Appendix D – 2011 Implementation Plan (MDOT)

Maryland Climate Action Plan

Maryland Department of Transportation
Draft 2012 Implementation Plan

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April 11, 2011

Maryland Department of Transportation

report

Maryland Climate Action Plan - MDOT Draft 2012 Implementation Plan

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Table of Contents

Table of Contents, continued

List of Tables

List of Figures

Executive Summary

In 2007 Governor Martin O'Malley signed an Executive Order establishing the Maryland Commission on Climate Change (the Commission). Sixteen state agency heads, six General Assembly members, local government officials, and representatives from the private sector and non-governmental organizations comprise the Commission. The Commission released a plan of action for addressing climate change in August 2008, and will report each year in November to the Governor and Legislature on progress in implementing the recommendations found in the Climate Action Plan (CAP) and in meeting the preliminary greenhouse gas (GHG) emission reduction goals.

On May 7, 2009, Governor Martin O'Malley signed into law the Maryland Greenhouse Gas Emissions Reduction Act of 2009 (Act) requiring Maryland to achieve a 25 percent reduction in 2006 GHG emissions by 2020. While the majority of GHG related emissions are created by power generation, the transportation sector produces approximately 32 percent of the state's GHG emissions. Achieving a significant reduction in GHG emissions from the transportation sector will be critical to supporting the requirements articulated in the Act.

The Act requires the Maryland Department of Environment (MDE) to develop a proposed Statewide GHG reduction plan by 2011, to solicit public comment on the proposed plan from interested stakeholders and the public, and to adopt a final plan by 2012. The Act also requires the State to demonstrate that the 25 percent reduction can be achieved in a way that has a positive impact on Maryland's economy, protects existing manufacturing jobs and creates significant new "green" jobs in Maryland.

By 2011 the Act requires MDE to:

- Develop a 2006 Statewide greenhouse gas emissions inventory;
- Develop a projected "business as usual" emissions inventory for 2020; and
- Develop and publish for public comment a proposed plan to achieve a 25 percent GHG emissions reduction by 2020.

The MDOT work program summarized in this document supports the ongoing effort of MDE to develop the proposed statewide GHG reduction plan. As part of the GHG reduction plan process, MDE developed agency-based GHG targets that are designed to support the overall State goal. Using key elements of the 2008 Climate Action Plan and the 2009 MDOT Implementation Status Report, MDE provided MDOT a GHG reduction target for 2020 of 6.2 mmt CO_2e in February, 2011. This document provides a summary of the MDOT work program that addresses the GHG reduction target and goals in the Act.

THE MDOT WORK PROGRAM – PAST & PRESENT

Through the Commission's work, MDOT was designated as the implementing agency for six Transportation and Land Use (TLU) mitigation and policy options, and is a primary supporting

agency on two others. The policy options (and subsequent work accomplished by MDOT) are primarily focused on reducing GHG emissions through a wide array of strategies that address infrastructure investment, travel demand management programs, transit investment, clean fuel programs, and new vehicle technology standards.

MDOT was also charged to work with the Maryland Department of Planning (MDP) on land use and location efficiency policies and programs, the Maryland Insurance Administration (MIA) to support the analysis of the Pay-as-You-Drive (PAYD) insurance in Maryland, and the Maryland Department of the Environment (MDE) to implement transportation technologies to reduce GHG emissions per mile. As part of the Phase III work program, MDP took over the responsibility for the TLU mitigation and policy option that addressed land use, and MIA took over the policy option addressing PAYD. The results of both the land use and PAYD initiatives will be presented by MIA and MDP in separate documents (they are referenced in this document in Section 3.5). Both of these policy options affect GHG emissions in the transportation sector, and as such, will be included in subsequent updates of this document.

Phase I

In January 2009, MDOT engaged in a multi-phase work plan to define specific programs, actions, and strategies to address the eight TLU mitigation and policy options. The goal of the Phase I work program focused on defining, evaluating, ranking and determining the feasibility of a series of transportation strategies and actions – consistent with the Commission's Climate Action Plan – that will assist Maryland in achieving GHG reduction targets.

MDOT created seven broad Working Groups to address each of the TLU policy options, and a Coordinating Committee to oversee the process of identifying GHG reduction strategies. The Coordinating Committee membership was designed to ensure full representation of all MDOT modal agencies and other relevant State agencies. The Working Groups provided technical guidance and included local representation though the participation of the Baltimore Metropolitan Council (BMC), the Metropolitan Washington Council of Governments (MWCOG), Montgomery County and the City of Baltimore.

In Phase I, 72 strategies were defined by the working groups and 57 were considered critical or important to reducing GHG emissions. Of the 57 strategies, 44 were capable of being implemented by 2020. A macro-level assessment of the strategies was completed as part of Phase II.

Phase II

Phase II began in July 2009 with the objective of quantifying the contribution the strategies defined during Phase I. Under the Phase II work program MDOT organized the strategies into six specific areas to account for potential GHG emission reductions. They included:

- **The proposed national vehicle standards program** to improve fuel economy and reduce greenhouse gases, which were formally proposed by USEPA and USDOT on September 15, 2009.

- **The Maryland Clean Car Program** signed into law by Governor Martin O'Malley in April 2007, which adopts California's more stringent vehicle emissions standards for cars sold in the state.
- **USEPA's proposed National Renewable Fuels Standards** program for 2010 and beyond, which requires new volume standards to be used for renewable transportation fuels.
- **Currently funded and planned transportation system investments 2006-2020**, which are defined in the Maryland 2009 - 2014 Consolidated Transportation Program (CTP), and in the Metropolitan Planning Organizations (MPOs) Transportation Improvement Programs (TIPs) and Long-Range Plans (LRPs) through 2020.
- **Currently funded and planned Transportation Emissions Reduction Measures (TERMs)**, which are defined in the 2009-2014 CTP and in the MPO TIPs and LRPs, including off-highway projects as defined by MAA and MPA.
- **Unfunded TLU strategies** defined by the Phase I Working Groups and Coordinating Committee.

Phase III

Phase III began in December 2010. Phase III provides an update of work completed in previous phases and provides MDE with data and information to support the development of the proposed Statewide GHG reduction plan. The purpose of the Phase III work program is to update the contribution of the transportation sector related strategies that support the Act and to provide the data and information to MDE for incorporation into the proposed 2011 plan submittal.

The major work elements of the Phase III process include:

- Revise the on-road mobile 2006 inventory and 2020 business-as-usual (BAU) forecast of statewide GHG emissions based on EPAs MOVES model.
- Update the GHG emission reduction benefits and costs of Maryland funded transportation plans and programs through 2020, existing and proposed TERMs, and new State and Federal fuel and vehicle technology programs and standards.
- Review and refine the definition, description, costs and GHG emissions benefits of the unfunded transportation GHG reduction strategies through 2020.
- Consult with policy option partner agencies (including MDP for TLU-2, MIA for TLU-6, and MDE for TLU-10) throughout development of the *2011 Implementation Status Report*.
- Address the 2009 GHG Reduction Act legislative requirements in preparation of the *2011 Implementation Status Report*.

RESULTS OF THE MDOT WORK PROGRAM

Phase III of the MDOT work program confirmed the status of the transportation sector related strategies along with updating the GHG emissions estimates associated with the strategies. Several key findings have been identified as part of the Phase III work program.

- MDOT has adopted programs and strategies that achieve **85 percent** or **5.30 mmt CO_2e** of the MDE assigned 2020 GHG emission reduction target.
- GHG beneficial projects adopted in the 2011-2016 CTP and MPO plans and programs total a **$13.2 billion** capital investment through 2020 that represents **50 percent** of the current capital programs.
- Other transportation sector related GHG reduction strategies focusing on clean fuels and improved state and federal fuel economy standards will result in **6.42 mmt CO_2e** reductions in on-road mobile source emissions by 2020.
- In total, transportation sector GHG related emissions could be reduced by a total of **11.72 mmt CO_2e** in 2020, with a total transportation infrastructure capital investment $13.2 billion through 2020.
- Using the 25 percent reduction from 2006 emissions as a benchmark to measure progress of the transportation sector, the **11.72 mmt CO2e** reduction by 2020 achieves **68 percent** of the Act goal.
- If additional transportation funding becomes available, MDOT identified a set of strategies that could reduce GHG up to **3.14 mmt CO_2e** at a cost ranging from **$2.9 - $7.1 billion** (cost range is based on the potential level of implementation).
- Based on the 25 percent reduction from 2006 emissions, at the highest level of strategy implementation, including unfunded transportation sector strategies, the transportation sector could achieve a **14.86 mmt CO_2e** reduction by 2020, or **87 percent** of the Act goal.

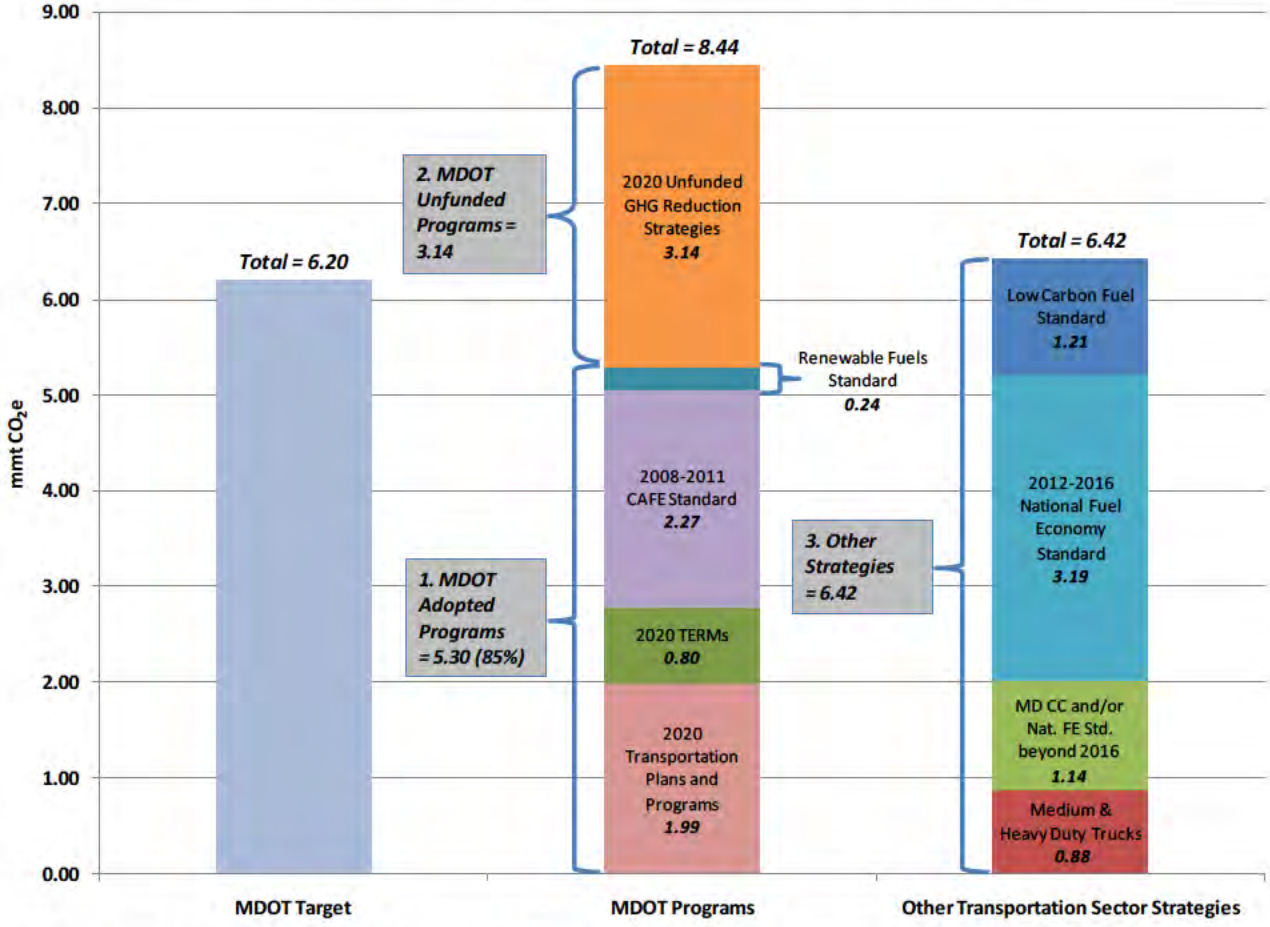
Figure ES.1 provides a summary of the GHG emissions for all programs analyzed as part of this effort. MDOT has identified and adopted programs and strategies that achieve 85 percent or 5.30 mmt CO_2e of the 6.2 mmt CO_2e 2020 target emission reduction target established by MDE. This includes all transportation infrastructure plans and programs currently defined in the adopted *MDOT 2011 - 2016 Consolidated Transportation Program (CTP)*, and all adopted metropolitan planning organization long range plans and programs. In total, this represents a $13.2 billion capital investment in the transportation system statewide. Major projects include the MARC growth and investment plan, the MTA light rail "Red Line" in Baltimore, and the light rail "Purple Line" in the Washington D.C. suburbs.

Figure ES.1 also includes a summary of "unfunded" strategies that could reduce transportation related GHG emissions by another 3.14 mmt CO_2e by 2020. These strategies were identified during Phase I of this work program and could be implemented by 2020 if funding was available. Based on the final design of these strategies, the capital cost could range from $2.9 billion to $7.1 billion. Major projects types in the unfunded program include an expansion of public transit statewide, expanded statewide travel demand management programs, and a targeted congestion pricing program.

Taken together, MDOT has identified plans, programs and strategies that could reduce transportation related emissions by 8.44 mmt CO_2e by 2020. The capital cost to implement this package could range from $16.1 billion to $20.3 billion, with $13.2 billion already fully committed.

MDOT has also accounted for other transportation sector related GHG reduction strategies (Figure ES.1) that focus on cleaner fuels and improved fuel economy standards. Implementing these state and federal programs will result in another 6.42 mmt CO_2e reduction by 2020 with little or no direct cost to Maryland.

Figure ES.1 MDOT Greenhouse Gas Emissions Summary

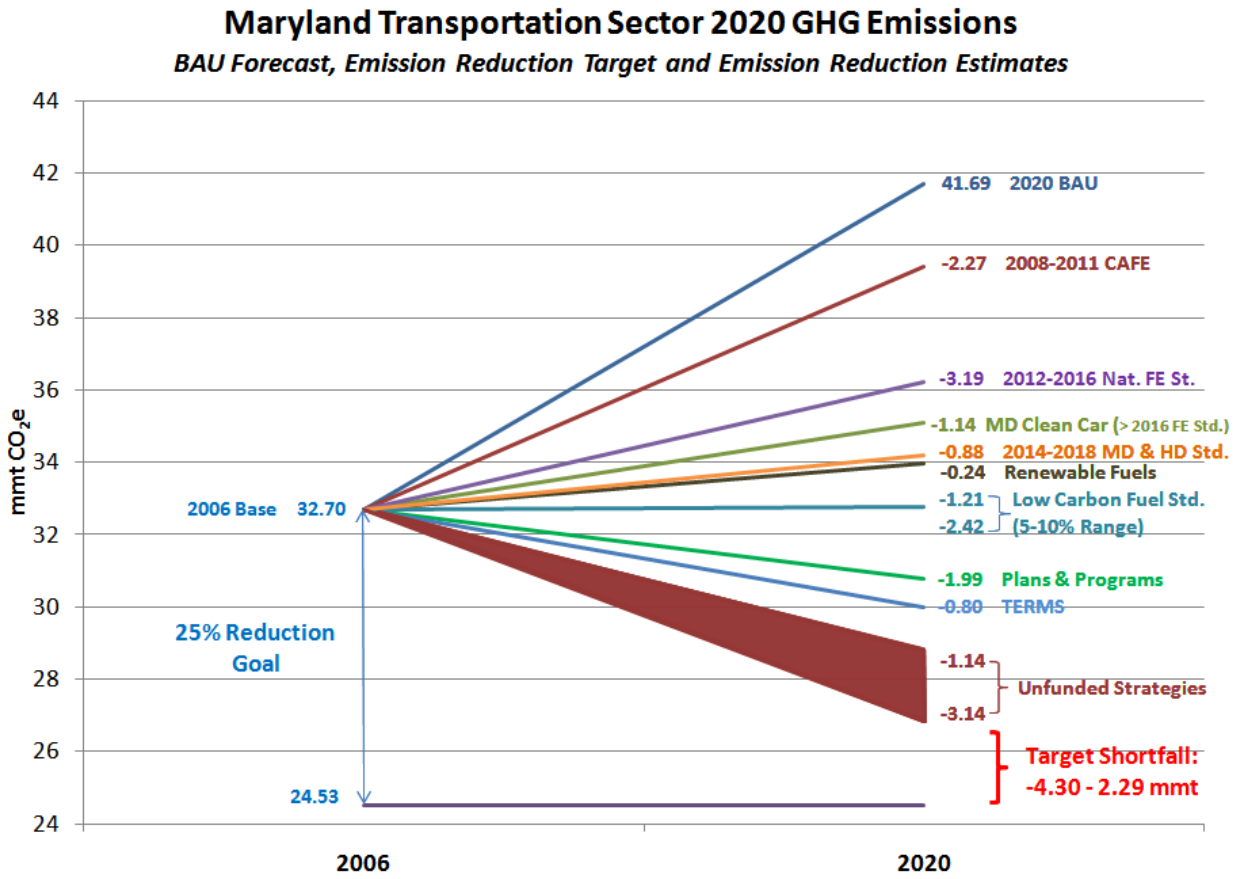


Based on the Phase III work program results, transportation sector GHG related emissions could be reduced by a total of 14.86 mmt CO_2e by 2020. This represents a significant reduction in GHG emissions statewide with an equally significant overall investment ranging from $16.1 billion to $20.3 billion.

Prior to receiving the MDE GHG target of 6.2 mmt CO_2e, MDOT used a benchmark for achieving a 25 percent reduction in 2006 emissions as a way to evaluate progress toward achieving the goal of the Act. Figure ES.2 illustrates the anticipated 2020 transportation sector

reductions within the framework of a statewide reduction goal of 25 percent below 2006 levels by 2020. To achieve a 25 percent GHG emissions reduction in 2006 by 2020 from the transportation sector, a 17.16 mmt CO_2e reduction in emissions is required. By implementing all strategies and programs included in Figure ES.2, 2020 transportation sector emission reductions could reach as much as 87 percent (14.86 mmt) of the 25 percent GHG reduction goal for 2020. The figure further illustrates a 2.29 to 4.30 mmt CO_2e target shortfall for the transportation sector.

Figure ES.2 Maryland 2020 Transportation GHG Emissions Forecast and Reductions



While these programs provide the State significant reductions in transportation related GHG emissions, MDOT and the modal administrations continue to actively pursue and implement energy conservation strategies into the daily operating activities of each agency. Included in this report are several samples of energy conservation strategies that have been implemented by MDOT and the modal administrations to gain greater energy independence, efficiency, and focus on the application of cutting edge "green" technology.

MDOT is committed to supporting and consulting with MDE throughout the process in developing the Statewide GHG Reduction Plan. MDOT has been mindful to focus on strategies that will achieve GHG reductions and will positively impact Maryland's economy, and protect existing manufacturing jobs while creating new "green" job opportunities in Maryland. MDOT also affirms that the strategies included in this plan document will not negatively impact rural

communities and will continue to support Maryland's ability to attract, expand and retain aviation services.

1.0 The MDOT Climate Action Plan Implementation Process

1.1 BACKGROUND

In response to the threat and growing concern with climate change, the Maryland Commission on Climate Change (the Commission) was established in April 2007. The Commission includes 16 Maryland agency heads, six General Assembly members, local government officials, and representatives from the private sector and non-governmental organizations. The Commission released a plan of action for addressing climate change in August 2008. Each year in November, the Commission will report to the Governor and Legislature on progress in implementing the Climate Action Plan (CAP) and in meeting the preliminary GHG reduction goals set in it.

In May 2009, Governor Martin O'Malley signed The Maryland Greenhouse Gas Emissions Reduction Act of 2009. The Act establishes a requirement that Maryland achieve a 25 percent reduction of 2006 emissions by 2020. Since the transportation sector contributes 32 percent of the state's GHG emissions, achieving a significant reduction in transportation GHG emissions will be critical to supporting the requirements articulated in the Greenhouse Gas Emissions Reduction Act.

Through the Commission's work, MDOT has been designated as the implementing agency for six Transportation and Land Use (TLU) mitigation and policy options, and is a primary supporting agency on two others. MDOT's policy options are primarily focused on reducing GHGs through vehicle miles of travel (VMT) reductions. MDOT is also charged to work with the Maryland Department of Planning (MDP) on statewide land use and location efficiency strategies, Maryland Insurance Administration (MIA) on expanding deployment of Pay-As-You-Drive insurance, and Maryland Department of the Environment (MDE) to implement transportation technologies to reduce GHG emissions per mile.

1.2 PROCESS

To develop an implementation plan for the policy options developed by the Commission, MDOT established a fully collaborative process comprised of seven Working Groups focused on each TLU policy option, and a Coordinating Committee to provide guidance and oversight for the entire process. Working Group meetings held between February and May 2009 defined a total of 72 strategies (Phase I). The Coordinating Committee reviewed and adjusted the strategy definitions, leading to a list of 44 strategies prioritized for analysis in Phase II.

The Phase II work program conducted a detailed GHG emissions analysis and supported MDOT in the continued refinement of the MDOT Climate Action Plan Implementation activity. The objective of the Phase II work program was to understand the contribution that the transportation sector can make to meeting the 2020 target included in The Maryland

Greenhouse Gas Emissions Reduction Act of 2009 while supporting long term (beyond 2020) GHG reduction goals.

The final Phase II MDOT Draft Implementation Status Report and Appendices were submitted to MDE in November 2009 and are currently posted as part of the November 2009 Report to the Maryland Commission on Climate Change on MDEs website (www.mde.state.md.us).

This document summarizes the Phase III process which updates the *Maryland Climate Action Plan - MDOT 2009 Implementation Status Report* and provides the materials supporting MDE's completion of the *2012 Draft Implementation Plan* as required by the Maryland Greenhouse Gas Emissions Reduction Act of 2009 (Act).

1.3 REPORT

The remainder of the report is organized into the following major sections.

Section 2 – 2006 Baseline and 2020 Business-as-Usual (BAU) Forecast Greenhouse Gas Emissions Inventory Update

- Establishes an updated transportation sector 2006 baseline GHG emissions inventory and a 2020 BAU forecast of GHG emissions based on EPAs MOVES model.

Section 3 – 2020 Transportation Sector Detailed Assessment

- Quantifies GHG reduction strategies associated with existing and proposed vehicle technology and fuel standards.
- Quantifies by transportation GHG reduction policy option the GHG reductions and costs from the MDOT Consolidated Transportation Program (CTP), Metropolitan Planning Organizations (MPOs) Transportation Improvement Programs (TIPs) and Long-Range Plans (LRPs), and Transportation Emission Reduction Measures (TERMs) through 2020.
- Refines the unfunded transportation GHG reduction strategy definitions and provides forecasts of GHG emissions reductions and capital costs through 2020.

Section 4 – 2020 Transportation Sector Summary Results

- Summarizes MDOTs progress in meeting the GHG reduction target through MDOT adopted programs and other transportation sector programs.
- Summarizes overall progress in the transportation sector in reducing GHG emissions through 2020.

Appendices

A. 2006 Baseline and 2020 BAU Emissions Inventory Documentation

B. CTP, MPO TIP/LRP Project Listings by Policy Option

C. TERM Analysis Assumptions, Costs, and Results

D. Unfunded GHG Reduction Strategy Emission Reductions and Cost Assumptions

E. MDOT Summary Forms

2.0 2006 Baseline and 2020 BAU Forecast Greenhouse Gas Emissions Inventory Update

The greenhouse gas (GHG) inventory for Maryland's transportation sector includes the 2006 baseline and the 2020 business-as-usual (BAU) forecast year. The inventory was calculated by estimating emissions of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) then converting those emissions to carbon dioxide equivalents that are measured in the units of million metric tons (mmt CO_2e). Carbon dioxide represents about 97 percent of the transportation sector's GHG emissions. The inventory includes both on-road and off-road sources as defined by the Energy Information Administration (EIA).

The on-road portion of the inventory was developed using EPA's new emissions model MOVES (Motor Vehicle Emissions Simulator). The inventory results represent an update of previous analyses conducted by the Center for Climate Strategies (CCS) for the Climate Action Plan (CAP) in 2008 and MDOT's Implementation Status Report, dated November 2009. Those inventory efforts were performed with EPA's MOBILE6.2 emission factor model. The MOVES model provides a more robust estimate of greenhouse gas emissions as compared to the simplified approaches used in MOBILE6.2. In MOVES, greenhouse gases are calculated from vehicle energy consumption rates and vary by vehicle operating characteristics including speed. In addition, the MOVES model includes the affects of current legislation on future vehicle fuel economy standards. The off-road portion of the inventory uses emission rates and data from EPA's State Greenhouse Gas Inventory Tool (SIT) and remains unchanged from the November 2009 MDOT Implementation Status Report.

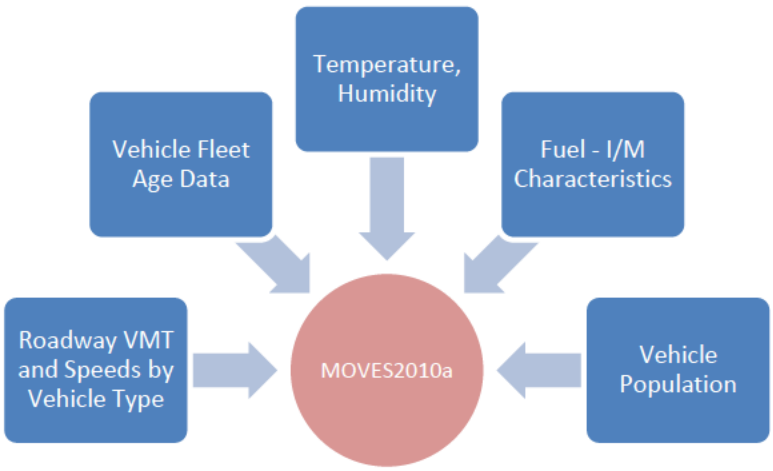
The inventory includes the revised 2006 base year and 2020 BAU forecast based on traffic count data (VMT-based) from the Maryland State Highway Administration (SHA). A more detailed description of the 2006 baseline and 2020 BAU forecast GHG emissions inventory update process can be found in Appendix A.

2.1 On-Road Analysis Process

The data, tools and methodologies employed to conduct the on-road vehicle GHG emissions inventory were developed in close consultation with MDE and are consistent with the *Technical Guidance on the Use of MOVES2010 for Emission Inventory Preparation in State Implementation Plans and Transportation Conformity, EPA-420-B-10-023, April 2010.* EPA's MOVES model was officially released on March 2, 2010 and was followed with a revised version (MOVES2010a) in August 2010. The MOVES2010a version incorporates new car and light truck greenhouse gas emissions standards for model years 2012-2016 and updates effects of corporate average fuel economy (CAFE) standards for model years 2008-2011. The MOVES2010a model estimates the reductions in greenhouse gases associated with those standards in future calendar years.

As illustrated in Figure 2.1, the MOVES2010a model has been integrated with local traffic, vehicle fleet, environmental, fuel, and control strategy data to estimate statewide emissions.

Figure 2.1 Emission Calculation Data Process



The modeling assumptions and data sources were developed in coordination with MDE and are consistent with other SIP-related inventory efforts. The process represents a "bottom-up" approach to estimating statewide GHG emissions based on available roadway and traffic data. A "bottom-up" approach provides several advantages over simplified "top-down" calculations using statewide fuel consumption. These include:

- Addresses potential issues related to the location of purchased fuel. Vehicle trips with trip ends outside of the state (e.g. including "thru" traffic) create complications in estimating GHG emissions. For example, commuters living in Maryland may purchase fuel there but may spend much of their traveling in Washington D.C. The opposite case may include commuters from Pennsylvania working in Maryland. With a "bottom-up" approach, emissions are calculated for all vehicles using the transportation system.
- Allows for a more robust forecasting process based on historic trends of VMT or regional population and employment forecasts and their relationship to future travel. For example, traffic data can be forecasted using growth assumptions determined by the MPO through their analytic (travel model) and interagency consultation processes.

GHG emission values are reported as annual numbers for the 2006 baseline and 2020 BAU scenarios. The annual values were calculated based on 12 monthly MOVES runs. Each monthly run used traffic volumes, speeds, temperatures, and fuel values specific to an average day in each month.

For the 2006 and 2020 BAU emissions inventory, the traffic data was based on roadway segment data obtained from the Maryland State Highway Administration (SHA). This data does not contain information on congested speeds and the hourly detail needed by MOVES. As a result, post-processing software (PPSUITE) was used to calculate hourly congested speeds for each roadway link, apply vehicle type fractions, aggregate VMT and vehicle hours traveled (VHT), and prepare MOVES traffic-related input files. The PPSUITE software and process

methodologies are consistent with that used for regional inventories and transportation conformity analyses throughout Maryland.

Other key inputs including vehicle population, temperatures, fuel characteristics, and vehicle age were obtained from and/or prepared in close coordination with MDE staff. The following sections summarize the key input data assumptions used for the inventory runs.

Traffic Volume and VMT Forecasts

The traffic volumes and VMT within the SHA traffic database were forecast to estimate future year emissions. Several alternatives are available to determine forecast growth rates, ranging from historical VMT trends to the use of MPO-based travel models that include forecast demographics for distinct areas in each county.

For the 2020 BAU scenario, the forecasts were determined using assumptions from the original Maryland CAP, which was based on historic trends of 1990-2006 highway performance monitoring system (HPMS) VMT growth. Table 2.1 summarizes the growth rates by county. The average statewide annualized growth rate was assumed to be 1.8 percent.

Table 2.1 Maryland VMT Annual Growth Rates for 2020 BAU

County	Annualized 2006-2020 Growth
Allegany	1.3%
Anne Arundel	2.0%
Baltimore	1.3%
Calvert	2.5%
Caroline	1.3%
Carroll	1.9%
Cecil	2.4%
Charles	2.2%
Dorchester	0.9%
Frederick	2.5%
Garrett	1.4%
Harford	1.8%
Howard	3.2%
Kent	0.5%
Montgomery	1.5%
Prince George's	1.7%
Queen Anne's	2.2%
Saint Mary's	2.0%
Somerset	0.9%
Talbot	1.8%
Washington	2.1%
Wicomico	1.5%
Worcester	1.3%
Baltimore City	0.8%
Statewide	***1.8%***

The analysis process (e.g. using PPSUITE post processor) re-calculates roadway speeds based on the forecast volumes. As a result, future year emissions are sensitive to the impact of increasing traffic growth on regional congestion. The VMT summary is provided in Table 2.2.

Table 2.2 Maryland 2006 and 2020 BAU VMT Forecast

Annual VMT (millions)	2006 Baseline	2020 BAU Forecast
Light Duty	51,212	63,878
Medium/Heavy Duty Truck & Bus	5,406	6,775
TOTAL VMT (in Millions)	**56,618**	**70,653**

2.2 OFF-ROAD ANALYSIS PROCESS

Off-road GHG emission analyses rely on the emission factors and methodologies provided in EPA's State Inventory Tool (SIT). The tool estimates off-road CO_2, CH_4 and N_2O emissions. The SIT methodologies for estimating CO_2 follow a simple, top-down approach using state fuel consumption data. Emission factors based on fuel type are applied directly to the fuel consumption data to produce CO_2 estimates. This includes fuel consumption data for transportation fuel types including aviation gasoline, distillate fuel, jet fuel, motor gasoline, residual fuel and natural gas. Off-road CH_4 and N_2O emissions were estimated by the SIT tool based on fuel consumption data, emission factors, energy contents for aircraft and density factors for rail and marine vehicles. Inputs to the SIT tool for the 2006 baseline inventory are based on the United States Department of Energy (US DOE) Energy Information Administration (EIA) State Energy Data (SED).

Forecasting Assumptions

Historical information from EIA's SED was used to project off-road source emissions to future years. Consistent with the Maryland CAP off-road methodology, the SIT model was used to estimate the GHG emissions. Historical fuel consumption was updated to include 2007 data that was not available when the CAP was developed. Based on the transportation emissions source, fuel consumption projections used the historical fuel consumption data to forecast the growth. For aviation, specific forecasts were obtained from the Federal Aviation Administration's (FAA) APO terminal area forecasts. The growth rates selected for each off-road component were conservative, reasonable and consistent with historic trends. Table 2.3 summarizes the off-road inventory growth rate data sources.

Table 2.3 Off-Road Transportation Source Growth Rate Assumptions

Fuel Type	Category	Data Used for Forecasting
Motor Gasoline	Marine	1990-2007 Data
Distillate Fuel	Vessel Bunkering	Same as 2007 Data
	Military	Same as 2007 Data
	Railroad	Half the growth as 2000-2007
Natural Gas	Other (Total Minus Vehicle Fuel Consumption)	1990-2007 Data
Residual Fuel	Vessel Bunkering	2000-2007 Data
	Military	Same as 2007 Data
	Other (Total Minus Military & Other)	2000-2007 Data
Aviation Fuel	Aviation	FAA APO Terminal Forecasts

2.3 TRANSPORTATION SECTOR INVENTORY RESULTS

The 2006 baseline and 2020 BAU transportation sector GHG emissions forecast are summarized in Table 2.4. The on-road analyses include data, methods, and procedures approved by MDE during the consultation process of developing the inventory methodology. Off-road analyses utilized the SIT tool and updated information obtained from EIA.

Table 2.4 Maryland 2006 and 2020 Transportation Sector GHG Emissions

GHG Emissions (mmt CO_2e)	2006 Baseline	2020 BAU Forecast
Light Duty Vehicles	*24.22*	*31.48*
Medium/Heavy Duty Trucks & Buses	*5.45*	*7.11*
Total On-Road	29.67	38.59
Off-Road	3.03	3.10
TOTAL GHG Emissions	**32.70**	**41.69**

3.0 2020 Transportation Sector Detailed Assessment

The 2020 transportation sector assessment identifies the GHG emissions reduction impact of anticipated vehicle technology improvements in fuel economy or GHG emissions per mile, renewable fuel standards and low carbon fuels, and implemented and adopted transportation plans, programs and TERMs in Maryland through 2020. It also provides an assessment of the overall GHG emissions reduction benefit resulting from unfunded transportation GHG reduction strategies defined by the Working Groups and Coordinating Committee in Phase I. Both funded and unfunded transportation GHG reduction strategies focus on transportation investments, technology and other related programs that lead to a reduction in VMT, a reduction in fuel consumption, and improved travel efficiency.

The goals and objectives in MDOT's Maryland Transportation Plan (MTP) and the associated projects, programs, and TERMs identified in the CTP, MPO TIPs and LRPs lead to significant GHG reductions from the transportation sector by 2020. The MTP and its goals of quality of service, safety and security, system preservation and performance, environmental stewardship, and connectivity for daily life, help guide MDOT in a direction that is consistent with the objectives of the Climate Action Plan and the Maryland Greenhouse Gas Reduction Act of 2009.

Section 3 describes the estimated GHG emission reductions and associated costs of the following subsections.

