Reduction of

GREENHOUSE GAS EMISSIONS REPORT

DECEMBER 2024

Maryland ENVIRONMENTAL SERVICE

Message from the Executive Director

The Maryland Environmental Service (MES) is once again pleased to present this annual report detailing our efforts towards reducing greenhouse gas emissions in the State of Maryland. This report is required by Section 3-103.4(f) of the Natural Resources Article of the Annotated Code of Maryland.

MES' mission is to deliver operational and technical service projects to protect and enhance the environment for the benefit of Maryland's citizens. We are a not-for-profit business unit of the State of Maryland, operating on a fee-for-service basis. The agency serves federal, state, and local governments, as well as private sector partners, meeting or exceeding required environmental regulations.

Maryland continues to be a national climate change leader. Last December, the Maryland Department of the Environment published the Climate Pollution Reduction Plan (CPRP) as the state's strategy to achieve the ambitious climate change mitigation goals established in the Climate Solutions Now Act (CSNA) of 2022. Then, on June 4, 2024, Governor Moore issued an Executive Order to advance the climate change goals and environmental justice initiatives in the CPRP. These actions underscore the urgency, breadth, and magnitude of activities that must be undertaken to achieve the state's sustainability goals.

This annual report highlights our current and planned measures to reduce greenhouse gas emissions while still providing a high level of service to our customers. The agency's incorporation of electric vehicles and equipment, operation of recycling facilities, beneficial use of biosolids, and dissemination of solar expertise, are but a few examples of how we currently reduce greenhouse gas emissions in the state. Our planned projects for landfill gas beneficial use, carbon sequestration, electric vehicle charging infrastructure, and solar installations, among others, are expected to be completed in the next few years and demonstrate MES' commitment to supporting the state's climate change goals.

Sincerely,

Charles C. Glass, Ph.D., P.E.
Executive Director

TABLE OF CONTENTS

1. Introduction to the Maryland Environmental Service

MES was established by the General Assembly in 1970 to assist with the preservation, improvement, and management of the quality of air, land, water, and natural resources, and to promote the health and welfare of the citizens of the state. Today, we employ over 800 teammates and operate more than 1,000 environmental projects across Maryland and the Mid-Atlantic Region. As a not-for-profit business unit of the State of Maryland, MES provides multi-disciplinary environmental services to enhance and protect the environment through innovative solutions to the region's most complex challenges.

MES HQ

We are a leader in solving Maryland's environmental problems. MES plans, constructs, and operates projects within our four main operating groups:

- Environmental Dredging and Restoration
- Environmental Operations
- Water and Wastewater
- Technical and Environmental Services

Detailed descriptions of each operating group are given below.

1.1 Environmental Dredging and Restoration Program

The Environmental Dredging and Restoration Group (EDR) provides operational and technical services on behalf of our clients in the areas of dredged material management, outreach and engagement related to dredged material management, habitat restoration, remediation, environmental management system implementation, and permitting and mitigation services. The EDR Group supports our clients with the planning, engineering, construction, environmental and regulatory management, and operations for our partners' facilities. MES operates three dredged material containment facilities (DMCFs) and the Paul S. Sarbanes Ecosystem Restoration Project at Poplar Island (Poplar Island) on behalf of the Maryland Port Administration (MPA).

Poplar Island is a restoration effort located in the Chesapeake Bay in Talbot County that beneficially uses dredged material collected from the approach channels to the Baltimore Harbor to restore lost remote island habitat. The three DMCFs include the Masonville DMCF located near the Middle Branch of the Patapsco River in Baltimore, the Cox Creek DMCF in Anne Arundel County, and Hart-Miller Island DMCF which stopped accepting dredged material inflow in 2009. MES is supporting MPA with the ongoing wildlife habitat restoration effort at Hart-Miller, including the opening of the 300-acre south cell to public use in partnership with Maryland Department of Natural Resources (DNR). In December 2022, MPA purchased the former Tronox Hawkins Point facility adjacent to the Cox Creek DMCF. MES and our subcontractors are providing support to MPA for remediation planning and site operations at the Sediment Technology and Reuse (STAR) Facility. In coordination with remediation activities, the site will be developed to become the future hub of processing dredged material from the Cox Creek DMCF for innovative and beneficial reuse.

MES further provides environmental management system, sustainability, and remediation services to MPA at their marine terminals including environmental monitoring and reporting, hazardous waste

Cox Creek DMCF

management, groundwater treatment plant operation and maintenance, hazardous waste landfill post-closure care, and stormwater best management practices (BMP) maintenance, inspection, and repair. In addition, MES supports MPA's sustainability efforts through assistance with grant applications and administration.

MES also manages dredging projects for other clients including the Deep Creek Lake Arrowhead Cove Dredging Project on behalf of Garrett County. Past and current work has included planning, permitting and design, and construction which began in September 2023. The project involved mechanical removal of approximately 11,000 cubic yards of sediment from Arrowhead Cove in Deep Creek Lake. The dredging was completed in the first quarter of 2024, with site restoration occurring in spring and summer 2024.

1.2 Environmental Operations

The Environmental Operations (EO) Group serves county government, large municipalities, the private sector, and state Government, offering solutions for solid waste challenges, recycling services, and energy/steam management. Other services provided by the EO Group include solid waste engineering, recycling durable medical equipment, used oil and antifreeze collection, and mobile chlorofluorocarbon recovery operations.

The group operates award-winning landfills and dual- and single-stream recycling centers, which serve millions of Marylanders including a one-of-a-kind recycling operation on behalf of the Maryland Department of Aging (MDoA) that reclaims used durable medical equipment (DME) and returns that equipment to Marylanders that have a need for this special equipment. Additionally, the EO Group manages composting facilities that transform yard, leaf, and food waste into highly sought-after products; namely, Leafgro® and Leafgro Gold®.

The EO Group provides Harford County with integrated solid waste management including landfill operations, engineering services, composting, recycling, litter control, and management of the County's homeowner drop-off facilities.

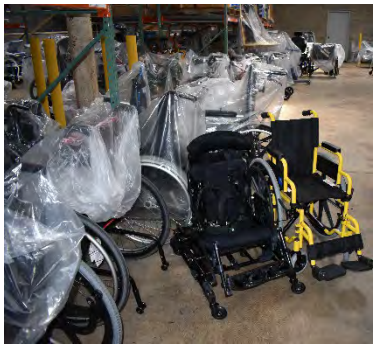
The Eastern Shore counties of Caroline, Queen Anne's, and Talbot, and later Kent, (Midshore counties), established a regional agreement with MES to meet the solid waste disposal needs of their citizens for, what is now, more than a 90-year period. MES currently oversees, engineers, operates, and monitors several solid waste facilities in the Midshore region on behalf of the partnering counties, including active and closed Resource Conservation and Recovery Act (RCRA) Subtitle D landfills, a solid waste transfer station, and multiple pre-RCRA Subtitle D landfills. MES also administers and operates a resident recycling program on behalf of the Midshore counties.

MES operates a dual-stream Materials Recycling Facility (MRF) for the Montgomery County Department of Environmental Protection (DEP) in Derwood, Maryland. Mixed paper and comingled materials, such as glass, metal cans, and plastic containers that are picked up from homeowners' residences, are processed at the facility. MES also operates a similar project at the Prince George's County MRF. This recycling facility accepts single-stream recyclables collected from county residents.

The EO Group also operates highly successful leaf and yard waste composting programs. Two compost products made by MES at the Montgomery County and Prince George's County compost facilities, *Leafgro*® and *Leafgro GOLD*®, are marketed successfully by MES staff. Our *Leafgro GOLD*® Compost is produced using food waste as feedstock at the nationally renowned Prince George's County Organics Composting Facility located in Upper Marlboro, Maryland.

The EO Group, on behalf of the Department of Public Safety and Correctional Services (DPSCS), operates a 4 MW cogeneration facility supplying electricity and thermal resources to the Eastern Correctional Institution (ECI), the largest prison in the state. The group also operates plants at three other Maryland Correctional Facilities, providing steam for heating, laundry, and cooking.

In October 2024, the University of Maryland Eastern Shore (UMES) retained MES to operate their central steam plant. The plant provides steam for heating 17 buildings distributed throughout the UMES campus.



DME Donations

EO partners with various government agencies in Maryland to provide other essential services. The group collaborates with the Maryland Department of the Environment (MDE) to support used oil and antifreeze collection and operate a mobile chlorofluorocarbon recovery unit. Additionally, EO partners with the MDoA to manage the Durable Medical Equipment (DME) program. This program receives discarded durable medical equipment that would typically end up in a landfill, so it can be refurbished, recycled, and commissioned for reuse.

1.3 Water and Wastewater Program

MES' Water and Wastewater (W/WW) Group is comprised of two divisions. The Operations and Maintenance (O&M) Division operates numerous municipal, county, and state-owned wastewater treatment plants (WWTPs), drinking water treatment plants (WTPs), and sewage pumping stations. Facilities that are owned by the private sector are also operated by the W/WW Group under contract. The W/WW Group operated 238 facilities across Maryland and the Mid-Atlantic region in fiscal year 2024 (FY24). In addition to providing skilled, certified operators to run these facilities, MES also has staff that are dedicated to performing periodic maintenance, equipment repairs, and retrofits to ensure that each facility meets or exceeds the applicable regulatory requirements.

Sandy Point State Park Water Tower

The W/WW Group's Engineering Services Division plans and implements capital improvement programs for many of these facilities. Engineers manage capital upgrades to achieve compliance with Maryland's Enhanced Nutrient Removal (ENR) standards.

The Engineering Services Division's Biosolids Management Section manages the solids generated from the WWTPs. Engineering, planning, permitting, regulatory compliance, and operational support is furnished by the biosolids staff.

1.4 Technical and Environmental Services

The Technical and Environmental Services (TES) Group provides multi-disciplinary environmental planning, monitoring, environmental systems maintenance, geospatial, and engineering and renewable energy services to our partners. This includes tasks such as:

- Planning
- Permitting
- Inspection Services
- Monitoring
- Regulatory Reporting
- Geographic Information Systems (GIS)
- Stormwater Management
- Renewable Energy Services

Bowie State Regional Pond

One of the Group's major projects involves providing environmental compliance and environmental systems maintenance support to the Maryland Aviation Administration (MAA) at the Baltimore Washington International Thurgood Marshall Airport (BWI). This includes collecting waste deicing fluid at BWI so that it does not runoff into nearby streams. MES staff collected 2.78 million gallons of spent de-icing fluid at BWI in the 2023-2024 deicing season. Some of the recovered deicing fluid is recycled rather than disposed, thereby reducing costs to MAA.

The TES Group continued to provide environmental compliance support services to the State Highway Administration (SHA). MES assisted with emergency drainage remediation projects that posed a potential impact to public safety and the environment. MES also began executing additional stormwater construction work for SHA.

TES staff assists the Maryland Energy Administration (MEA) with implementation and assessment of energy programs and policies. In support of the state's commitment to establishing clean energy, MES completed a solar suitability evaluation of landfills, rubble fills, and brownfields. In continuance of this evaluation, MEA has requested MES to provide outreach and educational support to inform site owners and operators of the benefits of solar energy generation. Additionally, the group worked with DNR to install solar panels on the rooftops of structures at five state parks.

2. Greenhouse Gas and Climate Change Mitigation Policies

2.1 Global Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is the United Nations (UN) body charged with regularly assessing climate change science. The IPCC finalized their *Sixth Assessment Report* via the release of the *Climate Change 2023 Synthesis Report* in March 2023. The IPCC concludes that human activities, chiefly through greenhouse gas (GHG) emissions, have resulted in global warming, with global surface temperatures from 2011 – 2020 rising 1.1°C above 1850-1900 (Figure 1).[1] The observed warming has, amongst other adverse impacts, resulted in global sea level rise of nearly 8 inches from 1901 – 2018 (Figure 2), an acidification of ocean water, an increase in weather extremes that are highly attributable to human activity, and disproportionate impacts to vulnerable communities.[1]

Solar Panels at MES HQ

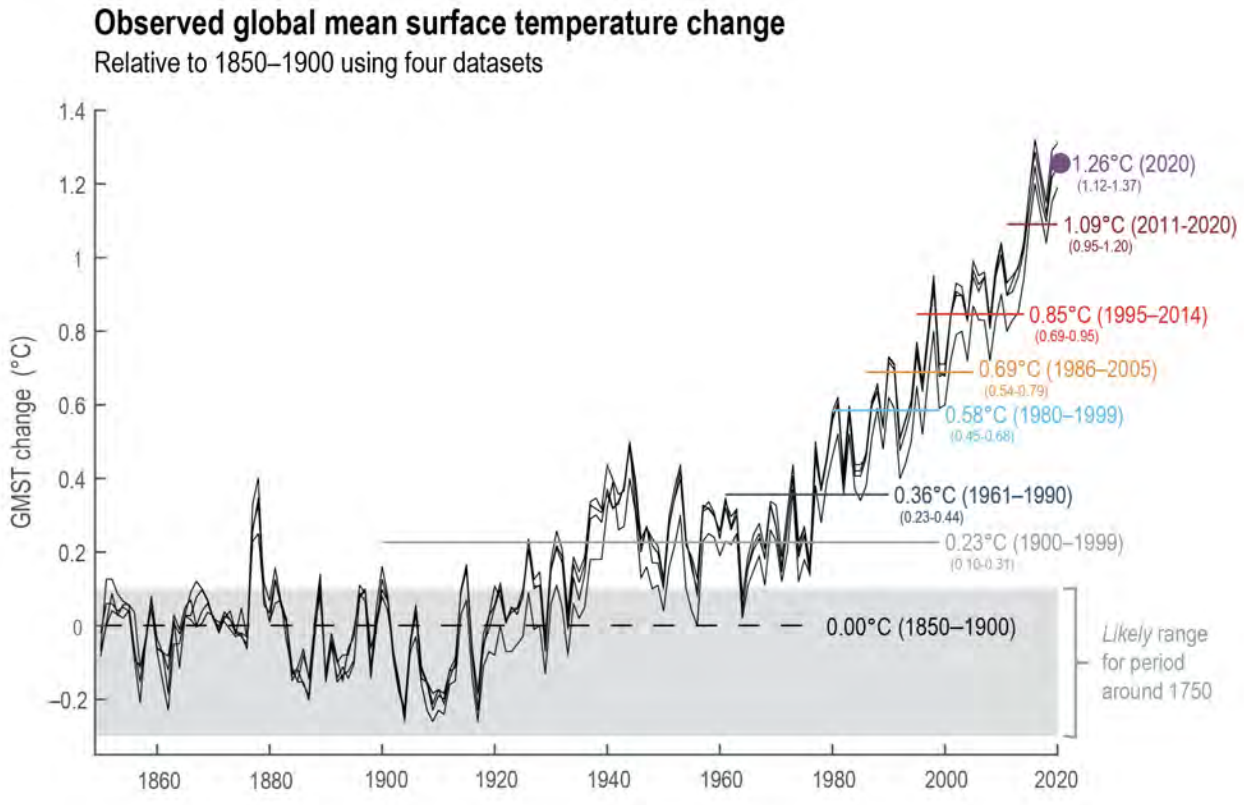


Figure 1 – Global Warming, 1850 – 2020, Adapted from Figure 1.12 in IPCC, 2021.[2]

The 2015 UN Climate Change Conference (COP21) resulted in the adoption of the Paris Agreement, an international treaty with the explicit goal of limiting global warming to well below 2°C, and preferably below 1.5°C, relative to pre-industrial levels. The UN's vehicle for meeting this goal is global reductions in anthropogenic GHG emissions. However, the IPCC now asserts in their *Sixth Assessment Report* that it is likely that global temperatures will increase by more than 1.5°C during the 21st century, and that limiting the exceedance to 2°C will be difficult.[1]

The IPCC contends that future warming and associated impacts may be irreversible but can be limited by significant global GHG reductions.[1] This conclusion forms the basis for many of the regulatory efforts underway in the U.S. and worldwide to limit anthropogenic climate change.

