Reducing Greenhouse Gas Emissions in Maryland: A Progress Report

Maryland
Department of the Environment

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www.mde.maryland.gov/ggra

A Word from Secretary Horacio Tablada

Maryland's ambitious and inclusive approach to climate action has grown more effective with every update to the Greenhouse Gas Emissions Plan. This progress report tells the story of the state's advancement toward those goals and highlights the need for continued action. In 2022, with the Climate Solutions Now Act (CSNA), Maryland adopted the most ambitious greenhouse gas (GHG) reduction goals of any state in the nation. The new targets include reducing statewide GHG emissions by 60% from 2006 levels by 2031 and achieving net-zero emissions by 2045 with a positive impact on Maryland's economy and work opportunities.

Maryland's current climate plan, the 2030 Greenhouse Gas Reduction Act (GGRA) Plan (2030 Plan), will be in effect until the new CSNA plan is finalized at the end of 2023. The 2030 Plan consists of a suite of programs and initiatives that, if implemented, would achieve reductions over the required targets. The plan advances measures with an eye to benefit overburdened and underserved communities and address long-standing environmental injustices.

Maryland's GHG reductions are required to have a positive impact on Maryland's economy, to protect existing manufacturing jobs, and to create new jobs within the state. According to a World Resources Institute report published in 2020, Maryland leads the nation in reducing GHG emissions while growing its economy.

I invite all Marylanders to participate in developing plans by attending meetings of the Maryland Commission on Climate Change (MCCC) and other forums. For more information, please visit the Maryland Department of the Environment (MDE) Climate Change Program website.

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Executive Summary and Introduction

Purpose

The 2016 GGRA[1] requires the MDE to develop plans to achieve the state's GHG emissions reduction goals and to monitor the implementation of those plans. The GGRA further stipulates that MDE must submit a report to the Governor and the General Assembly describing 1) the state's progress toward achieving its GHG reduction goals and 2) the GHG reductions needed by 2050 in order to avoid changes to the Earth's climate system, based on the predominant view of the scientific community at the time of the latest report.

25% by 2020: Achieved

Maryland more than achieved its GHG reduction goal for 2020. The GGRA of 2009 established the goal of reducing statewide GHG emissions by 25% from 2006 levels by 2020. In 2020, statewide GHG emissions were 30% below the 2006 baseline based on a new GHG accounting methodology required by the Climate Solutions Now Act (CSNA), which is explained in this report. Statewide GHG emissions in 2020 were 33% below the 2006 baseline using the accounting methodology from when the 2020 goal was established and achieved.

The COVID-19 pandemic had a significant impact on GHG emissions in 2020. The pandemic's most pronounced impact on GHG emissions was in the transportation sector, specifically regarding on-road gasoline and aviation emissions, resulting from restrictions and stay-at-home orders in the state beginning in 2020. Statewide GHG emissions would have likely been 26% below 2006 levels in 2020 without COVID-19 impacts using the new accounting methodology. **Thus, Maryland would have met or exceeded its GHG reduction goal for 2020 with or without COVID-19.**

60% by 2031: A New Goal to Reach

In 2022, CSNA established new GHG reduction goals for Maryland. CSNA requires statewide GHG emissions to be 60% below 2006 levels by 2031, and net-zero by 2045. These are the most ambitious GHG reduction goals in the nation. As explained in this report, Maryland must develop a new plan in order to meet its new 2031 goal.

In 2021, MDE published the 2030 GGRA Plan,[2] which identified a path to reducing emissions around 49% by 2031 based on MDE's methodology that used the 100-year global warming potential (GWP)[3] of GHGs. CSNA requires MDE to shift to using the 20-year GWP, which amplifies the near-term climate impact of methane (CH_4) and other short-lived climate pollutants. When the 2030 GGRA Plan is adjusted to the new methodology, it would achieve a 44% reduction in GHG emissions by 2031.

This report evaluates progress toward meeting Maryland's new 2031 goal by analyzing data on 11 different 2030 GGRA Plan metrics. The report finds that Maryland is roughly on track for meeting its prior targets, which would achieve a 44% reduction in statewide GHG emissions by 2031. However, with the new targets in place, future actions will need to be considered.

Figure 1 (below) illustrates the impact of shifting from the 100-year to 20-year GWP, and the gap between projected and target GHG emissions levels in 2031. If the 2030 GGRA Plan were fully implemented, then the state would need to find an additional 19.7 million metric tons of carbon dioxide equivalent ($MMTCO_2e$) reduction - or an additional 16% reduction in statewide GHG emissions from 2006 levels - by 2031 to meet the goal for that year.

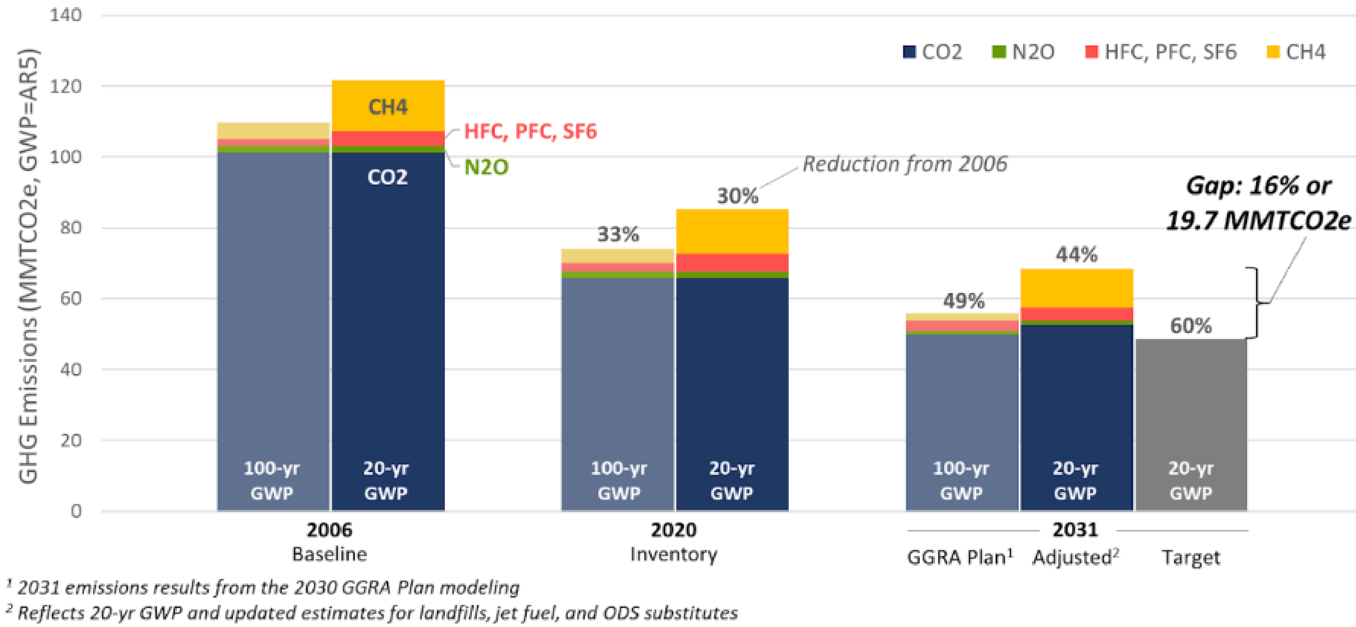

Figure 1. Maryland historical emissions, projected emissions, and emissions gap. (Click figure to expand).

By the end of June 2023, MDE intends to publish a draft plan to identify the policies that are needed to achieve the new goal of reducing statewide GHG emissions by 60% by 2031. The measures that will be required to achieve the new goal have not yet been modeled, however, it is clear that Maryland will not achieve the 2031 goal by implementing the 2030 GGRA Plan measures alone. Federal actions, including funding may help the state implement select 2030 GGRA Plan measures, but the state will need to develop and implement significantly more stringent measures over the next 8 years to achieve the 2031 goal.

Fortunately, Marylanders do not need to wait for a new GHG reduction plan to know how to take action to address climate change. Here are four priority actions to take this decade that will help Maryland meet its GHG reduction goals:

- Rapidly transition to electric/ZEV vehicles while continuing to support plug in hybrid vehicles to achieve reductions in the near term;
- Rapidly construct more in-state clean power generation, especially solar power;
- Rapidly replace space heating and water heating equipment with efficient electric heat pumps; and
- Plant, grow, and manage more trees.

The Latest Science

The United Nations Intergovernmental Panel on Climate Change (IPCC) finds that sustaining natural and human systems will be much more challenging if global warming reaches 2 degrees Celsius above pre-industrial levels than if the global temperature reaches just 1.5 degrees (IPCC, 2018). Nearly 200 nations are signatories to the Paris Agreement, committing to substantially reduce global GHG emissions to limit the global temperature increase in this century to 2 degrees Celsius while pursuing efforts to limit the increase even further to 1.5 degrees (United Nations, 2022).

In 2022, the IPCC released its Working Group III contribution to the Sixth Assessment Report, which examines the GHG emissions reductions that would be needed to limit global warming to 1.5 or 2 degrees Celsius. The report finds that global GHG emissions must reduce rapidly through 2040 and that CO_2 emissions must reach net-zero around 2050 to limit global warming to 1.5 degrees Celsius (IPCC, 2022). Figure 2 below illustrates the 1.5-degree Celsius pathway in blue.

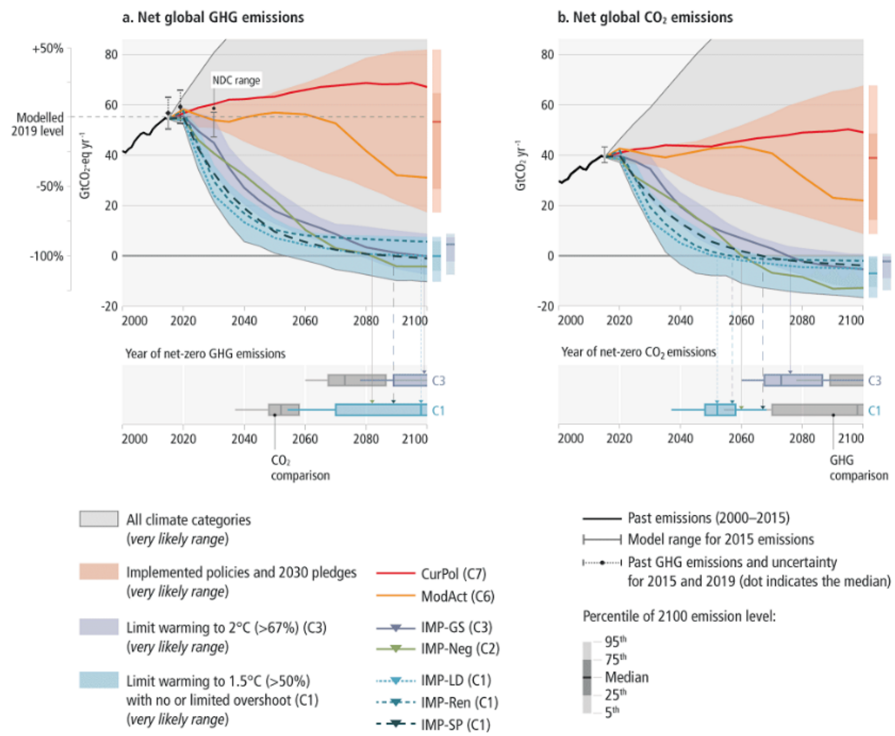

Figure 2. IPCC Working Group III 2.0-degree Celsius and 1.5-degree Celsius pathways. (Click figure to expand).

The Climate Solutions Now Act

In 2022, Maryland's GHG reduction goals were modified in response to the latest science indicating that more stringent goals are necessary to combat climate change. CSNA set new goals to reduce statewide GHG emissions by 60% by 2031 and achieve net-zero emissions by 2045. Maryland's goals are the most ambitious GHG reduction goals in the nation.

CSNA also requires MDE to shift to using the 20-year GWP for CH_4 in future GHG reduction plans. Following GHG accounting norms, MDE will apply the 20-year GWP to all GHGs, which amplifies the role of CH_4 and other short-lived climate pollutants in the state's GHG emissions inventory. MDE now estimates that the 2030 GGRA Plan, if fully implemented, would reduce statewide GHG emissions by around 44% by 2031 using the new accounting methodology. This leaves approximately 19.7 million metric tons of $MMTCO_2e$ or an additional 16% reduction in statewide GHG emissions from 2006 levels to be achieved by 2031.

It is clear that Maryland will not achieve the 2031 goal of CSNA by implementing the 2030 GGRA Plan measures alone. Federal actions, including new funding may help toward achieving this, but the state will need to develop and implement additional measures over the next eight years to achieve the 2031 goal.

2020 Goal Achieved

Statewide Summary

The GGRA of 2009 established a statewide GHG emissions reduction goal of 25% from 2006 levels by 2020. **Maryland surpassed this goal with a 30% reduction of gross GHG emissions since 2006** (emissions in 2020 were 33% below the 2006 baseline using the accounting methodology from when the 2020 goal was established and achieved). Figure 3 (below) shows the state's GHG emissions over time. Reductions in the electricity sector made large contributions toward reaching the goal, as seen in the Sector Trends section later in this report.

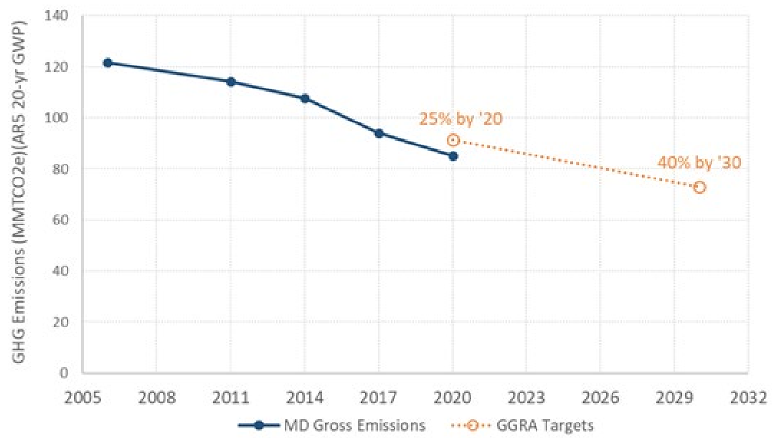

Figure 3. Maryland's statewide GHG emissions from 2006-2020 and GGRA of 2016 emission reduction goals. (Click figure to expand).

COVID-19 Impacts on the 2020 Goal

The COVID-19 pandemic resulted in reduced economic and travel activity. The pandemic's most pronounced impact on GHG emissions was in the transportation sector, specifically in regard to on-road gasoline and aviation emissions, resulting from restrictions, and stay-at-home orders in the state beginning March 2020, and continued disruptions thereafter. Other sectors (e.g., electricity use) do not show a discernible effect that can be easily attributable to the pandemic (e.g., weather and fuel changes). To account for this, MDE analyzed an alternative model of the 2020 emissions inventory using 2017 emissions levels for on-road gasoline and aviation emissions as a conservative estimate of pre-pandemic levels. The resulting statewide gross emissions reduction is 26% below 2006 levels. **Thus, Maryland would have achieved its 25% by 2020 goal even if the pandemic-related transportation reductions had not occurred**.

Sector Trends

The sector contributions of Maryland's 2020 GHG emissions inventory is illustrated in Figure 4 below. Transportation, electricity use, and direct fuel use in buildings comprised nearly three-fourths of Maryland's GHG emissions in 2020, using a 20-year GWP.

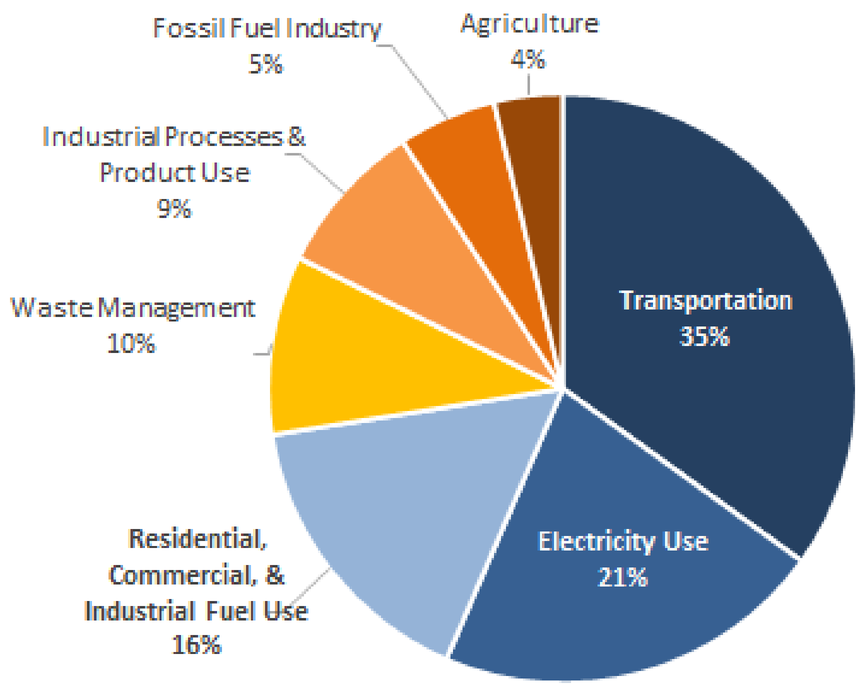

Figure 4. Maryland's 2020 GHG emissions sector contributions. (Click figure to expand).

Transportation

The transportation sector accounted for 35% of Maryland's GHG emissions in 2020 with most emissions (82%) in this sector coming from on-road gasoline and diesel vehicles. On-road gasoline and diesel emissions have decreased steadily and will continue to decrease with the influx of vehicles meeting federal Corporate Average Fuel Economy (CAFE) standards and increased demand for electric vehicles. Heavy-duty diesel vehicles have remained consistent since 2006 but EPA's more stringent heavy-duty engine and vehicle GHG standards will be fully implemented by model year 2027. From 2006 to 2017, on-road emissions decreased from 29.7 to 28.6 MMTCO$_2$e, and in 2020 decreased to 24.3 MMTCO$_2$e.[4]

Non-road and other emissions, which are relatively minor compared with on-road emissions, come from vehicles, including airplanes, trains, marine vessels, farming equipment, recreational vehicles, and other motorized vehicles that do not operate on public roads. Collectively these emissions have remained relatively steady.

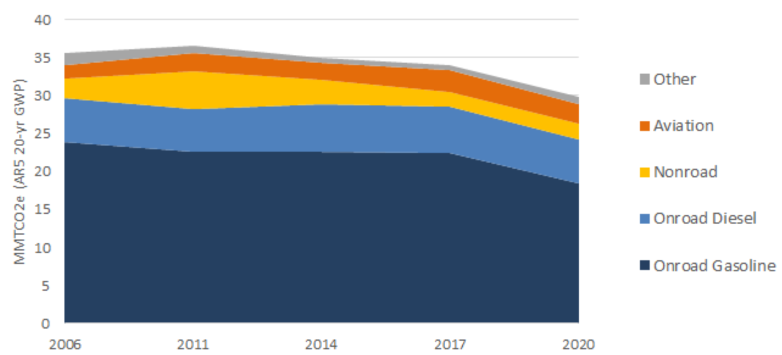

Figure 5. Transportation sector emissions. (Click figure to expand).

Electricity

Statewide GHG emissions from electricity includes emissions from in-state generators and electricity generation occurring outside of the state but delivered to and consumed in-state. The electricity use sector of the GHG inventory considers all electricity generated in-state as consumed in-state and remaining statewide electricity demand is accounted for as "net imported power." The emissions associated with the net imported power are estimated using average emission rates across the PJM system. PJM is a regional transmission organization that coordinates the movement of wholesale electricity in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia, and the District of Columbia. As of 2020, approximately half of the electricity consumed in Maryland was produced in-state and the other half was imported via PJM.

In 2020, electricity consumption accounts for 21% of Maryland's gross GHG emissions. While this may seem like a large amount, the electricity sector has made significant progress since 2006. GHG reductions in this sector can be attributed to programs that reduce total electricity demand and through programs aimed at reducing the carbon intensity of the electricity consumed. Reduced demand results from the EmPOWER program, Maryland's program for improving energy efficiency. To reduce the carbon intensity of the electricity generated, the state relies on the Renewable Portfolio Standard (RPS) and other clean energy initiatives to incentivize more renewable energy generation. In addition, the Regional Greenhouse Gas Initiative (RGGI) and other pollution control programs reduce CO_2 emissions from fossil fuel-fired energy generation, also impacting the carbon intensity of the electricity. The combination and interaction between these programs lowers emissions intensity of both in-state electricity generation and imported electricity (largely driven by the replacement of some coal-fired power generation with natural gas, and increased sources of renewable energy), resulting in a sector-wide emissions reduction of 57%.

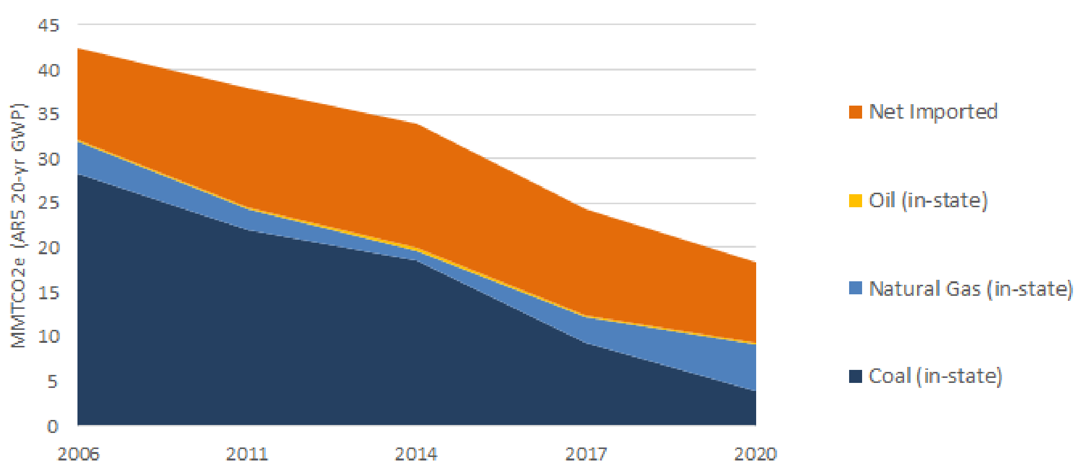

Figure 6. Electricity Use Emissions. (Click figure to expand).

Residential, Commercial, and Industrial Fuel Use

Residential, commercial, and industrial (RCI) fuel use accounted for 16% of Maryland's GHG emissions in 2020 (Figure 9). This includes emissions from direct fuel combustion typically used for space heating, water heating, cooking, and industrial heating processes. RCI fuel use emissions have decreased by 20% from 2006 to 2020, primarily driven by GHG reductions in the industrial sector.

Residential fuel use emissions decreased by 8% between 2006 and 2020 (Figure 8); however, the number of households increased by roughly 8% over the same period, indicating homes improved in fuel use efficiency over the 14-year period (Maryland Department of Planning (MDP), 2022). Commercial fuel use emissions increased 15% from 2006 to 2020 driven by growth in that subsector. Industrial fuel use emissions decreased 58%, largely due to reduced coal use in that subsector.

Residential and commercial fuel use can be influenced by year-to-year fluctuations in weather, particularly tied to heating demand, as can be seen in 2014 (Figure 7). Degree days are a simplified form of historical weather data and are commonly used in energy monitoring to examine the relationship between energy consumption and outside air temperature (BizEE, 2022). As demand increases, more fuel is used to keep buildings at habitable temperatures.

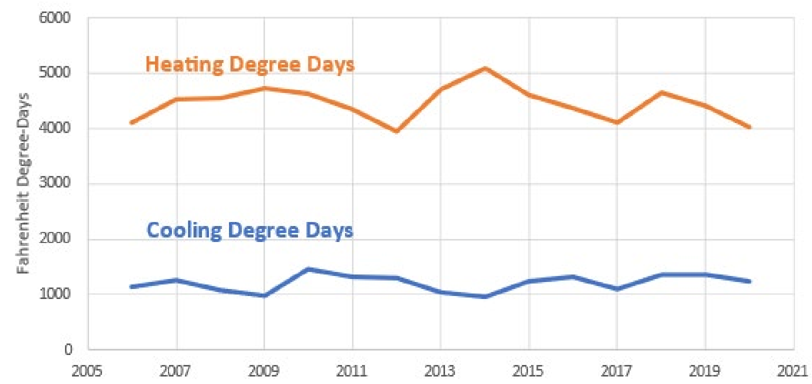

Figure 7. Maryland degree day (NOAA, 2022) s. (Click figure to expand).

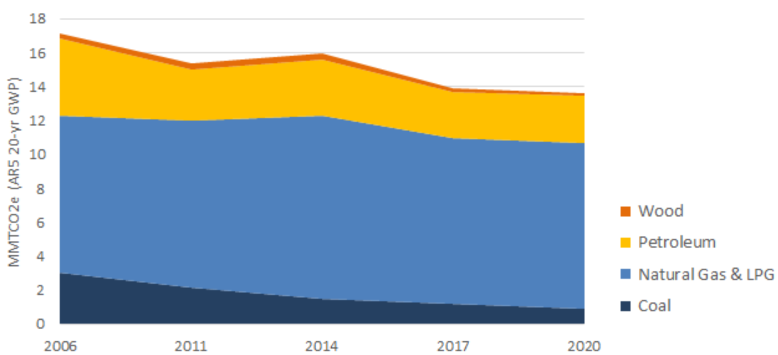

Figure 8. RCI fuel use emissions by fuel. (Click figure to expand).

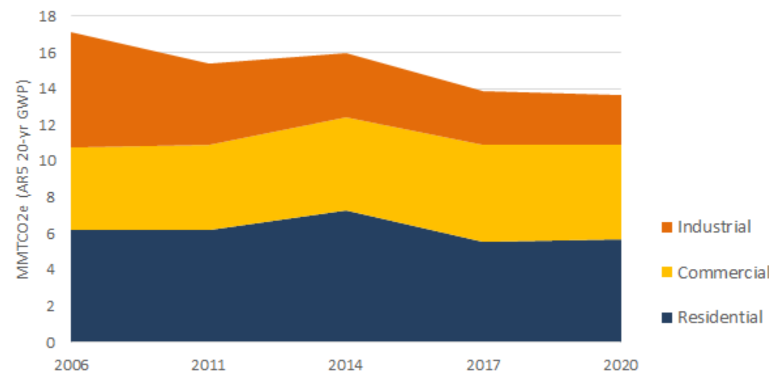

Figure 9. RCI fuel use emissions by end-use sector. (Click figure to expand).

Industrial Processes and Product Use

Industrial processes and product use (IPPU) represents 9% of Maryland's GHG emissions in 2020 (Figure 10). This sector includes GHG emissions from the four main industrial processes that occur in the state:

- CO_2 emissions from cement production, soda ash, dolomite and lime/limestone consumption;
- CO_2 emissions from iron and steel production;
- Sulfur hexafluoride (SF_6) emissions from electric power transmission and distribution systems, transformers use; and
- Hydrofluorocarbon (HFC) and perfluorocarbon (PFC) emissions resulting from their use primarily in cooling and refrigeration equipment.

Note that fuel use for industrial facilities is reported in the RCI category of the emissions inventory.

IPPU emissions decreased by 23% from 2006 to 2020. The reduction is almost entirely due to the closure of the Sparrows Point Steel Mill. In 2020, 96% of IPPU emissions resulted from a chemical reaction in the process of manufacturing cement and the use of HFCs for cooling and refrigeration equipment. Other sources, while minimal, include limestone use, soda ash use, non-fertilizer usage of urea, and SF_6 use for electric power transmission and distribution systems.