3.1 Vehicle Technology Improvements

3.2 Transportation Fuels

3.3 Implemented and Adopted Transportation Plans and Programs

3.4 Unfunded Transportation GHG Reduction Strategies

3.5 Other Transportation GHG Reduction Initiatives

These subsections each provide an overview, strategy definitions, GHG reduction approach, and a summary of results that include GHG emission reductions and estimated capital costs. All related information for projects included in the MDOT 2011 - 2016 CTP, adopted MPO plans, and TERMs is presented in Appendix B and C. The detailed GHG emission reductions, cost assumptions, implementation tracking process, and co-benefits for the unfunded transportation sector strategies are presented in Appendix D.

3.1 VEHICLE TECHNOLOGY IMPROVEMENTS

Overview

Vehicle fuel economy standards are a key consideration in estimating future GHG emissions. By 2020, a number of state and federal initiatives that affect fuel economy standards will be in-place and significantly contribute to the 2020 transportation sector GHG reductions. The MOVES2010a emissions model was used to estimate the GHG emissions impact for each of the programs. The technology advances are designed to improve vehicle fuel economy and reduce average GHG emissions per mile. The standards are phased-in for each vehicle model year starting with model year 2008. The technology improvements include:

- The existing CAFE standards for vehicle model years 2008 to 2011,
- The Obama administration's National Program for model years 2012 to 2016 as finalized in the May 7, 2010 joint rulemaking by US DOT and EPA, and
- The Maryland Clean Car Program that incorporates the California emission standards beginning with model year 2011.

Assuming federal approval, there are two federal proposals for additional vehicle standards that would affect fuel economy and potential greenhouse gas emissions prior to 2020. These include:

- The national program covering 2017-2025 model year cars and light-duty trucks, and
- Fuel efficiency and greenhouse gas standards for 2014-2018 model year medium and heavy-duty vehicles.

The effects of the above proposed programs are included as potential greenhouse gas emissions reduction strategies for the Maryland transportation sector by 2020. The programs were analyzed in the MOVES2010a model by adjusting vehicle energy consumption rates by the proportional change in fuel economy or engine standards. Assumptions have been made on each vehicle program based on the best available information at the time of the analysis. The assumptions and modeling methodology were reviewed and approved by MDE. Legislative action or further program refinement could change or modify assumptions used to complete the GHG emission estimates.

National Fuel Economy Standards

There are two promulgated national programs in place that strengthen the fuel economy standards for light duty cars and trucks. They include:

- *CAFE Standards (Model Years 2008-2011)* – Vehicle model years through 2011 are covered under existing CAFE standards that will remain intact under the new national program.
- *National Program (Model Years 2012-2016)* – The light-duty vehicle fuel economy for model years between 2012 and 2016 are based on the May 7, 2010 Rule "*Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule" (EPA-HQ-OAR-2009-0472-11424:http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OAR-2009-0472-11424)*. Fuel economy improvements begin in 2012 until an average 250

gram/mile CO_2 standard is met in the year 2016. This equates to an average fuel economy near 35 mpg.

The above programs are included in the MOVES vehicle energy consumption rates. To analyze the GHG emissions impacts of the programs, the MOVES2010a vehicle energy consumption rates default database was adjusted by holding constant the emission rates for post-2007 model years. The difference between the default modeling runs and the adjusted emission rates scenario provide the GHG emission reductions for the CAFE and National Program fuel economy standards. The details of the adjustments to the MOVES2010a vehicle energy consumption rates table are provided in Appendix A.

Maryland Clean Car Program

The Maryland Clean Car Program implements California's low emissions vehicle standards to vehicles purchased in Maryland starting with model year 2011. By creating a consistent national fuel economy standard, the 2012-2016 National Program, which closely resembles the California program, replaces Maryland's Clean Car Program for those model years. As a result, the GHG reduction credits for the Maryland Clean Car Program, apply only to 2011 and post-2016 model year vehicles.

The Maryland Clean Car Program is not a direct input to the MOVES2010a model. Therefore, adjustments to the default vehicle energy consumption rates were needed to estimate the GHG reduction. These adjustments were based on the percentage change in fuel economy values between the programs. The fuel economy performance estimates required for model years 2011 and post-2016 were obtained by the California Air Resources Board (CARB) report, *Comparison of Greenhouse Gas Reductions for the United States and Canada Under U.S. CAFE Standards and California Air Resources Board Greenhouse Gas Regulations, dated February 25, 2008*.

Proposed National 2017-2025 Light-Duty Vehicle Standards

The US DOT, EPA and the state of California are currently working towards additional fuel economy standards for light-duty vehicles beyond the 2016 model year. It is expected that a single set of national standards will be proposed by September 2011 covering model year 2017-2025 cars and light-duty trucks. If adopted, the national standards will replace the Maryland Clean Car Program for post-2016 model year vehicles.

The energy rates for the proposed standards were developed based on EPA and DOT's National Highway Traffic Safety Administration (NHTSA) establishment of 2017 and later model year light-duty vehicle greenhouse gas emissions and CAFE standards, *Light-Duty Vehicle Greenhouse Gas Emissions Standards and Corporate Average Fuel Economy Standards (published May 7, 2010).* A range of options are being considered for new standards ranging from a 3 - 6 percent annual improvement in fuel economy from 2017 to 2025. The adjustments to the MOVES2010a vehicle energy rates were based on these percentage changes in fuel economy.

Proposed National 2014-2018 Medium and Heavy Vehicle Standards

EPA and NHTSA are proposing new standards for three categories of medium and heavy-duty vehicles: combination tractors, heavy-duty pickups and vans, and vocational vehicles. The

proposed rulemaking for these standards is *Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles (published November 30, 2010).* The categories were established to address specific challenges for manufacturers in each area. For combination tractors, the agencies are proposing engine and vehicle standards that begin in the 2014 model year and achieve up to a 20 percent reduction in carbon dioxide (CO_2) emissions and fuel consumption by the 2018 model year.

For heavy-duty pickup trucks and vans, the agencies are proposing separate gasoline and diesel truck standards, which phase in starting in the 2014 model year and achieve up to a 10 percent reduction for gasoline vehicles and a 15 percent reduction for diesel vehicles by the 2018 model year (12 and 17 percent respectively if accounting for air conditioning leakage). Lastly, for vocational vehicles, the agencies are proposing engine and vehicle standards starting in the 2014 model year that would achieve up to a 10 percent reduction in fuel consumption and CO_2 emissions by the 2018 model year.

Specific standards have not yet been proposed for this program. Based on the percent ranges provided above, analyses have been conducted by adjusting existing MOVES fuel economy assumptions to estimate the GHG reduction estimates.

Results

The GHG reductions from National Fuel Economy Standards, the Maryland Clean Car Program, the proposed National Fuel Economy Standards beyond 2016, and the proposed Medium and Heavy Duty Vehicle standards reduce projected 2020 GHG emissions by 7.47 mmt CO_2e as shown in Table 3.1.

Table 3.1 Maryland 2020 Vehicle Technology GHG Emissions Reductions

GHG Emissions Reduction by Program	Annual GHG Emission Reduction (mmt CO_2e)
CAFE Standards (2008 – 2011 MY)	2.27
National Program (2012 – 2016 MY)	3.19
Maryland Clean Car Program (2011 MY) & National Fuel Economy Standards (2017 – 2025 MY)	1.14
Proposed National 2014-2018 Medium and HDV Standards	0.88
2020 GHG Emission Total	**7.48**

While this analysis focuses on 2020, it is important to highlight that preliminary 2030 GHG emissions forecasts provide insight into the relationship between the currently proposed vehicle technology programs, continued vehicle turnover, and VMT growth. It is probable that continued growth in VMT, if additional standards are not implemented, will eventually offset the benefit of the proposed improvements to vehicle technology and fleet turnover. The goal of transportation and land use strategies is to reduce the rate of growth in VMT so that the combined benefits of VMT related strategies and vehicle and fuels technology will be more significant. Understanding these relationships will be essential in attempting to achieve potential post-2020 targets, such as those outlined in the Maryland Greenhouse Gas Emission

Reduction Act of 2009 (90 percent below 2006 by 2050). Additional improvements to fuel economy standards and continued fleet turnover will be critical to meeting post-2020 GHG reduction targets.

3.2 TRANSPORTATION FUELS

Overview

Accounting for increases in the availability of renewable and low carbon fuels in 2020 is an important component of estimating potential GHG emission reductions from the Maryland transportation sector. The 2020 GHG inventory projection considers the final National Renewable Fuel Standard Program (RFS2) as well as a range of potential benefits associated with the 11-state Northeast and Mid-Atlantic Low Carbon Fuel Standard (LCFS) Memorandum of Understanding.

The potential effects of these fuel programs are included as GHG emissions reduction strategies for the Maryland transportation sector by 2020 and will augment the GHG emission reduction benefits achieved through vehicle technology improvements.

Renewable Fuels and Fuel Assumptions

The MOVES2010a greenhouse gas analysis uses fuel assumptions through 2012 as developed and reviewed by MDE. Assumptions for years beyond 2012 continue to use the same fuel standards and characteristics within the MOVES model.

The EPA issued the Renewable Fuel Standard Program (RFS2) final rule in March 2010, which mandates the use of 36 billion gallons of renewable fuel annually by 2022. Based on an approach utilized by the Metropolitan Washington Council of Governments (MWCOG), the use of renewable fuels will represent a 2 percent reduction in total mobile CO_2 emissions in 2030. For this analysis, a 1 percent overall reduction in 2020 on-road emissions was assumed to result from the implementation of the proposed renewable fuel standard.

Low Carbon Fuel Standard

On December 30, 2009, eleven Northeast and Mid-Atlantic states signed a Low Carbon Fuel Standard (LCFS) Memorandum of Understanding. The Signatory States committed to evaluating a regional low carbon fuel program that will reduce the average carbon intensity of transportation and potentially heating fuels in the Northeast and Mid-Atlantic Region. The states are working to evaluate and develop an agreed upon framework for the program, which would be followed by a model rule based on that framework. The framework and model rule are to include key program elements that could be adopted through state-specific administrative rulemaking or state legislative authority, if individual states choose to adopt and implement a LCFS.

The Signatory States committed to finalizing a proposed program framework in early 2011 that addresses the following elements: 1) compliance goals expressed as a percent reduction in average carbon intensity from an agreed upon baseline, to be achieved over a specific timetable; 2) parties to be regulated under the program; 3) whether heating fuels are to be included in the

program and, if so, options for including such fuels; 4) appropriate mechanisms for creating and trading credits for the sale of low carbon fuels; and 5) appropriate monitoring, compliance and enforcement mechanisms, and approaches to program review.

The LCFS framework, including compliance goals, has not yet been established. As a result, a conservative dissemination approach representing a range of impacts was utilized. The use of low carbon fuels was assumed to represent a 5-10 percent reduction in total mobile CO_2 emissions in 2020.

Results

The GHG reductions in Maryland from the National Renewable Fuel Standard Program and the 11-state Low Carbon Fuel Standard reduce projected 2020 GHG emissions by 1.45-2.66 mmt CO_2e as shown in Table 3.2.

Table 3.2 Maryland 2020 Transportation Fuels GHG Emissions Reductions

GHG Emissions Reduction by Program	Annual GHG Emission Reduction (mmt CO_2e)
Renewable Fuel Standard Program (RFS2)	0.24
Low Carbon Fuel Standard (5% - 10%) (1)	1.21 – 2.42
2020 GHG Emission Total	**1.45 – 2.66**

Note: (1) Figure ES.1, Figure 4.2 and Table 4.1 present only the result of the 5 percent reduction assumption, 1.21 mmt.

3.3 IMPLEMENTED AND ADOPTED TRANSPORTATION PLANS & PROGRAMS

Overview

Transportation projects, TERMs, land use, and travel forecast data from the following list of approved transportation programs were used to assess and quantify the GHG emissions of the State's proposed transportation investments through 2020.

- Maryland 2011-2016 CTP
- MWCOG 2011-16 TIP and 2010 CLRP adopted 11/17/10
- BRTB 2011-14 TIP adopted 7/27/10 and Transportation Outlook 2035 (adopted 11/07, amended 2/24/09)
- Hagerstown/Eastern Panhandle MPO 2010-2013 TIP adopted 6/16/10 and 2035 LRMTP adopted 4/28/10
- Salisbury-Wicomico MPO 2010-2013 TIP adopted 9/28/09 and Draft 2010 LRTP scheduled for adoption in October 2010

- Cumberland Area MPO 2010-2013 TIP adopted 10/15/09 and Draft 2010 LRTP schedule for adoption in October 2010
- WILMAPCO DRAFT 2012-2015 TIP and 2040 RTP (adopted 10/10)
- Modal Plans including – Maryland Area Regional Commuter (MARC) Growth and Investment Plan, Port of Baltimore Regional Landside Access Study, Maryland Statewide Freight Plan, Washington Metropolitan Area Transit Authority (WMATA) Capital Plan, Maryland Aviation Administration (MAA) Capital Plan

Based on the macro-level analysis of the State's fiscally constrained transportation infrastructure and program investment through 2020, and the associated local land use policies, statewide growth in VMT is forecast to be 1.4 percent annually. This represents a slower rate of growth than was included in the Maryland Climate Action Plan developed in 2007.

TERMs identified in the 2011-2016 CTP and MPO TIPs and LRPs to meet criteria pollutant targets, as well as continuation of current programs such as Commuter Connections, CHART, and Metropolitan Area Transportation Operations Coordination (MATOC) are assessed individually to determine estimates of GHG emission reductions and costs through 2020.

Funded Maryland Plans and Programs

Greenhouse Gas Emission Reductions

The 2020 BAU GHG emission forecast utilizes a methodology consistent with the Climate Action Plan (CAP). The HPMS historical growth rate was based on county reported HPMS VMT totals for the 1990-2006 timeframe. Using HPMS data and the associated timeframe, the average statewide annualized growth rate would be 1.8 percent, which is consistent with the assumptions used for past GHG analysis efforts under the Maryland CAP. Through consultation with MDE, it was determined in Phase II that the updated forecast should consider the MPO transportation and land use forecasts used in the development of TIPs, LRPs and the Maryland CTP. These plans and programs identify the committed and funded projects in Maryland. The modeling conducted by each regional MPO includes the impact of the planned projects and the adopted regional demographic forecasts.

To account for the impact of planned transportation plans and programs in 2020, MPO forecast travel and land use data were employed where available. For rural counties not included in a MPO or travel demand model domain, HPMS historical growth rates were used. The growth rates under this scenario incorporate the impacts of future regional demographic projections from each county, cooperatively developed by the MPO for modeling purposes, and the impacts of planned transportation projects (highway and transit) in the regional TIPs and LRPs. Under this scenario, the average statewide annualized growth rate is 1.4 percent (see Table 3.3). Project level analyses were not performed.

Table 3.3 Maryland VMT Forecasts and Annual Growth Rate

County	Annualized 2006-2020 Growth	
	HPMS Historical (CAP)	MPO Modeling (Plans/Programs/ Adopted Land Use)
Allegany	1.3%	-0.6%
Anne Arundel	2.0%	1.6%
Baltimore	1.3%	1.3%
Calvert	2.5%	1.9%
Caroline	1.3%	1.3%
Carroll	1.9%	2.1%
Cecil	2.4%	1.7%
Charles	2.2%	1.8%
Dorchester	0.9%	0.9%
Frederick	2.5%	2.0%
Garrett	1.4%	1.4%
Harford	1.8%	2.6%
Howard	3.2%	3.3%
Kent	0.5%	1.3%
Montgomery	1.5%	0.6%
Prince George's	1.7%	0.9%
Queen Anne's	2.2%	0.7%
Saint Mary's	2.0%	2.0%
Somerset	0.9%	0.9%
Talbot	1.8%	1.8%
Washington	2.1%	1.5%
Wicomico	1.5%	0.8%
Worcester	1.3%	1.3%
Baltimore City	0.8%	0.8%
Statewide	***1.8%***	***1.4%***

The statewide GHG reductions in 2020 are equivalent to the VMT difference between the BAU VMT growth rate (1.8 percent) and the 1.4 percent VMT growth rate. As presented in Table 3.4, this difference results in a VMT reduction in 2020 of 3.578 billion vehicle miles. The reduction in VMT is translated to a GHG emission reduction based on an emissions factor (grams CO_2e / mile) as calculated through the MOVES model based on Maryland's on-road vehicle fleet in 2020 (see section 2 and Appendix A).

Table 3.4 Maryland 2020 BAU VMT Compared to 2020 Plans and Programs VMT

Scenario	2020 BAU	2020 Plans & Programs Forecast
Annual VMT (millions)		
Light Duty	63,878	60,643
Medium/Heavy Duty Truck & Bus	6,755	6,432
TOTAL VMT (millions)	**70,653**	**67,075**

Project Implementation Costs

Maryland 2011-2016 Consolidated Transportation Program

Projects that contribute to a change in VMT growth and/or improve system efficiency are a subset of the complete state capital program. These are roadway and transit infrastructure projects, Transportation Emission Reduction Measures (TERMs), and other state and regional programs that act to reduce VMT and/or delay by adding capacity, improving flow, reducing bottlenecks, managing travel demand, or improving overall system efficiency through enhanced system management and operations. These projects are multimodal in nature and span multiple agencies, including MdTA, MAA, MPA, MTA, SHA, and WMATA, as well as local governments. The total costs of these projects are $4.832 billion (approximately 40 percent of the capital program in the 2011-2016 CTP). Table 3.5 illustrates the groupings of applicable 2011-2016 CTP projects by transportation GHG reduction policy option.

Table 3.5 2011-2016 CTP Projects by Transportation GHG Reduction Policy Option

GHG Reduction Policy Options	Projects	Total Cost (2011–2016) (billions $) (1)
Public Transportation (2)	38	$2.431
Intercity Passenger and Freight Transportation (3)	18	$0.348
Bike and Pedestrian (4)	19	$0.321
Transportation Pricing and Demand Management	2	$1.375
Transportation Technology	10	$0.358
2011 – 2016 CTP Total	**87**	**$4.832**

Note: (1) The total cost includes TERMs listed in the 2011 – 2016 CTP. These are documented in more detail in the TERM section on pg. 3-13 and Appendix C.

(2) The total cost includes 4 development and evaluation projects in the CTP (Red Line, Purple Line, Corridor Cities Transitway, Bethesda Metro South Entrance). Implementation costs for these projects not included in the CTP are included in the MPO plans and programs in Table 3.6.

(3) CTP projects include all capacity expansion and interchange improvements on interstate highways and intermodal connectors.

(4) CTP projects include all capacity expansion projects with accommodations for bike or pedestrian elements in the project description. The costs listed represent total project cost identified in the CTP.

Examples of CTP projects within each policy option are listed below:

- **Public Transportation**: Includes all MTA and WMATA capital projects dedicated to the expansion and increased level of service of public transportation services in Maryland. Projects include infrastructure expansion, vehicle purchase and replacement, transit operations and transit support facilities in the 2011-2016 CTP. Example projects include:
  - MARC Growth and Investment Plan implementation,
  - Completion of the Silver Spring transit center,
  - LOTS capital procurement projects,
  - WMATA Capital Improvement Program, and
  - Matching funds to WMATA for the Passenger Rail Investment and Improvement Act.
- **Intercity Passenger and Freight Transportation**: Includes all highway capacity projects on interstate highway system routes and intermodal connectors in Maryland. Also includes funding for the Baltimore intercity bus terminal, MARC infrastructure and operations improvements, American Recovery and Investment Act funding for planning and engineering for BWI MARC/Amtrak Station improvements and the Baltimore and Potomac tunnel, and rail freight capacity improvements on railroads owned by Maryland.
- **Bike and Pedestrian**: Combination of bicycle and pedestrian infrastructure inclusion in roadway projects (complete streets implementation), SHA's Sidewalk Program and Community Safety and Enhancement Program, projects and programs supporting completion of the statewide transportation trails network, and improved bicycle and pedestrian access to transit facilities. The total cost reported for roadway capacity projects with bicycle and pedestrian accommodations represents the total project cost.
- **Transportation Pricing and Demand Management**: Includes MDTA projects, primarily the Intercounty Connector and I-95 Express Toll Lanes. Also includes state funded commute alternative incentive programs in the Baltimore and Washington regions.
- **Transportation Technology**: Includes CHART program implementation, state and local programs for signal synchronization, MTA diesel-hybrid electric bus purchases, transit CAD/AVL system upgrades and high speed tolling at I-95 Fort McHenry toll plaza.

Maryland MPO TIPs and Long Range Plans

The total cost of the subset of projects and TERMs contributing to changes in VMT growth and/or system efficiency in the MPO TIPs and LRPs through 2020 is **$8.863 billion**. Table 3.6 illustrates groupings of applicable MPO TIP and LRP projects by transportation GHG reduction policy option.

Table 3.6 MPO TIP and LRP Projects by Transportation GHG Reduction Policy Option

GHG Reduction Policy Options	Projects	Total Cost (2011–2020) (billions $) (1)
Public Transportation (2)	31	$4.532
Intercity Passenger and Freight Transportation	33	$2.736
Bike and Pedestrian	32	$1.064
Transportation Pricing and Demand Management	4	$0.022
Transportation Technology	7	$0.032
MPO TIPs and LRP Total	**107**	**$8.387**

Note: (1) Total cost includes TERMs listed in the MPO TIPs and LRPs as documented in more detail in the TERM section on pg. 3-13 and Appendix C.

(2) Total cost excludes the cost of planning, preliminary engineering and ROW acquisition for four development and evaluation projects as identified in the CTP (Red Line, Purple Line, Corridor Cities Transitway, Bethesda Metro South Entrance).

Projects in MPO TIPs and LRPs funded and committed for completion by 2020 include:

- **Public Transportation**: Major projects planned for opening by 2020 include the Purple Line (Bethesda to New Carrolton), Corridor Cities Transitway (Shady Grove to COMSAT), Red Line (Social Security Administration to Bayview Medical Center), and the MARC Penn Line extension from Perryville to Elkton.
- **Intercity Passenger and Freight Transportation**: Major roadway capacity projects impacting truck freight movement in Maryland planned for opening by 2020 include: I-695 from I-95 South to MD 122, I-695 from I-83 to I-95 North, MD 32 grade separation and interchange at I-795, MD 4 upgrade in Prince Georges County, and US 50 access control improvements in Wicomico County. In addition, there are funded long range projects associated with the MARC Growth and Investment Plan and Maryland Statewide Freight Plan included under this strategy. The GHG reduction benefit from full implementation of the National Gateway and Northeast Corridor Infrastructure Master Plan are included in the unfunded GHG reduction strategy assessment.
- **Bike and Pedestrian**: Combination of bicycle and pedestrian infrastructure inclusion in roadway projects (complete streets implementation), projects supporting completion of the statewide transportation trails network, as well as improved bicycle and pedestrian access to transit facilities. This policy option also includes implementation of a number of local and regional sidewalk, trail, recreation and enhancement programs.
- **Transportation Pricing and Demand Management**: Includes implementation of Baltimore regional ride share and guaranteed ride home programs and MWCOGs Commuter Connections program.
- **Transportation Technology**: Includes installation, repair and replacement of variable message signs; congestion management programs including the employment of variable message signs, CCTV, signal coordination, the deployment of local Intelligent Transportation Systems (ITS) projects (transit signal priority systems, automatic passenger

counters, traffic signal control software, etc.), and the development of park and ride facilities; Congestion Mitigation and Air Quality Improvement Program (CMAQ) projects; Clean Air Partners; and advanced transportation management systems utilizing fiber optics.

Transportation Emission Reduction Measures (TERMs)

Greenhouse Gas Emission Reductions

The Clean Air Act Amendments of 1990 (CAAA) and the Safe, Accountable, Efficient, Flexible, Transportation Efficiency Act (SAFETEA-LU) requires MPOs and state departments of transportation to perform air quality analyses, to ensure that the transportation plan and program conform to the mobile emission budget established for the criteria pollutants such as NOx, VOCs, CO and particulates in the State Implementation Plans (SIP). As a result, MPO's and DOT's are required to identify transportation emissions reduction measures (TERMs) that provide criteria pollutant emission-reduction benefits. These measures are assessed in conformity documentation and include specific information on the costs and expected air-quality benefits.

The criteria pollutant reductions of a large share of these strategies are included in the BRTB, MWCOG, HEPMPO, and WILMAPCO air quality conformity processes. For these strategies, reductions in VMT or fuel consumption as estimated by BRTB, MWCOG, MDOT and MDE are adjusted to reflect 2020 conditions and converted to GHG emission reductions. For the strategies where a prior analysis has not been completed, observed data on the benefits of these strategies in other locations or research reports were utilized to determine potential 2020 benefits (see Appendix C for all TERM assessment approaches).

Project Implementation Costs

The range of TERMs considered is diverse in strategy, scope and implementation requirements. The total cost of TERMs listed within the CTP and MPO TIPs and LRPs is estimated at $483 million.[1] The total cost of additional TERMs sponsored by Maryland Aviation Administration (MAA) and Maryland Ports Administration (MPA) is not included in this report.

The TERMs were organized into the transportation GHG reduction policy options as follows (this list is representative and not inclusive of all the TERMs included in the analysis, refer to Appendix C for descriptions of all the TERMs):

- **Public Transportation:** Projects that enhance public transportation amenities and improve level-of-service through station access improvements, bus stop programs, traveler information, activity center shuttle services, park-and-ride lot expansion, free bus transfers, enhanced commuter and reverse commute service, MTA college pass and commuter choice Maryland pass.

[1] TERMs listed within the CTP and MPO TIPs and LRPs are also included in the total cost estimates presented in Tables 3.5 and 3.6. The summary of total TERM project costs by GHG reduction policy option are listed in Appendix C, Table C.1.

- **Intercity Passenger and Freight Transportation:** No TERM projects.
- **Bike and Pedestrian:** Projects include sidewalk and street rehabilitation, bicycle and pedestrian facilities, acquisition of scenic easements, streetscapes, and functional/safety improvements.
- **Transportation Pricing and Demand Management**: Projects are tied to commute alternative and incentive programs including specific projects such ridesharing (Commuter Connections), guaranteed ride home, TDM program management and marketing, outreach and education programs (Clean Air Partners), parking cash-out subsidies, transportation information kiosks, local carsharing programs, telework partnerships, parking impact fees, and vanpool programs.
- **Transportation Technology:** Projects fall across two primary categories: clean vehicle technology and intelligent transportation systems. Clean vehicle technology includes truck idling (truck stop electrification or auxiliary power units), transit bus purchases, state fleet purchases. Intelligent transportation systems includes CHART, MATOC, and signal coordination/management/upgrade programs. Also includes projects at BWI Marshall such as aircraft taxi/idling/delay reduction strategies, vehicle fleet purchases, dedicated lanes, smart park facilities, APUs for ground service equipment, and facility electricity usage. Maryland Port Administration (MPA) projects include cargo handling equipment replacements and engine repowers, and truck replacements and engine repowers.

Implementation of many of the TERMs requires capital investments along with annual administrative and operations costs. The costs included in Table 3.5 are predominantly capital costs, reflecting expenditures for new technologies, equipment and vehicles as well as transit support infrastructure (bus shelters, park-and-ride lots). For commuter programs and most ITS related programs, there are significant annual administrative and operations costs included.

Results

Greenhouse Gas Emission Reductions

The reduced forecasted rate of VMT growth resulting from implementation of the CTP and MPO TIPs and LRPs through 2020 contributes to a 1.99 mmt CO_2e reduction by 2020 compared to the 2020 BAU forecast.

VMT reduction or fuel consumption savings resulting from the implementation of TERMs through 2020 results in a 0.795 mmt CO_2e reduction in 2020. The TERM strategies are all exclusive of the VMT impacts and resulting GHG emissions from existing plans and programs analysis, ensuring that no double counting of benefits occurs. The contribution of TERMs by each GHG emission reduction strategy policy option is presented in Table 3.7.

Table 3.7 GHG Reduction Summary by Transportation GHG Reduction Policy Option

GHG Reduction Policy Options	Annual 2020 GHG Reduction (mmt CO_2e)
Maryland Funded Plans and Programs (excluding TERMs)	**1.99**
Transportation Emission Reduction Measures (TERMs)	**0.795**
Public Transportation	0.277
Intercity Passenger and Freight Transportation	--
Bike and Pedestrian	0.001
Transportation Pricing and Demand Management	0.199
Transportation Technology	0.319
Total – Implemented and Adopted Transportation Plans and Programs	**2.785**

Project Implementation Costs

The total cost of the subset of projects, programs, and TERMs within the 2011-2016 CTP and MPO long-range plans through 2020 that contribute to the reduction in GHG emissions is $13.219 billion (approximately 50 percent of the complete State capital program 2011 – 2020).

Table 3.8 presents the total capital cost summary of Maryland plans, programs and TERMs 2011 – 2020 by transportation GHG reduction strategy policy option. Refer to Appendix B for the complete project listing.

Table 3.8 Draft Cost Summary by Transportation GHG Reduction Policy Option

GHG Reduction Policy Options	Total Cost (2011–2020) (billions $) (2)
Public Transportation	$6.963
Intercity Passenger and Freight Transportation (1)	$3.085
Bike and Pedestrian (1)	$1.385
Transportation Pricing and Demand Management	$1.397
Transportation Technology	$0.390
Total – Implemented and Adopted Transportation Plans and Programs	**$13.219**

Note: (1) The total cost reported represents the complete project cost. The specific cost of the bike or pedestrian element is not reported. There are no overlaps with any roadway capacity projects identified in the intercity passenger and freight transportation policy option.

(2) Total cost includes $483 million for TERMs documented in more detail in Appendix C.

3.4 UNFUNDED TRANSPORTATION GHG REDUCTION STRATEGIES

Overview

The 2008 Maryland Climate Action Plan (CAP) established GHG emission reduction targets from 2006 levels including targets of 25 percent by 2020 and 90 percent by 2050. In order to assist Maryland in meeting these targets, the Commission also identified 42 GHG "mitigation" policy options designed to reduce GHG emissions. A total of eight transportation and land use policy options were outlined in the CAP. While many State agencies are involved, MDOT was designated as the implementing agency for six policy options, and is a supporting agency on the two others. MDOT's policy options are primarily focused on reducing GHG emissions through vehicle miles of travel (VMT) reductions and vehicle and transportation system technology improvements.

MDOT developed a multi-phase approach in order to address the responsibility of acting as the implementing agency for the six policy options. That process included the development of a coordinating committee as well as working groups for each policy option.

In Phase I, a total of 44 strategies were determined to have an implementation timeframe of 2020 or before. These were evaluated in Phase II, with the understanding that these strategies could only be realized should funding become available.

Phase III takes the findings of the working groups and coordinating committee in Phase I and Phase II and reassesses the GHG emission reduction benefits through:

1. A more careful consideration of the barriers to implementation by 2020;
2. A review of the GHG reduction and cost methodologies, and;
3. Inclusion of updated emission factors based on vehicle technology and transportation fuel forecasts for Maryland in 2020 from EPAs MOVES model.

The incremental benefit of the unfunded transportation GHG reduction strategies evaluated in Phase III is a 1.14 mmt to 3.14 mmt CO_2e reduction in 2020. The implementation cost estimate (capital costs only) of the Phase III unfunded transportation sector GHG reduction strategies from 2011 to 2020 is $2.911 to $7.011 billion in addition to the funded transportation plans, programs and TERMs through 2020.

Unfunded Transportation GHG Reduction Strategy Policy Options

The strategies described in this section were determined by the working groups and coordinating committee in Phase I to be priorities for GHG emission reduction in Maryland and are considered feasible for implementation by 2020. These strategies could only be realized should additional funding become available.

More detailed information, regarding the strategy analysis approach and assumptions can be found in Appendix D.

Public Transportation

This policy option identifies public transportation strategies to reduce on-road mobile source transportation GHG emissions. The strategies are designed to help Maryland meet a goal of doubling transit ridership by 2020, and continuing that same growth rate beyond 2020. In order to achieve this growth, actions to increase the attractiveness and convenience of public transportation, improve the operational efficiency of the system, and increase system capacity are required. Policies also involve supportive actions with regard to land use planning and policy, pricing (disincentives to auto use), and bike and pedestrian access improvements. Policies to reduce GHG produced by public transportation services are also included.

The following strategies defined by the public transportation working group were identified to address the expected gap in meeting the transit ridership goal defined in the Climate Action Plan (e.g. a doubling of 2000 transit ridership by 2020). The intent is for these strategies to complement and support funded MTA and WMATA plans and programs identified for implementation by 2020 in the 2011-2016 CTP and MPO TIPs and long-range plans.

- Additional Capacity on Existing Transit Routes
- Increase Frequencies of Transit Services Statewide
- Expanded Park and Ride Capacity
- Increase Coverage of Transit Services – New Commuter / Intercity Bus Routes
- Increase Coverage of Transit Services – New Local Bus Routes
- Implement Bicycle and Pedestrian Improvements to Support Transit
- Reduce GHG Emissions from Transit Vehicles
- Bus Priority Improvements
- Plan Transit in Conjunction with Land Use

Intercity Passenger and Freight Transportation

This policy option enhances connectivity and reliability of non-automobile intercity passenger modes and multimodal freight through infrastructure and technology investments. For intercity passenger modes, this includes expansion of intercity passenger rail and bus services as well as improved connections between air, rail, intercity bus and regional or local transit systems. For freight movement, this includes expansion and bottleneck relief on priority truck and rail corridors and enhanced intermodal freight connections at Maryland's intermodal terminals and ports.

The intercity transportation working group identified improving passenger convenience for intermodal connections at airports, rail stations, and major bus terminals as the primary pre-2020 unfunded intercity transportation strategies. Two primary strategies are assessed for intercity passenger transportation in Maryland by 2020: (1) improve passenger access, convenience, and information across all modes at BWI Airport, and (2) improve travel times, reliability and overall level of service on the MARC Penn Line and Amtrak NE Corridor

consistent with the MARC Growth and Investment Plan, and Northeast Corridor Infrastructure Master Plan.

The intercity transportation working group did not recommend specific freight strategies in addition to projects identified in implemented and adopted transportation plans and programs for consideration before 2020. Recent developments and Maryland strategic involvement in the CSX Transportation National Gateway initiative will result in implementation of freight rail projects in Maryland and the mid-Atlantic region that will help reduce truck VMT in Maryland by 2020. Funding for the National Gateway is a public-private partnership between the federal government, six states and the District of Columbia, and CSX. The benefit of the National Gateway is assessed in this report.

The benefits of Norfolk Southern's Crescent Corridor initiative is not assessed in this report as direct GHG emission reduction benefits to Maryland are unknown, and a level of support and funding commitment from Maryland has not been recommended to date (see Section 3.5 for more details).

Bike and Pedestrian

This policy option includes infrastructure design and construction policies; funding, regulatory, and land use strategies; and education and marketing measures. These strategies result in improved bike and pedestrian amenities, resulting in an increase in the number of trips made on foot or bicycle, particularly in urban areas and adjacent to Maryland's trail networks. This policy recognizes that local governments are responsible for the design and maintenance of approximately 80 percent of roads in Maryland. Land use and location efficiency strategies addressing density, mix of uses, and urban design represents a very strong predictor of bike and pedestrian travel.

The following strategies were recommended for possible implementation prior to 2020 by the bike and pedestrian working group:

- Promote use and regular review/updates to existing manuals and design standards
- Complete Streets – improve bike/pedestrian access through corridor retrofits and new roadway construction projects
- Update existing land use policy guidance and zoning/development standards to include provisions for bike and pedestrian supportive infrastructure
- Bike facility and supportive infrastructure placement at strategic locations, including transit stations and government facilities
- Provide funds for low-cost safety solutions
- Education, safety programs, and marketing programs to encourage bicycle travel

Transportation Pricing and Demand Management

This policy option addresses transportation pricing and travel demand management incentive programs. It also tests the associated potential GHG reduction benefits of alternate funding sources for GHG beneficial programs. These strategies amplify GHG emission reductions from

other strategies by supporting Smart Growth, transit, and bike and pedestrian investments. The draft MDOT policy design, developed by the pricing working group in Phase I, considers four strategy areas combined with an education component for state and local officials.