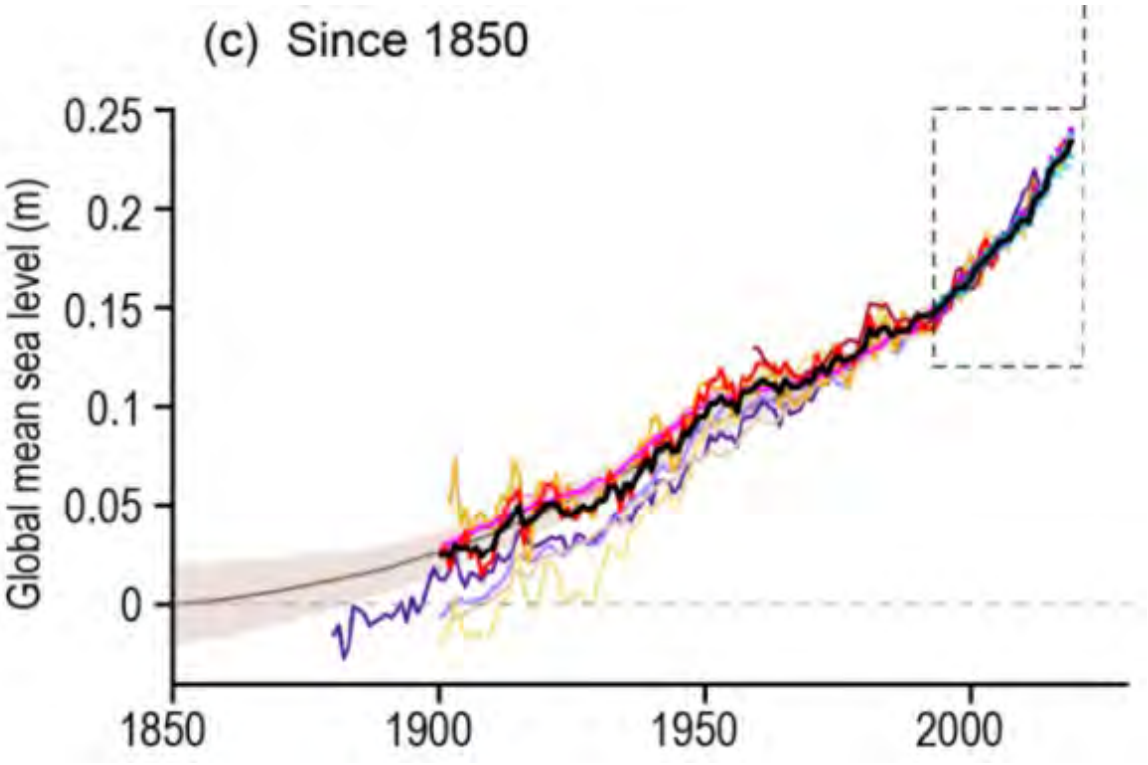


Figure 2 - Changes in Global Mean Sea Level, Since 1850. Tide-gauge and altimeter-based estimates since 1850. The consensus estimate is shown in black. Adapted from Figure 2.28(c) in IPCC, 2021.[3]

2.2 Maryland Greenhouse Gas Emissions

The Greenhouse Gas Reduction Act (GGRA) requires MDE to complete triennial inventories of the state's GHG emissions. The inventories capture gross GHG emissions from in-state activities, as well as out-of-state GHG emissions for imported electricity. A base inventory was completed for calendar year 2006 and represents the GHG emissions to which future emission reduction targets will be compared. The most recent published triennial inventory was completed for 2020 and shows gross GHG emissions of 85 million metric tons carbon dioxide equivalents ($MMTCO_2e$) using 20-year Global Warming Potentials (GWPs).[4] The results of the 2020 inventory are depicted by sector in Figure 3 and by gas composition in Table 1.

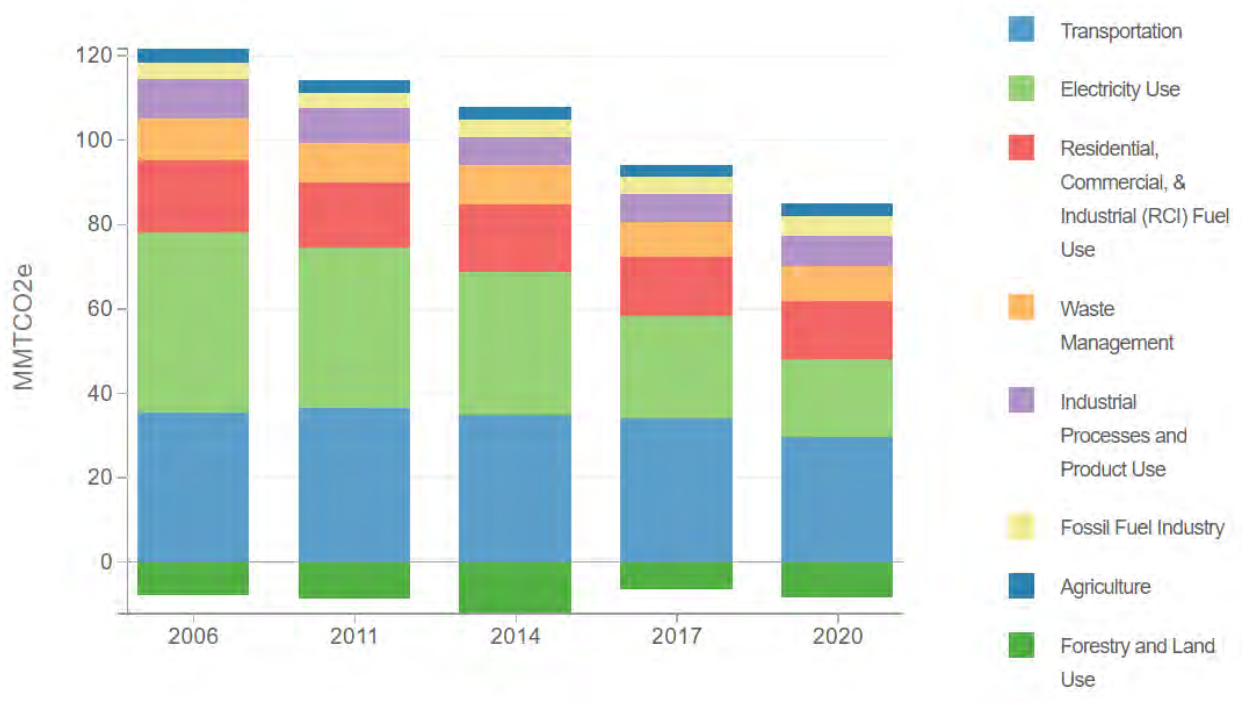


Figure 3 – Maryland GHG Emissions by Sector; from Maryland GHG Emissions by Sector in MDE, 2022.[5]

Gas	Gross Emissions ($MMTCO_2e$)	Percent of Total
Carbon Dioxide (CO2)	66.0	78%
Methane (CH_4)	12.5	15%
F-gases (HFC, PFC, SF6)	5.2	6%
Nitrous Oxide (N_2O)	1.3	2%

Table 1 – Maryland Gross GHG Emissions by Select Gas, 2020; Adapted from Figure of Gross GHG Emissions Breakout by Gas in MDE, 2022. [6]

Transportation accounted for the most GHG emissions by sector in 2020, comprising approximately 35% of gross GHG emissions in the state.[4] Nearly 82% of the 30 $MMTCO_2e$ transportation sector emissions were generated by on-road gasoline and diesel vehicle emissions.[4]

Electricity consumption comprised 22% of gross GHG emissions in 2020, with those emissions nearly split between in-state electricity generation and imported electricity.[4] Nearly all the GHG emissions associated with in-state electricity generation are produced from coal and gas-fired plants.[4]

Residential, commercial, and industrial (RCI) fuel use accounts for 16% of the GHG emissions in Maryland.[4] These are emissions for direct fuel combustion of fossil fuels used for tasks such as space heating, hot water heaters, cooking, and industrial fuel use. Natural gas and liquid petroleum use accounted for most of these emissions.[4]

Waste management is a core business line of MES. Emissions from this sector originate from landfills, waste combustion, and WWTPs. This sector accounted for more than 8 $MMTCO_2e$, or approximately

10%, of the state's gross GHG emissions in 2020.[4] MES continues to focus on reducing emissions from this sector, especially methane emissions from landfills and nitrous oxide emissions from WWTPs.

Gross GHG emissions are reduced, or netted, by carbon that is sequestered. Maryland forests, wetlands, submerged aquatic vegetation (SAV), soils, and landfilled carbon can serve as carbon sinks, in which more carbon is absorbed or retained than is released. Forests and landfilled carbon have historically been key carbon sinks in Maryland. MDE estimates, for example, that trees, forest carbon, and landfilled carbon sequestered more than 8 $MMTCO_2e$ in 2020.[4]

Maryland's 2020 net GHG emissions of 77 $MMTCO_2e$ constitute a reduction of almost 33% compared to the 2006 baseline net emissions of 114 $MMTCO_2e$. The principal driver for this reduction is decreased power plant emissions, largely attributed to Maryland's participation in the Regional Greenhouse Gas Initiative (RGGI) and the ongoing phase-out of coal-fired electricity generation. Considerable progress has been made toward the state's climate change mitigation goals, yet significant challenges still lie ahead.

2.3 Climate Solutions Now Act of 2022

The State of Maryland passed the most ambitious GHG reduction law in the US with its passage of the CSNA of 2022. The CSNA requires the state to achieve at least a 60% reduction in GHG emissions relative to their 2006 levels by 2031 and reach net-zero emissions by 2045[7]. The law required MDE to prepare and adopt a CSNA implementation plan no later than December 31, 2023. Several noteworthy provisions of the CSNA are included below.

- At least 75% of all electricity supply purchased by Maryland for use at state facilities be from zero or low carbon sources beginning on January 1, 2030.
- MDE must establish Building Energy Performance Standards (BEPS) for certain buildings (covered buildings) with a gross floor area greater than 35,000 square-feet. The BEPS are intended to achieve a 20% reduction, relative to a 2025 baseline, in direct GHG emissions from covered buildings by January 1, 2030, and net-zero emissions by January 1, 2040.
- The state government must transition its entire fleet of passenger cars and light duty trucks to zero-emission vehicles (ZEVs) by 2031 and 2036, respectively. Purchase allocations of ZEVs by state entities quickly ramps to achieve this goal, with certain interim allotments of hybrid electric vehicles (HEVs) as a bridging mechanism.
- The law requires the State Department of General Services (DGS) to ensure the development of charging infrastructure in support of this goal.
- Identifies and defines "overburdened" and "underserved" communities. These communities are funding targets for climate change mitigation.
- Creates the Climate Catalytic (C3) Fund, comprised of both public and private investment, to advance clean energy measures and GHG emission reduction technology. At least 40% of the C3 funds are to be allocated to projects assisting low- and moderate-income (LMI) households.
- Requires that MDE use the 20-year Global Warming Potential (GWP) in estimating the state's GHG reductions.

2.4 Climate Pollution Reduction Plan

In December 2023, MDE published the *Climate Pollution Reduction Plan (CPRP)* as a roadmap to achieve the aggressive goals of the CSNA. The CPRP identifies many policies that, according to MDE, will reduce GHG emissions in the state by 60% from 2006 levels in 2031, and will achieve net-zero by 2045. MDE defines net-zero as "a state in which the total GHG emissions from Maryland's economy will

be equal to the GHGs removed from the atmosphere through natural and technological systems annually."[8] MDE also projects that these policies, if implemented, will reduce fossil fuel use in the State by 80% by 2045.[8] Figure 4 depicts MDE's projected decarbonization milestones through implementation of the CPRP.

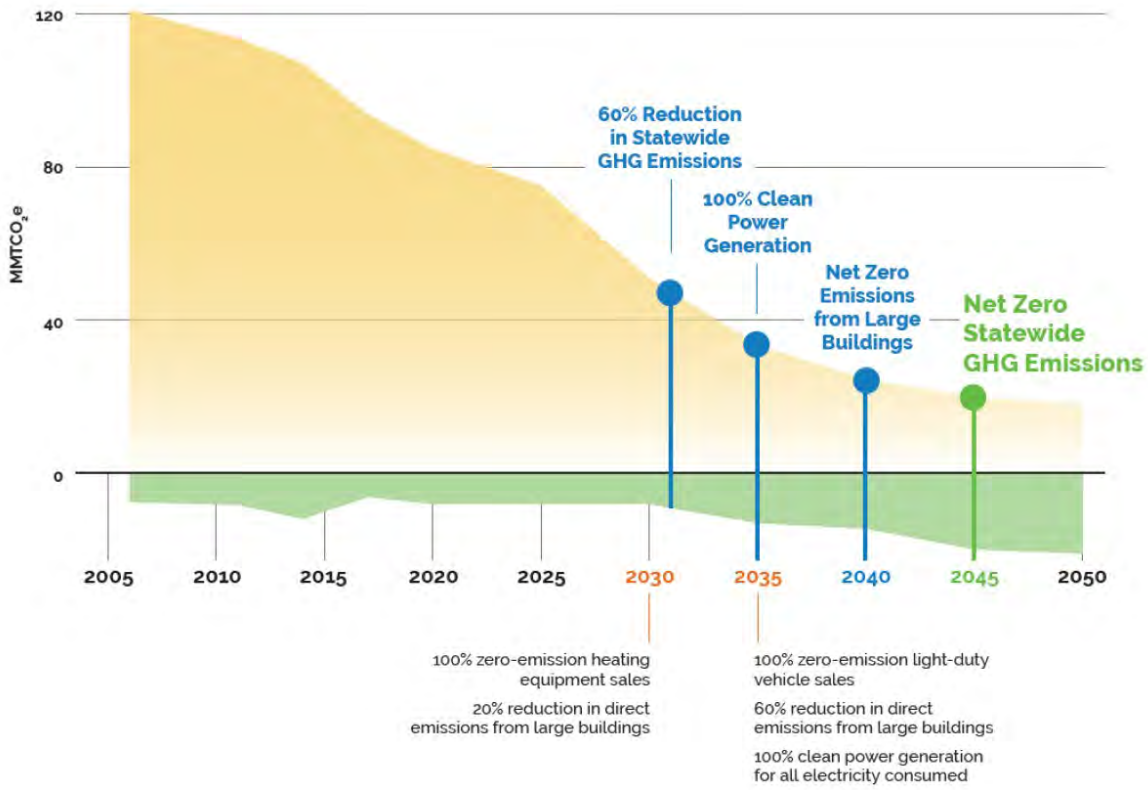


Figure 4 – Major Milestones in Maryland's Decarbonization Timeline; from Figure 1 in MDE, 2023.8

MDE includes existing, expanded, and newly proposed policies in the CPRP and acknowledges that the continuation of existing policies alone will result in the state's underperformance of its 60% GHG reduction target for 2031. Certain policies that may have the potential to influence MES operations are summarized below from information provided in MDE's CPRP.[8]

Economywide

- Clean Economy Standard (new): provides incentives for investments in clean electricity, clean buildings, clean vehicles, and clean industry with investments targeted toward overburdened and underserved communities; establishes regulatory standards for individual sectors of the economy; and, expands Maryland's cap and invest program.

