Charting the Path Forward:
A Transportation Strategy for Meeting Long-term Air Quality and Greenhouse Gas Emissions Goals and Enhancing Maryland's Economy and Quality of Life

Developed by:
Maryland Department of Transportation
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Executive Summary

Transportation is vital to growing Maryland's economy and positioning the State as a key location for businesses and tourism. Smart transportation policies and investments will simultaneously support economic development, enhance communities, and address environmental priorities for improving air quality, restoring the Chesapeake Bay, and addressing the threats of climate change.

The State of Maryland has made substantial progress in combating air pollution and greenhouse gas (GHG) emissions. Transportation policies and investments have played a key role in these improvements – supporting a vibrant economy, improving public health, and enhancing access to jobs, services, and recreational opportunities.

All of Maryland is now meeting the national air quality standard set in 2008 for ground level ozone. Even as the state has experienced growth in population and the economy, motor vehicle emissions of the pollutants that contribute to ozone have dropped by more than 35% since 2002. Since 2008, Maryland has met the national air quality standards associated with extremely small particles, and motor vehicle emissions associated with fine particles have dropped by more than 25% since 2002. Maryland is also on-track to meet the GHG emissions reduction targets set in the state's 2009 Greenhouse Gas Emissions Reduction Act (GGRA), which calls for a 25% reduction in GHGs from 2006 levels by 2020.

Despite this progress, further environmental challenges lie ahead:

- **Stricter Ozone Standards –** In October 2015, the U.S. Environmental Protection Agency (EPA) made the national standard for ground level ozone stricter (effective December 28, 2015), which will require continued reductions in emissions.
- **Chesapeake Bay Restoration –** The Chesapeake is vital to the state's economy and recreation. About one-quarter of the nitrogen pollution that enters the Bay comes from air pollution.
- **Climate Change** – The Chesapeake Bay region is the third most vulnerable area in the country to sea level rise, and climate change threatens more severe weather. Scientists believe GHG emissions reductions of up to 72% by 2050 are needed to minimize climate impacts, and transportation sources contribute about one-third of the GHGs emitted in Maryland.

Charting the Path Forward. Maryland has developed a strategic vision for transportation decisions that will drive economic growth and address environmental priorities into the future. This strategy builds on the foundation of investments and policies in the Maryland Transportation Plan and Climate Action Plan:

- **Cleaner Vehicles and Fuels** – Providing incentives, polices, and infrastructure support to expand the market for vehicles that produce low or zero emissions.
- **Increasing Travel Choices** – Supporting mobility improvements and livable communities that facilitate use of transit, bicycling, and walking options.
- **Enhancing Travel Efficiency** – Optimizing system operations to reduce traffic congestion, improve travel time reliability, and reduce fuel consumption.
- **Spurring Innovation** – Advancing clean energy technologies in transportation.
- **Strategic Highway Capacity Enhancements**- Reducing traffic congestion in critical transportation corridors to positively impact air quality.

This strategy will support thriving Maryland communities, create jobs, and establish Maryland as a national leader in clean transportation and technology.

1. Introduction

The State of Maryland has made significant progress in improving air quality, and 2015 marked the first-year that the entire state met the national air quality standards for ground level ozone set in 2008. However, in the face of new, stricter Federal air quality requirements and efforts to restore the Chesapeake Bay, Maryland will need to continue to make progress towards reducing mobile source pollutant emissions that contribute to ozone formation and deposition of nitrogen in the Bay. Additionally, the state is working to reduce greenhouse gas (GHG) emissions by 25% from 2006 levels by 2020, and recently extended this commitment to reduce GHG emissions to 40% below 2006 levels by 2030 to address climate change while continuing to strengthen and grow the state's economy.

Maryland has made substantial progress in combating ozone pollution and greenhouse gas emissions, while supporting economic growth and job creation. The transportation sector has played a key role in this progress, and will be a critical component of strategies to address future challenges.

Transportation is vital to the state's economy – connecting people to jobs and health care services, supporting recreational opportunities and tourism, and moving freight to support the economy. With an extensive highway, transit, and bicycling network, the Port of Baltimore, BWI Thurgood Marshall International Airport, and other aviation facilities, Maryland's transportation network is a critical element of the state's economic development and quality of life. Yet transportation sources continue to be major contributors to air pollutant emissions and GHG emissions.

This document provides a strategic roadmap for the transportation sector to further its contributions to support a clean and healthy environment by reducing mobile source emissions while supporting a strong Maryland economy and job growth. It is intended to be a living document that will be updated as the state continues to make progress toward air quality goals.

Maryland's Air Quality and Impacts

Maryland's ozone air pollution ("smog") is exacerbated by the state's geographic location and meteorological conditions. Like most states east of the Mississippi River, Maryland receives air pollution that blows in from other states. On many days, up to 70% of Maryland's ozone problem originates in upwind states. Pollution floating from power plants from areas west of Maryland combines with local pollution, and is then trapped along the western edge of the Chesapeake Bay by winds, contributing to high ozone levels in parts of the state.[1]

Air pollution is associated with adverse health effects. While ozone in the atmosphere blocks the sun's harmful rays, ozone at the ground level can be harmful to human health and may cause shortness of breath, coughing, wheezing, chest tightness, and throat irritation.[2] Particle pollution is a mixture of small particles and liquid droplets such as dust and organic chemicals, which can cause premature death in people with heart or lung disease, non-fatal heart attacks, increase respiratory symptoms, and worsen

[1] Maryland Department of the Environment. Clean Air Progress in Maryland: Accomplishments in 2015. Available at: http://www.mde.state.md.us/programs/Air/Documents/GoodNewsReport/GoodNewsReport2015Final.pdf.
[2] U.S. EPA. Patient Exposure and the Air Quality Index. Available at: http://www3.epa.gov/apti/ozonehealth/aqi.html.

asthma.[3] The smallest of these particles, less than 2.5 microns in diameter (called $PM_{2.5}$), are the most harmful since they can get deep into the lungs. Certain groups are more susceptible to the effects of ozone and particulate matter, including children, the elderly, and people with lung diseases such as asthma.[4] Additionally, particulate matter is a main cause of haze that limits visibility, reducing the ability to see distant views and scenic vistas.[5]

Air pollution also affects Maryland's waterways and the Chesapeake Bay. Through a process called atmospheric deposition, pollution released into the air eventually falls to the ground settling onto land or water. A significant source of pollution affecting the Bay is airborne nitrogen, specifically nitrogen oxides (NO_X) produced by equipment powered by gas, coal, oil, including motor vehicles. Excess nitrogen and other chemicals can lead to increased algae growth that blocks sunlight that other aquatic plants need.[6] As algae die, they deplete oxygen levels in the water, creating "dead zones" where fish, crabs, oysters and other aquatic organisms cannot survive.[7]

2. Cleaner Air, a Growing Economy, and Enhanced Mobility – The Good News about Air Quality and Transportation in Maryland

Thanks to the sustained efforts of government, businesses, environmental advocates, scientists, health professionals and many others, Maryland has seen dramatic improvements in air quality over the past 15 years – providing improvements to public health and quality of life.

Maryland Meets 75 parts per billion Ground Level Ozone Standards Statewide

The U.S. Environmental Protection Agency (EPA) establishes limits for air pollutants in the atmosphere to protect public health, and periodically reviews and updates the national air quality standards according to the latest science and available technology.[8] For the first time ever, all of Maryland is meeting the Federal 8-hour ozone concentration standard of 75 parts per billion (ppb) established in 2008. EPA determined in 2015 that the Baltimore metropolitan area (Baltimore City and Baltimore, Anne Arundel, Howard, Harford and Carroll counties) is meeting the ozone standard, based on air monitoring data from the past three years. This accomplishment demonstrates significant progress in reducing adverse impacts of air quality on health in Maryland.