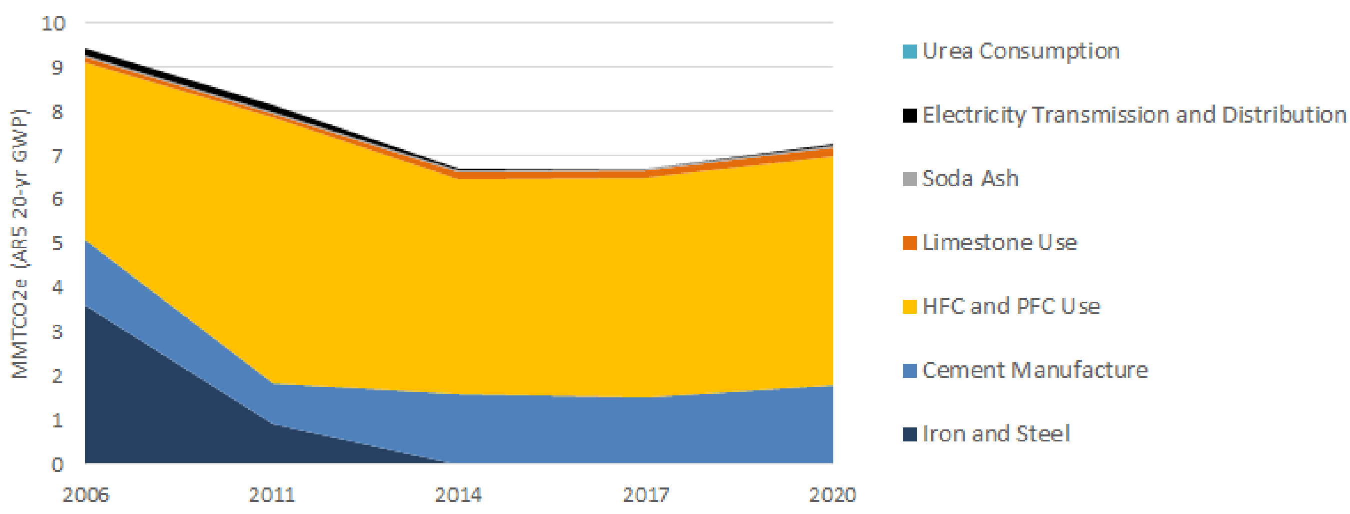

Figure 10. Industrial processes and product use emissions. (Click figure to expand).

Fossil Fuel Industry

Direct emissions from the fossil fuel industry comprised 5% of Maryland's GHG emissions in 2020 (Figure 11). Most of these emissions are from the natural gas industry, which includes the in-state emissions from the production, transmission, and distribution of CH_4). A small portion of emissions are from coal mining, which includes underground and surface mines and abandoned mines. From 2006 to 2020, emissions from coal mining decreased by 58% while emissions from the natural gas industry increased by 30%. The increase is largely due to the liquefied natural gas (LNG) export activities at Cove Point, which overshadow modest reductions in CH_4 emissions from the natural gas distribution system due to pipeline replacements.

CH_4 emissions, which accounts for 72% of the sector emissions, have decreased by 12% since 2006. CO_2 emissions, which are from fuel use at natural gas transmission and LNG export facilities, make up 28% of sector emissions and have increased.

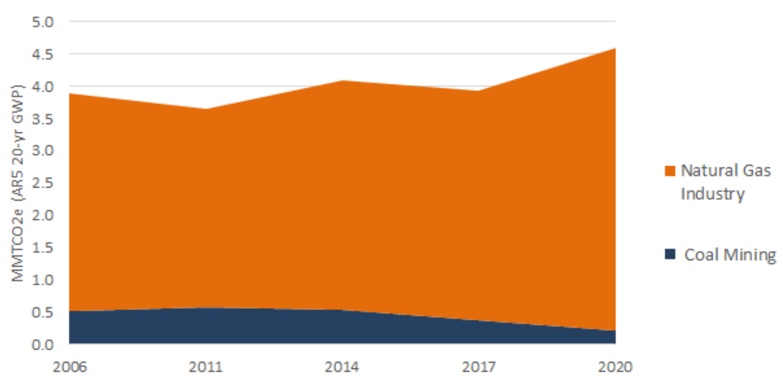

Figure 11. Fossil fuel industry emissions. (Click figure to expand).

Agriculture

The agriculture sector represented 4% of the state's GHG emissions in 2020 (Figure 12). This sector includes emissions from enteric fermentation, manure management, and nutrient application. Energy emissions (combustion of fossil fuels in agricultural equipment) are not included in this sector as they are already accounted for under the RCI fuel use sector and non-road transportation subsector. Reductions in atmospheric CO_2 from carbon sequestration in soils is also not included in this sector; it is instead included in the forestry and land use sector along with other emissions sinks. Agriculture sector emissions have remained fairly constant since 2006.

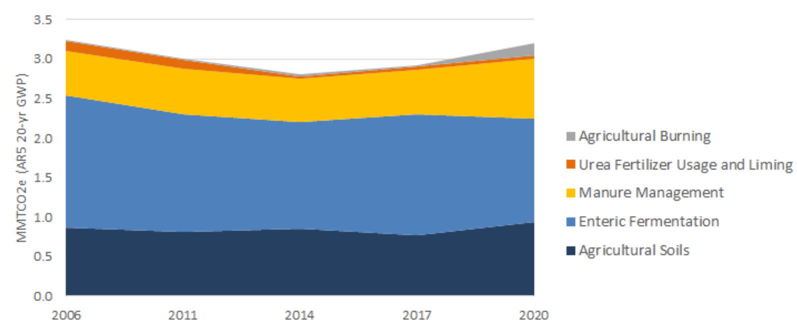

Figure 12. Agriculture sector emissions. (Click figure to expand).

Waste Management

Waste management accounted for 10% of Maryland's GHG emissions in 2020 (Figure 13). This sector includes emissions from landfills, wastewater management, waste combustion, and residential open burning. This sector has experienced a gradual decrease in emissions since 2006 despite population growth.

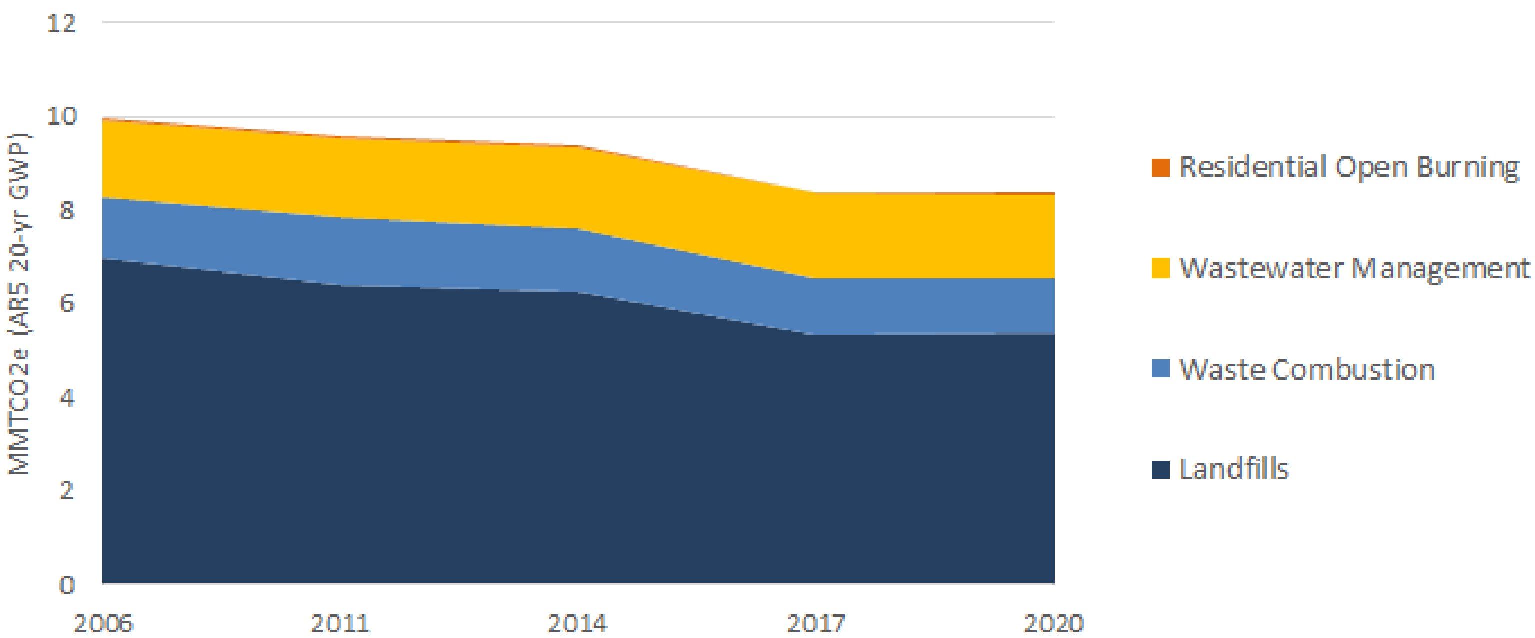

Figure 13. Waste management emissions. (Click figure to expand).

Forestry and Land Use

The forestry and land use sector includes a combination of emissions sources and sinks, which makes it unique from other emissions sectors. Emissions in this sector include CH_4 and nitrous oxide (N_2O) emissions from wildfires and prescribed forest burns, N_2O from the application of synthetic fertilizers to settlement soils,[5] and CH_4 from reservoirs and coastal wetlands. Net emissions sinks (carbon sequestration pathways) in this sector include the carbon flux[6] in forested and treed landscapes; carbon stored in harvested wood products, wood in landfills, and landfilled yard trimmings and food scraps; carbon flux in agricultural soils; and carbon flux in coastal (tidal) wetlands and submerged aquatic vegetation. This sector is not included in Maryland's gross emissions accounting and is instead factored into Maryland's net emissions calculation.

Negative emission values in Figure 14 signify carbon sequestration. In 2020, the forestry and land use sector counteracts 9% of Maryland's gross GHG emissions. The interannual variability seen in statewide estimates of tree and forest carbon flux reflects the impact of disturbance as well as changes to tree growth rates based on weather (e.g., precipitation) and atmospheric CO_2. Although the amount of carbon sequestered varies from year-to-year; Figure 15 shows a positive trend and depicts an increase in the total amount of carbon stored in Maryland's trees and forests.

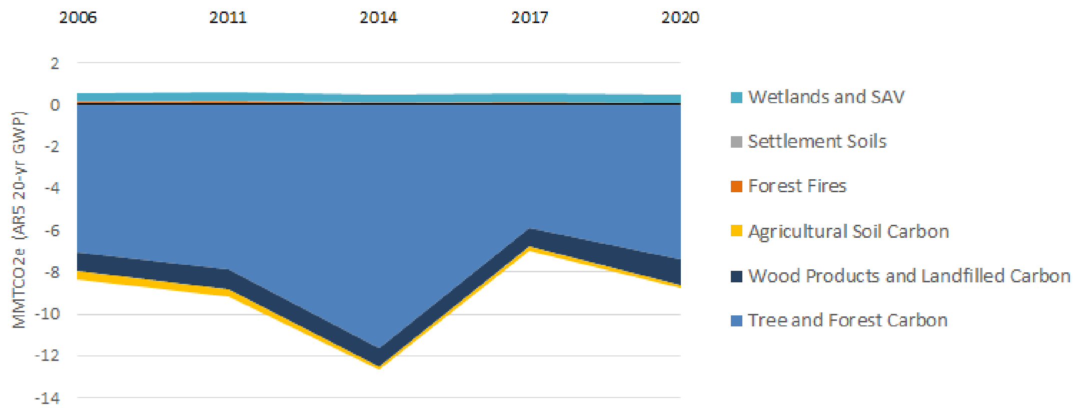

Figure 14. Net emissions impact of different sources and sinks within the forestry and land use sector. (Click figure to expand).

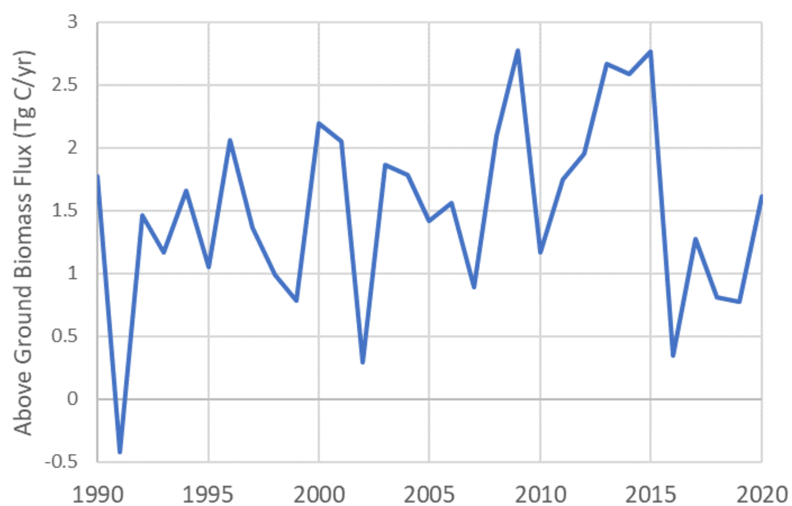

Figure 15. Annual aboveground forest carbon flux in Maryland from the NASA/UMD high resolution forest carbon monitoring product, where positive values represent net growth in the forest carbon sink and negative values (e.g., in 1991) highlight a net loss of carbon due to unfavorable weather conditions and forest disturbance. (Click figure to expand).

Progress Toward Meeting 2030 GGRA Plan Targets

Metric

Zero Emission Vehicles

% light-duty passenger vehicles on the road that are ZEVs.

Goal

Substantially increase the share of light-duty passenger ZEV cars and trucks in Maryland.

Background

On-road transportation emissions are the single largest source of GHG emissions in Maryland. Most of those emissions come from light-duty passenger cars and trucks, followed by heavy-duty diesel trucks. The transportation strategy in the 2030 GGRA Plan for reducing GHG emissions rely on four pillars that induce behavioral change among all users of the State's transportation system, and innovation as a transition to a low-carbon emissions pathway to achieve the 2030 goal. These pillars include travel choice, travel efficiencies, infrastructure design, and vehicle technologies. Travel choices provide Marylanders with reliable clean transportation alternatives to driving single occupancy vehicles, efficiencies focused on reducing congestion and unreliable travel, and infrastructure design directs improvements for resiliency and clean energy utilization. Vehicle technology improvements focus on accelerating the deployments of electric and other zero emissions vehicles (ZEVs) that are powered by increasingly clean electricity. The 2030 GGRA Plan also includes improvements in efficiency of conventional vehicles achieved through federal Corporate Average Fuel Economy standards. The deployments of ZEVs will be achieved through a suite of state and federal programs to incentivize the purchase of ZEVs, along with the national build-out of EV charging infrastructure that will produce significant impacts on GHG emissions reductions by 2030. Meeting the new goal of a 60% reduction by 2031 will require significantly faster electrification progress combined with other new emerging and innovative strategies.

Maryland is committed to the conversion of ZEV technology for the medium- and heavy-duty (MHD) vehicle fleets. In 2020, Maryland signed the MHD ZEV Memorandum of Understanding (MOU) and has been actively participating in the Multi-State ZEV Task Force to develop the MHD ZEV Action Plan. The plan will provide a framework for meeting the target of at least 30 percent of all new truck and bus sales being ZEVs by 2030 and 100 percent by 2050 that includes only ZEV buses beginning in 2023. The Maryland Department of Transportation (MDOT) is also currently updating the Maryland State Freight Plan, which identified the need for EV infrastructure and the use of alternative energy sources for freight transportation vehicles, multimodal support equipment, or related applications as a strategy for consideration. To build on these efforts, MDOT will continue to partner with key stakeholders within the trucking industry and explore opportunities for electrification and alternative energy at current truck parking locations, intermodal facilities, and warehousing locations. In the meantime, MDOT has been leveraging Diesel Emissions Reduction Act (DERA) funding through the U.S. Environmental Protection Agency to achieve diesel emission reductions in port operations since 2008. This has been accomplished through engine retrofits with diesel particulate filters (which reduce black carbon emissions) and replacing cargo handling equipment and drayage trucks with new diesel equipment which has been shown to yield reduced emissions benefits in the near term.

The Maryland National Electric Vehicle Infrastructure (NEVI) Plan was approved by FHWA and will provide dedicated funding to strategically deploy Electric Vehicle (EV) charging infrastructure. The NEVI plan lays the foundation for the strategic deployment of a convenient, accessible, reliable, and equitable EV charging network.

Maryland has a robust network of EV charging stations and Alternative Fuel Corridors (AFCs). Since the initial AFC Nomination in 2016, MDOT has successfully nominated 23 corridors for designation as EV AFCs with 18 designated as corridor ready status. These corridors support over 1,200 charging stations with nearly 3,350 charging ports located throughout the state with the highest concentration of EV charging stations along the I-95 and I-270 corridors. Of these stations, 16 currently meet the site requirements of at least four Combined Charging System (CCS) ports with at least 150 kilowatts (kW) of power each, or 600kW for the entire site as required by NEVI.

The 2030 GGRA Plan builds upon Maryland’s early action to deploy ZEVs through the Maryland Clean Cars Program’s ZEV mandate regulation. This regulation requires car manufacturers to sell ZEVs in Maryland and deploy EV charging infrastructure coordinated by the Zero Emission Electric Vehicle Infrastructure Council (ZEEVIC).

Progress

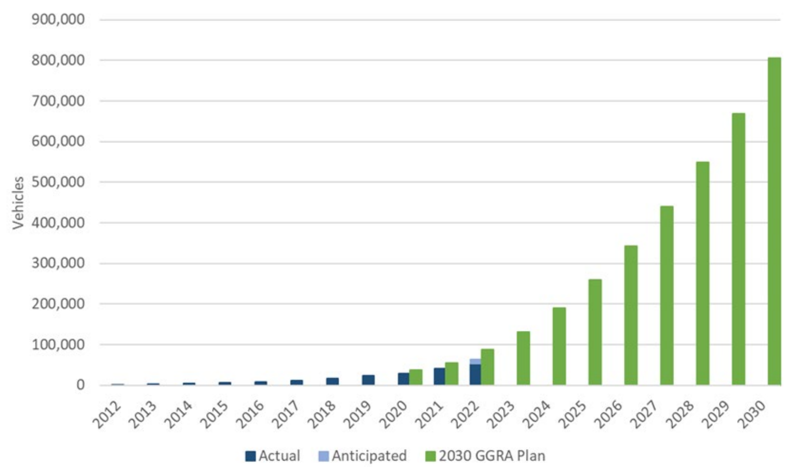

Figure 16. Registered battery electric vehicles and plug-in hybrid electric vehicles through July 2022, and 2030 GGRA Plan projected EV stock. (Click figure to expand).

As of July 2022, a total of 52,966 EVs were registered in Maryland (an additional 10,000 are anticipated through the end of 2022). Of those EVs, 19,333 were plug-in hybrid electric vehicles while 33,633 EVs were battery-powered electric vehicles. Under the ZEV MOU, Maryland set a goal of registering 60,000 ZEVs by 2020, and 300,000 ZEVs by 2025. The 2030 GGRA Plan set an additional target of 790,000 ZEVs by 2030. Maryland did not meet its 2020 target.

Achieving the goals in the transportation sector will require ZEVs to reach a much broader range of consumers, moving beyond early adopters and into the mainstream market. The federal EV tax credit will help accelerate adoption along with the state's reform of the ZEV incentive programs to increase accessibility. The federal EV tax credit has limitations but can reach up to $7,500.

The Clean Cars Act of 2022 represents one such reform as this legislation reestablishes the qualified plug-in EV and fuel cell electric vehicle excise tax credit and alters certain eligibility requirements and tax credit values. Subject to available funding starting July 2023, a person may claim an excise tax credit equal to (1) $5,000 for each zero-emission heavy equipment property purchased or leased; (2) $3,000 for each zero-emission plug-in electric drive or fuel cell EV purchased; (3) $2,000 for each three-wheeled zero-emission electric motorcycle or autocycle purchased; or (4) $1,000 for each two-wheeled zero-emission electric motorcycle purchased.

Sales of ZEVs have reached 6% of new vehicle sales in 2022, increasing from 2% in 2020 (MDOT, 2022). ZEV new car sales are expected to increase significantly over the next several years with the EV incentives and infrastructure build-out. In addition, the purchase of ZEV transit and school buses, and heavy-duty trucks will be main contributors in Maryland meeting its GHG reduction goals.

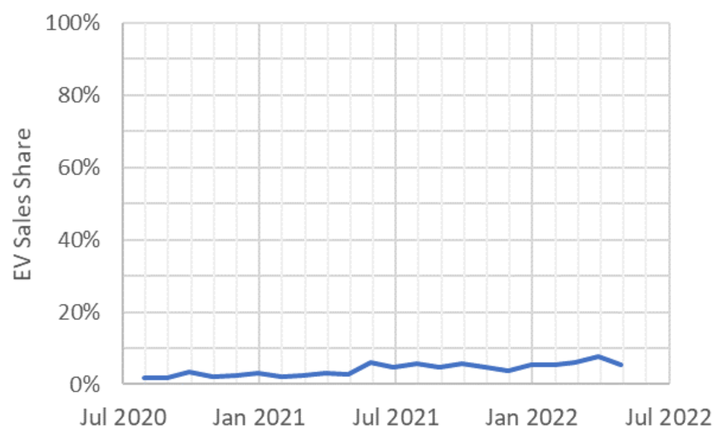

Figure 17. Monthly ZEV sales share. (Click figure to expand).

Metric

Vehicle Miles Traveled

Vehicle miles traveled annually.

Goal

Slow the growth of vehicle miles traveled by continued and expanded investments in public transit systems and multi-modal transportation.

Background

Vehicle miles traveled (VMT) is a major indicator of transportation sector GHG emissions. VMT has steadily increased in Maryland since 2014, with over 60 billion VMT in 2019. VMT growth has been consistent with population growth as VMT per capita has remained stable. While population increase is expected to create additional demand for the State's transportation systems, VMT in Maryland dropped dramatically in 2020 due to the COVID-19 pandemic. While MDOT anticipates that VMT will rebound back to 2019 levels over the next five years, there is uncertainty regarding the exact timeline and pace of the recovery.

The 2030 GGRA Plan identifies the significant shifts impacting transportation demand and outlines strategies that support the framework for transportation investments. These changes include economic shifts and demographics that impact how the transportation system is used, and social preferences and new work environments shift the demand for mobility.

Updated VMT growth rates consistent with MDP population growth projections and metropolitan planning organization cooperative land use and travel demand forecasts indicate that investments in infrastructure and alternate travel options will limit annual VMT growth to 0.6% in 2030, versus 1.2% with no additional investments (GGRA reference case). A 0.6% VMT growth rate is consistent with average annual growth from 2016 to 2019 (0.5%), and the average annual growth for most of the decade (0.8%). This assumes that VMT growth in 2021 and beyond gradually returns to pre-pandemic levels.

Progress

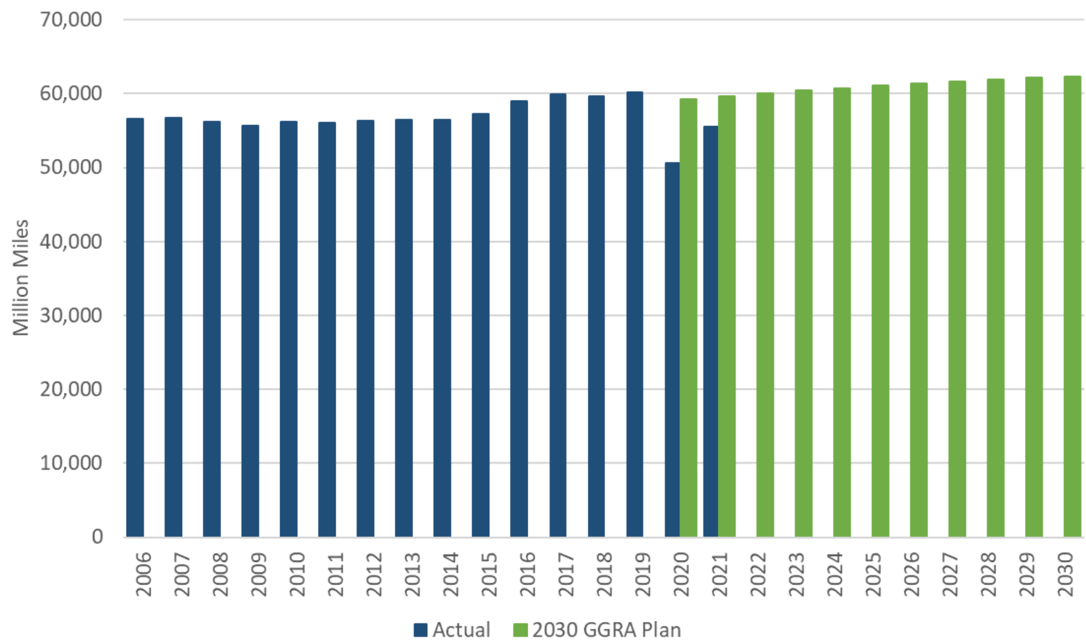

Figure 18. Historic VMT and projected VMT from the 2030 GGRA Plan in millions of miles traveled. (Click figure to expand).

The transportation sector was particularly impacted by COVID-19 in 2020 and 2021, which caused a dramatic reduction in VMT from light-duty passenger vehicles. VMT in Maryland has been on a steady upward trajectory since 2014 and peaked in 2019 with over 60 billion VMT. The 2021 VMT data show that travel continues to gradually rebound, although total annual VMT is still anticipated to be slightly lower than below 2019 levels. While the exact timeline is uncertain, the Maryland Department of Transportation (MDOT) estimates that VMT will rebound to 2019 levels by 2024/2025 timeframe.

The 2030 GGRA Plan includes several programs aimed at reducing VMT growth regardless of continued projected population and economic growth by providing alternatives to personal vehicle travel. The state continues to invest in public transit, encourage high density housing and provide more housing near transit, improve the quality of bike and pedestrian infrastructure, and invest in downtown communities. While reducing GHG emissions is the one of the primary strategies of the 2030 GGRA Plan, electric vehicles, providing alternative choices and investing in public transit and other modes of active transport will ensure Maryland residents, workers, businesses and other stakeholders have reliable and equitable access to jobs and travel.

Metric

Clean and Renewable Sources

% of annual in-state electricity generated by clean sources.

Goal

Go beyond the 50% Renewable Portfolio Standard and build in-state renewable energy to achieve 100% clean electricity by 2040.

Background

In order to effectively decarbonize Maryland's electricity supply, the state intends to increase deployment of clean and renewable energy resources through the RPS and other clean energy initiatives while reducing CO_2 emissions from energy generation through RGGI and other pollution control programs. The 2030 GGRA Plan advanced measures to accelerate deployment of clean energy that have not been enacted, including a proposed Clean and Renewable Energy Standard, to achieve 100% clean electricity in Maryland by 2040.

The 2030 GGRA Plan projected substantial increases in the rate of clean energy deployment as a result of those measures and a coincident decrease in fossil fuel-fired generation. Maryland will need to increase its deployment of clean energy resources in order to reach the projections in the Plan and achieving the new goal of a 60% reduction in statewide GHG emissions by 2031 will require still more clean energy deployment beyond that.