- Strategic Energy Investment Fund (expanded) (SEIF): funds for the SEIF are primarily generated from GHG compliance programs, for example RGGI and Renewable Portfolio Standard (RPS) alternative compliance payments. MDE proposes expanding the funding sources of the SEIF to

new or expanded climate pollution reduction programs. MEA administers distribution of funds from the SEIF.

Electricity

- Renewable Portfolio Standard (modified): advances and diversifies Maryland's access to renewable energy by requiring electricity suppliers to provide increasing proportions of renewable electricity to retail consumers. The current RPS is set to ratchet renewable electricity supply to 52.5% and 20.4% for non-municipal and municipal suppliers, respectively, by 2030. The RPS is driven by the creation, sale, and transfer of renewable energy credits (RECs), both Tier 1 and Tier 2.

  MDE's CPRP calls for the elimination of municipal waste-to-energy (WTE) as a Tier 1 energy source and aligning clean power sources and their definitions in the proposed Clean Power Standard with renewable energy sources identified in the RPS.

- Clean Power Standard (proposed): is intended to compliment the RPS and satisfy Governor Moore's commitment to 100% clean energy by 2035. MDE suggests that the Clean Power Standard will "likely allow for solar, wind, hydro, nuclear, energy storage, and other zero-emission technologies to qualify as clean energy sources, while eliminating existing eligibility and subsidies for municipal solid waste (MSW) incineration."[8]

- State Incentives for Renewable Energy (existing): MEA advances renewable energy in the state using funding made available through the SEIF, principally obtained through RGGI and RPS alternative compliance payments.

- Community Solar Act (existing): makes permanent the Community Solar Pilot Program that was established in 2015 and requires that 40% of community solar power output be directed to LMI subscribers.

Transportation

- Zero Emission Vehicle Infrastructure Plan (existing): the Maryland Department of Transportation is planning for the rapid growth of ZEVs on Maryland roadways. Their current National Electric Vehicle Infrastructure (NEVI) plan identifies 23 EV Alternate Fuel Corridors throughout the state with an additional 40 – 48 charging stations along those corridors.

- Advanced Clean Trucks (existing): adopts, as permitted under Section 177 of the federal Clean Air Act, the California Clean Truck Act which requires increasing allocations of medium- and heavy-duty ZEV sales. Manufacturers must phase-in Class 2b-8 ZEV sales beginning with model year 2027. By 2035, ZEV sales must comprise 40% of truck tractor sales (Class 7-8), 55% of pickup truck/van sales (Class 2b-3), and 75% of rigid truck sales (Class 4-8).

- Advanced Clean Fleets (proposed): proposes the adoption of California's Advanced Clean Fleets regulation. It applies to medium- and heavy-duty trucks within drayage operations, local and state governmental fleets, and fleets that have 50 or more vehicles or generate $50 million in gross revenue. The California regulation requires the phased-in purchase of ZEVs for the applicable fleets, that drayage trucks entering seaports and intermodal rail yards be ZEVs by 2035, and that

state and local agencies purchase 100% ZEVs beginning in 2027. This regulation, if adopted, would complement the Advanced Clean Trucks Act.

Building

- Building Energy Performance Standards (existing): MDE is in the process of implementing, per the CSNA, Building Energy Performance Standards (BEPS) for covered commercial and residential buildings that have a gross floor area of 35,000 square feet or larger. The goal of BEPS is to achieve a 20% reduction in net direct GHG emissions by January 1, 2030, as compared with 2025 levels, and net-zero direct GHG emissions by January 1, 2040. Additionally, owners of covered buildings must utilize the EPA ENERGY STAR Portfolio Manager and report direct GHG emissions from their buildings beginning in 2025.

- Zero-Emission Heating Equipment Standard (proposed): The Zero-Emission Heating Equipment Standard (ZEHES) is intended to reduce fossil-fuel heating equipment by requiring new or replacement heating equipment to be zero-emission beginning later this decade.

Waste

- Control of Methane Emissions from Municipal Solid Waste Landfills (existing): The regulation promulgated by MDE under COMAR 26.11.42 requires landfills that have buried waste above certain thresholds install a landfill gas (LFG) collection and control system. The goal of this legislation is to reduce emissions of methane, a potent GHG, with a 20-year GWP of 79.7 (non-fossil origin).[9]

- Food Residuals Diversion Law (existing): The law, and MDE regulations that followed (COMAR 26.04.13), now require certain entities that generate at least one ton of separated food residuals per week to divert the residuals to an organics recycling facility from final disposal at a landfill or waste incinerator.

MES operations are currently subject to many of the laws and regulations noted above, and we foresee opportunities to reduce GHG emissions following the adoption of several of MDE's proposed actions in the CPRP. For example, our headquarters building has a gross floor area of 45,291 square-feet and will fit the definition of a covered building in the forthcoming BEPS. We own two municipal solid waste landfills and operate another on behalf of a client-partner, all of which are subject requirements of the landfill methane regulations. The renowned Prince George's County Organic Composting Facility, which MES operates on behalf of the county, receives food residuals from generators who are required by the food residuals diversion law to divert their food waste from landfills and incinerators. MES assisted MEA in developing a list of brownfield sites and landfills potentially suitable for solar energy in support of the state's clean power and community solar initiatives.[10] These are just but a few examples of how MES operations are intertwined with state policies to reduce GHG emissions.

2.5 Executive Order No. 01.01.2024.19

On June 4, 2024, Governor Moore issued Executive Order No. 01.01.2024.19 (Order) directing a whole-of-government approach to addressing climate change in Maryland. Key requirements of the Order include[11]:

1. Climate Implementation Plan
   Each state agency is required to consult with MDE and submit a Climate Implementation Plan (CIP) to the Governor by November 1, 2024. The CIP must address how, and with what resources, the state agency will implement the requirements of MDE's CPRP that are within its purview. Included within the CIP shall be a description of how the agency will advance environmental justice and the potential return(s) on investment that will be realized from its activities related to CPRP implementation.
2. Heating Standards
   The Order requires MDE to propose a zero-emission heating equipment standard that will phase-in zero-emission heating equipment. It also requires a proposal from MDE to expand Maryland's RPS to include a clean heat standard for homes and businesses.
3. Modification of the Regional Greenhouse Gas Initiative
   The Order stipulates that MDE must develop and propose a plan to the Regional Greenhouse Gas Initiative (RGGI), to establish a regional cap for power plant carbon dioxide emissions that is consistent with the state's 100% clean energy goals.
4. Transportation
   The Maryland Department of Transportation (MDOT) must implement a number of measures aimed at reducing GHG emissions in the transportation sector. These include, but are not limited to, upgrading the state's Zero-Emission Vehicle Plan, and implementing MDOT's Carbon Transportation Program as well as its Carbon Reduction Strategy.
5. Clean Energy
   The Order prioritizes the state's transition to clean energy by requiring MEA to set a framework for a transition to 100% clean electricity by 2035.

The Order is a mandate for state agencies to take decisive action to mitigate GHG emissions.

3. MES Operating Programs - Current GHG Emission Reduction Activities

Longstanding focus has been placed on improving energy efficiency to better serve our customers and mitigating the environmental impact associated with our operations.

Current projects that will result in GHG reductions are detailed for each group in the following subsections.

3.1 Environmental Dredging and Restoration Projects

MPA Port of Baltimore Diesel Equipment Upgrade Program

The Diesel Emissions Reduction Act (DERA) Program provides grants to improve air quality and public health by reducing harmful emissions from diesel engines. This program offers funds to retrofit or replace older diesel engines to reduce emissions, and accelerate replacement of this equipment to newer, cleaner technologies. The MPA has a robust environmental program, which includes reducing emissions from vehicles, vessels, and cargo handling equipment at port facilities. MES receives the EPA grant funding

and administers the program on behalf of MPA. Companies that own the vehicles, cargo handling equipment, and vessels take part in the program by matching EPA funds. The funding levels varying depending on the selected technology and equipment or vehicle type.

In FY24, a total of 22 pieces of equipment were replaced by this program (four cruise ship engines, 15 on-road, Class eight heavy duty trucks, one forklift, and two terminal tractors). One of the on-road trucks was replaced with an EV semi-truck (Kenworth T680-E). The EPA's Diesel Emission Quantifier Tool[12] was used to quantify emissions reductions resulting from these replacements. The output from this web-based tool is shown in Table 2 below. Inputs used for the DEQ tool were obtained from actual usage data from the vehicles that were being replaced. Diesel emissions reductions were achieved because of improved emissions control technologies and enhanced fuel efficiency. It was assumed that vehicle fuel use efficiency for the upgraded on-road equipment was 6.6 mpg, and for off-road equipment a 20% improvement in fuel efficiency. Emissions reductions for the criteria air pollutants (NOx, CO and $PM_{2.5}$) and hydrocarbons (HC) were achieved. GHGs were reduced by an estimated 26.4%, or 461 $MTCO_2e$.

Parameter	**NOx**	**$PM_{2.5}$**	**HC**	**CO**	**CO_2**	**Fuel Use (gal)**
Baseline for Upgraded Vehicles/Engines (short tons)	21.105	0.746	1.069	5.303	1,925.30	171,140
Amount Reduced After Upgrades (short tons)	15.432	0.694	0.932	3.106	508.6	45,207
Percent Reduced After Upgrades	73.10%	93.10%	87.20%	58.60%	26.40%	26.40%

Table 2 – EPA DEQ Output for MPA's FY24 Port of Baltimore Diesel Equipment Upgrade Program

MES Electric Pick-Up Trucks at MPA Facilities

MES is assisting our client, MPA, with implementation of the fleet electrification requirements of the CSNA. In FY24, MES completed the purchase and began operating two Ford F-150 Lightning® all electric half-ton pickup trucks. The trucks were delivered in late December 2023 and have replaced a 2012 diesel engine F-350 1-ton pickup truck and a 2015 gas engine ¾-ton pick-up truck. Estimated FY24 emission reductions by use of these vehicles are captured in Table 13.

In addition, EDR continues to take steps to reduce the emissions associated with and maintenance of the diesel emissions systems in the trucks and equipment currently employed at the MPA facilities that MES operates on behalf of MPA. In FY24, MES also replaced three heavy-duty trucks with EPA Tier 2 diesel emissions, and seven pieces of diesel equipment operating at the DMCF's with equipment that meets newer more stringent diesel emissions standards (EPA Tier 4 final requirements). In FY25, MES will be continuing our implementation of ZEVs and equipment with two additional fully electric half-ton pickup trucks and a full electric zero-turn mower.

3.3 Environmental Operations Projects

Midshore I Landfill - Sterling Gas Engine

In collaboration with Qnergy, Inc. (Qnergy), and with grant funding made available by MEA, MES installed a 5.6 kW Qnergy PowerGen at the closed Midshore I landfill in August 2022. The unit uses Free Piston Stirling Engine technology to convert thermal energy to generate mechanical work. The technology is touted as being fuel agnostic, largely due to the external combustion of the fuel to heat a working gas such as helium. The working gas expands in a compression chamber and moves a

reciprocating displaced piston, which causes a power piston to move and interact with a linear alternator to produce electricity. As the gas cools and contracts, the process resets before repeating again. Qnergy's PowerGen technology is ubiquitous in the oil and gas sector providing, for example, critical power at remote production sites disconnected from the electric grid. Its application to biogas, however, was unproven until the technology was piloted at MES' Midshore I Landfill. Its use at Midshore I supplements the pre-existing LFG collection and control system through which LFG and its principal component, methane, are combusted.

Qnergy PowerGen at Midshore I Landfill

Electricity produced by the PowerGen is returned to the local grid, offsetting a portion of the site's electricity consumption. In FY24, the Maryland Public Service Commission (PSC) certified the use of LFG to produce electricity via the Qnergy PowerGen as a Renewable Energy Facility under the RPS. In FY24, the unit produced 9.4 MWh and an equivalent number of Tier 1 RECs under the RPS. Using the EPA's Greenhouse Gas Equivalencies Calculator[13], this renewable energy generation offset 2.8 MTCO2e in FY24, equivalent to removing one (1) passenger car from the roadways.

Midshore I Landfill – Carbon Offsets

The Midshore I Landfill is also registered under Verra's Verified Carbon Standard (VCS). The VCS is a widely used carbon crediting program that facilitates the verification, marketing, and trading of GHG reductions. The Midshore I Landfill generates carbon offsets under its VCS project by capturing LFG and either combusting it in the Qnergy PowerGen or flaring it. These activities destroy methane inherent in the LFG and convert it to more innocuous byproducts, such as carbon dioxide, which reduces the GHG emitted Midshore I Landfill. Carbon offsets are verified by a third-party on a vintage year (calendar year) basis. MES' collection and control of LFG at Midshore I yielded 12,200 carbon credits for vintage year 2023, each equivalent to 1 $MTCO_2e$ that has been additionally removed through the project activity.

Electric Drive Heavy Equipment

MES' Midshore II Landfill team took delivery of a new electric-drive bulldozer near the end of FY24 – a Caterpillar D6XE. This machine replaced a conventional, solely diesel-powered, waste-equipped bulldozer. The D6XE fits the bill for a landfill dozer and features a high-drive design, an advantageous trait for any landfill application.

In contrast to the machine it replaced, and conventional dozers generally, the D6XE's engine drives a generator which converts mechanical engine power into electricity. The electricity is sent to an electric motor which powers the machine's final drives. This simplified design has 90% less parts than a conventional power train and provides max torque at any speed.

CAT D6XE Delivered to Midshore II

In addition to the added torque, the D6XE is touted as being 35% more fuel-efficient than its conventional counterpart. MES projects, based on operating data from the CAT D6XE and a conventional CAT D6, that the electric-driver dozer will use 3,511 fewer gallons of diesel per year. Using the EPA's Simplified GHG Emissions Calculator[14], it will offset 37 $MTCO_2e$ annually.