The detailed definitions of the four strategy areas are listed below:

- **Maryland motor fuel taxes or VMT fees –** There are two primary options for consideration: (1) an increase in the per gallon motor fuel tax consistent with alternatives under consideration by the Blue Ribbon Commission on Maryland Transportation Funding, and (2) establish a GHG emission-based road user fee (or VMT fee) statewide by 2020 in addition to existing motor fuel taxes. Both options would create additional revenue that could be used to fund transportation improvements and systems operations to help meet Maryland GHG reduction goals.
- **Congestion Pricing and Managed Lanes –** Establish as a local pricing option in urban areas that charges motorists more to use a roadway, bridge or tunnel during peak periods, with revenues used to fund transportation improvements and systems operations to help meet Maryland GHG reduction goals.
- **Parking Impact Fees and Parking Management –** Establish parking pricing policies that ensure effective use of urban street space. Provision of off-street parking should be regulated and managed with appropriate impact fees, taxes, incentives, and regulations.
- **Employer Commute Incentives –** Strengthen employer commute incentive programs by increasing marketing and financial and/or tax based incentives for employers, schools, and universities to encourage walking, biking, public transportation usage, carpooling, and teleworking.

Transportation Technology

This policy option aims to reduce GHG emissions from on and off-road vehicles/engines through the deployment of technologies designed to cut GHG emission rates per unit of activity through such measures as idling reduction, engine/vehicle replacements, and the promotion of fuel efficient technologies. This policy option also encompasses improvements to transportation system efficiencies through measure such as traffic signal synchronization/optimization and active traffic management.

The following strategies were identified for further analysis and possible implementation under this policy option:

- **Active Traffic Management (ATM) / Traffic Management Centers –** Provide real-time, variable-control of speed, lane movement, and traveler information (for drivers and transit users) within a corridor and conduct centralized data collection and analysis of the transportation system. System management decisions are based on inroad detectors, video monitoring, trend analysis, and incident detection (currently performed by CHART).
- **Traffic Signal Synchronization / Optimization –** Traffic signal operations are synchronized to provide an efficient flow or prioritization of traffic, increasing the efficient operations of the corridor and reducing unwarranted idling at intersections. The system can also provide

priority for transit and emergency vehicles. Specific performance measure is "reliability." Traffic Signal Synchronization is currently performed by SHA and local jurisdictions.

- **Marketing and Education Campaigns –** Initiate marketing and education campaigns to operators of on-and off-road vehicles.
- **Timing of Highway Construction Schedules –** Consider requiring non-emergency, highway and airport construction be scheduled for off-peak hours that minimize the delay in traffic flow. Include incentives for completing projects ahead of schedule.
- **Green Port Strategy –** Develop and implement a "Green Port Strategy" consistent with industry trends and initiatives including EPA's Strategy for Sustainable seaports.
- **Reduce Idling Times –** Reduce idling time in light duty vehicles, commercial vehicles (including the use of truck stop electrification), buses, locomotive, and construction equipment.
- **Technology Improvements for On-highway Vehicles –** Promote and incentivize fuel efficiency technologies for medium and heavy-duty trucks (on-highway vehicles).
- **Incentives for Low-GHG Vehicles –** Provide incentives to increase purchases of fuel-efficient or low-GHG vehicles / fleets.
- **Technology Advances for Non-highway Vehicles –** Encourage or incentivize retrofits and/or replacement of old, diesel-powered non-highway engines, such as switchyard locomotives, with new hybrid locomotives.
- **Incentives for Low-Carbon Fuels and Infrastructure –** Incentivize the demand for clean low-carbon fuels and the development of infrastructure to provide for increased availability/accessibility of alternative fuels and plug-in locations for electric vehicles.

Evaluate the Greenhouse Gas Emission Impacts of Major Projects and Plans

This policy option focuses on the process of evaluating GHG emissions of all state and local major projects. The goals of this policy option are to understand the impacts of new, major projects on the Governor's GHG reduction commitment; and to develop guidance for the state and other major project sponsors to use. In Phase I, the working group identified three potential implementation strategies for this policy option:

- Participate in Framing National Policy
- Evaluation of GHG Emissions through the NEPA Process
- Evaluation of GHG Emissions through Statewide/Regional Planning

Results

Table 3.9 presents the results of the Phase III unfunded transportation GHG reduction strategy analysis. The GHG reduction estimates summarized here represent GHG reductions beyond the benefits of implemented and adopted transportation plans, programs, and TERMs. The preliminary cost estimates of the unfunded strategies represent additional capital costs that are not included in the CTP or MPO plans. Ranges of GHG reductions and costs are illustrated in

order to reflect the relationship between achieving more significant GHG reductions and the costs associated with achieving those reductions.

The GHG emission reductions from all projects, programs and TERMs included in funded plans and programs are accounted for within the bundled assessment of the emission reduction benefits in 2020 of implementing the State's implemented and adopted transportation plans, programs, and TERMs (see Section 3.3).

A more detailed summation of the analysis conducted for each policy option, including an overview and definition, approach to the analysis, assumptions and results, is provided in Appendix D.

Table 3.9 Unfunded GHG Reduction Strategy Policy Options – 2020 Emission Reduction and Cost Summary

GHG Reduction Policy Options	GHG Reduction (mmt CO_2e)	Total Additional Cost 2010 - 2020 (million $)
Public Transportation	0.39 - 0.62	$1,214 - $1,765
Intercity Passenger and Freight Transportation	0.11	$0.748
Bike and Pedestrian	0.16	$0.598 - $0.817
Transportation Pricing and Demand Management	0.24 – 2.01	$0.300 - $3,690
Transportation Technology	0.24	$0.051
Evaluate GHG Impacts of Major Projects & Plans	N/A	N/A
Total 2020 GHG Reduction and Costs	**1.14 – 3.14**	**$2.911 – $7,071**

3.5 ADDITIONAL TRANSPORTATION SECTOR GHG EMISSION REDUCTION INITIATIVES (NOT QUANTIFIED)

Overview

MDOT and other Maryland agencies are collaborating on regional and state initiatives and programs that will result in GHG emission reductions from the transportation sector in 2020. These initiatives are documented in this section without quantified GHG emission reductions or costs because they are early in the planning and implementation process, and are not yet associated with specific projects and or identified funding.

In addition there are a number of management, maintenance, and operational activities ongoing or soon to be underway throughout MDOT that will result in GHG emissions from the transportation sector. These items are documented in this section in order to present the additional activities MDOT is undertaking to reduce or offset GHG emissions from the transportation sector. The magnitude of GHG emission reductions of these strategies are

unknown at this time, and in many cases the strategies affect stationary or point source transportation sector GHG emissions which are not modeled in this report.

State and Regional Initiatives

Blue Ribbon Commission

The Blue Ribbon Commission (BRC) on Maryland Transportation Funding is currently evaluating transportation funding shortfalls, identifying potential new revenue sources and any legislation required to initiate them, and the potential uses for additional transportation funds. The overall purpose of BRC is to review, evaluate and make recommendations concerning Maryland transportation funding, particularly related to:

- The current State funding sources and structure of the Maryland Transportation Trust Fund,
- Additional financial support to address MDOTs increasing need for air quality and climate change beneficial projects, and water resource management,
- Short and long-term transit, highway, and pedestrian/bicycle construction and maintenance funding needs,
- Options for public-private partnerships, including partnerships with local governments,
- The structure of regional transportation authorities and the ability of those authorities to meet transportation needs,
- The impact of economic development and smart growth on transportation funding, and
- Options for sustainable, long-term revenue sources for transportation.

A final report on findings and recommendations of the BRC is due to the Governor and General Assembly on or before November 1, 2011. To date, the BRC has investigated existing state revenue sources and yields, historic transportation expenditures in Maryland, alternative revenue and transportation funding programs in neighboring states, and potential new revenue sources in Maryland. The potential new primary revenue sources in Maryland investigated by BRC thus far includes increases in the vehicle titling, sales and use taxes, motor fuel taxes, vehicle registration fees, driver's license fees, and corporate income taxes. Also investigated are changes to MTA transit fare policy and toll rates on MDTA facilities.

Potential uses of alternative revenue sources into Maryland's Transportation Trust Fund include GHG beneficial strategies such as MTA capital expansion needs to address the doubling transit ridership goal, unspecified climate change/air quality related projects, and facilitation of future TOD projects.

The ultimate findings and recommendations of the BRC and the next steps taken by the General Assembly in 2011 and 2012 should help to address the significant estimated cost of the unfunded transportation GHG reduction strategies identified in this plan.

Electric Vehicles

MDOT has been working closely with MDE, MEA, Baltimore City and the Baltimore Electric Vehicle Initiative (BEVI) to select appropriate locations for 65 electric vehicle re-charging

stations around the state. Several of the re-charging stations will be located at MDOT and modal facilities such as MDOT Headquarters in Hanover, the BWI MARC / AMTRAK station, the BWI parking garage and park-and-ride lots maintained by SHA. MDOT's continued involvement in expanding the availability of electric vehicle recharging stations throughout the state will contribute to statewide GHG emission reductions and complement the efforts of the Maryland General Assembly, which has passed legislation approving electric vehicle tax credits and electric vehicle use of HOV lanes, and Governor O'Malley who has proposed legislation to create an Electric Vehicle Infrastructure Council, and establish a state income tax credit of 20 percent of the cost of electric vehicle charging equipment for individuals and businesses.

Transportation and Climate Initiative / NASTO Coordination

In June of 2010, the Secretary of the Maryland Department of Transportation, along with other transportation, environment and energy agency heads of eleven Northeast and Mid-Atlantic states and the District of Columbia, signed a declaration of intent to collaborate to:

- Improve the efficiency of the transportation system,
- Reduce roadway congestion,
- Upgrade public transport,
- Address the challenges of vehicle miles traveled,
- Reduce air pollution and energy use, and
- Ensure that long-term development is sustainable and enhances quality of life in communities within their jurisdictions

As an active member of the Transportation and Climate Initiative (TCI), MDOT will work with other state agency heads over the next three years to develop the most effective and efficient ways for states to meet their own energy, transportation and climate goals through state-based and regional strategies. As part of its three-year work plan, the TCI will focus development of state-level strategies and policies in four areas: alternative fuel and advanced technology vehicles, sustainable communities, freight movement, and information and communications technologies. While the framework is still under development, the TCI has the potential to generate a significant reduction in Maryland's transportation sector GHG emissions.

Transit Oriented Development (TOD) Designation

TOD is an important tool to help leverage future growth, public investments, and achieve Smart Growth and sustainable communities. Maryland has great TOD potential, with more than 75 existing rail, light rail, and subway stations, and dozens more proposed in the next 20 years. People living within a half mile of a transit station drive 47 percent less than those living elsewhere and are up to five times more likely to use transit.[2]

[2] http://www.mdot.maryland.gov/Planning/TOD/TOD_Basics.html

Legislation signed by Governor O'Malley in 2008 facilitates the development of TOD in Maryland by authorizing MDOT to use its resources to support "designated" TOD projects. Designated TOD projects are those that are good models of TOD, have strong local support, represent a good return on public investment, demonstrate strong partnerships, and can succeed with a reasonable amount of State assistance but not without state support.

Due to limited State and local resources, not all TOD projects that represent good sustainable development can be "designated" under this program. Instead, projects are prioritized that meet the criteria above and cannot succeed without public sector support. Designated projects could benefit from several potential tools, depending on the needs of the particular project at the particular stage of development. Among the benefits are prioritization for transportation funds and resources, financing assistance, tax credits, prioritization for the location of State offices and support from the State Highway Administration on access needs. As of June 2010, Maryland has designated the following 14 TODs for priority State support:

1. Aberdeen
2. Branch Avenue
3. Laurel
4. Naylor Road
5. New Carrollton
6. Odenton
7. Owings Mills
8. Reisterstown Plaza
9. Savage
10. Shady Grove
11. State Center
12. Twinbrook
13. Westport
14. Wheaton

TOD is consistent with Governor O'Malley's Smart, Green and Growing initiative that brings together state agencies, local governments, businesses and citizens to: create more livable communities, improve transportation options, reduce the state's carbon footprint, support resource based industry, invest in green technologies, preserve valuable resource lands, and restore the health of the Chesapeake Bay.

Carbon Neutral Corridor

Based on several ongoing initiatives within Maryland, MDOT in partnership with other state agencies has engaged in a unique project that takes a multidisciplinary approach to plan and evaluate policies, programs and actions to address energy efficiency and reduce GHG emissions.

The project titled the "Carbon Neutral Corridor" identifies strategies that focus on sustainable transportation, smart growth, land conservation and restoration, and energy efficiency practices that support a long-term goal of achieving significant reductions in carbon emissions. The project objective is the development of an implementation plan that will addresses specific actions and funding needs that would lead to eventual implementation of corridor strategies to reduce carbon emissions.

The selection in 2010 of the first project corridor, US 40 from the Baltimore City line to the Susquehanna River, was a critical first step in initiating the planning effort. Ongoing work in

2011 includes defining and testing multiple transportation, land use, conservation, and energy consumption scenarios, working with corridor stakeholders to build understanding of the Carbon Neutral Corridor concept and a coalition of support for corridor recommendations, and informing the public and seeking comment on corridor strategies for reducing GHG emissions from all economic sectors. The US 40 corridor's diverse transportation system, economy, and environment permits the recommendations of the US 40 corridor plan to be transferable to other areas in Maryland.

Crescent Corridor

Norfolk Southern's Crescent Corridor is expected to bring safety, environmental, and economic benefits to Maryland, including the creation of 1,800 green jobs in the next decade. Each year, the Crescent Corridor should divert more than 858,000 long-haul trucks from Maryland highways to the rails, especially along I-95. At the same time, it should conserve up to 2.8 million gallons of fuel and eliminate 31,000 tons of CO_2 emissions annually in Maryland by 2020.

The Crescent Corridor will provide Maryland shippers with a new high-speed intermodal freight option between the Northeast and Southeast that could reduce their annual logistics costs by nearly $35 million. The development of a new intermodal facility in Greencastle, Pa., located in Franklin County near the border of western Maryland, is expected to open in early 2012.

The Crescent Corridor program of projects is estimated to cost $2.5 billion for full development by 2020. There is no current plan for funding support from Maryland to NS, however MDOT, along with the National Capital Region Transportation Planning Board (TPB) have expressed support for the Crescent Corridor project. A critical concern of the TPB and MDOT (including the Hagerstown-Eastern Panhandle MPO) is that NS ensure that local impacts, including increased local truck traffic in the vicinity of intermodal facilities, noise, safety, grade crossing (conversion to separated grade crossings on major transportation routes), and hazardous materials considerations, are adequately addressed to the satisfaction of these entities as these projects are developed.

CSX Transportation's National Gateway initiative is described and quantified in Section 3.4 as an unfunded intercity freight transportation GHG reduction strategy.

PlanMaryland – Maryland Department of Planning

PlanMaryland, the State's first comprehensive plan for sustainable growth and development, presents an opportunity to address climate change mitigation and adaptation issues in Maryland, in the context of many related quality-of-life, economic, social and environmental goals. The strategies identified in TLU-2, Land Use and Location Efficiency, in the 2008 Climate Action Plan, are directly tied to the objectives of PlanMaryland and are overall consistent with Maryland's Smart, Green and Growing policies. MDP is working with MDOT and MDE with a focus on policies and programs implemented by 2020 to reduce dependence on motor vehicle travel (especially single-occupant vehicles). These policies and programs may include incentives and requirements for projects and regional land use patterns that shorten trip length and greatly facilitate the use of alternative transportation mode choices to reach employment,

shopping, recreation, education, religious and other destinations. The benefits of PlanMaryland are documented separately from this document through MDPs role in developing the Draft 2012 Implementation Plan. There are VMT related benefits associated with PlanMaryland that will accrue to the transportation sector.

Pay-as-you Drive (PAYD) Insurance – Maryland Insurance Administration

For Pay-as-you Drive Insurance, the Climate Action Plan identified a policy goal to make PAYD coverage available to all Maryland drivers as early as possible and to push for adoption of incentives or pilot programs for Maryland drivers. The Maryland Insurance Administration (MIA) led a workgroup in 2009 with MDOT, MDE, representatives from the insurance industry, representatives from consumer advocacy groups, and other stakeholders to explore options for implementing and marketing insurance policies that tie the cost of premiums to miles or hours driven. The workgroup agreed that while the extent to which PAYD insurance will reduce GHG emissions is unclear, it is beneficial to encourage the expansion of these programs in the state as they do offer more options to consumers. Based on a survey with insurance carriers, most indicated they will not offer PAYD due to the cost of developing the product and the regulatory environment MIA will continue to monitor the carriers and work with them to the extent that they would like to offer this product in the state; however, based on the carriers' timeframe, PAYD will not have an immediate impact on the reduction of GHG.

MDOT Modal Administration Activities

A sample of ongoing or planned administrative, management, maintenance, and operations strategies that will result in reductions in energy consumption from the transportation sector are listed below by agency. These strategies reduce GHG emissions through helping to decrease rates of energy consumption from transportation infrastructure and support facilities. Potential greenhouse gas reductions from these strategies are not calculated, as emissions from non-mobile sources are not estimated by MDOT. Partnerships with other agencies are noted.

Maryland Aviation Administration (MAA)

1. Purchased CNG buses for use as shuttles for the Consolidated Rental Car Facility.
2. Implemented Smart Park way-finding system in parking garages that results in reduced vehicle roaming for parking spaces.
3. Designated a "cell phone" lot to reduce vehicle circulation in the terminal area when awaiting pickup of an arriving passenger.

Maryland Port Administration (MPA)

1. Applied for and received EPA grants for demonstration emission reduction projects on MPA fleet vehicles, cargo handling equipment at MPA terminals, and on construction equipment at Hart Miller Island and Poplar Island.
2. Applied for and received EPA grant for a Port-wide assessment of technologies that can effectively reduce emissions related to cargo movement.
3. Retrofit and repowered tugs with anti-idling technology and new engines.

4. Flex-fuel vehicles, alternative fuel vehicle, and hybrid vehicles have been introduced into the MPA fleet.
5. Plans to install a fuel tank capable of storing E85 will be included in the new fuel island configuration at Dundalk Marine Terminal.

Maryland Transit Administration (MTA)

1. In addition to its ongoing replacement of the bus fleet in the Baltimore region with diesel electric hybrid buses (assessed as a TERM in section 3.3), MTA is installing new electric cooling systems on older buses that provide an additional 9 percent fuel savings. In total 259 older diesel buses in the MTA fleet have had this technology installed. All current and future hybrid buses already have this system built in.
2. Installed front-mounted bike racks on all local MTA buses in 2009 and 2010.
3. All 219 MTA "New Flyer" buses, as well as all new hybrids, are equipped with an idle shut down feature that turns the bus off after idling more than 10 minutes.

State Highway Administration (SHA)

1. SHA in partnership with DNR, and Department of Corrections has a target of planting one million trees by 2011.
2. Pilot Study ongoing to convert sign lighting to LED is 90 percent complete
3. Conversion of traffic signals to LED is 25 percent complete
4. Conversion of roadway lighting to LED is ongoing
5. MEA Partnership to support pilot wind energy project at Westminster Maintenance Shop.
6. Transition to bio-diesel is 100 percent complete at all facilities
7. E85 tank was installed at the Hanover Complex through MEA grant and E85 is being dispensed to SHA and MAA vehicles.
8. SHA is working with contractors to locate truck staging areas and to avoid unnecessary idling of construction equipment. Delivery truck idling at sites limited to 5 minutes.

Maryland Transportation Authority (MDTA)

1. E85 dispensers are being installed at the Baltimore Harbor tunnel, ICC Eastern Operations Facility and other locations.
2. The ICC Eastern Operations Facility will use geothermal heating and cooling
3. Message signs and lane signal indications are being replaced with LED lighting
4. For the Travel Plaza Reconstruction Projects, MDTA is specifying that the site/building design and construction seek to obtain Silver LEED Certification.
5. All new roofs are being done to LEED standards as cool roofs.

MDOT Headquarters

1. 75 percent of Headquarters fleet are hybrids

2. Pilot program for hydrogen fuel cell vehicles
3. Electric vehicle recharging system

4.0 2020 Transportation Sector Results

This section presents an overview of the total emission reductions anticipated from the Maryland transportation sector in 2020 and compares those results against two distinct metrics:

1. The MDOT, agency-specific reduction target of 6.2 mmt CO_2e given to MDOT by MDE in February 2011; and
2. The 25 percent statewide GHG emissions reduction goal established in the Maryland Greenhouse Gas Emissions Reduction Act of 2009.

4.1 2020 Emissions Reduction Overview

Table 4.1 presents a summary of the total 2020 transportation sector emission reductions and costs broken down into the following categories: vehicle technologies; transportation fuels; funded and adopted Maryland Plans, Programs, and TERMs; and unfunded GHG reduction strategies that are all included in Section 3.0 of this document.

Table 4.1 Transportation Sector 2020 GHG Emission Reductions and Costs

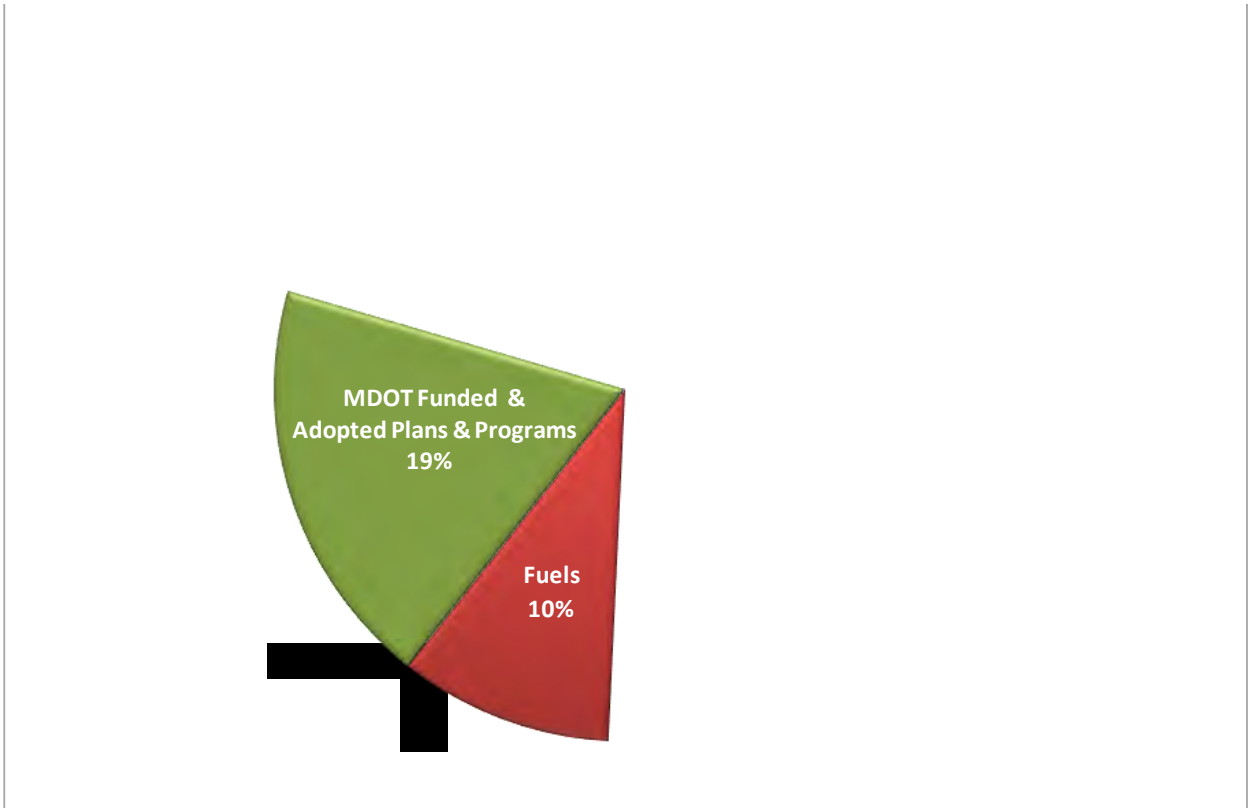
Transportation Sector GHG Reduction Strategy	2020 GHG Reduction (mmt CO_2e)	Total Cost (2010-2020) (billions $)
Vehicle Technologies		
CAFE Standards (2008 – 2011 MY)	2.27	-
National Fuel Economy Standards (Federal) (2012 – 2016 MY)	3.19	-
Maryland Clean Car Program (2011 MY) & Maryland Clean Car or National Fuel Economy Standards (2017 – 2025 MY)	1.14	-
Proposed National 2014-2018 Medium and HDV Standards	0.88	-
Vehicle Technologies Total	**7.48**	**-**
Transportation Fuels		
Renewable Fuel Standard Program (RFS2)	0.24	-
Low Carbon Fuel Standard (5%)	1.21	-
Transportation Fuels Total	**1.45**	**-**

Transportation Sector GHG Reduction Strategy	2020 GHG Reduction (mmt CO_2e)	Total Cost (2010-2020) (billions $)
Funded and Adopted Maryland Plans, Programs and TERMs		
Maryland Plans, Programs, and TERMs Total	**2.79**	**$13.219**
GRAND TOTAL FOR ADOPTED PROGRAMS		
GRAND TOTAL for Vehicle Technology, Transportation Fuels, and Funded Programs	***11.72***	***$13.219***
Unfunded GHG Reduction Strategies		
Land Use and Location Efficiency	**--**	*MDP Responsibility*
Public Transportation	0.39 – 0.62	$1,214 - $1,765
Intercity Passenger and Freight Transportation	0.11	$0.748
Pay-as-you-Drive Insurance	--	*MIA Responsibility*
Bike and Pedestrian	0.16	$0.598 - $0.817
Transportation Pricing and Demand Management	0.24 – 2.01	$0.300 - $3,690
Transportation Technology	0.24	$0.051
Unfunded Strategies Total	**1.14 – 3.14**	**$2.911 - $7.071**
GRAND TOTAL OF MDOT PROGRESS (ADOPTED AND UNFUNDED)		
GRAND TOTAL GHG Reductions and Costs	***12.86 – 14.86***	***$16.130 - $20.290***

The total emission reductions attributable to the transportation sector in 2020 are anticipated to range from 12.86 – 14.86 mmt CO_2e, with an estimated cost spanning $16.130 - $20.290 billion.

Figure 4.1 provides a breakdown of the transportation sector emission reductions by category. Notably, vehicle technologies and fuels, measures that result in little to no direct costs to the state, contribute 61 percent of the transportation sector's 14.86 mmt CO_2e reductions in 2020. MDOT strongly supports these programs and is also committed to the funded and adopted plans and programs that contribute 19 percent of the GHG reductions. Based on future funding availability, the unfunded measures and strategies have the potential to contribute as much as 20 percent of the total 2020 transportation sector emissions reductions.

Figure 4.1 2020 Transportation Sector Emission Reductions by Sector Category



4.2 PROGRESS TOWARD THE MDOT AGENCY-SPECIFIC TARGET

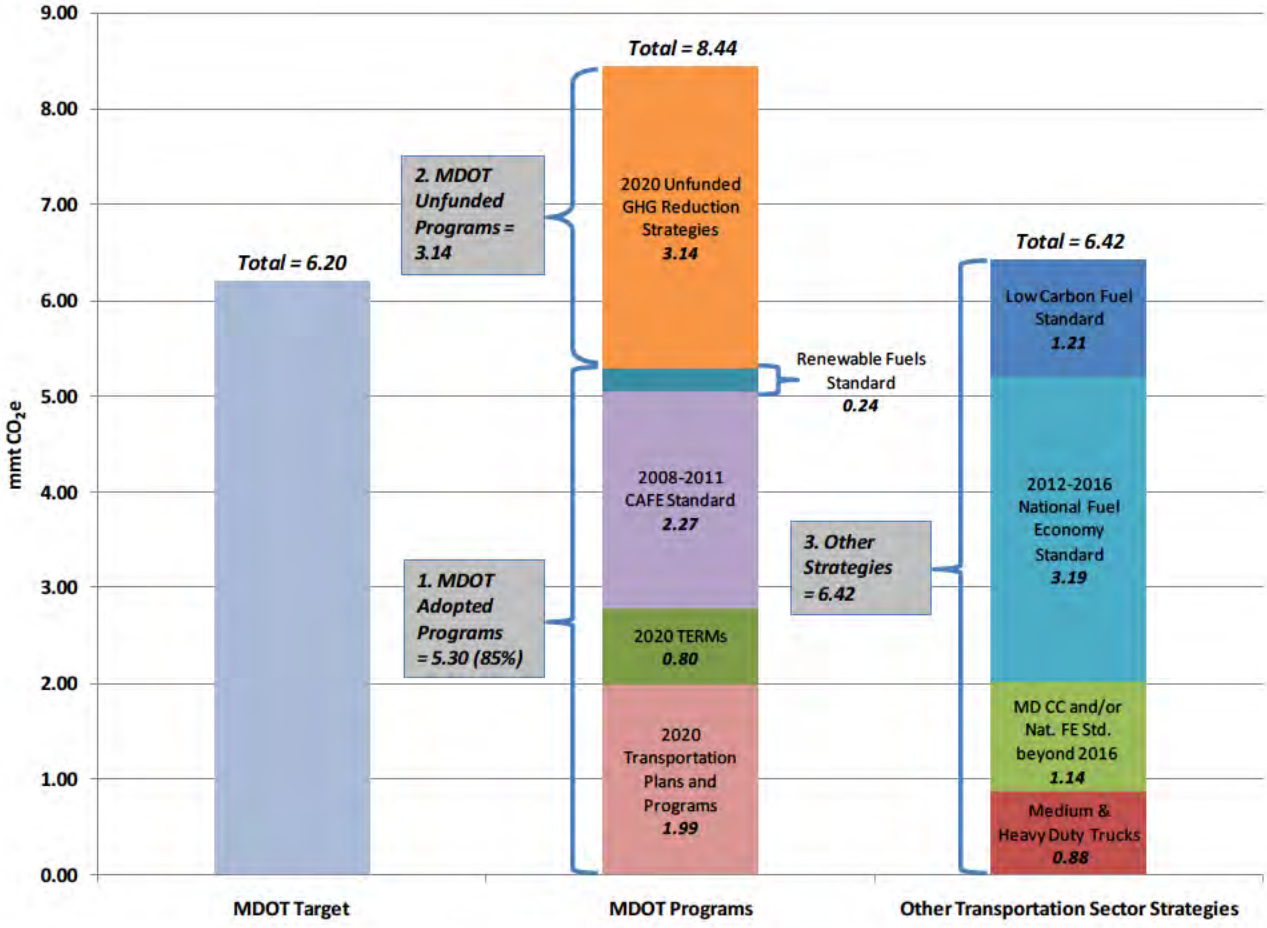
Figure 4.2 provides a summary of the 2020 transportation sector GHG emissions reductions within the context of the MDE-assigned 2020 GHG reduction target of 6.2 mmt CO_2e. The transportation sector reductions have been arranged into three categories for comparison purposes: (1) all MDOT adopted transportation programs, (2) MDOT unfunded transportation programs, and (3) other transportation sector strategies.

1. To date, MDOT has adopted programs that achieve approximately 5.30 mmt CO_2e reductions or 85 percent of the total 2020 target.
2. The unfunded GHG reduction strategies could yield an additional 1.14 – 3.14 mmt CO_2e reduction by 2020.

Should additional funding become available, in total the adopted programs and unfunded strategies would total 8.44 mmt CO_2e in 2020, or 136 percent of the 6.2 mmt reduction target.

3. By 2020, an additional transportation sector emissions reduction of 6.42 mmt CO_2e can be expected from the implementation of state and federal programs addressing cleaner fuels and improved fuel economy standards.

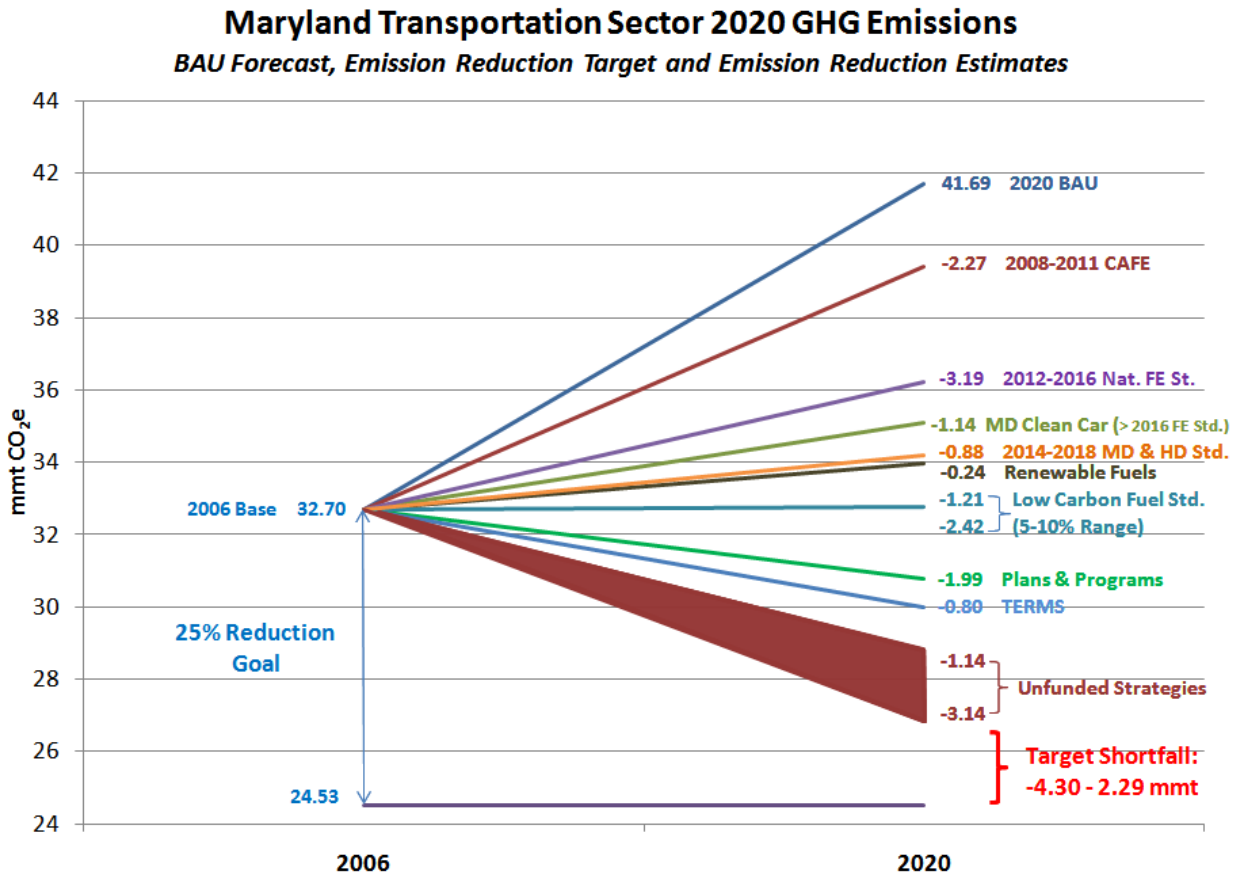
Figure 4.2 Maryland Transportation Sector GHG Emissions – Summary of 2020 GHG Reductions



4.3 TRANSPORTATION SECTOR PROGRESS TOWARD A STATEWIDE 25 PERCENT REDUCTION GOAL

As part of the Phase I and Phase II work program, MDOT used a 25 percent reduction in 2006 emissions as a benchmark to evaluate progress toward GHG reductions by 2020. Figure 4.3 illustrates the anticipated 2020 transportation sector reductions within the framework of a statewide reduction goal of 25 percent below 2006 levels by 2020. In order to achieve a 25 percent GHG emissions reduction from the transportation sector, a 17.16 mmt CO_2e reduction in emissions from the 2020 BAU forecast would be required. At the highest level of strategy implementation, 2020 transportation sector emission reductions could reach as much as 87 percent (14.86 mmt CO_2e) of the 25 percent GHG reduction goal for 2020. The figure further illustrates a 2.29 to 4.30 mmt CO_2e target shortfall for the transportation sector.