Progress

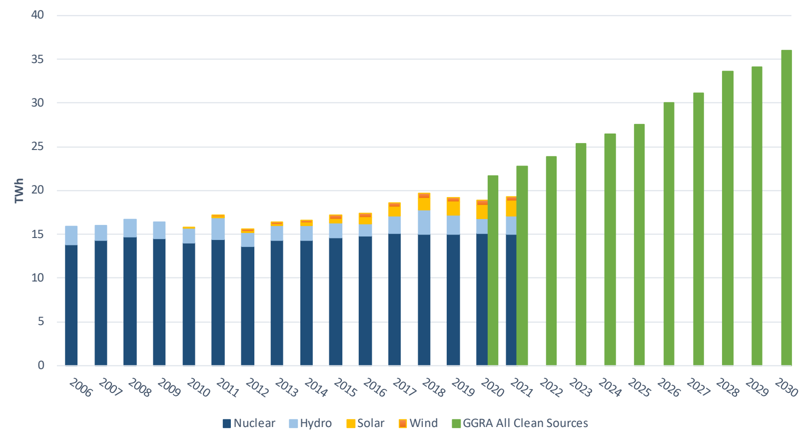

Figure 19. Historic in-state clean and renewable electricity generation as well as projected clean and renewable generation from the 2030 GGRA Plan. (Click figure to expand).

The state is meeting the RPS goals, however, there still is a discrepancy between the projected and realized in-state renewable generation due to multiple factors. First, the 2030 GGRA Plan called for additional enhancements to clean energy policy to complement the RPS goals that have yet been enacted. Second, Maryland has seen setbacks to deploying solar and wind energy for various reasons, namely delays in offshore wind development and barriers to solar development, including but not limited to siting and supply chain issues.

A backlog of projects awaiting approval by PJM has also contributed to the issue.[7] Still, the state also must find ways to accelerate clean energy deployment. The MCCC has identified this as a priority challenge for the state to overcome and is exploring recommendations in 2022 to achieve that.

Offshore wind represents one of the most reliable clean energy resources available to the state. The Maryland Offshore Wind Energy Act of 2013 created an offshore wind carveout of Tier 1 resources under the RPS of a maximum of 2.5% of electricity sold in Maryland in 2017, and later. The Clean Energy Jobs Act (CEJA) added a second round of offshore wind procurement for a minimum of an additional 1,200 megawatts (MW) with a residential cap of annual bills to protect ratepayers. The Maryland Public Service Commission (PSC) has approved several major wind projects to be built more than a dozen miles off the Maryland coast between first and second rounds of applications.

To support the growth of a healthy offshore industry, the state must continue to work with neighboring states, federal agencies, and local municipalities to design and deploy offshore and onshore transmission systems to integrate the large amount of offshore wind projects anticipated in the waters of the East Coast. To do so, Maryland will continue to lead in the discussions of the Regional SMART-Power partnership with Virginia and North Carolina.

Under the CEJA and through the SMART-Power partnership, Maryland aims to expand education and training programs to grow a new offshore wind workforce, expand local supply chains, support the redevelopment of and improvements to critical port infrastructure, and advance research and innovation. In addition, Maryland will work with the U.S. Department of the Interior Bureau of Ocean Energy Management to explore the expansion of offshore wind lease areas in federal waters.

Metric

Carbon Intensity of Imported Electricity

Carbon intensity of electricity from imports.

Goal

Achieve 100% clean electricity by 2040 by both building clean energy and capping emissions from fossil fuel-based energy via the Regional Greenhouse Gas Initiative.

Background

Carbon intensity is a measure of how much CO_2 is released per unit of electrical energy used. As the entire region shifts to cleaner fuels, carbon intensity of Maryland's imported electricity decreases. In 2020, approximately half of the electricity consumed in Maryland was imported from neighboring states. For this reason and others, Maryland's success in reducing GHG emissions is tied to the decarbonization efforts of the broader region.

Progress

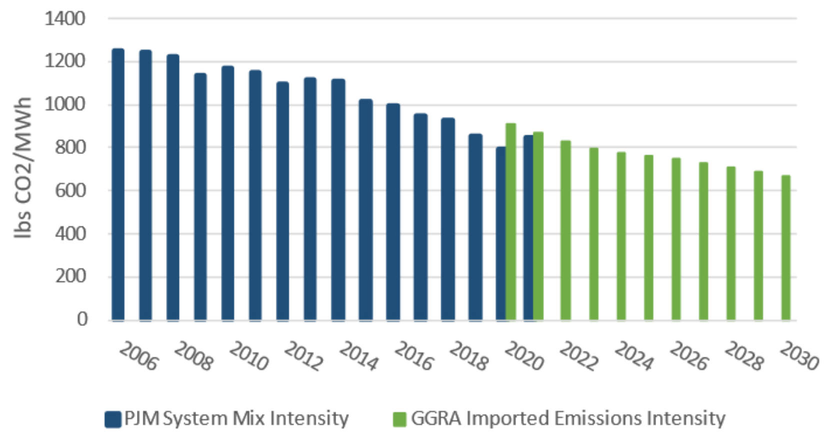

Figure 20. Historical carbon intensity of electricity in the PJM system and 2030 GGRA Plan projections. (Click figure to expand).

Between 2005 and 2021, carbon intensity rates fell by about 35% across PJM (Figure 20). The PJM states continue to use cleaner, more energy efficient fuels and continue to replace older, less efficient units. Many PJM states have encouraged investment in clean and renewable technologies, demand response, and energy efficiency. This trend has contributed to the decline in emissions rates over both the long term as well as year-over-year.

There are several power sector programs focused on decarbonization in the state, with one key program being RGGI. As a RGGI participating state, Maryland caps and reduces CO_2 emissions from its own in-state fossil fuel electricity generators. The 2030 GGRA Plan identified expansion of the RGGI partnership to additional states, especially Maryland's neighbors in PJM territory, as a priority measure to reduce the emissions intensity of Maryland's imported power. RGGI has successfully welcomed new members to the program in recent years, substantially improving its coverage of the PJM region and dramatically improving the impact on carbon pollution in the region, including cleaning Maryland's imported power. RGGI states largely recognize that all participating states can benefit from a broader market with more participants. Larger markets increase economic efficiency and cost-effectiveness, align more closely with the regional nature of the PJM transmission grid, and can help drive even greater consumer savings.

In order for RGGI to be consistent with a 100% clean electricity program by 2040, the participating states would need to agree to reduce the cap to zero CO_2 emissions by 2040. The RGGI states have commenced a periodic program review to evaluate the program's emissions cap and other elements and will be discussing program changes with stakeholders in spring 2023.

Metric

Building Energy Use Intensity

Energy use intensity (kBTU/SF) of buildings from all energy sources.

Goal

Improve the overall energy efficiency of buildings.

Background

Energy use intensity (EUI) is a measure of a building's total energy use on a per square foot basis and is a common metric used to measure energy efficiency. Residential and commercial buildings have seen modest improvements in energy efficiency since 2006 as seen in the following figures.

Progress

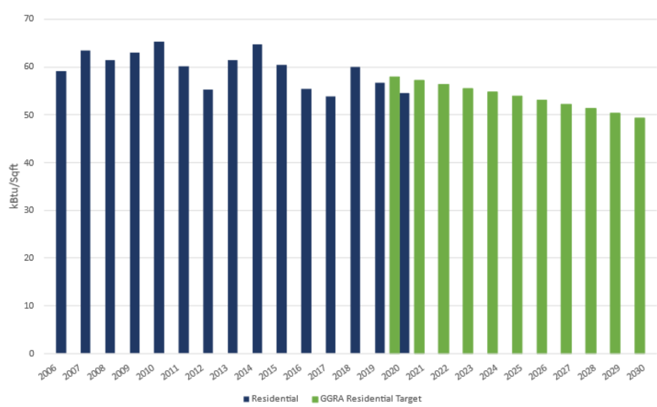

Figure 21. Historic residential building EUI[8] and projected EUI from the 2030 GGRA Plan.[9] Annual variation in building energy consumption is strongly correlated with annual variation in weather. (Click figure to expand).

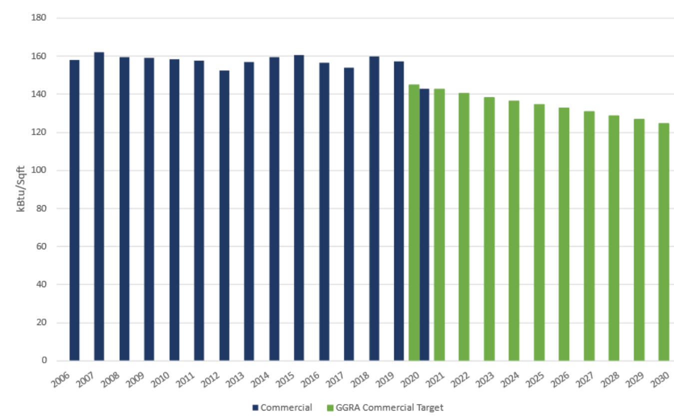

Figure 22. Historic commercial building EUI and projected EUI from the 2030 GGRA Plan. Annual variation in building energy consumption is strongly correlated with annual variation in weather. (Click figure to expand).

EmPOWER Maryland is the state's program for improving the energy efficiency of buildings. Residential energy efficiency programs include discounted light-emitting diodes and appliances; heating, ventilation, and air conditioning (HVAC) rebates; home energy audits; weatherization, and limited-income programs. Commercial and industrial energy efficiency programs are designed to encourage businesses to upgrade to more efficient equipment, such as lighting or HVAC retrofits, or to improve overall building performance through weatherization or building shell upgrades. For larger commercial buildings or industrial facilities, a utility can customize its program offerings for cost-effective improvements.

EmPOWER also requires utilities to implement a cost-effective demand response program. These Direct Load Control programs have 680,000 residential and 8,800 commercial participants as of December 2021 (PSC of Maryland, 2022). In 2021, a majority of the state's electric utilities experienced a decrease in per capita energy use and per capita peak demand as compared to 2020. Considered statewide, both metrics also show a decrease from 2020 even with more people working from home during COVID-19.

In 2021, the MCCC recommended that the core objective of EmPOWER change from electricity demand reduction to a portfolio of mutually reinforcing goals, including GHG emissions reduction, energy savings, net customer benefits, and reaching underserved customers. In 2022, CSNA put those requirements into law. The PSC is currently working with the electric and gas utility companies, and other stakeholders to design and implement the future programming for EmPOWER.

Metric

Fuel Use In Buildings

Residential and commercial building electrification.

Goal

Reduce direct emissions from the building sector through improved energy efficiency and electrification of heating equipment.

Background

Combustion of fossil fuel in buildings is a substantial source of emissions, mostly resulting from space and water heating. The 2030 GGRA Plan aims to reduce emissions from buildings by prioritizing energy efficiency and by converting heating systems to efficient electric heat pumps that are powered by increasingly clean and renewable electricity.

Many homes and businesses in Maryland already are heated by heat pumps, which use electricity to move heat from outside to inside of buildings (they also reverse the cycle to provide efficient cooling). These heating systems are more efficient than combustion systems and produce far fewer emissions, especially since Maryland's electricity supply is already fairly clean. As Maryland's electricity supply continues to decarbonize, the pollution benefits of heat pumps will continue to grow.

Progress

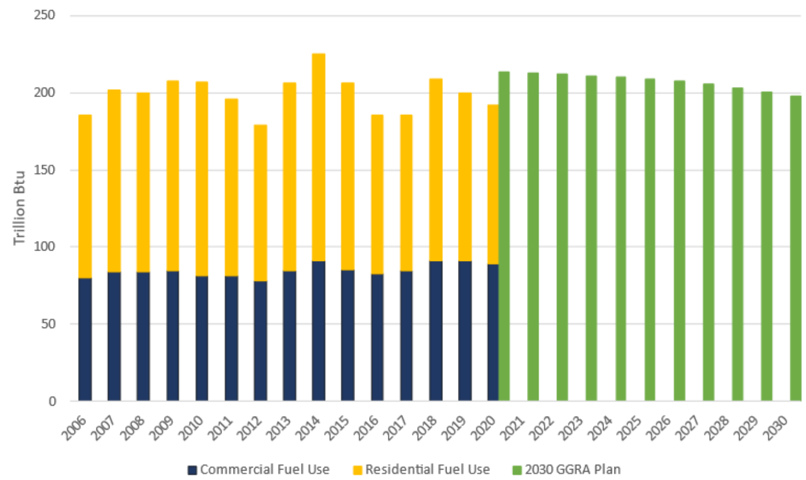

Figure 23. Total fuel use in residential and commercial buildings, historical and 2030 GGRA Plan projections. (Click figure to expand).

Note that the 2030 GGRA Plan projection is higher than it should be for heating fuel use in buildings. Modeling for the 2030 GGRA Plan benchmarked building fuel use to 2014, which happened to be a year with peak heating demand. If the benchmark would have been closer to the average, which is roughly equivalent to fuel use in 2020, then the projection would show a gradual decrease in fuel use dipping below average levels.

The 2030 GGRA Plan acknowledged that more policies are needed to reduce emissions and called on the MCCC to produce a Building Energy Transition Plan in 2021 to further develop policies for decarbonizing Maryland's building sector. The MCCC's Building Energy Transition Plan included several recommendations, including that the state should set a target for 50% of residential HVAC and water heater sales to be heat pumps by 2025, reaching 95% by 2030. The MCCC's Plan also called for new standards to guide large commercial and multifamily residential buildings to electrify and fully decarbonize by 2040, targets that CSNA put into law. As buildings large and small transition faster from combustion to heat pump solutions for space and water heating, direct fuel use - and direct emissions from buildings - will decrease.

Metric

Hydrofluorocarbons from Refrigerants, Aerosols, and Foams

MMtCO_2e from hydrofluorocarbons.

Goal

Reduce hydrofluorocarbons by 23% below 2014 levels.

Background

Short-lived climate pollutants (SLCPs) are air pollutants that have a warming influence on our climate, but a relatively short lifetime in the atmosphere. As opposed to CO_2, which has an atmospheric lifetime of thousands of years, SLCPs have an atmospheric lifetime of only a few years to a few decades. The most common SLCPs are CH_4, black carbon, and hydrofluorocarbons (HFCs).

HFCs are chemicals used as propellants and refrigerants in a variety of products, as well as air conditioning and refrigeration systems. They are extremely potent GHGs when released into the atmosphere. HFCs are the fastest growing source of GHG emissions in the U.S. and globally.

Progress

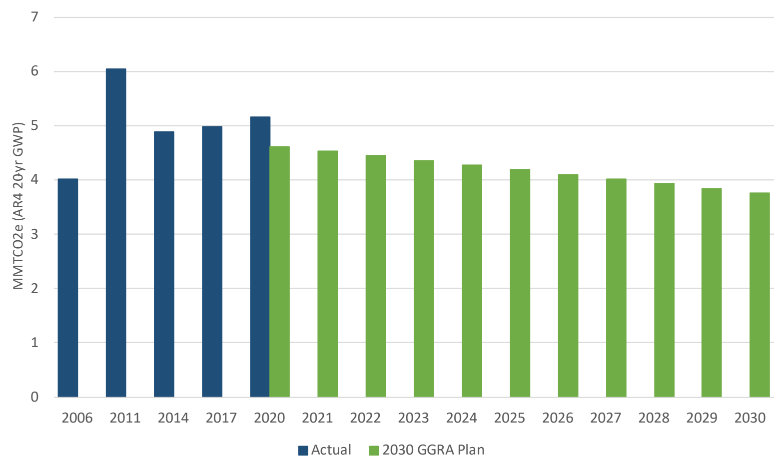

Figure 24. HFC emissions vs 2030 GRRA Plan projected emissions. (Click figure to expand).

The American Innovation and Manufacturing (AIM) Act was enacted by the U.S. Congress on December 27, 2020. The AIM Act directs the U.S. Environmental Protection Agency (EPA) to address HFCs by phasing down production and consumption, maximizing reclamation and minimizing releases from equipment, and facilitating the transition to next-generation technologies through sector-based restrictions. The phase down will be focused on production and consumption of HFCs in the US by 85%over the next 15 years, with a narrow clause preempting new state regulations for certain uses of HFCs for at least 5 years should replacements for certain applications not become widely available. The AIM Act also directs EPA to guide reclamation and releases from equipment and facilitate the transition to next-generation technologies through sector-based restrictions. AIM is in alignment with the Kigali Amendment to the Montreal Protocol of 2016. A global HFC phasedown is expected to avoid up to 0.5 degrees Celsius of global warming by 2100.

MDE promulgated a regulation in 2020 that will phase out the use of certain HFCs in multiple end-uses, such as foam products and certain refrigeration equipment in retail establishments such as supermarkets. These regulations drive GHG emission reductions as the prohibited HFCs are transitioned to lower GWP substitutes. With the proposed action in place, HFC emissions are expected to be reduced annually starting in 2021, and by approximately 23% in 2030.

Metric

Methane (CH_4)

Annual methane emissions from all sources.

Goal

Reduce methane emissions from natural gas transmission and distribution, and waste management.

Background

Non-energy emissions of CH_4 are predominantly from waste management, including municipal solid waste landfills, composting and enteric fermentation, wastewater treatment plants, natural gas transmission, storage, and natural distribution, as well as agricultural practices and manure management. The 2030 GGRA Plan included targeted measures and regulations to identify and mitigate emissions from the energy industry, and the waste management sector. Reducing CH_4 emissions is an important part of a comprehensive plan to address climate change and is critical to the state's efforts to meet the requirements of the GGRA of 2016.

Progress

MDE implemented a CH_4 minimization plan to first address CH_4 from the energy sector. From 2006 to 2020, statewide CH_4 emissions decreased by 13%. As seen in the figure above, municipal solid waste landfills are the largest source of CH_4 emissions in the state. MDE adopted regulations for the control of the natural gas transmission and storage sector in 2020 requiring leak detection and repair measures for compressor stations and storage facilities. Six facilities in Maryland began conducting surveys for CH_4 leaks and reporting to MDE in 2021.

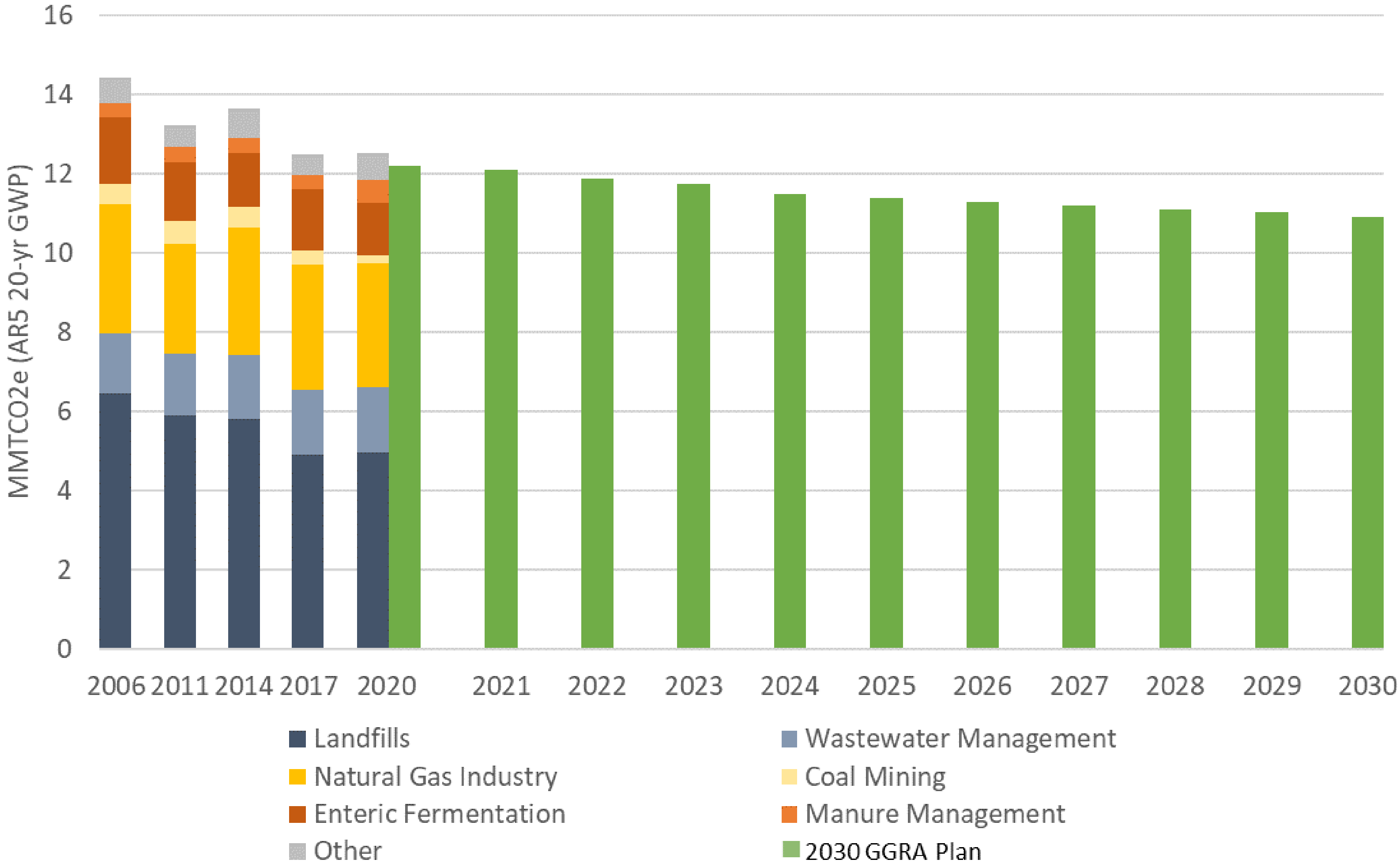

Figure 25. CH_4 emissions by sector and projected emissions from the 2030 GGRA Plan. (Click figure to expand).

Metric

Trees and Forests

Acres of afforestation and reforestation, acres under forest management, and number of urban trees.

Goal

DNR estimates an average annual target of 550 acres of afforestation, 600 acres of reforestation, between 150,000 and 500,000 urban trees planted, and sustainable forest management on 38,000 acres of private land.

Background

The 2030 GGRA Plan includes a range of state commitments aimed at growing and maintaining Maryland's natural carbon sinks. Carbon sinks offer several benefits, including enhancing the ability of land to sequester carbon and mitigate GHGs, building resilience in ecosystems and communities, improving water and air quality, and providing public health and ecosystem co-benefits, among others.

The Maryland Department of Natural Resources (DNR) manages several statewide programs to support the GGRA target of afforestation or reforestation on 68,530 acres and the planting of 2.65 million urban trees by 2030. To achieve these goals, DNR estimates an average annual target of 550 acres of afforestation, 600 acres of reforestation, and between 150,000 and 500,000 urban trees planted.

Additionally, the state seeks to provide sustainable forest management on 38,000 acres of private land annually by 2030, ensuring that 50% of state-owned forest lands will continue to be third-party certified as sustainably managed, support forest markets that keep land in forest use, and provide sustainable management for multiple benefits. The 2030 GGRA Plan's targets for 2030 assume a fully funded suite of management programs, a healthy forest industry, and a high level of landowner engagement.

The Tree Solutions Now Act (TSNA) of 2021 directed the state to plant and maintain an additional 5 million native trees by 2031. As a climate mitigation goal, these trees are considered additional to those already projected as part of the 2030 GGRA Plan and focus on afforestation activities.[10] The intent of this legislation is that at least 500,000 of these trees be planted in urban underserved areas. MDE is charged with coordinating the tracking and implementation of this tree planting goal with leadership support from DNR, Maryland Department of Agriculture (MDA), Chesapeake Bay Trust, and MDOT.

Progress

Table 1. Afforestation, reforestation, forest management and urban tree planting activities in Maryland over the past three years relative to the GGRA of 2016 baseline in 2006.[11] (Click table to expand).

Forest activities	2006	2019	2020	2021
Afforestation acres	1233.9	272.3	402.6	337.8
Reforestation acres	3318	254.2	312	234.6
Forest management acres	30,629.7	43,566	45,096	50,327
Urban trees planted	665,628	179,398	271,431	218,923

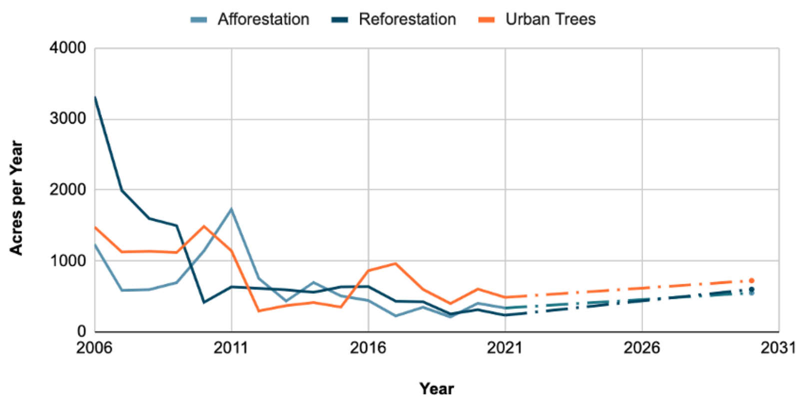

Figure 26. Implemented acres of afforestation, reforestation and urban tree planting[12] from the GGRA of 2016 baseline year of 2006 through 2021 and the estimated acreage target for each practice in 2030 based on the 2030 GGRA Plan. (Click figure to expand).

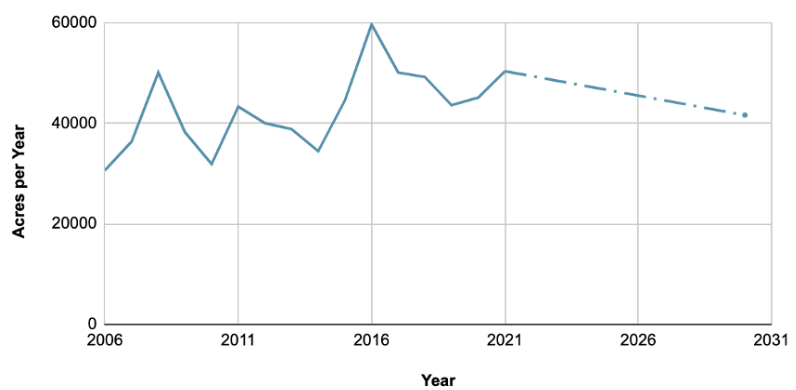

Figure 27. Acres under forest management in Maryland from the GGRA of 2016 baseline year of 2006 through 2021 and the estimated acreage target for 2030 based on the 2030 GGRA Plan. (Click figure to expand).

Over the past 15 years, Maryland has achieved average annual metrics consistent with meeting the statewide GGRA goals. The combined, long-term effects of the 2008-09 recession and subsequent local market conditions, as well as changes in eligibility criteria and availability of cost-sharing through various incentive programs, have decreased demand for tree planting. In addition, forest management strategies have evolved to place greater emphasis on natural regeneration and wider tree spacings, which has reduced the number of trees planted through reforestation. Between 2019 and 2021 (Table 1), state programs and local partnerships resulted in 337 acres per year of afforestation; 267 acres per year of reforestation; 46,329 acres per year of forest management; and 223,251 urban trees planted.

Building on research from the National Aeronautics and Space Administration (NASA) Carbon Monitoring System (CMS), a United States Climate Alliance (USCA)- funded project in 2020-2021 led to the development of a new method for calculating annual forest carbon fluxes in the state. Led by the University of Maryland, with support from DNR and MDE, this effort combines high-resolution light detection and ranging (LiDAR) data on forest height and structure, a predictive ecosystem model, and annual estimates of forest cover change from Landsat satellite imagery to quantify annual changes to the state's forest carbon stocks.

