climate CHANGE WORKING GROUP OF FREDERICK COUNTY

ACHIEVING NET ZERO GREENHOUSE GAS EMISSIONS BY 2050

A POSITION PAPER ON ENERGY AND CLIMATE CHANGE IN FREDERICK COUNTY

Editor: Karen Russell

Contributors: Nile Oldham, Jeff Wilson, Ron Kaltenbaugh, Elizabeth Law, Bob Robey, Bill Steigelmann, Ellis Burruss, Ed Grayzeck, Kerrie Kyde

Founded in 2016, the Climate Change Working Group's mission is to assist Frederick County administrators and residents in adapting to and mitigating the impacts of climate change through responsible planning, education and advocacy. Contact: Karen Russell, Founder and Chair, ccwgfredco@gmail.com

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EXECUTIVE SUMMARY

The Climate Change Working Group of Frederick County (CCWG) presents this position paper on climate change and energy choices that affect the county. It is one of a series of projected position papers that, when synthesized from a systems perspective, can form the foundation of a plan to address the local impacts of climate change.

It is imperative that greenhouse gases cease to be emitted into earth's atmosphere by 2050, in order to stay under a global average temperature limit of 2°C (3.8°F). Beyond that threshold, the habitability of the earth is threatened.

This paper identifies factors to consider and actions to take for the County to become carbon neutral[1] in energy consumption by 2050. It breaks down energy generation and consumption into sectors, based on data from the U.S. Energy Information Administration: 1) Electricity; 2) Residential, Commercial, Industrial/Agricultural; and 3) Transportation. It proposes ways to electrify all sectors as rapidly as possible, and supply all of the electricity from non-carbon sources – mostly renewable such as solar, wind, hydroelectric, and nuclear, as a transition source. Finally, the paper addresses carbon-free energy security.

Information and data analysis show how decarbonizing each sector would reduce the amount of energy needed. By 2050, Frederick County could maintain its current electricity consumption, even with an expected 40% increase in population -- about 100,000 people. The key to this result is efficiency in both energy generation and consumption, as well as energy conservation.

Our recommendations form the basis from which to advocate for effective energy policy. It is a working document—designed to be updated, as new information comes to light.

PROBLEM STATEMENT

A 2018 Special Report from the Intergovernmental Panel on Climate Change entitled *Global Warming of 1.5°C* found clear benefits to limiting warming to 1.5° (2.7°F), and that the increase in earth's temperature is likely to reach 1.5°C between 2030 and 2052.[2] According to the U.S. Environmental Protection Agency, Maryland has already warmed about 1°C (1.8°F).[3]

The State has passed legislation to decarbonize 50% of its electric sector by 2030, and proposals are in the works to increase that to 100% by 2040.[4] How can Frederick County contribute to decarbonizing Maryland, in time?

1 Carbon neutrality, or having a net-zero carbon footprint, refers to achieving net-zero carbon dioxide emissions by balancing carbon emissions with carbon removal, often through carbon offsetting or simply eliminating carbon emissions altogether. Wikipedia.org

2 IPCC, 2018: Summary for Policymakers. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty* [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press.

3 What Climate Change Means for Maryland, U.S. Environmental Protection Agency, EPA 430-F-16-022, August, 2016

4 Clean Energy Jobs Act, Maryland Senate Bill 516, May 25, 2019

Units of Power and Energy. For the purposes of this paper, all energy usage, including gasoline, natural gas, diesel, heating oil, as well as electricity, is expressed in terms of watts (W) or watt-hours (Wh). A *watt* is the rate at which *power* is generated or used. *Energy* is the power multiplied by the time period, and is typically expressed as kilowatt-hours (kWh). Larger amounts of energy are expressed as kilowatts (kW-- a thousand watts), megawatts (MW-- a million watts), gigawatts (GW-- a billion watts), or terawatts (TW-- a trillion watts).

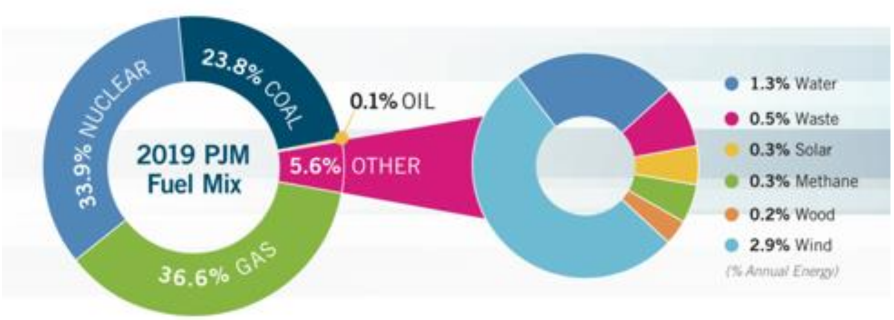
Both measures are important for understanding the energy system. Measuring power at any given moment is essential for keeping the demands on the energy system within its capacity, so that the required rate of usage is not greater than the rate at which power is being delivered. Measuring total energy is useful to help quantify total usage, in order to manage energy use over a time period. For example, the capacity of a power plant is measured in kW, while monthly household energy bills are measured in kWh. Similarly, peak energy consumption at a given time is measured in kW, while battery storage, or how long a battery holds a charge, is measured in kWh.

Data reporting. Data are reported in this paper for three sectors: 1) Electricity; 2) Residential, Commercial, Industrial/Agriculture; and 3) Transportation. This is consistent with the method used by the United States Energy Information Administration, the source of most of the data in this paper.

Framework for Understanding Energy in Maryland

Before we discuss energy use in Frederick County, we will consider Maryland as a whole. Maryland's energy consumption is about 385 terawatt hours (TWh/year, of which Frederick County's estimated consumption is 16.3 TWh/year **(See Appendix I, Tables 1 and 2).** Maryland consumes more than five times as much energy as it produces.[5]

The State is part of the PJM[6] regional electric transmission system or grid that coordinates the movement of electricity in all or parts of 13 states and the District of Columbia. PJM delivers electricity generated by power plants that use nuclear, coal, gas, and hydroelectric, as well as by renewables such as wind and solar, to the power grid, and controls and protects the flow of electricity that sustains the grid. Gas and nuclear power plants provide just over 70% of the energy in the PJM. PJM's 2019 fuel mix is shown in detail below:[7]



[5] U.S. Energy Information Administration, Maryland Profile. Updated September 2019. Web. https://www.eia.gov/state/?sid=MD
[6] The name PJM is a holdover from its founding. Original members were Pennsylvania, New Jersey, and Maryland.
[7] PJM 2019 Annual Report, p.17 https://www.pjm.com/about-pjm/who-we-are/annual-report.aspx

Energy Efficiency. It takes energy to produce energy. Coal and oil must be extracted from the ground, refined, and shipped long-distance in order to power electric generating plants and vehicles or to supply heat to buildings. Converting sunlight into electricity requires the manufacturing of solar panels. Internal combustion engines consume gasoline or diesel fuel to power vehicles. These are examples of **input** energies. **Input** energy is the energy required to produce what end users consume; what end users consume is called **output** energy. The combination of input and output energies is referred to as **end-to-end**.

Energy efficiency can be expressed as a percentage determined by dividing the output energy by the input energy. It is difficult to generalize about the efficiency of electric power plants or vehicles, because their efficiencies vary depending on the fuel used to create the electricity or the mechanics of the power plant, or a vehicle's weight, air resistance or type of engine.

Sources of energy vary widely in their efficiencies. In the examples that follow, only input energy that occurs in Maryland is considered.

In producing electricity:

- Calvert Cliffs nuclear power plant produces electricity with 33% efficiency; 67% of the energy produced is released as heat[8];
- Hydroelectric plants, such as the Conowingo Dam, can be up to 95% efficient[9];
- Wind turbines capture and convert to electricity about 50% of the wind energy that hits the blades[10];
- Solar photovoltaic (PV) panels capture and convert to electric energy 15% to 20% of the solar energy that hits the surface[11].