Giant Miscanthus Demonstration Project

Giant Miscanthus Planting at Midshore II

A recent study led by researchers at the University of Maryland indicates that growing the perennial species *Miscanthus x Giganteus* (Giant Miscanthus) on marginal land may reduce regional climate warming and drying.[15] These reductions are driven by the plant's larger leaf canopy, which results in more solar reflection, increased evapotranspiration, and decreased sensible heat transfer.[15] At higher production yields, the crop has been shown to be a net sequester of carbon, storing up to 1 $MTCO_2e$ per acre per year in soil.[16]

Giant Miscanthus is a sterile, perennial warm season grass that is propagated by rhizome division. Stands of Giant Miscanthus can persist for up to 25 years and require few inputs after establishment relative to the grain crops that dominate Maryland farmland. It can grow up to approximately 12 feet tall and its roots can reach nearly 8 feet below ground surface.[17] Its end uses include biofuels and bioproducts, such as bedding material in poultry houses, which is becoming increasingly common on the Eastern Shore.

The Midshore II landfill has two borrow pits adjacent to the permitted disposal area. Both borrow pits have been exhausted of available soil and are considered marginal land. Typically, these exhausted borrow pits are stabilized with a mix of native plant species. However, MES sought and received approval from MDE to plant a climate-friendly perennial crop – Giant Miscanthus – in one of the borrow pits.

In November 2023, MES, with our partner Twin Maples Farms, LLC, planted approximately 15 acres of Giant Miscanthus rhizomes in an exhausted borrow pit at the Midshore II landfill. Once fully established by its third growing season, the crop may yield 7 to 12 tons per acre.[18] With net carbon sequestration proportional to crop production[15], the crop may sequester approximately 12 $MTCO_2e$ annually at the high end of expected yields.

Recycling Operations

Recycling offers significant GHG mitigation advantages, chiefly by reducing the extraction and use of virgin materials. The use of recycled materials as new product inputs often reduces the primary energy requirements associated with those products.

MES has estimated GHG emissions avoided through recycling operations we provide to our customers using the EPA's Waste Reduction Model (WARM) Tool.[19] This tool provides users with high-level GHG emissions and energy estimates by comparing baseline and alternative materials management practices. Materials management practices include source reduction, landfilling with and without flaring or energy recovery, waste combustion to energy, recycling, composting, and anaerobic digestion. The difference between baseline emissions and alternative management emissions represents the avoided or incurred emissions by implementing the alternative waste management practice(s).

The EO Group operates two MRFs on behalf of the two most populous counties in Maryland: Prince George's and Montgomery. The group also provides regional recycling of source-separated materials for

the Midshore counties, administers the recycling program at HWDC, operates the DME program on behalf of MDoA, and collects and transports BWI food waste for composting.

An analysis of estimated GHG emissions avoided by operating these recycling programs is presented in Table 3 and detailed in the subsections that follow.

Environmental Operations Project	Source Reduced *(tons)*	Recycled* *(tons)*	Composted *(tons)*	FY24 Change (Alt - Base) [e] *('MTCO$_2$E)*	Eq. Cars Removed[e] *(#)*	Eq. Home Energy Use[e] *(#)*
Montgomery County MRF[a]		41,394		(109,085)	25,445	14,650
Prince George's County MRF[a]		31,124		(93,810)	21,882	12,598
Midshore Regional Recycling Program[a]		3,168		(8,224)	1,918	1,104
Harford Waste Disposal Center[a]		2,065	18,505	(3,153)	735	423
MDoA Durable Medical Equipment Program[a,b]	116	50		(218)	51	29
BWI Food Scraps[a, c]			130	(3)	1	0
Prince George's County Organics Composting Facility[d]			96,460	(8,864)	2,068	1,190
Totals	116	77,802	152,719	**(221,319)**	**52,100**	**29,995**

a - Material amounts represent sold and/or outbound tonnages for FY24

b - Emissions reductions from source reduced (repurposed) durable medical equipment not captured in WARM estimate.

c - BWI food waste excluded from Prince George's County Organics Composting Facility emission reduction calculation.

d - Includes only composting of food waste and grass, those materials that result in a net reduction of GHG emissions compared to the baseline scenario of landfilling.

e - Estimated emission reductions based on the implemented waste management alternative for the project relative to baseline emissions for landfilling or waste-to-energy, depending on the project.

Table 3 - Estimated Avoided GHG Emissions by Implementing the Alternative Relative to the Baseline Waste Management Practice ($MTCO_2e$)

Montgomery County MRF – Carbon Emissions Modeling

The Montgomery County MRF is a dual stream recycling facility which MES has been operating since 1999. Montgomery County residents separate their recyclables into two separate categories: paper/cardboard and glass/plastic/metals. Separating the recyclables into two separate streams results in less contaminated end products that can be better marketed for resale.

Montgomery County MRF recycling data for FY24 is shown in Table 4. Compared against a baseline of combusting all recycled material at the Montgomery County Resource Recovery Facility (MCRRF), except ferrous and non-ferrous metals, operation of the Montgomery County MRF reduced GHG emissions by an estimated 109,085 $MTCO_2e$. It should be noted that this analysis assumes that all ferrous and non-ferrous metals from ash produced at the MCRRF are recycled.

Commodity	FY24 Tonnage Recycled	Avoided Emissions ($MTCO_2e$)
Corrugated Containers	16,056	(42,763)
Mixed Paper (general)	19,202	(58,983)
HDPE	948	(1,985)
PET	1,719	(3,960)
PP	202	(431)
Mixed Plastics	218	(484)
Aluminum Cans	491	0
Steel Cans	971	0
Glass	1,586	(480)
Totals =	**41,394**	**109,085**

Table 4 – EPA WARM Carbon Emissions Modeling Results, Montgomery County MRF

Prince George's County MRF – Carbon Emissions Modeling

The Prince George's County MRF is a single stream system located in Capital Heights that provides recycling services for material collected from approximately 300,000 homes in the county. WARM modeling performed for the Prince George's County MRF was compared against a baseline of disposing the materials at the Brown Station Road Landfill. A summary of recycled commodities managed at the Prince George's County MRF and their respective avoided emissions is presented in Table 5 below.

Commodity	FY24 Tonnage Recycled	Avoided Emissions ($MTCO_2e$)
Corrugated Containers	14,074	(42,979)
Mixed Paper (general)	11,200	(37,724)
HDPE	1,013	(789)
PET	2,547	(2,690)
PP	538	(438)
Mixed Plastics	242	(229)
Aluminum Cans	486	(4,443)
Mixed Metals	1,024	(4,518)
Totals =	**31,124**	**(93,810)**

Table 5 – EPA WARM Carbon Emissions Modeling Results, Prince George's County MRF

Midshore Regional Recycling Program

The Midshore Regional Recycling Program (MRRP) is a cooperative partnership between Caroline, Kent, Queen Anne's, and Talbot Counties that was established in 1993. The MRRP is a residential recycling drop-off program that allows residents of the four Midshore service counties to drop off their separated paper, cardboard, metal cans, and glass at one of thirty-five separate locations throughout the region.

These source-separated recyclables are collected, transported, marketed, and sold by MES on behalf of the Midshore counties. In addition, the MRRP manages the residential electronics drop-off and recycling program on behalf of the Midshore counties.

In FY24, MES delivered 3,168 tons of materials to local recycling markets via the MRRP, offsetting an estimated 8,224 $MTCO_2e$ of GHG emissions (Table 6). The baseline scenario evaluated was the disposal of these materials at the Midshore II Landfill.

Commodity	**FY24 Tonnage Recycled**	**Avoided Emissions ($MTCO_2e$)**
Corrugated Containers	1,231	(4,480)
Mixed Paper (primarily residential)	628	(2,422)
Mixed Plastics	415	(392)
Mixed Electronics	53	(49)
Mixed Metals	153	(677)
Glass	688	(204)
Totals =	**3,168**	**(8,224)**

Table 6 – EPA WARM Carbon Emissions Modeling Results, Midshore Regional Recycling Program

Harford County Integrated Solid Waste Management

The EO Group has been providing solid waste management services for Harford County since 2015. These services include:

- Operation of the County's Landfill and Homeowner Drop-Off Center
- Yard Waste Composting
- Single Stream Recycling Services
- Litter Control and Adopt-a-Road Programs
- Recycling Education and Outreach
- Engineering and Procurement Services

Curbside recycling material brought to the homeowner's drop-off site at the Harford Waste Disposal Center is transported to a transfer station and then to a commercial recycling facility in Baltimore County. Waste management data was input into the EPA's WARM model and compared to the baseline scenario of landfilling. An estimated 3,153 $MTCO_2e$ emissions were avoided because of Harford County's recycling programs (Table 7).

Commodity	FY24 Tonnage Recycled	FY24 Tonnage Composted	GHG Emissions Compared to Baseline ($MTCO_2e$)
Food Waste (non-meat)	NA	10	(6)
Yard Trimmings[a]	NA	18,496	1,575
Mixed Plastics	3	NA	(2)
Mixed Electronics	66	NA	(61)
Mixed Metals	29	NA	(129)
Structural Steel	1,381	NA	(2,691)
Mixed Recyclables	587	NA	(1,838)
Totals =	**2,065**	**18,505**	**(3,153)**

a. Includes all sold material mulched or composted for WARM modeling purposes.

Table 7 – Carbon Emissions Avoided Due to Recycling Programs Harford County Solid Waste

Durable Medical Equipment

Many residents of Maryland require the use of DME, such as wheelchairs, walkers, shower chairs, and other assistive devices to maintain their safety and mobility. Often the cost of this equipment is a serious burden, not only to uninsured residents, but also to insured residents whose insurance approvals are delayed or denied. To address this need, the MDoA has developed an innovative statewide DME reuse program that provides medical equipment at no direct cost to Maryland residents in need.

DME can be donated to any of the 18 collection locations across the state, and, additionally, the program can make direct residential and commercial curbside pickups of bulk DME donations.

MES operates the DME program on behalf of MDoA. In FY24, the program recycled 49.5 tons of mixed metals from medical equipment that could not be repurposed. Compared against a baseline waste management scenario of landfilling, and using the EPA's WARM tool, the recycling of these materials resulted in 218 $MTCO_2e$ of avoided GHG emissions.

Organics Composting

Organics composting is a key strategy employed in Maryland to reduce methane emissions from landfills. In addition to diverting organic wastes, such as food waste and yard waste, from the landfill or waste incinerator, composting also recycles nutrients and sequesters carbon into soil, and plays a role in the circular economy.

Food waste management continues to present an opportunity for reducing GHG emissions nationally. In 2018, the EPA estimated that 63 million tons of food waste were generated as part of their MSW inventory.[20] Most of this food waste was landfilled, and only 4% composted, as depicted in Figure 5. When food and other organic materials decompose in a landfill under anaerobic conditions, bacteria break down the materials and generate methane. Methane is a potent, short-lived, GHG, the generation of which is minimized when composting occurs under aerobic conditions.

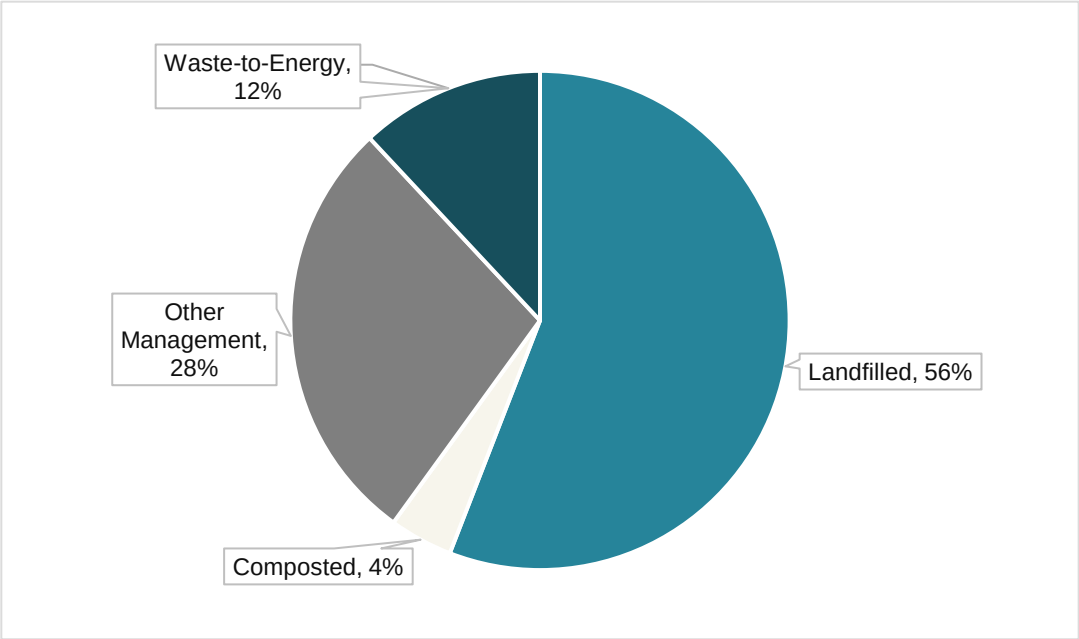


Figure 5 - US Food Waste Management, 2018 (adapted from EPA, 2024)

MES operates several large composting facilities that generate high-quality, marketable material. These include the Prince George's County Organics Composting Facility, the Montgomery County Yard Trim Facility, and, as previously detailed, the HWDC. In addition, MES collects food waste from BWI and transports this material to food waste composting and anerobic digestion facilities in the state.

Prince George's County Organics Composting Facility

MES continues to operate the Prince George's County Organics Composting Facility in Upper Marlboro. Yard waste is composted in windrows and converted into a dark, humus-like material that MES markets as Leafgro®. MES utilizes the GORE® in-vessel aerated pile system, as shown in the image below, to convert food waste processed at the facility into Leafgro GOLD®. MES sold 18,817 tons of Leafgro GOLD® and 7,762 tons of Leafgro® in FY24.

MES used the EPA's WARM model to determine the GHG emissions avoided by composting the food waste in lieu of landfilling as the baseline scenario. A total of 16,350 tons of food waste were composted at the facility in F24 resulting in 7,874 $MTCO_2e$ of GHG emissions avoided. Because the baseline scenario of landfilling at the Brown Station Road Landfill includes LFG energy recovery, the WARM results produced for composting most of the remaining materials (e.g., yard waste) received at the facility resulted in a net increase GHG emissions (Table 8).

Food Waste Composting System at Prince George's County Organic Composting Facility

Commodity	FY24 Tonnage Composted	GHG Emissions compared to Baseline ($MTCO_2e$)
Food Waste	16,350	(7,874)
Yard Trimmings	55,910	9,436
Grass	5,778	(990)
Leaves	18,414	9,052
Branches	8	5
Totals =	**96,460**	**9,629**

Table 8 – Carbon Emissions, Alternative to Baseline Waste Management, Prince George's County Organic Composting Facility

Montgomery County Yard Trim Composting Facility

The Montgomery County Yard Trim Composting Facility is located near Dickerson and has been in operation since 1983. Leaves, grass, and yard trim collected in Montgomery County are accepted at this site where it is composted using windrow composting. Finished compost produced at the site is sold in both bulk and bagged form by MES staff as the trademarked Leafgro® product. MES staff sold a total of 19,083 tons of compost in bulk, and 649,900 bags (17,820 tons). The bagged Leafgro® compost is a popular organic product sold at garden centers and retail operations in the Mid-Atlantic region.

