Maryland Programs

With so many options offered in the state of Maryland, it can often be confusing when going to apply for an assistance program. Thankfully, the online applications process has been streamlined by myMDTHINK.

For offline application options and additional information about Maryland energy programs, please visit the OHEP's Applying for Energy Assistance page.

The Arrearage Retirement Assistance (ARA) ARA assists with large, past due electric and gas bills. Eligible Marylanders may receive up to $2,000 towards their past due bill. Past due bills must be $300 or greater to be considered eligible. Customers may only receive an arrearage grant once every five years, with certain exceptions. Arrearage grants received between January 1, 2020 and December 31, 2021 will not count towards the five-year limitation.

The Utility Service Protection Program (USPP) was created to protect low-income families from utility turn-offs during the peak seasons. Marylanders who participate in MEAP are also allowed to participate in USPP. Participation requires a budget billing plan to even monthly costs. Failure to make consecutive payments may result in removal from USPP.

Maryland Department of Housing and Community Development

This department implements housing policy that promotes and preserves homeownership and creates innovative community development initiatives to meet the challenges of a growing Maryland. They offer a number of energy efficiency programs that include:

- **The Weatherization Assistance Program** helps eligible limited income households in Maryland with the installation of energy conservation materials in their homes, condos or apartments. These upgrades reduce the consumption of energy and the cost of maintenance for these dwellings.
- **The Multifamily Energy Efficiency and Housing Affordability Program (MEEHA)** promotes energy efficiency and affordability in Maryland's multifamily rental housing developments for limited and moderate-income households. These upgrades reduce a building's energy use and lower utility bills for occupants and owners. MEEHA funds are restricted to affordable multifamily rental properties with income or rent restrictions for a minimum of 20% of units for tenants with income at or below 80% of AMI.
- **The BeSMART Home Loan Program** provides financing to improve the energy efficiency and comfort of Maryland homes. By replacing and upgrading appliances, heating,

ventilation and cooling systems, and whole house envelope improvements – homeowners can save on their utility bill.

EmPOWER Maryland Low Income Energy Efficiency Program (LIEEP)

EmPOWER helps low-income households with the installation of energy conservation materials in their homes at no charge. These improvements reduce a household's energy use and lower the monthly utility bills, and will also make occupants more comfortable and may improve the air quality and overall health of the family. This program includes a home energy audit.

Fuel Fund of Maryland

The Fuel Fund of Maryland is a non-profit organization that provides financial assistance to low-income households facing an energy crisis or home utility hardship. They help resolve outstanding energy bills as well as provide navigation through an array of financial and community resources.

Maryland Utilities with Low-Income Rate Assistance

Many utilities in Maryland offer deposit, reconnection fee, and application fee waivers to qualifying customers.

A Helping Hand

Utility deposits and fees can be in the hundreds of dollars, so the waivers can represent significant savings for low-income customers.

The programs are administered under different names, but the services are often similar.

Energy Efficiency Resources

In addition to direct bill and fee financial assistance, several Maryland utilities offer energy efficiency assistance programs to help low-income customers reduce their bills by consuming electricity or gas more efficiently.

211 Maryland

This network of call centers provides resources for Marylanders seeking assistance regarding any matter. Their services include but are not limited to

- Financial problems
- Legal issues
- Health concerns
- Family difficulties

Dial 2-1-1 at any time for free information on and referral to thousands of services in over 150 languages.

Website: 211md.org

Maryland Public Service Commission (PSC)

The Maryland PSC is the agency that regulates utilities in the state and directly assists consumers through their Consumer Affairs Division.

Website: psc.state.md.us
Phone (Baltimore Metro Area): 410-767-8000
Phone (Statewide): 800-492-0474

ENERGY SECTOR JOBS

The energy sector generates a significant amount of employment for Maryland both directly and indirectly.