In 2000, the entire state recorded pollution levels above the ozone standard, and by 2014 most of the state was meeting the standard (see Figure 1). Between 2003 and 2014, ozone standards were exceeded in Maryland on average about 29 days per year. However, over the past three years, ozone exceedance days have been reduced dramatically, with only 5 in 2014 and 8 days in 2015.[9]

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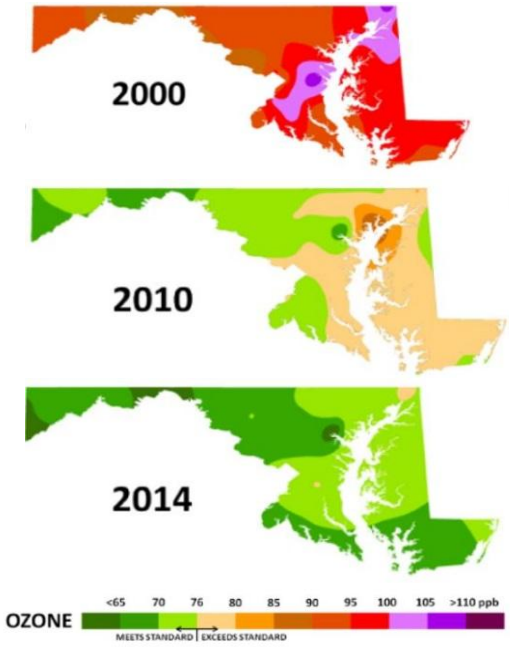
[3] U.S. EPA. Particulate Matter: Health. Available at: http://www3.epa.gov/pm/health.html.
[4] U.S. EPA. Patient Exposure and the Air Quality Index. Available at: http://www3.epa.gov/apti/ozonehealth/aqi.html.
[5] U.S. EPA. Particulate Matter: Health. Available at: http://www3.epa.gov/pm/health.html.
[6] Chesapeake Bay Foundation. Air Pollution. Available at: http://www.chesapeakebay.net/issues/issue/air_pollution#inline.
[7] Chesapeake Bay Foundation. Dead Zones. Available at: http://www.cbf.org/about-the-bay/issues/dead-zones.
[8] U.S. EPA. Ozone Standards. Available at: http://www3.epa.gov/ttn/naaqs/standards/ozone/s_o3_index.html.
[9] Maryland Department of the Environment. Historical Air Quality Data. Available at: http://www.mde.state.md.us/programs/Air/AirQualityMonitoring/Pages/HistoricalData.aspx

Figure 1. Maryland's Shrinking Ozone Problem, 2000- 2014

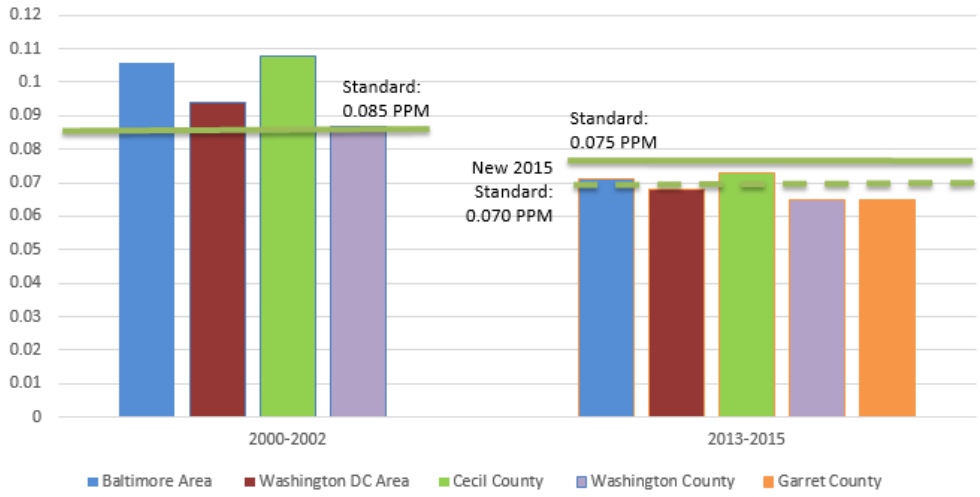


As national ozone standards became more stringent, Maryland rose to the challenge and statewide ozone levels dropped significantly (see Figure 2).

Ozone is created by chemical reactions between nitrogen oxides (NOx) and volatile organic compounds (VOC) in the presence of sunlight and heat. As a result, weather conditions and pollution levels together play a role in ozone formation, and will affect Maryland's ability to meet new more stringent standards.

Source: Maryland Department of the Environment.

Figure 2. Maryland Ozone Design Values, 2000-2002 and 2013-2015, Compared to National 8-Hour Ozone Standards

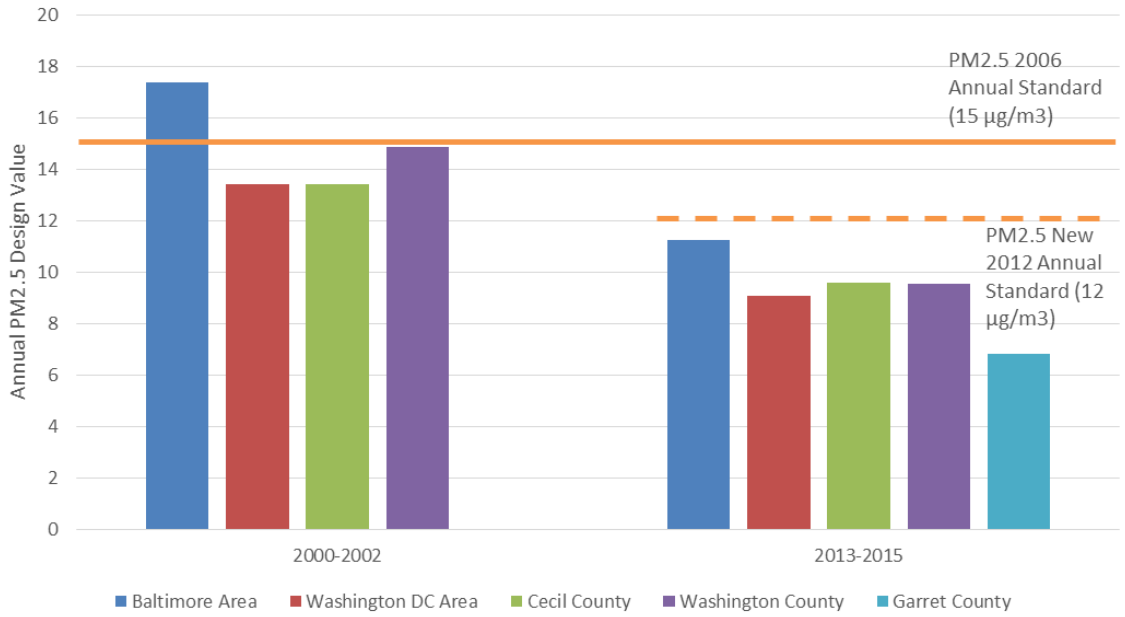


Note: A design value is a statistic that describes the air quality status of a given location relative to the level of the National Ambient Air Quality Standards (NAAQS) used to designate and classify nonattainment areas. Design Values were calculated based on the three year average of the fourth highest max value for the monitor with the highest reading in each area. Source: U.S. EPA, http://www3.epa.gov/airdata/ad_rep_mon.html. [Note: Data for 2015 are not final]

Maryland Meets Fine Particle Standards

The EPA has established two primary air quality standards for $PM_{2.5}$ -- annual and daily standards -- to provide public health protection from both long- and short-term effects of exposure to fine particle pollution. As with ozone, Maryland has seen substantial reductions in particulate matter in the atmosphere. Fine particulates are composed of nitrogen and/or sulfur compounds and other compounds. A variety of Federal and state controls, as well as other regulations aimed at reducing sulfur dioxide (SO_2) and nitrogen oxides (NOx), have reduced emissions from power plants. Within the transportation sector, the 2007 heavy duty highway rule reduced emissions from heavy duty diesel trucks and reduced levels of sulfur from diesel fuel, together with the Diesel Vehicle Inspection Program. Since 2008, Maryland overall has met the national standards for $PM_{2.5}$, including more stringent regulations set in 2012 (see Figure 3).[10]

Figure 3. Maryland $PM_{2.5}$ Design Values, 2000-2002 and 2013-2015, Compared to National Annual $PM_{2.5}$ Standard