MES modeled the net GHG emissions of the composting operations at the Montgomery County Yard Trim Composting Facility compared to a baseline of disposing the materials at the MCRRF. It should be noted that WARM does not account for carbon dioxide emissions when combusting biomass such as yard trimmings because it is considered a biogenic source of emissions.[21]

A summary of the WARM modeling results is given in Table 9. The WARM modeling results indicate GHG emission reductions of 6,023 $MTCO_2e$ for WTE (baseline), and 3,985 $MTCO_2e$ for composting (implemented alternative).

Management Practice	FY24 GHG Emissions Comparison ($MTCO_2e$)
WTE	(6,023)
Composting	(3,985)
Net (Composting – WTE)	2,039

Table 9 – Carbon Emissions, Alternative to Baseline Waste Management, Montgomery County Yard Trim Compost Facility

BWI Food Scraps

MES collects food scraps from the BWI Airport and transports them to food waste composting facilities in the state. In FY24, MES collected 130 tons of food waste at BWI and estimates that BWI food waste composting resulted in three MTCO2e of avoided emissions, compared to the baseline scenario of WTE at the Baltimore Refuse Energy Systems Company (BRESCO) in Baltimore, MD.

3.4 Technical and Environmental Services Projects

Solar Feasibility for State and Local Government

MEA, through their Solar Technical Assistance Program, provides technical assistance at no direct expense to state entities and local governments for solar site surveys and preliminary project development. The technical assistance is initiated upon the submittal of a request to MEA and, if approved, is thereafter passed on to MES who provides the technical assistance or, jointly with MEA, selects a technical service contractor.

Technical assistance includes, for example, photovoltaic array sizing and siting, shading, estimated solar electricity generation, system costs, and return on investment. An example of Solar Access Assessment Data is shown as Figure 6. By providing this essential service, MES is helping local governments make informed decisions on incorporating solar energy.

Montgomery County Yard Trim Composting Facility

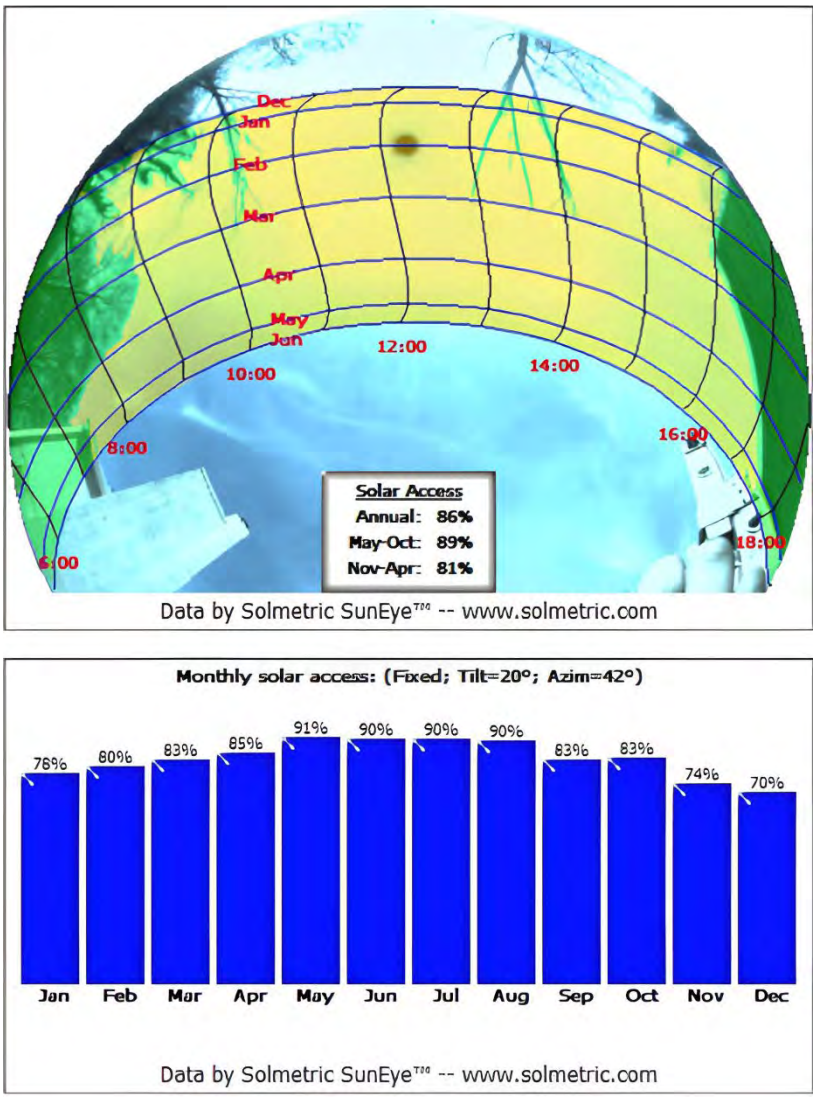


Figure 6 – Example Solar Access Assessment Data for a Local Government

Five Million Trees for Maryland

The State of Maryland, via the Tree Solutions Now Act of 2021, has set an ambitious goal of planting five million trees on public and private land by 2031. MES assists MDE in progressing toward this goal by developing a tracking database, public reporting tools, and an ArcGIS hub site for the Five Million Trees Initiative. Figure 7 shows the progress of this initiative through October 31, 2024. MES also assists with data entry and quality assurance/quality control of tree plantings performed by other state agencies.

Trees offer countless benefits to the state. They sequester carbon by absorbing carbon dioxide during photosynthesis and store it in their tissue. Their root systems stabilize the soil, reducing erosion, while also absorbing essential nutrients like nitrogen and phosphorus, which reduces runoff of sediment and nutrients into waterways.

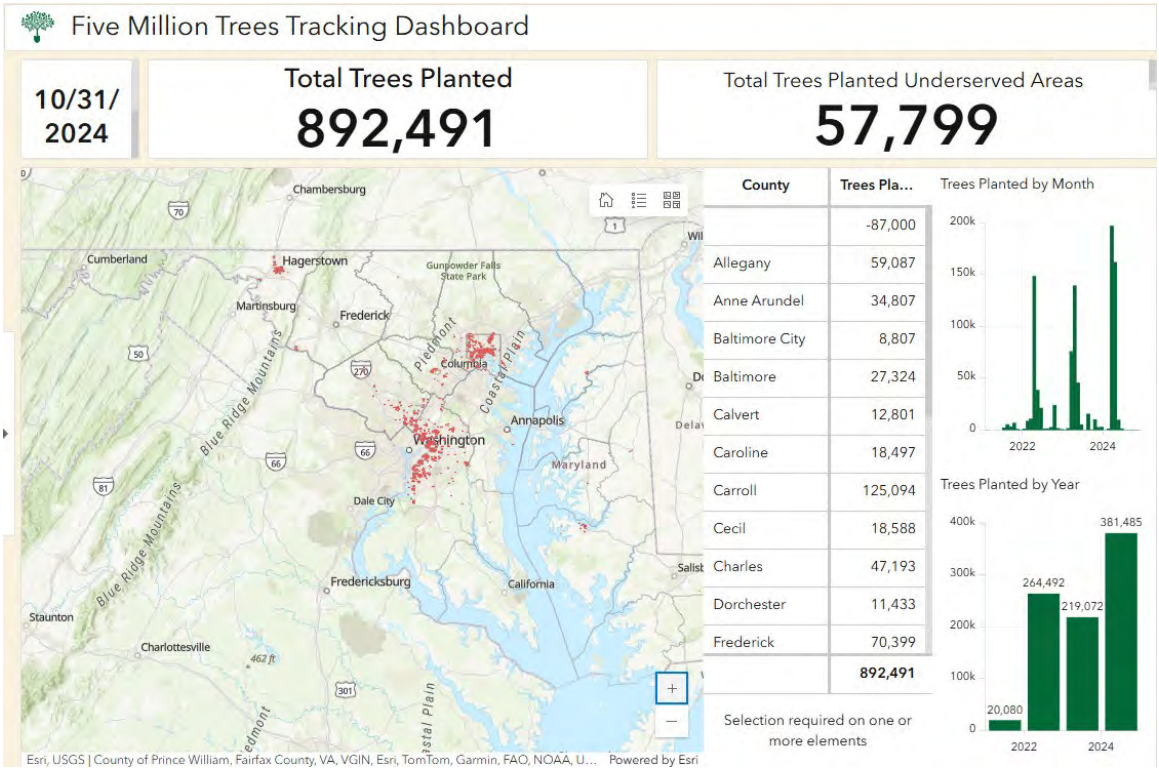


Figure 7 – Five Million Trees Initiative Tracking Dashboard

3.5 Water and Wastewater Program Projects

Biosolids Program GHG Impacts

MES operates 67 municipal WWTPs encompassing a wide range of capacities and treatment technologies. Untreated sludge, or alternatively treated biosolids, generated from these sites are handled using a diverse array of management practices. MES' biosolids management regime includes transporting untreated sludges from most of the smaller capacity WWTPs to one of three larger, regional facilities. Once those sludges are received at our regional facilities they are dewatered and treated further using lime stabilization. This process treats the sludges and reduces the pathogens in the final product to meet EPA and MDE standards to make it suitable for land application onto farmland. The final lime-stabilized product is then transported, and land applied by a contractor to farms in Virginia.

The agricultural community endorses the reuse of treated biosolids and values the product for its nutrient content and soil conditioning properties. Approximately 54% (expressed on a dry solids basis) of the biosolids generated by all of MES' facilities are recycled beneficially in this manner. This mirrors biosolids practices nationwide.[22]

The biosolids management carbon footprint for MES' facilities was calculated using the Biosolids Assessment Emissions Model (BEAM, version 2.0).[23] This model was originally developed by the Canadian Council of Ministers of the Environment in 2009, and further refined to its current version by the Northeast Biosolids and Residuals Association (NEBRA) in 2022. BEAM is the standard method of choice for biosolids management practitioners for determining the carbon footprint of each practice. Assumptions used in the BEAM model are given in Table 10.

One of the advantages of land application is sequestering carbon in the soil and offsetting the GHG emissions when substituting biosolids for commercial fertilizers.[24,25] Biosolids land application is also endorsed by the EPA, most state environmental agencies, and universities.

In order to determine the GHG mitigation impact from land applying biosolids, MES calculated the carbon footprint using BEAM for two scenarios: first, the current practice of land applying biosolids from our three regional facilities at the Dorsey Run, Freedom District, and MCI WWTPs, and, second, a hypothetical scenario where the biosolids from these three facilities would be landfilled instead of land applying the material. The difference in carbon footprints for these two scenarios indicates the expected GHG emissions avoided by land applying instead of landfilling. The results for these scenarios are presented in Tables 11 and 12, respectively. Comparing the carbon footprint for the landfilling option versus beneficial reuse (current practice of land application) shows that 8,300 $MTCO_2e$ was avoided by reusing biosolids for agricultural land application. This has the same impact as removing 1,936 gasoline-fueled passenger cars from the public roadways on an annual basis.

Sequestering the biosolids carbon via land application instead of it being released as LFG at a landfill and avoiding the use of chemical fertilizers at the farm where the material is applied, results in a net negative carbon balance.

Item	**Assumptions**
Biosolids Tonnages and Analytical Data	FY 24 data from MES in-house databases
Land Application Site Locations	Assumes Culpeper, Va.
Landfills - for Cambridge and ECI	Landfills used for Cambridge, ECI assume no LFG utilization for energy
Landfill - for La Plata	Assumes disposal to King George County, Va. Landfill; uses LFG utilization for energy
Landfill Option for Dorsey, Freedom, and MCI WWTPs	Assumes disposal to King George County, Va. Landfill; uses LFG utilization for energy
Polymer Usage	Assume 38 lb./day (from MES data for select WWTPs)
Lime stabilization dosage	Assumes 0.25 T lime/dry ton sludge treated (typical value)
Electricity for lime stabilization	Assumes negligible electrical use
U.S. Department of Energy eGrid region	SERC Virginia/Carolina - weighted GHG emissions = 284 g/kwh generated (published data)
Global Warming Potential (GWP)	GWP = 20; as per Maryland Commission on Climate Change (MCCC)

Average Truckload Weight	20 wet tons = 18 mt
Pathogen Treatment	Class B (for both land app and landfilling)
Bulk density of lime stabilized biosolids	50 lb./cu. ft = 881 kg/m3
Class 8 Heavy Duty Truck Fuel Efficiency	6.6 miles/gallon diesel fuel
BEAM default values	Where indicated in model

Table 10 – Assumptions Used – BEAM Model

	Annual Amount Generated - FY 24		Current Practice	
Facility Name	**Wet Tons/yr.**	**Dry Tons/yr.**	**Management Method**	**MTCO2e /year**
Cambridge WWTP	3,259	536	Landfilling	4,813
Deep Creek Lake WWTP	432	97	Landfilling	518
Eastern Correctional Institution (ECI) WWTP	525	97	Landfilling	315
La Plata WWTP	1,599	291	Landfilling	2,298
Dorsey Run AWWTP	1,011	229	Class B Land Application	120
Freedom District WWTP	3,097	894	Class B Land Application	382
Maryland Correctional Institution (MCI) WWTP	1,679	325	Class B Land Application	144
WWTPs - Transportation Practice Only	13,267	209	Transportation to Other WWTPs	34
Totals =	**24,869**	**2,678**		8,624

Table 11 – Carbon Footprint for MES WWTPs, Current Practice – Land Application

	Annual Amount Generated - FY 24		Hypothetical Landfilling Practice	
Facility Name	**Wet Tons/yr.**	**Dry Tons/yr.**	**Management Method**	**MTCO2e / year**
Cambridge WWTP	3,259	536	Landfilling	4,813
Deep Creek Lake WWTP	432	97	Landfilling	518
Eastern Correctional Institution (ECI) WWTP	525	97	Landfilling	315
La Plata WWTP	1,599	291	Landfilling	2,298
Dorsey Run AWWTP	1,011	229	Landfilling	1,214
Freedom District WWTP	3,097	894	Landfilling	5,215
Maryland Correctional Institution (MCI) WWTP	1,679	325	Landfilling	2,517
WWTPs - Transportation Practice Only	13,267	209	Trucked to Other WWTPs	34
Totals =	**24,869**	**2,678**		**16,924**

Table 12 – Carbon Footprint for MES WWTPs, Hypothetical Practice – Landfilling Instead of Land Application

3.6 Initiatives at MES Headquarters (HQ)

Solar Array at MES Headquarters

Solar arrays consisting of both ground and roof mounted thin film solar panels were installed at MES Headquarters (HQ) in 2008. These arrays were augmented in 2016 with a 300-kilowatt (kw) canopy-type solar array that was installed in portions of the MES headquarters parking lot. The aggregate power rating of MES' headquarters solar arrays is 599 kW.