Figure 4.3 Maryland 2020 Transportation GHG Emissions Forecast and Reductions



Maryland Climate Action Plan

Maryland Department of Transportation
Draft 2012 Implementation Plan – Appendix

Martin O'Malley, Governor

Anthony G. Brown, Lt. Governor

Beverley K. Swaim-Staley, Secretary

April 11, 2012

Maryland Department of Transportation

report

Maryland Climate Action Plan - MDOT Draft 2012 Implementation Plan - Appendix

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April 11, 2011

Table of Contents

Table of Contents, continued

List of Tables

List of Tables, continued

List of Figures

A. 2006 Baseline and 2020 BAU Emissions Inventory Documentation

This technical analysis report documents the methodology and assumptions used to produce the greenhouse gas (GHG) inventory for Maryland's on-road portion of the transportation sector. Statewide emissions have been estimated for a 2006 baseline and a 2020 forecast business-as-usual (BAU) scenario. The inventory was calculated by estimating emissions for carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Those emissions were then converted to carbon dioxide equivalents that are measured in the units of million metric tons (mmt CO_2e). Carbon dioxide represents about 97 percent of the transportation sector's GHG emissions.

The on-road portion of the inventory was developed using EPA's new emissions model MOVES (Motor Vehicle Emissions Simulator). The inventory results represent an update of previous analyses conducted by the Center for Climate Strategies (CCS) for the Climate Action Plan (CAP) in 2008 and MDOT's Draft Implementation Plan, dated November 2009. Those inventory efforts were performed with EPA's MOBILE6.2 emission factor model. The MOVES model provides a more robust estimate of greenhouse gas emissions as compared to the simplified approaches used in MOBILE6.2. In MOVES, greenhouse gases are calculated from vehicle energy consumption rates and vary by vehicle operating characteristics including speed. In addition, the MOVES model includes the affects of current regulations on future vehicle fuel economy standards.

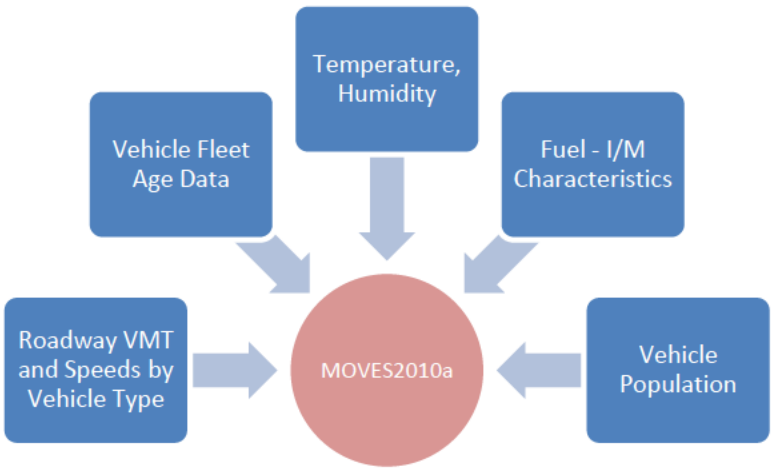
The off-road portion of the transportation sector uses emission rates and data from EPA's State Greenhouse Gas Inventory Tool (SIT). The data and assumptions were developed for the November 2009 MDOT Draft Implementation Plan and remains unchanged.

On-Road Analysis Process

The data, tools and methodologies employed to conduct the on-road vehicle GHG emissions inventory were developed in close consultation with MDE and are consistent with the *Technical Guidance on the Use of MOVES2010 for Emission Inventory Preparation in State Implementation Plans and Transportation Conformity, EPA-420-B-10-023, April 2010*. EPA's MOVES model was officially released on March 2, 2010 and was followed with a revised version (MOVES2010a) in August 2010. The MOVES2010a version incorporates new car and light truck greenhouse gas emissions standards for model years 2012-2016 and updates effects of corporate average fuel economy standards for model years 2008-2011. The MOVES2010a model estimates the reductions in greenhouse gases associated with those standards in future calendar years.

As illustrated in Figure A.1, the MOVES2010a model has been integrated with local traffic, vehicle fleet, environmental, fuel, and control strategy data to estimate statewide emissions.

Figure A.1 Emission Calculation Data Process



The modeling assumptions and data sources were developed in coordination with MDE and are consistent with other SIP-related inventory efforts. The process represents a "bottom-up" approach to estimating statewide GHG emissions based on available roadway and traffic data. A "bottom-up" approach provides several advantages over simplified "top-down" calculations using statewide fuel consumption. These include:

- Addresses potential issues related to the location of purchased fuel. Vehicle trips with trip ends outside of the state (e.g. including "thru" traffic) create complications in estimating GHG emissions. For example, commuters living in Maryland may purchase fuel there but may spend much of their traveling in Washington D.C. The opposite case may include commuters from Pennsylvania working in Maryland. With a "bottom-up" approach emissions are calculated for all vehicles using the transportation system.
- Allows for a more robust forecasting process based on historic trends of VMT or regional population and employment forecasts and their relationship to future travel. For example, traffic data can be forecasted using growth assumptions determined by the MPO through their analytic (travel model) and interagency consultation processes.

GHG emission values are reported as annual numbers for the 2006 baseline and 2020 BAU scenarios. The annual values were calculated based on 12 monthly MOVES runs as summarized in Figure A.2. Each monthly run used traffic volumes, speeds, temperatures and fuel values specific to an average day in each month.

Figure A.2 Calculation of Annual Emissions

For the 2006 and 2020 BAU emissions inventory, the traffic data was based on roadway segment data obtained from the Maryland State Highway Administration (SHA). This data does not contain information on congested speeds and the hourly detail needed by MOVES. As a result, post processing software (PPSUITE) was used to calculate hourly congested speeds for each roadway link, apply vehicle type fractions, aggregate VMT and VHT, and prepare MOVES traffic-related input files. The PPSUITE software and process methodologies are consistent with that used for state inventories and transportation conformity analyses throughout Maryland.

Other key inputs including vehicle population, temperatures, fuel characteristics and vehicle age were obtained from and/or prepared in close coordination with MDE staff. The following sections summarize the key input data assumptions used for the inventory runs.

Summary of Data Sources

A summary of key input data sources and assumptions are provided in Table A.1. Many of these data inputs are consistent to those used for SIP inventories and conformity analyses. There are several data items that require additional notes.

Traffic volumes and VMT are forecasted for the 2020 BAU analysis. A discussion of forecasted traffic volumes and vehicle miles of travel (VMT) is discussed in more detail in the following section.

Vehicle population is a key input that has an important impact on start and evaporative emissions. At the time of this study, final decisions (per MDE consultation) had not been made on the use of Maryland registration data as a surrogate for vehicle population. In urban areas, registration data can over-estimate the actual number of daily vehicle trips due to high transit usage. As a result, for this study, vehicle population was calculated from VMT using MOVES default estimates for the typical miles per vehicle by source type (e.g. vehicle type). The PPSUITE post processor automatically prepares the vehicle population file under this method. This alternative was determined to be acceptable for this inventory, especially considering that start and evaporative emissions are much lower for CO_2 as compared to other pollutants.

The vehicle mixes is another important file that is used to disaggregate total vehicle volumes and VMT to the 13 MOVES source types. MDE is still reviewing options to prepare these data input assumptions. For this inventory, the vehicle mix was calculated based on 2008 SHA vehicle type pattern percentages by functional class, which disaggregates volumes to four vehicle types: light-duty vehicles, heavy-duty vehicles, buses, and motorcycles. As illustrated in Figure A.3, the four vehicle groups were related to EPA's MOBILE6.2 weight-based vehicle

categories. EPA's MOVES Technical Guidance was then used to convert the MOBILE6.2 categories to the MOVES source types.

Figure A.3 Defining Vehicle Types

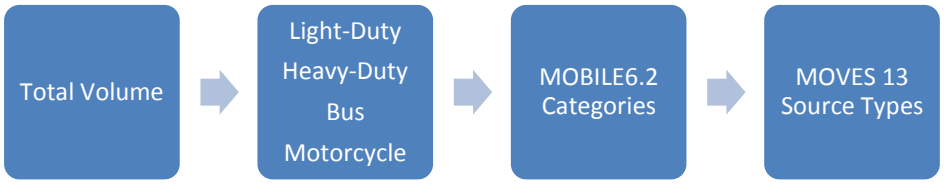


Table A.1 Summary of Key Data Sources

Data Item	Source	Description	Difference between 2006 and 2020BAU
Roadway Characteristics	2008 Maryland State Highway Administration (SHA) Universal Database	Includes lanes, segment distance, facility type, speed limit	*Same Data Source*
Traffic Volumes	2008 Maryland State Highway Administration (SHA) Universal Database	Average Annual Daily Traffic Volumes (AADT)	Volumes forecasted for 2020 BAU
Seasonal Adjustments	SHA 2008 *ATR Station Reports in the Traffic Trends System Report Module* from the SHA website	Adjust AADT to average day in each month	*Same Data Source*
VMT	Highway Performance Monitoring System 2006	Used to adjust VMT to the reported 2006 HPMS totals by county and functional Class	VMT forecasted for 2020 BAU
Hourly Patterns	SHA 2008 *Traffic Trends System Report Module* from the SHA website	Used to disaggregated volumes and VMT to each hour of the day	*Same Data Source*
Vehicle Type Mix	2008 SHA vehicle pattern data; MOVES Technical Guidance	Used to split traffic volumes to the 13 MOVES vehicle source types	*Same Data Source*
Ramp Fractions	MOVES Defaults	MOVES Defaults	*Same Data Source*
Vehicle Ages	2008 Maryland Registration data	Provides the percentage of vehicles by each model year age	*Same Data Source*
Hourly Speeds	Calculated by PPSUITE Post Processor	Hourly speed distribution file used by MOVES to estimate emission factors	Higher volumes produce lower speeds in 2020 BAU
I/M Data	Provided by MDE	Based on 2006 and current I/M program	Different I/M Program Characteristics
Fuel Characteristics	Provided by MDE	Fuel characteristics vary from 2006-2012 then constant to 2020	Different Fuel Characteristics
Temperatures	Provided by MDE	Average Monthly Temperature sets	*Same Data Source*

Vehicle Population	Calculated by PPSUITE Post Processor; MOVES Default Miles/Vehicle Data	Vehicle population calculated by PPSUITE from VMT using MOVES Default miles/vehicle estimates	2020 BAU based on VMT growth

Traffic Volume and VMT Forecasts

The traffic volumes and VMT within the SHA traffic database were forecast to estimate future year emissions. Several alternatives are available to determine forecast growth rates, ranging from historical VMT trends to the use of MPO-based travel models that include forecast demographics for distinct areas in each county.

For the 2020 BAU scenario, the forecasts were determined using assumptions from the original Maryland CAP, which was based on historic trends of 1990-2006 HPMS VMT growth. Table A.2 summarizes the growth rates by county. The average statewide annualized growth rate was assumed to be 1.8 percent. Table A.3 summarizes total 2006 baseline and 2020 forecast VMT by vehicle type.

Table A.2 VMT Annual Growth Rates (Per Maryland CAP) for 2020 BAU

County	Annualized 2006-2020 Growth
Allegany	1.3%
Anne Arundel	2.0%
Baltimore	1.3%
Calvert	2.5%
Caroline	1.3%
Carroll	1.9%
Cecil	2.4%
Charles	2.2%
Dorchester	0.9%
Frederick	2.5%
Garrett	1.4%
Harford	1.8%
Howard	3.2%
Kent	0.5%
Montgomery	1.5%
Prince George's	1.7%
Queen Anne's	2.2%
Saint Mary's	2.0%
Somerset	0.9%
Talbot	1.8%
Washington	2.1%
Wicomico	1.5%
Worcester	1.3%
Baltimore City	0.8%
Statewide	***1.8%***

Table A.3 2006 Baseline and 2020 BAU VMT by Vehicle Type

Annual VMT	2006 Baseline	2020 BAU
Light Duty	51,212	63,878
Medium/Heavy Duty Truck & Bus	5,406	6,775
Total VMT	***56,618***	***70,653***

The analysis process (e.g. using PPSUITE post processor) re-calculates roadway speeds based on the forecast volumes. As a result, future year emissions are sensitive to the impact of increasing traffic growth on regional congestion.

Vehicle Technology Adjustments

The MOVES2010a emission model includes the effects of the following post-2006 vehicle programs on future vehicle emission factors:

- *CAFE Standards (Model Years 2008-2011)* – Vehicle model years through 2011 are covered under existing CAFE standards that will remain intact under the Obama Administration's national program.
- *National Program (Model Years 2012-2016)* – The light-duty vehicle fuel economy for model years between 2012 and 2016 are based on the May 7, 2010 Rule "*Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule" (EPA-HQ-OAR-2009-0472-11424:http://www.regulations.gov/#!documentDetail;D=EPA-HQ-OAR-2009-0472-11424*). Fuel economy improvements begin in 2012 until an average 250 gram/mile CO_2 standard is met in year 2016. This equates to an average fuel economy near 35 mpg.

The above technology programs were not included in the 2020 BAU, as they are included as credits applied to BAU emissions. To remove the potential emission credits of both of these programs, the MOVES2010a default database was revised. Fuel economy assumptions within MOVES2010a are provided as vehicle energy consumption rates within the "EmissionRates" table as illustrated in Figure A.4.

Figure A.4 MOVES Default "EmissionRate" Table

sourceBinID	polProcessID	opModelID	meanBaseRate	meanBaseRate	meanBaseRateIM	meanBaseRate	dataSourceId
1010146900000000000	601	300	0.814636		0.814636		406
1010147900000000000	601	300	0.814636		0.814636		406
1010146900000000000	602	100	0.294065		0.294065		406
1010147900000000000	602	100	0.294065		0.294065		406
1010146940000000000	601	300	0.814636		0.814636		406
1010147940000000000	601	300	0.814636		0.814636		406
1010146940000000000	602	100	0.294065		0.294065		406
1010147940000000000	602	100	0.294065		0.294065		406
1010146850000000000	601	300	0.517222		0.517222		406
1010146850000000000	602	100	0.186705		0.186705		406
1010146950000000000	601	300	0.814636		0.814636		406
1010147950000000000	601	300	0.814636		0.814636		406
1010146950000000000	602	100	0.294065		0.294065		406
1010147950000000000	602	100	0.294065		0.294065		406
1010146960000000000	601	300	1.55422		1.55422		406
1010147960000000000	601	300	1.55422		1.55422		406
1010146960000000000	602	100	0.56104		0.56104		406
1010147960000000000	602	100	0.56104		0.56104		406
1010146970000000000	601	300	1.66641		1.66641		406
1010147970000000000	601	300	1.66641		1.66641		406
1010146970000000000	602	100	0.601537		0.601537		406
1010147970000000000	602	100	0.601537		0.601537		406
1010146980000000000	601	300	1.69344		1.69344		406

To remove the benefits of the 2008-2011 CAFE standards and the 2012-2016 National Program, the database was revised so that all energy rates beyond 2007 were the same for each vehicle type, model year and fuel type. The table was updated per the following steps:

1. Open the "EmissionRate" table in the latest MOVES2010a default database (named: movesdb20100830). The fields to be modified include: *meanBaseRate* & *meanBaseRateIM* (values in both fields are the same)
2. Select records in the table that are related to energy consumption. This includes records with the polProcessID = 9101, 9102 and 9190.
3. Use the sourceBinID field to determine how each record correlates to vehicle type, model year and fuel type.
4. Modify meanBaseRate & meanBaseRateIM fields to be same for all model years beyond 2007 for the applicable vehicle type, model year and fuel type.

Emission Results

The 2006 and 2020 BAU emission results for the Maryland statewide GHG inventory are provided in Table A.4 and A.5 respectively. Within each table, emissions are also provided by fuel type and vehicle type.

Table A.4 2006 Annual On-Road GHG Emissions (mmt CO_2e)

	VMT (Millions)	CO_2	CH_4	N_2O	CO_2e
TOTAL	**56,618**	**29.101**	**0.047**	**0.521**	**29.67**
By Fuel Type					
Gasoline	52,720	23.195	0.0462	0.5183	**23.76**
Diesel	3,898	5.907	0.0003	0.0030	**5.91**
By MOVES Vehicle Type					
Motorcycle	319	0.120	0.0005	0.0004	**0.12**
Passenger Car	29,337	10.959	0.0178	0.1722	**11.15**
Passenger Truck	18,070	9.460	0.0202	0.2571	**9.74**
Light Commercial Truck	5,833	3.117	0.0067	0.0833	**3.21**
Intercity Bus	15	0.027	0.0000	0.0000	**0.03**
Transit Bus	40	0.052	0.0000	0.0000	**0.05**
School Bus	129	0.124	0.0002	0.0008	**0.13**
Refuse Truck	33	0.056	0.0000	0.0000	**0.06**
Single Unit Short-haul Truck	655	0.656	0.0008	0.0054	**0.66**
Single Unit Long-haul Truck	49	0.047	0.0000	0.0003	**0.05**
Motor Home	20	0.021	0.0000	0.0002	**0.02**
Combination Short-haul Truck	1,163	2.339	0.0001	0.0008	**2.34**
Combination Long-haul Truck	953	2.123	0.0001	0.0006	**2.12**

Table A.5 2020 BAU Annual On-Road GHG Emissions (mmt CO_2e)

	VMT (Millions)	CO_2	CH_4	N_2O	CO_2e
TOTAL	**70,653**	**38.360**	**0.048**	**0.186**	**38.59**
By Fuel Type					
Gasoline	65,686	30.502	0.0277	0.1815	**30.71**
Diesel	4,967	7.858	0.0201	0.0041	**7.88**
By MOVES Vehicle Type					
Motorcycle	402	0.155	0.0005	0.0006	**0.16**
Passenger Car	36537	14.247	0.0102	0.0744	**14.33**
Passenger Truck	22587	12.693	0.0137	0.0786	**12.79**
Light Commercial Truck	7295	4.177	0.0056	0.0268	**4.21**
Intercity Bus	18	0.033	0.0000	0.0000	**0.03**
Transit Bus	48	0.064	0.0001	0.0000	**0.06**
School Bus	155	0.155	0.0004	0.0004	**0.16**
Refuse Truck	45	0.077	0.0001	0.0000	**0.08**
Single Unit Short-haul Truck	805	0.852	0.0012	0.0024	**0.86**
Single Unit Long-haul Truck	75	0.075	0.0001	0.0002	**0.08**
Motor Home	27	0.029	0.0000	0.0001	**0.03**
Combination Short-haul Truck	1349	2.791	0.0016	0.0010	**2.79**
Combination Long-haul Truck	1309	3.013	0.0144	0.0010	**3.03**

Fuel Consumption Estimates

The MOVES output energy rates can be converted to fuel consumption values using standard conversion rates for gasoline and diesel fuel. Table A.6 provides the estimated 2006 and 2020BAU fuel consumption values. The 2006 values were compared to available information from FHWA and the Energy Information Administration (EIA). Differences result from the application of a "bottom-up" analysis approach and the issues discussed at the beginning of this Appendix.

Table A.6 2006 and 2020 BAU Fuel Consumption

Scenario	Fuel Type	MOVES2010a Output		Actual Statewide Fuel Sales[2] *(Thousand gallons)*
		Energy Consumption *(Trillion BTU)*	Estimated Fuel Consumption[1] *(Thousand Gallons)*	
2006	Gasoline	305.9	2,462,240	2,642,371
	Diesel	76.3	550,454	558,703
2020 BAU	Gasoline	402.3	3,237,943	-----
	Diesel	101.6	732,275	-----

Notes:

(1) Assumes following conversion rates:

- 1 gallon of gasoline fuel = 124,238 BTU
- 1 gallon of diesel fuel = 138,690 BTU
- http://www.eia.doe.gov/kids/energy.cfm?page=about_energy_conversion_calculator-basics

(2) On-highway Gasoline Fuel Consumption:

- FHWA - Highway Statistics 2007: Highway use of motor fuel - 2006, Table MF-27
- http://www.fhwa.dot.gov/policy/ohim/hs06/motor_fuel.htm

On-highway Diesel Fuel Consumption:

- EIA - Sales of Distillate Fuel Oil by End Use - Maryland
- http://tonto.eia.doe.gov/dnav/pet/pet_cons_821dst_dcu_SMD_a.htm

B. CTP, MPO TIP and CLRP Project Listings by Policy Option

The results presented in this Appendix summarize total costs by program and lists all projects and TERMs by transportation GHG reduction policy option. The review of project, program and TERM costs within the 2011-2016 CTP and MPO plans are sourced from the following documents:

- MDOT 2011 – 2016 Consolidated Transportation Program
- MWCOG 2011-16 TIP and 2010 CLRP adopted 11/17/10
- BRTB 2011-14 TIP adopted 7/27/10 and Transportation Outlook 2035 (adopted 11/07, amended 2/24/09)
- Hagerstown/Eastern Panhandle MPO 2010-2013 TIP adopted 6/16/10 and 2035 LRMTP adopted 4/28/10
- Salisbury-Wicomico MPO 2010-2013 TIP adopted 9/28/09 and Draft 2010 LRTP scheduled for adoption in October 2010
- Cumberland Area MPO 2010-2013 TIP adopted 10/15/09 and Draft 2010 LRTP schedule for adoption in October 2010
- WILMAPCO DRAFT 2012-2015 TIP and 2040 RTP (adopted 10/10)

The tables within this Appendix are described below:

- **Table B.1: Draft Cost Summary and 2020 GHG Reduction by Program / Transportation GHG Reduction Policy Option**

  A summary of total project cost by transportation sector policy option for capital projects and TERMs in 2011-2016 CTP and most recent MPO planning documents. The 2020 GHG reduction's presented in this table have been updated in 2011 per a new assessment of VMT growth rates, new data on implementation of TERMs, and new emission factors resulting from the transition from Mobile6 to MOVES.

- **Table B.2: Funded Maryland Plans, Programs and TERMs – Projects and Costs Grouped by Transportation GHG Reduction Policy Option**

  Project, program and TERM specific listing by transportation sector policy option including project source document, description and total cost.

Table B.1 Funded and Committed Maryland Plans, Programs, and TERMs Cost Summary

Program Element by Transportation GHG Reduction Policy Option	Total Cost (2011-2020) (billions $)[5]
Maryland Plans and Programs [(1)]	**$12.736**
Land Use and Location Efficiency	*MDP Responsibility*
Public Transportation	$6.757
Intercity Passenger and Freight Transportation	$3.085
Bike and Pedestrian	$1.269
Transportation Pricing and Demand Management	$1.375
Transportation Technology	$0.250
Maryland TERMs [(2)]	**$0.483**
Land Use and Location Efficiency	*MDP Responsibility*
Public Transportation	$0.206
Intercity Passenger and Freight Transportation	$ -
Bike and Pedestrian	$0.116
Transportation Pricing and Demand Management	$0.022
Transportation Technology	$0.139
TOTAL	**$13.219**

Notes:

1) Projects that contribute to a decrease in VMT growth and/or improve system efficiency are a subset of the complete state capital program. These are projects and programs that act to reduce VMT and/or delay by adding capacity, improving flow, managing travel demand, reducing bottlenecks, or improving overall system efficiency through enhanced system management and operations. These projects are multimodal in nature and span multiple agencies, including MdTA, MAA, MPA, MTA and SHA as well as regional and local transit operators.

2) Transportation Emission Reduction Measures (TERMs) identified in the CTP and MPO TIPs and LRPs to meet criteria pollutant targets, as well as continuation of current programs such as Commuter Connections, CHART, and Metropolitan Area Transportation Operations Coordination (MATOC) are assessed to determine estimates of GHG emission reductions and costs through 2020.

5) Projects listed within the 2011-2016 CTP and MWCOG and BRTB TIP/CLRP adopted or amended since June 2010 and the most recent or available draft versions of plans for Cumberland, Hagerstown/Eastern Panhandle, Salisbury/Wicomico and WILMAPCO.

Table B.2 Funded Maryland Plans, Programs and TERMs – Projects and Costs Grouped by Representative GHG Reduction Policy Option

Source	Project/Facility	Description	Project Type	Updated Costs (in 000$)	Updated Year Open/ Completion
FY 2011-16 CTP	MARC Frederick Extension	Service extension from Point of Rocks to City of Frederick including downtown Frederick and suburban stations connecting to the Brunswick Line and providing access to Washington, D.C.	Transit Construction	$4,186	Ongoing
FY 2011-16 CTP	MARC Improvements on Camden, Brunswick, and Penn Lines	Ongoing program of improvements on the MARC Camden, Brunswick, and Penn lines to ensure safety and quality of service.	Transit Construction	See intercity transportation	Ongoing
FY 2011-16 CTP	MARC Edgewood Station	Phase I of the project includes expanded parking and ADA platform improvements. Phase II improvements are to include replacement of the existing station trailer with a permanent building and site enhancements to enhance customer service and provide improved ADA access.	Transit Construction	$4,998	2013
FY 2011-16 CTP	MARC Growth and Investment Plan	Purchase of new railcars, improvements to station facilities and rail infrastructure, and expansion of parking are planned.	Transit Construction	$141,006	Ongoing
FY 2011-16 CTP	Paul S. Sarbanes Transit Center	This project provides a fully integrated transit center at the Silver Spring Metrorail Station. It includes the construction of bus bays for Metrobus and Ride On, an intercity bus facility, a taxi queue area, kiss and ride parking, and a MARC ticketing office.	Transit Construction	$66,133	2012
FY 2011-16 CTP	MARC Halethorpe Station Improvements	Phase I of the project provided an additional 428 surface parking spaces at the Halethorpe MARC Station. Phase II includes installation of high level platforms, a pedestrian bridge, new shelters, lighting, streetscaping, and improved ADA access.	Transit Construction	$19,285	2011

Source	Project/Facility	Description	Project Type	Updated Costs (in 000$)	Updated Year Open/ Completion
FY 2011-16 CTP	Owings Mills Joint Development	Project involves a master plan and site infrastructure improvements for joint development of the existing 46-acre surface parking lot at Owings Mills Metro Station.	Transit Construction	$13,879	2014
FY 2011-16 CTP	Metro Train Control System Upgrade	Project will replace the existing train control system. The current electronic components have exceeded recommended industry standard life cycles. The new technology will add reliability and provide new diagnostic capabilities for servicing.	Transit Construction	$25,043	2015
FY 2011-16 CTP	Metro Station Fire Management Systems (SCADA)	Design, acquisition, and installation efforts to replace equipment for the Metro system.	Transit Construction	$11,295	2012
FY 2011-16 CTP	Bus Procurement	Annual purchase of clean diesel hybrid electric buses to replace those that have been in service for 12 or more years.	TERM	See transportation technology	Ongoing
FY 2011-16 CTP	Bus On-Board CCTV Retrofit	Retrofit 541 buses with an on-board wireless closed circuit television (CCTV) system that will be compatible with the system being procured for new buses. The new system will link to various system components such as vehicle monitoring, automatic vehicle location (AVL), voice announcements and passenger counters.	Transit Operations	$10,187	2013
FY 2011-16 CTP	Replacement of Fare Collection Equipment and Smart Card	Replace existing fare collection equipment on Bus, Light Rail and Metro Subway with automatic fare collection equipment which includes the implementation of smart card technology and credit card readers on the rail systems. The project also includes the implementation of a customer service center to support the MTA and Washington Region transit properties.	TERM	$12,098	Complete
FY 2011-16 CTP	Intercounty Connector Buses	Purchase motor coaches to provide express bus service on the ICC when complete.	Transit Construction	$10,000	2011

Source	Project/Facility	Description	Project Type	Updated Costs (in 000$)	Updated Year Open/ Completion
FY 2011-16 CTP	CAD/AVL Systems	Provides radio data channel expansion to improve the bus fleet's voice and data communication. Will improve customer service by providing real time management and schedule adherence.	Transit Operations	See transportation technology	2011
FY 2011-16 CTP	Closed Circuit Television Improvements	Installation of CCTV equipment in stations and maintenance facilities. Phase I of the project included 1 Light Rail and 10 Metro locations. Phase II includes additional work at 4 Metro, 1 MARC and 5 Light Rail Stations as well as the Metro Portal.	Transit Operations	$2,740	2011
FY 2011-16 CTP	Southern Maryland Commuter Bus Initiative	Construction of Commuter Bus Park and Ride lots at Dunkirk, Prince Frederick, Waldorf, La Plata, Charlotte Hall, and Newmarket in Southern Maryland.	Transit Construction	$28,807	2014
FY 2011-16 CTP	Locally Operated Transit Systems Capital Procurement Projects (Local Jurisdictions)	Funding to rural and small jurisdictions for transit vehicles, equipment and facilities. In addition, the MTA provides rideshare funds to Baltimore City, Anne Arundel, Baltimore, Calvert, Carroll, Frederick, Harford, Howard, Montgomery and Prince George's Counties and the Tri-County Council for Southern Maryland to promote the use of carpools and vanpools. MTA facilitates federal funds for locally-sponsored projects.	Transit Construction	$115,900	Ongoing
FY 2011-16 CTP	Montgomery County Local Bus Program	Funding for annual bus replacement. The current program funds approximately six to ten buses for replacement of existing Ride On vehicles, fareboxes, and stop annunciators.	Transit Construction	$12,700	Ongoing
FY 2011-16 CTP	Prince George's County Local Bus Program	Annual funding for approximately 3-5 buses per year to replace existing vehicles in the County's "The Bus" fleet.	Transit Construction	$4,120	Ongoing
FY 2011-16 CTP	MARC West Baltimore Station Parking Expansion	Construct additional parking spaces at the West Baltimore MARC Station in Baltimore City.	Transit Construction	$9,755	2013

Source	Project/Facility	Description	Project Type	Updated Costs (in 000$)	Updated Year Open/ Completion
FY 2011-16 CTP	Takoma/Langley Park Transit Center	Construction of an off-street transit center at the intersection of MD 193 and MD 650 in the Takoma/Langley Park community.	Transit Construction	$24,188	2013
FY 2011-16 CTP	Capital Program Support Fund	MTA agency wide improvements – ongoing and FY 2011	System Preservation Minor Projects Program	$3,600	2011, 2012
FY 2011-16 CTP	Charles County-Expansion Buses	Project underway	LOTS	$910	Underway
FY 2011-16 CTP	Harford County Expansion Buses (ARRA)	12 heavy-duty low-floor hybrid expansion buses	LOTS	$4,212	2011
FY 2011-16 CTP	Howard County Expansion Buses (ARRA)	Bus expansion	LOTS	$1,620	2011
FY 2011-16 CTP	Howard Street Revitalization	This project is part of the Main Howard Street Revitalization Project.	Transit Construction	$3,843	2012
FY 2011-16 CTP	Washington Blvd. Improvements		System Preservation Minor Projects Program	$2,162	2011
FY 2011-16 CTP	Light Rail Parking Expansion (ARRA)		System Preservation Minor Projects Program	$3,460	Underway
FY 2011-16 CTP	Real Time Passenger Information Systems		System Preservation Minor Projects Program	$2,570	Underway
FY 2011-16 CTP	WMATA Capital Improvement Program	This program includes Maryland's share of funding for WMATA's CIP.	Transit Construction	$1,027,437	Ongoing
FY 2011-16 CTP	Matching Funds for Passenger Rail Investment and Improvement Act of 2008	The federal legislation authorizes new federal funds to be appropriated over a 10 year period for WMATA. The federal legislation also requires $50.0 million per year from each jurisdiction in matching funds. Maryland has funded the first five years of this match.	Transit Construction	$300,000	Ongoing

Source	Project/Facility	Description	Project Type	Updated Costs (in 000$)	Updated Year Open/ Completion
FY 2011-16 CTP	Rail Cars/Capital Improvement Program	Funds Maryland's share of 48 new rail cars that were ordered in FY 2003. This program also funds Maryland's allocated share of the WMATA development and evaluation program.	Transit Construction	$6,456	Ongoing
FY 2011-16 CTP	WMATA ARRA Capital Program	Capital projects include bus procurement, station improvements, and upgrades to operation systems.	Transit Construction	$18,870	2011
FY 2011-16 CTP	Metro Matters Railcars and Buses	The Metro Matters funding agreement was executed in October, 2004 and outlines an integrated financial plan that will fund the IRP and SAP through FY 2010. The plan will rely on local, state, and federal funding and short and long term debt as necessary. Projects include all system infrastructure, rolling stock, vehicles and equipment.	Transit Construction	$62,712	Ongoing
BRTB 2011-2014 TIP	MARC Aberdeen Station Parking Expansion	Development of Plans and Environmental Documentation for two-phase expansion of parking capacity at the Aberdeen MARC Station on an MTA-owned parcel at Taft Street (Phase I, approximately 65 spaces) and along APG Road below East Bel Air Avenue (Phase II, approximately 90 spaces), opposite the station building.	TERM	$1,741	2012
BRTB 2011-2014 TIP	Local Bus Replacement	Routine replacement of buses past their useful service life with new hybrid electric buses. This project will provide the replacement of three diesel vehicles with three clean diesel hybrid buses for Howard Transit.	TERM	$594	2011
BRTB 2011-2014 TIP	CMAQ Areawide	The BRTB will use a competitive selection process to select $800,000 worth of Congestion Mitigation and Air Quality Improvement Program (CMAQ) projects in FY 2011. CMAQ projects reduce air pollution emissions from the transportation sector.	TERM	$1,700	Ongoing

Source	Project/Facility	Description	Project Type	Updated Costs (in 000$)	Updated Year Open/ Completion
BRTB 2011-2014 TIP	Mobility Bus Implementation	Project includes a mobile command center designed to provide communications and system interfaces that allow for the scheduling and control of paratransit service in case of an emergency and for fleet expansion and replacement	TERM	$5,244	2013
BRTB 2011-2014 TIP	Local Bus & Facilities - Annapolis	Capital assistance to the City of Annapolis for their transit system to purchase vehicles, equipment and facilities.	TERM	$2,680	Ongoing
BRTB 2011-2014 TIP	Rural Transit Systems-Capital	Capital assistance to purchase vehicles, equipment, and facilities. (Anne Arundel, Howard, Baltimore County	LOTS	$198	Ongoing
BRTB 2011-2014 TIP	Job Access and Reverse Commute Program	Develop transportation services designed to transport welfare recipients and low-income individuals to and from jobs and develop transportation services for residents of urban, suburban, and rural areas to suburban employment sites.	Transit	$8,755	Ongoing
BRTB 2011-2014 TIP	Small Urban Transit Systems-Capital	Capital assistance to purchase vehicles, equipment, and facilities. (Harford and Carroll County)	LOTS	$3,730	Ongoing
BRTB 2011-2014 TIP & Transportation Outlook 2035	Bus Replacements	Routine replacement of buses past their useful service life with new hybrid buses. Planned fleet replacement of 50-100 buses to hybrid diesel buses each of the next four years depending on funding.	TERM	$166,694	Ongoing
BRTB Transportation Outlook 2035	Red Line-Regional [1]	Construct an east-west rapid transit system from Social Security area to Bayview Medical Center	Transit	$1,538,750	2015
BRTB Transportation Outlook 2035	MARC-East Baltimore	New station	Transit	$70,000	2015