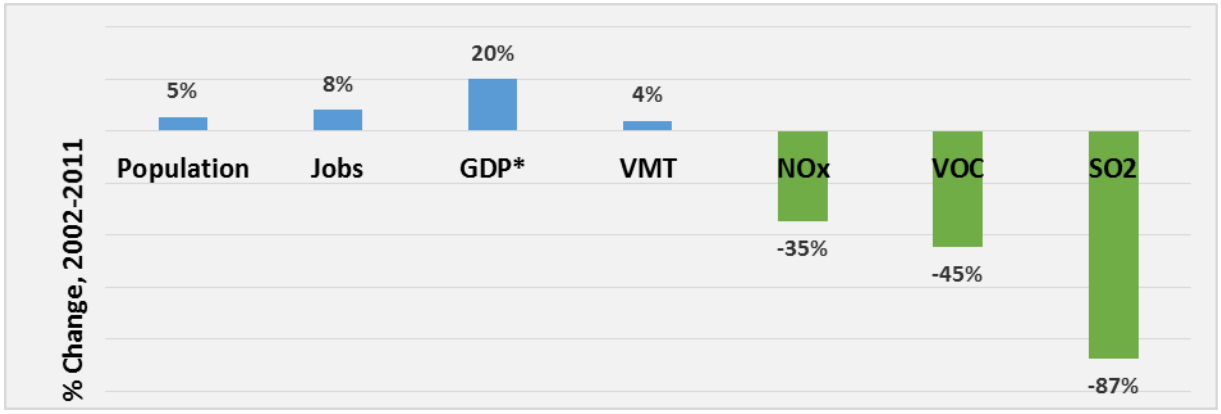
Note: Design Values calculated based on averaging the three years annual mean, for the monitor with the highest reading in each area. Source: U.S. EPA, http://www3.epa.gov/airdata/ad_rep_mon.html. [Note: Data for 2015 are not final]

Transportation Air Pollutant Emissions Have Dropped Significantly

Transportation emission reductions have played an important role in Maryland's air quality improvements. During a period when statewide population grew by 5% (from 5.44 to 5.74 million people) and total economic activity increased significantly, from 2002 to 2011, air pollution from motor vehicles decreased dramatically. Ozone precursors, NOx and VOC dropped by 35% and 45%, respectively, while SO_2 dropped by 87% (see Figure 4).

[1010] Clean Air Progress in Maryland: Accomplishments in 2015
http://www.mde.state.md.us/programs/Air/Documents/GoodNewsReport/GoodNewsReport2015Final.pdf

Figure 4. Percent Change in Demographics, Travel, the Economy, and Motor Vehicle Emissions, 2002-2011

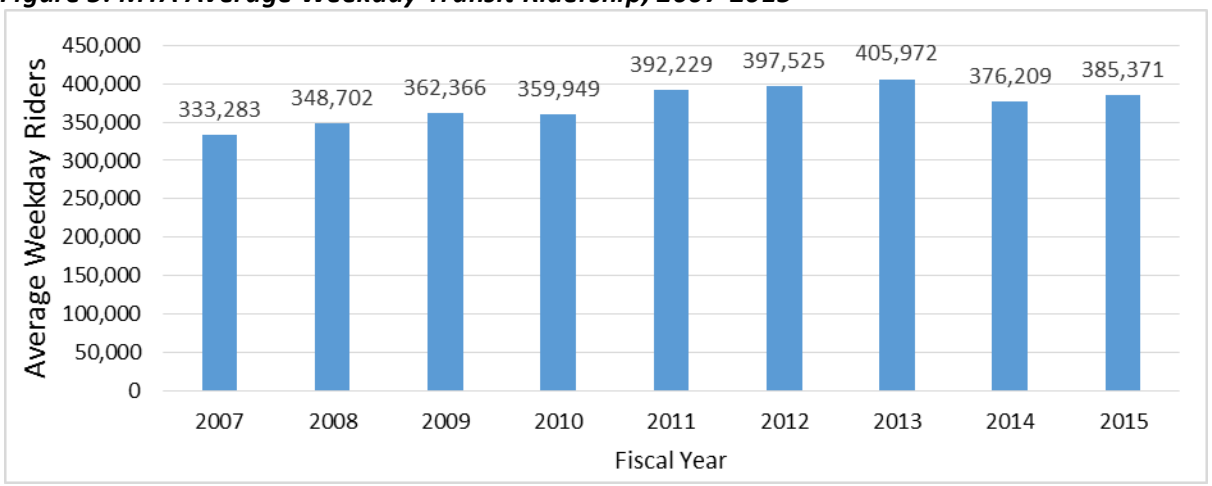


** GDP (gross domestic product) figures are inflation adjusted (in real dollars) and reflect the value added in production by the labor and capital of all industries located in a state. Sources: Maryland Department of Planning State Data Center (population and jobs), U.S Department of Commerce (State GDP), Maryland Department of Transportation (VMT), and Maryland Department of Environment (Motor vehicle emissions).*

These reductions in air pollution from transportation have occurred in large part due to tighter motor vehicle emissions standards, resulting in cleaner vehicles. The Maryland Department of Transportation's (MDOT's) programs supporting transit, ridesharing, bicycling and walking, as well as projects that reduce roadway congestion, also have supported these improvements. For instance, average weekday ridership on MTA services in Maryland increased from 333,283 riders in FY 2007 to 385,371 riders in FY 2015, an increase of more than 15% (see Figure 5).

From 2005 to 2015, total vehicle miles traveled (VMT) in Maryland has remained relatively steady (a 1% increase over the decade). Overall, VMT per person has declined over the past ten years (see Figure 6). While a combination of societal, technological, and economic factors have contributed to these trends, the state's investments in multimodal travel options, travel demand management, and transportation system management support these outcomes.

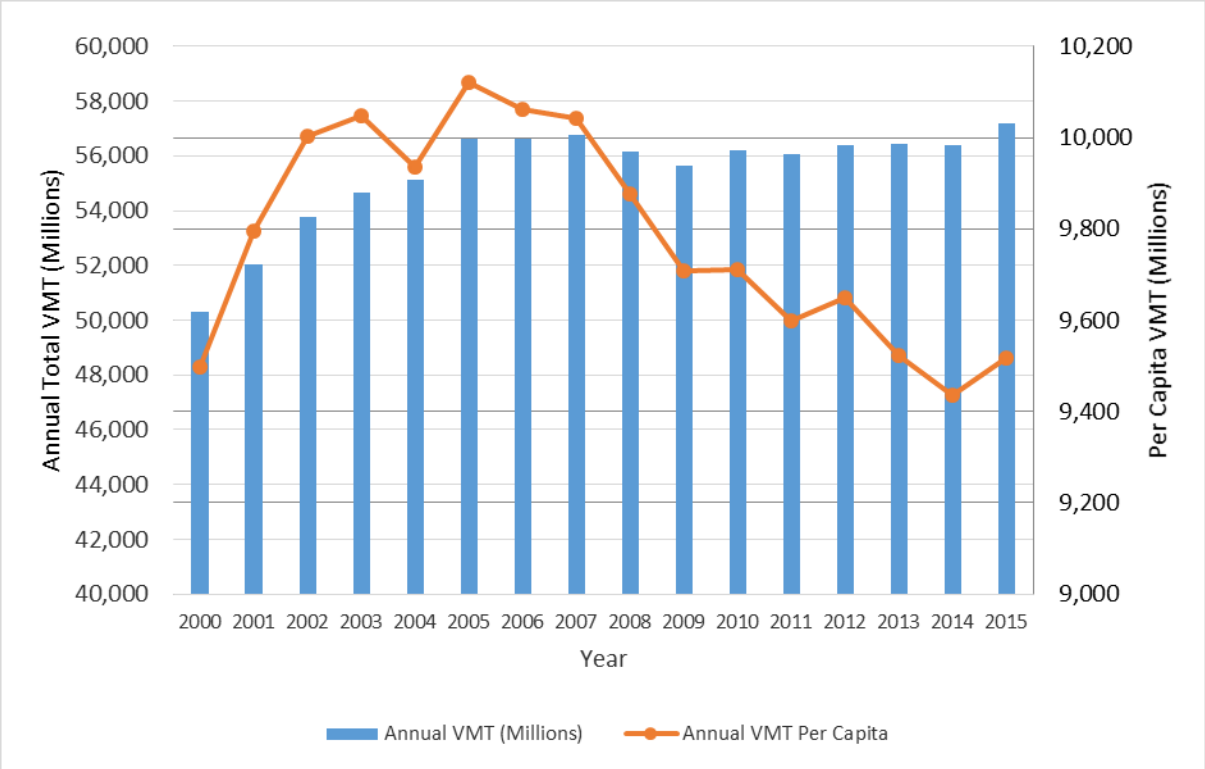
Figure 5. MTA Average Weekday Transit Ridership, 2007-2015



Source: Maryland Department of Transportation, 2016 Annual Attainment Report.