Associated categories and subcategories of sector employment directly associated with the delivery of energy and energy efficiency products, services and technologies to the market may include all or portion of the jobs in categories such as:

- Utilities
- Engineering
- Electrical/ Electrician
- Solar Energy Equipment Manufacturing, Sales, Installation and Contracting
- Wind Energy Equipment Manufacturing, Sales, Installation and Contracting
- HVAC Equipment Manufacturing, Sales, Installation and Contracting
- Energy Efficiency Contracting, Services and Equipment
- Energy Management Equipment and Services
- Biofuel Production and Distribution
- Biomass Energy Production Equipment and Services
- Electric Vehicle Manufacturing, Sales, and Service
- Battery and Energy Storage Equipment Manufacturing, Sales, Installation and Maintenance

Job related impact indirectly associated with the energy sector in certain categories listed below, include but are not limited to:

- Banking and Financial Services
- Legal Services
- Construction
- Well Drilling
- Research & Product Development
- Marketing
- Shipping, Warehousing and Storage
- Government

Jobs in Energy

There are over 140,275 direct and indirect jobs* associated with the energy sector in the State of Maryland, generating an estimated $12,568,422,708 annually in salaries and wages.

**The Annual MCEC Employment and Wages report is derived from the most recently available Bureau of Labor Statistics' (BLS) Quarterly Census of Employment and Wages (QCEW).*

GLOSSARY

This brief glossary defines some of the key terms, acronyms, and organizations for understanding clean energy. A comprehensive glossary, with regular updates, can be viewed online at mdcleanenergy.org/glossary.

Aggregators can be either a web site or a group that aggregates customers together in order to approach a supplier with a larger volume of business. Aggregators are licensed by the PSC.

Building Energy Performance Standards (BEPS) are policies that require commercial and multifamily buildings to meet certain performance levels, typically for energy use or greenhouse gas emissions.

Bioenergy is renewable energy derived from biological sources, known as biomass, to be used for heat, electricity, or vehicle fuel in the forms of biofuel, biogas or pyrolysis.

Biomass is renewable organic material that comes from plants and animals. Sources for energy include: wood and wood processing wastes, agricultural crops and waste materials, biogenic materials in municipal solid waste, animal manure and human sewage for producing biogas/renewable natural gas.

Black Liquor is a by-product substance produced by the paper pulping process. It can be combusted to produce electricity.

Budget Billing is offered by most utilities and suppliers, which allows customers to pay a fixed amount each month. Annual bills are averaged out over 12 months, for equal payments until the total bill is paid, unless adjusts are needed to reflect changes in usage.

Carbon Capture and Storage (CCS) is the process of catching and storing carbon dioxide from industrial operations like the burning of fossil fuels or cement and steel production before it is released into the atmosphere.

Carbon Neutral is transparent process of calculating emissions, reducing those emissions and offsetting residual emissions such that net carbon emissions equal zero.

Carbon Offset reflects emission savings or storage that can be considered to cancel out emissions that would otherwise have occurred.

Clean Energy is recognized in Maryland as solar photovoltaic technology, solar heating, geothermal, wind, biofuels, ethanol, other qualifying biomass as defined in § 7–701 of the Public Utilities Article, ocean - including energy from waves, tides, currents, and thermal differences; a fuel cell that produces energy from biofuels, ethanol, or other qualifying biomass; energy efficiency and conservation and any other technology as defined in statute https://mgaleg.maryland.gov/2017RS/chapters_noln/Ch_365_sb0313T.pdf

CO_2 or "Carbon" is a natural and man-made gas, which is one of the most common greenhouse gases that scientists report is causing global warming.

Certificate of Public Convenience and Necessity (CPCN) is issued by the PSC and provides authority for a person to construct or modify a new generating station or high-voltage transmission lines.

Deregulation for energy means that generation, transmission and distribution are "de-coupled." The Maryland PSC, in cooperation with local utilities, allows electricity and natural gas customers to choose their own suppliers.

Distribution Systems are the network of wires and equipment (electricity) or pipes (natural gas) that carries energy from the transmission or transportation systems to the point of use.

Distributed Generation (DG) is any small-scale electric generation that is located at or near the point of end use. It may be interconnected with a local utility company's distribution system or not. It may be owned and operated by a customer, a utility, or a non-utility company.

Electricity Suppliers generate or purchase electricity on the wholesale market and sell it to customers on the retail market at rates that are not subject to government approval. They do not typically own any generation.