In heating and cooling:

- Depending on design, age, and fuel, heating furnaces transfer 60-98% of the generated heat to a building[12];
- Solar thermal (solar hot water and heat pipes) is 60-70% efficient, and are more efficient at producing heat from solar energy than PV panels are at producing electricity;
- Focused solar to heat molten salt generators (not to be confused with molten salt nuclear reactors) may be limited in efficiency at 30-50%[13], but they come with their own overnight storage;
- Geothermal energy uses 1 unit of electricity and 4 units of "free energy" extracted from the ground to generate 5 units of energy for the building, an efficiency of 400%.[14]

8 Energy Education, Nuclear Power Plant, University of Calgary. Web. 5 April 2019 https://energyeducation.ca/encyclopedia/Nuclear_power_plant

9 "Energy Efficiency." Electropedia - Battery and Energy Technologies. Web. 5 April 2019. https://www.mpoweruk.com/energy_efficiency.htm#comparison

10 "Wind Turbine- Efficiency." Wikipedia. Web. 5 April 2019. https://en.wikipedia.org/wiki/Wind_turbine#Efficiency

11 "Solar cell efficiency." Wikipedia. Web. 5 April 2019. https://en.wikipedia.org/wiki/Solar_cell_efficiency

12 Furnaces and Boilers. U.S. Department of Energy https://www.energy.gov/energysaver/home-heating-systems/furnaces-and-boilers. 2 Feb 2019

13 https://en.wikipedia.org/wiki/Solar_thermal_energy#Low-temperature_solar_heating_and_cooling_systems. Web. 11/16/19

14 "Energy Environmental – How is efficiency measured?" Energyhomes.org/renewable-technology/geoefficiency.html. 11 Feb 2019.

In transportation:

- Gasoline and diesel engines transfer only about 20% of their fuel energy to the wheels—most of the rest is dissipated as heat[15];
- Electric vehicles transfer over 77% of the electric energy (used to charge their batteries) to the wheels. [16]

Regional Greenhouse Gas Initiative. Maryland belongs to the Regional Greenhouse Gas Initiative (RGGI), a cooperative effort among the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont, and Virginia[17] to cap and reduce CO_2 emissions from the power sector. The emissions cap becomes stricter over time. Within the RGGI states, fossil-fuel-fired electric power generators with a capacity of 25 megawatts (MW) or greater are required to hold "allowances" equal to their CO_2 emissions over a 3-year period. An "allowance" represents a limited authorization to emit one short ton (2000 lbs.) of CO_2. "Allowances" are issued by the individual member states and are purchased by regulated power plants to demonstrate compliance with the cap. As emissions caps are reduced, the cost of allowances rises, and provides an increasing incentive to provide non-carbon power. They can be used to demonstrate compliance in any state and are traded in regional auctions or through secondary markets. States can invest the proceeds from these auctions in consumer benefit programs to improve energy efficiency.[18] In Maryland, the proceeds go to the state's Strategic Energy Investment Fund.

Renewable Portfolio Standard. In 2004, Maryland's legislature enacted a Renewable Portfolio Standard (RPS), a regulation that requires electricity suppliers to meet a prescribed minimum portion of their retail electricity sales with various renewable energy sources, which have been classified within the RPS Statute as Tier 1 and Tier 2 renewable sources. The program is implemented through the creation, sale and transfer of Renewable Energy Credits (RECs). Tier 1 sources include Solar, Wind, Qualifying Biomass, Methane from a Landfill or Wastewater Treatment Plant, Geothermal, Ocean, Fuel Cell that produces electricity from a Tier 1 source, Hydroelectric Power Plants of less than 30 MW capacity, Poultry Litter-to-Energy, Waste-to-Energy, and Refuse-Derived Fuel. Tier 2 includes hydroelectric power other than pump storage generation.[19]

Renewable Energy Credits or Certificates. When a renewable energy generator -- a wind farm or solar power plant, for example -- generates a megawatt-hour (MWh) of energy, it creates two sources of value: 1) electricity, which it can sell at prevailing market rates, and 2) a Renewable Energy Credit (REC), a certificate recognizing under federal law that it generated one MWh of electricity from clean sources, which it can also sell. RGGI utilities, for example, can buy RECs to comply with the RPS. RECs can be generated from the following renewable energy sources: wind, solar, moving water (hydropower), organic plant and waste material (biomass), and the earth's heat (geothermal).[20]

15 "Where the Energy Goes: Gasoline Vehicles." U.S. Department of Energy. Fueleconomy.gov http://www.fueleconomy.gov/feg/atv.shtml. Web. 10 April 2019

16 All-Electric Vehicles. U.S. Department of Energy. www.fueleconomy.gov, Web. 6.11.20.

17 As of Spring 2020, Virginia is in the process of rejoining RGGI.

18 Elements of RGGI. The Regional Greenhouse Gas Initiative. https://www.rggi.org/program-overview-and-design/elements Web. 4/28/2020

19 Maryland Renewable Energy Portfolio Standard Program—Frequently Asked Questions. Maryland Public Service Commission. Web. 6.8.20 https://wwpsc.state.md.us/electricity/maryland-renewable-energy-portfolio-standard-program-frequently-asked-questions/

20 Renewable Energy Credits (RECs). Energysage. www.energysage.com Web. 4/28/2020

Clean Energy Jobs Act. In 2019, the Maryland legislature passed the Clean Energy Jobs Act, which became effective January 1, 2020.[21] Under the legislation, the state's RPS increases to 50% by 2030; 14.5% of the energy must come from solar. It calls for a cost/benefit assessment of increasing the RPS to a goal of 100% clean electricity by 2040. There are incentives for 1,200 MW of offshore wind. It also requires a "study of nuclear energy and its role as a renewable or clean energy source that can effectively combat climate change in the State".[22] That study, *Nuclear Power in Maryland: Status and Prospects*[23], was conducted by Maryland Department of Natural Resources Power Plant Research Program and completed in January, 2020.

Framework for Understanding Energy in Frederick County

Energy conservation. Conservation can be a quick and long-lasting contribution to achieving net-zero emissions. Many of the most effective actions are low-cost and in the direct control of consumers, so no legislative action is necessary.

Office of Sustainability and Environmental Resources. In a June 23rd, 2020 presentation[24] to the Frederick County Council, Office of Sustainability and Environmental Resources (OSER) Director Shannon Moore identified climate change actions to date. Highlights include conservation programs, as well as the purchase of electric buses for the TransIt fleet and installing a 1MW solar array at the Ballenger-McKinney Waste Water Treatment Plant, with on-site battery storage. (**Appendix IV)**

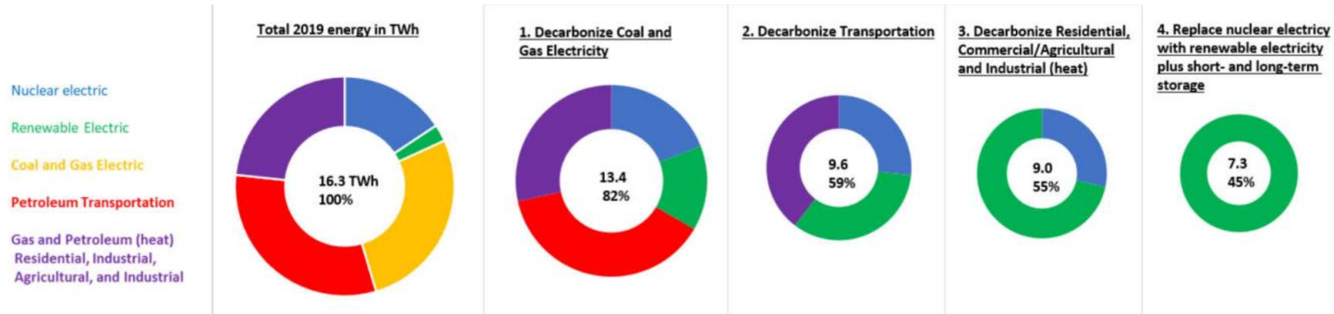
Livable Frederick. The Livable Frederick Master Plan[25], adopted in September 2019, is a comprehensive plan that reflects the community's vision for how and where to grow. It calls for achieving a zero-carbon footprint by 2040 and includes a goal of "leading in the use of clean energy sources, such as solar, wind, geothermal, biofuels and hydropower." Three initiatives under the goal are: 1. Strive to be greenhouse gas neutral in energy production and consumption; 2. Strive for energy independence and security in Frederick County; and 3. Transition to a cleaner and more efficient transportation system, with electric vehicle (EV) readiness and accommodation of autonomous vehicles incorporated into public and private projects. There are numerous supporting initiatives under these three primary initiatives (**Appendix II**).

Energy Generation and Consumption in Frederick County. It is important to separate energy generation from energy consumption in the county. Only solar electric energy is generated (wind generation is negligible) and it amounts to a mere fraction of what is consumed in all three sectors. If the County were to generate electricity to offset its current electricity consumption of 2.5 TWh/yr (**Appendix I, Table 2**) through solar arrays alone, a reasonable estimate of the surface area required for siting them would be about 14 square miles. If all sectors were electrified by 2050, the County would require an estimated 10.0 TWh/yr, about 55 square miles, 8% of its land area (**Appendix III**).