The method improves Maryland's GHG inventory by reducing the uncertainty associated with estimates of forest carbon stock change, increasing the temporal and spatial resolution of those estimates, and providing a consistent methodology to estimate carbon stock change in forests and trees outside of forests. Importantly, this work allows for attribution of annual fluxes to key drivers, including land use change, weather, rising atmospheric CO_2 and disturbance. The underlying ecosystem model used to support this forest monitoring work was also used to project forest carbon sequestration potentials within the 2030 GGRA Plan,[13] highlighting the value of plan-inventory integration with a consistent science approach.

Metric

Agricultural Soils

Acres of agricultural land under climate-friendly agricultural practices.

Goal

Additional acres with Best Management Practices that increase carbon sequestration in agricultural soils.

Background

The 2030 GGRA Plan includes a range of state commitments aimed at growing and maintaining Maryland's natural carbon sinks. In support of this goal, MDA has worked with the Healthy Soils Consortium and the Maryland Soil Health Advisory Committee to identify and promote the use of specific agricultural practices that enhance the sequestration capacity of Maryland farms.

One mechanism for incentivizing climate-friendly agricultural practices is the Maryland Healthy Soils Program. Under law, MDA is charged with developing a Healthy Soils Program to:

- Improve the health, yield, and profitability of the soils of the state;
- Increase biological activity and carbon sequestration in agricultural soils; and
- Promote further education and adoption of healthy soil practices.

While many Maryland producers have been practicing various soil conservation practices over the last 20 years,[14] the Healthy Soils Program will create new financial incentives for voluntary participation in these practices to enhance resilience to extreme weather, drought, flood and wildfire and create a potential pathway for producers to participate in emerging carbon and nutrient trading markets.

CSNA included important provisions that impact the Maryland Healthy Soils Program and requires an annual appropriation of funding for the Healthy Soils Program. Funding for the program will advance the recommendation made by the Soil Health Advisory Committee in January 2022 (MDA, 2022).

The 2030 GGRA Plan's estimated acreage numbers for 2030 are based on the ongoing implementation of the Maryland Phase III Watershed Implementation Plan and new implementation of the Maryland Healthy Soils Program.

The 2030 GGRA Plan's estimated acreage numbers for 2030 are based on the ongoing implementation of the Maryland Phase III Watershed Implementation Plan and new implementation of the Maryland Healthy Soils Program.

Progress

Table 2. Implemented acres of key agricultural practices in Maryland over the past three years relative to the GGRA of 2016 baseline in 2006. Note: Acres are fiscal year, not calendar year. (Click table to expand).

Conservation Practices[16]	Acres in 2006	Acres in 2019	Acres in 2020	Acres in 2021
Conventional Tillage to No Till, annual (CPS 329)	524,923	647,072	647,072	647,072
Conventional Tillage to Reduced Tillage, annual (CPS 345)	167,021	194,122	194,122	194,122
Cover Crops, annual (CPS 340)	127,614	481,904	488,685	434,426
Land Retirement, cumulative (CPS 327, 342 and 512)	20,377	23,730	24,939	25,040
Forest Buffers and Tree Plantings, cumulative (CPS 391 and 612)	16,972	20,714	21,839	21,821
Prescribed Grazing, cumulative (CPS 528)	3,292	10,287	10,250	10,217

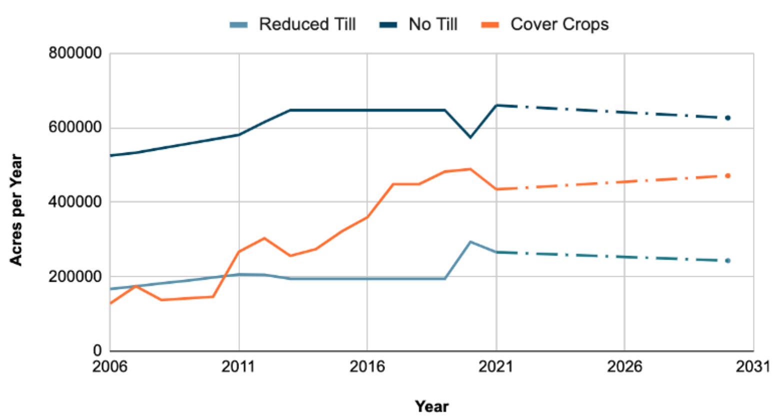

Figure 28. Implemented acres of select agricultural practices from the GGRA of 2016 baseline year of 2006 through 2021 and the estimated acreage target for each practice in 2030 based on the 2030 GGRA Plan. (Click figure to expand).

Over the past 15 years, Maryland farmers have increasingly adopted and maintained conservation-friendly practices. To better measure the climate and soil health benefits of these practices, MDE and MDA are developing improved quantification tools through partnerships with the USCA and Colorado State University. In the 2030 GGRA Plan, MDA and MDE utilized an early version of the U.S. Department of Agriculture and Colorado State University's Carbon Management & Emissions Tool (COMET) Planner tool. Building from this investment, MDE received a USCA Technical Assistance grant to integrate directly state-specific data within COMET's underlying biogeochemical model to generate historical annual agricultural soil carbon fluxes across all cropland (2006-2021), develop a method to quantify annual fluxes for future state inventories, and consider future fluxes under a range of planning scenarios for ongoing implementation of best management practices toward future GHG goals. This work will ensure we can accurately capture the additional carbon contributions of Maryland farmers against the broader agricultural soil carbon landscape.

MDA is piloting two new initiatives as part of Healthy Soils programming. First, the Cover Crop Plus+ program focuses on long term farm planning for soil health. Based on a 3-year contract, rather than an annual contract, farmers interested in going beyond the state's traditional Cover Crop program will receive financial support from MDA to do so. Signups for the first year closed on July 18, 2022, and 20 producers have submitted applications. A second initiative, the Healthy Soils Competitive Fund, will allow farmers the flexibility to propose individualized soil health management needs and a corresponding budget. Program details are in development with an application period expected in early 2023.

Metric

Tidal Wetlands

Acres of restored wetlands.

Goal

230 acres of tidal wetland restored per year by 2030.

Background

The 2030 GGRA Plan includes a range of state commitments aimed at growing and maintaining Maryland's natural carbon sinks. Carbon sinks offer several benefits, including enhancing the ability of land to sequester carbon and mitigate GHGs, building resilience in ecosystems and communities, and providing public health and ecosystem co-benefits, among others. Blue carbon ecosystems, including tidal or coastal wetlands, are particularly efficient at sequestering and storing carbon.

DNR has supported multiple initiatives to drive tidal wetland creation, protection and restoration. As part of the 2030 GGRA Plan, DNR projected an additional 300 acres of wetland restored per year by 2030 via existing state and federal programs. The Coastal Wetlands Initiative has centered on restoring natural tidal marsh hydrology to coastal wetlands through ditch plugging practices and when combined with other state efforts, such as through DNR's Chesapeake and Atlantic Coastal Bays Trust Fund and Natural Filters Program, is expected to result in an annual average of 150 additional acres restored per year through 2030.

These state efforts have been enhanced by federal agency activities throughout Maryland, including at Blackwater National Wildlife Refuge, Deal Island, and Poplar Island. Given that a significant portion of the planned 2030 acres will be implemented by the U.S. Army Corps of Engineers (USACE) and other federal partners, Maryland anticipates an average annual implementation of 80 acres per year through 2030.

New federal resources for coastal wetland restoration being made available to states from the Infrastructure Investment and Jobs Act (IIJA), have increased acreage estimates related to federally-funded state actions. However, given recent USACE reporting, federal partner actions in the 2030 GGRA Plan were likely overestimated. The revised 2030 goal of 230 acres per year is consequently lower by 70 acres per year than originally outlined in the 2030 GGRA Plan.

Progress

Table 3. Implemented acres of tidal wetland restoration in Maryland by 2020 and projected by 2030 relative to the GGRA of 2016 baseline in 2006. (Click table to expand).

Activity	2006 Baseline, acres per year	Acres Restored by 2020	Additional Acres by 2030	Total Acres Restored
State Action, Federally Funded	0	505.5	1317	1,823.5
State Action, State Funded	0	3.8	0	3.8
Federal Partners	0	512	750	1,262

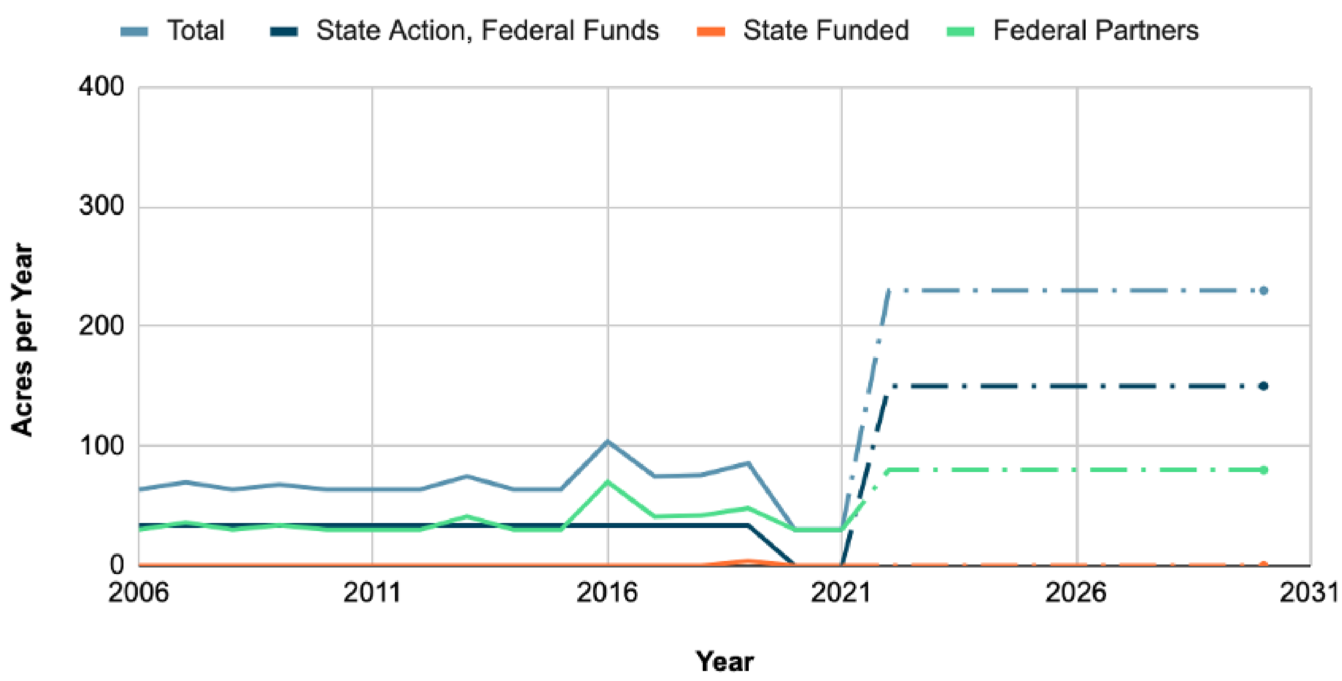

Figure 29. Implemented acres of wetland restoration from the GGRA of 2016 baseline year of 2006 through 2021 and the estimated acreage target for each activity category in 2030 based on the 2030 GGRA Plan. (Click figure to expand).

Tidal wetland restoration has remained a priority in Maryland in support of the state's water quality, habitat restoration, and climate change goals. Significant federal dollars are potentially available to accelerate the pace of tidal wetland creation and restoration in support of the GGRA goals. Two programs available through NOAA and funded by the IIJA are dedicated to creating habitat and increasing coastal resilience through nature-based solutions like coastal wetlands. Maryland anticipates competing for these and other federal dollars, and the projected acres of restoration are based on projects that have been either submitted or identified for federal funding. Carbon and other ecosystem service credits generated through tidal wetland restoration are also potential sources of funding. DNR is partnering with The Nature Conservancy to do complete assessments of five potential tidal wetland restoration projects in Maryland for the feasibility of the projects to generate and sell carbon credits.

Recent results from the Sea Level Affecting Marsh Migration model indicate that Maryland is likely to experience an expansion of tidal wetlands in the next 30 years as sea level rises and pushes inland while many marshes are able to keep pace with the predicted rate of sea level rise. After 2050, the range of possibilities for marshes in the state widens, with a net gain of marshes predicted if global GHG emissions decrease, but widespread losses if the trend of emissions continues to increase. Much of the area predicted to convert to wetlands is currently forested, so there can be a net loss of carbon even if wetland area is maintained or expands. DNR has created a new type of easement, the Coastal Resilience easement, to identify and conserve lands that are predicted to transition to wetlands and have ecological importance now and into the future.

The recent incorporation of coastal wetlands into the EPA's national GHG inventory has relied on a mix of data sources that still present large uncertainties at higher spatial and temporal scales. Accurate assessment of GHG fluxes are impacted by the range of CH_4 emissions in palustrine wetlands, the depth of soils lost to erosion, extraction, and drainage, and differing soil carbon burial rates and the fraction of carbon lost to the atmosphere. To improve these estimates for Maryland, DNR and MDE have engaged scientific experts to refine the emission reduction estimates associated with the range of wetland classes found within the Chesapeake and Coastal bays and have produced an estimate of the blue carbon inventory for the state to be included in the 2020 GHG inventory. This work has leveraged spatially-explicit data from NASA's CMS and the Smithsonian Environmental Research Center Coastal Carbon Atlas. The monitoring approach also draws from research across the state to quantify impact of salinity on the net GHG benefits of tidal wetlands given the potential for methane release. To maintain a dynamic understanding of our blue carbon stocks, these assessments will continue to be coupled with sea level rise modeling and the potential impacts of sea level rise on future carbon sequestration rates.

Reaching Climate Solutions Now Act Goals

Overview

CSNA requires the state to achieve a 60% reduction in GHG emissions from 2006 levels by 2031, which is the most ambitious near-term climate target of any state in the nation. CSNA also requires that Maryland achieve net-zero GHG emissions by 2045.

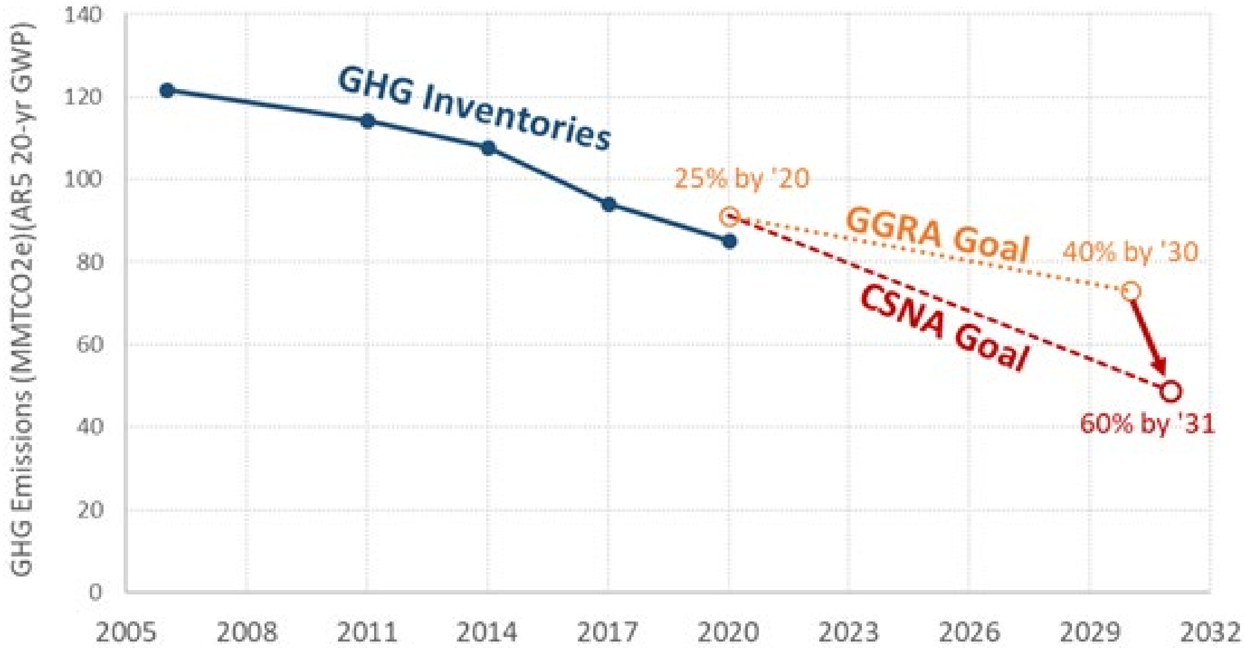

Figure 30. Maryland's statewide GHG emissions from 2006-2020 and GGRA of 2016 and CSNA emission reduction goals. (Click figure to expand).

MDE must develop a plan to achieve the 2031 goal by the end of 2023. The plan must include policy recommendations for the continued operations of Maryland's existing zero carbon electric generators, produce a net economic benefit to the state and net increase in jobs, use the 20-year GWP for methane, and may not include highway widening or additional road construction as GHG reduction measures. A draft plan is due to be published in June 2023.

Opportunities and Challenges Ahead

Through a range of programs, policies, and initiatives included in the 2030 GGRA Plan and now a landmark new law establishing an ambitious 60% reduction target, Maryland is clearing a path for other states to fight climate change. However, based on current policies (both state and federal), significant gaps in policy outcomes remain. Based on the current implementation status and associated emission reduction rate of several emission drivers included in this report, the gaps identified could prevent Maryland from hitting its 2031 target.

A supplemental sensitivity analysis as part of the 2030 GGRA Plan modeling identified an “optimistic scenario” that considers how Maryland could achieve additional GHG reductions with supportive federal actions. While the optimistic scenario shows that Maryland could exceed a 44% reduction in GHG emissions by 2031 with supportive federal actions, it also shows that Maryland could still need to find an additional 13 $MMTCO_2e$ of reductions over the next 8 years to achieve the 60% by 2031 goal.

A wide range of emission reduction successes have been presented herein, but this report also indicates that without full implementation of the programs included in the 2030 GGRA Plan, additional support from the federal government, and significant new state and local actions, Maryland may not meet the mandated 60% reduction by 2031 goal established by CSNA.

The analysis conducted for this progress report indicates that certain sectors comprise much of the emissions and policy gap, with a particular need to rapidly transition to ZEVs and efficient electric heating systems in buildings. Further, more rapid deployment of renewable energy is necessary to build upon the already strong reductions from electricity generation and provide sufficient zero-carbon electricity to power those electrified transportation and building sectors. MDE is working with the MCCC, state agencies, federal agencies, and the private sector to find opportunities to accelerate decarbonization of these and other sectors.

Maryland has been an early national leader on climate and continues to work to meet the most ambitious goals in the nation for reducing GHG emissions.

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Justin Arseneault, Forest Planner, Maryland Forest Service, DNR

Virginia Burke, Transportation Air Quality Program Manager, MDOT

Sandy Hertz, Climate Change Resilience and Adaptation Director, MDOT

Endnotes

[1] MD Env Code § 2–1204 (2016).

[2] The final version of Maryland's 2030 GGRA Plan can be found on the Maryland Department of the Environment website at mde.maryland.gov/programs/air/ClimateChange/Pages/Greenhouse-Gas-Emissions-Reduction-Act-%28GGRA%29-Plan.aspx.

[3] GWP is a measure of the amount of energy that is trapped in Earth's atmosphere over a given timeframe from one ton of emissions of a given gas, relative to the amount of energy trapped by one ton of carbon dioxide (CO_2). For example, methane traps 28 times more energy than CO_2 over a 100-year period and it traps 84 times more energy than CO_2 over a 20-year period based on the IPCC Fifth Assessment Report (AR5).

[4] For on-road transportation emissions, Maryland's 2020 GHG emissions inventory utilizes the latest version of the U.S. EPA's Motor Vehicle Emission Simulator, MOVES3, released in late 2020. Results differ slightly from estimates using different MOVES versions, including those in the 2022 Annual Attainment Report found at mdot.maryland.gov/tso/pages/Index.aspx?PageId=121.

[5] Synthetic nitrogen fertilizers applied to lawns, golf courses, and other landscaping within settlement areas.

[6] In GHG inventories, the term "flux" is used to describe the exchange of CO2 to and from the atmosphere. When more carbon is sequestered and stored than is released to the atmosphere in a given year, this constitutes a net removal of carbon from the atmosphere (e.g., negative flux from the atmosphere and positive flux to the land).

[7] As a result of the rapid growth in renewable generation development, the number of projects entering the PJM Generator Interconnection Queue has nearly tripled over the past four years. PJM entered 2022 with nearly 2,500 projects under study; of these, 45 are solar projects in Maryland. PJM has recently proposed that future projects be reviewed on a first-ready, first-served basis rather than first-come, first-served. Improvements to generator interconnection procedures regarding permitting and site control may help reduce the current backlog of projects in the queue that delay other queued projects.

[8] Actual fuel use consumption estimates from EIA at eia.gov/state/seds/data.php?incfile=/state/seds/sep_use/res/use_res_MD.html&sid=MD, divided by the total square footage of residential buildings as determined by data from the Maryland Computer Assisted Mass Appraisal – CAMA Detailed Building Characteristics at data.imap.maryland.gov/datasets/ef9a0317a94e4d0d9eb46998e8b9c936_0/explore?location=38.809398%2C-77.268450%2C8.13 and projected with new building data from census.gov/construction/bps/data_visualizations to find annual EUIs.

[9] Projected fuel use consumption as per the 2030 GGRA Plan mde.maryland.gov/programs/Air/ClimateChange/Pages/Greenhouse-Gas-Emissions-Reduction-Act-(GGRA)-Plan.aspx, using the same square footage as calculated with the EIA data.

[10] The afforestation baseline used to establish additionality under the Tree Solutions Now Act of 2021 comes from the Draft 2019 GGRA plan.

[11] Afforestation in the 2030 GGRA Plan includes Riparian Forest Buffers and other additional afforestation activity; Reforestation acres include plantings post timber harvest; Forest management acres include management on both private and public lands; Urban trees include Forest Conservation Act, Reforestation Law 5-103, and Tree-Mendous/Marylanders Plant Trees program plantings.

[12] Urban tree planting is an afforestation activity but is accounted for separately in the 2030 GGRA Plan; for parity, this graph assumes a planting density of 450 trees per acre.

[13] For more details on the modeling, please see Hurtt et al. 2019 (doi.org/10.1088/1748-9326/ab0bbe) and Ma et al. 2021 (doi.org/10.1088/1748-9326/abe4f4).

[14] Maryland's national leadership in cover crop adoption has been highlighted in recent USDA reports: ers.usda.gov/webdocs/publications/100551/eib-222.pdf.

[15] Practice name is followed by the related USDA-NRCS code.

[16] More information on the Cover Crop Plus+ program can be found at the Maryland Department of Agriculture website at mda.maryland.gov/resource_conservation/Pages/Cover-Crop-Plus.aspx.

References

BizEE. (2022). *Degree Days*. Retrieved from Energy Lens: energylens.com/articles/degree-days#why.

IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 3-24, doi:10.1017/9781009157940.001.

IPCC, 2022: Summary for Policymakers. In: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.001.Maryland Department of Agriculture. (2022). The Maryland Healthy Soils Program Final Report: A Path Forward. Maryland Department of Agriculture. (2022). The Maryland Healthy Soils Program Final Report: A Path Forward. Maryland Department of Agriculture. (2022). *The Maryland Healthy Soils Program Final Report: A Path Forward.*

Maryland Department of Planning. (2022). *Projections*. Retrieved from Maryland State Data Center: planning.maryland.gov/MSDC/Pages/S3_Projection.aspx

Maryland Department of Transportation. (2022). *MVA Vehicle Sales Counts by Month for Calendar Year 2022*. Retrieved from Open Data Portal: opendata.maryland.gov/Transportation/MVA-Vehicle-Sales-Counts-by-Month-for-Calendar-Yea/un65-7ipd/data.

NOAA National Centers for Environmental information, Climate at a Glance: Global Mapping, published December 2021, retrieved on January 6, 2022 from ncdc.noaa.gov/cag/.

Public Service Commission of Maryland. (2022). The EmPOWER Maryland Energy Efficiency Act REPORT of 2022. Baltimore.

United Nations. (2022). *The Paris Agreement*. Retrieved 2022, from United Nations: un.org/en/climatechange/paris-agreement.

USEPA. (2022, January 21). *Maryland Analyzes Coastal Wetlands Susceptibility to Climate Change*. Retrieved from epa.gov: epa.gov/arc-x/maryland-analyzes-coastal-wetlands-susceptibility-climate-change.

Appendix A: Figure Glossary

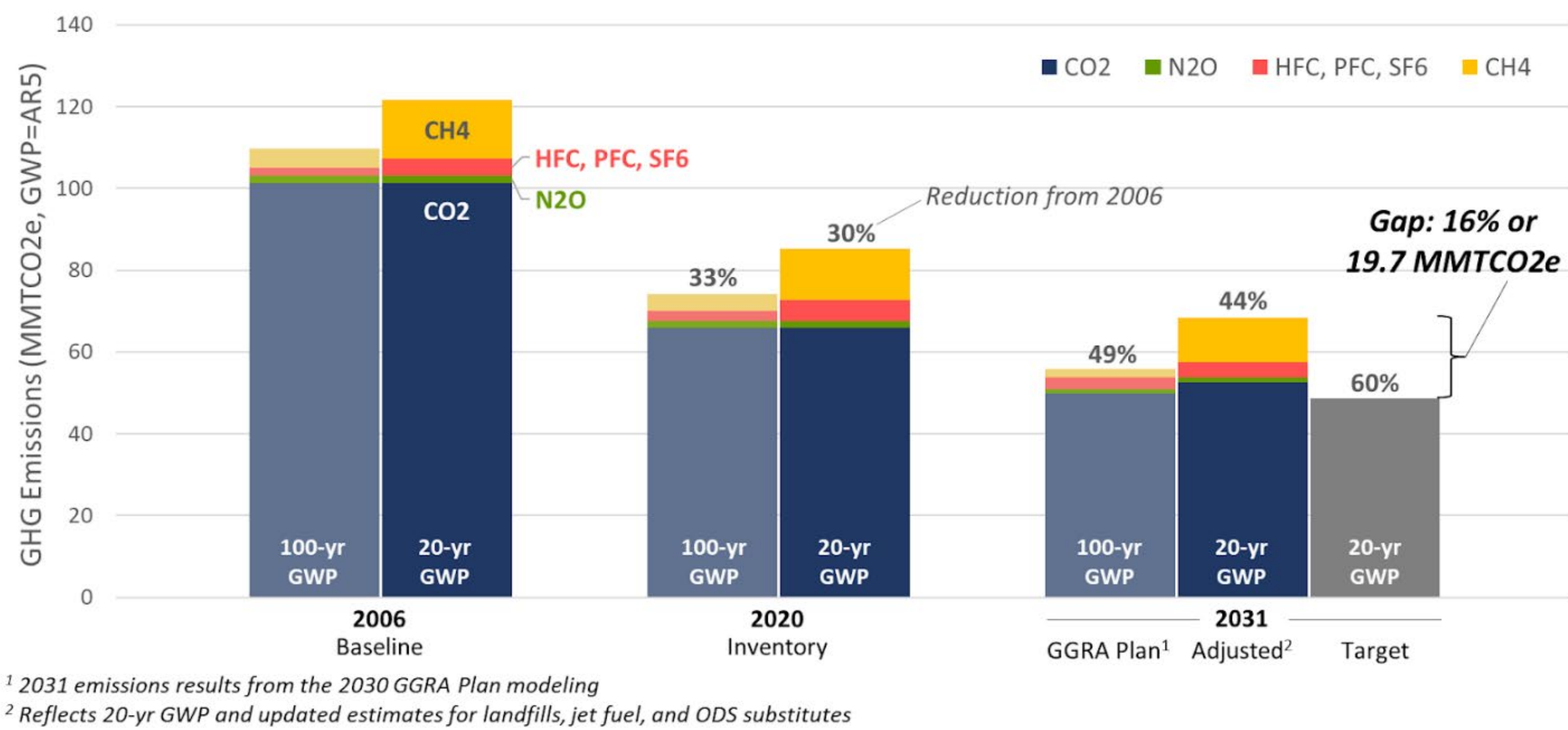

Figure 1. Maryland historical emissions, projected emissions, and emissions gap. (Click figure to return).