Note: MTA used ridership estimate differences between the new APC system and previous systems to adjust previous bus ridership figures to allow for comparable data.

Figure 6. Annual VMT and VMT per Capita in Maryland, 2000-2015



Sources: Maryland Department of Information Technology, Maryland Annual Vehicle Miles of Travel, October 2015, https://data.maryland.gov/Transportation/Maryland-Annual-Vehicle-Miles-of-Travel/exua-btti; Maryland State Data Center, Population Estimates, October 2015, http://planning.maryland.gov/msdc/S2_Estimate.shtml; Maryland Department of Transportation, 2016 Attainment Report.

Ensuring that Transportation Plans and Investments Support Air Quality Goals

The Clean Air Act requires transportation planning and air quality planning processes to be coordinated within a state. Transportation plans and Transportation Improvement Programs must show that they support (or "conform" to) the State Implementation Plan for air quality, using travel and emissions modeling (referred to as the transportation conformity process).

These analyses demonstrate continued reductions in emissions from motor vehicles. For instance, the Baltimore region's most recent draft Transportation Conformity Determination shows summer NOx reductions of 64% and VOC reductions of 56%, and direct $PM_{2.5}$ reductions of 50% from motor vehicles between 2017 and 2040.[11] These reductions come from new Federal vehicle emissions and fuel standards, as well as regional transportation investments and Transportation Emissions Reduction

[11] Baltimore Regional Transportation Board, Transportation Conformity Determination, Prepared for the FY 2014-2017 Transportation Improvement Program and the 2011 Long Range Transportation Plan.

Measures (TERMs). Similarly, the Washington, DC region's latest Transportation Conformity Determination also shows substantial emissions reductions from motor vehicles (see Figure 7).[12]

Figure 7. Regional Air Quality Conformity Documents Show Continued Reductions in Motor Vehicle Emissions

Pollutant	Region	Calendar Year				% Change
		2015	2017	2025	2040	2017-2040
NO_X, average summer day, tons per day	Baltimore	-	50.7	25.9	18.2	-64%
	Washington*	128.3	91.1	42.0	20.3	-78%
VOC, average summer day, tons per day	Baltimore	-	26.5	18.2	11.6	-56%
	Washington*	62.4	50.7	35.5	19.1	-62%
Fine Particulate Matter ($PM_{2.5}$) tons per year	Baltimore	-	887	538	441	-50%
	Washington*	1860	1523	926	720	-53%

**Washington figures represent the entire Washington, DC region, including parts of Maryland, Virginia, and the District of Columbia; the Washington figures, however, do not include the impacts of TERMs, which are less than 0.1 ton per day for each year.*

Sources: Baltimore Regional Transportation Board, Draft Conformity Determination of Maximize2040 and the Amended 2016-2019 Transportation Improvement Program, September 2015. National Capital Region Transportation Planning Board, 2015 Amendment, Financially Constrained Long Range Transportation Plan for the National Capital Region, Air Quality Conformity Analysis of the 2015 CLRP Amendment and FY2015-2020 TIP, October 21, 2015.

Working with Neighboring States to Address Interstate Pollution

In addition to addressing pollution generated within its boundaries, Maryland is also committed to working with neighboring states to address interstate pollution that is carried downwind. Maryland participates in EPA's Good Neighbor program to address pollution from its power plants that affects areas like Philadelphia and New York, and encourages other states to do so.[13] In regards to transportation, Maryland is involved in the Transportation and Climate Initiative of the Northeast and Mid-Atlantic States (TCI). TCI brings together top environment, transportation, and energy agency officials from eleven states and the District of Columbia to work together to reduce GHGs in the transportation sector and help build a clean energy economy.

3. Meeting Today's and Future Environmental Challenges – Ozone, Restoring the Bay, and Climate Change

Despite recent and expected progress in improving air quality and reducing GHG emissions, significant environmental challenges lie ahead over the next 20 years.

More Stringent Ground-Level Ozone Standard

In October 2015, EPA modified the national standard for ground level ozone, reducing it from 75 to 70 parts per billion. [14] There are regions of Maryland that are not likely to meet the 70 ppb standard when designations become final in October 2017. Additionally, temperature is a factor in the formation of

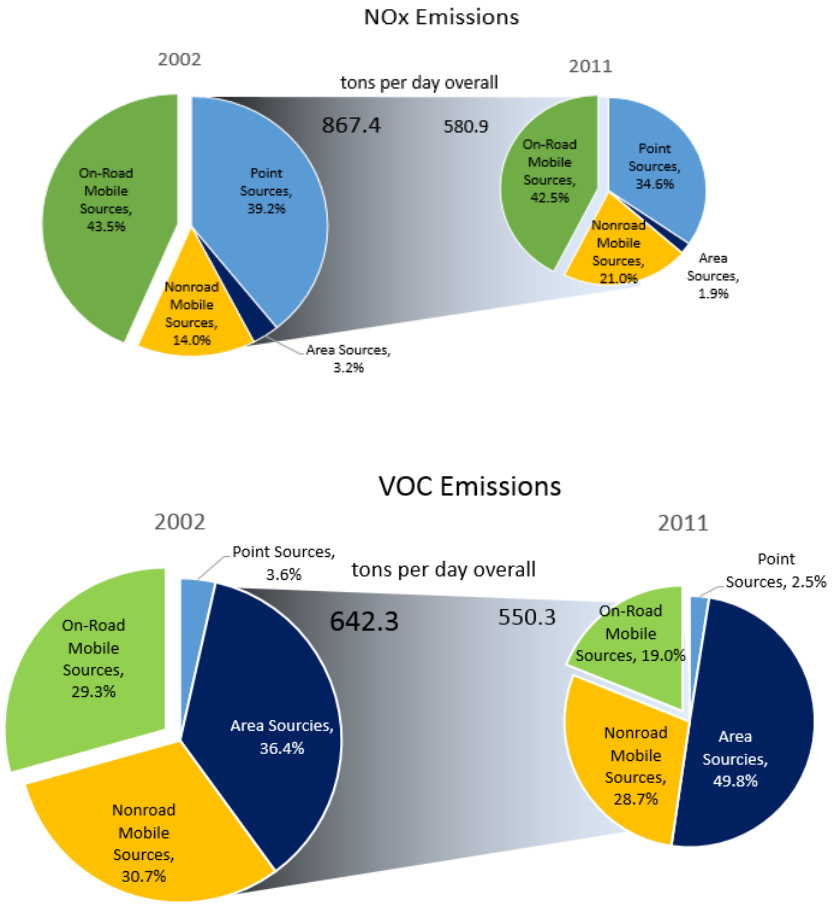
[12] These figures represent the entire Washington, DC region, including parts of Maryland, Virginia, and the District of Columbia. National Capital Region Transportation Planning Board, 2015 Amendment, Financially Constrained Long Range Transportation Plan for the National Capital Region, Air Quality Conformity Analysis of the 2015 CLRP Amendment and FY2015-2020 TIP, October 21, 2015.

[13] Maryland Department of the Environment. Clean Air Progress in Maryland: Accomplishments in 2015. Available at: http://www.mde.state.md.us/programs/Air/Documents/GoodNewsReport/GoodNewsReport2015Final.pdf.

[14] 80 FR 65292

ground-level ozone; a hot summer may put parts of Maryland in nonattainment. Despite significant progress in reducing emissions, motor vehicles (on-road mobile sources) continue to make up a large share of total NOx emissions in Maryland. Nonroad mobile sources, including airplanes, trains, and commercial marine vessels, as well as agricultural equipment, construction equipment, and lawnmowers, also are significant contributors. Together, these mobile sources make up over 63% of NOx emissions and nearly 48% of VOC emissions in 2011 (see Figure 8).

Figure 8. Contribution of Different Sources to NOx and VOC Emissions in Maryland, 2002 - 2011



Source: Maryland Department of the Environment.

The current emissions budgets used in transportation conformity analyses in Maryland are based on the 85 ppb ozone standard set in 1997. Based on relevant modeling forecasts, including sector-based analyses, emissions budgets may need to be considerably lower to meet the70 ppb standard.