Source	Project/Facility	Description	Project Type	Updated Costs (in 000$)	Updated Year Open/ Completion
BRTB Transportation Outlook 2035	MARC-Middle River	Relocate with station improvements	Transit	$15,000	2015
BRTB Transportation Outlook 2035	MARC-Aberdeen	Relocate with station improvements	TERM	$15,000	2015
BRTB Transportation Outlook 2035	Expand real-time transit information	Expand accuracy and availability of real-time bus schedules.	Transit Information	$10,000	2013
HEPMPO Draft FY 2010-13 TIP	Small Urban Transit System-Capital	Capital assistance for vehicles and equipment.	Transit	$923	2010
MWCOG 2010 CLRP	Purple Line Transitway [2]	Construction of Bethesda to New Carrollton	Transit	$1,716,000	2020
MWCOG 2010 CLRP	Corridor Cities Transitway (CCT) [3]	Bus rapid transit line along a 14-mile corridor from Rockville through Quince Orchard, Gaithersburg and Germantown to Clarksburg.	Transit	$1,193,000	2020
MWCOG 2010 CLRP	Veirs Mill Road Bus Enhancement	Rockville to Wheaton	Transit	$15,000	2020
MWCOG 2010 CLRP	Four Corners Transit Center	Construct Four Corners Transit Center US 29/MD 193	Transit	$2,565	2015
MWCOG 2010 CLRP	Olney Transit Center	Olney Transit Center, adjacent to or north of MD 108	Transit	$1,000	2015
MWCOG 2010 CLRP	University Blvd Bus Enhancement	Kensington to Silver Spring	Transit	$500	2020
MWCOG 2010 CLRP	Norbeck Road Park and Ride	Norbeck Road Park and Ride, Norbeck Rd. at Georgia Avenue	Transit	$200	2015
MWCOG 2010 CLRP	White Oak Transit Center	Along Lockwood Drive east of New Hampshire Avenue	Transit	$1,791	2010
MWCOG 2010 CLRP	I-95/495: Branch Avenue Metro Access	Construct 8-lane access road to improve access to Branch Avenue METRO Station	Transit	$127,592	2020

Source	Project/Facility	Description	Project Type	Updated Costs (in 000$)	Updated Year Open/ Completion
MWCOG 2011-16 TIP	Bus Purchases - ARRA	This ARRA project provides $6,550,000 for the purchase of one diesel bus and additional hybrid buses.	Transit Improvements	$6,550	Ongoing
MWCOG 2011-16 TIP	Montgomery Mall Transit Center	This project provides for the County portion of the new Montgomery Mall Transit Center.	Transit Improvements	$1,100	2011
MWCOG 2011-16 TIP	Public Transit Systems	Provision of vehicles, equipment and other projects in support of public transportation. Federal and state assistance with local match. Project selection based on application from local providers.	Transit Improvements	$10,000	Ongoing
MWCOG 2011-16 TIP	Bethesda Metro South Entrance [4]	This project provides access from Elm Street west of Wisconsin Avenue to the southern end of the Bethesda Metrorail Station. Currently there is one entrance, near East-West Highway. The Metrorail station was built with accommodations for a future southern entrance.	Transit Improvements	$60,000	2015
MWCOG 2011-16 TIP	Bus Stop Improvement Program	Installation and improvement of capital amenities at bus stops in Montgomery County.	Transit Improvements	$10,000	Ongoing
WILMAPCO FY 2012-2015 TIP	Small Urban Transit System-Capital Assistance	Capital assistance to the Cecil County Department of Aging.	Transit-System Preservation	$313	Ongoing
WILMAPCO 2040 RTP	MARC Extension - Perryville to Elkton	Extend peak period MARC service from Perryville to Elkton	Transit Construction	$22,204	2020
Public Transportation - TOTAL				**$6,962,996**	
FY 2011-16 CTP	I-295/I-495, National Harbor	Construct access improvements and MD 414 Extended.	Highway Capacity	$4,126	2013
FY 2011-16 CTP	MD 295, Baltimore Washington Parkway	Widen from 4 to 6 lanes from I-695 to I-95 (1.50 miles).	Highway Capacity	$4,982	2012
FY 2011-16 CTP	I-95 Ft. McHenry Tunnel (MDTA)	Moravia Road to the Tunnel Modifications. 4 continuous through lanes.	Highway Capacity	$11,716	2011

Source	Project/Facility	Description	Project Type	Updated Costs (in 000$)	Updated Year Open/ Completion
FY 2011-16 CTP	I-70 Baltimore National Pike	Extension of MD 475 (East Street) from South Street to the proposed Monocacy Boulevard. Includes storm water management, urban diamond interchange, and new MD 355 Bridge.	Highway Capacity	$5,236	2011
FY 2011-16 CTP	I-70 Baltimore National Pike	Widen east of MD 85 to east of MD 144, replace the bridge over Reich's Ford Road, reconstruct the ramps at Monocacy/ Reich's Ford Road	Highway Capacity	$48,646	2014
FY 2011-16 CTP	Francis Scott Key Highway (MDTA)	Interchange improvements at MD 695 and Quarantine Road: Interchange and road improvements.	Interchange Capacity	$5,484	2012
FY 2011-16 CTP	I-95/MD 24 Interchange (MDTA)	I-95/MD 24/MD 924: Phase 1 includes minor improvements and a grade-separated interchange.	Interchange Capacity	$29,334	2012
FY 2011-16 CTP	US 40, Pulaski Hwy	Construct interchange improvements at MD 715	Interchange Capacity	$33,103	2013
FY 2011-16 CTP	US 40, Dual Hwy	Widen US 40 at Edgewood Drive intersection.	Interchange Capacity	$2,081	2011
FY 2011-16 CTP	MARC Improvements on Camden, Brunswick, and Penn Lines	Ongoing program of improvements on the MARC Camden, Brunswick, and Penn lines to ensure safety and quality of service.	Transit Construction	$91,225	Ongoing
FY 2011-16 CTP	Freight Line Grade Crossing Rehabilitation	Crossings in Queen Anne's and Caroline County	System preservation and safety enhancement.	$1,990	Ongoing
FY 2011-16 CTP	Baltimore Intercity Bus Terminal	Construction underway	System Preservation Minor Projects Program	$1,930	2011
FY 2011-16 CTP	MD 5, Branch Avenue	Widen from 4 to 6 lanes from north of MD 373 to US 301 (1.07 miles). Bike/pedestrian accommodations where appropriate.	Highway Capacity w Bike/Ped	See bike and pedestrian	2011

Source	Project/Facility	Description	Project Type	Updated Costs (in 000$)	Updated Year Open/ Completion
FY 2011-16 CTP	BRAC Intersections near Fort Meade	Intersection improvements at key locations along access routes to Ft. Meade. Bike/Ped facilities provided where appropriate.	Intersection w Bike/Ped	See bike and pedestrian	2012
FY 2011-16 CTP	BRAC intersections near Bethesda Naval Center	Intersection improvements along access routes to Bethesda Naval Center. Bike/Ped facilities where appropriate.	Intersection w Bike/Ped	See bike and pedestrian	2012
FY 2011-16 CTP	BRAC Intersections near Aberdeen Proving Grounds	Intersection improvements along access routes to Aberdeen Proving Grounds. Bike/Ped facilities where appropriate.	Intersection w Bike/Ped	See bike and pedestrian	2012
FY 2011-16 CTP	High Speed Rail Passenger Rail Grant Funding for B&P Tunnel	ARRA Funding for PE and NEPA	Intercity Rail	$60,000	
FY 2011-16 CTP	SHA Primary Development and Evaluation Programs	Study's to address safety, congestion concerns on selected state highway corridors.	Highway Capacity	$48,370	
BRTB 2011-2014 TIP	Southeast Infrastructure	Support highway access improvements in SE Baltimore. Includes a new 2 lane extension of Danville St. from Clinton St. to Haven St.	Highway Capacity	$5,500	2013
BRTB 2011-2014 TIP	New Vail Street	Extend New Vail St. 1200 feet north from current terminus at Keith Ave. Project will reduce commercial vehicle traffic on Broening Highway, Dundalk Ave., and Holabird Ave.	Highway Capacity	$4,440	2014
BRTB 2011-2014 TIP	Edmonson Avenue Bridge	New bridge will be 23 feet wider than existing bridge to accommodate a dual track light rail line. Increase number of lanes from 8 to 10. Could improve conditions for bikes and pedestrians.	Highway Capacity	$34,500	2013
BRTB 2011-2014 TIP	US 29, Columbia Pike	Widen the northbound section of US 29 from Seneca Drive to MD 175	Highway Capacity	$3,640	2014
BRTB Transportation Outlook 2035	MD 295	I-195 to MD 100: Widen from 4 to 6 lanes, full interchange at Hanover Road.	Highway Capacity	$144,000	2015

Source	Project/Facility	Description	Project Type	Updated Costs (in 000$)	Updated Year Open/ Completion
BRTB Transportation Outlook 2035	I-695	I-95 South to MD 122: Widen from 6 to 8 lanes.	Highway Capacity	$373,300	2015
BRTB Transportation Outlook 2035	I-695	I-83 Harrisburg to I-95 North: Widen from 6 to 8 Lanes.	Highway Capacity	$373,200	2015
BRTB Transportation Outlook 2035	Russell Street Project	I-95 to City Line: Add N/S lanes to ramp and intersection upgrades. Add a lane from Russell Street Gateway I-95 to City Line.	Highway Capacity	$20,000	2015
BRTB Transportation Outlook 2035	MD 32	MD 108 to I-70: 2 to 4 lanes, Full interchanges at Dayton Ship, Rosemary Lane, MD 144 with ramps and upgrade I-70 interchange.	Highway Capacity	$219,000	2015
BRTB Transportation Outlook 2035	I-795	Pleasant Hill Rd/Dolfield Rd: new interchange and improve ramps.	Interchange Capacity	$67,000	2013
BRTB Transportation Outlook 2035	US 1	US 1 at MD 175: new full interchange.	Interchange Capacity	$30,000	2015
HEPMPO LRTP	Halfway Blvd Ext.	Newgate Blvd to MD 63: new 4 lane divided road.	Highway Capacity	$8,911	2020
HEPMPO LRTP	Paul Smith Blvd	US 40 Alt to US 40: new 2 lane connector.	Highway Capacity	$5,025	2020
HEPMPO LRTP	Eastern Blvd	Antietam Drive to MD 60 to Northern Avenue: new 4 lane divided road.	Highway Capacity	$511,356	2020
HEPMPO LRTP	Edgewood Drive	Entire segment Inside Corporate Limits: widen to 4 lanes.	Highway Capacity	$20,093	2020
HEPMPO LRTP	Longmeadow Road	US 11 to Marsh Pike: widen to 5 lanes.	Highway Capacity	$11,186	2020
HEPMPO LRTP	Marsh Pike	MD 60 to Longmeadow Road: widen to 5 lanes with signal.	Highway Capacity	$6,895	2020
HEPMPO LRTP	Newgate Blvd	Halfway Blvd to US 40: new 2 lane road	Highway Capacity	$7,828	2020
HEPMPO LRTP	Professional Court (PH III)	Yale Drive to Varsity Lane: widen to 4 lanes	Highway Capacity	$7,946	2020

Source	Project/Facility	Description	Project Type	Updated Costs (in 000$)	Updated Year Open/ Completion
HEPMPO LRTP	Professional Court (PH IV)	Varsity Lane to Hagerstown Community College: new 4 lane road.	Highway Capacity	$6,835	2020
HEPMPO LRTP	Wesel Blvd.	Burhans Blvd. to existing 4 Lane Segment: widen to 4 lanes.	Highway Capacity	$4,150	2020
HEPMPO LRTP	Maugans Avenue (PH II)	I-81 to Main St in Village of Maugansville: widen to 3 lanes	Highway Capacity	$6,446	2020
HEPMPO LRTP	MD 65 - S Potomac Street	Oak Ridge Drive to Wilson Blvd: widen to 4 lanes.	Highway Capacity	$19,106	2020
HEPMPO LRTP	US 11 - Pennsylvania Avenue	Burhans Blvd to Maugans Avenue - Widen to 4 Lanes plus Auxiliary Lane	Highway Capacity	$27,636	2020
HEPMPO LRTP	Robinwood Drive	Hagerstown CC to MD 64: new 4 lane alignment north of Hagerstown Community College	Highway Capacity	$9,532	2020
HEPMPO LRTP	Professional Court Ext (PH I)	Eastern Blvd to Antietam Creek Bridge: widen to 4 lanes with bridge over Antietam Creek.	Highway Capacity	$6,655	2020
HEPMPO LRTP	Professional Court Ext (PH II)	Antietam Creek Bridge to Yale Drive: new 4 lane divided road.	Highway Capacity	$7,134	2020
MWCOG 2010 CLRP	I 70 Interchange at Meadow Road	Reconstruct the interchange to provide missing ramp movements.	Highway Capacity	$27,000	2016
MWCOG 2010 CLRP	MD 4	Widen to 6 lanes, upgrade with interchanges at Westphalia Rd. and Suitland Pkwy.	Highway Capacity	$460,680	2020
MWCOG 2010 CLRP	I-270	New interchange at Watkins Mill Rd. Ext.	Highway Capacity	$178,530	2016
S/WMPO LRTP	US Route 50 - Ocean Gateway	Vienna Bypass (MD 731A to White Lowe Road) (9.7 miles) Access Control Improvements.	Access Improvements	$64,800	2020

Source	Project/Facility	Description	Project Type	Updated Costs (in 000$)	Updated Year Open/ Completion
S/WMPO LRTP	US Route 50 - Ocean Gateway	Hobbs Road/Walston Switch Road (1.8 Miles)	Interchange Construction	$31,300	2020
WILMAPCO 2040 RTP	MD 272	Widen from 2 to 4 lanes, divided.	Highway Capacity	$32,861	2020
Intercity Passenger and Freight Transportation - TOTAL				**$3,084,708**	
FY 2011-16 CTP	MD 404, Shore Highway	Upgrade from Cemetery Road to east of MD 480. Bike/Ped accommodation included.	Highway Capacity w Bike/Ped	$7,511	2013
FY 2011-16 CTP	MD 124, Woodfield Road	Construct 6 lane divided highway from south of Airpark Road to north of Fieldcrest Road (1.14 miles). Bike/pedestrian accommodations where appropriate.	Highway Capacity w Bike/Ped	$9,281	2011
FY 2011-16 CTP	MD 5, Branch Avenue	Widen from 4 to 6 lanes from north of MD 373 to US 301 (1.07 miles). Bike/pedestrian accommodations where appropriate.	Highway Capacity w Bike/Ped	$7,102	2011
FY 2011-16 CTP	MD 237, Chancellors Run Road	Upgrade and widen MD 237 to a multi-lane highway from Pegg Road to MD 235 (2.80 miles). Bike/Ped accommodations.	Highway Capacity w Bike/Ped	$8,963	2011
FY 2011-16 CTP	US 113, Worcester Highway	Upgrade to a 4 lane divided highway from Goody Hill Road to Massey Branch (1.8 miles). Access control improvements, bike/pedestrian accommodations.	Highway Capacity w Bike/Ped	$12,990	2012
FY 2011-16 CTP	MD 355, Rockville Pike	Construct Interchange at Randolph Road/Montrose Parkway. Bike/pedestrian accommodations where appropriate.	Highway Capacity w Bike/Ped	$5,049	Complete
FY 2011-16 CTP	MD 97: Georgia Avenue	Interchange improvements at Randolph Road. Bike/pedestrian accommodations where appropriate.	Highway Capacity w Bike/Ped	$54,353	2016

Source	Project/Facility	Description	Project Type	Updated Costs (in 000$)	Updated Year Open/ Completion
FY 2011-16 CTP	MD 755	Edgewood Road streetscape	Streetscape w Bike/Ped	$3,961	2011
FY 2011-16 CTP	BRAC Intersections near Fort Meade	Intersection improvements at key locations along access routes to Ft. Meade. Bike/Ped facilities provided where appropriate.	Intersection w Bike/Ped	$44,613	2012
FY 2011-16 CTP	BRAC intersections near Bethesda Naval Center	Intersection improvements along access routes to Bethesda Naval Center. Bike/Ped facilities where appropriate.	Intersection w Bike/Ped	$33,703	2012
FY 2011-16 CTP	BRAC Intersections near Aberdeen Proving Grounds	Intersection improvements along access routes to Aberdeen Proving Grounds. Bike/Ped facilities where appropriate.	Intersection w Bike/Ped	$17,528	2012
FY 2011-16 CTP	Enhancement Projects	College Park Trolley Trail, Melrose Park Access Trail, North Gate Park	Bicycle/ Pedestrian Facility	$1,083	2011
FY 2011-16 CTP	SHA Sidewalk Program	This program will provide matching funds for the construction of sidewalks adjacent to State highways. Fifty percent of project costs will be required from local and municipal project sponsors, except in urban revitalization areas where projects are eligible for 100 percent state funding, and in priority funding areas where projects are eligible for 75 percent state funding.	Bicycle/ Pedestrian Facility	$5,700	Ongoing
FY 2011-16 CTP	Herring Run Greenway	Construct new portions of a 8 foot wide trail between Harford Road and Sinclair Lane, extended to the west to Lake Montebello and Morgan State University, extended to the east to Sinclair Lane.	Bicycle/ Pedestrian Facility	$1,980	2012
FY 2011-16 CTP	Key Highway	Key Highway; from I 95 to Lawrence Street; construct a ten foot wide bicycle pedestrian path	Bicycle/ Pedestrian Facility	$554	2011
FY 2011-16 CTP	Jones Falls Trail	Woodbury Light Rail Station to Cylburn Auditorium	Bicycle/ Pedestrian Facility	$2,000	2012
FY 2011-16 CTP	Broken Land Parkway Pathway	Cradlerock Way to Snowden River Pkwy	Bicycle/ Pedestrian Facility	$386	2011

Source	Project/Facility	Description	Project Type	Updated Costs (in 000$)	Updated Year Open/ Completion
FY 2011-16 CTP	Shady Grove Metro Access	Shady Grove Rd. to Redland Rd. bikepath	Bicycle/ Pedestrian Facility	$1,255	2011
FY 2011-16 CTP	Community Safety and Enhancement Program	SHA element of the Statewide Neighborhood Conservation Program	Bicycle/ Pedestrian Facility	$103,000	Ongoing
BRTB 2011-2014 TIP	Little Pipe Creek Trail & Wakefield Valley Community Trail	Macadam trail that will link two municipalities (Union Bridge and New Windsor); will connect to the Wakefield Valley Community Trail in New Windsor (which links to Westminster; which will result in a continuous 8-mile long trail)	TERM	$400	2014
BRTB 2011-2014 TIP	Areawide Recreational Trails Program	This program is intended to develop and maintain recreational trails for motorized and nonmotorized recreational trail users. It includes projects that provide for the redesign, reconstruction, non-routine maintenance, or relocation of recreational trails to benefit the natural environment.	TERM	$2,500	Ongoing
BRTB 2011-2014 TIP	Areawide Enhancement Projects	Pedestrian/bicycle facilities; acquisition of scenic easements and historic sites; scenic/historic highway programs; landscaping/beautification; historic preservation; rehabilitation/operation of historic transportation facilities, including railroad facilities and canals; preservation of abandoned railway corridors; archeological planning/research; and mitigation of water pollution due to highway runoff.	TERM	$18,500	Ongoing
BRTB 2011-2014 TIP	Areawide Environmental Projects	Non-capacity improvements which include projects dealing with noise abatement, wetlands, reforestation, landscape planting, scenic beautification and pedestrian or bicycle facilities.	TERM	$24,930	Ongoing

Source	Project/Facility	Description	Project Type	Updated Costs (in 000$)	Updated Year Open/ Completion
BRTB 2011-2014 TIP	Charles Street Gateway Rehabilitation	Streetscape and functional improvements on Charles Street from 25th Street to University Parkway including new sidewalks, lighting, crosswalks, ADA ramps, and aesthetic improvements.	TERM	$28,320	2013
BRTB 2011-2014 TIP	West Baltimore MARC Neighborhood Improvements	Sidewalk and street rehabilitation, pedestrian lighting, additional trees and tree pits, new crosswalks, and ADA ramps. Limits are Edmondson Ave. between Benalou and Pulaski, and Pulaski St. between Edmondson and West Saratoga.	TERM	$1,400	2012
BRTB 2011-2014 TIP	Central Avenue Reconstruction	Central Avenue is to be reconstructed between Monument and Lancaster Street. This work will include total reconstruction of the street, including new curbs, sidewalks, roadway sub-base, roadway surface, utility adjustments and other roadway appurtenances such as roadway lighting, signage and lane markings.	TERM	$39,825	2012
Cumberland Area MPO	Allegheny Highlands Trail	Baltimore Avenue in Cumberland to Woodcock Hollow Road (9.3 miles)	Bicycle/ pedestrian	$4,600	2020
MWCOG 2010 CLRP	MD 85, Buckeystown Pike	Upgrade to a four to six-lane divided highway from south of English Muffin Way to north of Grove Road (2.40 miles). Widen MD 85 to a four-lane divided highway from south of English Muffin Way to the State Highway Administration/Westview development complex, then 6 lanes through the I-270 interchange, then 4 lanes from north of Spectrum Drive to Grove Road. The interchange at I-270/MD 85 will be partially reconstructed as part of this line item. Auxiliary lanes where necessary. Bicycles accommodated.	Highway Capacity w Bike/Ped	$245,992	2020
MWCOG 2010 CLRP	MD 97, Georgia Avenue	Interchange improvements at MD 28/Norbeck Road. Bike/Pedestrian accommodations where appropriate	Highway Capacity w Bike/Ped	$139,154	2020

Source	Project/Facility	Description	Project Type	Updated Costs (in 000$)	Updated Year Open/ Completion
MWCOG 2010 CLRP	MD 124	Widen to 6 lanes from Midcounty Hwy to Warfield Rd	Highway Capacity w Bike/Ped	$152,433	2020
MWCOG 2010 CLRP	Century Blvd./Crystal Rock Loop	This project provides for the planning, design, and construction of the extension of Century Blvd. to Crystal Rock Drive. Bike and pedestrian accommodations included.	Highway Capacity w Bike/Ped	$7,000	2011
MWCOG 2010 CLRP	Burtonsville Access Road	MD 198 to entrance to Burtonsville Shopping Center	Highway Capacity w Bike/Ped	$7,949	2013
MWCOG 2010 CLRP	US 1, Baltimore Avenue	College Avenue to Sunnyside Avenue	Highway Capacity w Bike/Ped	$135,008	2020
MWCOG 2010 CLRP	MD 450, Annapolis Road	Widen from Whitfield Chapel Road to MD 3	Highway Capacity w Bike/Ped	$63,504	2020
MWCOG 2010 CLRP	MD 28, Rockville Town Center	MD 586/911	Highway Capacity w Bike/Ped	$5,296	2020
MWCOG 2010 CLRP	MD 118	MD 355 to M 83 Watkins Mill Rd.	Highway Capacity w Bike/Ped	$4,000	2020
MWCOG 2010 CLRP	MD 124 Woodfield Road Extended	MD 108 1200' North of Main Street (MD 108) to MD 27 Ridge Road (MD 27)	Highway Capacity w Bike/Ped	$1,040	2011
MWCOG 2010 CLRP	Dower House Road	MD 223 Woodyard Road to MD 4 Pennsylvania Avenue	Highway Capacity w Bike/Ped	$40,900	2020
MWCOG 2011-2016 TIP	Chapman Avenue Extended	Randolph Road to Old Georgetown Road	Highway Capacity w Bike/Ped	$6,217	2013
MWCOG 2011-2016 TIP	Father Hurley Blvd. Extension	From Wisteria Road to MD 118 as a four-lane divided, closed section highway with future provisions for two additional lanes. Pedestrian improvements.	Highway Capacity w Bike/Ped	$8,422	2011
MWCOG 2011-2016 TIP	Burtonsville Access Road	New roadway between MD 198 and School Access Rd. Includes sidewalks and parallel hiker/biker path.	Highway Capacity w Bike/Ped	$4,236	2013
MWCOG 2011-2016 TIP	Montrose Parkway East	4-lane divided parkway form Parklawn Drive to Veirs Mill Road. Includes bikepath and sidewalk.	Highway Capacity w Bike/Ped	$33,467	2015

Source	Project/Facility	Description	Project Type	Updated Costs (in 000$)	Updated Year Open/ Completion
MWCOG 2011-2016 TIP	Annual Bikeway Program	This program provides funds to design and construct bikeway and trail projects in Montgomery County.	Bicycle/ Pedestrian Facility	$1,650	Ongoing
MWCOG 2011-2016 TIP	Annual Sidewalk Program	This pedestrian access improvement program provides sidewalks and bus pads on County-owned roads and some State-maintained roadways under the Maryland State Highway retrofit sidewalk program.	Bicycle/ Pedestrian Facility	$7,178	Ongoing
MWCOG 2011-2016 TIP	Pedestrian Safety Program	This project provides for the construction of physical structures and/or installation of traffic control devices which include but are not limited to: new crosswalks; pedestrian refuge islands; bus pull-off areas; fencing to channel pedestrians to safer crossing locations; inlaid and/or overhead pedestrian signals or warning beacons; improving signage, etc.	Bicycle/ Pedestrian Facility	$8,000	Ongoing
MWCOG 2011-2016 TIP	Falls Road East Side Hiker/Biker Path	Acquire ROW and construct 4mi path	Bicycle/ Pedestrian Facility	$7,730	2015
S/WMPO LRTP	Northeast Collector Phase III	College Avenue and Beaglin Park Drive/Kelly Road and Zion Road.	Highway Capacity w Bike/Ped	$2,990	2015
S/WMPO LRTP	Pemberton Drive Widening	Parsons Road to Crooked Oak Lane (including bike path).	Highway Capacity w Bike/Ped	$3,830	2015
S/WMPO LRTP	Riverside Drive Roundabout	Intersection of Riverside Drive, Mill Street, Carroll Street, and Camden Avenue.	Highway Capacity w Bike/Ped	$6,500	2015
S/WMPO LRTP	US Route 13 - North Salisbury Boulevard/ Ocean Highway	Salisbury Bypass to Delaware State Line (4.0 miles) - Divided highway reconstruct with access control improvements.	Highway Capacity w Bike/Ped	$50,800	2015
Bike and Pedestrian - TOTAL				**$1,384,783**	

Source	Project/Facility	Description	Project Type	Updated Costs (in 000$)	Updated Year Open/ Completion
FY 2011-16 CTP	I-95 John F. Kennedy Memorial Highway	Express Toll Lanes (ETL) Construction: Improve the I-95 interchanges with I-895, I-695 and MD 43 and construct two Express Toll Lanes in each direction on I-95 from I-895 North to north of MD 43 (9.63 miles).	Highway Capacity	$360,101	2014
FY 2011-16 CTP	InterCounty Connector*	Construct new East-West multi-modal highway in Montgomery and Prince George's counties between I-270 and I-95/US 1.	Highway Capacity	$1,014,651	2014
BRTB Transportation Outlook 2035	Baltimore Region Rideshare Program - 2006 (Baltimore City, Carroll, Baltimore, Harford, Howard, Anne Arundel)	Provides funding support to local rideshare coordinators to strengthen ridematching and ridesharing coordination services to both commuters and employers	TERM	$4,325	Ongoing
MWCOG 2011-16 TIP	Commuter Connections Program	Commuter Operations Center, Guaranteed Ride Home, Marketing, Monitoring and Evaluation, Employer Outreach, Telecommute Project	TERM	$12,681	Ongoing
MWCOG 2011-16 TIP	Commuter Connections Program	Ridesharing - Regional element for Frederick, Montgomery and Prince Georges	TERM	$4,405	Ongoing
MWCOG 2011-16 TIP	Commuter Connections Program	Expanded guaranteed ride home to Baltimore region and St. Mary's County	TERM	$770	Ongoing
Transportation Pricing and Travel Demand Management - TOTAL				**$1,396,933**	
FY 2011-16 CTP	Transportation Emission Reduction Measures (TERMS)	Fifteen counties are in air quality non-attainment or maintenance status. This program will help address CAA requirements by implementing projects that will achieve measurable reductions in mobile source emissions.	TERM	$24,683	Ongoing
FY 2011-16 CTP	CHART	Transportation Emission Reduction Measures (TERMS)	TERM	$90,600	Ongoing
FY 2011-16 CTP	US 29	MD 410 to Wayne Avenue signals	Signal Systems	$1,104	Ongoing
FY 2011-16 CTP	MD 650	Sheridan Street to Metzerott Rd.	Signal Systems	$1,840	2011
FY 2011-16 CTP	MD 2 and MD 710	Signal reconstruction (ARRA)	Signal Systems	$1,621	Ongoing
FY 2011-16 CTP	Baltimore County	Signal reconstruction (ARRA)	Signal Systems	$1,721	Ongoing

Source	Project/Facility	Description	Project Type	Updated Costs (in 000$)	Updated Year Open/ Completion
FY 2011-16 CTP	Bus Procurement	Annual purchase of 40-foot hybrid buses to replace those that have been in service for 12 or more years.	Transit Construction	$202,049	Ongoing
FY 2011-16 CTP	CAD/AVL Systems	Provides radio data channel expansion to improve the bus fleet's voice and data communication. Will improve customer service by providing real time management and schedule adherence.	Transit Operations	$1,106	2011
FY 2011-16 CTP	LED Signals	Replace dynamic message signs and lane use signals with LED technology (Baltimore Harbor and Ft. McHenry Tunnel)	Signal Systems	$3,744	2011
FY 2011-16 CTP	SHA Signalization Projects	District traffic management projects, ARRA LED and traffic detection projects.	Signal Systems	$29,114	2012
BRTB 2011-2014 TIP	Variable Message Signs	Repair and replace Variable Message Signs. Variable Message Signs report traffic activities, accidents, and detours throughout the city. Providing up to date information to drivers will help manage congestion.	TERM	$1,000	Ongoing
BRTB 2011-2014 TIP	Areawide Congestion Management	The employment of variable message signs, video for traffic management (CCTV), traffic movement detectors, signal system coordination and remote timing, permanent congestion monitoring systems employed by the CHART program, deployment of local jurisdiction intelligent transportation system (ITS) projects, and the development of park and ride facilities.	TERM	$15,900	Ongoing
BRTB 2011-2014 TIP	CMAQ Areawide	The BRTB will use a competitive selection process to select $800,000 worth of Congestion Mitigation and Air Quality Improvement Program (CMAQ) projects in FY 2011. CMAQ projects reduce air pollution emissions from the transportation sector.	TERM	$1,700	Ongoing
BRTB 2011-2014 TIP	PA/LED Sign Replacement-LRT and Metro	This project will develop specifications and construct enhancements or additions of ADA compliant public address and LED sign systems for LRT and Metro.	Transit Facility	$7,391	2014

Source	Project/Facility	Description	Project Type	Updated Costs (in 000$)	Updated Year Open/ Completion
MWCOG 2011-16 TIP	Congestion Management	Congestion management program includes projects associated with the following: traffic management - new or reconstruct signals, signing and lighting; signal systemization; commuter action - engineering and construction of Park-n-Ride facilities; CHART - engineering and construction of ITS projects; and intersection capacity improvement - engineering and construction of intersection improvements.	TERM	$4,500	Ongoing
MWCOG 2011-16 TIP	Clean Air Partners	Air Quality Public Education Project	TERM	$1,000	Ongoing
MWCOG 2011-16 TIP	Fiber Optics: Advanced Transportation Management System	US 39 - Briggs Chaney Road to Howard County Line	System Management	$600	2012
Transportation Technologies - TOTAL				**$389,673**	
Funded and Committed Maryland Plans, Programs, and TERMs - TOTAL				**$13,219,093**	

Notes:

1) The BRTB Outlook 2035 estimated a total Red Line implementation cost of $1.539 billion. The 2011-2016 CTP identifies $200.7 million in planning, engineering and ROW costs for this project.

2) The MWCOG 2010 CLRP estimated a total Purple Line implementation cost of $1.716 billion. The 2011-2016 CTP identifies $237.0 million in planning, engineering and ROW costs for this project.

3) The MWCOG 2010 CLRP estimated a total Corridor Cities Transitway implementation cost of $1.193 billion. The 2011-2016 CTP identifies $36.5 million in planning, engineering and ROW costs for this project.

4) The MWCOG 2010 CLRP estimated a total Bethesda METRO South Entrance implementation cost of $60 million. The 2011-2016 CTP identifies $2.4 million in planning and engineering costs for this project.

C. TERM Analysis Assumptions, Costs, and Results

TERMs identified in the 2010-16 CTP and MPO TIP and CLRPs as well as continuation of current programs such as Commuter Connections, CHART, Metropolitan Area Transportation Operations Coordination (MATOC) are assessed to determine estimates of GHG emission reductions and costs through 2020.

The air quality benefits of a large share of these strategies have been analyzed through BMC's and MWCOG's air quality conformity process. For these strategies, reductions in VMT or fuel consumption as estimated by BMC, MWCOG, MDOT and MDE are adjusted to reflect 2020 conditions and converted to GHG emission savings. For the strategies where a prior analysis has not been completed, observed data on the benefits of these strategies in other locations or research reports were utilized to determine potential 2020 benefits.

Maryland Statewide TERMs

These TERMs span both the MWCOG and BMC metropolitan regions and are operated through multiple partnerships between the MPOs and State agencies including SHA and MTA. The annual emission reduction benefits of these programs are tracked by MDOT through the Annual Attainment Report. Table C.1 lists these TERMs and details the assumption required to translate 2008 and 2009 observed benefits in terms of reduced fuel consumption or VMT to 2020 GHG emission reductions.

Table C.1 Maryland Statewide TERMs

TERM Description	Assumptions
CHART	Multiply vehicle hours of delay by MOVES idle emission factor
Signal Systemization Total	Multiply vehicle hours of delay by MOVES idle emission factor
Metropolitan Area Transportation Operations Coordination (MATOC)*	Multiply fuel savings by carbon content of fuel. Assume carbon content of fuel at 0.0088 tons/gallon (EPA)
Guaranteed Ride Home	Apply 1.4 % annual VMT growth rate to 2011 Attainment Report[1] VMT reduction. Assume 2 minutes idling per trip.

[1] MDOT 2011 Annual Attainment Report on Transportation System Performance, 2011.

TERM Description	Assumptions
Employer Outreach (inc. for bicycles)	Apply 1.4 % annual VMT growth rate to 2011 Attainment Report VMT reduction. Assume 2 minutes idling per trip.
Integrated Rideshare	Apply 1.4 % annual VMT growth rate to 2011 Attainment Report VMT reduction. Assume 2 minutes idling per trip.
Commuter Operations and Ridesharing Center	Apply 1.4 % annual VMT growth rate to 2011 Attainment Report VMT reduction. Assume 2 minutes idling per trip.
Telework Resource Center	Apply 1.4 % annual VMT growth rate to 2011 Attainment Report VMT reduction. Assume 2 minutes idling per trip.
Mass Marketing	Apply 1.4 % annual VMT growth rate to 2011 Attainment Report VMT reduction. Assume 2 minutes idling per trip.
MTA College Pass	Apply 1.4 % annual VMT growth rate to 2011 Attainment Report VMT reduction. Assume 2 minutes idling per trip.
MTA Commuter Choice Maryland Pass	Apply 1.4 % annual VMT growth rate to 2011 Attainment Report VMT reduction. Assume 2 minutes idling per trip.
Transit Store in Baltimore	Apply 1.4 % annual VMT growth rate to 2011 Attainment Report VMT reduction. Assume 2 minutes idling per trip.