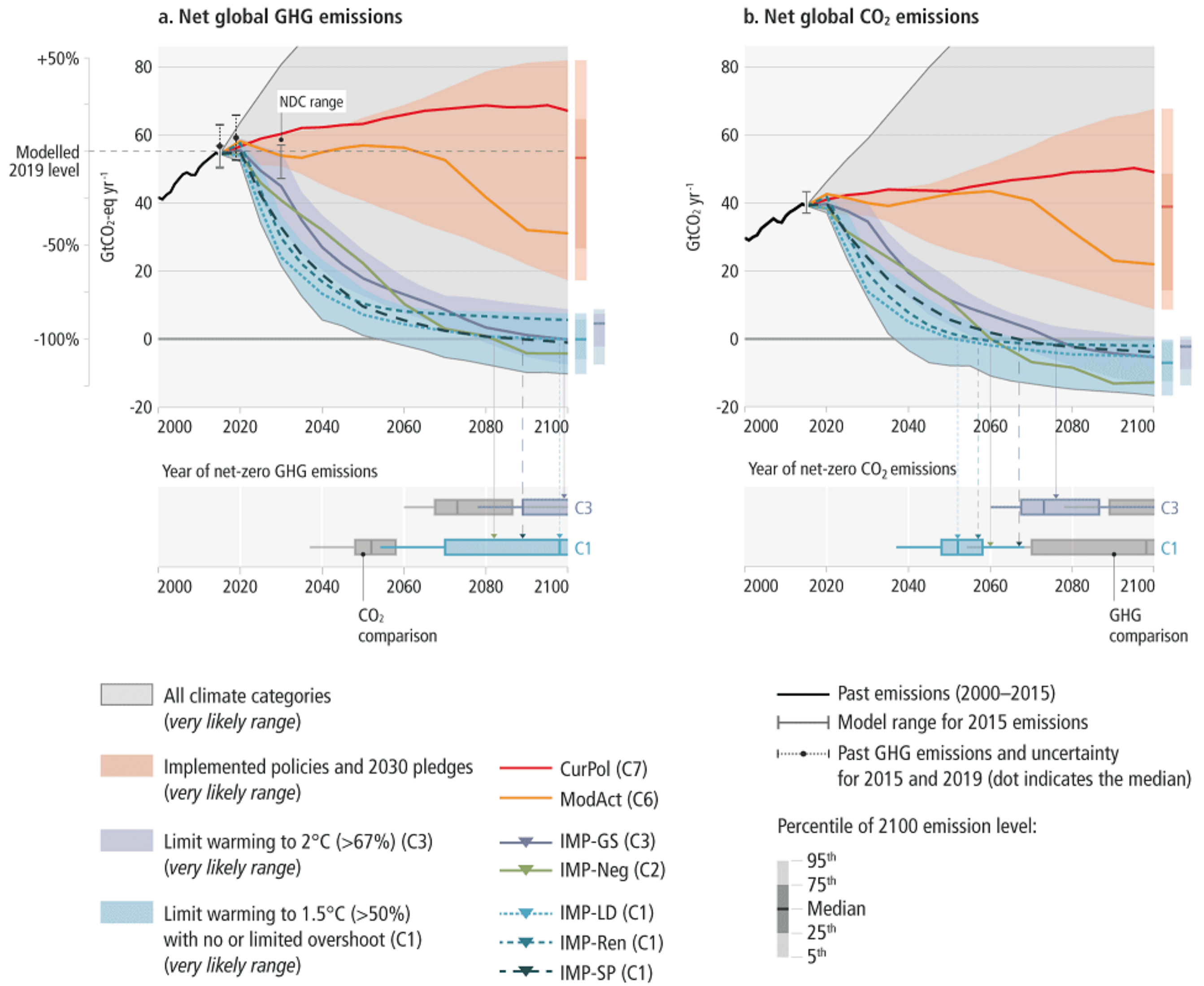

Figure 2. IPCC Working Group III 2.0-degree Celsius and 1.5-degree Celsius pathways. (Click figure to return).

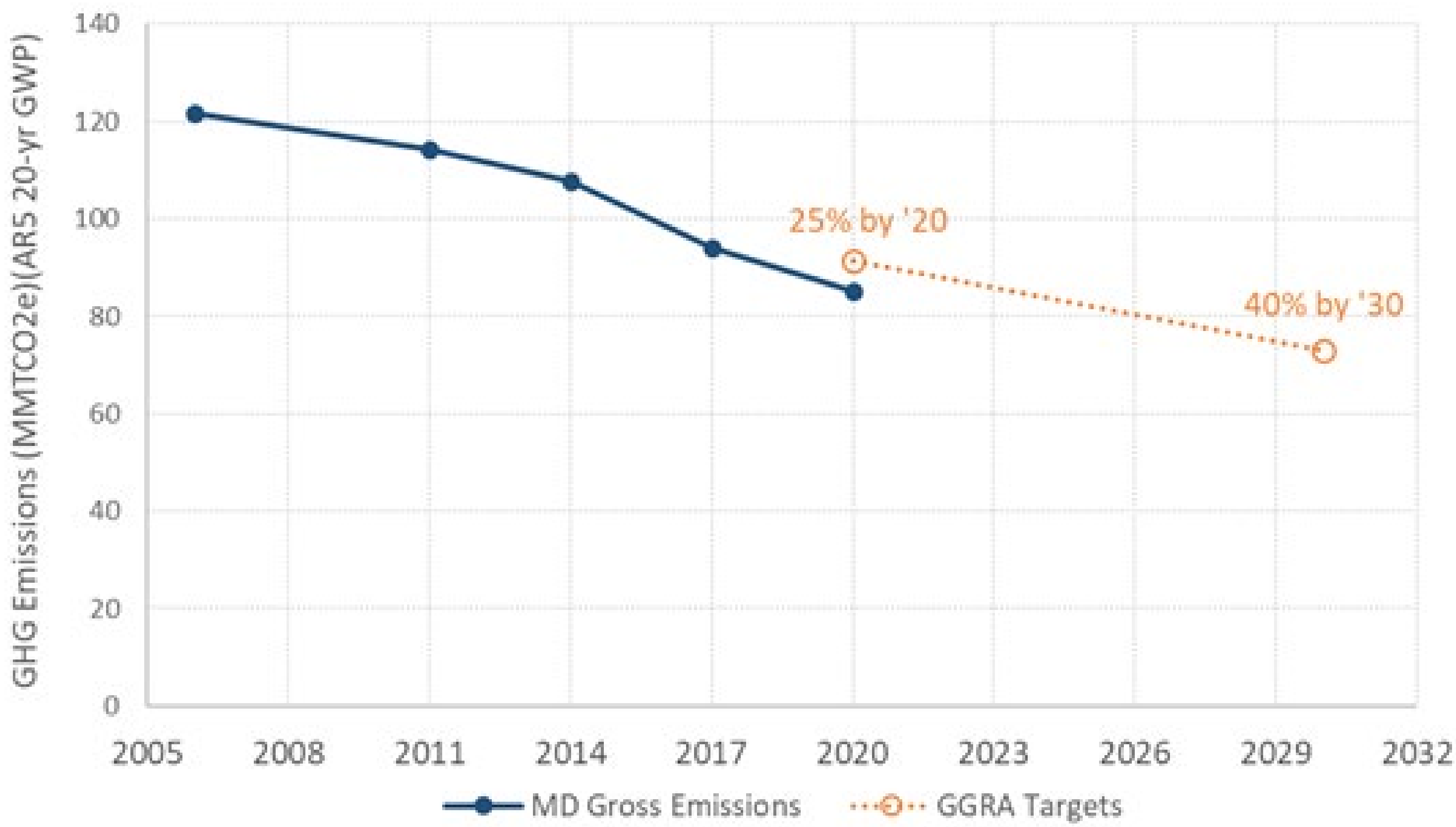

Figure 3. Maryland's statewide GHG emissions from 2006-2020 and GGRA of 2016 emission reduction goals. (Click figure to return).

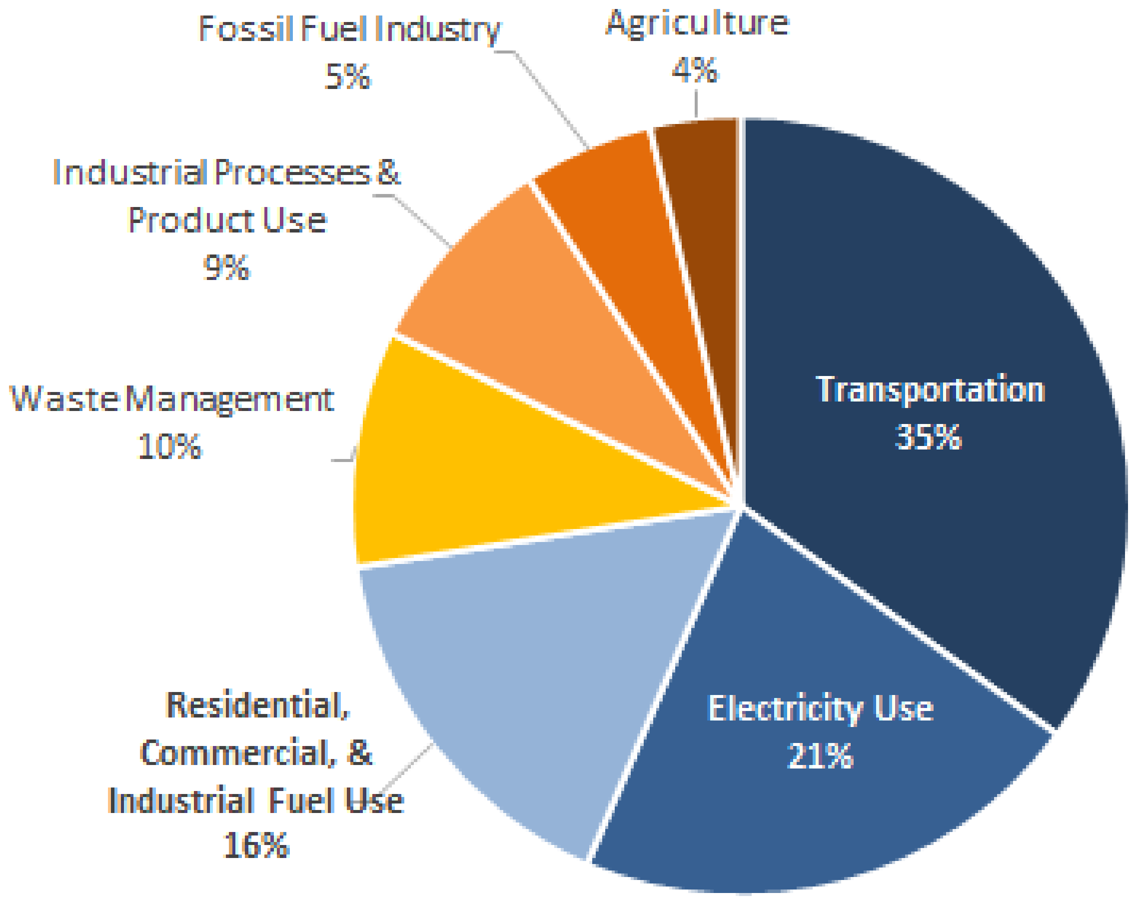

Figure 4. Maryland's 2020 GHG emissions sector contributions. (Click figure to return).

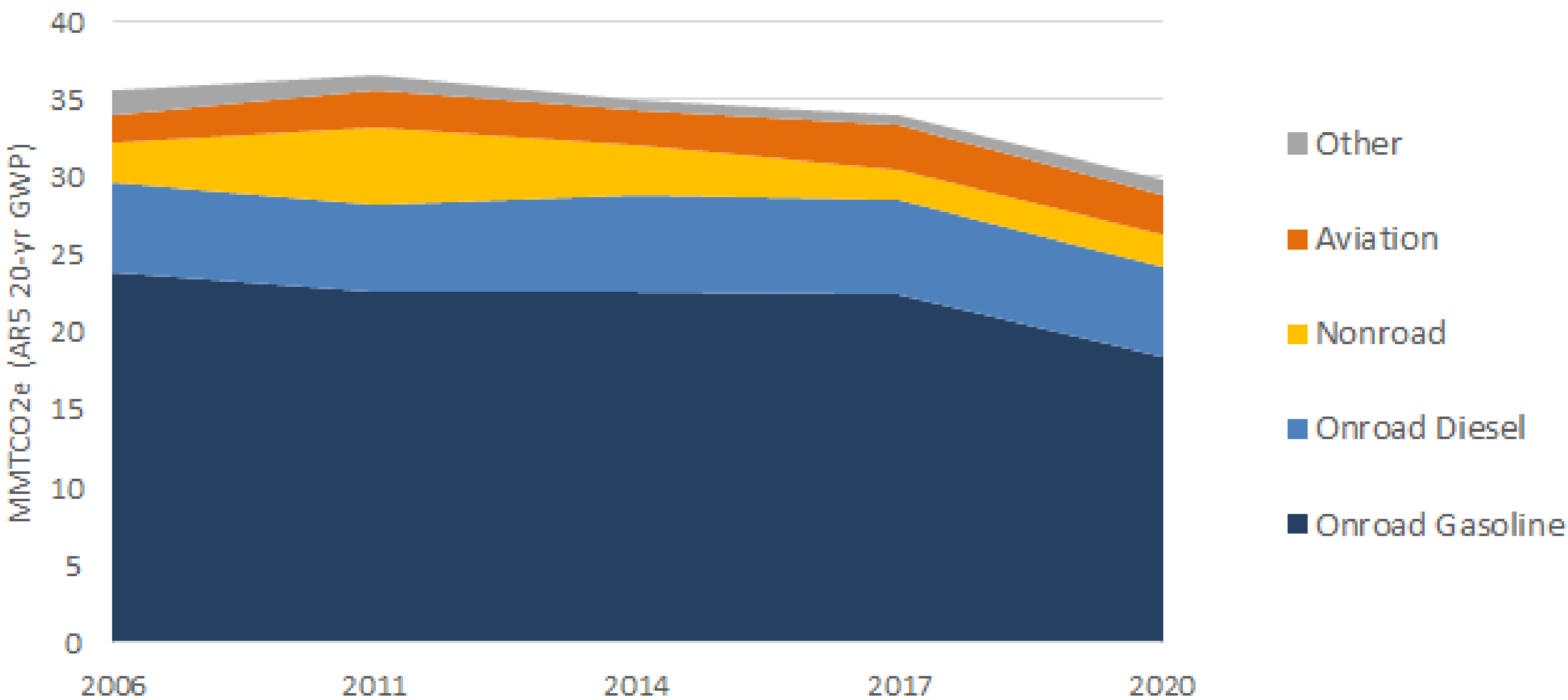

Figure 5. Transportation sector emissions. (Click figure to return).

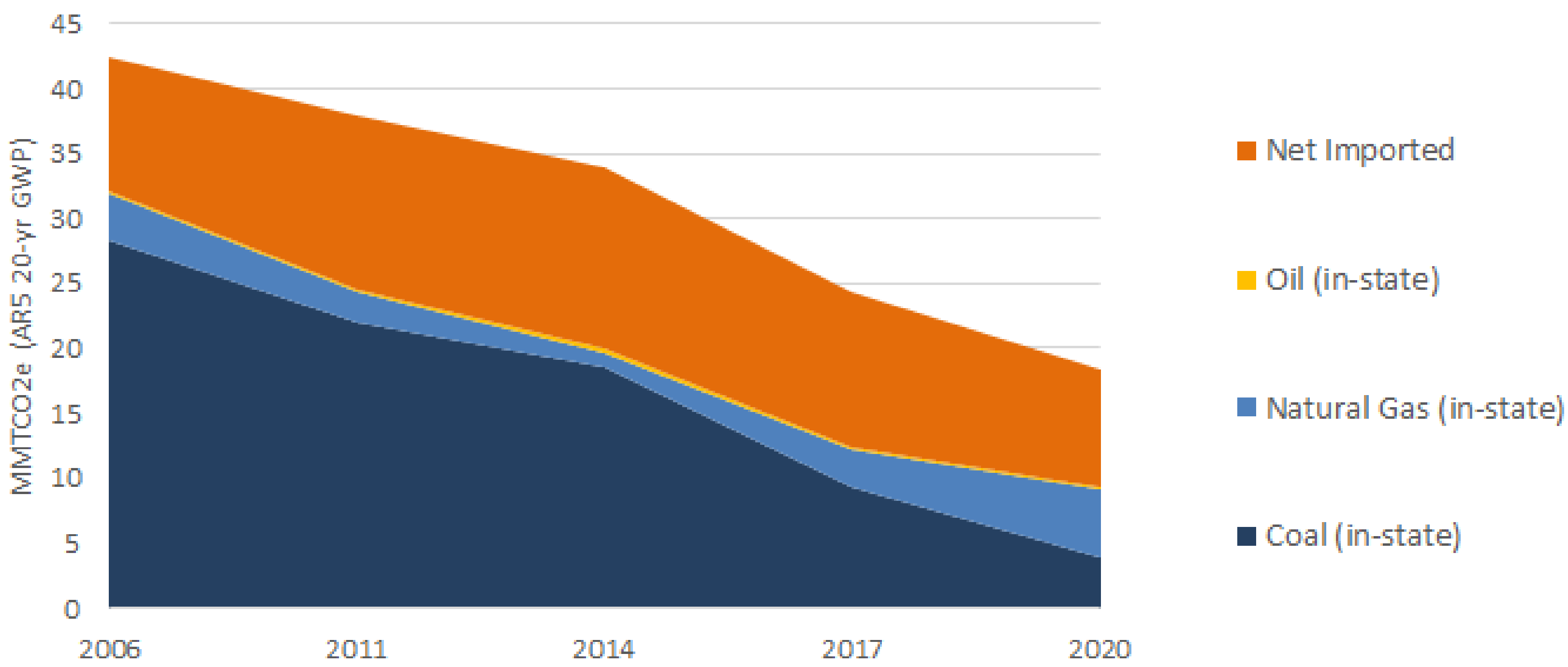

Figure 6. Electricity Use Emissions. (Click figure to return).

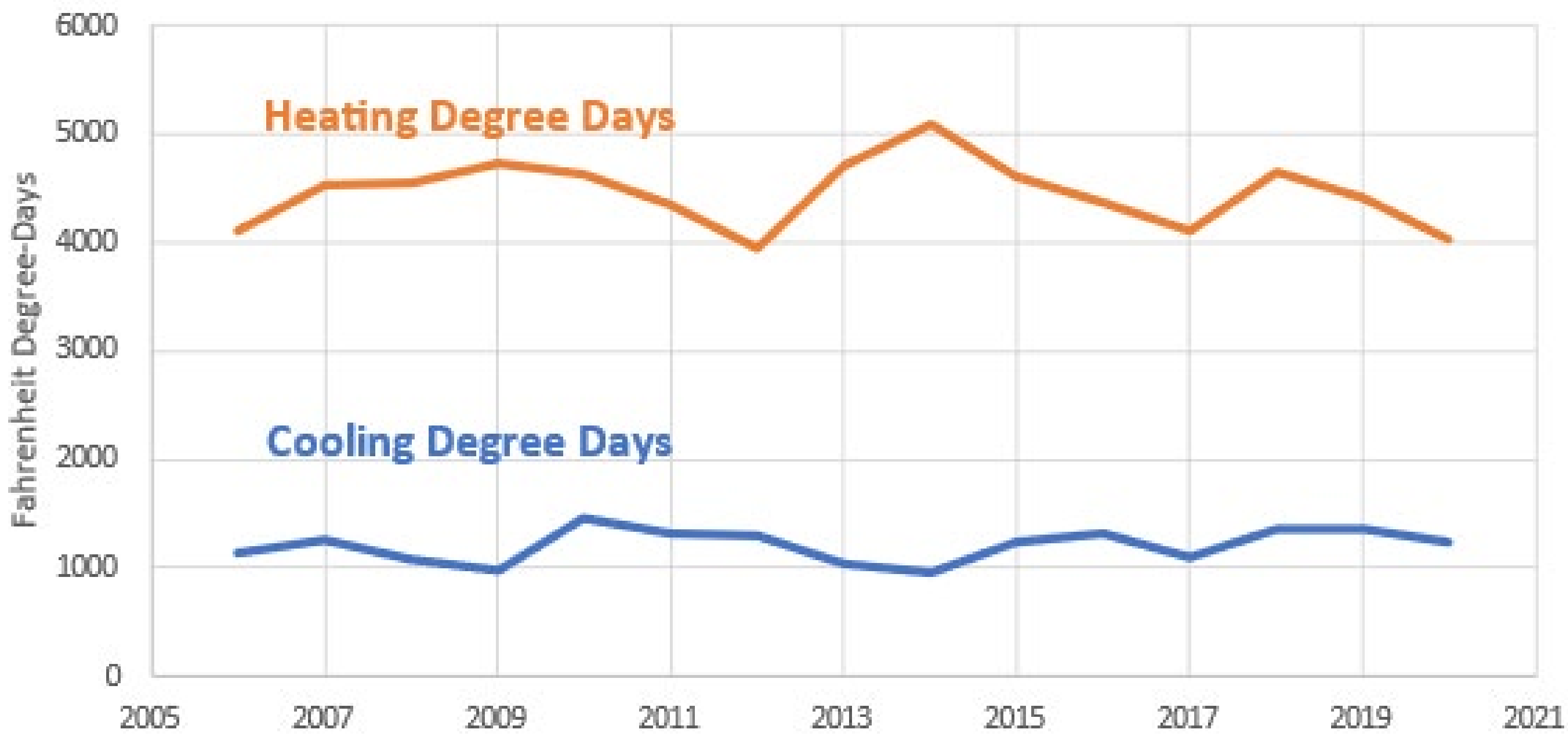

Figure 7. Maryland degree days (NOAA, 2022). (Click figure to return).

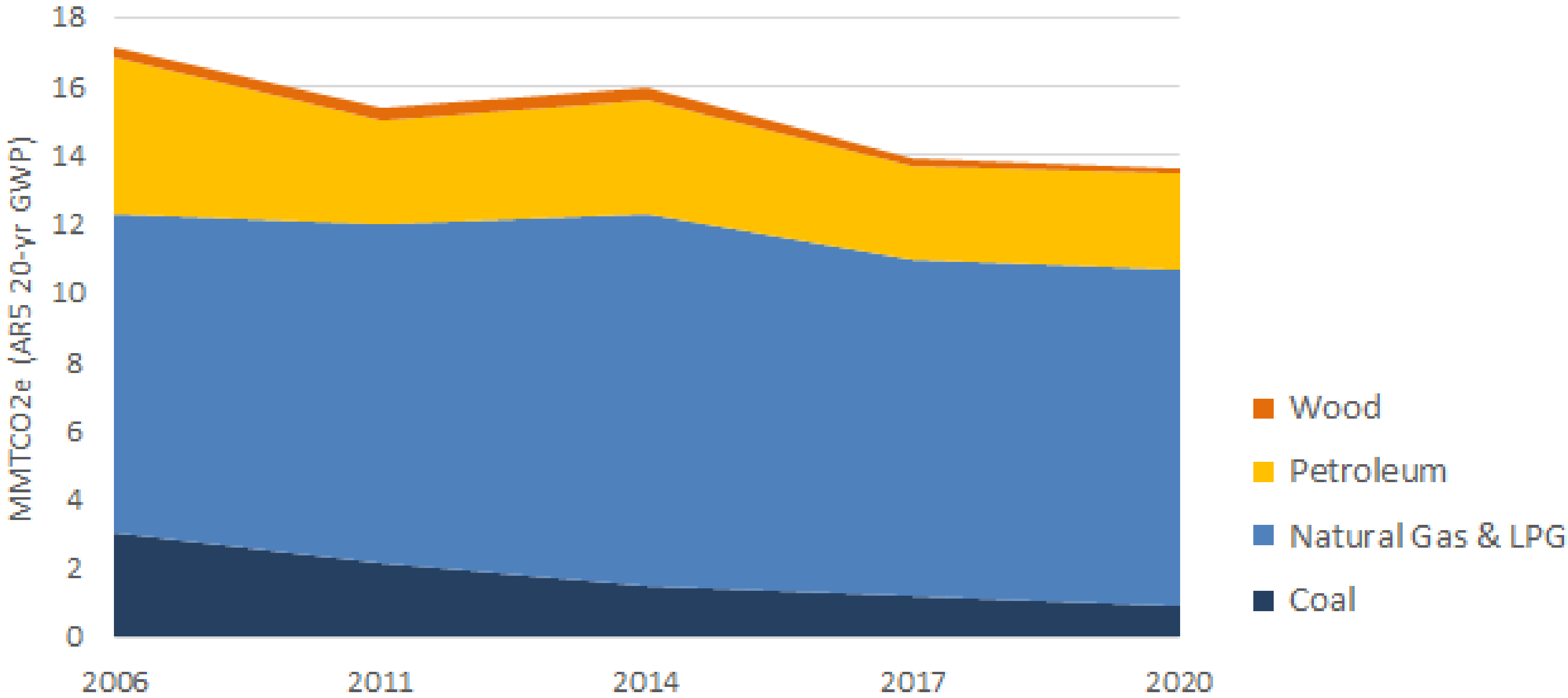

Figure 8. RCI fuel use emissions by fuel. (Click figure to return).