EmPOWER Maryland is the state's energy efficiency program with a goal of a 15% reduction in energy use and 15% reduction in peak demand per capita by the year 2015 (based on 2007 levels).

Energy Audit is defined as a comprehensive investigation of an energy consumer's energy usage, which typically takes several hours for homes and several days for commercial entities.

Energy Cooperatives ("energy co-op") act as the energy supplier, the utility, and the owner of generation. There is no consumer choice in these markets, offered in some parts of Maryland.

Energy Storage is a broad category of technologies that can store energy for use at a later time, which are particularly useful for renewable energy sources such as wind or solar (which are intermittent), since energy is saved for discharge to the grid when needed.

Electricity Suppliers generate or purchase electricity on the wholesale market and sell it to customers on the retail market at rates that are not subject to government approval. They do not typically own any generation.

Electric Vehicles (EVs) run on an engine charged by a battery. They need to plug into an electricity source to recharge the battery and can potentially discharge electricity back to the grid.

Fuel Cell is a device that converts chemical energy from a fuel into electricity. Future-oriented research is looking to utilize hydrogen for the fuel, but fuel cells can also use natural gas and methanol.

Generation is the process of refining raw resources into useable electricity.

Geothermal Energy utilizes heat from the earth to produce energy.

Grid / Electric Grid is the network of power providers and consumers connected by transmission and distribution lines and operated by one or more control centers.

Greenhouse Gas (GHG) contributes to the greenhouse effect by absorbing infrared radiation, e.g., carbon dioxide and chlorofluorocarbons.

Hydraulic fracturing ("fracking") is a process for extracting natural gas from previously hard-to-reach areas. The driller injects waters and chemicals into the well to fracture the rocks down below, letting the natural gas escape. In March 2017, the Maryland General Assembly passed House Bill 1325, which will place a permanent ban on fracking in the state.

Hydropower utilizes the natural flows of water to spin a turbine and create electricity. Tidal and wave energy are types of hydropower.

Independent System Operators (ISOs) is an organization formed at the direction or recommendation of FERC.

kW (kilowatt) is unit of power, used to express how much a generation source can produce in an instant at its maximum capacity. It measures capacity, not actual production. Actual production over time is measured by kilowatt hour (kWh). Similarly, a megawatt (MW) is a unit of power equal to one million watts, especially as a measure of the output of a power station.

Load Serving Entity (LSE) is an entity that delivers electricity or natural gas. It can be an Alternative Electricity Supplier, Natural Gas Supplier, or a Utility.

Maryland Clean Energy Center (MCEC) is an instrumentality that serves as a statewide green bank with a mission to transform the energy economy in Maryland by increasing clean energy jobs, driving commercialization of technological innovations, and enabling consumer adoption of clean energy products and services.

Micro Grids are self-contained electricity grids that can be disconnected from the larger grid if need be, and host their own source of generation.

Natural Gas is a fossil fuel energy source, containing many different compounds. The largest component of natural gas is methane (CH4).

Net Energy Metering is the measurement of the difference between electricity that is supplied by an electric company and the electricity that is generated by an eligible customer-generator and fed back to the electric company over the eligible customer-generator's billing period.

Net Zero Carbon means that carbon emissions created during the production of power are balanced or canceled out by removing, from the atmosphere, the same amount of carbon that was emitted.

Nuclear Energy is released during nuclear fission or fusion, especially when used to generate electricity, and may include large scale and Small Modular Reactors (SMR)

PJM Interconnection (PJM) See page 9.

Peak Demand is the maximum amount of electricity an end-user needs at the time when it's using the most electricity at a specific time.

People's Counsel / Maryland Office of People/'s Counsel (OPC) See page 10.

Plug-in Hybrid is a vehicle that uses both a gasoline internal combustion engine and a battery powered engine. The battery can be recharged by plugging the vehicle into a power source and often it can run on battery power alone.

Power Plant Research Program (PPRP) See page 11.

Power Purchase Agreement (PPA) is a financial agreement in which a power generator agrees to sell the power produced by its generation to a customer at rates that can be variable or fixed.