With current technology, it is not practical to become renewable energy independent. A more reasonable scenario would be a combination of in-county generated solar power and carbon-free power imported

21 *Clean Energy Jobs*. Maryland General Assembly – Legislature, 2019 Regular Session – Senate Bill 516 Chapter http://mgaleg.maryland.gov/2019RS/Chapters_noln/CH_757_sb0516e.pdf Web. 5.22.20
22 Ibid. p.43
23 Power Plant Research Program, Maryland Dept. of Natural Resources, *Nuclear Power in Maryland: Status and Propects*. PPRP-NP-2020, DNR Publication No. 12-011620-203. Web. 5.22.20 https://dnr.maryland.gov/pprp/Documents/NuclearPowerinMaryland_Status-and-Prospects.pdf
24 Moore, Shannon. "Climate Change: Baseline, Goals, Regional Coordination, and Frederick County Plans and Actions to Date." Slide presentation 6.23.20 https://frederickcountymd.gov/DocumentCenter/View/326825/ClimateChange-WF
25 Frederick County, MD. The Livable Frederick Master Plan, 2019. https://www.livablefrederick.org/

from the PJM system. The graphic below illustrates how the 2019 fuel mix for total power needs in Frederick County of 16.3 TWh can be reduced over time through energy efficiency measures and a practical deployment of gridded solar arrays.



An estimation of the yearly per capita cost of electricity if all sectors were electric is revealing. Consider how much every person in Frederick County currently spends each year for gasoline, heating oil, electricity and any other form of power. **Appendix I**, **Table 3** shows calculations based on today's cost for the three sectors that, when projected through 2050, yield an estimated per capita cost of $3,116.00 or about $260 per month. This cost reflects a total projected population of 362,000 and a single monthly amount for electricity that would include the Transportation, and Residential, Commercial, Industrial/Agriculture sectors.

ELECTRICITY SECTOR

Maryland's total consumption of energy is about 441 TWh/year, of which electricity consumption is about 59 TWh/year. If Maryland were to electrify Residential, Commercial, Industrial/Agriculture and Transportation consumption, it would require 167 TWh/year, or about three times more electric energy than is currently consumed. Frederick county's current electricity consumption is 2.5 TWh/year. If the County's total current energy consumption were electrified, it would require 7.1 TWh, also about three times more electric energy than is currently consumed. By 2050, based on population projections alone, it would take 15% more electricity to power the State (193 TWh/year) and 40% more electricity to power the County (10.0 TWh/year). In both cases, however, that is only about half of the total input energy used today -- 441 TWh/year State and 18.7 TWh/year County. (**Appendix I**).

Nuclear and Renewable Power. Given the urgency of reducing atmospheric greenhouse gases in order to remain below 2°C, consider that nuclear generated electricity emits no greenhouse gases and, for now at least, may be part of the solution. Nuclear power provides constant reliable baseload power to the grid, while renewables like solar and wind provide power intermittently. Innovations in both technologies are advancing rapidly. Reliable battery storage capability is the leading edge of innovation in solar and wind technology. Tesla built a 100MW/129MWh battery that was switched on in Australia in November of 2017. Manufacturing costs are falling. Enhancements to the power grid could allow electric vehicle batteries to store excess solar and wind production once Vehicle-to-Grid[26] technologies mature and become available. Nuclear power is undergoing significant transformation, with the development of Generation IV nuclear reactors. Using various technologies, these reactors are generally smaller than existing plants and modular in design, allowing parts to be constructed in a factory and safely transported to remote locations for assembly. They are safer than existing nuclear plants, have passive emergency shut down and cooling, and a few designs have the ability to generate additional fuel and even burn the waste from plants already in operation. Although all nuclear power plants require large exclusion zones (land areas on which public access is forbidden), it is likely that some of that area could be used for the installation of large solar generating systems.

Community Choice Energy. State legislation introduced but not finalized during the 2020 Session authorized a pilot program to be carried out in Montgomery County, whereby the county could become an aggregator and purchase electricity on behalf of its electric customers. The Community Choice Energy (CCE) Pilot Program[27] envisioned in the bill would allow Montgomery County to use its aggregated purchasing power to realize a lower cost per kWh and offset its electricity use with carbon and greenhouse gas-free energy sources. If enough counties enacted such programs, customer demand could force a faster transition to renewable and carbon-free power generation. If similar legislation is passed in an upcoming Legislative Session, and Montgomery County initiates a pilot program, Frederick County could learn more and determine the viability of following suit by requesting the opportunity to closely observe their planning and deliberations. (**Appendix V**)

In the near term, Frederick County electricity customers could more easily and readily switch to renewable power if they understood the various purchasing options. We recommend a public education program that points out contractual obligations and the pros and cons of the following options:

Community Solar. Maryland has authorized the construction of Community Solar systems. In these projects, an organization builds a large solar array and leases a portion to utility customers who cannot, or choose not to, have an on-site system, such as renters or those who live where there is little direct sun available. The electric utility then credits the monthly electric bill of each leaseholder with the amount of electricity generated in his or her share of the community solar system, the same as would have occurred if that portion of the system had been installed on the leaseholder's own property.

Solar Co-op. A co-op enrolls a group of neighbors as members, who work with community partners to install solar electric systems together. By using the bulk buying power of the group, each participant saves on the cost of his or her system.

Renewable Energy Choice through the Public Service Commission. Retail energy suppliers sell directly to customers, using the local utility's distribution system to deliver electricity. Electricity customers can purchase renewable energy through the Public Service Commission website. Click on "Shop for Electricity."

Solar Panel System for Homeowners. Homeowners either buy or lease solar panels installed on their properties by solar companies, and receive the electricity that they generate directly into their homes. In grid-tied systems, excess power generated is fed back to the grid. RECs are available to system owners.

26 "Vehicle to Grid (V2G) Technology." Institute of Electrical and Electronic Engineers, Web access 8.11.2020, https://innovationatwork.ieee.org/vehicle-to-grid-v2g-technology/

27 Maryland General Assembly House Bill 561Electric Industry-Community Choice Energy-Pilot Program. Sponsor Delegate Lorig Charkoudian. Web. 5.22.20 http://mgaleg.maryland.gov/2020RS/bills/hb/hb0561t.pdf

Property Assessed Clean Energy. PACE is a mechanism for financing various clean energy, efficiency, and other property enhancements such as solar panels, insulation, cool roofs and LED lighting. It is a low-interest loan that is repaid through a property tax surcharge. Frederick County recently set up a PACE program for commercial businesses.

RESIDENTIAL, COMMERCIAL, INDUSTRIAL/AGRICULTURAL SECTOR

In Maryland, this sector consumes 90 TWh/year in non-electric energy (e.g. fuel oil, natural gas) to cook, enjoy gas fireplaces, provide heat for buildings, and manufacture concrete, asphalt, and fertilizer. In the County, it is estimated that 3.8 TWh/year of non-electric energy are consumed. For a typical residential building, fossil fuels can account for 50-75% of building energy use and emissions, according to the Building Electrification Initiative.

The key to reducing greenhouse gas (GHG) emissions in this sector involves replacing on-site fossil fuel generated power with equipment powered by electricity.[28] For example, heat pumps are increasing in efficiency and can now replace both space heating and space cooling equipment powered by oil and gas. This is an area in which market preferences can slow the transition; in a recent webinar[29] sponsored by Arlington, VA, Kenny Hewitt, Construction Manager of the Shooshan Company reported that residential condominium customers prefer gas stoves and fireplaces.

Energy conservation and efficiency practices reduce greenhouse gas emissions. Examples include replacing lighting fixtures with LEDs that use less power and installing occupancy sensors that shut off lights and equipment when rooms are unoccupied, as well as variable speed drives (VSDs) that control motors or pumps such that they run at full speed, only when needed. (See **Appendix VI**, for more.)