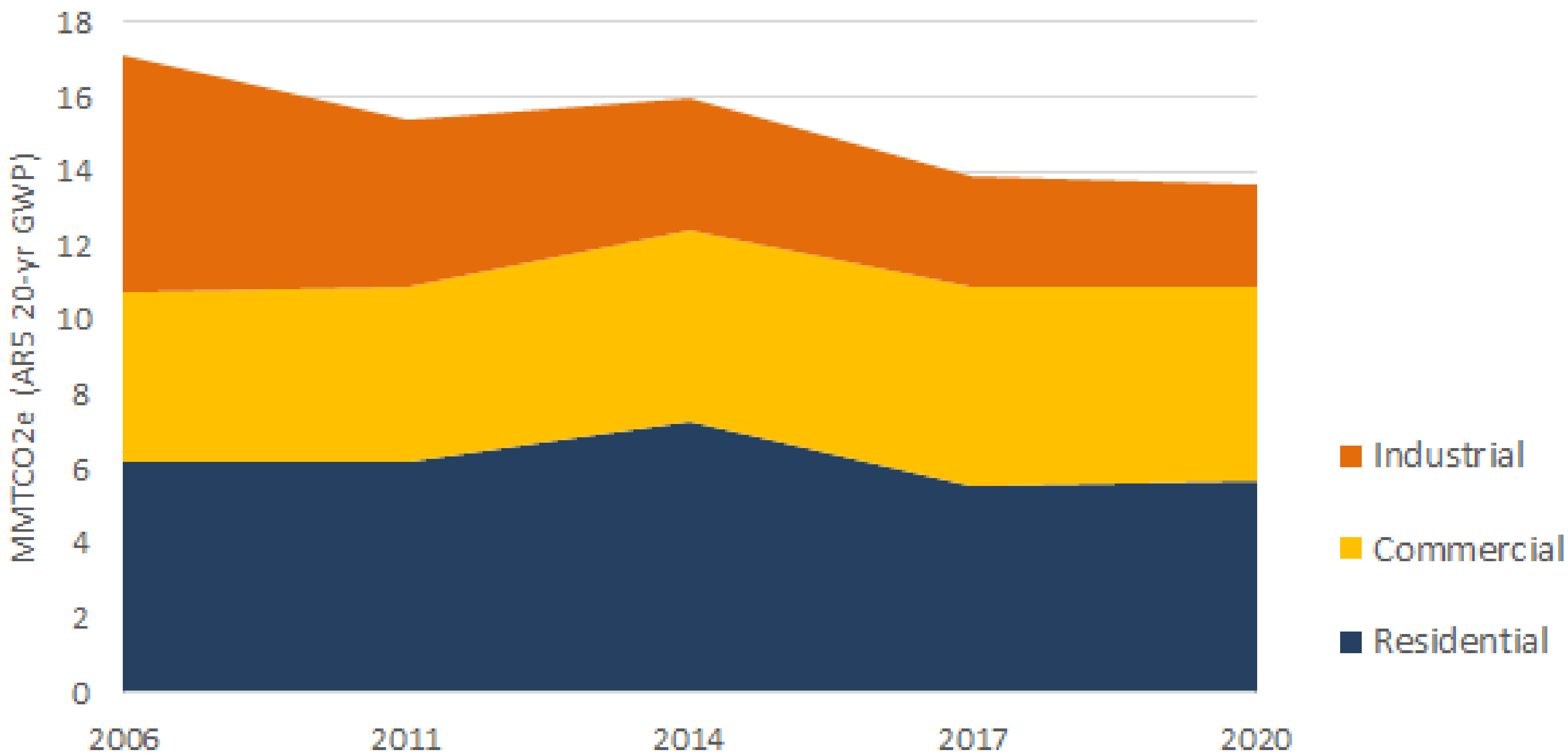

Figure 9. RCI fuel use emissions by end-use sector. (Click figure to return).

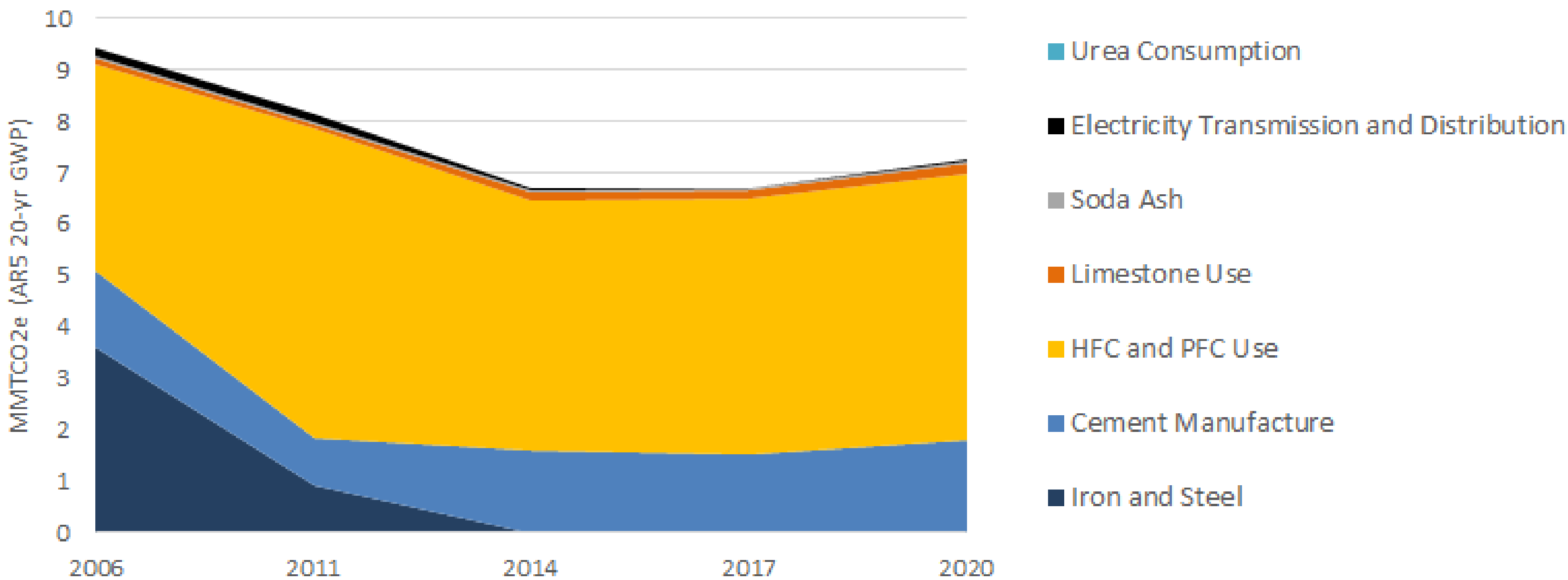

Figure 10. Industrial processes and product use emissions. (Click figure to return).

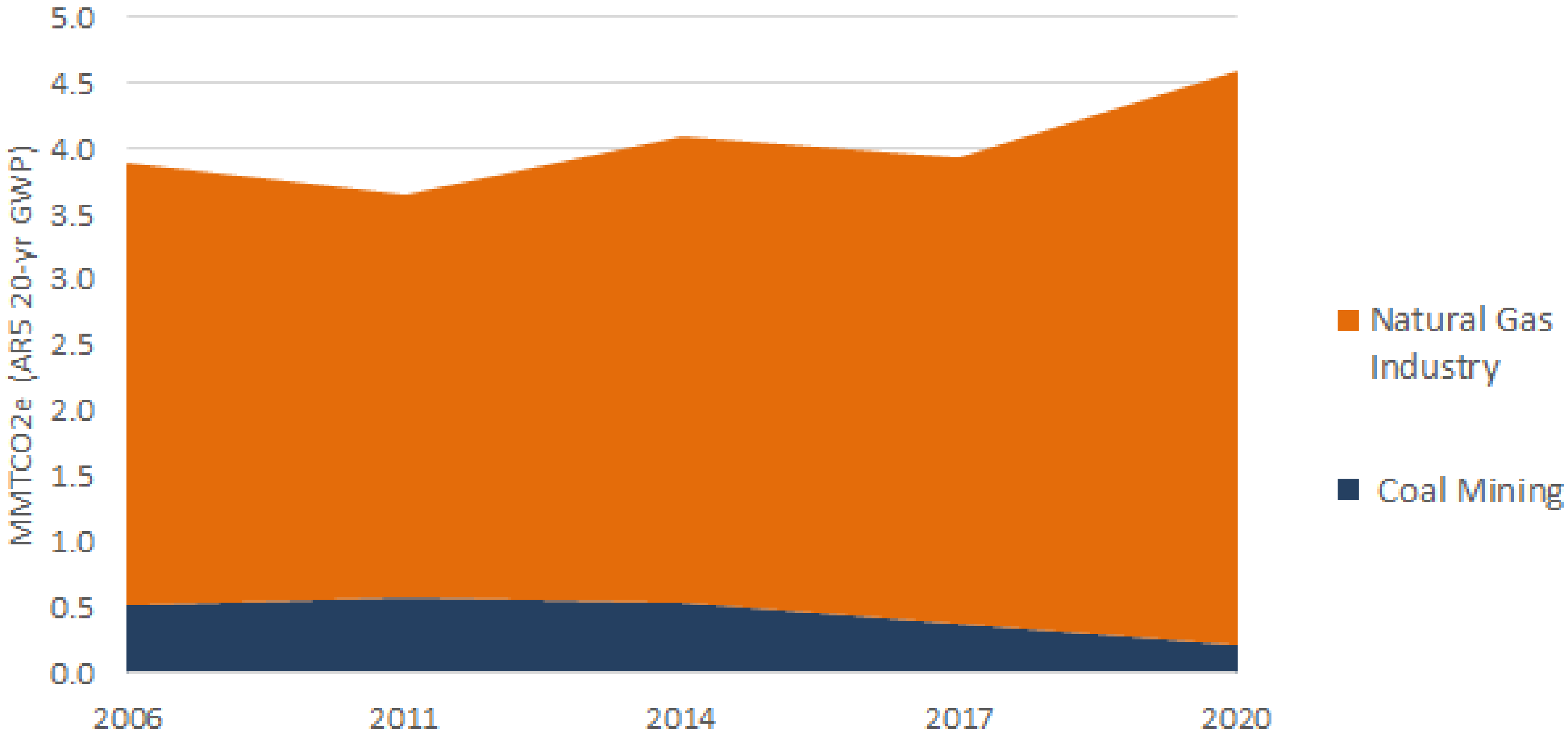

Figure 11. Fossil fuel industry emissions. (Click figure to expand).

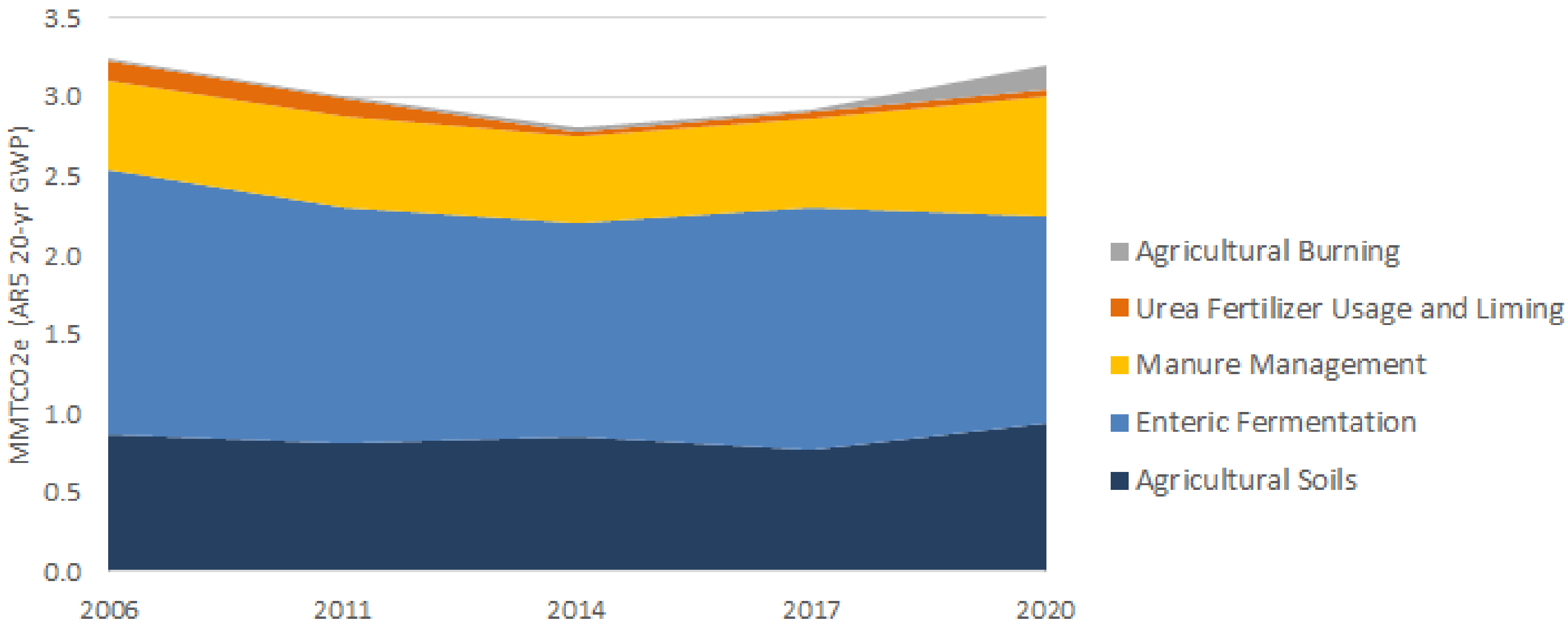

Figure 12. Agriculture sector emissions. (Click figure to return).

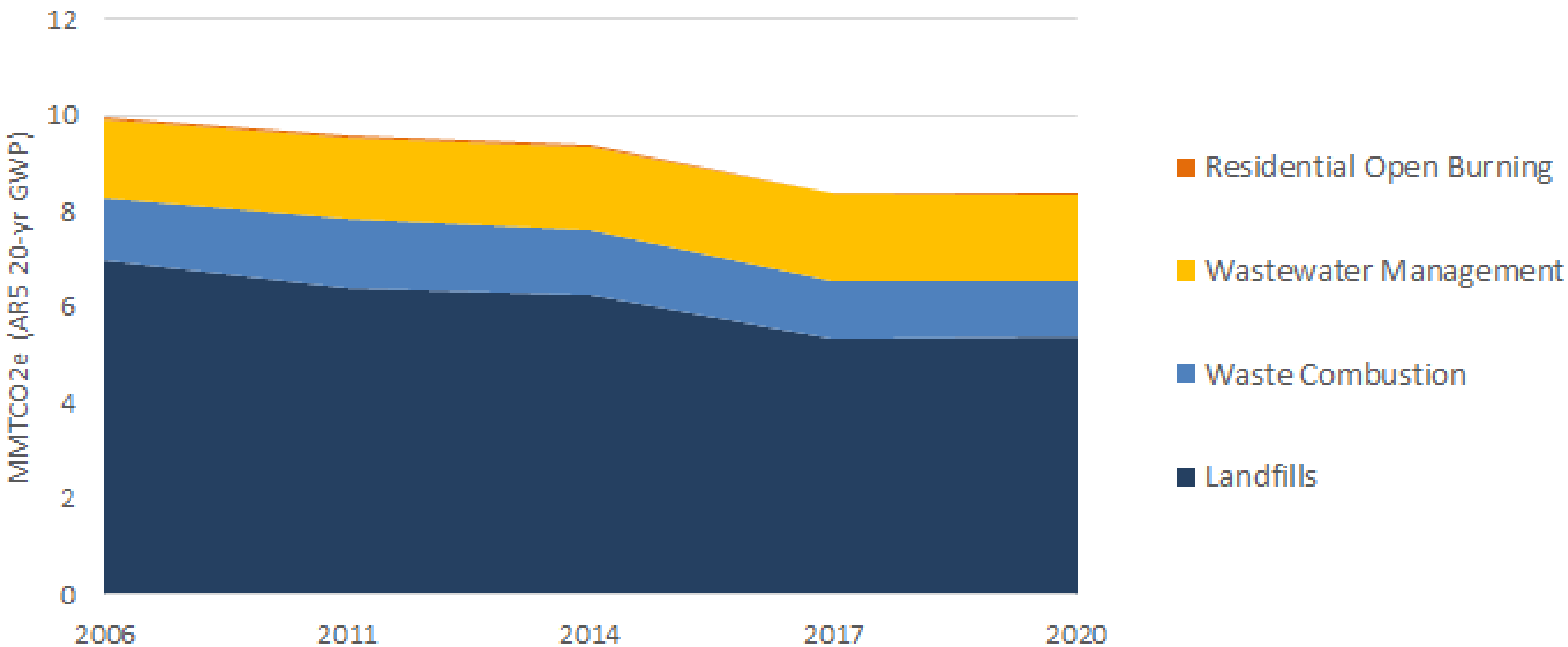

Figure 13. Waste management emissions. (Click figure to return).

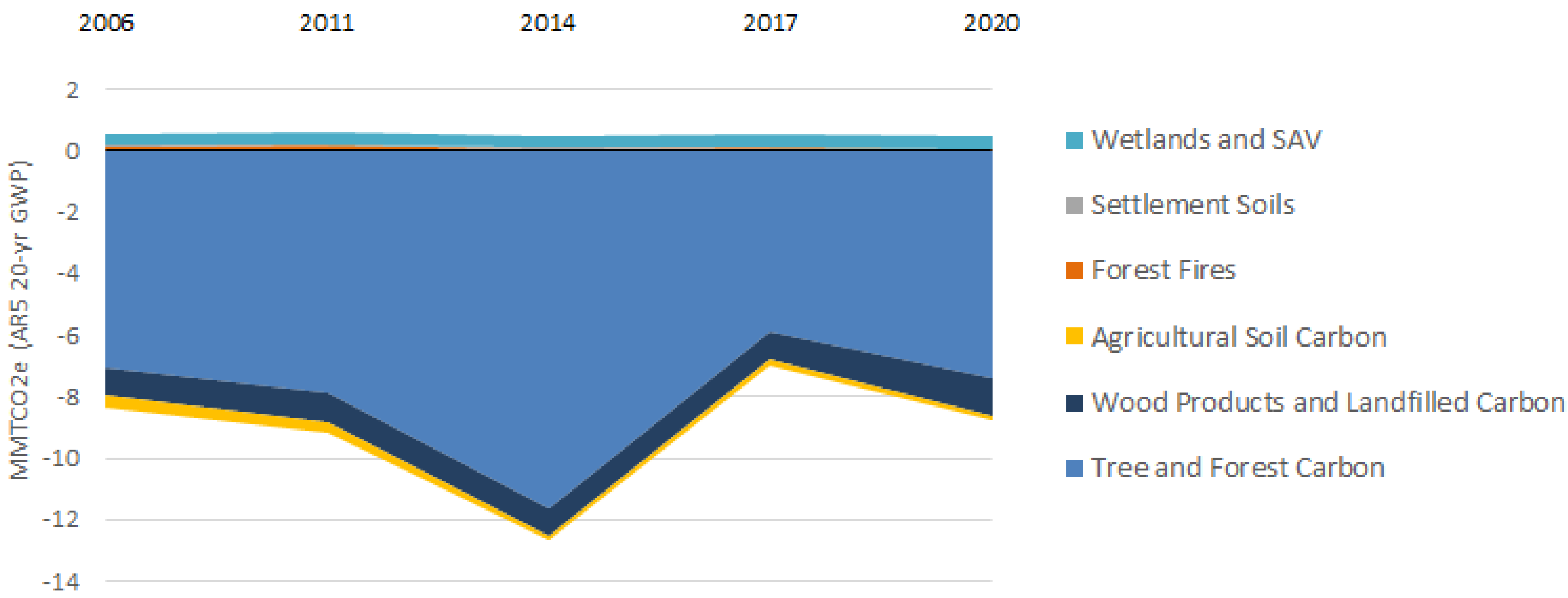

Figure 14. Net emission impact of different sources and sinks within the forestry and land use sector. (Click figure to return).

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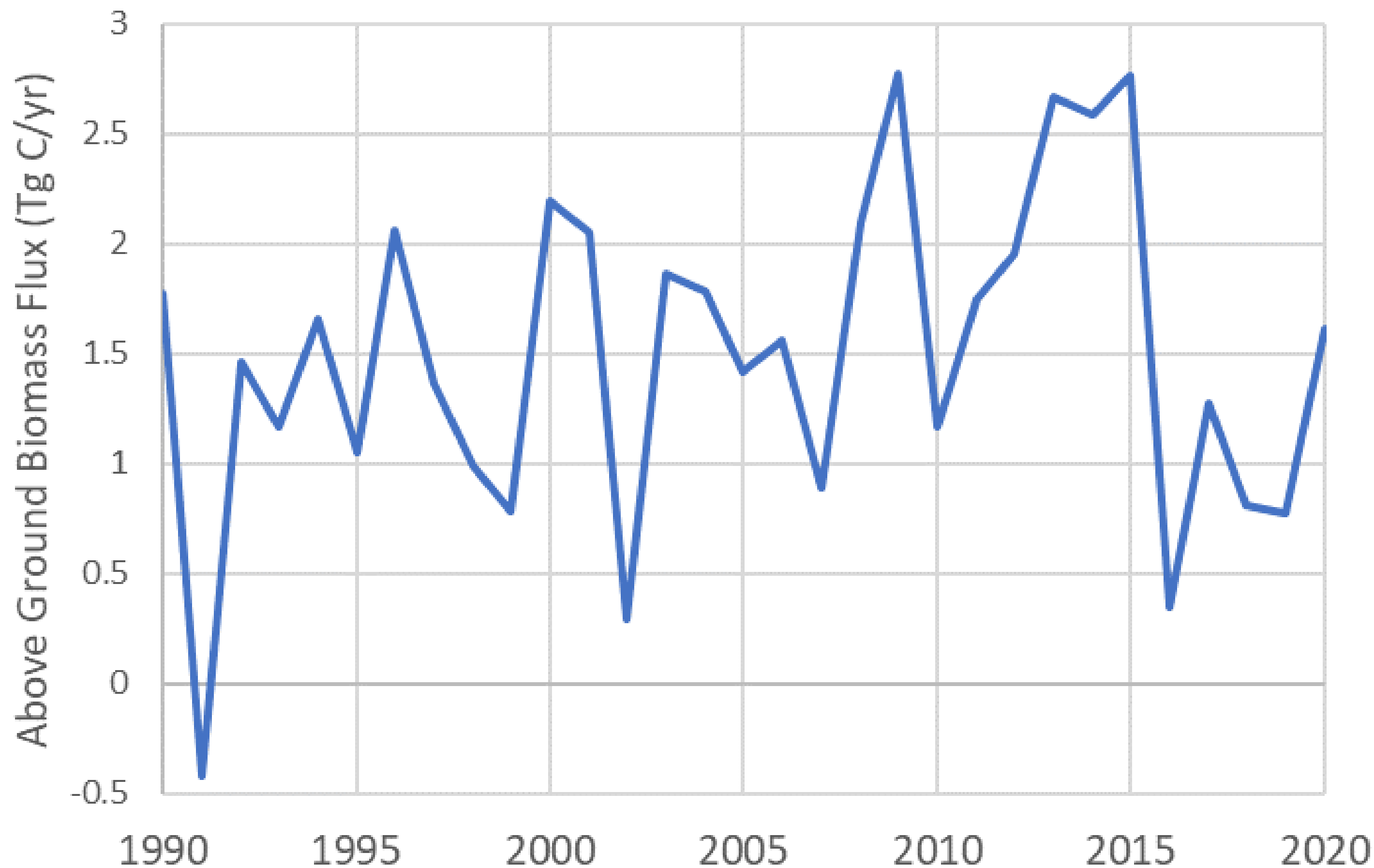

Figure 15. Annual aboveground forest carbon flux in Maryland from the NASA/UMD high resolution forest carbon monitoring product, where positive values represent net growth in the forest carbon sink and negative values (e.g., in 1991) highlight a net loss of carbon due to unfavorable weather conditions and forest disturbance. (Click figure to return).

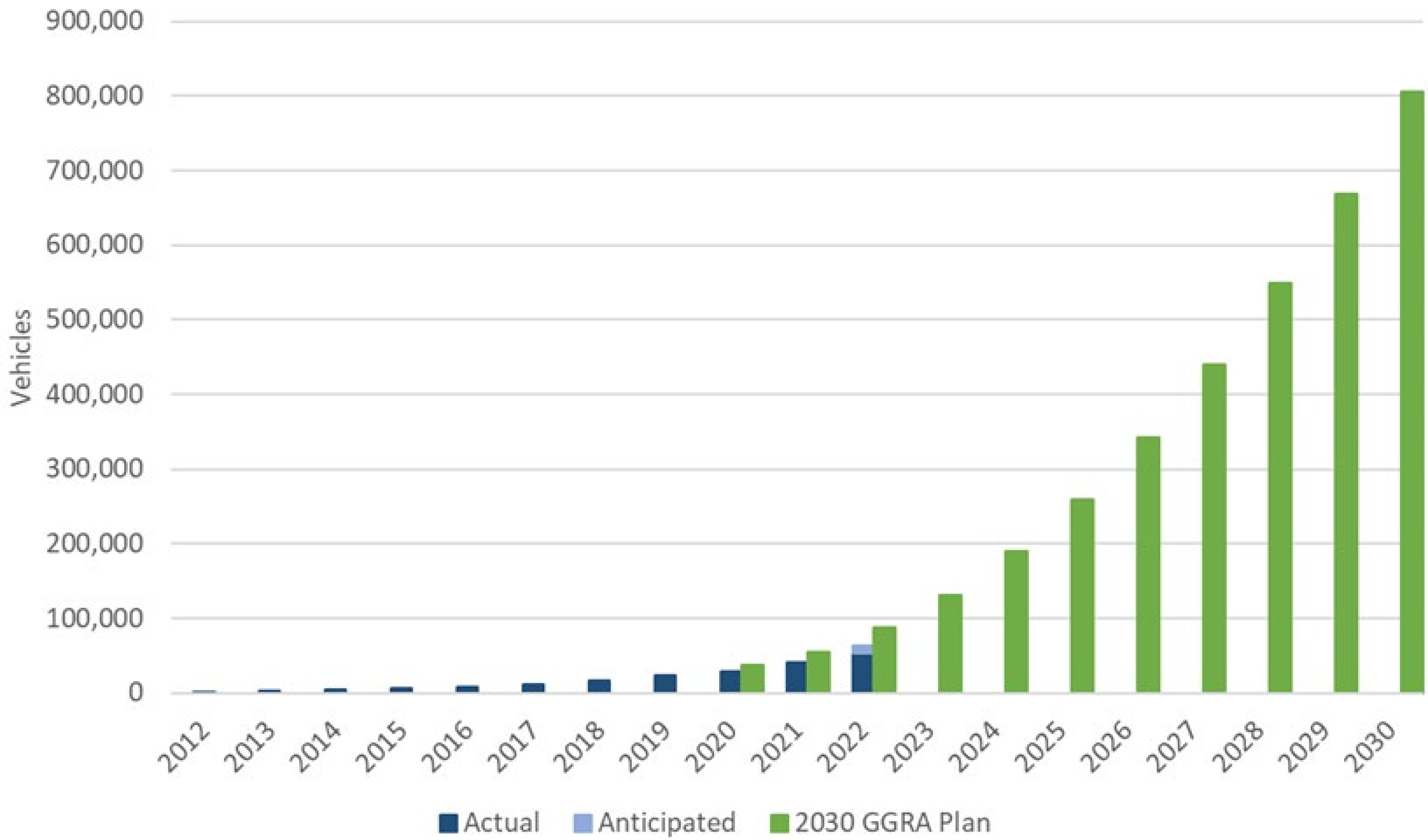

Figure 16. Registered battery electric vehicles and plug-in hybrid electric vehicles through July 2022, and 2030 GGRA Plan projected EV stock. (Click figure to return).