Propane is normally a gas, but can be compressed into liquid form. It is a gas that is the byproduct of natural gas processing and petroleum refining. Propane has a wide variety of uses, and is increasingly being used as a vehicle fuel in the United States.

Public Service Commission of Maryland (PSC) See page 9.

Quick Home Energy Check-up (QHEC) is a free, brief energy assessment for residential ratepayers as part of the EmPOWER Maryland program.

Regional Greenhouse Gas Initiative (RGGI) is a compact between states to reduce greenhouse gases from power plants. Maryland is a member of RGGI.

Renewable Energy sources regenerate and can be sustained indefinitely; these include biomass, hydropower, geothermal, wind and solar.

Renewable Fuel Standard (RFS) is a federal program that requires transportation fuel sold in the United States to contain a minimum volume of renewable fuels.

Renewable Portfolio Standard (RPS) is a mechanism many states use to incentivize the deployment of new renewable energy generators. The basic approach of the RPS is to require every entity that sells electricity in the state (LSE's) to have a percentage of renewable energy in their mix. Maryland includes OREC (offshore wind), SREC (solar) and TREC (thermal) generation methodologies eligible in the state RPS regulations. There is typically an Alternative Compliance Payment (ACP) that acts as a penalty for LSE's that fail to meet the standard.

Maryland RPS Tier 1 is the category for most energy sources that qualify for the RPS. The Tier 1 ACP is higher than Tier 2, and Tier 1's requirements do not sunset.

Maryland RPS Tier 2 refers to large scale hydro and any other energy source that is not in Tier 1. Tier 2 sunsets after a set period of time and has a lower ACP than Tier 1.

Slamming is the unauthorized switching of a customer's account to another utility or competitive energy supplier without the customer's consent.

Smart Grid is the general term usually meaning an electricity grid that allows for two-way communication between those that deliver energy and those that use energy.

Smart Meters or Advanced Meters are digital electricity meters that communicate frequently with the utility to provide more detailed and exact measurement of electricity use, as well as other functions, such as outage detection.

Solar Photovoltaics (PV) See page 27.

Solar Thermal ("solar hot water") uses heat from the sun to warm up water, which can then be used in a business or a home.

Strategic Energy Investment Fund (SEIF) is generated from the proceeds from Maryland's sale of carbon allowances, which is part of the RGGI structure. The SEIF has mainly been used to help lower income Marylanders pay their energy bills and to fund energy efficiency investments.

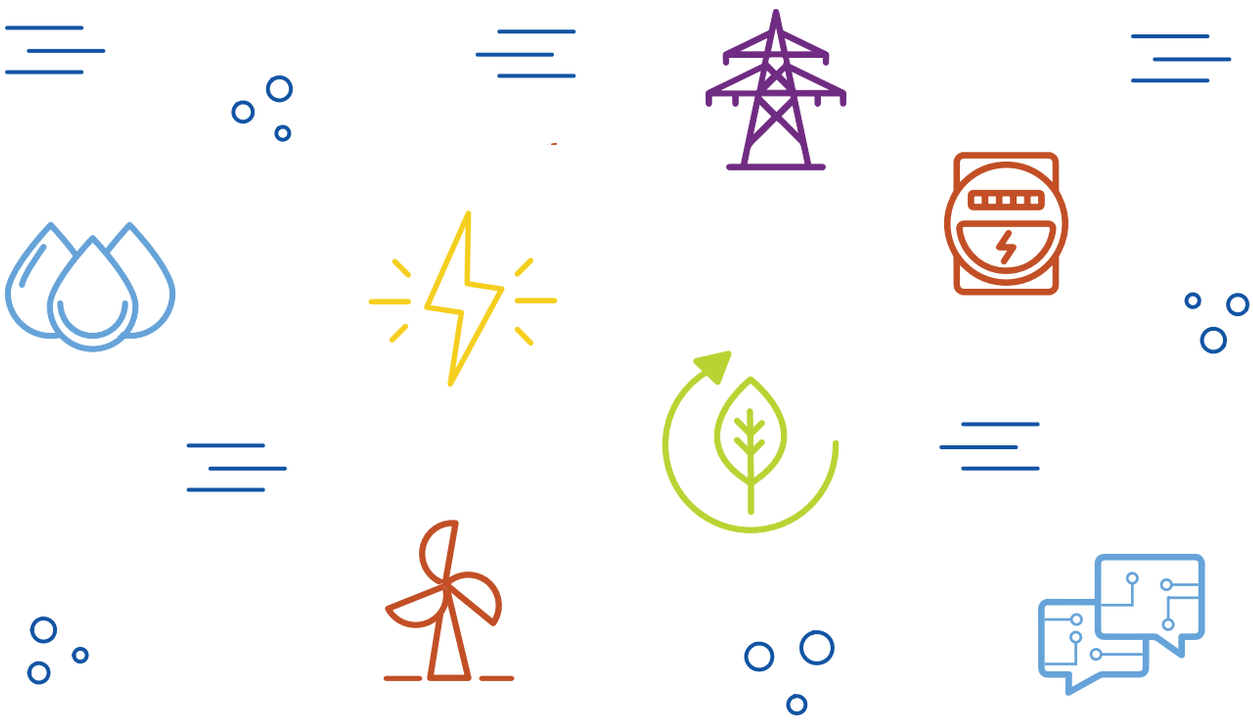
Tidal Energy utilizes the naturally occurring motion of incoming and outgoing tides to produce energy.