The Frederick County OSER offers homeowners the online Green Homes Challenge, which informs homeowners of environmentally friendly and energy conservation practices, encouraging them to implement these practices using a competitive award. OSER also administers a Maryland Clean Energy Communities grant for a household Power Saver Retrofits program. This program helps income-qualifying households to retrofit dwellings with energy efficient window coverings, etc. The County lists the following resources for home energy efficiency improvements:

- Maryland Energy Administration. MEA provides funding and resources that help Maryland residents save money while making smart energy-saving choices.[30]
- Maryland Clean Energy Center. Catalogs programs and incentives for homeowners, businesses, solar installers, and more.[31]

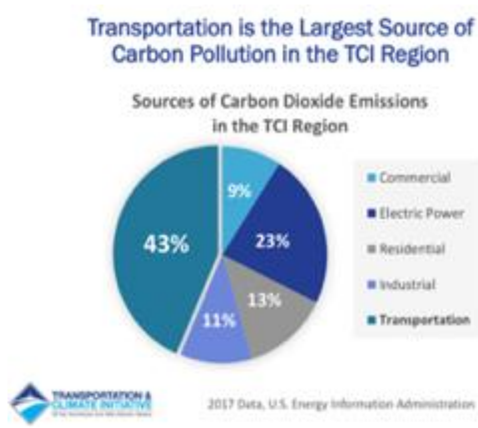
In 2007, the State formed the Maryland Green Building Council and the High Performance Green Building Program to address issues associated with energy efficiency, sustainable materials and technologies, water efficiency, toxin reduction, and smart growth/sustainable development in State-

28 Building Electrification Initiative. https://www.beicities.org/about. Web. 7.22.20
29 Arlington, Virginia Office of Sustainability and Environmental Management, Pathway to Zero Carbon Energy Education Series, "To Electrify or Not to Electrify,,,?" May 1, 2020. https://register.gotowebinar.com/recording/1861747370836012303
30 "Energy Incentives," Maryland Energy Administration. https://energy.maryland.gov/Pages/default.aspx Web 7.11.20
31 "What does MCEC do?," Maryland Clean Energy Center. https://www.mdcleanenergy.org/ Web. 7.11.20

funded building construction projects and public school projects. The program requires the use of one of three green building certification or rating programs: 1) Leadership in Energy and Environmental Design (LEED); 2) International Green Construction Code (IgCC); or 3) Green Globes assessment protocol of the Green Building Initiative. Frederick County built the Brunswick Library to LEED standards in 2011. We recommend forming a local Green Building Council to advise on building codes and facilitate a faster transition to green building construction across the county, in public as well as privately funded construction.

TRANSPORTATION SECTOR

Transportation. Maryland transportation energy consumption is 121 TWh/year, mostly from internal combustion engines. Due to the inefficiencies of these engines, only about 24 TWh/year, or 20%, make the wheels turn in vehicles. In the County, transportation consumes 5.1 TWh/year of non-electric energy; only about 1.0 TWh/year actually drives vehicles.



This chart from the Transportation Climate Initiative (TCI)[32] shows carbon pollution by source in the TCI region, which covers 12 Northeast and Mid-Atlantic states, including Maryland, and the District of Columbia. In this region, 43% of CO_2 emissions are from transportation. TCI is a proposed regional collaborative effort directed by agencies within each member state. It supports the deployment of clean vehicles and fueling infrastructure through a cap-and-invest approach similar to the Regional Greenhouse Gas Initiative. Gasoline and diesel wholesale fuel suppliers and others who bring fossil fuels into the regional distribution system would be treated as emitters and required to obtain allowances to emit a certain amount of carbon. The number of available allowances would be gradually reduced, giving emitters time to find the cheapest market-based solutions for decreasing their emissions and therefore need to buy allowances. The timetable for signing a Memorandum of Understanding (MOU) is the fall of 2020. The Mitigation Work Group of the Maryland Commission on Climate Change prioritizes the review of all proposed transportation measures, including the TCI.

Maryland is also a member of the Multi-state Zero Emission Vehicle (ZEV) Task Force, through which the governors of 10 states (Maryland, California, Connecticut, Massachusetts, Maine, New Jersey, New York, Oregon, Rhode Island, Vermont) have committed to seeing 3.3 million ZEVs on the road by 2025.[33] In November of 2019, these governors signed a MOU[34] committing to coordinated action to ensure the successful implementation of their state zero-emission vehicle (ZEV) programs. It should be

32 "Transportation is the Largest Source of Carbon Pollution in the TCI region" Transportation and Climate Initiative webinar slides, 12/17/2019
https://www.transportationandclimate.org/sites/default/files/TCI%20Public%20Webinar%20Slides_20191217.pdf
33 About the Zev Task Force. Multi-state ZEV Task Force, Web 6.12.20 https://www.zevstates.us/about-us/
34 State Zero-Emmissions Vehicle Programs Memorandum of Understanding. Web. 7.24.20
file:///Users/1ceramicat/Downloads/zev-mou-10-governors-signed-20191120.pdf

noted that the Maryland Department of the Environment website lists incentives for electric vehicle purchases.[35]

While electric vehicles can have a measurable impact on reaching zero carbon emissions by 2050, their perceived high up-front cost can be a barrier, when compared to internal combustion engine vehicles. Over the life of the vehicle, however, the cost of ownership is less, due to the lower cost of electricity versus gasoline and maintenance cost of gasoline powered vehicles. Electric vehicles (EVs) are also much more efficient than internal combustion engines; compare the 77% energy efficiency of EVs to the 20% efficiency of gasoline and diesel powered engines.

In January 2019, the Maryland Public Service Commission (PSC) approved a pilot program proposed by four of the state's largest utilities to deploy more than 5,000 charging stations in the service territories of Baltimore Gas and Electric Company, Delmarva Power and Light Company, Potomac Edison and Potomac Electric Power Company. Maryland's goal is to have 300,000 zero-emission electric vehicles on its roadways by 2025. According to a PSC press release, utilities may recover part of the cost of this infrastructure program through ratepayer bills, subject to comprehensive review.[36]

Locally, a Green Building Council could encourage EV charging by requiring some combination of EV-ready infrastructure such as pre-wiring, or added breaker space, and some minimum number of charging spaces for commercial buildings. Requiring new residential construction to include EV charging infrastructure would also support the transition to electrified transportation. We recommend the creation of a local Green Building Council.

According to 2018 statistics from the Department of Labor, Licensing, and Regulation, nearly 24% of Frederick County residents work in Montgomery County, while 2.7 % work in the District of Columbia.[37] Convenient and affordable public transportation that allows travel around Frederick and to the Montgomery County/Washington, D.C. area can cut GHG emissions generated by commuter traffic and allow shorter commutes, particularly if powered by carbon-free electricity generation. Frederick County is a member of the Metropolitan Washington Council of Governments (COG). Frederick City Alderman Kelly Russell chairs the COG Transportation Planning Board (TPB), which is tasked with implementing a federally mandated, long-range transportation plan for the National Capital Region. Called Visualize2045, the plan includes a Maryland Department of Transportation "Traffic Relief Plan," which will add two new toll lanes in each direction on I-270. Developments and public hearings on this plan bear monitoring, as there are competing proposals. Advocacy groups such as Trains Not Tolls[38] want all-day MARC service and Montgomery County businessman Robert Eisinger's High Road Foundation[39] seeks a monorail along I-270. Bus Rapid Transit creates express routes between key destinations, for instance, between Urbana and the Shady Grove Metro Station. All are worthy of consideration.

Frederick County is electrifying its bus transit fleet and has begun to electrify its government vehicle fleet. Transitioning the school bus fleet to electric would be a worthy next step, as pollution from diesel buses is especially harmful to children. Climate Mayors, a peer-to-peer bipartisan network of US mayors,

[35] Zero Emission Vehicles, Maryland Dept. of the Environment Web 6.12.20 https://mde.maryland.gov/utility/404.aspx?oldUrl=https%3A%2F%2Fmde%2Emaryland%2Egov%2Fprograms%2FAir%2FMobileSources%2FPages%2FZEV%2Easpx%2520Web%25206%2E12&k=ZEV.aspx%20Web%206.12

[36] "Maryland PSC Approves Modified Utility Electric Vehicle Portfolio." Maryland Public Service Commission press release dated 1/14/2019. Web 7.25.20 https://www.psc.state.md.us/wp-content/uploads/MD-PSC-Approves-Modified-Utility-EV-Charging-Portfolio_01142019-1.pdf

[37] Marshall, Ryan. "I-270 work expected to finish by end of year." Frederick News Post article, p. A5, July 24, 2020.

[38] Trains not Tolls. Facebook page. Web 6.12.20 https://www.facebook.com/TrainsnotTolls/

[39] High Road Foundation. Web 6.12.20 https://www.thehighroadfoundation.org/

has established the Climate Mayors Electric Vehicle Purchasing Collaborative,[40] which offers member municipalities a way to reduce the price of electric vehicles by purchasing collaboratively.