Chesapeake Bay Restoration

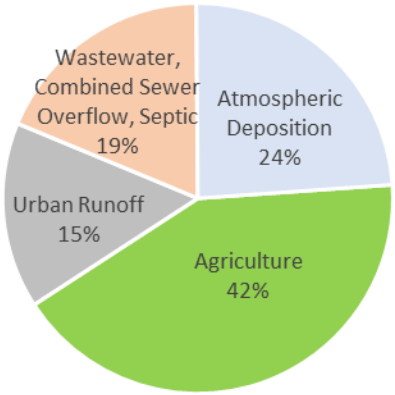
Maryland's quality of life is inextricably tied to the Chesapeake Bay watershed. Rivers, streams, and aquifers in the watershed supply drinking water; oyster, crab and other fisheries provide economic livelihood; natural areas buffer against storms and flooding and provide wildlife habitat; and beaches,

rivers and other waterfront attractions bolster the recreation and tourism industries in Maryland.[15] Roughly $2.03 billion and 32,025 jobs are generated each year in Maryland due to recreational boating, and the Bay's commercial seafood industry in Maryland and Virginia contributes nearly $3.4 billion in sales and 34,000 jobs to the local economy.[16]

In 2010 EPA established targets for the nutrients that can enter the Bay to achieve water quality standards, called Total Maximum Daily Load (TMDL) limits. Atmospheric deposition of NOx and reduced nitrogen (e.g., ammonia) contribute to a significant portion of the total nitrogen load delivered to the Bay. Primary sources of NOx emissions are electric power plants and mobile sources. Ammonia (NH_3) sources are predominately agricultural, with ammonia released from manure and emissions from ammonia-based fertilizers.

Air quality improvements have supported reductions of nitrogen from atmospheric deposition in the Bay and its watershed, with NOx from atmospheric deposition in the Chesapeake Bay watershed estimated to have decreased by about 60% between 1985 and 2015.[17] However, air pollution continues to be an important contributor to nitrogen in the Bay (see Figure 9), and mobile source emissions play an important role in the Bay's health.[18]

Figure 9. Nitrogen Loads to the Bay by Source, Estimated 2014



Note: Loads simulated using Watershed Model (Phase 5.3.2) and wastewater discharge data from watershed jurisdictions, Atmospheric deposition simulated using the Chesapeake Bay Airshed Model; documented March 31, 2015. Source: Chesapeake Bay Foundation, http://www.chesapeakebay.net/indicators/indicator/reducing_nitrogen_pollution

Climate Change Impacts and Reducing Greenhouse Gases

Climate change is one of the most daunting environmental threats facing the world, with potentially costly or catastrophic impacts on ecosystems, water supplies, urban development, and public health.

[15] Maryland Sea Grant, Chesapeake Bay Facts and Figures. Available at: http://www.mdsg.umd.edu/topics/ecosystems-restoration/chesapeake-bay-facts-and-figures

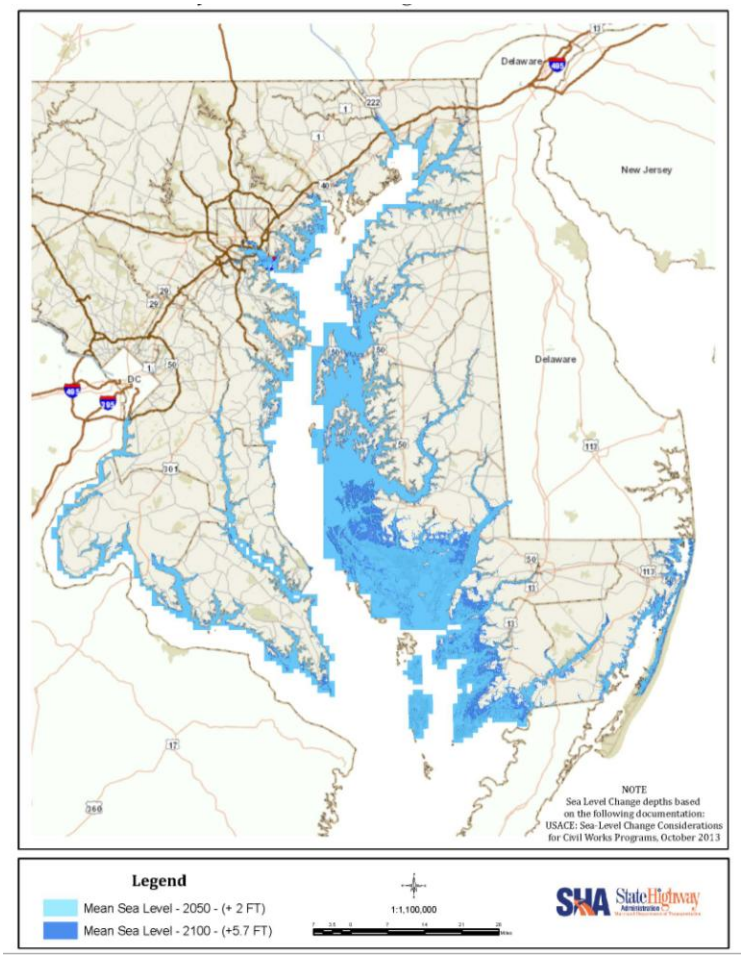
[16] Chesapeake Bay Foundation, The Economic Importance of the Bay, citing the Economic Impact of Maryland Boating in 2007 report and a study from the National Oceanic and Atmospheric Administration (NOAA). Available at: http://www.cbf.org/about-the-bay/issues/cost-of-clean-water/economic-importance-of-the-bay

[17] Chesapeake Bay Foundation, http://gis.chesapeakebay.net/air/.

[18] Urban runoff (water that washes pollutants from paved surfaces, including roads, into water bodies) is also impacted by transportation. Source: The Chesapeake Bay Program, Reducing Nitrogen Pollution. Available at: http://www.chesapeakebay.net/indicators/indicator/reducing_nitrogen_pollution

Maryland – with 3,100 miles of tidal shore along the Chesapeake Bay and Atlantic Ocean, and low-lying and rural and urban lands – is ranked the third most vulnerable state to sea level rise, behind Louisiana and southern Florida (see Figure 10).[19] Historic records show that sea level has been rising faster in the mid-Atlantic than the global average – with sea levels increasing by one foot within Maryland's coastal waters in the last 100 years, due to a combination of global sea level change, weakening of the Gulf Stream, and naturally occurring regional land subsidence.[20] Additionally, climate change is linked to severe weather like hurricanes, floods, and temperature fluctuations.

Figure 10. Maryland Projected Sea Level Change, 2050 and 2100



Source: Maryland State Highway Administration.

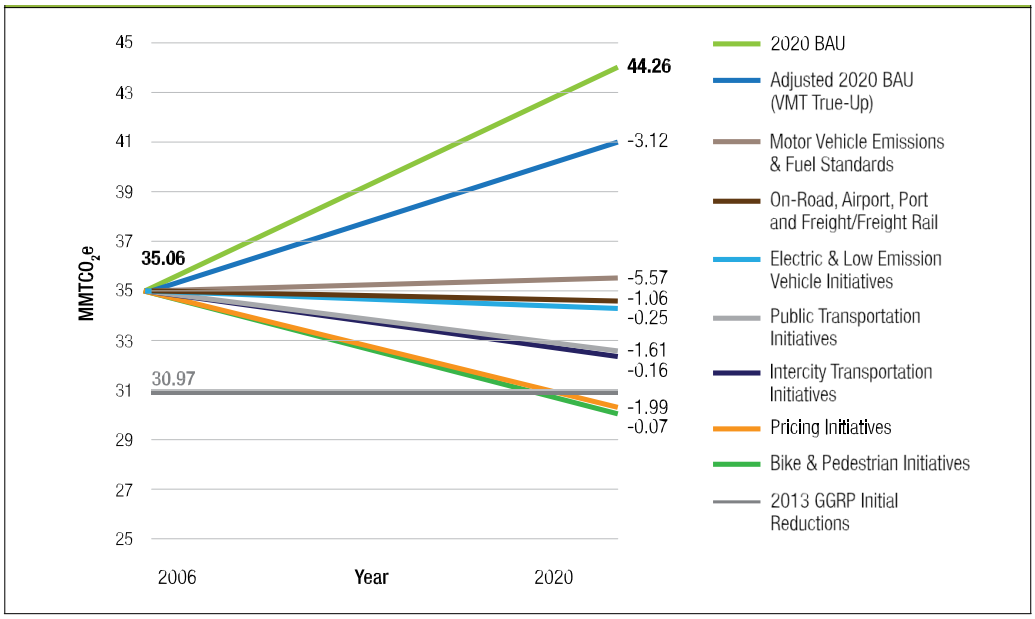
Maryland has moved ahead to combat climate change through passage of the Greenhouse Gas Reduction Act of 2009 (GGRA). The Act requires a 25% reduction in emissions from 2006 levels by 2020, through policies and programs that have a positive impact on the state's economy and job creation. The

[19]Maryland Department of Natural Resources. The impact of climate change. http://www.dnr.state.md.us/naturalresource/spring2011/7.asp

[20] "Maryland Department of Natural Resource, Maryland Department of Environment, and Maryland Department of Planning, "Comprehensive Strategy for Reducing Maryland's Vulnerability to Climate Change – Phase I: Sea-level rise and coastal storms." Report of the Maryland Commission on Climate Change Adaptation and Response Working Group, August 2008.