Transmission involves the movement of large quantities of electricity, gas, or liquid fuels over a long distance at high rates.

Waste to Energy (WTE) is energy recovery from waste by converting refuse materials into usable heat, electricity, or fuel through a variety of processes, including combustion (incineration), gasification, anaerobic digestion, and landfill gas (LFG) recovery.

Wind Power is derived from wind spinning a turbine that produces electricity. It does not produce any emissions. Wind energy can be generated from land based and offshore locations.

Zero Carbon energy sources produce no carbon emissions during production or service.



RESOURCES

This compiled list of resources provides access to additional information and references for the content covered in Energy 101. Online resources, with regular updates, can also be viewed online at mdcleanenergy.org/resources.

Framing the Maryland Energy Marketplace

Page 7: Maryland's Energy Challenges
eia.gov/state/analysis.php?sid=MD

Page 8: Maryland's Electricity Profile 2021
eia.gov/electricity/state/maryland/

The Regulatory Structure

Page 9
psc.state.md.us/

mdelectricchoice.com/

The Federal Energy Regulatory Commission
ferc.gov/what-ferc-does

PJM Interconnection
pjm.com/about-pjm

Page 11: Graphic Caption
dnr.maryland.gov/pprp/Documents/FinalRPSReport December2019.pdf

Regional Greenhouse Gas Initiative & the Strategic Energy Investment Fund

Page 13: The Regional Greenhouse Gas Initiative (RGGI)
rggi.org/

mde.maryland.gov/programs/Air/ClimateChange/RGGI/Pages/RGGIProgress.aspx#ref1

Strategic Energy Investment Act (SEIF)
rggi.org/auctions/auction-results

Strategic Energy Investment Act (SEIF)
energy.maryland.gov/SiteAssets/Pages/Strategic-Energy-Investment-Fund-%28SEIF%29-/FY21%20SEIF%20Report%20Vol%201%20Final.pdf

2020 Maryland RGGI Investments by Category
rggi.org/sites/default/files/Uploads/Proceeds/RGGI_Proceeds_Report_2020.pdf

SEIF Revenues by Source
energy.maryland.gov/SiteAssets/Pages/Strategic-Energy-Investment-Fund-%28SEIF%29-/FY21%20SEIF%20Report%20Vol%201%20Final.pdf

Power Supply Choice and the Retail Energy Market

Page 19: Third-Party Energy Supply Market
abell.org/publication/marylands-dysfunctionalresidential-third-party-energy-supplymarket/

baltimorefishbowl.com/stories/energy-supplier-choice-aimed-to-lower-marylanders-bills-but-some-customers-are-left-feeling-powerless/

Page 19: Maryland's Energy Supply Reform Bill
mygreenmontgomery.org/2021/marylandsenergy-supply-reform-bill-explained/

Climate Solutions Now Act of 2022
mgaleg.maryland.gov/mgawebsite/Legislation/Details/sb0528