Monthly performance data of our solar arrays is presented in Figure 8. Predictably, our solar arrays' FY24 monthly capacity factors were highest in the summer and lowest in the winter, averaging 11 percent on an annual basis. MES currently has a Power Purchase Agreement with Luminace Inc.

A total of 564,317 kwh was produced (as measured at the panel meters) in FY24. Using the EPA's on-line Greenhouse Gas Equivalencies Calculator, one can estimate the carbon emissions avoided for various mitigation strategies: in this case, from generating solar energy. This amount of solar energy is equivalent to the avoidance of 168 $MTCO_2e$ per year, which corresponds to removing 39 passenger cars from public roadways for one year.

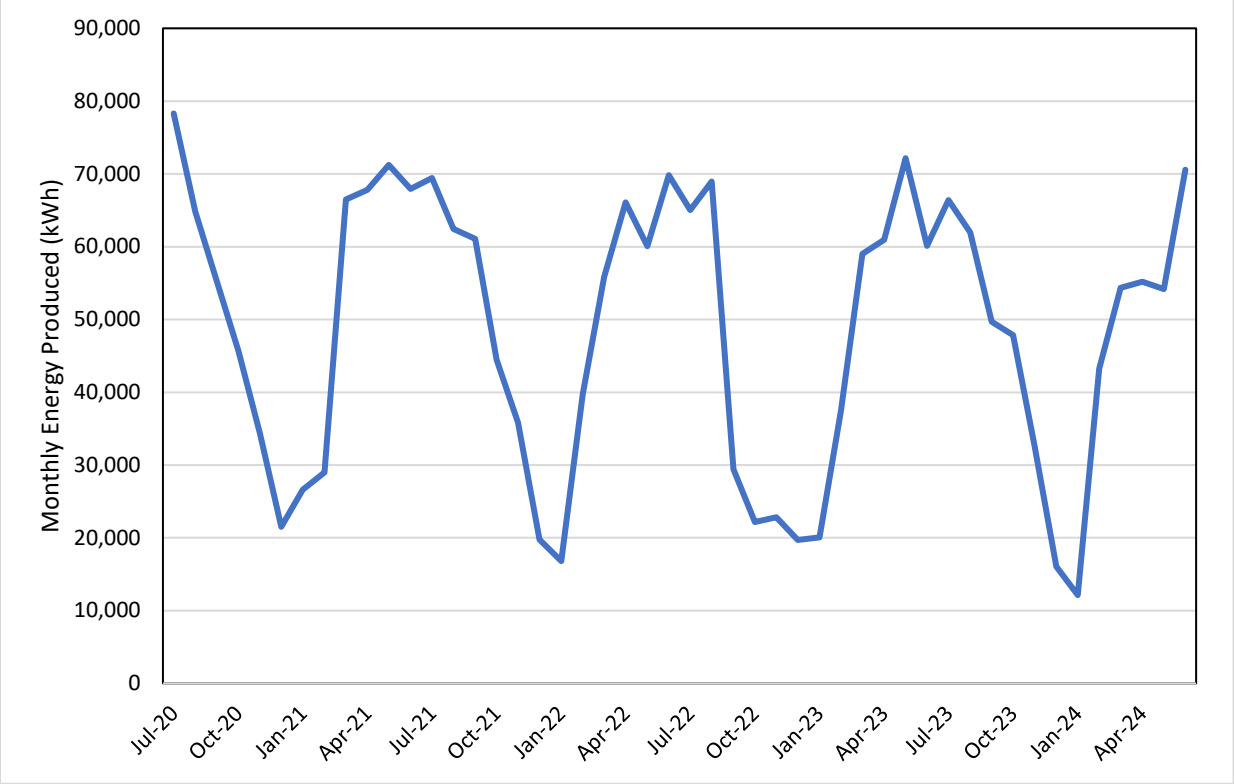


Figure 8 – Headquarters Solar Performance, FY21 – FY24

MES' headquarters solar system is registered with the Maryland PSC and is registered in PJM's GATs. As a Tier 1 renewable energy source, the solar arrays at MES headquarters generate not only clean energy but also Solar Renewable Energy Certificates (SRECs). With one SREC generated for each MWh of energy produced, the system generated 564.3 SRECs in FY24.

Electrification of Fleet Vehicles

MES has procured three BEVs, or all-electric vehicles, and one PHEV, for fleet use. A 2022 Chevrolet Bolt, 2023 Ford MACH E, and hybrid 2024 Mitsubishi Outlander are assigned to the MES pool for use at Headquarters, whereas the Ford Lightning is assigned to W/WW's Western Region. In addition, MES purchased two Ford F-150 Lightning® all electric half-ton pickup trucks for use by our EDR Group at MPA facilities.

Using U.S. Department of Energy missions estimates for each current EV and PHEV[26], carbon emissions estimates for the EVs and PHEVs, as well as a comparison to a comparable gasoline powered internal combustion vehicle, are quantified for FY24 **(**Table 13). Assuming the upstream power generation mix in MES' zip codes, the use of EVs and PHEVs in FY24 resulted in the avoidance of 10.4 MTCO2e compared to gasoline powered vehicles.

		EV Emissions		Conventional Vehicle Emissions		
Vehicle	**FY24 Mileage**	**Estimated Emissions (g CO_2/mi)**	**Total Emissions ($MTCO_2e$)**	**Average Estimated Emissions (g CO_2/mi)**	**Total Emissions ($MTCO_2e$)**	**Emissions Avoided $MTCO_2e$**
Chevy Bolt (HQ)	9,900	96	1.0	400	4.0	3.0
Ford Lightning F-150 (HQ)	13,112	169	2.2	400	5.2	3.0
Ford MACH - E (W/WW)	11,700	138	1.6	400	4.7	3.1
Ford Lightning F-150 (EDR)[a]	1,538	169	0.3	400	0.6	0.4
Ford Lightning F-150 (EDR)	2,601	169	0.4	400	1.0	0.6
Mitsubishi Outlander (HQ)	9,200	263	2.4	400	3.7	1.3
		Totals =	**7.9**		**19.2**	**11.3**

a Replaced a 1-ton diesel pick-up truck. The average estimated emissions used for this analysis are from gasoline vehicles.

Table 13 – MES Electric Vehicle Emissions

Telecommuting Impact on GHG Emissions

MES has continued the hybrid work policy for agency headquarters staff since 2020 in response to the lifestyle changes that resulted during the COVID-19 pandemic. This policy provides a climate change mitigation benefit by reducing the state's transportation emissions and a secondary benefit of reducing traffic congestion. The transportation sector accounts for the second highest GHG emissions in the state.

In October 2023, MES solicitated commute data from headquarters employees. Requested information included round-trip work commute distance and average number of days worked in the office and at home, respectively. Avoided total commute miles were used to estimate avoided annual GHG emissions due to telecommuting.

The 2023 survey had 142 respondents, which constituted most of headquarters-based staff. The results of the survey indicate that MES' telecommuting policy resulted in 827,580 vehicle miles that would have otherwise occurred and 321 $MTCO_2e$ in avoided emissions. This is equivalent to fully removing 72 passenger cars per year from the roadways.

MES replicated the 2023 telecommuting survey, with a few minor changes, in October 2024. A total of 165 headquarters-based employees responded to the survey. Several assumptions were made to calculate avoided commute miles due to the agency's telecommuting policy. These included a fifty-week work year, a five-day work week, and the use of passenger cars and light trucks for all commutes. Employees utilizing BEVs had avoided GHG emissions zeroed, whereas the avoided GHG emissions for those employees using PHEVs were halved. The survey also assumed that the work year was 50 weeks in length, to account for leave time. It also does not include those MES staff who work in field assignments, since they are usually required to report to a worksite each day.

The results of the October 2024 survey indicate that agency's teleworking policy resulted in 728,015 avoided miles on an annualized basis. Using an average EPA fuel efficiency of 22.8 miles per gallon (mpg) and a combustion value of 0.009 $MTCO_2e$ per gallon of fuel combusted, a total of 31,390 gallons of fuel and 284 $MTCO_2e$ were avoided on an annualized basis. This is equivalent to removing 66 passenger cars per year from the roadways.

The results of the 2024 teleworking survey were similar to 2023, with the slight reduction in avoided GHG emissions attributed to the 15 BEVs and PHEVs identified in the survey and used by our employees. These findings indicate that MES is, where feasible, contributing to meaningful reductions in the agency's transportation emissions footprint.

4. Quantifying MES' Carbon Footprint

MES sets organization-wide goals every fiscal year as part of our Building Excellence and Success Together (BEST) program. As part of the BEST program, MES first established the goal of baselining the carbon footprint in calendar year 2022. This effort was repeated for calendar year 2023. The objective of quantifying MES' carbon footprint is to better understand the driving forces of GHG emissions for each group and, based on this information, set actionable plans to reduce our carbon intensity in the future.

In FY24, MES modified the inventory period of our internal GHG estimate, bookending it with the fiscal year rather than the calendar year to better align with the periodicity of data capture for most of our operations. To enhance the quality of our effort, MES retained Paramount Energy Services, Inc. to perform a data quality evaluation and to provide guidance on improving the accuracy and repeatability of our agency-wide estimates. Paramount provided the following findings and conclusions, among others, which will be incorporated into our FY25 GHG inventory:

1. Incorporate reporting guidance using Standard Operating Procedures (SOPs), including SOPs for non-standard emission sources.
2. Clearly demarcate "in-scope" assets for the agency following the control approach of the GHG protocol. Clarify asset ownership, as it pertains to GHG reporting, with client-partners to ensure that GHG emissions are not double-counted or missed.
3. Limit reporting of GHG emissions for the next several cycles to only scope one and scope two emissions. These emission scopes of under the purview of MES, whereas most scope three emissions are not.
4. Report gross electricity consumption in accordance with the GHG protocol for behind-the-meter and net-metering applications.

Paramount opined that it may take three to five rigorous reporting cycles to comprehensively report on the agency's scope one and two emissions.

4.1 FY24 GHG Estimate

The approach to estimating FY24 GHG emissions remained largely unchanged from prior iterations. Each operating group internally defined projects and assets for GHG quantification. Standardized, simplified emission calculators were used for GHG estimation where feasible including, most notably, the EPA's Simplified GHG Emissions Calculator and, for the W/WW Group, the EPA's Local Greenhouse Gas Inventory Tool for WWTPs. Generally, these emission calculators use published emissions factors to estimate carbon emissions per unit of activity.

Figures 9 through 12 provide detail on the estimated emissions from each of the agency's operating arms, with the exception of EDR, and headquarters during FY24.