Maryland Department of the Environment (MDE) collaborated with MDOT and other agencies to develop the *Greenhouse Gas Reduction Act Plan.* The state is on track to meet and even exceed its 2020 emissions reduction goals, with emissions reductions coming from many sectors. Transportation is a key component of these reductions, falling from an estimated 35.06 million metric tons of carbon dioxide equivalent (MMTCO2e) in 2006 to 30.43 MMTCO2e in 2020; this is a projected 13% reduction in transportation emissions, but represents a 31% reduction from the business as usual (BAU) forecast of GHG emissions in 2020 (see Figure 11).

Figure 11. Maryland Transportation Sector GHG Emissions, 2006-2020 Forecast



Source: MDOT, Maryland 2015 Greenhouse Gas Reduction Act Plan.

Beyond the 2020 horizon of the GGRA, there is scientific consensus that global GHG emission reductions of 42-72% are needed by 2050 to minimize the worst climate impacts. In April 2016, Governor Hogan signed the Greenhouse Gas Reduction Act of 2016, requiring the state to cut emissions economy-wide by 40% below 2006 levels by 2030. The GHG reduction target is economy-wide (to be met through the most cost-effective and economically beneficial strategies across all sectors), and the transportation sector will be called upon as a key contributor to these reductions.

Metropolitan areas in Maryland have already initiated efforts to identify strategies that could yield significant reductions in GHG emissions by 2050. In 2008, the members of the Metropolitan Washington Council of Governments (MWCOG) adopted ambitious voluntary goals to reduce GHG emissions in the National Capital Region to 20% below 2005 levels by 2020 and to 80% below 2005 levels by 2050. MWCOG has since convened a Multi-Sector Working Group (MSWG) to identify and assess potentially viable and stretch GHG reduction strategies across all sectors of the economy, including Energy, the Built Environment, Land Use, and Transportation, and is now working on an action plan to identify the most viable strategies to move forward. The Baltimore Metropolitan Council (BMC) also has undertaken a focused effort to explore how to reduce GHGs from on-road transportation sources. BMC's "How Far Can We Get?" study evaluated how far different types of strategies could contribute to reducing motor

vehicle emissions. Both of these efforts have identified a range of promising strategies, but also highlight the challenges and need for aggressive strategies to achieve significant reductions in GHG emissions.

4. Charting a Path Forward: Transportation Solutions for a Healthy Environment, Economic Vitality, and Quality of Life

Moving forward, Maryland will address these environmental challenges through actions and policies that continue to strengthen access and mobility, the economy, and community livability. A key state priority is to improve Maryland's economic competitiveness. With the Maryland Transportation Plan, the GGRA Plan, the Maryland Climate Action Plan, and other policies, the state has already identified aggressive yet achievable goals and actions to reduce GHGs, improve air quality, and support the Chesapeake Bay while promoting economic vitality.

Building on the GGRA Plan, which sought to make "the smartest environmental and economic decisions possible," this section of the document describes transportation strategies that are designed to address environmental challenges while simultaneously supporting job creation and economic vitality in Maryland. Partnerships with local governments, metropolitan planning organizations responsible for regional transportation planning, as well as private sector businesses and other stakeholders, are critical to implementation of these strategies, which can help grow our economy and create vibrant communities that attract and retain businesses.

Meeting Environmental Goals while Growing Maryland's Economy

The GGRA required that the resulting Plan not only reduce GHG emissions but also have a positive impact on job growth and economic development in Maryland, by focusing on jobs and businesses that contribute to sustainable economic prosperity.

The Regional Economic Studies Institute of Towson University conducted a study to analyze the annual economic benefits of the GGRA Plan, once fully implemented. According to the study, implementing the Plan's set of transportation strategies (Maryland Clean Cars Subprogram, Bicycle and Pedestrian initiatives, Electric Vehicle initiatives, etc.), could result in the following annual economic impacts:

- 3,100 jobs
- $3,491,312,335 in output (total value of goods and services)
- $1,284,658,134 in total net benefit

Source: Maryland Department of the Environment. The 2015 Greenhouse Gas Emissions Reduction Act Plan Update, October 2015

Cleaner Transportation and Fuels - *Advancing adoption of vehicle technologies and fuels that reduce GHGs and air pollutant emissions.*

Vehicle technology enhancements are critical to achieving significant reductions in emissions from motor vehicles. Maryland understands the importance of advanced vehicle technologies – a primary focus of the state's climate action plan is further deployment of alternative fuel and advanced technology vehicles to offset petroleum use and reduce mobile source emissions.

Motor Vehicle Emissions and Fuel Standards. Maryland has been a leader in adopting strategies to advance cleaner vehicles and fuels, via the Maryland Clean Cars Program, which implemented California's low emissions vehicle (LEV) standards to vehicles purchased in Maryland starting with model year 2011. Since then, adopted and proposed enhancements in Federal motor vehicle emissions standards overlap with this program, and further improvements in vehicle technologies and fuels are anticipated to play a key role in significantly improving air quality and reducing GHG emissions. These include:

- **EPA Tier 3 motor vehicle emissions and fuel standards for model years 2017-2025** – Will reduce air pollutant emissions from motor vehicles, and will reduce the sulfur content of gasoline from current average level of 30 ppm to 10 ppm beginning in 2017.
- **EPA's heavy duty engine and fuel sulfur rule** – This rule significantly reduces NOx and particulate emissions from new heavy-duty diesel vehicles. By lowering the sulfur of diesel fuel, it allows the use of advanced emissions control technologies.
- **National light-duty GHG and fuel economy program** - These standards apply to passenger vehicles and light-duty trucks, and are projected to result in an average industry fleet level of 163 grams/mile of carbon dioxide in model year 2025, which is equivalent to 54.5 miles per gallon if achieved exclusively through fuel economy improvements – a more than doubling of fuel economy from 2010 model year vehicles.
- **National medium and heavy-duty vehicle GHG and fuel efficiency standards** - Adopted national standards for medium- and heavy-duty engines and vehicles, and proposed Phase 2 national standards for medium-and heavy-duty engines (through model year 2027) will result in reduced GHG emissions from trucks and other large vehicles traveling through Maryland.

Increasing Zero Emissions Vehicles (ZEVs) and Supporting Plug-In Electric Vehicle (PEV) Deployment. The transition to zero emissions vehicles (ZEVs and PEVs) is a key strategy for reducing emissions in Maryland since light-duty vehicles make up most of the vehicles on the road. ZEVs are vehicles that produce zero to near zero tailpipe emissions (i.e., plug-in electric vehicles and fuel cell electric vehicles). The Maryland Clean Cars Program contains a ZEV mandate which requires that manufacturers make an increasing percentage of the vehicles available for sale in Maryland be ZEVs. It is estimated that by 2025 this Program could result in approximately 300,000 PEVs in Maryland. In addition, Maryland and several other states (California, Connecticut, Massachusetts, New York, Oregon, Rhode Island, and Vermont) signed a

memorandum of understanding in 2013 to increase ZEV deployment, creating a ZEV Program Implementation Task Force which released its first action plan in 2014.