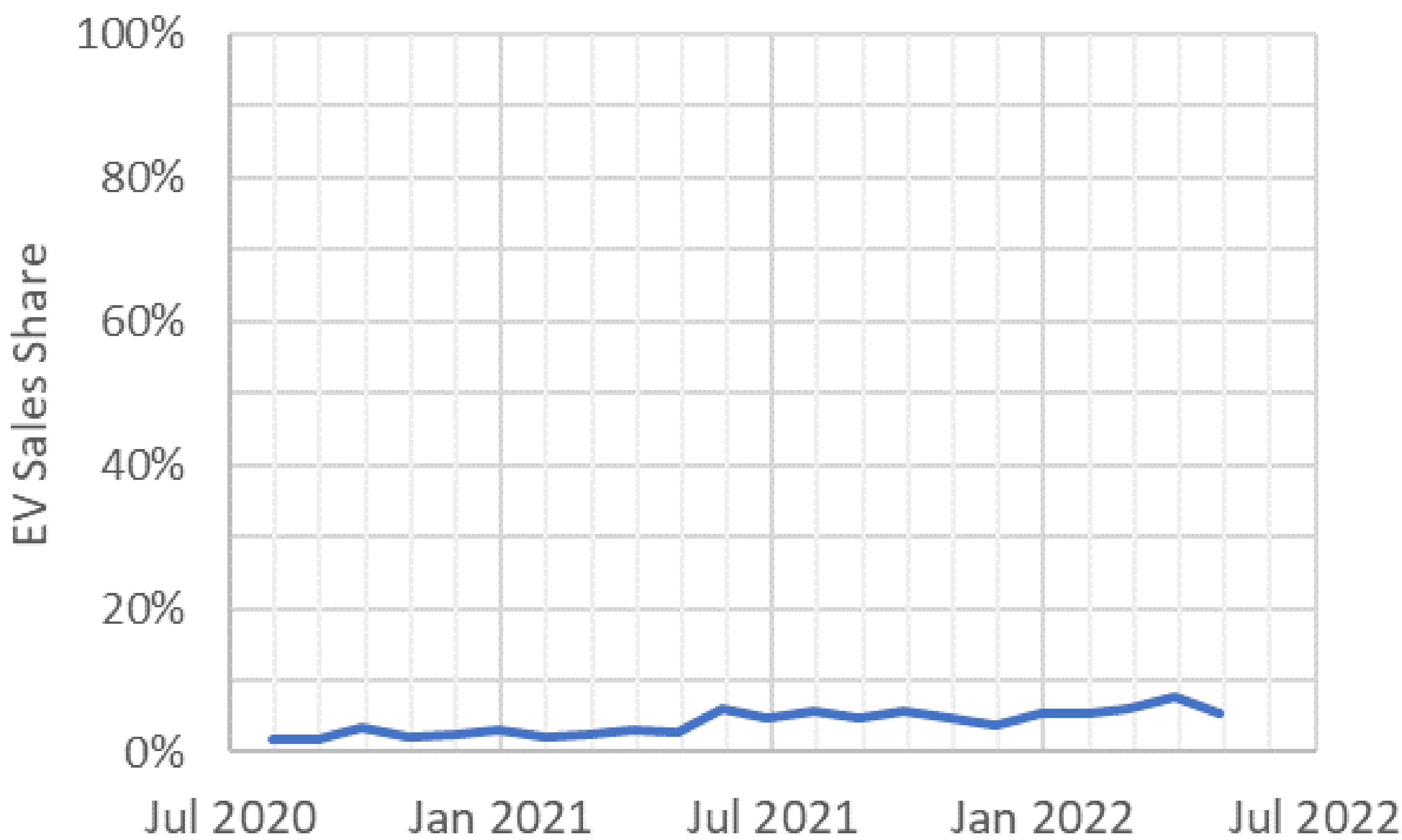

Figure 17. Monthly ZEV sales share. (Click figure to return).

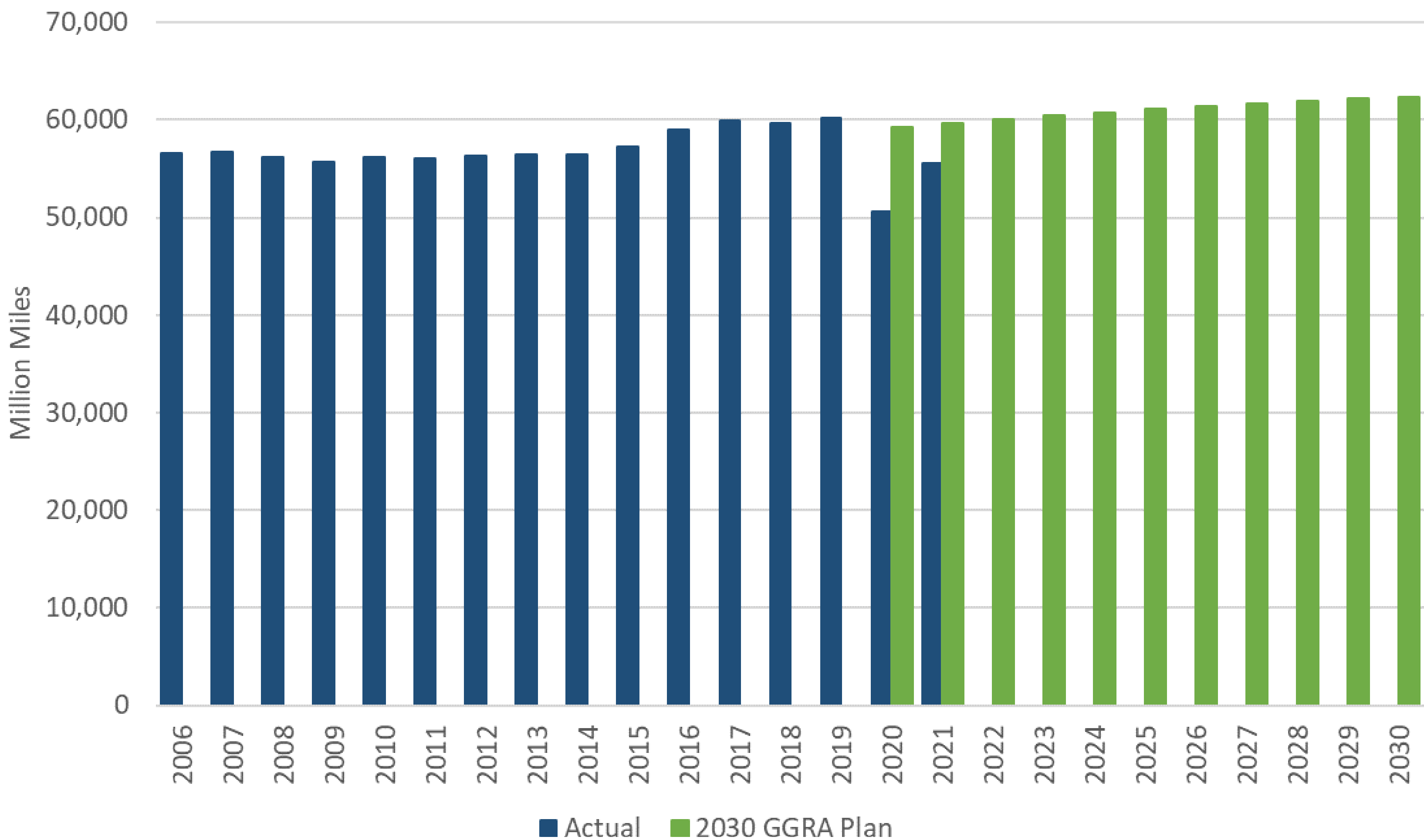

Figure 18. Historic VMT and projected VMT from the 2030 GGRA Plan in millions of miles traveled. (Click figure to return).

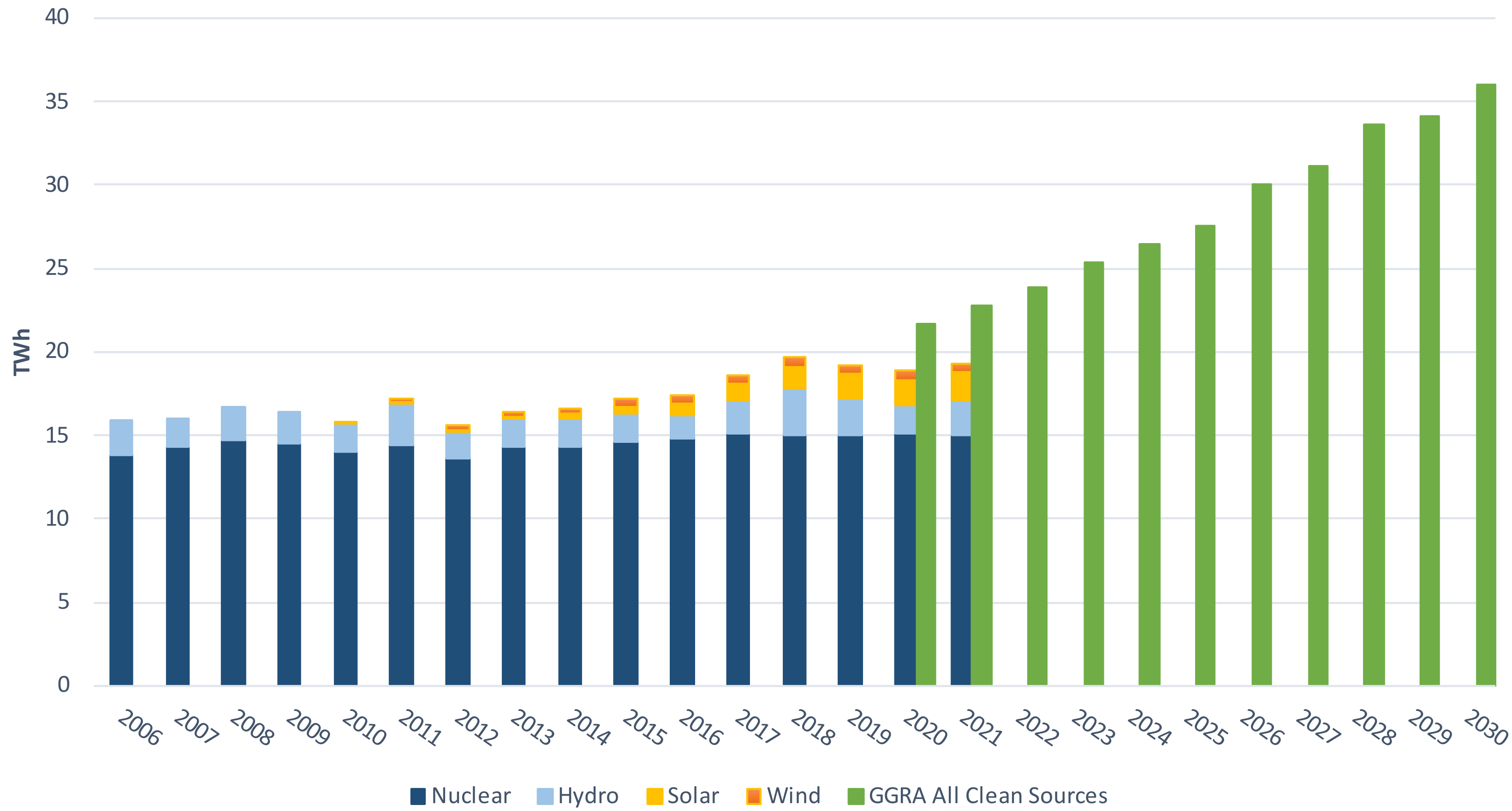

Figure 19. Historic in-state clean and renewable electricity generation as well as projected clean and renewable generation from the 2030 GGRA Plan. (Click figure to return).

Appendix A: Figure Glossary

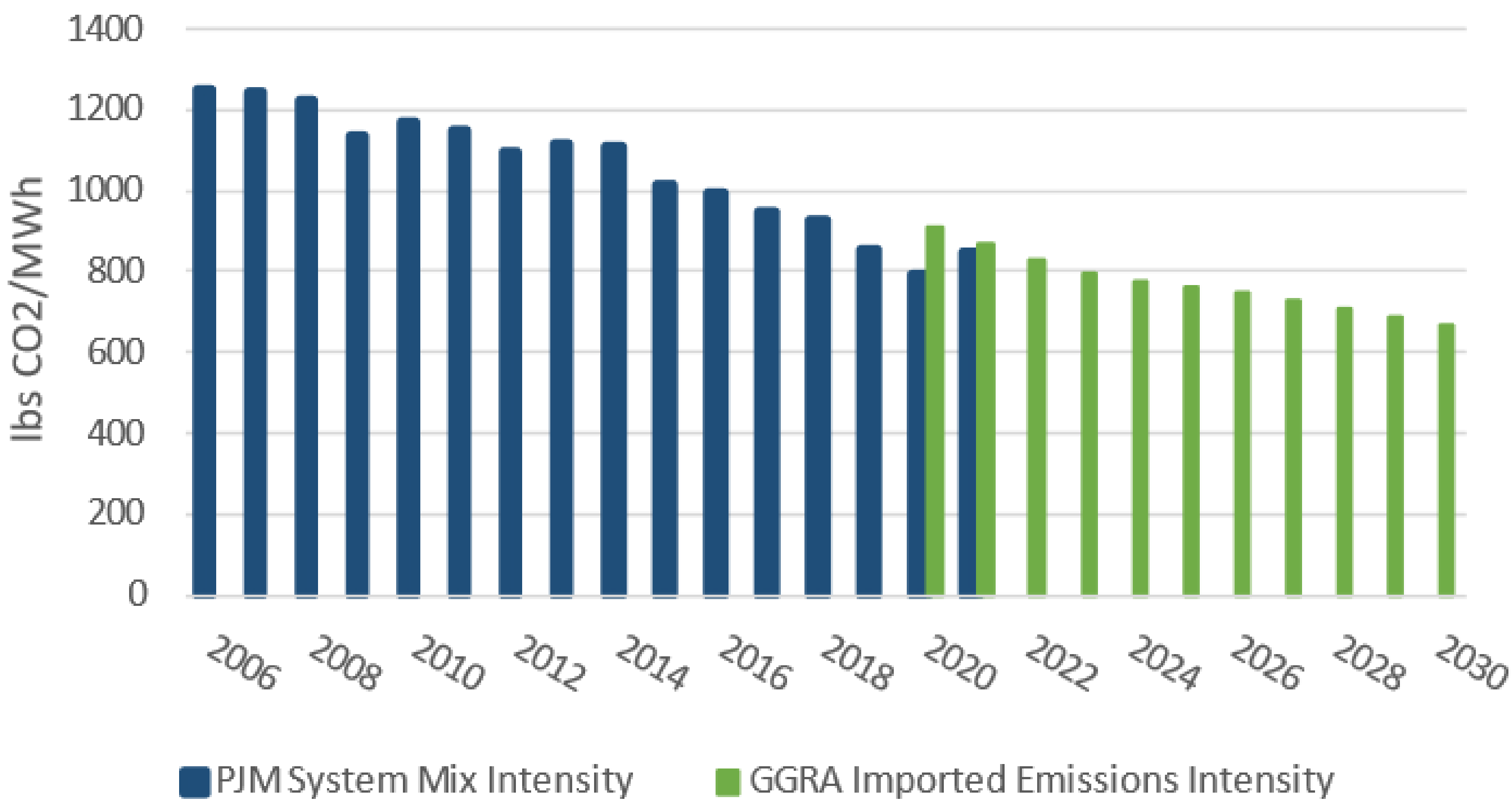

Figure 20. Historical carbon intensity of electricity in the PJM system and 2030 GGRA Plan projections. (Click figure to return).

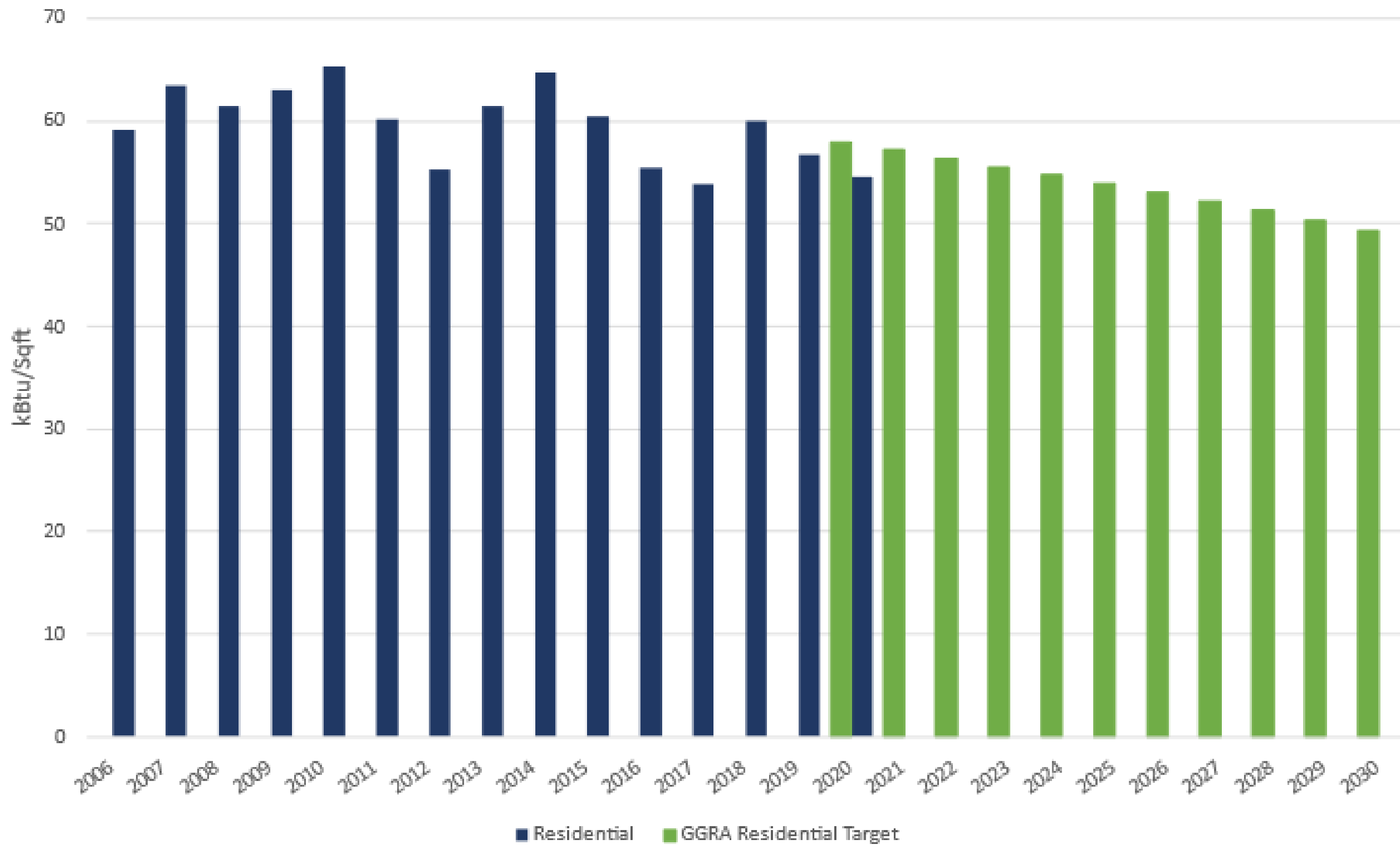

Figure 21: Historic residential building EUI[7] and projected EUI from the 2030 GGRA Plan.[8] Annual variation in building energy consumption is strongly correlated with annual variation in weather. (Click figure to return).

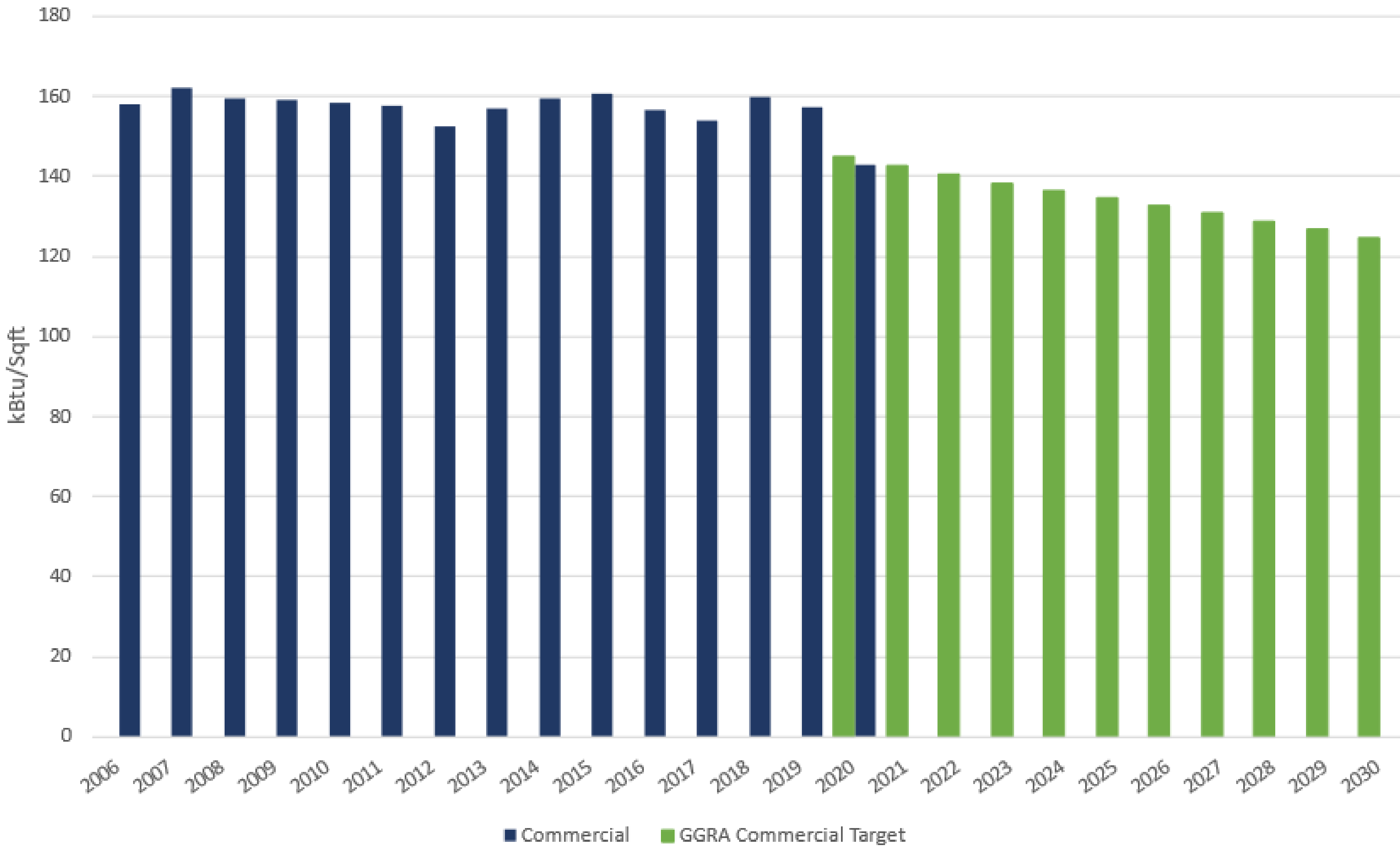

Figure 22. Historic commercial building EUI and projected EUI from the 2030 GGRA Plan. Annual variation in building energy consumption is strongly correlated with annual variation in weather. (Click figure to return).

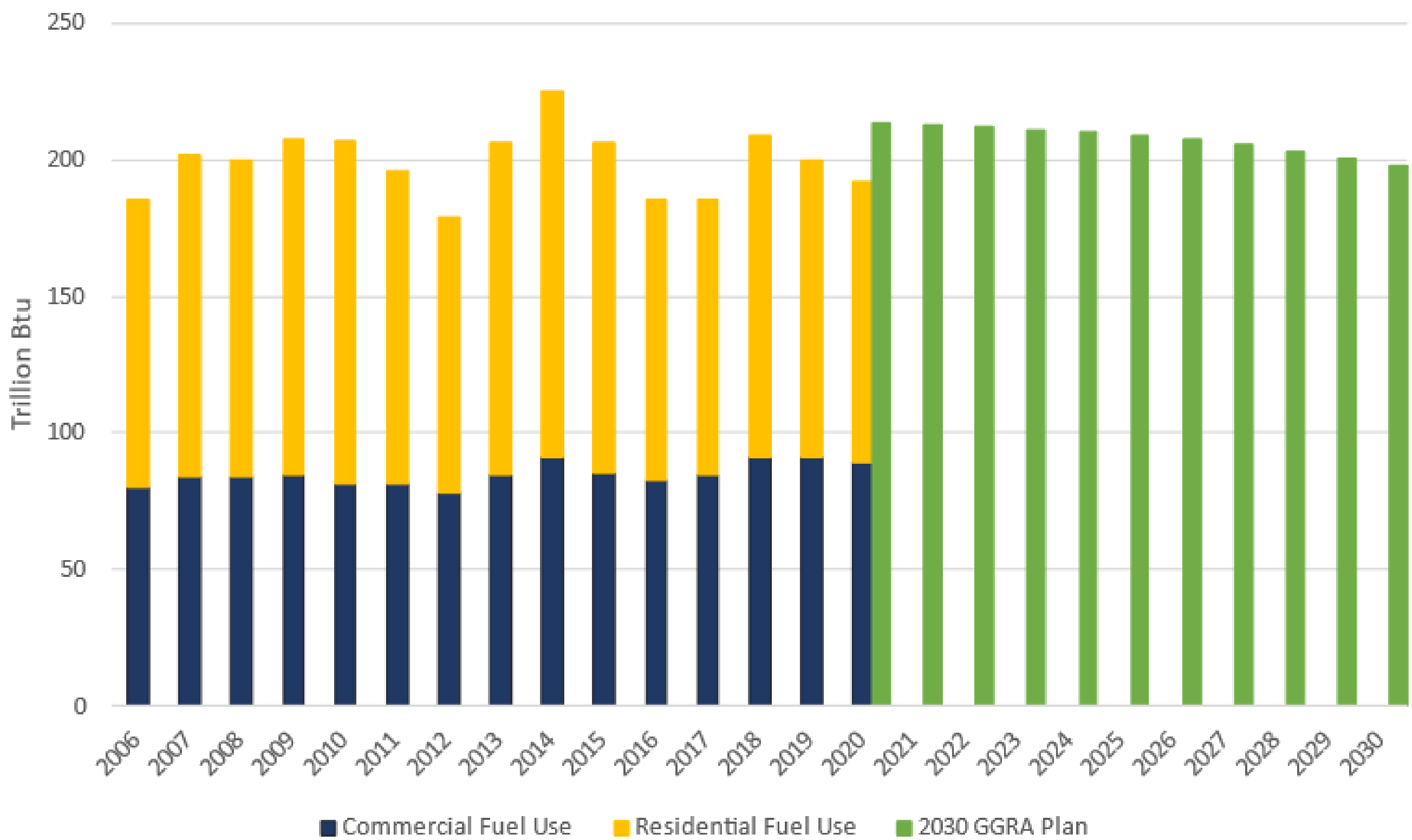

Figure 23. Total fuel use in residential and commercial buildings, historical and 2030 GGRA Plan projections. (Click figure to return).