Baltimore Regional Transportation Board

In order to determine the emission reductions associated with the Transportation Emission Reduction Measures (TERMs) for the Baltimore Region, VMT and fuel consumption data, obtained from the Baltimore Regional Transportation Board (BRTB) TIPs, LRPs, and conformity documentation, were used to determine a reduction in GHG emissions in 2020. VMT and fuel consumption data were projected to 2020 utilizing local data obtained from the documentation and the MAQONE 5.1 Model, including: VMT growth rates; cooperative forecasts; and average trip lengths, speeds, and vehicle occupancy rates. Emission factors were generated using MOVES 2010a. Where VMT or fuel consumption data were not readily available, project-specific data, obtained from the documentation, was used as an input to conduct independent, off-network analyses. These analyses utilized proven methodologies including recent research and off-network tools, such as MAQONE 5.1 or the COMMUTER Model, in order to calculate a 2020 VMT or fuel consumption reduction. Emission factors were then applied to determine an emissions benefit. Table C.1 outlines the assumptions utilized in the independent, off-network analysis of the BRTB TERM projects.

Table C.2 BRTB TERM Analysis Assumptions

Project Type	Description	Assumptions
Clean Technology	Hybrid Bus Replacements	Avg. annual revenue mileage = 30,472.85 (MAQONE5.1) Percent deadhead = 15% Avg. fuel economy of standard diesel = 3.860 mpg[1] Avg. fuel economy of hybrid = 4.580 mpg[1] Carbon content of diesel = 10.5 kg/gal
Commute Alternatives Incentive	Provide matching grant money to employees moving near their work	Participants = 1,260 Avg. work-trip length = 7.69 mi. 250 commute days Avg. trips/day = 1.8
Commute Alternatives Incentive	Johns Hopkins University FlexCar – car-sharing service to JHU students and people in the surrounding neighborhoods	Annual Flexcar fleet growth rate = 12.5% (based on 2007-2009 observed data) 31 cars available in 2020 Car ownership reduced per Flexcar = 15[2] Average annual VMT reduced/ownership reduced = 4,227[3]
Commute Alternatives Incentive	Park & Ride Lots	Avg. trip lengths based on county defaults from MAQONE 5.1. 250 days / year Statewide annual VMT growth = 1.35% 31 mph light-duty emission factors from MOVES
Outreach/ Education	Clean Air Partners – Ozone Action Days	2020 employment forecast from BMC 2035 LRP MAQONE 5.1. defaults used for average auto trip lengths by jurisdiction 3% of drivers participate (based on Sacramento, CA survey data) Average trips reduced = 1.04 / Ozone Action Day Number of ozone action days = 20 based on Clean Air Partners FY2008 Annual Report
Bicycle & Pedestrian	All trail, sidewalk, and bike/ped improvements	VMT estimated by BRTB Avg. trip length = 2.5 mile 250 days/year 31 mph light-duty emission factor Statewide annual VMT growth = 1.35%
Public Transit Improvement	Purchase and use 50 bi-level coaches	2020 employment forecast from BMC 2035 LRP MAQONE 5.1. defaults used for average auto trip lengths by jurisdiction Avg. ridership increase / coach/day = 200 260 operating days/year
Public Transit Improvement	Hampden neighborhood shuttle	Ridership / day = 250 (Based on 2010-2013 Conformity) Avg. trip length = 2 miles 260 operating days/year
Public Transit Improvement	Provide free service to state employees for MTA bus, light rail, some commuter buses, and Metro subway systems.	Off-network analysis tool – Commuter Model: Financial Incentives 100% employer participation rate State workers in 2020 = 70,527[4] Potential market = 28% of total state worker employment

Project Type	Description	Assumptions
Traffic Control	Traditional traffic signal heads are replaced with LED signal heads.	39,000 signals in Baltimore City Traditional signal power consumption = 150 (W) LED power savings = 90%

[1] Based on FTA Report: Transit Bus Lifecycle Cost: http://www.fta.dot.gov/documents/WVU_FTA_LCC_Final_Report_07-23-2007.pdf

[2] Based on white paper*: Go To 2040 Regional Comprehensive Plan Strategy Analysis: CARSHARING*, Chicago Metropolitan Agency for Planning.

[3] Based on forecast of average miles traveled per vehicle data available on the Research and Innovative Technology Administration's Bureau of Transportation Statistics website: http://www.bts.gov/publications/national_transportation_statistics/html/table_04_11.html

[4] Forecast from *Employment and Payrolls First Quarter 2008*, Maryland Department of Labor Licensing and Regulation to 2020 based on Cooperative Forecasts in the BRTB's Conformity Determination of Transportation Outlook 2035 and the 2010-2013 Transportation Improvement Program.

Maryland Aviation Administration

The *BWI, Thurgood Marshall Airport Greenhouse Gas Baseline Emissions Inventory* document, dated March 2008 was utilized in order to identify the key on-going GHG emission reduction activities conducted by MAA. The emission reduction strategies were categorized into four groups: aircraft, surface transportation; ground service equipment (GSE) / auxiliary power units (APUs), and electrical usage.

The 2006 CO_2 baseline contained in the 2008 emissions inventory document was utilized in combination with the FAA's Terminal Area Forecast, issued in December 2008, in order to determine forecast 2020 CO_2 emissions. This 2020 forecast was used as a benchmark from which to measure emissions reductions from the airport strategies. The following assumptions, organized by strategy group, were employed to calculate emissions benefits.

Aircraft emission reductions

- Based on the 2020 forecast, annual 2020 CO_2 emissions from aircraft in 2020 are equal to 142,766 metric tons (MT) per year.
- Taxi/idle/delay accounts for 4 percent of total CO2 emissions from aircraft operations, based on methodology from the *Port of Seattle Seattle-Tacoma International Airport Greenhouse Gas Emissions Inventory - 2006* (October, 2007).
- All measures result in 10 percent reduction in air taxi or aircraft turnaround idling/delay

Surface Transportation

Alternative Fuels - MAA Vehicles

- Based on the 2020 forecast, annual 2020 CO_2 emissions from surface transportation are equal to 84,367 mt/yr.
- 28 percent of MAA vehicles use alternative fuels

- MAA vehicles accounts for 12 percent of total CO_2 emissions from surface transportation, based on methodology from the *Port of Seattle Seattle-Tacoma International Airport Greenhouse Gas Emissions Inventory - 2006* (October, 2007).
- 70 percent of MAA vehicles using alternative fuels are gasoline-powered, and 30 percent are diesel-powered.
- 30 CNG shuttle buses in use in place of traditional diesel buses, resulting in 20 percent reduction in emissions.
- Gasoline vehicles will use E85, resulting in a 15 percent CO_2 emissions reduction, based on *Alternative Fuels: E85 and Flex Fuel Vehicles. EPA420-F-06-047* (October, 2006).
- Emission benefits from diesel vehicles utilizing B20, were not quantified in this report. MAA reported experiencing several problems with the implementation of biodiesel due to the fact that much of the fleet utilizing B20 can sit idle for extended periods of time during which the biodiesel became fouled.

Buses & Vans Congestion Reduction

- Buses & vans account for 1 percent of total CO_2 emissions from surface transportation, based on methodology from the *Port of Seattle Seattle-Tacoma International Airport Greenhouse Gas Emissions Inventory - 2006* (October, 2007).
- 5 percent of CO2 emissions reductions are attributable to reduced congestion

Vehicle Idling/Delay/VMT Reduction at Parking

- CO_2 emissions associated with vehicle parking account for 10 percent of total CO_2 emissions from surface transportation.
- A 30 percent reduction in parking time can be attributed to parking management measures, such as use of automated navigational signs or an increase in parking capacity, based on methodology from *Evaluating ITS Parking management Strategies: A Systems Approach* (May, 2000).

Ground Service Equipment (GSE) / Auxiliary Power Units (APUs)

All strategies under this group will result in a 10 percent reduction of GSE/APU usage.

Electrical Usage

Total electrical consumption is reduced by 20 percent, including: a state initiative to reduce electrical consumption by 15 percent from 2007, by 2015, and purchasing 5 percent of electricity from renewable energy sources.

Maryland Port Administration

The Port of Baltimore was recently awarded $3.5 million in Recovery Act funding to help clean the air in and around the Port. The funds will be used primarily for clean diesel technologies,

but it is anticipated that anti-idling devices, vehicle replacements, and engine repowers will result in GHG emissions reductions.

MPA provided data regarding the current and replacement equipment including type, average age of current engines and replacement engines, average use and remaining life. CO_2 emission factors were calculated for each operating piece of equipment based on EPA's, NONROAD technical guidance document, EPA420-P-04-009, dated April 2004. It was estimated that the replacement equipment (vehicles and engines) would result in a 5percent improvement in fuel efficiency. The following set of equipment assumptions was utilized in order to quantify GHG emission reductions associated with the anticipated use of the Recovery Act funding:

- 15 truck engines (average model year 1990, average HP 150) will be replaced with MY 2004 engines.
- 10 truck engines (average model year 1992, average HP 150) will be replaced with MY 2004 engines.
- 5 truck engines (average model year 1996, average HP 150) will be replaced with MY 2007 engines.
- 65 truck engines (average model year 1996, average HP 150) will be replaced with MY 2007 engines, which will include auto engine start stop (AESS) technology preventing idling for longer than 10 minutes.
- 7 locomotives will be equipped with auto engine start stop (AESS) technology.
- 7 Forklifts, MY 1991-1997 will be repowered / replaced.
- Replace 1 MY 2000 rough terrain forklift
- Replace 1 MY 2000 crawler tractor
- Replace 5 MY 1994 and 3 MY 2001 terminal tractors
- Repower 3 MY 1992 terminal tractors

Metropolitan Washington Council of Governments

In order to determine the emission reductions associated with the TERMs for the Washington DC Region, project-specific data, obtained from TIPs, LRPs, and conformity documentation, was used to determine a reduction in VMT or fuel consumption.

Table C.2 presents the assumptions required to translate 2008 and 2009 reductions as estimated by MWCOG for the entire Washington DC region, into Maryland specific impacts, annually in 2020.

Table C.3 MWCOG TERM Analysis Assumptions

Project Type	Description	Source	Assumptions / Methodology (1) (2)
Clean Technology	Bose Automobile Anti-Air Pollutant and Energy Conservation System	1	Use running emissions factor for transit bus Avg. bus speed: 15 mph Assume fuel economy increases 15%, 500 buses Avg. bus mileage: 140 mi/day-bus Annual operation days: 312
Clean Technology	Truck Idling (Truck Stops and Auxiliary Power Unit)	1	Use idle emissions factor for HDT 500 engines, Avg. truck idle: 8 hrs/day Annual operation days: 312
Clean Technology	100 CNG Buses in place of old Diesel Buses (2010)	1	Avg. bus VMT: 40,000 miles/yr, Avg. bus speed: 15 mph CNG bus consumes 9% less fuel compared to old diesel bus
Clean Technology	100 Hybrid Buses in place of old Diesel Buses (2010)	1	Avg. bus VMT = 40k miles per year, avg speed = 15mph, hybrid bus consumes 36% less fuel compared to diesel, Hybrid and Alternative Fueled Vehicles: (http://www.kingcounty.gov/operations/procurement/Services/Environmental_Purchasing.aspx)
Commute Alternatives/ Incentives	Glenmont METRO Parking Garage Expansion	1	Use statewide avg. EF for LDV Avg. trip length: 15.5 miles Cold start idle time: 2 mins/start, 300 days/yr
Clean Technology	Purchase 185 Buses to Accommodate Ridership Growth	2	Apply 49 percent MWCOG region VMT in Maryland (per travel demand model, 2000 model calibration report). Apply updated MOVES derived 2020 g CO2e/mile (344 g/mi) compared to TPB emissions factor (358.78 g/mi).
Commute Alternatives/ Incentives	Employer Outreach for Public Sector Agencies	2	Apply 49 percent MWCOG region VMT in Maryland (per travel demand model, 2000 model calibration report). Apply updated MOVES derived 2020 g CO2e/mile (344 g/mi) compared to TPB emissions factor (358.78 g/mi).
Commute Alternatives/ Incentives	Expanded Employer Outreach for Private Sector Employers	2	Apply 49 percent MWCOG region VMT in Maryland (per travel demand model, 2000 model calibration report). Apply updated MOVES derived 2020 g CO2e/mile (344 g/mi) compared to TPB emissions factor (358.78 g/mi).
Commute Alternatives/ Incentives	Expansion of Car Sharing Program	2	Apply 49 percent MWCOG region VMT in Maryland (per travel demand model, 2000 model calibration report). Apply updated MOVES derived 2020 g CO2e/mile (344 g/mi) compared to TPB emissions factor (358.78 g/mi).
Public Transit Improvement	Improve Pedestrian Facilities Near Rail Stations	2	Apply 49 percent MWCOG region VMT in Maryland (per travel demand model, 2000 model calibration report). Apply updated MOVES derived 2020 g CO2e/mile (344 g/mi) compared to TPB emissions factor (358.78 g/mi).
Commute Alternatives/ Incentives	Implement 10 Neighborhood Circulator Bus Service to Metrorail	2	Apply 49 percent MWCOG region VMT in Maryland (per travel demand model, 2000 model calibration report). Apply updated MOVES derived 2020 g CO2e/mile (344 g/mi) compared to TPB emissions factor (358.78 g/mi).
Commute Alternatives/ Incentives	Transit Stores in Maryland	2	Apply updated MOVES derived 2020 g CO2e/mile (344 g/mi) compared to TPB emissions factor (358.78 g/mi).

Project Type	Description	Source	Assumptions / Methodology (1) (2)
Commute Alternatives/ Incentives	6 Kiosks in Maryland	2	Apply updated MOVES derived 2020 g CO2e/mile (344 g/mi) compared to TPB emissions factor (358.78 g/mi).
Public Transit Improvement	Park-and-ride lots (Germantown Transit Center, MD 210/MD 733, Southern Maryland, Frederick County, US 340, I 70/MD 355, I 270/MD 80	2	Apply 49 percent MWCOG region VMT in Maryland (per travel demand model, 2000 model calibration report). Apply updated MOVES derived 2020 g CO2e/mile (344 g/mi) compared to TPB emissions factor (358.78 g/mi).
Commute Alternatives/ Incentives	MD/DC Vanpool Incentive Program	1	Use statewide avg. EF for LDV Avg. trip length: 15.5 miles Cold start idle time: 2 mins/start 300 days/yr
Commute Alternatives/ Incentives	Voluntary Employer Parking Cash-Out Subsidy	2	Apply 49 percent MWCOG region VMT in Maryland (per travel demand model, 2000 model calibration report). Apply updated MOVES derived 2020 g CO2e/mile (344 g/mi) compared to TPB emissions factor (358.78 g/mi).
Public Transit Improvement	Bus Information Displays with Maps at Bus Stops	2	Apply 49 percent MWCOG region VMT in Maryland (per travel demand model, 2000 model calibration report). Apply updated MOVES derived 2020 g CO2e/mile (344 g/mi) compared to TPB emissions factor (358.78 g/mi).
Public Transit Improvement	Construction of 1000 Additional Parking at WMATA Metrorail Stations	2	Apply 49 percent MWCOG region VMT in Maryland (per travel demand model, 2000 model calibration report). Apply updated MOVES derived 2020 g CO2e/mile (344 g/mi) compared to TPB emissions factor (358.78 g/mi).
Public Transit Improvement	Enhance Commuter Services on Major Corridors in Maryland	2	Apply updated MOVES derived 2020 g CO2e/mile (344 g/mi) compared to TPB emissions factor (358.78 g/mi).
Public Transit Improvement	Enhanced Commuter Services on Major Corridors in (Reverse Commute)	2	Apply 49 percent MWCOG region VMT in Maryland (per travel demand model, 2000 model calibration report). Apply updated MOVES derived 2020 g CO2e/mile (344 g/mi) compared to TPB emissions factor (358.78 g/mi).
Public Transit Improvement	Free Bus Service Off-Peak (10:00 AM –2:00 PM Mid-Day and Weekends)	2	Apply 49 percent MWCOG region VMT in Maryland (per travel demand model, 2000 model calibration report). Apply updated MOVES derived 2020 g CO2e/mile (344 g/mi) compared to TPB emissions factor (358.78 g/mi).
Public Transit Improvement	Free Bus-to-Rail/Rail-to Bus Transfer (Similar to NYC Pricing Structure)	2	Apply 49 percent MWCOG region VMT in Maryland (per travel demand model, 2000 model calibration report). Apply updated MOVES derived 2020 g CO2e/mile (344 g/mi) compared to TPB emissions factor (358.78 g/mi).
Public Transit Improvement	Parking Impact Fees	2	Apply 49 percent MWCOG region VMT in Maryland (per travel demand model, 2000 model calibration report). Apply updated MOVES derived 2020 g CO2e/mile (344 g/mi) compared to TPB emissions factor (358.78 g/mi).
Public Transit Improvement	Real Time Bus Schedule Information	2	Apply 49 percent MWCOG region VMT in Maryland (per travel demand model, 2000 model calibration report). Apply updated MOVES derived 2020 g CO2e/mile (344 g/mi) compared to TPB emissions factor (358.78 g/mi).

Notes: (1) Unless noted otherwise, to obtain 2020 estimate, annual VMT growth rate (1.4 percent) is applied to 2008/2010 MWCOG TERM estimates.

(2) Annualization factor for commute alternatives/incentives and transit TERMs is 250 days.

Sources:(1) Analysis Of Potential Transportation Emissions Reductions Measures (TERMs) Under Consideration For The Conformity Of The 2009 CLRP & FY 2010-2015 TIP, Transportation Planning Board, June 2009.

(2) GHG emission reductions in 2020 calculated by MWCOG. Refer to: Preliminary Analysis of Potential Transportation-Related GHG Reduction Strategies for the Washington D.C. Region, Transportation Planning Board, May 2010.

Table C.4 presents the complete 2020 TERM listing with source, description, and estimated GHG reduction.

Table C.4 Transportation Emission Reduction Measures (TERMs) Project Listing

Project Type	Agency	Source	Project	Description	2020 GHG Reduction (mmt CO2e)
Clean Technology	Office of the Secretary	BRTB Outlook 2035 & TIP Conformity Report	IdleAire Advanced Truckstop Electrification System	This project involves the installation of up to 190 Advanced Truckstop Electrification (ATE) units at truck stops in Jessup and Baltimore City. The ATE units provide individual electric service to trucks utilizing parking spaces.	**0.0031**
Commute Alternatives Incentive	ARTMA/ Annapolis Transit	BRTB Outlook 2035 & TIP Conformity Report	Fare-less Cab	When a company participates in Fare-less Cab, an employee who participates in the program can get a free cab ride home in the event of illness (personal or family) or unscheduled overtime. Clean Commute Annapolis will invoice the participating company.	**0.0000**
Commute Alternatives Incentive	Baltimore City	BRTB Outlook 2035 & TIP Conformity Report	Live Near Your Work	Provide matching grant money to employees moving near their work.	**0.0021**
Commute Alternatives Incentive	Howard County	BRTB Outlook 2035 & TIP Conformity Report	Park & Ride at MD 32/MD 108	Funds for land acquisition for Park & Ride MD 32/MD 108 is included in this project. New roadway construction in Howard County - Sharing Costs with SHA.	**0.0002**
Commute Alternatives Incentive	JHU Sustainability Initiative	BRTB Outlook 2035 & TIP Conformity Report	Car Sharing Program - JHU Sustainability Initiative	Johns Hopkins University Sustainability Initiative has partnered with FlexCar to offer car-sharing service to JHU students and people in the surrounding neighborhoods. Car-sharing is a service in which members can get online and rent a car by the hour.	**0.0008**
Commute Alternatives Incentive	MDOT	BRTB Outlook 2035 & TIP Conformity Report	I-95 at MD 543 Park-n-ride lot	128 new spaces	**0.0001**
Commute Alternatives Incentive	MDOT	BRTB Outlook 2035 & TIP Conformity Report	US 1 at MD 23 Park-n-Ride Lot	60 new spaces	**0.0000**
Commute Alternatives Incentive	MDOT	BRTB Outlook 2035 & TIP Conformity Report	MARC BWI Rail Station Parking Garage	1790 Spaces	**0.0024**

Project Type	Agency	Source	Project	Description	2020 GHG Reduction (mmt CO2e)
Commute Alternatives Incentive	MDOT	BRTB Outlook 2035 & TIP Conformity Report	MARC Halethorpe Station Parking Expansion	Expand surface parking and investigate future parking at the Halethorpe MARC Station. Parking spaces will be added. The scope of the proposed work also includes high level platforms, new shelters, improved accessibility for persons with disabilities, lighting improvements.	**0.0001**
Commute Alternatives Incentive	MDOT	BRTB Outlook 2035 & TIP Conformity Report	MARC Odenton Parking Expansion	A 700-space parking lot, and a facility study for structured parking (garage or parking deck)	**0.0002**
Bicycle and Pedestrian	MDOT	BRTB Outlook 2035 & TIP Conformity Report	Gwynns Falls Trail - Phase II and III	5.5 miles. Develop a linear park and recreational trail along the Gwynns Falls, linking Leakin Park to Middle Branch Park. Phase 3 will link Carroll and Middle Branch Parks to the Inner Harbor.	**0.0002**
Bicycle and Pedestrian	MDOT	BRTB Outlook 2035 & TIP Conformity Report	Star Spangled Heritage Trail - Phase II	Complete design and Installation of Phase II of the Star Spangled Heritage Trail, a system of interpretive kiosk signs, site signs, and sidewalk markers, integrated with the Downtown Pedestrian Wayfinding System, from monument Square to Penn Station.	
Bicycle and Pedestrian	MDOT	BRTB Outlook 2035 & TIP Conformity Report	Druid Hill Park: Jones Falls Greenway Extension	The pedestrian/bicycle path system in Druid Hill Park will be renovated to extend the Jones Falls Greenway through Druid Hill Park. The project is also to include resurfacing existing walks and making new connections for safe crossings at park roads.	
Bicycle and Pedestrian	MDOT	BRTB Outlook 2035 & TIP Conformity Report	Govans Area Streetscape Improvements	Install brick sidewalks along the fronts of the businesses on Dock Street from Randall Street to Susan Campbell Park and installation of landscaped island between Randall and Craig Street.	
Bicycle and Pedestrian	MDOT	BRTB Outlook 2035 & TIP Conformity Report	Abington Road/Route 924/Box Hill S. Pkwy (Phase I)	Abington Rd. between existing MD Rte. 924 and Box Hill South Pkwy. to be improved to adequately handle existing and projected traffic loads. 4,400 LF of closed section road is to be built. Sidewalks will also be constructed to improve pedestrian access from the communities of Box Hill to commercial sites along MD Rte. 924	

Project Type	Agency	Source	Project	Description	2020 GHG Reduction (mmt CO2e)
Bicycle and Pedestrian	MDOT	BRTB Outlook 2035 & TIP Conformity Report	Howard County Pathway System	A project to develop a 30-mile spinal pathway system linking Alpha Ridge Park, David Force Park, Centennial Park, Lake Elkhom, King's Contrivance, and follow Little Patexent River to Savage Park.	
Bicycle and Pedestrian	MDOT	BRTB Outlook 2035 & TIP Conformity Report	Columbia - 100 Parkway Area Sidewalks	Construction of approximately 4000 ft. of pedestrian sidewalks to connect residential communities along Columbia 100 Parkway to restaurant/shopping areas and Howard High School.	
Bicycle and Pedestrian	MDOT	BRTB Outlook 2035 & TIP Conformity Report	Broken Land Parkway Sidewalks	A project for the design and construction of a sidewalk along the east side of Brokenland Parkway between the two intersections with Cradlerock Way.	
Bicycle and Pedestrian	MDOT	BRTB Outlook 2035 & TIP Conformity Report	Hunt Club Sidewalk	Construction of approximately 4000 LF of sidewalk along Hunt Club Rd. from US 1 to Bauman Dr.	
Bicycle and Pedestrian	MDOT	BRTB Outlook 2035 & TIP Conformity Report	Snowden River Parkway Sidewalks	Construction of approximately 4000 ft. of sidewalks from Dobbin Road to Tamar Drive.	
Bicycle and Pedestrian	MDOT	BRTB Outlook 2035 & TIP Conformity Report	Broadneck Peninsula Trail - Phase II	This is part of a larger project to develop a multi-use trail to connect Bay Bridge and Sandy Point State Park with B&A Trail. Phase II goes from Bay Dale to Green Holly.	
Bicycle and Pedestrian	MDOT	BRTB Outlook 2035 & TIP Conformity Report	South Shore Trail - Phase II	This is a portion of a larger trail project which involves acquiring property, design and construction of a trail between Annapolis and Odenton on WB&A.	
Bicycle and Pedestrian	MDOT	BRTB Outlook 2035 & TIP Conformity Report	Herring Run Greenway - Phase II and III	Phase II (Morgan State to Northern Parkway) and Phase III (Sinclair Lane to Armistead Gardens) of the Herring Run Greenway. The Herring Run Greenway Trail will add to the recreational and commuting opportunities for citizens of Baltimore City and the region.	
Bicycle and Pedestrian	MDOT	BRTB Outlook 2035 & TIP Conformity Report	Jones Falls Trail - Phase II	Creation of bike/ped trail from the Penn Station area south to the Maryland Science Center at the Inner Harbor.	
Bicycle and Pedestrian	MDOT	BRTB Outlook 2035 & TIP Conformity Report	Taylor Avenue Bike/Ped Facilities	Build a new bike/ped trail along Taylor Avenue	

Project Type	Agency	Source	Project	Description	2020 GHG Reduction (mmt CO2e)
Bicycle and Pedestrian	MDOT	BRTB Outlook 2035 & TIP Conformity Report	Long Gate Sidewalk	The project is for the reconstruction of approximately 1500 LF Concrete curb storm drain inlets and sidewalk along Long Gate Parkway, including the bridge over MD 100.	
Bicycle and Pedestrian	MDOT	BRTB Outlook 2035 & TIP Conformity Report	Ilchester Road Walkways	A project for the construction of a sidewalk in Ilchester Rd. from Crestwood Ln. to Wharf Ln.	
Bicycle and Pedestrian	MDOT	BRTB Outlook 2035 & TIP Conformity Report	Robert Fulton Sidewalks	A project to construct approximately 4000 LF of sidewalk along Robert Fulton Drive from Solar Walk Way to Columbia Gateway Drive.	
Bicycle and Pedestrian	MDOT	BRTB Outlook 2035 & TIP Conformity Report	St. John's Lane Sidewalk	Project to construct sidewalk and pathway improvements along St. Johns Lane to link Mt. Hebron High School to US 40.	
Public Transit Amenities Improvement		BRTB Outlook 2035 & TIP Conformity Report	Public Transit Amenities Improvement Total - shelters, sidewalks, lightning and signage		**0.0013**
Public Transit Improvement	MDOT	BRTB Outlook 2035 & TIP Conformity Report	Charles Street Improvements	Construct sidewalk	**0.0001**
Public Transit Improvement	MDOT	BRTB Outlook 2035 & TIP Conformity Report	Local Bus Replacement	Purchase 4 new vehicles	**0.0001**
Public Transit Improvement	MDOT	BRTB Outlook 2035 & TIP Conformity Report	Bus Replacements	Purchase 100 buses in Contract Year - 1	**0.0016**
Public Transit Improvement	MDOT	BRTB Outlook 2035 & TIP Conformity Report	Bus Replacements	Purchase 125 buses in Contract Year - 2	**0.0020**
Public Transit Improvement	MDOT	BRTB Outlook 2035 & TIP Conformity Report	Bus Replacements	Purchase 107 buses in Contract Year 3: 94 - 40 ft. Low-floor diesel buses; 3 - 30 ft. Low-floor diesel buses; 10 - 40ft. Hybrid Electric Buses	**0.0017**
Public Transit Improvement	MDOT	BRTB Outlook 2035 & TIP Conformity Report	MARC New Bi-level Coach Purchase	Purchase and use 50 bi-level coaches	**0.0146**
Public Transit Improvement	MDOT	BRTB Outlook 2035 & TIP Conformity Report	Hampden Shuttle	Neighborhood shuttle in Hampden, including connection to Woodberry Light Rail Station (Bus Route #98) and MTA bus routes #22 and #27	**0.0001**

Project Type	Agency	Source	Project	Description	2020 GHG Reduction (mmt CO2e)
Public Transit Improvement	MDOT	BRTB Outlook 2035 & TIP Conformity Report	State Worker Free Transit Program	Provide free service to state employees for MTA bus, light rail, some commuter buses, and Metro subway systems.	**0.0053**
Traffic Control	Baltimore City	BRTB Outlook 2035 & TIP Conformity Report	Traffic Signal LED Upgrades	Traditional traffic signal heads are to be replaced with LED signal heads.	**0.0260**
Commute Alternatives Incentive		MWCOG TERMs Analysis, 2009 CLRP	Employer Outreach for Public Sector Agencies	Marketing and implementing employer based TDM programs	**0.0079**
Commute Alternatives Incentive		MWCOG TERMs Analysis, 2009 CLRP	Expanded Employer Outreach for Private Sector Employers	Marketing and implementing employer based TDM programs	**0.0010**
Commute Alternatives Incentive	WMATA	MWCOG TERMs Analysis, 2009 CLRP	Expansion of Car Sharing Program	Funds incentives for1000 new car sharing customers. Car sharing customers typically increase their transit ridership and decrease driving. Started sponsorship in 2005.	**0.0002**
Public Transit Improvement		MWCOG TERMs Analysis, 2009 CLRP	Improve Pedestrian Facilities Near Rail Stations	Assumes improvements to sidewalks curb ramps, crosswalks, and lighting in order to improve pedestrian access to 11 MARC stations and 12 Metrorail stations in Montgomery County.	**0.0010**
Public Transit Improvement		MWCOG TERMs Analysis, 2009 CLRP	Construction of 1000 Additional Parking at WMATA Metrorail Stations	A total of 1000 parking spaces will be added at different Metrorail Stations	**0.0010**
Clean Technology	WMATA	MWCOG TERMs Analysis, 2009 CLRP	Purchase of 185 Buses to Accommodate Ridership Growth	WMATA will purchase 185 new CNG buses in the District of Columbia and deploy them on 36 crowded routes resulting in increased frequency. (assume 1/4 of benefit to Maryland)	**0.0136**
Commute Alternatives Incentive		MWCOG TERMs Analysis, 2009 CLRP	Implement Neighborhood Circulator Buses	The circulator bus service would operate over an expanded period from 5:30 am to 10:00 am and from 3:00 pm to 8:00 pm on weekdays. (assume half of benefit in Maryland)	**0.0022**
Commute Alternatives Incentive		MWCOG TERMs Analysis, 2009 CLRP	Voluntary Employer Parking Cash-Out Subsidy	A program that gives equal compensation "cash-out" to employees who choose not to use free parking provided by employers and use alternative modes of travel instead.	**0.0120**

Project Type	Agency	Source	Project	Description	2020 GHG Reduction (mmt CO2e)
Commute Alternatives Incentive		MWCOG TERMs Analysis, 2009 CLRP	Transit Stores in Maryland	Establish 10 transit stores in MD.	**0.0062**
Commute Alternatives Incentive		MWCOG TERMs Analysis, 2009 CLRP	6 Kiosks in Maryland	Establish 6 Transportation Information Kiosks in Maryland similar to those being placed in Virginia and DC	**0.0000**
Commute Alternatives Incentive		MWCOG TERMs Analysis, 2009 CLRP	Parking Impact Fees	This measure would consist of a parking impact fee administered by local governments throughout the region. The fees would allow governments to recoup some of the costs associated with maintaining the roadway infrastructure and mitigating the adverse effects on traffic.	**0.0877**
Public Transit Improvement	WMATA	MWCOG TERMs Analysis, 2009 CLRP	Bus Information Displays with Maps at Bus Stops	Provide more information at 2,000 Metrobus locations (assume 1/3 of benefit in Maryland).	**0.0016**
Public Transit Improvement		MWCOG TERMs Analysis, 2009 CLRP	Real Time Bus Schedule Information	Provide real time bus schedule information to the transit riders through internet and at bus shelter display units. Satellite technology would track buses and customers would determine real-time location and arrival time of a specific bus.	**0.0009**
Public Transit Improvement		MWCOG TERMs Analysis, 2009 CLRP	Free Bus-to-Rail/Rail-to-Bus Transfer (Similar to NYC Pricing Structure)	This program would institute a free bus to rail transfer similar to the reduced fare rail to bus transfer.	**0.0037**
Public Transit Improvement		MWCOG TERMs Analysis, 2009 CLRP	Free Bus Service Off-Peak (10:00 AM - 2:00 PM Mid-Day and Weekends)	Free bus service (10:00AM-2:00PM mi-day, weekends): Free service during the mid day and all day on weekends.	**0.0031**
Public Transit Improvement		MWCOG TERMs Analysis, 2009 CLRP	Enhanced Commuter Services on Major Corridors in Maryland (HOV Facilities)	Bus service on corridors with HOV facilities and bus lanes such as US 50, I-270, and US 29. Commuters would be picked up at Metrorail Park & Ride facilities close to Metro stations and transported to major work centers	**0.0049**
Public Transit Improvement		MWCOG TERMs Analysis, 2009 CLRP	Enhanced Commuter Services on Major Corridors (Reverse Commute)	Proposes bus service to Potomac Mills and Arundel Mills shopping centers from Metrorail stations. The service would benefit reverse commuters whose work place is in Prince William and Anne Arundel Counties.	**0.0014**

Project Type	Agency	Source	Project	Description	2020 GHG Reduction (mmt CO2e)
Public Transit Improvement		MWCOG TERMs Analysis, 2009 CLRP	Metrorail Feeder Bus Service	Improve Metrorail feeder bus service at two underutilized park and ride lots and implement a fare buydown program.	**0.0003**
Clean Technology		MWCOG TERMs Analysis, 2009 CLRP	Bose Automobile Anti-Air Pollutant and Energy Conservation System	The Bose Automobile Anti- Air Pollutant and Energy Conservation System is a mechanical, gas turbine operated system with no platinum catalysts involved as in catalytic converter systems. This system can be used with all types of fuel. It is expected to	**0.0057**
Clean Technology		MWCOG TERMs Analysis, 2009 CLRP	Truck Idling (Truck Stops and Auxiliary Power Units)	This is a voluntary program designed to install pollution-reduction technology on existing diesel vehicles and equipment. Under this program it is proposed to use a small diesel auxiliary power unit (APU), which will be mounted on the truck chassis to pr	**0.0109**
Clean Technology		MWCOG TERMs Analysis, 2009 CLRP	100 CNG Buses in place of Old Diesel Buses	The 100 oldest remaining buses in the fleet will be replaced in 2010 with CNG buses.	**0.0006**
Clean Technology		MWCOG TERMs Analysis, 2009 CLRP	100 Hybrid Buses in place of Old Diesel Buses	The 100 old diesel buses in the fleet will be replaced in 2010 with Hybrid Buses	**0.0010**
Commute Alternatives Incentive		MWCOG TERMs Analysis, 2009 CLRP	MD/DC Vanpool Incentive Program	This measure is a package of programs and incentives designed to increase the number of vanpools in the region. Expansion of existing Virginia program.	**0.0037**
Public Transit Improvement	WMATA		Glenmont Metro Parking Garage Expansion	Provides for the design and construction of 1200 additional garaged parking spaces at the Glenmont Metrorail Station on the west side of Georgia Ave. The project will be designed and constructed by WMAA.	**0.0033**
Clean Technology	MDOT	MWCOG 2010 CLRP CDR	Fleet Replacement	MDOT auto fleet, gas to hybrid, 250 vehicles	**0.0014**
Bike and pedestrian	Montgomery County	MWCOG 2010 CLRP CDR	Bicycle Facilities	Ongoing	**0.0000**
Bike and pedestrian	Region	MWCOG 2010 CLRP CDR	Bicycle Parking	Ongoing	**0.0000**
Bike and pedestrian	MDOT	MWCOG 2010 CLRP CDR	Bike Facilities at Park and Ride Lots	Ongoing	**0.0001**