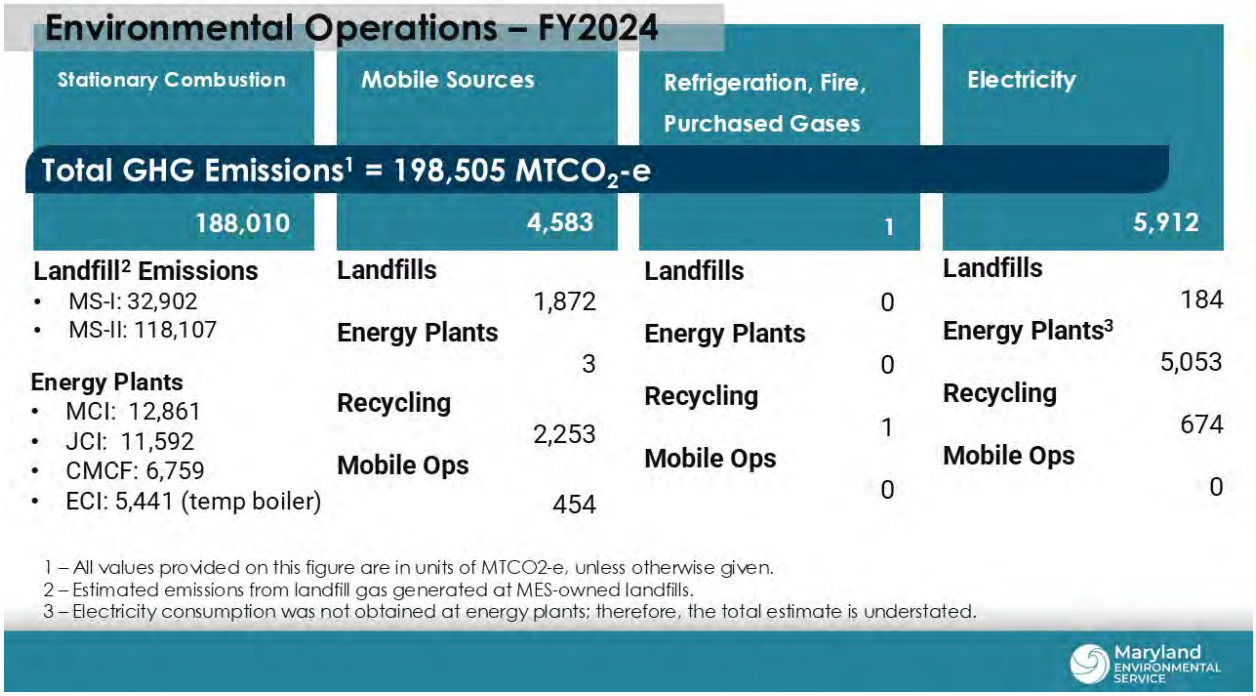


Figure 9 – Estimated GHG Emissions by EO, FY24

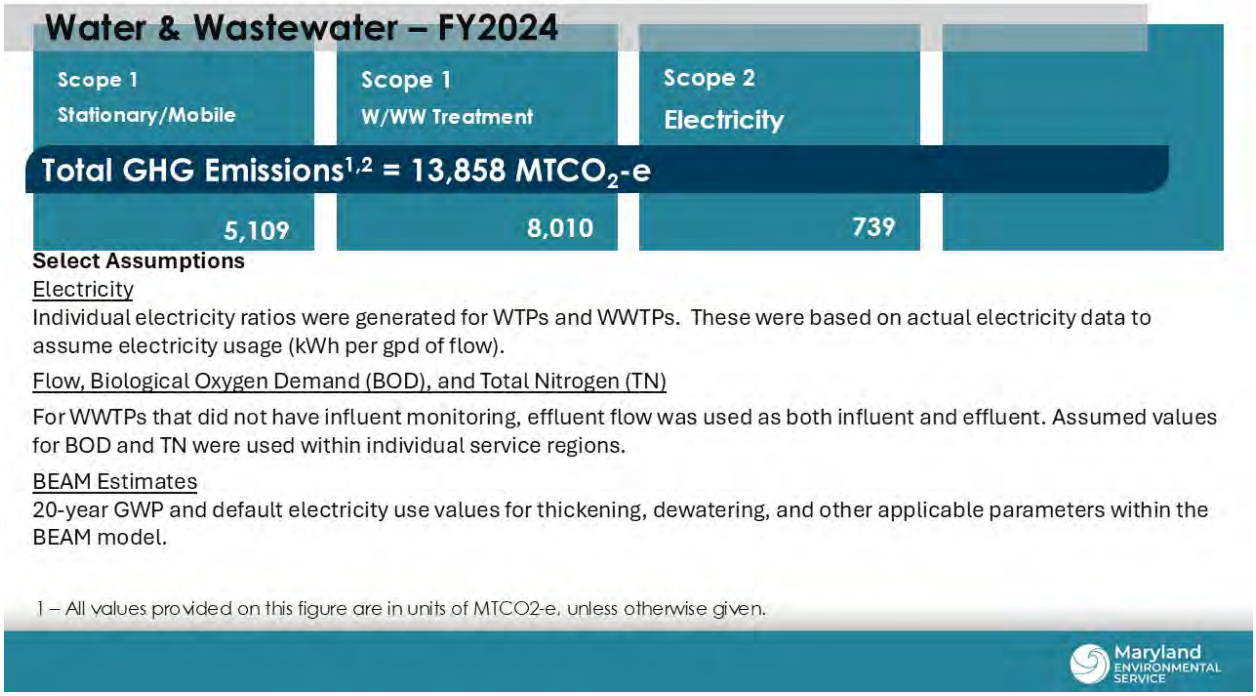


Figure 10 – Estimated GHG Emissions by W/WW, FY24

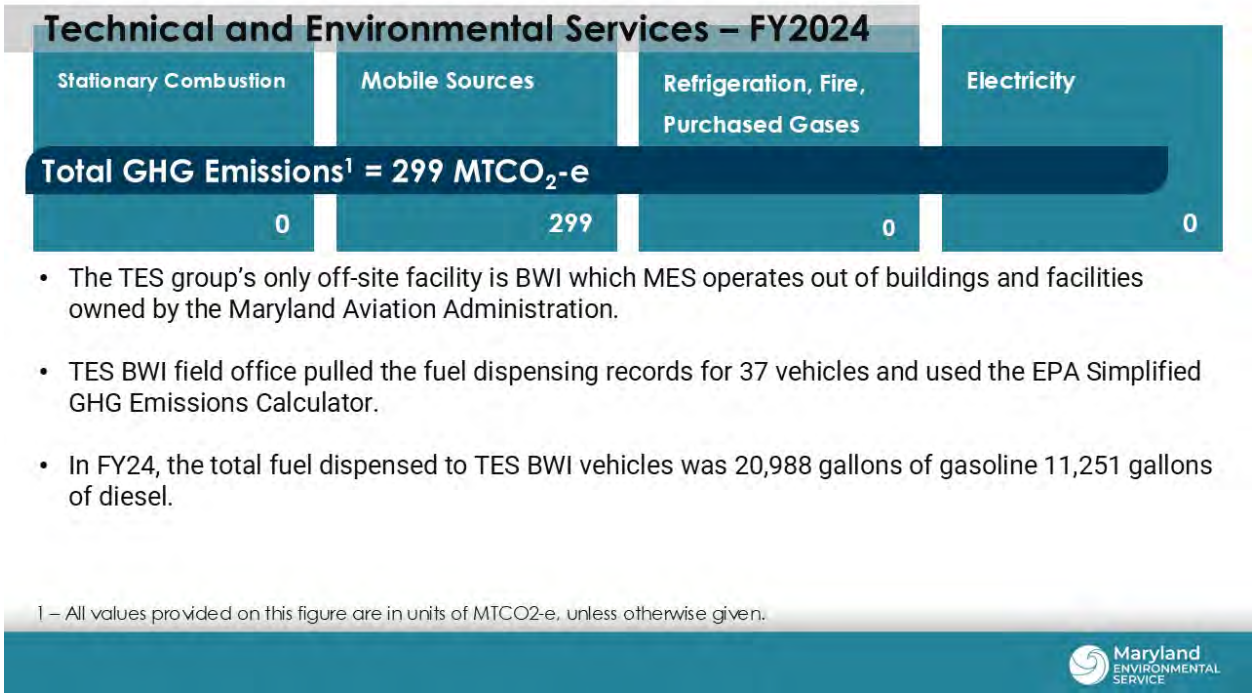


Figure 11 – Estimated GHG Emissions by TES, FY24

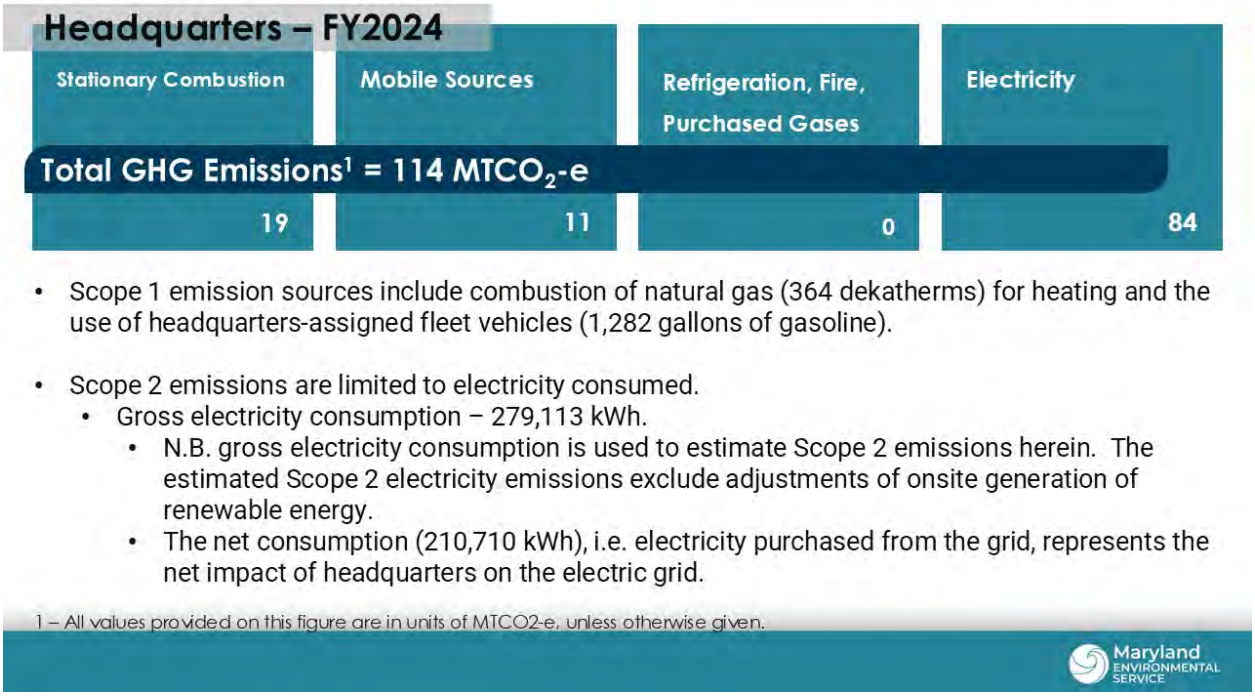


Figure 12 – Estimated GHG Emissions by HQ, FY24

MES estimates that agency-wide GHG emissions were 214,936 $MTCO_2e$ in FY24. The bulk of the emissions are from stationary sources, principally LFG-associated emissions at MES-owned landfills (70%) and GHGs emitted at the energy plants we operate (17%). Emissions from mobile sources account for 7% of the total estimated FY24 GHG emissions. Heavy equipment operations at our EDR field sites and waste management facilities contribute the most to this category.

The FY24 GHG emission estimate represents a decrease of 59,615 $MTCO_2e$ compared to our calendar year (CY) 2022 estimate, which was provided in MES' prior *Reduction in Greenhouse Gas Emissions Report* published in December 2023. The causes of the observed change between the two periods include, but are not limited to:

- ECI Cogeneration Facility – Boiler Fuel Conversion
  MES kicked off the boiler fuel conversion project at the ECI Cogeneration Facility in July 2023. The boilers are being converted to use natural gas as the primary fuel rather than wood chips. Natural gas is a reliable, energy dense, relatively clean fuel, the use of which will annually offset the harvesting, transportation, and combustion of 55,000 tons of wood fuel at the facility.

  Electricity sourced from the grid and from temporary generation supplied ECI with its power needs during the portion of the boiler fuel conversion project that occurred in FY24. FY24 emissions generated from stationary combustion at the Cogeneration Facility were, consequently, reduced significantly, by 72,733 MTCO2e compared to those produced in CY22. Although GHG emissions from purchased electricity roughly doubled from CY22 to FY24, the increase only amounted to 2,477 MTCO2e. Accordingly, maintenance downtime of the ECI Cogeneration Facility reduced GHG emissions by nearly 70,000 MTCO2e. MES expects that the completed fuel conversion will reduce GHG emissions from the facility; however, the magnitude of the GHG reduction observed in FY24 is not expected to continue with the facility coming back online in FY25.

- W/WW – Modification of Scope 2 Estimation Methods
  In the CY22 estimate, literature values were used to estimate GHG emissions associated with purchased electricity. These values (2,000 and 1,200 kWh/MG treated for water and wastewater, respectively), were considerably higher than actual electricity consumption rates that were obtained from several of the treatment plants. Actual electricity consumption rates formed the basis of the FY24 GHG estimates for consumed electricity. This contributed to a reduction of approximately 25,000 MTCO2e from CY22 to FY24.

MES has closed some data gaps since our initial GHG baseline prepared for CY22, yet several remain, including:

- Electricity use at many WTPs and WWTPs continues to be estimated from empirical data collected from a limited number of facilities. At other facilities, electricity usage data, and therefore GHG emissions from electricity production, are omitted entirely.
- Emissions from some emission-generating infrastructure owned by our client-partners was excluded from this analysis. An example is the GHG emissions generated from the landfill at HWDC. Better delineation of in-scope assets is needed in the future.

- Raw data used to produce the FY24 GHG estimate were collected, aggregated, and reviewed by MES employees not experienced in calculating GHG emissions or carbon accounting. The FY24 GHG estimate was not fully third-party validated.

5. Future Carbon Emissions Mitigation Projects

5.1 Fleet Projects, EV Program

MES has awarded a contract to Blue Whale EV, LLC to design and install a new electric vehicle supply equipment (EVSE) system at our Headquarters facility. Installation of the system will enable MES to grow our EV fleet. The initial phase will include 10 Level II charging ports, two direct current fast charge (DCFC) charging ports, and new electrical infrastructure that will allow MES to grow our electric vehicle charging capacity to 50 ports in future phases. It is expected that MES will begin installation of the twelve new charging ports in 2025, with operations beginning in Spring 2026. MES intends to procure additional EVs and PHEVs concurrent with the EV infrastructure improvements at Headquarters.

In addition to the electrification of the passenger fleet, MES continues to seek opportunities to incorporate hybrid (electric drive) heavy equipment into their operations. This style of equipment has seen increased market penetration and has several advantages over traditional machinery. These include greater fuel efficiency, and by extension a lower carbon intensity, reduced noise levels, and greater torque.

Blink 180kW DC FastCharger

5.2 Beneficial Use of Landfill Gas at Midshore II

MES and the Midshore counties executed a Memoranda of Understanding to extend the service period of the Midshore II Landfill beyond the previously established contractual closure date of 2030. The Midshore II Landfill will now accept MSW until it has reached its permitted capacity of 7.8 million cubic yards, or approximately 4.68 million tons of waste. MES projects that the landfill's service life will now extend into the early 2040s. The service period extension has ecological value in that it enables the Midshore counties and their constituents to use an existing resource rather than potentially constructing a new landfill, Midshore III, on a greenfield in Queen Anne's County.

The service period extension will also provide a larger feedstock for LFG generation. While this may seem counterintuitive, additional waste-in-place and a longer term for waste placement is advantageous for the control and beneficial use of LFG. Larger volumes of LFG consolidated to a sole source are more attractive to third-party developers who seek to beneficially use the gas as compared to an equivalent volume of gas distributed between multiple sites, all else being equal.

Accordingly, MES issued a request for proposals (RFP) for the beneficial use of LFG at the Midshore II Landfill in September 2024. The RFP stipulated the collection and control of LFG in accordance with the Maryland Landfill Methane Regulations in addition to promoting the beneficial use of the captured LFG.

MES has received and is reviewing several proposals from offerors for renewable natural gas production at the landfill. MES anticipates entering contract negotiations with one of the offerors in 2025.

5.3 ECI Cogeneration Facility – Natural Gas Conversion

MES, as detailed our December 2023 *Reduction of Greenhouse Gas Emissions Report* kicked off the boiler conversion project at the ECI Cogeneration Facility. This project entails converting the two 38 MMBtu wood-fired boilers to natural gas. Concurrent with the boiler conversion work, MES began flowing natural gas on the new service pipeline to a temporary boiler installed at the facility to provide continuity of thermal energy to the prison.

MES' subcontractors were completing the fuel conversion commissioning phase at the writing of this report in November 2023. Operational testing is expected to be completed soon thereafter. The use of natural gas in lieu of debarked wood chips at the ECI cogeneration facility is expected to reduce GHG emissions from stationary combustion at the facility by approximately 19,000 $MTCO_2e$ using an estimated high heating value for the debarked wood chips.

The Cogeneration Facility has, historically, supplied most of the electricity used at the ECI complex. The CSNA requires that 75% of electricity used at state facilities, which include ECI, come from clean, no, or low carbon energy sources by January 1, 2030. There is no statutory or regulatory definition of low-carbon, although MES anticipates that once established it will exclude natural gas-fired generation. Opportunities may exist however with nascent technologies for carbon capture and sequestration of stack gases. Implementation of these technologies could result in, or near, net-zero electricity generation at the facility in the future.

5.4 Pyrolysis and Biochar Production

We continue our efforts to establish a biosolids pyrolysis project at the Dorsey Run Advanced WWTP. Construction of a regional facility to pyrolyze most of the sludge solids generated by the W/WW Program facilities remains an MES priority and we estimate that the design tonnage for this proposed facility is 6,900 wet tons per year.

Pyrolysis is a process by which carbonaceous organic material undergoes thermal degradation in the absence of oxygen into smaller volatile molecules. Solid wastes or other organic biomass (woody wastes, municipal sludges, etc.) are usually the feedstocks used in the pyrolysis process. Pyrolysis is usually conducted in the temperature range of 500 to 900^{o}C. Depending on the temperature, the products of pyrolysis are (1) a liquid or bio-oil, (2) a charcoal-like solid called biochar, and (3) a low BTU value synthesis gas, or syngas, which is composed of combustible gases such as CO (carbon monoxide), H_2, (hydrogen) and light hydrocarbons. A process schematic of a typical pyrolysis process is depicted in Figure 13.

One end product of pyrolysis is a solid biochar, which, has many beneficial uses. It can be marketed as a soil conditioner and sequester carbon. The pyrolysis process sequesters the carbon in the char product, and because it does not readily degrade, it remains in the soil for hundreds of years, thereby "locking" the carbon to the soil. One carbon sequestration evaluation for using biochar as a soil conditioner estimates that the process can sequester 0.58 $MTCO_2e$ per dry ton of biosolids processed. Using this carbon sequestration rate our proposed project would sequester approximately 800 $MTCO_2e$ per year.