In line with its expansive ZEV policies, Maryland has implemented a number of programs to encourage the purchase of plug-in vehicles and the installation of electric vehicle supply equipment (EVSE). The Maryland Electric Vehicle Infrastructure Council (EVIC) currently operates to promote the use of PEVs in Maryland through the development of PEV and charging infrastructure action plans, permitting standards, and local and regional on-the-ground efforts. Beginning in 2014 Maryland has offered an excise tax credit of $125 per kilowatt-hours of battery capacity up to a maximum of $3,000 for the purchase of a qualifying plug-in electric vehicle. Together with the federal tax credit, this could account for up to a $10,000 tax break on the purchase price of a PEV in Maryland.

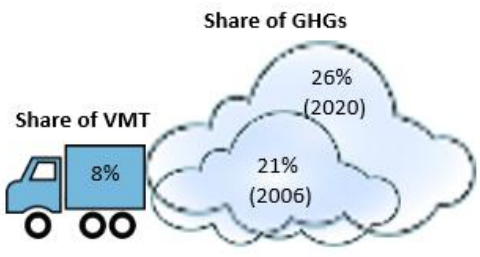
In addition to incentivizing the PEVs, Maryland has been active in ensuring that the needed charging infrastructure is in place to make the PEVs a success. Maryland offers a rebate for 50% of the purchase and installation cost of an EVSE, up to $900 for residential installations, $5,000 for commercial, and $7,500 for retail service stations. This program has been a great success, with the numbers of applicants increasing significantly each year. Maryland has used $1 million in settlement money to leverage an additional $1 million in private sector investment to develop an Electric Vehicle Infrastructure Program (EVIP). The goal of EVIP is to develop a Level 3 DC Fast Charger network that, when completed in 2016, will have over 40 Level 3 DC Fast Chargers set up throughout the State. Moreover, Maryland has worked to install Level 2 Chargers at commercial businesses, Park & Rides, and workplaces, resulting in a network of over 700 public, Level 2 chargers in the State.

While fuel economy standards will push manufacturers to offer more ZEVs, efforts to incentivize purchases of these vehicles and ensure consumers can plug in will help to more rapidly increase consumer adoption. Maryland is currently working on developing a State Action Plan for the upcoming fiscal year, with goals that include:

- Implement education and outreach to create general EV awareness beyond early adopters.
- Implement several WorkPlace Charging events throughout the State.
- Work with auto dealers to successfully address concerns they may have towards marketing and selling plug-in vehicles.
- Conduct outreach to both commercial and residential property owners.
- Extend and enhance incentives for plug-in vehicles and EVSE, which are due to sunset in 2017.
- Investigate options for lowering the higher initial purchase cost of plug-in vehicles to consumers.

Addressing the Diesel Legacy Fleet. Heavy-duty diesel vehicles (HDDVs) play an important role in Maryland's economy, but also are a significant source of NOx, $PM_{2.5}$, and GHG emissions; and as emissions from light-duty vehicles decline, HDDVs make up an increasingly large share of motor vehicle emissions. Older diesel vehicles emit 2 to 3 times as much NOx as post-2010 vehicles, and

Heavy-duty vehicles make up a disproportionately large share of on-road GHG emissions, compared to their mileage on the road, and that share is growing.



Source: MDOT, Maryland 2015 Greenhouse Gas Reduction Act Plan.

generally twice as much $PM_{2.5}$ as 2007 vehicles. Maryland can advance programs to address HDDVs from the legacy fleet, including vehicle replacements and retrofits, as well as efforts to reduce heavy-duty vehicle engine idling (discussed further below).

Port-Related Initiatives. The Port of Baltimore is an economic engine for the state, and Maryland is working to support its growth while reducing emissions. The Dray Truck Replacement Program is an example of a program to address the diesel legacy fleet by replacing older dray trucks – large diesel trucks used to haul freight from port facilities to local distribution points – at the Port of Baltimore with newer, cleaner trucks that meet or exceed MY 2010 EPA engine standards. To date, the Program has replaced approximately 130 dray trucks since the launch of the program, which is funded by federal and state grants and with a 50 percent match by truckers.[21] Additionally, through the Clean Diesel Program, the Maryland Port Authority (MPA) retrofit, repowered, or replaced a total of 79 port-related vehicles and pieces of equipment.

A Cleaner State Fleet / Multi-Modal Emissions Initiatives. MDOT is retrofitting and replacing aging fleet vehicles to reduce GHG emissions and improve air quality:

- **Transit** – MTA is replacing older diesel buses with hybrid or clean diesel vehicles, and is purchasing diesel MARC Train locomotives that meet stringent new EPA requirements for all types of pollutants.
- **Freight Rail** – Maryland is also looking to reduce emissions from rail freight shipments by reducing the footprint of goods movement through the state and by implementing diesel technology retrofits to comply with EPA regulations.[22] Moreover, Maryland is reducing the emissions impact of freight rail through installing auxiliary power units (APUs) on diesel locomotives to reduce the need for long idling periods.
- **Airports** – The Maryland Aviation Administration (MAA) reduces pollutants emitted by BWI Airport's ground support vehicle fleet through the implementation of alternative fuels and other strategies that reduce petroleum consumption. In fact, BWI Airport has used compressed natural gas (CNG) vehicles since the 1990s, and it has a CNG fueling station on-site. BWI also has 20 alternative fuel and bi-fuel vehicles in the state's airport maintenance fleet, and MAA now uses only CNG buses as shuttles for BWI's new Consolidated Rental Car Facility.
- **Construction and Maintenance Equipment** - SHA is retrofitting dump trucks used for maintenance activities with special filters designed to reduce diesel fuel emissions.

Additionally, Maryland has also instituted a requirement that at least 50% of state fleet vehicles blend a minimum of 5% biodiesel (or other biofuel approved by EPA) into their petroleum, with the exception of any vehicles where the manufacturer's engine warranty would be voided from such fuel use.

[21] Maryland Port Authority, 2014 Dray Truck Replacement Program. Available at: http://portofbaltimoredraytruckreplacementprogram.info/2010-epa-dtrp. Also, EPA, Funding for Projects to Improve Air Quality at Ports. Available at: http://www2.epa.gov/ports-initiative/funding-projects-improve-air-quality-ports#awarded2014. Also, MDE.

[22] Maryland Department of Transportation, Maryland Statewide Freight Plan. Available at: http://www.mdot.maryland.gov/Office_of_Planning_and_Capital_Programming/Freight/Documents/Freight_Plan_Final.pdf

Increasing Travel Choices - *Supporting livable, economically vibrant communities by facilitating use of transit, bicycling, and walking.*

Maryland is working to create economically vibrant communities and business locations where it is easy to walk, bike, and use public transit.

Transit-Oriented Development and Coordinated Land Use Planning. Transit-oriented development (TOD) involves development around transit stations to create communities where people live, work, and shop all in walking distance to transit. Increasingly, businesses are recognizing the value of being located in areas with access to transit and a range of travel options to improve access for employees and draw customers. Moreover, the benefits of transit-oriented development go beyond simply getting more people onto transit. Transit-oriented communities that contain mixed use development encourage more bicycle and pedestrian trips, shorten vehicle trip lengths, and enable people to own fewer vehicles – all of which contribute to reduced fuel consumption and emissions.

> Employers in urbanized areas increasingly want to be located in mixed use areas near transit to attract workers.

Progress continues to be made across the state's 16 designated TOD locations, with multiple sites undergoing active development. Maryland is also making targeted transportation infrastructure investments to support critical state and regional economic development needs, including the revitalization of designated Sustainable Community Areas.

Transit Improvements. Commuting by public transportation, rather than driving alone, allows an individual to reduce his or her annual CO_2 emissions by an estimated 4,800 pounds per year. Maryland has committed significant funding for new transit services and initiatives to increase transit ridership, including:

- The BaltimoreLink project, a $135 million investment to streamline existing bus and rail modes in the Baltimore area into a unified, interconnected transit system to improve access to jobs and the broader regional transportation network – The project will provide access to 130,000 more jobs than are accessible via the current network, and increase the service area by 18 square miles which will increase the number of people with access to transit by 30,000.[23]
- The Purple Line, a 16-mile light rail line that will have 21 stations between Bethesda in Montgomery County and New Carrollton in Prince George's County, and will connect to WMATA's Metrorail, MARC, Amtrak, and local bus services.

[23] Maryland Transit Administration, What is Baltimore Link? Available at: http://mta.maryland.gov/baltimorelink.