A barrier to electrifying transportation is the need to educate people about options that are new and different. Electric car drivers' education classes may help penetrate the market for electric vehicles.

The zero-carbon goals of electrifying transportation are enhanced by minimizing the need to commute to work or drive to shops and stores. Livable Frederick (p. 47) discusses district retrofitting that could include bikeability, with more opportunities to walk, shop, work and recreate closer to home. Teleworking has become more accepted, as people adapt to the Covid-19 pandemic. Developing a robust broadband infrastructure would improve internet access and allow more people to work from home.

ENERGY SECURITY FOR FREDERICK COUNTY

The International Energy Agency defines energy security as the uninterrupted availability of energy sources at an affordable price. In the United States the responsibility for insuring a reliable electrical system depends on the voltage level of electricity being transmitted. Transmission power is power carried on transmission lines at 100,000 volts and above. Utilities that operate transmission power are legally mandated to operate as prescribed in Reliability Standards by the North American Electric Reliability Corporation and as overseen by the Federal Energy Regulatory Commission.
Power transmitted below the 100,000-volt threshold is called distribution power. This is the power that is ultimately stepped down to levels useable by residential and commercial buildings. Utilities that operate distribution power are overseen by state public service commissions, which are tasked with ensuring that the utilities operate reliably. Power companies are required to create redundancy in their distribution networks so that if a distribution line goes down, electricity can be rerouted to supply customers.

There is also the issue of resiliency should the source of power fail, and that is usually provided by micro-grids. Localized, small scale microgrids, combining distribution and multiple generators, are seen as a key element of the "smart grid,"[41] an electricity supply network that uses digital communication technology to detect and react to local changes in usage. It improves energy efficiency through automation. As the grid becomes more automated, with sensors that can often predict a failure before it occurs, a network of microgrids that can be automatically disconnected, or "islanded," from the main grid will help prevent a widespread failure. There are numerous demonstration projects in which solar power and battery storage are being used to provide emergency power within microgrids during a failure.[42,43] Additionally, excess energy, when it exists, can be used to remove CO_2 from the atmosphere, charge electric cars or make carbon neutral fuels.

40 "What is the Collaborative?. Climate Mayors. Web 6.12.20 https://driveevfleets.org/what-is-the-collaborative/
41 What is the Smart Grid? U.S. Department of Energy. 6 Feb 2019 https://www.smartgrid.gov/the_smart_grid/
42 About Microgrids. Microgrids at Berkeley Lab. https://building-microgrid.lbl.gov/about-microgrids 5 Feb 2019
43 Distributed Generation. Wikipedia. https://en.wikipedia.org/wiki/Distributed_generation 5 Feb 2019

RECOMMENDATIONS

1. Request that the Frederick County delegation support the Community Choice Energy Pilot Program when it is reintroduced. If the bill is passed and Montgomery County initiates a pilot program, encourage County government to request permission to have a close presence in the program's planning and deliberations. This would benefit the Frederick County delegation should the County wish to follow suit.

2. Design and implement a renewable energy consumer education program. Competition among solar electricity providers may create opportunities for consumers, but it does nothing to educate them about various options to purchase renewable power. Define the options, describe how they work, untangle industry buzz words so that pricing can be understood. These options include Community Solar, solar co-ops, renewable energy choice through the Public Service Commission, home solar system installation and the Property Assessed Clean Energy (PACE) program for businesses.

3. Establish a Frederick County Green Building Council to advocate and develop incentives for: accelerating the adoption of more energy efficiency and conservation in building systems retrofits or new construction; installing carbon-free sources of electricity to reduce reliance on carbon-generated electricity from the PJM grid; incorporating charging stations for electric vehicles when planning new developments and advocating for smart growth that minimizes the human footprint, while creating walkable neighborhoods that reduce the need for driving.

4. Explore incentives to support telework and broadband access. From an emissions perspective, teleworking is even better than using electric transportation. Not only does this reduce emissions, it also reduces road congestion and wear. The county should support and encourage telework options for county residents. It should work to ensure that all areas of the county have good broadband Internet access.

5. Monitor the public discussion of Phase 1 and Phase 2 plans for the I-270 corridor, in particular as they relate to increasing the availability of MARC trains, Bus Rapid Transit and other intra-county public transit options.

6. Assess and take advantage of State and regional programs for opportunities to advance the deployment of electric vehicles, as well as the installation of a more robust charging station network. For example, the Maryland Commission on Climate Change Mitigation Work Group reviews all proposed transportation measures, including the TCI. The Multi-state Zero Emission Vehicle (ZEV) Task Force is committed to seeing 3.3 million ZEVs on the road by 2025. The Maryland PSC approved a pilot program proposed by four of the state's largest utilities to deploy more than 5,000 charging stations in the service territories of Baltimore Gas and Electric Company, Delmarva Power and Light Company, Potomac Edison and Potomac Electric Power Company. Tax credits and rebate programs at the state and federal level are also available to incentivize the transition to zero emission vehicles.

7. Encourage Frederick County to electrify its school bus fleet in addition to its public Transit fleet and county vehicle fleet.

8. Encourage electric vehicle drivers' education.

9. Conduct a County-wide assessment of the use and siting of microgrids, as a way not only to increase energy security in Frederick County, but also to provide carbon free energy and store excess power.

Energy Generation and Consumption in Maryland and Frederick County, and Cost per TWh, including projections to 2050

Energy Efficiency. It takes energy to produce energy. Coal and oil must be extracted from the ground, refined, and shipped long-distance in order to power electric generating plants and vehicles or to supply heat to buildings. Converting sunlight into electricity requires the manufacturing of solar panels. Internal combustion engines consume gasoline or diesel fuel to power vehicles. These are examples of **input** energies. **Input** energy is the energy required to produce what end users consume; what end users consume is called **output** energy. The combination of input and output energies is referred to as **end-to-end**.

Table 1. Maryland's Total Energy Consumption (in TWh/year)

Sectors	A. Input energy (estimated share of US total)[44]	B. Input energy (estimated total energy[45] consumed)	C. Useful output energy & efficiency (%) needed	D. Electric energy & efficiency (%) needed to produce C if all sectors were electric	E. Estimated non-carbon electric energy needed to power all sectors electrically in 2050
Electric	**200**	**174**	**59* (34%)**	**59**	**68**
Residential, Industrial, Commercial/Agriculture	**103**	**90**	**76 (85%)**	**76 (100%)**	**88**
Transportation	**138**	**121***	**24 (20%)***	**31 (77%)**	**36**
Total	**441**	**385***	**160**	**167**	**193**

*MD numbers reported by the US Energy Information Administration. Other numbers are estimated. Totals may not equal the sum of displayed figures due to rounding errors.

Notes for Table 1:

A. Estimates of the total (end-to-end) energy needed to extract, refine, and deliver fuels to MD, plus the energy released when these fuels are consumed in MD.

B. Estimates of the energy consumed in Maryland
   1. The transportation sector consumed about 121 TWh of mainly petroleum fuels
   2. The estimated energy it takes to generate the electricity consumed in MD, based on an estimated average power plant efficiency of 34%.
   3. The estimated fossil fuel heat consumed by the additional three sectors, by calculation.
   4. The total energy consumed in MD.

C. Estimates of the energy to satisfy the needs of each sector
   1. Based on US Dept. of Energy figures for the efficiency (tank to wheels) of gasoline & diesel vehicles[46]
   2. EIA published electricity consumption in MD.
   3. Based on an estimated efficiency of fossil fuel furnaces, stoves, and manufacturing processes

D. Estimates of the amount of electrical energy it would take to supply amounts in column C
   1. Based on US Dept of Energy figures for the efficiency (grid to wheels) of electric vehicles
   2. Electricity to electricity, no conversion factor needed
   3. Based on an estimated efficiency of electric furnaces, stoves, heat pumps,[47] and manufacturing processes

E. Estimates of the electric energy that will be needed for all-electric sectors by 2050, based on the estimates in column D. Assumes the population increases by the predicted 40% (between 2020 & 2050) and efficiency ratings and behavior patterns do not change in the next 30 years.[48]

[44] Jacobson, Mark Z., et al. "100% Clean and Renewable Wind, Water, and Sunlight All-Sector Energy Roadmaps for 139 Countries of the World," Joule Magazine Aug 23, 2017. Web June 11, 2020. https://www.cell.com/joule/fulltext/S2542-4351(17)30012-0

[45] U.S. Energy Information Administration. https://www.eia.gov/state/data.php?sid=MD. Web. 28 January 2019

[46] "All-Electric Vehicles." U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy https://www.fueleconomy.gov/feg/evtech.shtml Web. 6.11.20

[47] "Heat Pumps Buying Guide." Consumer Reports. Web. 6.11.20 https://www.consumerreports.org/cro/heat-pumps/buying-guide/index.htm

[48] "Public School Enrollment Projections," Projections to 2045, Population Projections spreadsheet, Maryland State Data Center. https://planning.maryland.gov/MSDC/Pages/s3_projection.aspx Web 6.11.20. Frederick County's 2020 population is 260,800. The projected population for 2045 is 344,150, a growth rate of 1.1%/year. Projecting out to the year 2050, these figures result in an estimated 2050 population of 363,500, an increase of 102,700 people or about 40%.