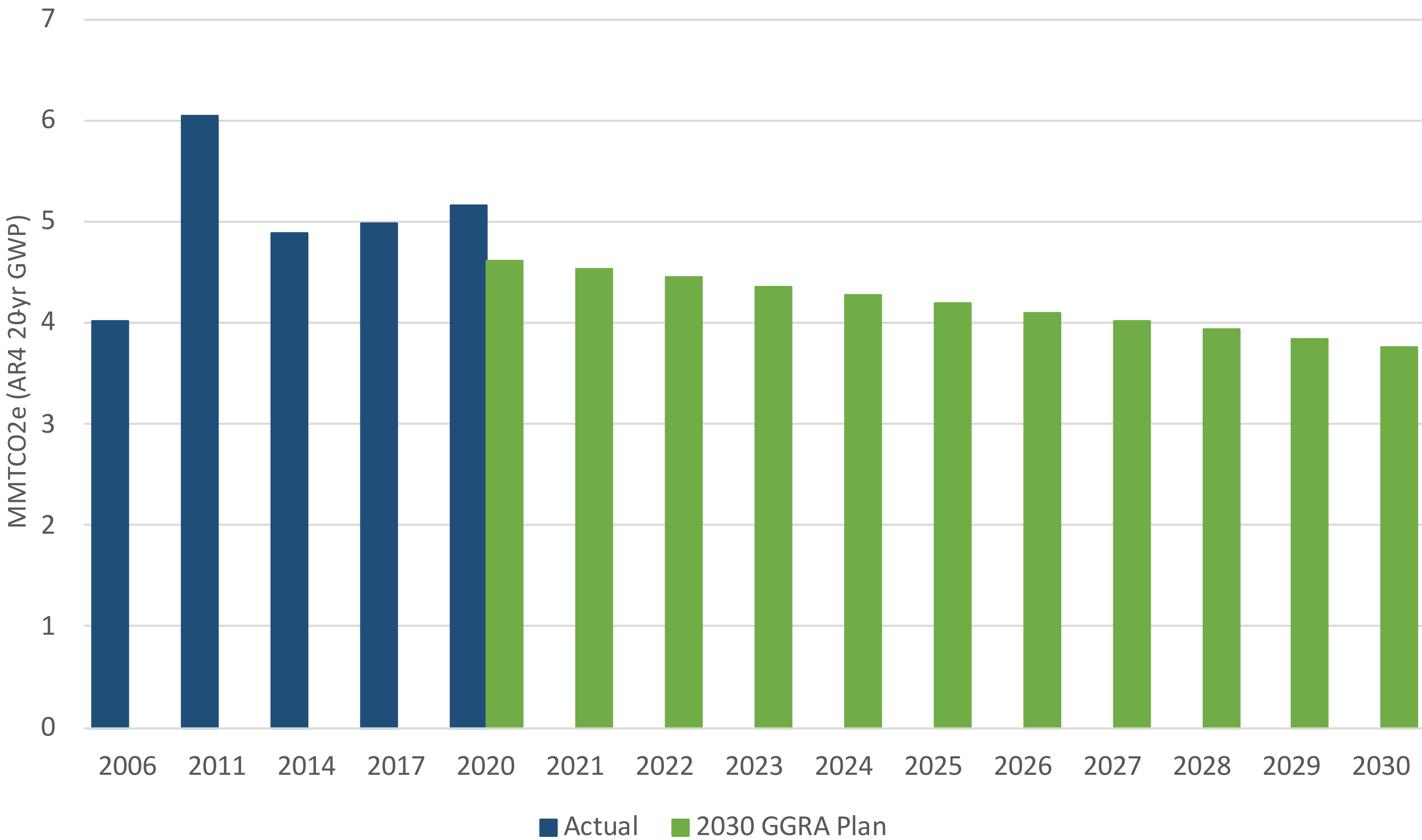

Figure 24. HFC emissions vs 2030 GRRA Plan projected emissions. (Click figure to return).

Appendix A: Figure Glossary

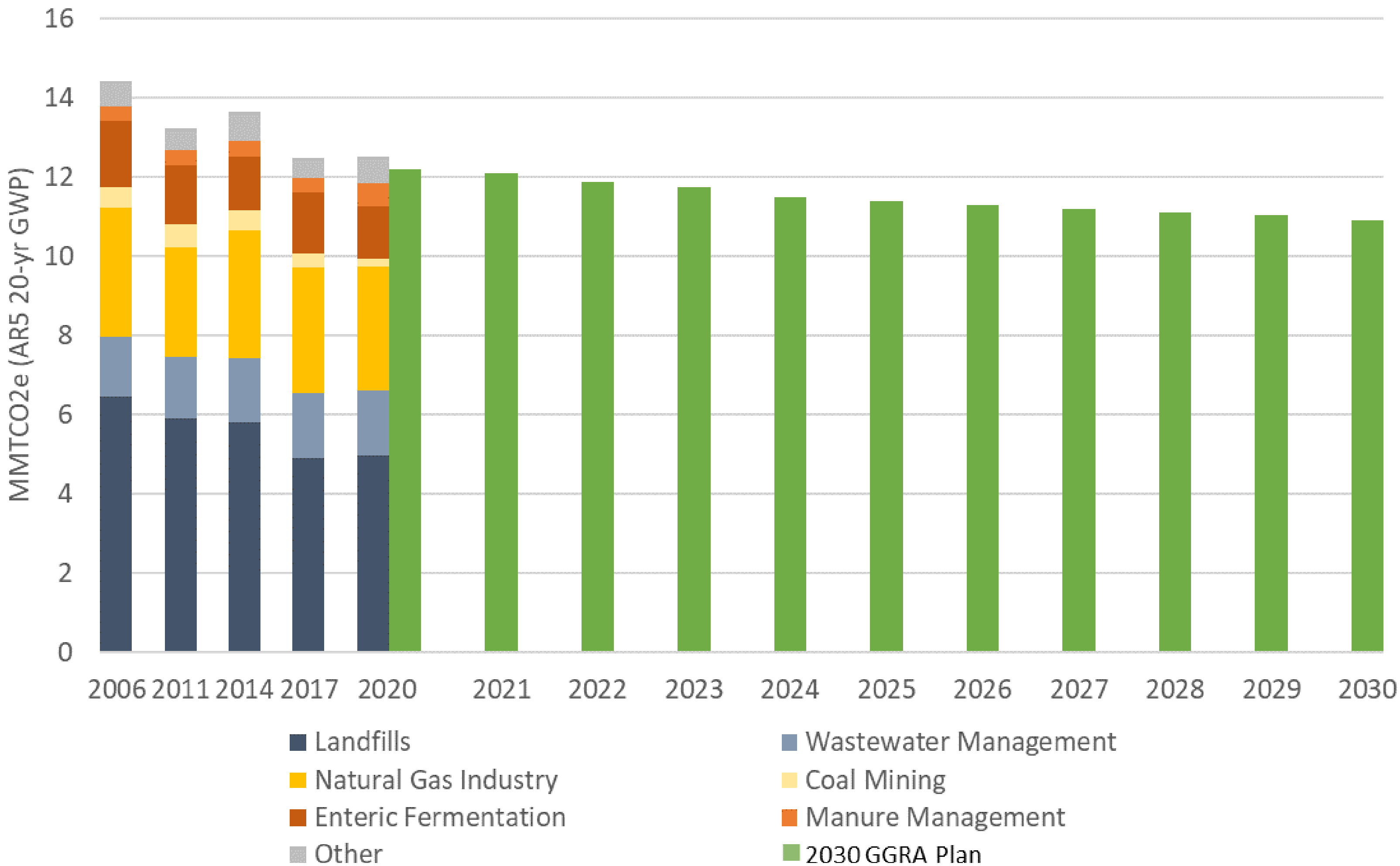

Figure 25. CH_4 emissions by sector and projected emissions from the 2030 GGRA Plan. (Click figure to return).

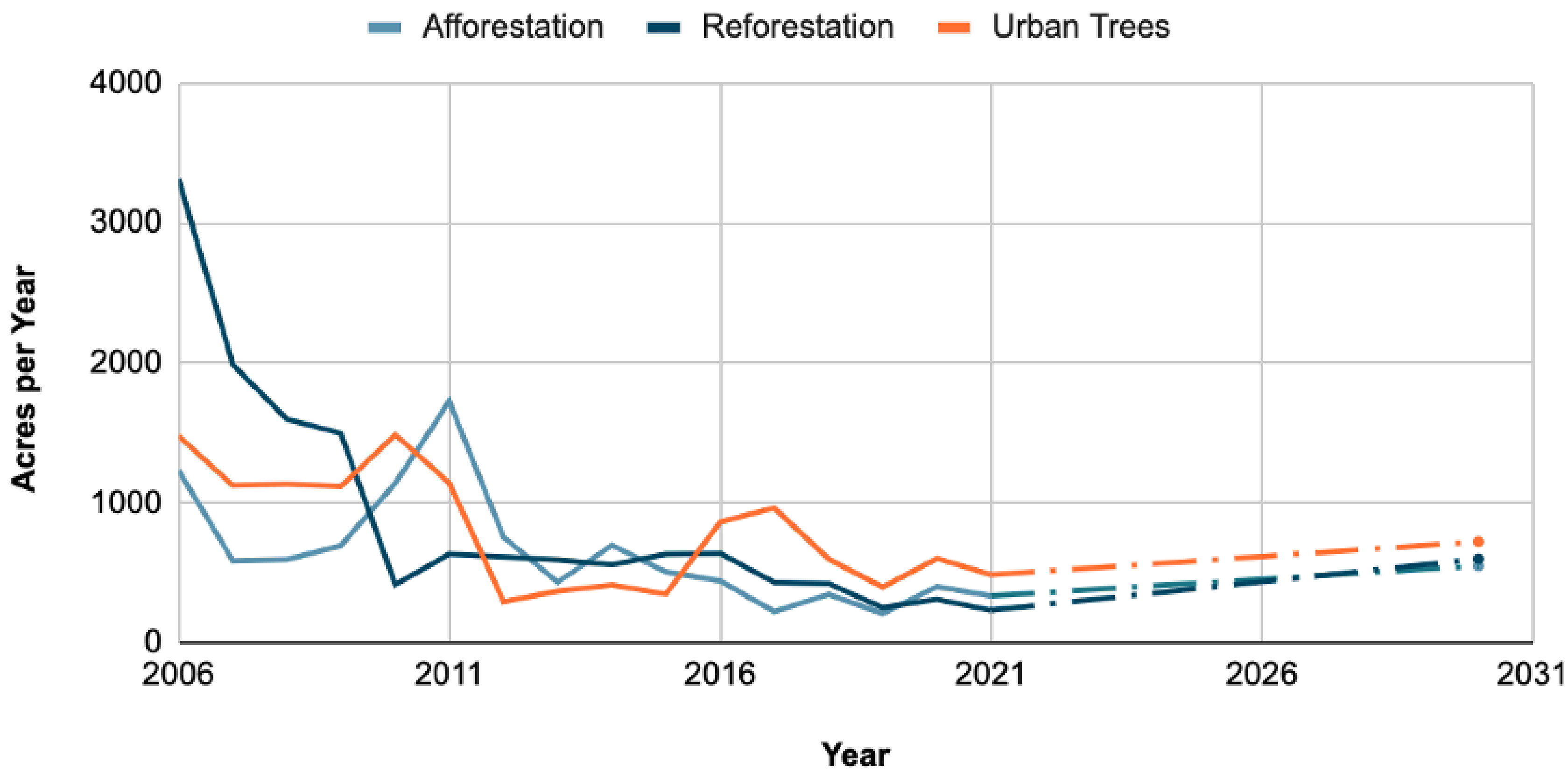

Figure 26. Implemented acres of afforestation, reforestation and urban tree planting[9] from the GGRA of 2016 baseline year of 2006 through 2021 and the estimated acreage target for each practice in 2030 based on the 2030 GGRA Plan. (Click figure to return).

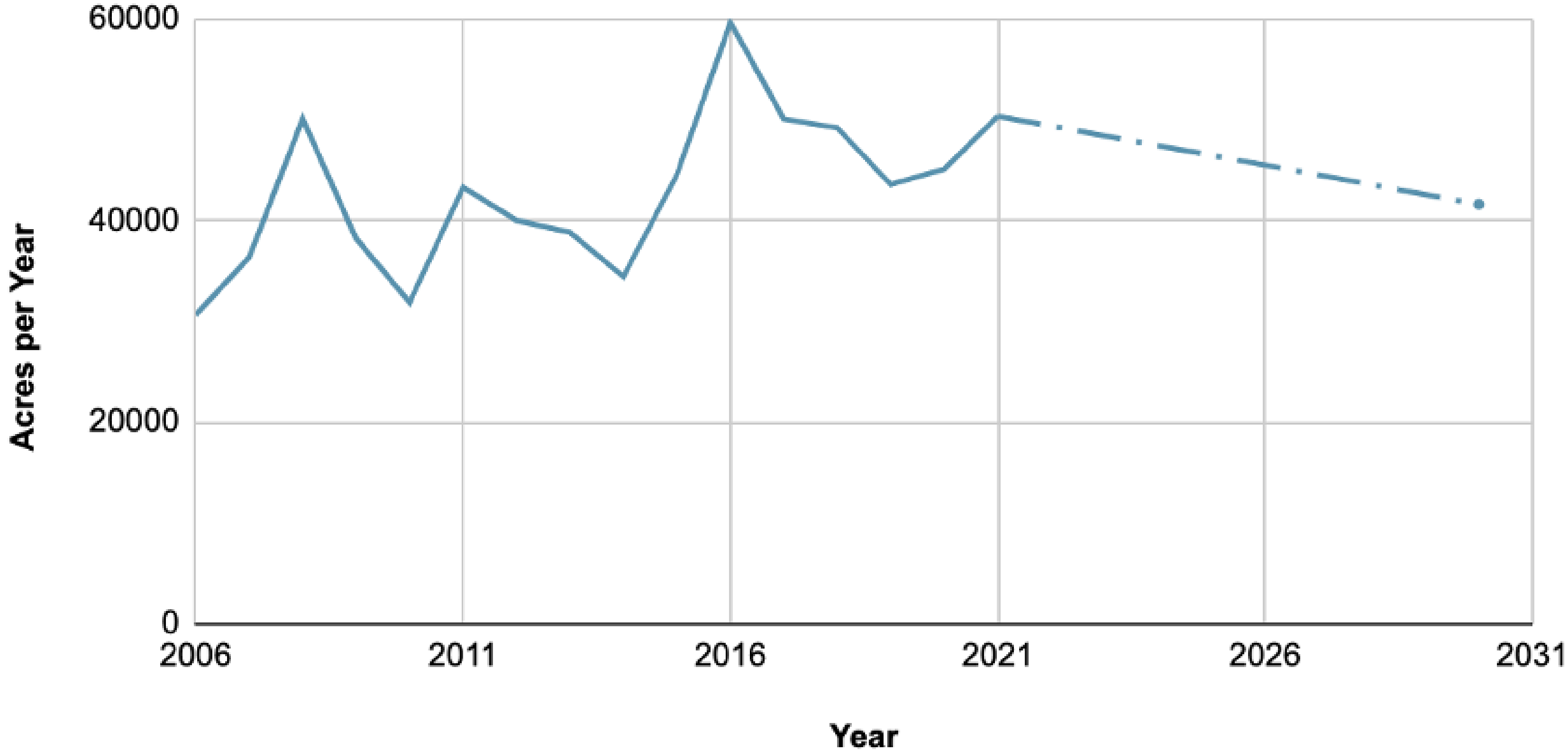

Figure 27. Acres under forest management in Maryland from the GGRA of 2016 baseline year of 2006 through 2021 and the estimated acreage target for 2030 based on the 2030 GGRA Plan. (Click figure to return).

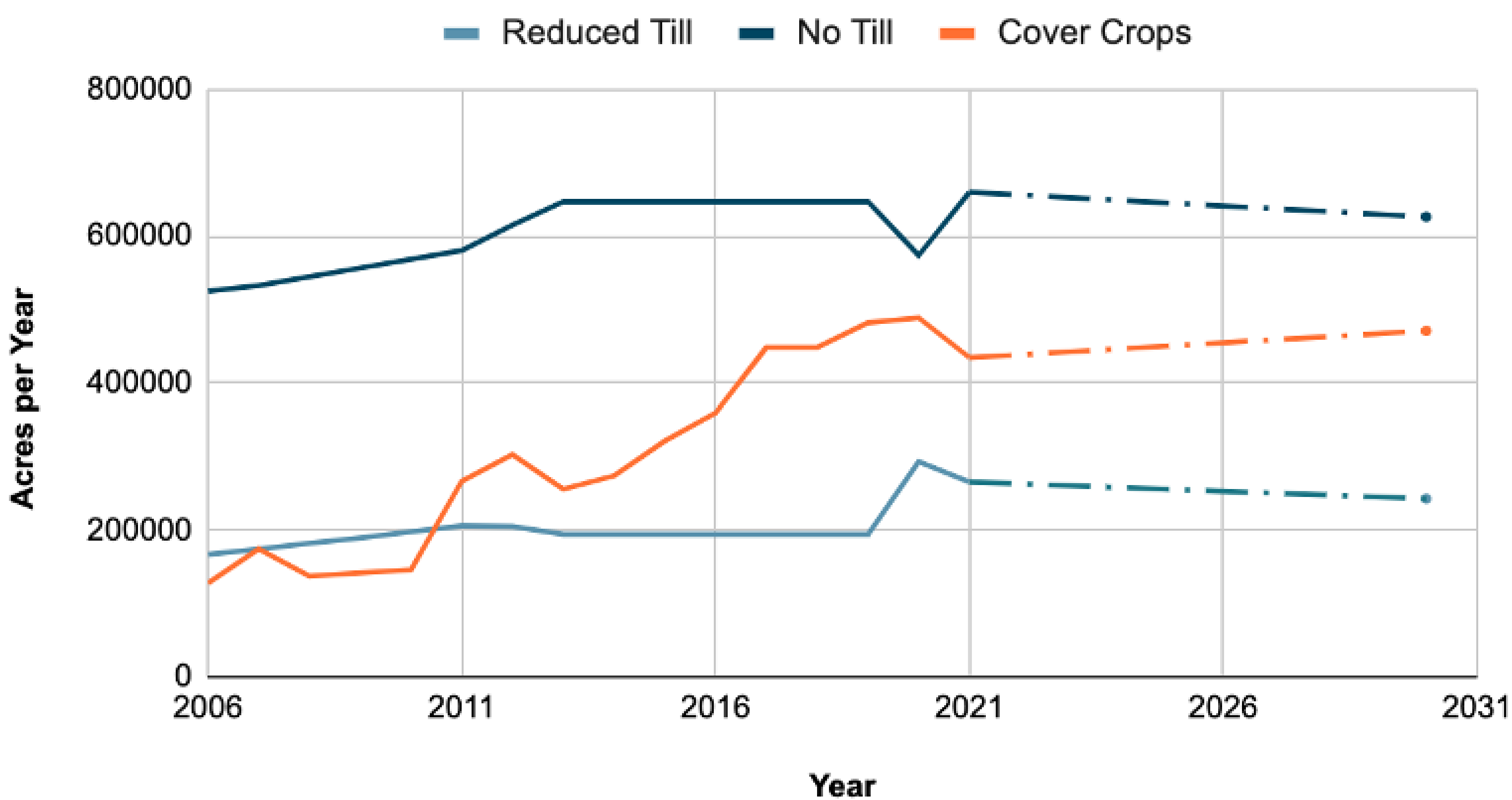

Figure 28. Implemented acres of select agricultural practices from the GGRA of 2016 baseline year of 2006 through 2021 and the estimated acreage target for each practice in 2030 based on the 2030 GGRA Plan. (Click figure to return).

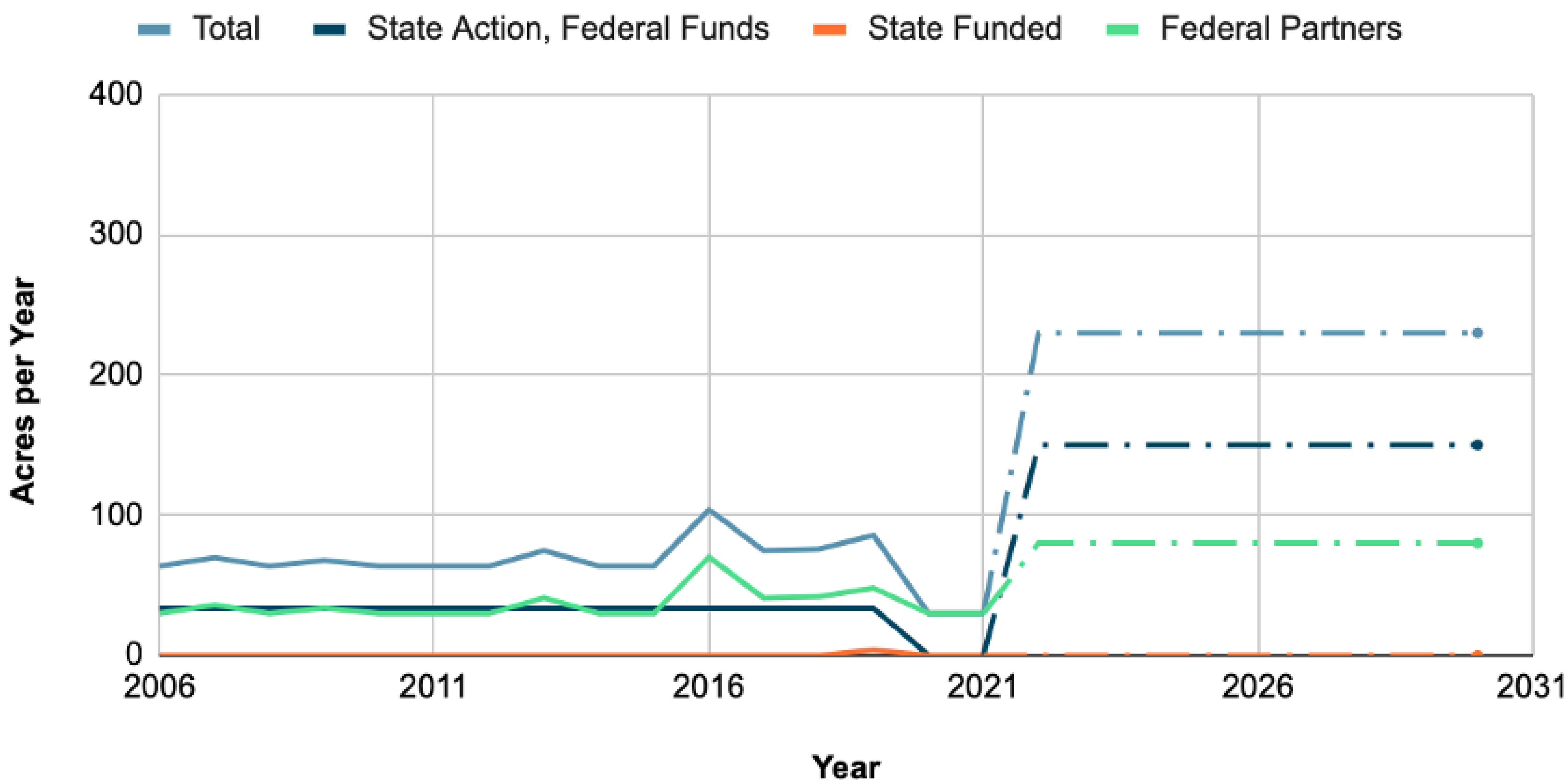

Figure 29. Implemented acres of wetland restoration from the GGRA of 2016 baseline year of 2006 through 2021 and the estimated acreage target for each activity category in 2030 based on the 2030 GGRA Plan. (Click figure to return).

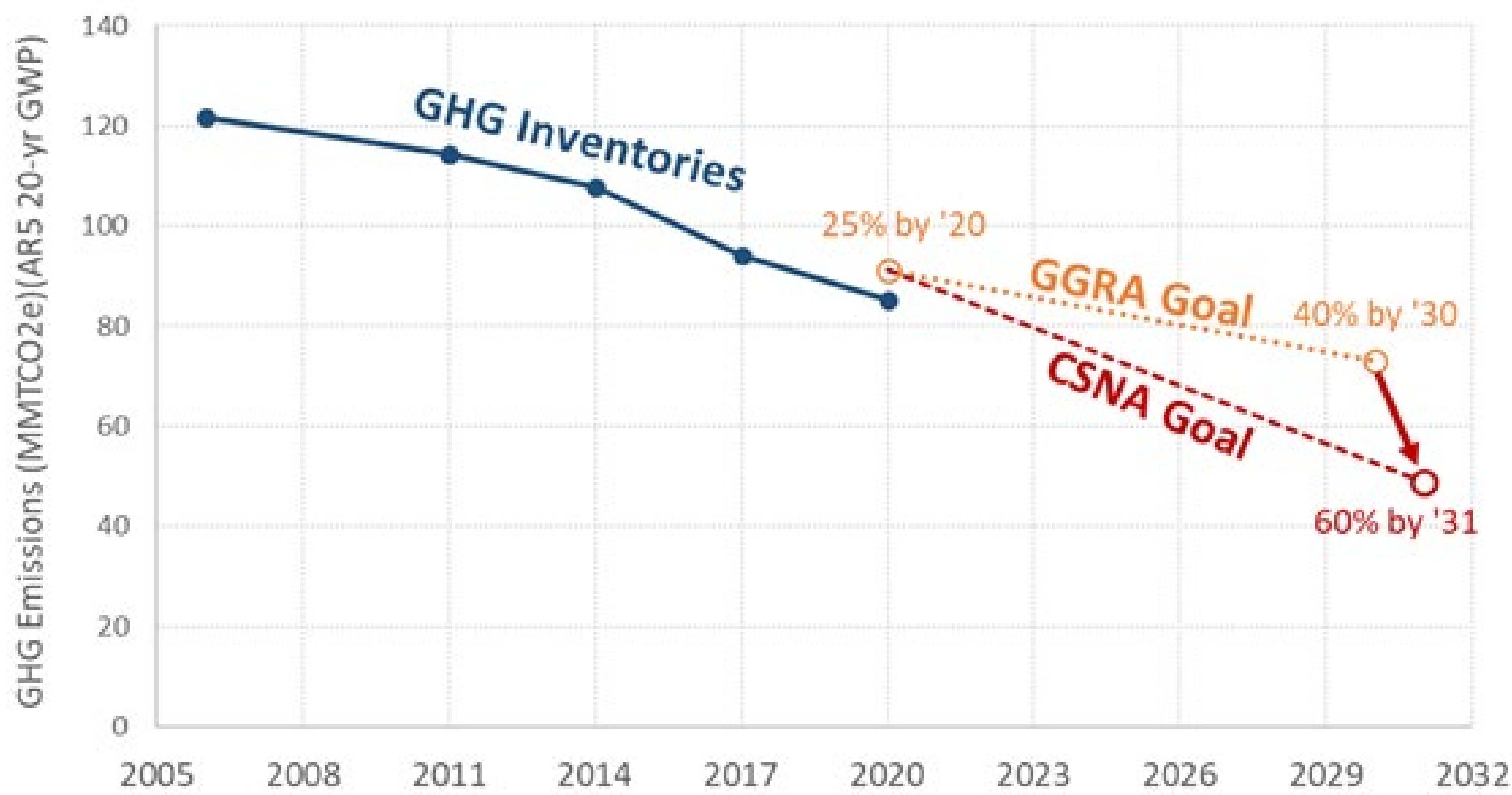

Figure 30. Maryland's statewide GHG emissions from 2006-2020 and GGRA of 2016 and CSNA emission reduction goals. (Click figure to return).

Appendix B: Table Glossary

Table 1. Afforestation, reforestation, forest management and urban tree planting activities in Maryland over the past three years relative to the GGRA of 2016 baseline in 2006.[8] (Click table to return).

Forest activities	2006	2019	2020	2021
Afforestation acres	1233.9	272.3	402.6	337.8
Reforestation acres	3318	254.2	312	234.6
Forest management acres	30,629.7	43,566	45,096	50,327
Urban trees planted	665,628	179,398	271,431	218,923

Table 2. Implemented acres of key agricultural practices in Maryland over the past three years relative to the GGRA of 2016 baseline in 2006. Note: Acres are fiscal year, not calendar year. (Click table to return).

Conservation Practices[12]	Acres in 2006	Acres in 2019	Acres in 2020	Acres in 2021
Conventional Tillage to No Till, annual (CPS 329)	524,923	647,072	647,072	647,072
Conventional Tillage to Reduced Tillage, annual (CPS 345)	167,021	194,122	194,122	194,122
Cover Crops, annual (CPS 340)	127,614	481,904	488,685	434,426
Land Retirement, cumulative (CPS 327, 342 and 512)	20,377	23,730	24,939	25,040
Forest Buffers and Tree Plantings, cumulative (CPS 391 and 612)	16,972	20,714	21,839	21,821
Prescribed Grazing, cumulative (CPS 528)	3,292	10,287	10,250	10,217

Table 3. Implemented acres of tidal wetland restoration in Maryland by 2020 and projected by 2030 relative to the GGRA of 2016 baseline in 2006. (Click table to return).

Activity	2006 Baseline, acres per year	Acres Restored by 2020	Additional Acres by 2030	Total Acres Restored
State Action, Federally Funded	0	505.5	1317	1,823.5
State Action, State Funded	0	3.8	0	3.8
Federal Partners	0	512	750	1,262