Project Type	Agency	Source	Project	Description	2020 GHG Reduction (mmt CO2e)
Bike and pedestrian	MDOT	MWCOG 2010 CLRP CDR	Sidewalks at/near rail stations	Ongoing	**0.0000**
Bike and pedestrian	MDOT	MWCOG 2010 CLRP CDR	Neighborhood Conservation Program	Ongoing	**0.0001**
Public Transit Improvement	Montgomery County	MWCOG 2010 CLRP CDR	Germantown Transit Center	Completed 2005	**0.0007**
Public Transit Improvement	MDOT	MWCOG 2010 CLRP CDR	Park and ride lot - MD 210/MD 373	Completed 2003	
Public Transit Improvement	MDOT	MWCOG 2010 CLRP CDR	Various Park and Ride lots (including Southern Maryland)	Completed 2001, 2003, 2005	
Public Transit Improvement	MDOT	MWCOG 2010 CLRP CDR	New surface parking at transit centers	Ongoing	
Public Transit Improvement	MDOT	MWCOG 2010 CLRP CDR	Frederick County park and ride lots	2 new/expanded lots, completed 2005, 2008	
Public Transit Improvement	MDOT	MWCOG 2010 CLRP CDR	Park and ride lot - US 340/Mt. Zion Road	Opened 2008, expanded 2011	
Public Transit Improvement	MDOT	MWCOG 2010 CLRP CDR	Park and ride lot - I 70/MD 355	Completed 2010	
Public Transit Improvement	MDOT	MWCOG 2010 CLRP CDR	Park and ride lot - I 270/MD 80	Completed 2009	
Public Transit Improvement	MDOT	MWCOG 2010 CLRP CDR	Grosvenor Metro Station Parking	2004	**0.0035**
Public Transit Improvement	MDOT	MWCOG 2010 CLRP CDR	Bethesda Shuttle Bus Services	2004	**0.0000**
Public Transit Improvement	MDOT	MWCOG 2010 CLRP CDR	Bike Racks on Ride-On Buses	2004	**0.0000**

Project Type	Agency	Source	Project	Description	2020 GHG Reduction (mmt CO2e)
Outreach/ Education	SHA	BRTB Outlook 2035 CDR, MWCOG 2009 CLRP	Clean Air Partners	A public/private consortium that carries out a public education campaign in the Baltimore and Washington D.C. regions, to encourage individuals to take actions to reduce air emissions and protect their health from air pollution.	**0.0065**
ITS	SHA	MDOT 2011 AR	CHART	Statewide CHART program	**0.1639**
ITS	SHA	MDOT 2011 AR	Signal Systemization Total	Statewide signal system optimization	**0.0045**
ITS	SHA	2009 MDOT CAP Implementation Status Report	Metropolitan Area Transportation Operations Coordination (MATOC)*	The MATOC program coordinates and supports regional sharing of transportation systems' conditions and info management during regional incidents.	**0.0665**
Commute Alternatives Incentive	MDOT	MDOT 2011 AR	Guaranteed Ride Home	Statewide (includes all Commuter Connection program benefits)	**0.0236**
Commute Alternatives Incentive	MDOT	MDOT 2011 AR	Employer Outreach (inc. for bicycles)	Statewide (includes all Commuter Connection program benefits)	**0.1007**
Commute Alternatives Incentive	MDOT	MDOT 2011 AR	Integrated Rideshare	Statewide (includes all Commuter Connection program benefits)	**0.0207**
Commute Alternatives Incentive	MDOT	MDOT 2011 AR	Commuter Operations and Ridesharing Center	Statewide (includes all Commuter Connection program benefits)	**0.0597**
Commute Alternatives Incentive	MDOT	MDOT 2011 AR	Telework Resource Center	Statewide (includes all Commuter Connection program benefits)	**0.0429**
Commute Alternatives Incentive	MDOT	MDOT 2011 AR	Mass Marketing	Statewide (includes all Commuter Connection program benefits)	**0.0072**
Public Transit Improvement	MTA	MDOT 2011 AR	MTA College Pass	Discounted monthly transit passes to university/college students.	**0.0029**
Commute Alternatives Incentive	MTA	MDOT 2011 AR	MTA Commuter Choice Maryland Pass		**0.0157**
Public Transit Improvement	MTA	MDOT 2011 AR	Transit Store in Baltimore		**0.0055**
TOTAL					**0.7618**

D. Unfunded GHG Reduction Strategy Emission Reduction and Cost Assumptions

Public Transportation

The GHG reduction benefits of the funded public transportation policy option strategies identified in the CTP and MPO plans through 2020 are estimated as part of the emissions analysis of the funded plans and programs project bundle. The unfunded public transportation strategy approach is detailed below.

The 2008 Climate Action Plan refers to MTA's 2001 Maryland Comprehensive Transit Plan (MCTP) goal of doubling transit ridership by 2020 from a 2000 baseline by increasing transit funding 42 percent. The strategies identified by the TLU-3 working group and the coordinating committee in 2009 fell into three distinct strategy groups, all supporting the MCTP goal. These strategy groups are: (1) increased capacity and revenue miles across all transit modes, (2) enhanced transit level of service, and (3) improved access and increased development adjacent to stations.

To quantify the incremental increase in ridership required to meet the MCTP ridership goal, and the associated GHG reductions along with the investment required to get there, a trend in ridership growth projected to 2020 is developed. The trend include the system expansion projects in the fiscally constrained plans and programs through 2020. The transit ridership trend is included in the GHG reduction benefits calculated for the Maryland plans and programs.

GHG Emission Reduction - Data and Assumptions

There are two primary sources in Maryland for tracking transit ridership data: the National Transit Database administered by FTA and the Maryland Annual Attainment Report. Data for both of these sources are obtained by operator tracking of daily system use. Future ridership projections are generated by transit agencies and modeled by MPO's based on socioeconomic assumptions and expansion of the transit system.

To develop a ridership forecast for Maryland through 2020 the following information is used:

- From 2001 to 2010, the Maryland Annual Attainment Report (AAR) indicates an average annual ridership growth rate of 1.44 percent. This includes an annual growth rate outside of Baltimore of 4.04 percent, and inside Baltimore of -0.16 percent (services inside Baltimore include MTA bus, metro rail, and light rail). The flat ridership growth over the past decade in Baltimore is partly due to light rail system closures due to the double tracking project and service cuts to the local bus system.

- From 2007 to 2010, transit ridership in Baltimore has shown a rebound, increasing at a rate of 1.79 percent per year.
- The BRTB and MWCOG constrained long range plans indicate average annual ridership growth rates through 2030 of 0.64 percent in the Baltimore region and 2.17 percent in the Washington region. These modeled growth rates account for changes in land use and transit system expansion. This equates to an average urbanized area growth rate (weighted based on total ridership) in Maryland of 1.82 percent annually.

Table D.1 summarizes four alternative transit ridership growth trends and forecasts in Maryland.

Table D.1 Maryland Transit Ridership Trends

Scenario	Annual Growth Rate	2020 Ridership Forecast (million unlinked trips)	MCTP 2020 Goal Differential (million unlinked trips)
AR (2001-2010)	1.44%	305.7	146.8
AR Adjusted 1 [1]	2.72%	346.4	106.1
AR Adjusted 2 [2]	3.02%	356.8	95.7
MPO Forecasts (2010 – 2020)	1.82%	341.0	111.6
CAP 2020 Goal [3]	5.00%	452.5	--

Notes:

1) Adjustment assumes Baltimore region ridership maintains a 0.64 percent annual growth rate (per BMC forecasts).

2) Adjustment assumes Baltimore region ridership will maintain a 1.79 percent annual growth rate (consistent with growth 2007 to 2010).

3) MTA's 2001 Maryland Comprehensive Transit Plan (MCTP) calls for a doubling of transit ridership by 2020 from a 2000 baseline by increasing funding 42 percent.

The MCTP goal (doubling 2000 ridership by 2020) results in a target ridership in 2020 of 452.5 million. To achieve the 2020 goal requires an average annual ridership growth of 5.00 percent from 2010 to 2020.

The ridership growth rate representing transit projects and programs funded through 2020 in the CTP and MPO long range plans equals a 2.45 percent annual increase. This growth rate represents the average of the four alternatives presented in Table 1. The logic supporting use of this growth rate instead of the MPO based growth rate (1.82 percent) is tied to MPO model limitations with regard measuring the impacts of short term fluctuations in gasoline prices and economic growth.

This growth rate includes the ridership impact of implementation of all 2011-2016 CTP transit projects and TERMs, and MPO long range transit projects included in modeling assumptions by 2020 (includes Purple Line, Corridor Cities Transitway, Red Line).

The public transportation policy option focus is on the difference between the 452.5 million 2020 goal from the CAP and the 2020 transit ridership forecast of 337.5 million (based on the 2.45 percent annual growth rate). The difference represents 115.0 million unlinked transit trips. This

approach ensures no overlap or double counting of transit trips or GHG emission reductions and strictly accounts for the incremental growth required to achieve the MCTP goal.

GHG Emission Reduction – Results

There are three elements to the GHG reduction calculation for public transit expansion: VMT reduction, highway delay reduction, and land use and development interaction impacts. The GHG emission reduction from each element is added together to estimate the total estimated 2020 reduction.

VMT Reduction Element

To translate unlinked transit trips to VMT, an average vehicle occupancy and average transit trip length is required. The average auto occupancy in Maryland is 1.34 persons per vehicle from the 2007-2008 BRTB/TPB household travel survey. The average transit trip length of all Maryland transit trips is 13 miles per data from the 2007-2008 BRTB/TPB household travel survey.

The VMT reduction is translated to a GHG emissions based on the following equation:

$$mmt\ CO_2e = [VMT * EF_R] + [VMT/TL * IDLE * EF_I] + [VMT/TL * EF_S]$$

where:

EF_R = 2020 Running emissions factor = 344 grams/mile

TL = average trip length = 13 miles

IDLE = average idling time per trip = 2 minutes

EF_I = 2020 Idling emission factor = 4678 grams/hour

EF_S = 2020 Start emissions factor = 111 grams/start

Delay Reduction Element

Based on data from Texas Transportation Institute Urban Mobility Report (2009), on average 0.0594 gallons of gasoline are saved for every transit passenger trip in major metropolitan areas, including Baltimore and Washington D.C. One gallon of gas equals 0.0088 metric ton CO_2, and 83 percent of MD population is located in an urbanized area as defined by the 2000 US Census. Based on these relationships, the GHG emissions savings resulting from reduced highway system delay due to mode shift is calculated as follows:

$$mmt\ CO_2e = Tpt * Gpt * G_{CO2} * S * 1.05$$

where:

Tpt = transit passenger trips

Gpt = gallons of gasoline saved per transit passenger trip (0.0594 gallons/trip)

G_{CO2} = 0.0088 mt CO_2/gallon

S = share of population in urban areas (83 percent)

1.05 = EPA factor to convert from CO_2 to CO_2e

Land Use and Development Interaction Element

Accounting for the interaction between expanded transit and redevelopment adjacent to new transit stations is a significant synergy to account for in estimating potential GHG reductions from transit expansion. The process to account for this interaction is as follows:

Step 1: Estimate existing population accessibility to transit (Table D.2)

Table D.2 Existing Population Accessibility to Transit

Population	Access to Premium Transit Service (1/2 mile)	Access to All Urban Transit Service (1/2 - 1/4 mile)
Maryland Population (2007 ACS)	332,839 (6.1%)	1,991,580 (36.5%)

Source: 2007 American Community Survey, population by census tract

Step 2: Share of population in census tracts with supportive population density

Based on policy goals for PlanMaryland, MDP will seek to achieve 75 percent of Maryland's new development as compact development (4 units per acre for residential developments) in 2020. Assuming that 4 units per acre is the minimum density threshold for transit supportive density, based on 2010 census data, 23.6 percent of Maryland's population lives in census tracts with a residential density of 4 units per acre or greater. Based on the MDP growth target, in 2020 28.6 percent of the population will live in a census tract with a residential density of 4 units per acre or greater.

Step 3: Estimate 2020 population accessibility to transit (Table D.3)

Table D.3 2020 Population Accessibility to Transit

Scenario	Percent Access to Premium Transit
2010	6.1%
2020 Baseline (PlanMaryland Goal)	7.4%
2020 Baseline plus Unfunded Public Transit Expansion Goal	9.4% - 10.9%

Note: Premium transit is any transit mode that is on a fixed guideway.

Step 4: Estimate 2020 GHG reduction

Based on an estimate of 2.70 million households in 2020, the total VMT reduction is estimated as follows:

$$VMT_{LU} = HH * P_{acc} * VMT_{red}$$

where:

HH = 2020 Maryland households (2.7 million)

P_{acc} = 2020 accessibility (9.4% - 10.9%)

VMT_{red} = 6.5 daily vehicle miles less per household accessible to transit[2]

On-Road Transit Emissions

Added revenue miles result in additional emissions from on-road transit vehicles compared to the transit baseline in the MPO plans and programs. Based on data in the Maryland Attainment Report, total revenue miles by transit mode can be estimated from new transit passenger trips. Total emissions from revenue miles for local and commuter buses are calculated as follows:

$$mmt\ CO_2e = ([Rev * EF_R] + [Rev/TL * IDLE * EF_I] + [Rev/TL * EF_S])*HY_{adj}$$

where:

Rev = bus revenue miles

EF_R = 2020 Running emissions factor = 1342 grams/mile

TL = average transit trip length = 12.9 miles

IDLE = average idling time per trip = 4 minutes

EF_I = 2020 Idling emission factor = 12271 grams/hour

EF_S = 2020 Start emissions factor = 109 grams/start

HY_{adj} = Emission factor adjustment for hybrid diesel-electric buses (64 percent)[3]

Results

Example results for the average ridership growth rate scenario (average of the four alternative growth rates presented in Table 4.1) is presented in Table D.4.

Table D.4 GHG Emission Reductions

Average Ridership Growth Rate Scenario	VMT Reduction (mmt CO_2e)	Delay Reduction (mmt CO_2e)	Land Use Interaction (mmt CO_2e)	Added On-Road Emissions (mmt CO_2e)	TOTAL
2.45%	0.40	0.05	0.08	-0.017	0.51

[2] The secondary or indirect effects of transit expansion include long-term land use changes that redistribute growth focused on fixed-guideway transit stations. *The Broader Connection between Public Transportation, Energy Conservation and Greenhouse Gas Reduction* transit and land use analysis (Transit Cooperative Research Program Project J-11) estimated the average reduction of VMT per household by level of transit availability based on household trip survey data from the 2001 National Household Travel Survey. The model estimation from this study resulted in an average daily reduction of VMT per household of 6.5 for households with access to transit.

[3] Assume new buses in 2020 are 36% cleaner than forecast fleet average: (http://www kingcounty.gov/operations/procurement/Services/Environmental_Purchasing.aspx).

Cost Estimation Assumptions

The method for estimating the costs associated with these strategies is based on the incremental investment needed to increase annual transit ridership growth from the plans and programs to achieve the MCTP goal.

Revenue Mile Expansion Cost

The additional revenue miles required to accommodate the ridership growth by mode to reach the 2020 goal were estimated by using existing transit trip rates per revenue mile (based on Maryland specific 2009 data from the National Transit Database). These trip rates are:

- Heavy rail (Baltimore METRO, WMATA METRO Rail) – 3.2 passenger trips per revenue mile
- Commuter rail (MARC) – 1.3 passenger trips per revenue mile
- Light rail (MTA light rail) – 2.1 passenger trips per revenue mile
- Local bus (MTA, LOTS, WMATA) – 3.6 passenger trips per revenue mile (only includes WMATA bus service in Maryland)
- Commuter bus (MTA) – 0.7 passenger trips per revenue mile

The 2009 revenue miles per vehicle for each mode was used to determine the additional number of vehicles needed to accommodate the ridership growth for each mode (Table D.5). The revenue miles per vehicle for each mode were calculated using 2009 revenue miles and numbers of vehicles available for maximum service. The capital cost per mode was calculated using standard costs per vehicle type (also see Table D.5). Note that the costs for the local and commuter buses represent estimates for hybrid-electric transit buses. Data sources for this information included 2009 NTD data and documentation from ongoing WMATA and MTA plans and projects.

Table D.5 Revenue Miles per Vehicle and Cost per Vehicle

Mode	2009 Annual Revenue Miles per Vehicle	Cost per Vehicle
Heavy Rail	138,905	$3,000,000
Light Rail	41,381	$3,870,000
Commuter Rail	73,837	$2,800,000
Local Bus	24,493	$650,000
Commuter Bus	21,519	$650,000

The estimated incremental costs to achieve the MCTP goal were calculated based on the range of 2020 MCTP ridership differentials presented in Table D.1 and two alternative assumptions for mode share by transit mode. The first calculation assumption for mode share was based on

maintaining 2009 actual transit passenger trip mode share in 2020. [4] The second calculation assumption used 2020 forecasted transit passenger trip mode splits.[5] The steps to estimate the total cost are as follows:

1. The transit passenger mode splits were multiplied by the total increment of new transit passenger trips required to achieve the 2020 goal (95.7 to 146.8 million) and then multiplied by the passenger trips per revenue mile in order to estimate total new revenue miles by transit mode needed (see Table D.6)

Table D.6 Range of Incremental Revenue Miles Needed to Achieve Goal

Mode	High Need Estimate (million revenue miles	Low Need Estimate (million revenue miles)
Heavy Rail	13.82	9.38
Light Rail	2.00	1.04
Commuter Rail	3.09	2.51
Local Bus	23.10	15.52
Commuter Bus	2.74	2.79

2. The needed revenue miles were then divided by the annual revenue miles per vehicle data in Table D.5 to estimate the number of new vehicles required.
3. The total number of vehicles required was multiplied by the unit cost per vehicle to estimate total implementation cost.

This costing methodology does not estimate costs associated with the purchase of new ROW or construction of new fixed guideway transit systems (above the funded plans and programs) before 2020, or the annual operations and maintenance costs required to support the expanded transit system. The total cost estimate for expanded revenue miles above and beyond the plans and programs through 2020 ranges from $915 million to $1.298 billion.

Park-and-Ride Expansion Cost

To support this expansion in revenue miles, cost for additional park-and-ride lot spaces needed by 2020 were also estimated. Based on research data from METRA (Chicago region commuter rail system) detailed in Transit Research Cooperative Program Report 95, Chapter 3, for every

[4] The 2009 mode splits, based on NTD and MWCOG model data, were 32.7 percent heavy rail, 3.0 percent light rail, 3.0 percent commuter rail, 59.9 percent local bus, and 1.4 percent commuter bus.

[5] The 2020 mode splits, forecasted based on 2001 to 2009 NTD and MWCOG model data, were 32.7 percent heavy rail, 3.0 percent light rail, 3.6 percent commuter rail, 58.6 percent local bus, and 2.1 percent commuter bus. The 2020 light rail mode share was adjusted to maintain the 2001 percentage (since the share actually decreased between 2001 and 2007), and the local bus mode share was accordingly decreased.

25 percent increase in parking spaces there is an associated 15 percent increase in transit ridership. Current data from SHA and MTA indicate approximately 45,000 park-and-ride lot spaces in Maryland. In 2020, a 25 - 45 percent increase in ridership is estimated in order to achieve the 2020 targeted ridership goal. Based on the relationship detailed above, this increase would require between an additional 11,500 and 20,700 park-and-ride spaces in Maryland.

Assuming that the mix of locations of the park and ride lots stay the same as they are now, based on SHA general guidance total cost per space assumes $8,000 in construction and $2,000 in design and PE costs totaling $10,000 per space in capital costs (this does not include information on ROW acquisition costs). The total cost for new park-and-ride spaces above the plans and programs by 2020 ranges from $115.1 million to $207.2 million.

Results

Based on the assumptions outlined above, the unfunded TLU-3 strategies will yield an average 0.50 mmt reduction in GHG emissions in 2020 at an additional capital cost of approximately $1.214 – $1.765 billion.

Intercity Passenger and Freight Transportation

The GHG reduction benefits of the funded intercity passenger and freight strategies identified in the CTP and MPO plans through 2020 are estimated as part of the emissions analysis of the funded plans and programs project bundle. The unfunded strategy approach is detailed below.

The analysis for greenhouse gas reductions in Maryland by 2020 for unfunded strategies focuses on improving the transit mode share for trips to/from BWI Marshall Airport, and increasing ridership on Amtrak/MARC intercity rail service with an origin or destination in Maryland.

The intercity transportation working group did not specify any unfunded freight strategies for potential implementation prior to 2020. However, given Maryland's recent involvement and commitment to the National Gateway initiative, analysis of the truck VMT savings and associated GHG emission reductions in Maryland are estimated as an unfunded intercity transportation strategy.

GHG Emission Reduction Estimates - Data and Assumptions

Increased Transit Mode Share to/from BWI Marshall

Passenger miles for access trips to and from BWI Marshall total 377.97 million in 2007. Passenger miles for 2020 are obtained by extrapolating historic growth trends in total annual enplanements, which yielded an annual 2 percent growth rate (based on 2002 - 2007). [6] Total

[6] Obtained from Table 4 of 2007 Washington-Baltimore Regional Air Passenger Survey by National Capital Region Transportation Planning Board, et al.

passenger miles to/from BWI Marshall are then broken down into the current and target mode splits between private and public modes.

To quantify the greenhouse gas reduction associated with improved passenger connections at BWI Marshall, it is assumed that the transit mode share can be increased from 11.4 percent in 2007 to 20 percent by 2020. The mode share assumptions are based on:

- 12 percent is the existing public access mode share at BWI Marshall according to a 2008 ACRP Report.[7] Public transportation is defined in this report as rail, bus and shared ride vans, but excludes single-party limousines, courtesy shuttles, and charter operations.
- Table 10 in the 2007 Washington-Baltimore Regional Air Passenger Survey indicates that the average share of public mode of access in 2002, 2005, and 2007 is 11.4 percent.[8] Public mode of access includes rail services and airport bus, van or limo.
- San Francisco International Airport's (SFO) public access mode share of 23 percent, which is currently the highest in the U.S. based on 2005 data included in the referenced ACRP report. SFO has access from multiple rail transit modes, and has on average slightly more expensive daily/long-term parking fees of $14 per day.

20 percent is chosen as a reasonable target mode share for BWI Marshall in 2020, in order to estimate the potential for GHG reductions. This represents an increase over existing conditions and puts BWI Marshall at a transit access share similar to Washington National, Boston Logan, and New York JFK.

The difference between current transit access mode share at BWI Marshall and a mode share in 2020 of 20 percent results in GHG emission savings through a reduction in total passenger miles in a private vehicle. The passenger mile reduction estimates are presented in Table D.7.

Table D.7 Estimated Passenger Mile Reductions from Increased Transit Mode Share at BWI Marshall

BWI Marshall Access Trips	2020
Total Passenger-Miles (millions)	494.71
Current Mode Split	
Private Vehicle (88.6%)	438.31
Transit (11.4%)	56.40
Target Mode Split	
Private Vehicle (80%)	395.77
Transit (20%)	98.94
Private Vehicle Passenger Miles Reduced	**42.54**

[7] Airport Cooperative Research Program (ACRP) Report 4: Ground Access to Major Airports by Public Transportation. 2008.

[8] http://www.mwcog.org/uploads/committeedocuments/lF5dXlhf20081003124339.pdf

The passenger mile reduction estimate is translated to a VMT reduction based on an average occupancy (1.34 passengers per vehicle), and to GHG emission based on the calculation detailed on page D.3 of this Appendix.

Increased Ridership on Amtrak/MARC

Based on Amtrak projections, from 2010 to 2030, daily maximum ridership is expected to grow from 11,500 daily to 24,670 daily, or 3.9 percent annually on the Northeast Corridor (Amtrak Acela and NE Regional services, and MARC Penn line). This is based on implementation of capital elements of the Northeast Corridor Master Plan, which by 2030 identifies $8.014 billion in currently unfunded capital investment in Maryland (including improvements at Washington Union Station).

Annual passenger miles in Maryland on the Northeast Corridor in 2008 are 159.4 million on the MARC Penn Line, and 119.6 million on Amtrak. The 3.9 percent growth rate is compared to a baseline growth rate of 1 percent annually (consistent with growth 2000 – 2010) to estimate the increase in passenger miles in 2020.

Daily NEC Passenger Miles in Maryland (2010) = 279.1 million

Daily NEC Passenger Miles in Maryland (2020 – Baseline growth) = 308.2 million

Daily NEC Passenger Miles in Maryland (2020 – NEC Master Plan) = 407.9 million

2020 Added Passenger Miles = 99.7 million

The passenger mile increase estimate is translated to a VMT reduction based on an average occupancy (1.34 passengers per vehicle), and to GHG emissions based on the calculation detailed on page D.3 of this Appendix.

National Gateway

Based on analysis completed by CSX Transportation, for the moderate diversion scenario, the estimated truck VMT reduction in Maryland in 2020 is 23.0 million. The VMT reduction is translated to a GHG emission reduction based on the 2020 composite grams CO2e/mile running emissions factor for heavy duty vehicles (1342 g CO_2e/mile)

Cost Estimation Assumptions

Increased Transit Mode Share to/from BWI Marshall

Costs for the deployment of improved traveler information and enhanced convenience at BWI Marshall from 2011 to 2020 are variable based on the exact strategies chosen and the level of new infrastructure required.

Examples of the costs associated with providing in-terminal/in-station kiosks or other display boards of real-time transit arrival information are available via a number of recent studies through FHWAs Research and Innovative Technology Administration (RITA). In 2006, the Federal Transit Administration (FTA) sponsored a study to analyze the return-on-investment for real-time bus arrival time information systems. The Transit Tracker system deployed in the Tri-County Metropolitan Transportation District of Oregon (TriMet), deployed in 2001, was

evaluated. The system provides riders with a real-time estimate of the expected time the next transit vehicle will arrive at a specific bus stop or rail station. Information is provided to riders via electronic information displays, a dedicated phone line, and a Web site.

An estimate of the cost of the field equipment (designing, purchasing, and installing the dynamic message signs at 13 bus stops and all rail stations), servers, and Web development was $1.075 million. Operating and maintenance costs for Transit Tracker are estimated to be roughly $94,300 per year.[9]

This level of investment at the scale of the Baltimore light rail system would be significantly higher (TriMet example is deployed to all 12 light rail stations in the Portland system). Software development costs could go also support expansion of the existing BWI Ground Access Information System to include all modes of access to BWI., including Amtrak and MTA bus and light rail in Baltimore.

An estimate for full deployment of this technology in all 32 light rail stations and at BWI Marshall totals 2.87 million in capital costs and $250,000 in annual operations and maintenance costs.

Maryland received a $10 million grant as part of the American Recovery and Reinvestment Act High Speed Intercity Passenger Rail Program, for planning and engineering for the new BWI station project, which includes the addition of a fourth track along a 9-mile segment and additional platform space. Maryland is applying for additional federal high speed rail funds to complete the BWI Station reconstruction and new track project estimated at $250 million. This project is assumed to be completed by 2020 if funding becomes available.

Increased Ridership on Amtrak/MARC

Full deployment of the Northeast Corridor Master Plan required $8.014 billion in capital investment in Maryland through 2030. Near term projects on which Maryland has applied for federal high speed rail funds include preliminary engineering and environmental analysis for Northeast Corridor bridges over Bush, Gunpowder, and Susquehanna Rivers ($200 million).[10] Construction of the three bridges is estimated to ultimately cost $2.1 billion.

The majority of the funding for the Northeast Corridor Master Plan is anticipated to be through federal apportionments to Amtrak and the States. Assuming a 20 percent state match for the three bridges would bring Maryland's total commitment to $420 million for construction.

National Gateway

The National Gateway Project is a package of rail infrastructure and intermodal terminal projects that will enhance transportation service options along three major freight rail corridors

[9] http://www.itscosts.its.dot.gov/its/benecost.nsf/SingleCostTax?OpenForm&Query=Transit%20Management

[10] Maryland Seeks High-Speed Rail Money That Florida Spurned. The Baltimore Sun, March 15, 2011. http://articles.baltimoresun.com/2011-03-15/news/bs-md-rail-funds-20110315_1_high-speed-rail-bwi-station-rick-scott

owned and operated by CSX through the Midwest and along the Atlantic coast. The improvements will allow trains to carry double-stacked containers, increase freight capacity and make the corridor more marketable to major East Coast ports and shippers. In 2010, $98 million in TIGER funds were awarded to help complete the first corridor project, from Northwest Ohio to Chambersburg, Pennsylvania, through West Virginia and Maryland. Based on the National Gateway TIGER Grant Application, states are planning to commit 23 percent of the funding to complete the project ($189 million), with Maryland slated to commit $75 million.

Results

Based on the assumptions outlined above, the unfunded intercity passenger and freight strategies will yield a 0.11 mmt reduction in GHG emissions in 2020, with a draft estimated implementation cost of Table D.8 illustrates the GHG emission benefits and total cost of the TLU-5 unfunded strategies.

Table D.8 Estimated GHG Emission Reduction and Costs for Unfunded Strategies

Intercity Passenger and Freight Transportation	GHG Reduction (mmt CO_2e)	Total Cost 2010 - 2020 (million $)
Increased transit mode share to/from BWI Marshall	0.015	$253.12
Implement Northeast Corridor Master Plan	0.024	$420.0
CSX National Gateway	0.044	$75.0

Bike and Pedestrian

The GHG reduction benefits of the funded TLU-8 strategies identified in the CTP and MPO plans through 2020 are estimated as part of the emissions analysis of the funded plans and programs project bundle. The unfunded TLU-8 strategy approach is detailed below.

According to the MDOT Annual Attainment Report, bicycle and walking mode share for commute trips statewide in 2009 is 3.0 percent (0.4 percent biking, 2.6 percent walking). Per the 2007-2008 TPB/BMC Household Travel Survey, for the combined Baltimore and Washington metropolitan area, combined bicycling and walking mode share for commute trips is approximately 6.0 percent.

The focus of the analysis of TLU-8 strategies is to determine the mode shift and resulting GHG emission reductions of building out the *Maryland Trails* plan. A secondary analysis considers the mode shift and resulting GHG emission reductions from a comprehensive improvement in pedestrian infrastructure on urban roadways in areas adjacent to activity centers, transit stations and schools.

Maryland Trails: A Greener Way to Go is Maryland's coordinated approach to developing a comprehensive and connected statewide, shared-use trail network. This plan focuses on creating a state-wide *transportation trails* network. The *Maryland Trails* plan identifies approximately 820 miles of existing *transportation trails* and 770 miles of priority *missing links* (160 trail segments) that, when completed will result in a statewide trails network providing

travelers a non-motorized option for making trips to and from work, transit, shopping, schools and other destinations.

GHG Emission Reduction Estimates - Data and Assumptions

Buildout of the Maryland Trails Strategic Implementation Plan

The 2001 Baltimore Metropolitan Commission (BMC) Household Travel (HHT) Survey was analyzed to ascertain the potential impact of trail availability on travel modes in the study area. Whereas the Travel to Work data gathered by the US Census captures only trips to work, the HHT Survey asks respondents to record data on all trips, including work, shopping, recreation and leisure.

To calculate the VMT reduction potential of building out the statewide strategic trails plan, the mode share percentages across the BMC planning area within one mile of an existing transportation trail and within one mile of a priority missing link is estimated. This mode share data is extrapolated to all urban areas statewide to calculate the VMT shift potential of building out the state's transportation trails network.

Throughout the BMC planning area, 9.7 percent of all trips are taken by walking alone. The percentage of trips taken by foot almost doubles to 17.3 percent in areas that are within one mile of an existing transportation trail (see Table D.9).

Table D.9 BRTB Household Travel Survey Walk and Bike Mode Shares

Area	% Walk	% Walk to Transit	% Bicycle	% Bike to Transit	% Other
Within 1 Mile of Existing Trail	17.3	6.4	0.5	0.0	75.8
Within 1 mile of Priority *Missing Link*	6.0	1.2	0.4	0.0	92.4

The potential for capturing trips currently taken by car becomes more pronounced when comparing areas with existing access to a trail to areas within one mile of a priority missing link. According to the data, 92 percent of all reported trips in these areas were taken by car and only 6 percent were taken by walking (7.2 percent when combined with walk to transit trips).

The analysis was performed by applying the mode split percentages calculated for areas within one mile of an existing *transportation trail* to the areas within one mile of a priority *missing link.* By building out the *transportation trail* network, in 2020 up to 400.4 million vehicle miles could be shifted from car to nonmotorized modes of transportation, or a combination of walking or bicycling with transit (see Table D.10). .

Table D.10 2020 Greenhouse Gas Reductions from Buildout of Trail Plan

	Passenger Miles Adjacent to Missing Links	
Mode	**Pre-Trail Plan Buildout (millions) [1]**	**Post-Trail Plan Buildout (millions) [2]**
Walk	8.94	25.83
Walk & Transit	1.77	9.56
Bike	1.64	2.23
Bike & Transit	0	0.03
Other	2,176.06	1,783.71
VMT Shift (millions) [3]		**(60.70)**
GHG Reduction (mmt CO_2e)		**0.02**

Notes:

(1) 2020 PMT by mode derived by applying 1.4 percent annual VMT growth rate to 2001 household travel survey data in areas within 1 mile of a priority *missing link*.
(2) 2020 PMT by mode derived by applying 1.4 percent annual VMT growth rate to 2001 household travel survey data in areas within 1 mile of an existing *transportation trail*.
(3) VMT shift by mode extracts the VMT shift associated **only** with the provision of new transportation trails, not the impact of land use change. The assumption is that 15 percent of the mode shift is attributed to the provision of trail infrastructure, while the remainder is predominantly a result of land use change.

The VMT reduction is multiplied by a composite 2020 CO2e emissions factor using the equation detailed on page D-3 of this Appendix to obtain GHG emissions reductions.

It should be acknowledged that these mode share percentages cannot be entirely attributed to the presence or absence of a transportation trail. Other elements, such as distance between origins and destinations (i.e. the mix of uses or density), the relative bike or pedestrian "friendliness" of an area, access to transit, local encouragement efforts, and other factors contribute to travel mode choice.

Comprehensive Pedestrian Strategy

The pedestrian analysis was conducted using population density data by five population density ranges representing average population densities in rural/exurban, low density suburban, high density suburban, urban, and activity center or regional center. The deployment assumptions for adding pedestrian amenities in these different density ranges through 2020 are:

1. All new developments have buffered sidewalks on both sides of the street, marked/signalized pedestrian crossings at intersections on collector and arterial streets, and street lighting.
2. New or fully-reconstructed streets in denser suburban neighborhoods and urban areas (>4,000 persons/sq mi and business districts) incorporate traffic calming measures.
3. "Complete Streets" policies are adopted by Maryland state and local transportation agencies, requiring appropriate pedestrian accommodations on all roadways.