An added benefit of utilizing pyrolysis is the destruction of emerging organic contaminants such as per- and polyfluoroalkyl substances (PFAS). There is currently much concern from a public health perspective regarding PFAS contamination. PFAS is a family of approximately 15,000 fluorinated compounds, some

of which exhibit harmful health effects, such as endocrine disruption problems and the occurrence of certain cancers. PFAS compounds are sometimes called “forever chemicals” because they persist in the environment and do not breakdown naturally. Thus, not only would pyrolysis sequester carbon, but it would yield a positive public health outcome.

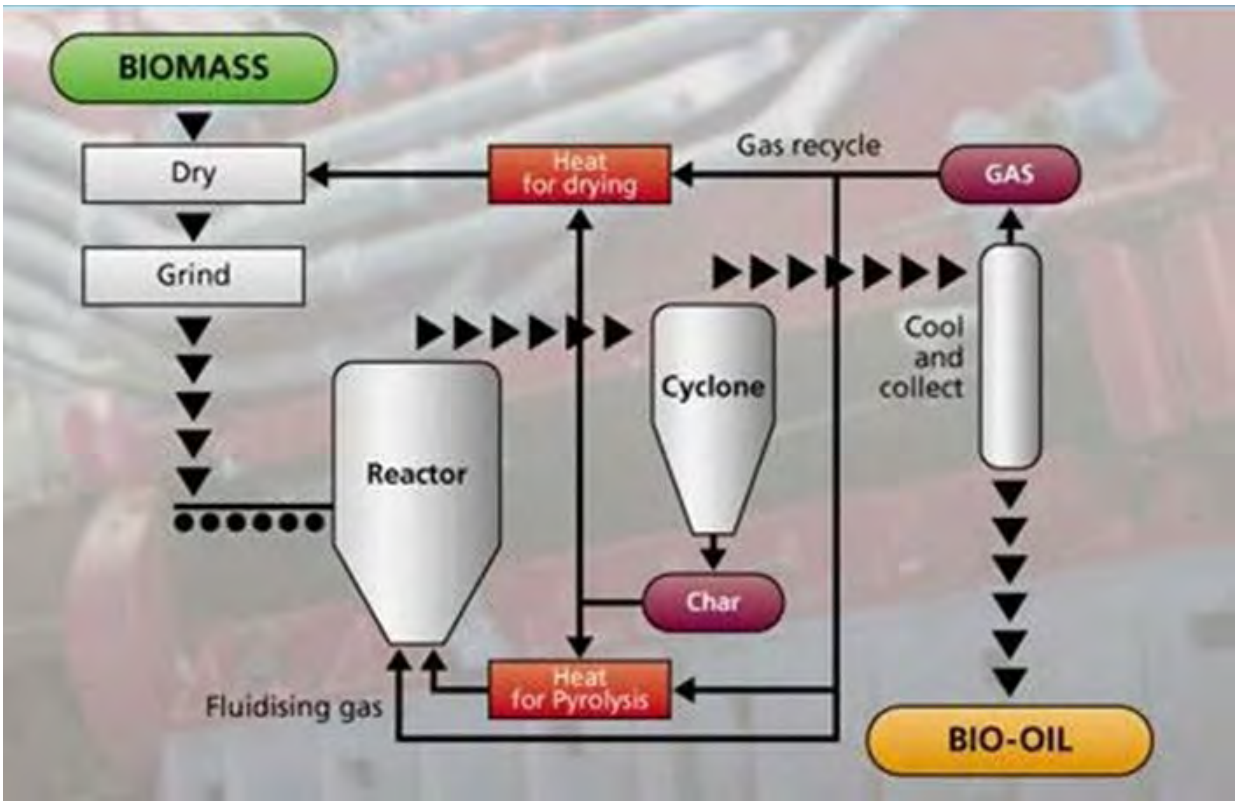


Figure 13 – Pyrolysis Process Schematic

5.5 Cambridge WWTP Floating Solar Panels

The City of Cambridge WWTP is owned by the City but has been operated under contract by MES for the past 30 years. This is the largest WWTP operated by MES, with a design capacity of eight million gallons per day (MGD). The facility practices advanced nutrient removal for nitrogen and phosphorus, prior to discharging its treated effluent to the Choptank River. Also, because the Choptank River is a shellfish harvesting area, the WWTP has a 6.5-acre Shellfish Protection Pond installed to store treated effluent prior to final discharge to the river, to serve as a contingency to protect against pathogen contamination of the shellfish area.

MES is in preliminary investigations to construct floating solar panels on the Shellfish Protection Pond. These systems have been installed at several water and wastewater facilities across the U.S. One two MW-DC system proposed for Cambridge by a private technology provider is depicted in Figure 14. The electricity generated would be used to offset the WWTP’s electricity purchases from the local utility, with any excess being exported to the grid. The estimated design output of this system is two GWh per year. Using the EPA Greenhouse Gas Equivalencies Calculator this amount of electricity production is equivalent to avoiding 594 $MTCO_2e$ per year.

The next steps in this project would be to explore funding sources and present the project to the Mayor and City Council of Cambridge for approval.

Figure 14 – Proposed Floating Photovoltaic (PV) Cells at the City of Cambridge WWTP Shellfish Protection Pond (courtesy of D^3 Energy, LLC)

5.6 Water / Wastewater Program Projects

Dorsey Run AWWTP – Solar Panel Installation and EV Charging Stations

Two energy projects have been studied for the Dorsey Run AWWTP. The first involves constructing solar panels on the roofs of three buildings at the site. A Preliminary Engineering Report (PER) prepared for MES by a consultant identified 0.4 acres of rooftop solar area to install the panels. This would generate 197 kwh per year of electricity that could be used to offset power from the grid. An alternative would be to install solar panels in the facility's parking lot, similar to the system at MES headquarters.

Also, to satisfy the mandate in the Maryland CSNA that the state convert its fleet to zero emissions vehicles, the PER investigated the installation on nine EV charging stations to service the electric vehicles to be used by staff at Dorsey. Three alternatives for EV charging were studied. The consultant recommended the use of solar powered EV charging stations, with the use of utility power as a backup in lieu of battery storage. This option would allow for on-demand charging during those periods where solar is not available.

MES will pursue funding for these two projects for the upgrade of the Dorsey Run AWWTP.

5.7 Environmental Dredging and Restoration Projects

The Paul S. Sarbanes Ecosystem Restoration Project at Poplar Island

The Paul S. Sarbanes Ecosystem Restoration Project at Poplar Island is an ecosystem restoration project beneficially using dredged material for wetland and upland restoration in the Chesapeake Bay. The U.S. Army Corps of Engineers (USACE) is the federal sponsor, and the Maryland Port Administration (MPA) is the state sponsor of the Poplar Island project. Beneficially reusing dredged material to restore Poplar Island's wetlands has the potential for providing significant carbon sequestration. This sequestered carbon is known as "blue carbon." The Blue Carbon Manual (manual) created by the Blue Carbon Initiative outlines defensible field and laboratory methods to determine carbon sequestration rates of wetlands. The University of Maryland Center for Environmental Science (UMCES) will use the methodology outlined in the manual to conduct assessments to determine the rates at which the wetlands on Poplar Island are sequestering carbon in the vegetation and soil. MES will provide management and review of this assessment. The services provided will assist MPA in assessing potential environmental benefits of carbon sequestration related to restoring wetlands through the beneficial reuse of dredged material. The information gained will be used to conduct benefits analyses to existing and future projects.

Poplar Island

MPA Port of Baltimore Diesel Equipment Upgrade Program

MES on behalf of MPA received a $3.47 million EPA DERA grant in Augst 2024. This additional DERA funding will support the continuation of the Port of Baltimore Diesel Equipment Upgrade Program (http://www.dieselupgrades.org/). The program incentivizes and accelerates the upgrade or retirement of older diesel engines at the Port of Baltimore to cleaner and zero-emission solutions leading to significant emission reductions and air quality and public health benefits. This funding will assist the equipment owners with replacing 42 units of cargo handling equipment and off-road equipment with EV and tier 4 diesel units over the next two years.

6. Conclusion

MES' mission is to provide operational and technical services that protect and enhance the environment for the benefit of Maryland citizens. Supporting our client partners by mitigating GHG emissions both internal and external to our operations fits squarely within our mission scope. Accordingly, MES has and will continue to position the agency to be a leader in emerging industries and technologies oriented towards sustainability.

Our existing suite of GHG emission reduction projects and activities reduced GHG emissions in the state by an estimated 242,780 $MTCO_2e$ in FY24. A tabular summary of these reductions is provided as Table 14.

Project / Activity	**GHG Reductions ($MTCO_2e$)**	**Equivalent Gas Cars[a] (#)**	**Equivalent Home Energy[b] *(# homes)***
Environmental Ops Recycling and Food Waste Composting Projects	221,319	51,624	29,722
Midshore I Landfill	12,200	2,846	1,638
Biosolids Land Application	8,300	1,936	1,115
Port of Baltimore Diesel Upgrade Program	461	108	62
MES Headquarters Telecommuting	284	66	38
MES Headquarters Solar Array	168	39	23
Midshore II Electric-Drive Dozer	37	9	5
MES Fleet Electric Vehicles	11	3	2
Totals =	**242,780**	**56,631**	**32,604**

a) Equivalent number of gasoline-powered vehicles driven for one year.

b) Equivalent number of homes' energy use, including both electricity and heating fuels, for one year.

Table 14 – agency GHG Reductions, FY24

MES has made meaningful contributions toward mitigating GHG emissions in the state through our existing programs and recent operational enhancements. Execution of our pipeline projects will help close the gap on the state's GHG reduction goals and magnify the agency's positive impact on the environment and citizens of the state.

REFERENCES

[1] Intergovernmental Panel on Climate Change, 2023. Summary for Policymakers. In: *Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp. 1-34, doi: 10.59327/IPCC/AR6-9789291691647.001

[2] Intergovernmental Panel on Climate Change, 2021. Figure 1.12 in IPCC, 2021: Chapter 1. In: *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 147–286, doi: 10.1017/9781009157896.003* .

[3] Intergovernmental Panel on Climate Change, 2021. Figure 2.28(c) in IPCC, 2021: Chapter 2. In: *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 287–422, doi: 10.1017/9781009157896.004* .

[4] Maryland Department of the Environment, 2022. *Maryland 2020 GHG Emissions by Sector.* Greenhouse Gas Inventory.
https://mde.maryland.gov/programs/air/climatechange/pages/greenhousegasinventory.aspx

[5] Maryland Department of the Environment, 2022. Figure of Maryland GHG Emissions Trends by Sector. In: MDE Greenhouse Gas Inventory.
https://mde.maryland.gov/programs/air/climatechange/pages/greenhousegasinventory.aspx

[6] Maryland Department of the Environment, 2022. Figure of Maryland Gross GHG Emissions Breakout by Gas 2022. In: Greenhouse Gas Inventory.
https://mde.maryland.gov/programs/air/climatechange/pages/greenhousegasinventory.aspx

[7] Climate Solutions Now Act of 2022. Article II, Section 17(b) of the Maryland Constitution - Chapter 38.
https://mgaleg.maryland.gov/2022RS/bills/sb/sb0528e.pdf

[8] Maryland Department of the Environment, 2023. Maryland's Climate Pollution Reduction Plan. Policies to Reduce Statewide Greenhouse Gas Emissions by 60% by 2031 and Create a Path to Net-Zero by 2045.
https://mde.maryland.gov/programs/air/ClimateChange/Maryland%20Climate%20Reduction%20Plan/Maryland%27s%20Climate%20Pollution%20Reduction%20Plan%20-%20Final%20-%20Dec%2028%202023.pdf

[9] Intergovernmental Panel on Climate Change, 2021. Table 7.15 In *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 923–1054, doi: 10.1017/9781009157896.009.*

[10] Maryland Environmental Service, 2024. *Maryland Landfill Solar Assessment.*
https://energy.maryland.gov/business/SiteAssets/Pages/Solar-Landfills/Final%20Solar%20Landfill%20Study_MEA_FINAL_2024.08.06.pdf

[11] Executive Order No. 01.01.2024.19, 2024. *Leadership by State Government: Implementing Maryland's Climate Pollution Reduction Plan.*

[12] Environmental Protection Agency, 2022. *Diesel Emissions Quantifier (DEQ) Tool, Ver. 9.1.*

https://cfpub.epa.gov/quantifier/index.cfm?action=main.home

[13] Environmental Protection Agency, 2024. Greenhouse Gas Equivalencies Calculator. Updated November 2024. https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

[14] Environmental Protection Agency, 2024. Simplified GHG Emissions Calculator. https://www.epa.gov/climateleadership/simplified-ghg-emissions-calculator

[15] He, Y., Jaiswal, D., Liang, X, and Long, S., 2022. *Perennial biomass crops on marginal land improve both regional climate and agricultural productivity*. Global Change Biology Bioenergy. https://onlinelibrary.wiley.com/doi/10.1111/gcbb.12937

[16] Terravesta. undated. *Carbon Life Cycle*. https://www.terravesta.com/shared-files/3688/?Terravesta-Miscanthus-Carbon-Life-Cycle-Report.pdf

[17] Kalmbach, B., undated. *Giant Miscanthus (Miscanthus x giganteus): An Alternative Crop in Maryland.* University of Maryland. https://agnr.umd.edu/sites/agnr.umd.edu/files/files/documents/Cornerstone%202020/Giant%20miscanthus%20crop%20profile%20poster_AGNR%20cornerstone%202020_Kalmbach%20-%20Brian%20Michael%20Kalmbach.pdf

[18] Kalmbach, B., Toor, G., & Ruppert, D, 2020. *Soil Fertility Recommendations-Nitrogen, Phosphorus, and Potassium Requirements of Miscanthus (EB-443)*. University of Maryland Extension.

[19] Environmental Protection Agency, 2023. Waste Reduction Model, Ver. 16. https://www.epa.gov/warm/versions-waste-reduction-model

[20] Environmental Protection Agency, 2024. *National Overview: Facts and Figures on Materials, Wastes and Recycling.* https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials

[21] Environmental Protection Agency, 2020. *Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM), Management Practices Chapters.*

[22] National Biosolids Data Project. https://www.biosolidsdata.org/

[23] North East Biosolids and Residuals Association, Northern Tilth LLC, and Northwest Biosolids, 2022. *Estimating greenhouse gas emissions from biosolids management*. BEAM 2022 spreadsheet model and supporting information. https://www.BiosolidsGHGs.org

[24] Villa Y.B. and Ryals, 2021. *Soil carbon response to long-term biosolids application.* Journal of Environmental Quality, September/October 2021.

[25] Brown, S., 2024. *Building Carbon Credits with Biosolids Recycling.* BioCycle, September 2004, Vol. 45, No. 9, p. 25.

[26] US Department of Energy, undated. Beyond Tailpipe Emissions Calculator. https://www.fueleconomy.gov/feg/Find.do?action=bt2

MARYLAND ENVIRONMENTAL SERVICE
259 NAJOLES ROAD | MILLERSVILLE, MARYLAND 21108