MD Public Service Commission: Retail Energy Supplier Complaint Reports
psc.state.md.us/retail-energy-supplier-complaint-reports/

Zero Carbon & Advanced Clean Energy Generation

Page 26: Near-Field Thermophotonics (TPX-Power project)
cordis.europa.eu/project/id/951976

Renewable Energy Solutions

Page 27
eia.gov/state/print.php?sid=MD

Page 28: Solar is a Growing Source of Jobs in Maryland
seia.org/state-solar-policy/maryland-solar

psc.state.md.us/wp-content/uploads/OSW-in-Maryland-Fact-Sheet-1.pdf

Page 29: Land-Based Wind
eia.gov/state/analysis.php?sid=MD#85

Offshore Wind
psc.state.md.us/wp-content/uploads/Maryland-PSC-Decision-Expands-Offshore-Wind-Development_12172021.pdf

Biomass and Waste to Energy (WTE)
eia.gov/state/analysis.php?sid=MD#85

Page 31: Hydroelectricity
eia.gov/state/analysis.php?sid=MD#91

Renewable Energy Credits

Page 32: Compliance RECs Versus Voluntary RECs
psc.state.md.us/electricity/wp-content/uploads/sites/2/MDRPS-Fact-Sheet-1.pdf

mgaleg.maryland.gov/mgawebsite/Laws/StatuteText?article=gpu&section=7-703&enactments=False&archived=False

Page 33: Types of RECS Based on Fuel Source
mgaleg.maryland.gov/mgawebsite/Laws/StatuteText?article=gpu&section=7-705&enactments=False&archived=False

srectrade.com/markets/rps/srec/maryland

Offshore wind RECs (ORECs)
psc.state.md.us/wp-content/uploads/OSW-in-Maryland-Fact-Sheet-1.pdf

Energy Efficiency

Page 35
psc.state.md.us/electricity/empower-maryland/

dhcd.maryland.gov/Residents/Pages/wap/Default.aspx

The Smart Grid

Page 38
gridwise.org/gmi-readiness/#:~:text=The%20GridWise%20Alliance%27s%20Grid%20Modernization,and%20the%20District%20of%20Columbia

Distributed Generation, Microgrids, and Storage Capacity

Page 40: Microgrids
energy.maryland.gov/business/Pages/ResilientMaryland.aspx

doe.icfwebservices.com/microgrid

Page 41: Energy Storage
energy.maryland.gov/business/PagesEnergyStorage.aspx

Electric Vehicles (EVs) and Alternative Transportation Solutions

Page 43
news.maryland.gov/mea/wp-content/uploads/sites/15/2021/02/ACEEE-Transportation-Electrification-Scorecard.pdf

marylandev.org/

Page 44: Maryland Electric Vehicles
marylandev.org/

energy.maryland.gov/transportation/pages/incentives_evserebate.aspx

evgo.com/

Alternative Fuels

Page 45
energy.maryland.gov/transportation/Pages/resources_biorefueling.aspx

Biofuel Availability in Maryland
eia.gov/state/analysis.php?sid=MD#85

energy.maryland.gov/transportation/Pages/resources_distributors.aspx

Low-Income Ratepayer Assistance Programs

Page 47: Maryland Department of Human Services' Office of Home Energy Programs (OHEP)
dhs.maryland.gov/office-of-home-energy-programs/

Page 48: Applying for Maryland Programs
mymdthink.maryland.gov/home

dhs.maryland.gov/officeof-home-energy-programs/how-do-you-apply/

Maryland Department of Housing and Community Development
dhcd.maryland.gov/Pages/EnergyEfficiency/default.aspx

Additional Resource Organizations & Programs

Maryland Clean Energy Center (MCEC)
mdcleanenergy.org

Maryland Energy Administration (MEA)
energy.maryland.gov

U.S. Energy Information Administration (EIA)
eia.gov

National Renewable Energy Laboratory (NREL)
nrel.gov

Maryland Commercial Property Assessed Clean Energy (MDPACE) Program
md-pace.com

Clean Energy Advantage (CEA) Loan Program
cealoan.org