Table 2. Frederick County's Total Energy Consumption (in TWh/year)

Sectors	A. Input energy (estimate of Frederick Co. share of US total scaled by MD population	B. Input energy (estimate of total energy consumed based on energy MD use[49] scaled by MD population	C. Useful Output energy & efficiency (%) needed	D. Estimated non-carbon electric energy needed to produce amount in column C if all sectors were electric	E. Estimated non-carbon electric energy needed to power all sectors electrically in 2050
Electric	8.5	7.4	2.5 (34%)	2.5	3.6
Residential, Industrial, Commercial/ Agriculture	4.3	3.8	3.2 (85%)	3.2 (100%)	4.6
Transportation	5.9	5.1	1.0	1.3 (77%)	1.9
Total	18.7	16.3	6.8	7.1	10.0

Figures in this table are estimates based on Table 1, scaled by population. The uncertainty of these estimates may be 10 % or greater, depending on the sector.

[49] U.S. Energy Information Administration. Web. 16 Nov 2018. https://www.eia.gov/state/data.php?sid=MD

Table 3. Average Cost per TWh

The following table estimates 2050 yearly per capita costs of electricity, if all sectors were electric. These calculations are based on today's costs. Transportation: $763; Electric: $1,208; Residential, Commercial, Industrial (includes Agriculture): $1,145.

Frederick County's Total Energy Consumption (in TWhr/year)

	Original Table 2 (above)						Financial extensions			
	A	B	C	D E	F	G	H	I	J	K
	Sector	A- Input energy (estimate of Frederick County share of total US snergy, scaled to population)	B Input energy (estimate of total energy consumed in the county, based on energy MD use, scaled by population)	C Useful output (efficiency) needed to supply each sector in the county	D Estimated non-carbon electric energy needed to produce C in 2019, if all sectors were electric	E Estimated non-carbon electric energy needed to power all sectors electrically in 2050	Weighted Average charge per **Kilowatt** Hour (in cents)	Weighted Average charge per **Terawatt** Hour (in dollars)	Estimated Charge	Per Capita
								1,000,000,000		
1	Transportation	5.9	5.1	1.0 (20%)	1.7 (60%)	2.4	$0.1151	$115,100,000	$276,240,000	$763
2	Electric	8.5	7.4	2.7 (36%)	2.7	3.8	$0.1151	$115,100,000	$437,380,000	$1,208
3	Residential, Commercial, Industrial	4.3	3.8	3.2 (85%)	2.6 (126%)	3.6	$0.1151	$115,100,000	$414,360,000	$1,145
4	Total	18.7	16.3	6.9	7.0	9.8			$1,127,980,000	$3,116
5										
6	Estimated population 2050								362,000	
7	Charge per capita								$3,115.97	
8										

	Subcalculation 1 Estimate Weighted Average Charge per KWh					Subcalculation 2 Estimate Capacity Mix for 2050			
10		Capacity					Projected		
11		Percentage	Charge/KWh				2050	%	
12	Solar	71.4%	0.0749	0.0535	pepco green value assurance	Solar	850	71.43%	eia energy outlook 2019
13	Wind	21.8%	0.0769	0.0168	constellation 100% wind	Wind	260	21.85%	projections for 2050
14	Nuclear	6.7%	0.0633	0.0043	current standard pepco rate	Nuclear	80	6.72%	
15	Total	100%		0.0746		Total	1190	100.00%	
16									
17	Adjust for transmission charges, etc.		64.8%	0.1151					

<u>Column H</u> Weighted average retail charge per kilowatt hour (in cents), expressed in current rates. Solar, wind, and nuclear power currently have different market rates. The charge to the county will be a weighted average of the three rates at a projected capacity mix. See subcalculation 1.
<u>Column I</u> Rates per kilowatt hour expressed in the charge per terawatt, by multiplying by one billion.
<u>Column J</u> Column G multiplied by column I
<u>Column K</u> Column J divided by the projected 2050 population of 362,000.
<u>Sub-calculation 1</u> A weighted average retail rate in current dollars. The capacity percentage comes from Sub-calculation 2. The weighted average retail charge of .0746 (line 15 column D) represents approximately two thirds of a typical electric bill. Dividing by 0.648 (line 17 column D) grosses up the generation charge to the full set of charges on a typical bill.
<u>Sub-calculation 2</u> The projected capacity mix for 2050 is derived from various sources. The nuclear capacity total is today's value.

Livable Frederick Energy Initiatives

Goal: Clean Energy – Lead in the use of clean energy sources, such as solar, wind, geothermal, biofuels, and hydropower

Initiative: Carbon Footprint Zero – Strive to become greenhouse gas neutral in energy production and consumption

Supporting Initiatives:

1. Support and promote clean energy initiatives, investment, business, and jobs through tax breaks, rebates, and other programs
2. Promote plans, programs, and initiatives to achieve a reduction in per capita consumption of energy in Frederick County

Initiative: Energy Independence – Strive for energy independence and security in Frederick County

Supporting Initiatives:

1. Develop distributed energy generation
2. Develop electrical grid resiliency
3. Become a net exporter of clean energy
4. Support the creation of localized microgrids
5. Institute energy independence in county facilities by installing solar panels and smart building technology in county buildings, exploring the use of smart lighting for roads and parking lots, and employing best practices for green construction in county buildings.

Initiative: Transportation – Transition to a cleaner and more efficient transportation system, with electric vehicle (EV) readiness and accommodation of autonomous vehicles incorporated into public and private projects.

Supporting Initiatives:

1. Promote the use of multi-modal transportation options such as Autonomous Vehicle (AV) transit and ride sharing choices.
2. Include EV readiness for future charging infrastructure in new development.
3. Develop a new goal to reduce petroleum consumption by Frederick County vehicles.
4. Provide incentives to use EVs and AVs
5. Work with state government to develop a transportation system parallel to the CSX rail line to provide all day service to and from Germantown, Gaithersburg, Rockville and Washington, DC.
6. Provide more transit service throughout the county with regular stops at senior centers, apartment complexes, shopping centers, medical services, and employment centers.
7. Install solar powered charging stations at county-owned parking garages and parking lots.
8. Incentivize development of communities where residents can walk to shops, dental and doctors' offices, and general services.
9. Explore the use of county fleet vehicle systems to optimize routing and reduce fuel consumption.
10. Reduce greenhouse gas emissions tied to roadway congestion by working with regional employers to shorten or eliminate commute times by developing incentives for telecommuting, staggered work schedules, car and van pools, and shuttles for employees.

APPENDIX III

Solar power and land area required to generate present and future County electricity needs:

According to the National Renewable Energy Laboratory, NREL calculator https://pvwatts.nrel.gov/pvwatts.php, one MW of fixed solar panels can generate up to 1422 MWh/year in MD, an annual average of 3.9 MWh/day. The calculator allows the user to customize the panel settings and this example is based on:
DC system size (kW) - 1000 kW (1 MW)
Module type – premium
Array type – fixed (open rack)
System losses – 14.08% (default)
Tilt (deg) – 39 (FC latitude)
Azimuth (deg) – 180 (south).

The current county consumption is about 2.5 TWh/year = 2.5 million MWh/year.
2500000/1422 comes to about 1758 MW of panels.
The number of panels that can be placed on an acre of land depends on the spacing between panels, which is a function of tilt angle and self-shading, accessibility, auxiliary equipment, etc. For this example, we've selected 5 acres/MW. The number of acres needed to offset the current county consumption is simply 1758 x 5 acres = 8790 acres, which at 640 acres/mi^2 comes to almost 14 square miles.

If the County could electrify all sectors, it would require an estimated 10.0 TWh in 2050, based only on an estimated population increase of 40%, that is, without considering improvements in technology, efficiency, and human behavior. That would require about four times more energy and about 55 square miles, or 8% of the County. Some fraction, possibly 10%, of this energy could be provided by roof-mounted panels on residential, commercial/agriculture, and industrial buildings but as much as 50 square miles of land may still be required.