- High-capacity bus transit services in the 19-mile long US 301/MD 5 corridor from White Plains in Charles County to the Branch Avenue Metrorail Station in Prince George's County; also high-frequency bus rapid transit in the US 29, MD 355, and MD 586 corridors in Montgomery Counties.
- New transit centers to facilitate safe and convenient transfers between multiple transit providers and modes, as well as new park and ride lots to promote use of commuter bus services.
- Enhancements to MARC commuter rail stations.
- Planning for a high-speed Maglev rail corridor between Baltimore and Washington, DC, which would allow for a 15-minute train trip between the two cities, and could generate significant economic benefits by greatly improving accessibility.

Using public transportation can reduce personal transportation costs – freeing up income for spending on recreation, services, or goods that can support the local economy. An individual in a two-person household can save $9,621 annually ($802 monthly) by switching to public transportation to commute to work, which would allow the household to live with one less car.

Source: American Public Transportation Association, Transit Savings Report, October 2015.

Enhancing the Bicycle and Pedestrian Environment. Bicycling and walking are clean, nonpolluting forms of transportation and also provide opportunities for physical activity. Improving infrastructure for bicycles and pedestrians enhances safety, supports active business districts, and enhances communities and recreational opportunities. Improved bicycling options can also play an important role in supporting transit ridership by increasing access to transit stations from nearby homes, jobs, and other destinations. Maryland is supporting these enhancements through:

- Implementation of Maryland's Bicycle and Pedestrian Master Plan to bring to fruition a 20-year vision to improve and support cycling and walking infrastructure in the state.
- Implementing SHA's Complete Streets Policy, requiring that all SHA staff and partners consider and incorporate complete streets criteria for all modes and types of transportation when developing or redeveloping the transportation system.
- Implementing SHA's new bicycle design guidelines that require all projects, including resurfacing projects, to include bicycle lanes, or to demonstrate that bicycle accommodations are provided to the greatest extent possible.
- Identifying and eliminating short gaps in existing sidewalk and trail systems.
- Adding bike racks at MARC and light rail stations, as well as bike share facilities at targeted stations.

Enhancing Travel Efficiency – *Optimizing transportation system performance through enhanced traveler information, systems operations, managing travel demand, and reducing idling*

Traffic congestion results in delays for travelers and freight deliveries. Efforts to manage travel demand and optimize transportation system performance support economic growth while yielding time and cost savings for travelers, reduced air pollution, and reduced GHG emissions. Travelers increasingly expect up-to-date, reliable real-time information, and are seeking the most convenient ways to get around –whether by driving, sharing rides, biking, walking, or taking transit. As technology has advanced, real-time data on travel conditions are enabling more dynamic ways for Maryland transportation agencies to manage transportation systems and communicate with the traveling public. Freight efficiency improvements can also help support Maryland's economic competitiveness. In addition, although new vehicles standards have drastically reduced vehicle emissions rates, there are time lags before these standards reach their full effect, due to the pace of vehicle turnover. Reducing vehicle idling is a way to yield near-term emissions reductions while saving money on fuel. Maryland is advancing these strategies through:

Making Travel Times More Predictable and Reliable. Applying technology to support smart travel decisions and optimize system operations, these strategies improve the dependability and consistency of travel times:

> Nationally, it is estimated that over half of traffic congestion experienced by drivers is due to traffic incidents, weather conditions, work zones, and poor traffic signal timing. Strategies to improve transportation system operations not only save time stuck in traffic, they enhance quality of life, support freight efficiency, and reduce motor vehicle emissions.
>
> *Source: Federal Highway Administration.*

- Upgrading traffic signal systems statewide with real-time communication to maximize operations efficiency.
- Converting toll plazas to electronic tolls and investigating time of day pricing on tolled facilities to encourage shifts to off-peak periods.
- Operating Coordinated Highways Action Response Team (CHART) and 511 services to provide local traveler information and severe weather information.
- Focusing on transportation system management and operations strategies, including incident management, road weather management, work zone management, and others to improve reliability.
- Exploring Integrated Corridor Management to optimize performance along major corridors and utilize capacity on parallel routes, and evaluating managed lanes (such as high-occupancy vehicle or high-occupancy toll lanes), and related strategies for future transportation investment, as appropriate.

Supporting Ridesharing, Telecommuting, and Other Options to Reduce Vehicle Commuting. Managing travel demand offers potential to save travelers time and money. Through investments in statewide and regional commuter assistance programs, including Commuter Choice Maryland and Commuter Connections in the Maryland suburbs of the Washington, DC area, MDOT promotes

teleworking, ridesharing, transit use, flexible work hours, and other options to reduce single occupancy vehicle trips.

Enhancing Freight Efficiency and Intermodal Connections. Maryland is working to improve freight intermodal connections and increase options for increased freight rail capacity. The 2015 Strategic Goods Movement Plan addresses enhancements to the goods movement around the state – an essential component of Maryland's economy. Some of the plan's goals also support the broader environmental goals for the transportation network. Strategies such as improving rail infrastructure and better addressing the impacts of freight on traffic congestion (e.g., truck routing, delivery operations, reducing incidents, etc.), also result in reduced emissions and fuel consumption.[24]

Reducing Vehicle Idling. Reducing idling from the in-use vehicle fleet is an integral part of Maryland's strategy to achieve near-term emissions reductions. Maryland is currently reducing mobile source idling emissions through its state anti-idling law, which stipulates that motor vehicles in the state may not idle their engine more than five consecutive minutes when a vehicle is not in motion. In addition to this policy, Maryland developed a "Don't Idle" education program in the Washington D.C. and Baltimore metropolitan areas designed to increase owners and operators knowledge of the benefits of reduced idling. Expansion to the education and outreach may include:

- Increased public information: Strategies to increase awareness include signage as a reminder of anti-idling restrictions in common idling locations, pamphlets and posters, web sites, and social media to reach different segments of the population.
- School initiatives: A particularly vulnerable group of stakeholders in regards to pollution from unnecessary idling are school children. Education to inform students and their parents can help to reduce idling and prompt increased enforcement of reduced idling by parents and school buses.
- Truck stop initiatives: Recognizing the high emissions rates of heavy-duty vehicles, outreach can be targeted to truck drivers at locations such as rest stops to achieve the maximum affect.
- On-line courses: On-line training can be particularly useful to help fleet owners and operators understand the various exemptions and behaviors allowed in restrictions found in a specific jurisdiction.

More Efficient Driving Behavior (Ecodriving). In addition to reducing idling, Maryland can encourage more fuel-efficient driving behaviors, often called "ecodriving", through outreach and education campaigns. Studies demonstrate that ecodriving, which involves smoother driving by less aggressive acceleration and deceleration, and improved vehicle maintenance, can allow drivers to reduce their fuel consumption by 2% to 4%.[25] While small in scale for an individual driver, when applied across a large segment of vehicles, ecodriving can have notable effects.

[24] Maryland Department of Transportation, 2015 Maryland Strategic Goods Movement Plan. Available here: http://www.mdot.maryland.gov/Office%20of%20Freight%20and%20Multimodalism/Strategic%20Goods%20Movement%20Plan.pdf.

[25] ICF International, "Smart Driving White Paper," prepared for Metropolitan Transportation Commission, October 2014.

Spurring Innovation – *Advancing the State as a leader in adopting clean energy technologies that create jobs while improving the environment.*

By adopting clean energy technologies, Maryland will spur job creation while reducing emissions. Maryland has made several strides in this area already, and has opportunities to significantly expand these initiatives. Strategies that may be advanced include:

Energy-Efficient Lighting. Opportunities exist for reducing the amount of energy used to light highway signs, traffic signals, and other transportation infrastructure; for instance, by replacing traffic lights and message signs from incandescent light bulbs to more efficient LEDs. Not only do LEDs run more efficiently, they last longer, thus reducing the frequency they need to be changed.

Clean Energy Production. In 2012, BWI Marshall Airport worked with Pepco Energy Services to install a 505 kW solar photovoltaic system on the top level of the Daily Garage. The system is tied directly to the airports electrical system to produce over 600,000 kilowatt hours of electricity reliably each year for the next 20 years. Additional opportunities may be available at transit stations and other properties.

Also, in 2009, the FHWA issued new guidance that allowed renewable energy facilities to be located in the highway right-of-way. Use of solar panels and wind power can generate electricity, reduce GHG emissions, and spur local jobs in the manufacture of these equipment.