Note: Changing the tilt angle of the panels so that the monthly energy is roughly equal throughout the year would increase the number of panels, spacing, and area required. Reducing the tilt angle would increase the number of panels but reduce the spacing and area required. Changing the array type to 2-axis tracking would generate a third more energy/panel, thereby reducing the number of panels and land area required. Depending on the configuration, technology improvements, and other factors, the future required area estimate of 55 square miles comes with an uncertainty of about ± 20 square miles.

This energy offset would work only if the solar arrays were grid-tied, and the grid accepted all of the generated energy. To ease future interaction with the grid, it is likely that battery storage would be required. At today's installation cost of about $0.7/W, it might cost several billion dollars or more to implement and tie to the grid, not counting the land procurement. Depending on how much storage is added, the cost could double or triple.

Becoming independent of the grid would require short-term storage -- at least several days of battery backup to cover storms or long periods of rain or heavy overcast. It would require even more long-term storage to hold the excess energy generated in the spring and fall and on longer summer days, for use on the shorter winter days, when energy demand is typically higher. The technologies for long-term storage are still under development. Until newer, more efficient storage techniques are developed and brought to scale, becoming solar energy independent is probably not economically or technically feasible.

Frederick County Government Actions to Mitigate Climate Change

Frederick County has accomplished significant reductions in GHG since 2007. On June 23, 2020, Shannon Moore, Director of OSER, gave a presentation to the county councilmembers on "Climate Change Baseline, Goals, Regional Coordination, and Frederick County Plans and Actions to Date." *(Please see presentation for details - https://frederickcountymd.gov/DocumentCenter/View/326825/ClimateChange-WF*
From 2007-2012 GHG emissions were reduced by 10.5%. County building electricity use was stable from FY'12-FY'19 despite an 8% increase in population. As of June 2020, 17% of building electricity use was provided by renewable energy. The greatest reductions were due to initiatives at water delivery facilities and waste water facilities followed by reductions in employee commuting mileage.

Climate Actions

- Electric buses powered by the sun: TransIt has five refurbished electric buses, four new electric buses and two hybrid electric buses.
- EV charging stations: The Department of Fleet Services installed 3 EV charging stations, two of which have dual heads to charge 2 vehicles at a time.
- EV and hybrid cars: The County currently has 5 plug-in hybrid cars and a newly purchased Toyota Prius.
- Solar electric array at Reichs Ford Road Site A Landfill (closed portion): In the summer of 2019, a photovoltaic array generating approximately 3.7 million kWh/year was completed on the closed landfill to supply power to seven large County government buildings and electric buses through virtual net metering with Potomac Edison. The project was coordinated by Office of County Executive.
- Landfill Gas-to-Energy project: From 2009 to 2018, the landfill gas-to-energy facility at the Reichs Ford Road Landfill reduced methane and generated approximately 2 MW of electricity, enough to power 1,200 homes and offset greenhouse gas emissions from fossil fuel plants. The facility ceased operation in June 2018 due to diminished landfill gas.
- Ballenger-McKinney wastewater treatment plant solar array: Projected to go online in Summer 2020, this county-owned project has a 1 MW generation capacity adjacent to the Ballenger-McKinney Wastewater Treatment Plant. Running continuously, the plant will generate approximately 1.85 million kWh per year. The project also includes an on-site battery energy storage system providing some limited additional back-up power beyond the plant's two-line electric utility service. The electricity generated by the solar array supplies approximately 17% of the plant's annual electrical usage.
- Variable frequency drives: With the completion of the Ballenger-McKinney enhanced nutrient removal wastewater treatment plant in December 2014, various VFDs were installed in certain portions of the facility. (see Appendix VI for a description of VFDs)
- Energy conservation through LED lighting upgrades and solar lights: Work completed in January 2020 provides an estimated annual savings of 177,477 kWh through upgrades at the Reich's Ford Landfill's administration building, transfer station, and old shop, and at the Urbana high zone booster pump station. Lighting retrofits at the New Design water treatment plant resulted in energy savings of 104,272 kWh/year. Numerous installations of LED lights at county buildings and in street lights throughout the county contributed to a substantial reduction of GHG as well as saving the county thousands of dollars in operating costs.

- Energy conservation: The Division of Planning and Permitting incorporated software in its application and permitting process that reduced paper use and travel required by employees and applicants. Remote workers can conduct reviews with no loss of service during the pandemic. Telecommunications tools like Microsoft Teams allow for virtual inspections to avoid vehicle trips. Frederick County's success is being held up as a model by organizations like Maryland Society of Professional Engineers and NAIOP's Maryland Chapter.
- LEED certification - Division of Public Works worked with an engineer and the contractor to build the Brunswick Library to LEED standards; the branch opened in Spring 2011.
- Roof replacements: Roofs were replaced on the west wing of Winchester Hall and the Adult Detention Center. The roofing material was changed from ethylene propylene diene monomer (EPDM) rubber to light gray thermoplastic polyolefin, resulting in an estimated savings of 110,000-kWh/year.
- HVAC systems: Upgrades and use of variable refrigerant flow HVAC Systems at numerous buildings throughout the county and replacement of 29 water source heat pumps in Winchester Hall reduced GHG through energy efficiency.
- Divesture of fossil fuels in the County's General Funds: Pension plan assets now have de minimis investments in fossil fuels in stock mutual fund bundles.
- Proactively gave bond rating agencies sustainability documentation including infrastructure investment related to climate resiliency.
- Interdepartmental cooperation: The Division of Emergency Management's Hazard Mitigation Plan and the Drainage Area Response Team (DART) Plan included DPW, OSER, Parks, and Planning input, with regard to climate resiliency.
- Reduced waste and composting: The Senior Services Division at the Senior Center eliminated disposable silverware, cups and plates, uses a high efficiency dishwasher, collected compost and used it in the garden. Restructured Meals on Wheels routes have increased fuel efficiency while delivering 3,200 meals per week during pandemic.
- Greener buildings: OSER established and promoted:
    - PACE -- OSER worked with County Divisions to create a Property Assessed Clean Energy loan program for businesses allowing them to borrow funds to adopt energy efficient upgrades and repay the funds through a special tax assessment.
    - Green Homes Challenge -- As of 6/17/2020, 2,372 Frederick County households are participating in the Green Homes Challenge, Be a Power Saver, Be a Renewable Star, and Be a Green Leader challenges.
    - Solarize and Solar Co-op initiatives -- Over 100 households installed solar through bulk purchase initiatives.
    - Refrigerator exchange – 234 inefficient refrigerators have been replaced.
    - Power Saver Retrofits -- Over 550 households have been retrofitted to date.

Community Choice Aggregation

Background

Community choice aggregators (CCAs) are local governmental entities that procure electricity on behalf of retail electricity customers within a certain geographic area. CCAs may be run directly by a city or county government or by a third party through a contractual arrangement such as a Joint Powers Agreement. Enabling legislation is required. There are currently eight states that enable CCAs, but one of those states has no active entities. At least five states have legislation pending, including Maryland.

In Maryland, customers already have the option to choose an alternative provider of their electricity. In these cases, the existing provider still delivers the electricity and provides the billing. CCA customers would be treated the same. They would continue to receive one bill, and make one payment.

There are three primary reasons for establishing a CCA:

- Rate reductions due to considerable bargaining power when representing a large group of customers;
- Greater local control of the choice of providers, including favoring local providers in order to encourage job retention and creation; and
- Offering a higher percentage of green sources than required by state targets. Many CCAs provide a basic service and offer other services with a higher green percentage, usually at a premium.

There are two ways of determining which individual customers will be included in the CCA: opt-in or opt-out. Almost all CCAs to date have been established using the opt-out approach, whereby the existing customer base is included in the new CCA unless they actively choose to opt out. This ensures the largest participation base; most customers do not make the effort to exclude themselves.

It is widely agreed that involvement in CCAs is growing, but enrollment data over a time span are difficult to find. There are anecdotal observations. In three states, in particular, community choice is growing rapidly. In California, the share of sales to electricity customers rose from 5 percent to 18 percent in the last year alone. In New York, nearly 50 municipalities have joined community choice programs in the past year. In Massachusetts, 150 communities have joined since 2015.

In Maryland, Delegate Lorig Charkoudian reintroduced legislation to permit Montgomery County to run a pilot CCA program. The bill received a favorable vote out of the House, but the Senate had not taken it up when the Legislative Session was cut short by the Covid-19 crisis.

There are several challenges facing anyone planning to create a CCA.

- Energy markets are complicated, sophisticated, and volatile. Personnel with the skill set to create and run a CCA must be hired, or contracted.
- Competitive rates can be difficult to sustain over long periods. Long-term purchase agreements can lock in costs that are higher than the fluctuating market climate.
- Exit fees payable to the original utility can raise total costs to the consumer. These rates are typically set by a state utility commission. The rationale for such fees is to reimburse the original utility for investments that the public utility commission had required in the past.
- At least initially, green sources of energy can be difficult to find, or insufficient to supply a large new customer base.
- Customer turnover can erode the economic base and bargaining power if customers moving into the area are difficult to obtain or to retain.

Residential, Commercial, Industrial/Agricultural Sector

The key to reducing GHG emissions in these sectors involves separate activities that should be pursued in parallel:

- Reduce the amount of energy used by on-site equipment;
- Install on-site sources of electricity that have zero emissions;
- Replace equipment that is powered by burning a fuel with similar equipment that is powered by electricity;
- Deploy energy efficient technology in buildings that reduce energy demand for heating and cooling;
- Recycle and reuse building materials to reduce lifecycle costs.

Reducing the Energy Use

The terms ***Practice Energy Conservation*** and ***Improve Energy Efficiency*** are often used interchangeably; however, there are some literal differences between them when it comes to actions taken to reduce energy use and thereby reduce annual energy bills and the creation and release of greenhouse gases:
Energy Conservation primarily means reduce or eliminate the output from energy-using devices at certain times (which thereby also eliminates or reduces the needed energy inputs).
Energy Efficiency primarily means modifying or replacing equipment so less input energy is needed to produce the desired or needed output (e.g., a certain amount of light from a lamp, or a certain amount hot water to take a shower).
The following are a few examples of the most effective ways to reduce electricity use.

Reducing Electricity Use

Lighting. All the sectors use electricity to provide illumination inside buildings as well as outside.

- Replace all lamps and lighting fixtures with LEDs
- Install occupancy sensors to shut-off lights and equipment when the associated building space is vacant or the equipment is not going to be used in the near future. Examples:
  In Homes: Bathrooms, bedrooms, basements, and garages
  In Commercial and Industrial Buildings: Rest rooms, conference rooms, private offices and cubicles, storage rooms, computers, printers, and lights in vending machines
- Install photo-cell controls that respond to the loss of sunlight to automatically activate outdoor security lighting

Space Cooling. Most homes and small/medium-size commercial buildings have electric air-conditioners or heat pumps to cool the interior rooms occupied by people during summer months.

- Replace older, low-efficiency (i.e., 14 SEER or lower) units with new high-efficiency (20 SEER) units. Also, replace air filters one or twice each year and check the ducting where it can be seen to ensure it is not leaking.
- Set programmable thermostat controls to prevent over-cooling when the home or building is not occupied.
- Add thermal insulation above the ceiling, and make sure the space between top-floor ceilings and the roof is well-ventilated to prevent heat build-up. Ensure windows and doors are well sealed so they block hot outdoor air from entering.

- Install awnings or use shades and drapes or reflective coatings to reduce direct sunlight from shining through windows.

Large commercial buildings typically use chillers to produce chilled water, which is pumped throughout the building to heat exchangers that cool the ventilation air that circulates through occupied spaces. The chiller system rejects waste heat to the atmosphere via a cooling tower.

- When an existing chiller needs to be replaced, be sure to select a more efficient model, and consider using thermal storage so chilled water can be produced at night when electricity rates are lowest.

Space Heating. Many homes and small/medium-size commercial buildings already use one or more heat pumps to make the interior spaces comfortably warm during winter months.

- When a new 20 SEER heat pump is purchased, the heating season performance factor (HSPF) also will be higher than the HSPF value of the replaced unit, so year-around electricity savings will occur.
- Set programmable thermostat controls to prevent over-heating when the home or building is not occupied, or at night when it is occupied.
- Add thermal insulation below the floor and on basement walls. Ensure windows and doors are well sealed so they block cold outdoor air from entering.
- Existing windows that are degraded, have major thermal insulation and/or air-leakage issues should be upgraded to versions with high-insulation/low air leakage ratings.
- In building areas with high ceilings, install large-diameter destratification fans or multiple smaller fans and ducts to return heated air near the ceiling to floor level during the winter, and promote better air circulation in other seasons.

Water Heating. Many homes and commercial &industrial/agricultural buildings use electric-resistance water heaters to supply hot water for sanitation, bathing, clothes washing, and cleaning floors and equipment.

- When a new water heater is needed, replace it with a heat-pump water heater, which is typically 65% to 100% more efficient.
- Install low-cost insulation on water-delivery piping.

Motor-Driven Equipment. The non-residential sectors always have electric motors driving fans, pumps, and other equipment that seldom need to operate at full speed.

- Install variable-speed drives (VSDs) to enable the motors to run at slower speeds when full-speed is not required. VFDs can produce large energy savings because the power and energy use of electric motors drops approximately with the cube of the rotational speed (rpm) of the motor (slowing to half-speed reduces the power and energy by a factor of approximately eight). Common applications in non-residential buildings are fans in the ventilation systems and cooling towers, pumps in the chilled-water and condensate systems, and refrigeration compressors. Other applications include sewage and water-supply piping systems and conveyor lines.

Reducing Fuel Use

- Homes and buildings that do not use electricity to provide space heating will instead use furnaces or boilers that burn fuel oil, natural gas, propane, or wood. When the existing space-heating equipment nears end-of-life, it likely to be more economical to replace it with an electric heat pump. Similarly, replacing all fuel-burning water heaters that are 10-years old or older with electric heat-pump water heaters will definitely be economic. Switching from fuel-burning to electric heating equipment will definitely reduce GHG emissions.

- The same is true with regard to replacing existing fuel-burning cooking and clothes-drying equipment with their high-efficiency electrical-powered counterparts.
- Manually shut-down fuel-powered agricultural equipment (e.g., tractors and trucks) when they are not going to be used in the next 15 or 20 minutes will also save money and reduce GHG emissions. Trucks powered by electric batteries are now available and economical. Battery-powered tractors are likely to become available in the next 5 years.

For more the past 11 years the State of Maryland has required the largest electrical utilities to offer Energy Efficiency Programs that provide generous financial incentives to all their retail customers who install the listed energy-conservation and energy-efficiency measures. In Frederick County, the electric utility for nearly all utility customers is Potomac Edison.[50] (These incentive programs are funded via a small tax on the electric bills of all retail customers, so it makes economic sense for customers to take advantage of these programs, to not only get back the money they paid into the programs, but to also get some of the money paid in by customers who do not take advantage of the programs.) In addition, the Maryland Energy Administration (MEA) has grant programs that encourage the installation of some measures. It should be noted that MEA has a special energy efficiency grant program that is targeted to the Agricultural Sector.

In addition, to the foregoing listed measures, which all are described in terms of retrofits to existing buildings, all the measures should be incorporated in to new construction of homes and buildings. The county should consider updating the Energy Code to the latest updates as soon as they become available. Individuals and organizations should seriously consider the long-term economics of exceeding Code requirements.

Frederick County can move beyond the commitment to incorporate green building techniques and concepts into the design and construction of new county funded facilities. The opportunity exists for evaluating the renovation of existing structures for improving energy conservation and performance. Like the State, the County can commit to the use of one of the three green building certification/rating programs. Further, it can adjust language in land Use management plans and building codes to encourage and/or require non-county funded new construction to also comply with the guidance provided by the Maryland Green Building Council. This may require recommending financial incentives for renovation of existing facilities

Generate Electricity On-Site, and in Special Situations also Produce Fuel. In Frederick County, the most desirable way to generate electricity on-site at homes, commercial & industrial facilities, and farms is to deploy a solar PV array coupled to a battery storage system. In some higher-elevation locations, a wind-powered generator plus battery storage system may be more practical and more economic. In many cases, a financial organization is willing to provide the funds needed to build the on-site generating system and be repaid by the utility customer from a large portion of the electricity bill savings that system produces over a period of 15 or 20 years.

Farms that raise animals may choose to invest in equipment that uses animal waste to produce a renewable fuel that can be burned to produce heat, or to generate electricity. In some cases the farm's on-site generator may be eligible for a utility CHP incentive and an MEA CHP grant.

[50] The Town of Thurmont serves as the electric utility for town residents, who are not eligible to participate in the utility programs described here.