4. By 2020, 50 percent of existing streets within ¼ mile of transit stations, schools, and business districts are audited for pedestrian accessibility and retrofitted with curb ramps, sidewalks, and crosswalks.

The approach is to apply an elasticity of VMT with respect to a pedestrian environment factor (PEF). PEFs represent an index reflecting qualities and deficiencies of pedestrian infrastructure. Elasticities from a 2001 study by Reid Ewing and Robert Cervero are applied to example changes in the PEF resulting from pedestrian improvements.[11] Two PEF change levels were tested that include different assumptions about the geographic scope of deployment (within ¼ mile of all transit stations/activity centers to within ½ mile). As Table D.11 shows, VMT decreases range from -1.5 percent in suburban areas (where it is assumed that a greater relative level of pedestrian improvement could be implemented) and -0.5 percent in urban areas.

Table D.11 Application of Pedestrian Environment Factor (PEF) Elasticities to VMT

	Suburban		Urban	
Portland PEF factors	**Base**	**Alt**	**Base**	**Alt**
Sidewalk availability	1	3	2	3
Ease of street crossing	1	2	2	2.5
Connectivity of street/ sidewalk system	1	1	3	3
Terrain	3	3	3	3
% change in PEF		50%		15%
% change in VMT:		**-1.5%**		**-0.5%**

The "suburban" percentage VMT reduction is applied to areas with population density less than 4,000 ppsm, the urban reduction to areas greater than 10,000 ppsm, and a mid-point reduction (1.0 percent) applied to areas between 4,000 and 10,000 ppsm.

The VMT change was not applied to all population; instead, it was applied to an estimate of the population affected by the relevant pedestrian improvements. This estimate varies by census tract density range, based on the estimated land area accessed by the improvements (Table D.6). The pedestrian strategy assumes pedestrian improvements only in certain areas, such as transit stations, school zones, and business districts, as it would probably be cost-prohibitive and not very effective to make such improvements to all neighborhoods, everywhere. The following assumptions are made about the number of each type of area:

- Schools – 1,446 total K-12 schools in Maryland (National Center for Educational Statistics, 2005-06) * 5/6 of population (schools) in metro areas = 1,200 schools. These were distributed across all density ranges, based on population.
- Transit stations: 104 transit stations in Maryland. These were distributed across the three highest density ranges, based on population.

[11] Ewing, R. and R. Cervero (2001) Travel and the Built Environment. *Transportation Research Record 1780*, 87-114.

- Business districts: Total population of 5,841,356 in 2010. Total business districts estimated at 413. Multiple estimation methods used:
  - 1 for each of the 368 cities, towns, and villages in the Maryland as defined in the 2000 Census. 1 per 15,000 people (approximately the market area for a grocery store) yields 390 districts. 1 per 5,000 people (market area for a convenience store), considering only urban population in areas w/>4,000 ppsm, yields 482 districts.

The percentage of total land area in Maryland affected is calculated based on improvements within a ¼ mile radius to a ½ mile radius. All numbers are increased from 2010 to 2020 based on an average annual population growth rate from 2000 to 2020 of 0.94 percent. The VMT reduction results in 2020 are presented in Table D.12. The VMT reduction is multiplied by a composite 2020 CO2e emissions factor using the equation detailed on page D-3 of this Appendix to obtain GHG emissions reductions.

Table D.12 Comprehensive Urban Area Pedestrian Improvement GHG Reductions

	% of Total Area		VMT Reduction for Impacted Population (million)		1/4 mi GHG	1/2 mi GHG
2020 PPSM	1/4 mi	1/2 mi	1/4 mi	1/2 mi	(mmt)	(mmt)
0 - 499	0.7%	3.0%	1.52	6.09	0.00	0.00
500 -1,999	7.9%	31.7%	14.54	58.18	0.01	0.04
2,000 - 3,999	24.2%	96.8%	49.70	198.78	0.04	0.14
4,000 - 9,999	52.4%	100%	99.92	190.51	0.07	0.14
10,000+	100%	100%	18.57	18.57	0.01	0.01
Total	**4.3%**	**17.3%**	**184.25**	**472.13**	**0.13**	**0.34**

Cost Estimation Assumptions

Buildout of the Maryland Trails Strategic Implementation Plan

Planning level estimates put the cost of building all priority *missing links* at approximately $378 million (2009 dollars).[12] It should be noted that under current planning processes, trail construction is primarily county-led, although significant funding is available from the state through the Transportation Enhancements Program and the Recreational Trails Program.

Comprehensive Pedestrian Strategy

The total capital cost estimate is $219.9 - $439 million over 10 years of implementation, or an average annual cost of $22 to $43.9 million (see Table D.13).

[12] The $378 million estimate for building all the missing links is a planning level estimate developed by MDOT and Cambridge Systematics that is not documented in the final Maryland Trail Strategic Implementation Plan.

Table D.13 Comprehensive Pedestrian Strategy Costs

		Cost per Area		Total Cost ($millions)	
Area Type	**Total #**	**1/4 mi**	**1/2 mi**	**1/4 mi**	**1/2 mi**
Schools	1,588	$191,000	$382,000	$151.6	$303.3
Transit Stations	104	$191,000	$382,000	$9.9	$19.0
Business Districts	454	$257,000	$514,000	$58.4	$116.7
Total 10-year capital ($millions)				**$219.9**	**$439.0**
Cost per Year, 2010-2020				**$22.0**	**$43.9**

Results

Based on the assumptions outlined above, the unfunded TLU-3 strategies will yield a 0.16 – 0.36 mmt reduction in GHG emissions in 2020 at a cost of approximately $597 - $817 million. Table D.14 illustrates the GHG emission benefits and total cost of the TLU-8 unfunded strategies.

Table D.14 Estimated GHG Emission Reductions and Costs for Unfunded Strategies

TLU-8 Bike and Pedestrian	GHG Reduction (mmt CO_2e)	Total Cost 2010 - 2020 (million $)
Buildout of the Maryland Strategic Trails Plan	0.02	$378
Comprehensive Pedestrian Strategy	0.13 – 0.34	$220 - $439

Transportation Pricing and Demand Management

The GHG reduction benefits of the funded pricing and demand management strategies identified in the CTP and MPO plans through 2020 are estimated as part of the emissions analysis of the funded plans and programs project bundle. The unfunded strategy approach is detailed in this section.

The draft MDOT policy design developed by the working group in Phase I considered four potential strategy areas combined with an education component for state and local officials:

- **Maryland motor fuel taxes or VMT fees –** There are two primary options for consideration: (1) an increase in the per gallon motor fuel tax consistent with alternatives under consideration by the Blue Ribbon Commission, and (2) establish a GHG emission-based road user fee (or VMT fee) statewide by 2020 in addition to existing motor fuel taxes. Both options would create additional revenue that could be used to fund transportation improvements and systems operations to help meet Maryland GHG reduction goals.
- **Congestion Pricing and Managed Lanes –** Establish as a local pricing option in urban areas that charges motorists more to use a roadway, bridge or tunnel during peak periods, with revenues used to fund transportation improvements and systems operations to help meet Maryland GHG reduction goals.

- **Parking Impact Fees –** Establish parking pricing policies that ensure effective use of urban street space. Provision of off-street parking should be regulated and managed with appropriate impact fees, taxes, incentives, and regulations.
- **Employer Commute Incentives –** Strengthen employer commute incentive programs by increasing marketing and financial and/or tax based incentives for employers, schools, and universities to encourage walking, biking, public transportation usage, carpooling, and teleworking.

In Phase III, motor fuel taxes were added as a pricing strategy in order to test alternative transportation revenue strategies consistent with concepts under discussion through the Blue Ribbon Commission.

GHG Emission Reduction Estimates - Data and Assumptions

Motor Fuel Taxes

Alternatives for new primary transportation revenue sources in Maryland under consideration by the Blue Ribbon Commission include potential increases to current per gallon taxes on motor fuels. These range from a nominal increase of $0.01 per gallon to $0.10 per gallon increase. The same assumptions used to calculate the benefit of VMT fees are applied here.

VMT Fees

VMT fees are a different form of a usage fee compared to current per mile gas taxes. Table D.15 presents the current motor fuel taxes in Maryland and adjacent states. This helps set a context for the magnitude of the VMT fees tested.

Table D.15 State and Federal Motor Fuel Taxes

State	State Tax ($/gallon)	Federal Tax ($/gallon)	Total ($/gallon)
Maryland	$0.235	$0.185	$0.420
Delaware	$0.230	$0.185	$0.415
Pennsylvania	$0.323	$0.185	$0.508
Virginia	$0.191	$0.185	$0.376
Washington DC	$0.200	$0.185	$0.385
Average	***$0.236***	***$0.185***	***$0.421***

Alternative VMT fees ranging from $0.01 per mile to a high of $0.05 per mile are evaluated in Maryland for the year 2020. Assuming 24 mpg light-duty vehicle average on-road fuel economy in 2020, these equate to an equivalent gas tax increase of $0.24 to $1.21 per gallon.

To estimate the related GHG reduction of VMT fees, travel cost elasticity's are applied to all private vehicle travel in Maryland. Automobile travel is generally inelastic, meaning that a price change causes a proportionally smaller change in vehicle mileage. For example, a 10 percent fuel price increase only reduces automobile use by about 1 percent in the short run, and

3 percent over the medium run. A 50 percent fuel price increase, which is significant to consumers, will generally reduce vehicle mileage by about 5 percent in the short run. The effect over time though will increase as consumers take the higher price into account in longer-term decisions, such as vehicle purchases and where to live or work.

A combined long and short run elasticity estimate was applied for both the VMT fee and congestion pricing analysis of a -0.45 percent change in volume for each 1.0 percent change in trip cost. This elasticity is consistent with the range of estimates made by FHWA in the 2006 Conditions and Performance Report.[13] .

The VMT reduction resulting from a statewide VMT fee in 2020 is illustrated in Table D.16. Depending on the level of per mile fee (from $0.01 to $0.05), statewide VMT reductions range from 0.6 percent to greater than 3 percent, with revenue ranging from $678 million to over $3.4 billion. The VMT reduction is multiplied by a composite 2020 CO_2e emissions factor (average for light, medium, and heavy-duty vehicles) using the equation detailed on page D-3 of this Appendix to obtain GHG emissions reductions.

Table D.16 Alternative VMT Reductions (2020)

VMT Fee ($/Mile)	Equivalent ($/gallon)	% VMT Reduction	Absolute VMT Reduction (Millions)	Revenue Collected ($ Millions)
$0.01	$0.24	0.65%	439	$678
$0.02	$0.48	1.30%	879	$1,365
$0.03	$0.72	1.96%	1,318	$2,060
$0.04	$0.96	2.61%	1,757	$2,765
$0.05	$1.20	3.26%	2,196	$3,478

Congestion Pricing and Managed Lanes

There are a total of 3,140 interstate and expressway lane miles in Maryland. Based on the 2008 Annual Attainment Report, 30.4 percent of freeway lane miles are congested daily in 2006. BMC and MWCOG travel demand models forecast 40 percent of freeway miles will be congested in 2020.

Table D.17 presents proposed ranges of deployment of congestion pricing in 2020.

[13] Cambridge Systematics and Harry Cohen, "Congestion Pricing and Investment Requirements", National Cooperative Highway Research Program Project 8-36, Task 85. Transportation Research Board, 2009. http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/NCHRP08-36(85)_FR.pdf

Table D.17 Maryland Congestion Pricing Deployment Levels

Percentage of Lane Miles to Apply Congestion Pricing	2020 Target
1. Half of congested areas, 1 lane each direction	7.5%
2. All congested areas, 1 lane each direction	15.0%
3. Half of congested areas, all lanes in both directions	20.0%
4. All congested areas, all lanes in both directions	40.0%

1. (Lowest Level) – Half of congested areas, 1 lane in each direction. The percentage for this scenario will be 7.5 percent in 2020, which is about 1/5 of 40 percent - the maximum percentage in Scenario 4.

2. (Mid-Level) – All congested areas, 1 lane in each direction. The maximum percentage will be 15.0 percent in 2020, which is about 2/5 of the maximum from Scenario 4. Two-fifths is used because the average number of lanes is slightly above 5 and congestion pricing will be applied on 2 of those lanes.

3. (Mid-Level) - Half of congested areas, all lanes in both directions. The maximum percentage will be 20.0 percent in 2020, which is exactly half of the maximum for Scenario 4.

4. (Maximum) – All congested areas, all lanes in both directions. The maximum percentage for this scenario will be 40 percent in 2020, which is calculated above.

To maintain level-of-service (LOS) D conditions on the priced facilities, an estimated congestion fee (cost per mile) ranging from $0.25 to $0.30 is required.

Two ranges of VMT reduction are estimated based on a moderate and high projection of growth in congested lane miles by 2020. In 2020, the annual VMT reduction from congestion pricing ranges from 279 million to a high of 1,499 million. The VMT reduction is multiplied by a composite 2020 CO_2e emissions factor (average for light, medium, and heavy-duty vehicles) using the equation detailed on page D-3 of this Appendix to obtain GHG emissions reductions.

The ultimate calculation of the GHG emissions reduction also accounts for fuel savings from reduced delay. The GHG benefit from reduced delay represents 25 percent of the total GHG reduction.

Parking Impact Fees and Parking Management

Most parking management strategies are under the domain of local government. In most U.S. cities, parking supply is constrained or priced only in the central business district (CBD) and possibly a few other major activity centers, primarily as a result of market forces that establish a strong premium on land costs. Outside of these areas, parking supply is generally plentiful, due to long-established planning and zoning regulations that require developers to provide ample parking, and free.[14]

[14] Shoup, D. (2005). *The High Cost of Free Parking.* APA Planners Press, Chicago, Illinois.

A recommendation of the TLU-9 working group is that Maryland should encourage testing of parking impact fees in transit-served metropolitan communities. These fees would be waived for employers who offer cash-in-lieu-of-parking and transit benefits. Parking impact fees serve as a disincentive for employers who choose not to offer parking and/or transit benefits to employees. The benefits of cash-in-lieu of parking and transit benefits provided by employers are estimated as part of the employer commute incentives strategy.

Employer Commute Incentives

A range of estimates is made for future participation in all employer based commute strategies. Data from national studies suggest that approximately 50 percent of the workforce could participate (based on job requirements) and 50 percent of workers offered the option would take advantage of it. Based on these assumptions, approximately 25 percent of the workforce could participate in some type of a commute program.

The 2008 State of the Commute survey in the Metropolitan Washington, D.C. region estimated that 19 percent of regional employed workers telework at least occasionally, of which 56 percent telework at least once a week.

As shown in Table D.18, EPAs COMMUTER Model was applied with baseline work-trip mode shares and trip distances specific to Maryland along with medium and high scenario assumptions for the extent of implementation and the employee participation rates in employer based commute programs in 2020.[15]

Table D.18 Employer Based Commute Strategy Participation Assumptions

Scenario	Description	Employer Participation Rate		
		Baseline	Scenario 1	Scenario 2
Parking & Transit Benefits	Parking fees/transit passes	10%	**15%**	**20%**
Employer Support Programs, Percentage of Employers Participating	Level 1	5%	**8%**	**10%**
	Level 2	2%	**2%**	**4%**
	Level 3	1%	**2%**	**3%**
	Level 4	1%	**2%**	**3%**
Alternative Work Schedules	Flex Time	5%	**8%**	**10%**
	Compressed 4/40	5%	**8%**	**10%**
	Compressed 9/80	5%	**8%**	**10%**
	Staggered Hours	5%	**8%**	**10%**
	Telecommute	5%	**8%**	**10%**

[15] The COMMUTER Model analyzes time and cost strategies using a "pivot-point" logit mode choice model, which uses the mode choice coefficients from regional travel models and applies a change in time and/or cost to "pivot" off of a baseline starting mode share to achieve a final mode share. http://www.epa.gov/OTAQ/stateresources/policy/pag_transp.htm#cp

Notes: The values in the table are all inputs into the USEPA Commuter Model. Level 1 includes a transit information center plus a transportation coordinator. Level 2 includes a transit information center and a policy of work hour's flexibility to accommodate transit schedules/delays, plus a transportation coordinator. Level 3 includes a transit information center and a policy of work hours flexibility, on-site transit pass sales, plus a transportation coordinator. Level 4 includes a transit information center and a policy of work hours flexibility, on-site transit pass sales, guaranteed ride home, and a full-time transportation coordinator.

The results of the two Commuter Model runs are listed in Table D-19. The change in VMT represents an additional reduction over the benefits of the TERM strategy benefits analysis in 2020. The VMT reduction is multiplied by a composite 2020 CO_2e emissions factor (average for light-duty vehicles) using the equation detailed on page D-3 of this Appendix to obtain GHG emissions reductions.

Table D.19 Employer Commute Incentives GHG Reductions (2020)

Employer Commute Incentives	Scenario 1	Scenario 2
Daily VMT Reductions	1,094,381	2,793,817
Annual VMT Reduction (millions)	273.60	698.45
2020 Emission Reductions (mmt CO2e)	**0.10**	**0.25**

Cost Estimation Assumptions

VMT Fees

In order to estimate the implementation cost, two different alternatives are evaluated for instituting a distance-based pricing framework.

Administrative Reporting – Motor vehicle owners self-report mileage through the motor vehicle registration and inspection process, or on-board odometer readings are recorded by inspectors. Under this scenario, the total cost is similar to costs for collecting state gas tax revenues. The cost assumptions for these strategies come from a 2008 Cambridge Systematics white paper completed for FHWA on *Estimating the Cost of Systemwide Road Pricing*.

Using these assumptions, Table D.20 presents annual revenue in 2020 and implementation costs. Implementation costs include annual administrative costs required for the program.

Table D.20 VMT Fee Annual Costs and Revenues (Administrative Scenario)

VMT Tax ($/Mile)	Equivalent ($/gallon)[1]	Revenue Collected ($ Millions)	Admin. Costs ($ Millions)	Net Revenue ($ Millions)
$0.01	$0.27	$678	$34	$644
$0.02	$0.55	$1,365	$68	$1,297
$0.03	$0.82	$2,060	$103	$1,957
$0.04	$1.09	$2,765	$138	$2,627
$0.05	$1.37	$3,478	$174	$3,304

Wireless Reporting – Under this scenario, motor vehicles will link to a receiver located at gas stations, where a RF (radio frequency) receiver picks up a transmission from an on-board unit (OBU) that provides the odometer reading since the last visit at a gas station.

The wireless reporting VMT fee system approach uses an on-board radio frequency (RF) transmitter connected to the vehicle odometer or to an electronic hub odometer. A recent paper on *Toll Collection Technology Considerations* estimated the price of GPS OBUs at $200 to $400.[16] Transceivers are located at gas stations and record mileage information between fill-ups. The estimate for these units, based on a recent paper on Vehicle Infrastructure Integration Benefit Cost Analysis, is $1,000, with an additional $4,800 for installation. Potential costs for electronic hub odometers, on-board units, and gas station RF receivers are presented in Table D.21.[17]

Table D.21 VMT Fee Capital Implementation Costs (Wireless Scenario)

Item	Units	Cost per Unit	Cost Extended
Hub Odometers (Electronic) & Start Up	4.72 million	$400	1,888 million
OBU RF Transmitters	4.72 million	$100	472 million
RF Receivers at Gas Stations	2,082	$5,800	$12.1 million
Total Deployment Cost			**2,372.1 million**

Total VMT fee estimated capital costs for the wireless reporting scenario are $2,372.1 million. The costs associated with the technology required to deploy a wireless system are highly variable, as the technologies required are continuing to advance, and increasingly the vehicle fleet is enabled with GPS units. Therefore, the costs in Table D.21 represent a high end estimate. Table D.22 illustrates total revenue collected in 2020 and the annual operations and maintenance costs in 2020.

Table D.22 VMT Fee Annual Costs & Revenues (Wireless Scenario)

VMT Fee ($/Mile)	Equivalent ($/gallon)[1]	2020 Revenue Collected ($ Millions)	2020 Annual O&M Cost ($ Millions)	2020 Net Revenue ($ Millions)
$0.01	$0.27	$678	$33.9	$644
$0.02	$0.55	$1,365	$68.3	$1,297
$0.03	$0.82	$2,060	$103.0	$1,957
$0.04	$1.09	$2,765	$138.3	$2,627
$0.05	$1.37	$3,478	$173.9	$3,304

[16] *Toll Collection Technology Considerations, Opportunities, and Risks*, Background Paper No. 8, Washington State Comprehensive Tolling Study, September 20, 2006 (IBI Group with Maryland Department of Transportation).

[17] *VII Initiative Benefit-Cost Analysis: Pre-Testing Estimates*, Draft Report, Sean Peirce and Ronald Mauri, John A. Volpe National Transportation Systems Center, Cambridge, Massachusetts, March 30, 2007.

Congestion Pricing and Managed Lanes

Initial capital costs include the on-board units (OBU) and installation, enforcement requirements and central system development. According to a 2008 study by the Puget Sound Regional Council (PSRC), the total capital startup cost for regional congestion pricing is $748.5 million. The same PSRC study estimated annual system costs, which include OBU repair, enforcement, and data communications needs at $287.7 million annually in 2008 dollars. These costs are expanded on a per capita basis (based on 2006 census population of the Seattle region, 3.3 million) to cover deployment to the Baltimore and Washington DC regions (total 2020 population in Maryland of 5.6 million). The maximum (if all urban freeways had congestion pricing) capital costs are $1.278 billion and annual operating costs of $0.491 billion. These values are scaled down based on the percentages of miles of deployment by scenario.

The capital cost estimates assume a major policy change allowing existing lanes to be priced. Therefore, no additional road facilities or capital expansion implementation costs are assumed in this estimate.

Employer Commute Incentives

The FY 2008 budget for the Metropolitan Washington Council of Governments' (MWCOG) regional Commuter Connections program was approximately $5 million, of which the largest expenses were $2.2 million for marketing and $1.0 million for employer outreach; other expenses included ridematching coordination and technical assistance ($0.6 million), a guaranteed ride home program ($0.5 million), a telework program, information kiosks, and evaluation.

The total statewide commute alternatives and incentives implementation cost through 2020 as evaluated through the TERM analysis is $136 million. The scope of the medium and high scenario tested here roughly increase participation in these programs by 50 and 100 percent respectively. While specific costs associated with this level in 2020 are not estimated here in detail, it is expected that through 2020, they would be in the order of $60 to $140 million.

Transportation Pricing and Demand Management Results

Based on the assumptions outlined above, the unfunded pricing and demand management strategies will yield a 0.24 – 2.01 mmt reduction in GHG emissions in 2020 at a cost of approximately $300 - $3,790 million. Table D.23 illustrates the GHG emission benefits and total cost of the unfunded strategies.

The VMT fees tested represent a significant increase in the current Maryland motor fuel tax. An evaluation of the total social cost of implementing a fee-based program is necessary in order to understand potential negative social and economic impacts.

Table D.23 Transportation Pricing and Demand Management Estimated GHG Emission Reductions and Costs for Unfunded Strategies

Transportation Pricing and TDM	GHG Reduction (mmt CO_2e)	Total Cost 2010 - 2020 (million $)
Blue Ribbon Commission – Motor Fuel Tax Alternatives	0.01 – 0.09	$0
VMT Fees	0.20 – 0.98	$0 – $2,372
Congestion Pricing	0.13 – 0.72	$240 - $1,278
Employer Commute Incentives	0.10 – 0.25	$60 -$140

Transportation Technology

The GHG reduction benefits of the funded Transportation Technology strategies identified in the CTP and MPO plans through 2020 are estimated as part of the emissions analysis of the funded plans and programs project bundle. The unfunded Transportation Technology strategy approach is detailed below.

The following strategies, identified by the Transportation Technology working group, were analyzed to determine the GHG emission reduction benefits and the estimated costs associated with Transportation Technology Strategies:

- Active Traffic Management and Traffic Management Centers
- Traffic Signal Synchronization / Optimization
- Initiate Marketing and Education Campaigns to Operators of On- and Off-Road Vehicles
- Timing of Highway Construction Schedules
- Green Port Strategy
- Reduce Idling Time in Light Duty Vehicles, Commercial Vehicles, Buses, Locomotives, and Construction Equipment
- Promote and Incentivize Fuel Efficiency Technologies for Medium and Heavy Duty Trucks
- Incentivize Fuel Efficient and Low GHG Vehicle Purchase (On-Highway Vehicles)
- Incentivize Technology Advances for Non-Highway Vehicles
- Provide Incentives for Low-Carbon Fuels and Infrastructure

The methodologies for analyzing each of the strategies varies and more information on the approach for each strategy can be found in the assumptions section, below.

GHG Emission Reduction Estimates - Data and Assumptions

Due to a lack of data, emissions resulting from the implementation of marketing and education campaigns, timing of highway construction schedules, green port strategy, incentives for low-GHG vehicles and incentives for low-carbon fuels and infrastructure were not analyzed.

The Maryland Port Administration will continue to provide leadership, seeking out innovative funding mechanisms that can be used by the Port and Port tenants to continue their voluntary environmental stewardship efforts.

The GHG reduction benefits associated with the Maryland Clean Car Program were included in the baseline 2020 GHG emissions analysis along with federal fuel economy, renewable fuel and low carbon fuel standards.

The assumptions used to arrive at the GHG emission reduction benefits and the estimated costs associated with implementation of the remaining Transportation Technology strategies are outlined below. All emission factors described in the assumptions below are subject to change following completion of updated MOVES modeling.

- **Active Traffic Management (ATM) / Traffic Management Centers –**The GHG emission benefits associated with this strategy were calculated based on 2009 data obtained from the CHART program, which were projected to 2020 utilizing the following assumptions:
  - An average annual statewide VMT growth rate of 1.4 percent
  - A 2020 fleet mix of 90 percent LDV, 3 percent HDGV, and 7 percent HDDV.
  - A 2009 average fuel economy (mpg) of 21.4 for LDVs, 8.0 for HDGVs, 8.3 for HDDVs, and 20.1 fleet-wide. A fuel economy adjustment factor of 0.74 (2009-2020).
  - A 2020 average fuel economy (mpg) of 29.4 for LDVs, 8.0 for HDGVs, 8.3 for HDDVs, and 27.3 fleet-wide. A fuel economy adjustment factor of 0.74.
  - A 2009 annual fuel savings of 6.4 mgal based on a delay reduction of 3.25 M veh-hr for trucks and 29.18 M veh-hr for cars.
- **Traffic Signal Synchronization / Optimization –** The GHG emission benefits resulting from the implementation of this strategy were calculated using the statewide average annual VMT growth rate, fleet mix, and fuel economy adjustment factor, and 2009 and 2020 fuel economy, assumptions as those used to calculate the benefits of the above traffic management strategies. In addition an annual 2009 fuel savings of 1,165,066.5 gallons, based on 2009 data from SHA, was used to project 2020 emissions benefits.
- **Reducing Idling Times –** The GHG emission benefits calculated from this strategy represent the sum of a reduction in 1) long term truck idling (overnight and loading), 2) transit bus idling, and 3) school bus operations.
  - Long Term Truck Idling – 3.4 percent of all class 8 truck (gross vehicle weight of 33,000 pounds or above – includes all tractor trailers) CO_2 emissions were assumed attributed to long term idling based on *Quantification of Pennsylvania Heavy-Duty Diesel Vehicle Idling Emissions,* Final Report March 2007. A 40 percent reduction in long-term truck idling was assumed, based on the assumption that this measure will be moderately enforceable, by 2020, resulting in a 1.36 percent reduction in class 8 truck GHG emissions.
  - Transit Bus Idling – Based on a California Air Resource Board (CARB) study (*On-Road Motor Vehicle Activity Data, Volume 1 – Bus Population and Activity Pattern, Final Report*), it was assumed that 7 percent of transit operating time is attributable to idling in excess of

1 minute. The average emission rate at the average operating speed of 15 mph is equivalent to 1,544 g/mi, while the CO_2 idling emission rate equals 12,271 g/hr. Assuming an 80 percent reduction, due to the high enforceability of this strategy, by 2020 results in a 0.21 percent reduction in transit bus emissions.

- School Bus Idling – Based on a CARB study (*On-Road Motor Vehicle Activity Data, Volume 1 – Bus Population and Activity Pattern, Final Report*), 14 percent of school bus operating time is attributable to idling in excess of 1 minute. The average emission rate at the average speed of 15 mph equals 1,254 g/hr. The average idling emission rate is equal to 5,042 g/hr. Using an assumption of a reduction in idling of 80 percent, due to the high enforceability of this strategy, by 2020 results in a 3.34 percent reduction in all school bus emissions statewide.

- **Technology Improvements for On-highway Vehicles –** EPA's SmartWay calculator was utilized to calculate the emission benefits from this strategy utilizing the following options: aluminum wheel sets for singlewide tires and automatic tire inflation. Bunker heaters and APUs were not included as they are included in the reduced idling times strategy. Based on these assumptions, the SmartWay calculator estimates a reduction in fuel burn of 4.6 percent. A 25 percent participation rate was anticipated, resulting in a 1.125 percent reduction in class 8 truck GHG emissions.

- **Technology Advances for Non-highway Vehicles –** In order to calculate the benefits from this strategy, a 5 percent reduction in fuel use was assumed. Since retrofitting, or utilizing after treatment technologies, does not increase fuel efficiency and engine replacements are reflected in the inventory, it is assumed that the impact of this strategy will be relatively small. An average annual off-road diesel fuel usage of 40,780,000 gal was assumed based on 2002-2006 EIA data. The projected annual growth in fuel use across all sectors, which is assumed to be conservative for off-highway diesel, is assumed to be 1.05, resulting in a total fuel use reduction of 2,133,866 gallons per year.

Cost Estimation Assumptions

- **Active Traffic Management (ATM) / Traffic Management Centers –** The costs associated with the implementation of this strategy were calculated assuming an annual funding rate of $12,960,000, which was published in the FY2011-2016 CTP.

- **Traffic Signal Synchronization / Optimization –** In order to estimate the costs associated with implementing this strategy, cost estimates for updating signal timing per intersection and retiming traffic signals in the Washington, DC area were obtained from the National Traffic Signal Report Card, and ITS costs estimated by DOT, respectively.

- **Reducing Idling Times –**
  - Long Term Truck Idling – The costs associated with a decrease in Class 8 truck emissions was estimated based an assumed anti-idling equipment cost of $5,000 per truck and a fuel savings of $3/gal.
  - Transit Bus Idling – The costs associated with this reduction were estimated based on an assumed anti-idling equipment cost of $5,000 per transit bus and a fuel savings of $3/gal.

- School Bus Idling – The costs associated with the reduction of school bus idling was based on a fuel cost of $3/gal.

- **Technology Improvements for On-highway Vehicles –** The costs for this strategy were calculated assuming a $1,500 / truck incentive and the participation of 6,705 trucks in 2020. The participation rate is based on 2006 HDDV trucks registered in Maryland (43.18 percent are class 8 trucks) and a growth factor of 1.1897 based on regional travel demand models and 1990-2008 HPMS.
- **Technology Advances for Non-highway Vehicles –** The costs for this strategy were estimated assuming that this program would be completely voluntary and reductions would be based only on a marketing campaign estimated to cost $500,000.

Transportation Technology Results

Based on the assumptions outlined above, the unfunded Transportation Technology strategies will yield a 0.24 mmt reduction in GHG emissions in 2020 at a cost of approximately $51.0 million, without accounting for any estimated fuel savings. Table D.24 illustrates the GHG emission reductions and costs by unfunded strategy.

Table D.24 Transportation Technology Estimated GHG Emission Reductions and Costs for Unfunded Strategies

Transportation Technology	GHG Reduction (mmt CO_2e)	Total Cost 2010 - 2020 (million $)
Active Traffic Management and Traffic Management Centers	0.03	$12.96
Traffic Signal Synchronization/ Optimization	0.01	$2.36
Reduce idling time in light duty vehicles, commercial vehicles, buses, locomotive, and construction equipment.	0.10	$24.97
Promote and incentivize fuel efficiency technologies for medium and heavy-duty trucks.	0.08	$10.06
Encourage Retrofit and /or Replacement of Non-highway Diesel Engines	0.02	$0.50

Evaluate the Greenhouse Gas Emission Impacts of Major Projects and Plans

GHG Emission Reduction Estimates - Data and Assumptions

The draft MDOT policy design considers the potential following strategies:

Actively Participate in Framing National GHG Emissions Evaluation Policy – Given the recent EPA proposed ruling that carbon emissions endanger Americans' health and well-being,

Maryland should actively participate in framing national policy rather than implementing specific, state guidance requiring GHG emissions evaluation of all major projects on both the NEPA and statewide/regional planning level.

Evaluation of GHG Emissions through the NEPA Process – The impact of GHGs on major capital projects through the current NEPA decision-making process should be encouraged. GHGs should be considered during the impact assessment phase when conducting alternatives analyses for all major capital projects. Where appropriate, the alternatives analysis should be accompanied by analysis of potential alternatives, such as transit-oriented land use and investment; adding toll lanes and express bus; express toll lanes; a hybrid transit-oriented express toll lane; or a rail and express bus scenario. Where the proposed projects may lead to increased GHG emissions, mitigation measures should be considered. The GHG analysis should be included as part of the Air Quality Technical Report and should allow for the demonstration of GHG benefits as well as impacts through both quantitative and qualitative components with the understanding that appropriate and/or approved emissions models and methodologies may not be available. The GHG analysis would be required:

- If there is an Environmental Impact Statement (EIS) or an Environmental Assessment (EA). Categorical Exclusions (CE's) will be screened out.
- For any roadway capacity enhancement project which is identified for analysis through interagency consultation.
- For active projects that have yet to receive federal sign-off on draft NEPA documents. It is recommended that any project with approved NEPA draft documents would be "grandfathered" through the process.

Evaluation of GHG Emissions through Statewide/Regional Planning – The impact of GHGs should be addressed in the statewide and/or regional planning processes. The process would be similar to the current conformity process for ozone and PM; however, instead of setting a budget, a mechanism for tracking GHG emissions reductions would be established. Regional level analyses (determining the GHG impacts on a larger scale than just the project level) account for control strategies that are in place such as fleet make up, analysis years, VMT increases, etc.

While the strategies outlined above were determined by the Working Group and the Coordinating Committee to be either critical or important strategies in assisting MDOT in meeting its goals, these strategies were not quantified. The strategies under this policy option are assumed to contribute to the overall goal of reducing GHG emissions from the transportation sector, however, it is unclear what the GHG emissions impact of implementing these strategies will be at this time.

Implementation Tracking

MDOT currently tracks the performance of Maryland's transportation system and ongoing transportation investments through the MDOT Annual Attainment Report on Transportation System Performance. The report tracks Maryland's transportation system and investment against five primary goals: quality of service, safety and security, environmental stewardship, system preservation and performance, and connectivity for daily life. The report also tracks

MDOTs and MDTAs capital and operating budgets and project completion Examples of specific performance measures the Attainment Report currently tracks that are directly attributable to GHG emission reductions include:

1. Annual VMT reductions from transportation emission reduction measures including ridesharing, guaranteed ride home, MTA College Pass and Commuter Choice Pass, and teleworking,
2. MTA percent of service provided on time and average weekday transit ridership,
3. User cost savings for the traveling public due to incident management,
4. Number of park-and-ride spaces and reduction in VMT through park-and-ride usage,
5. Percent of state owned facilities with sidewalks and high bicycle level of comfort, and
6. Percent of freeway and arterial lane-miles with volumes at or above congested levels

Co-Benefits

Job Creation Resulting from Policy Implementation

The FHWA estimates that every one billion dollars of federal highway investment, plus the state match, supports 30,000 jobs.[18] The FHWA analysis measures the impact of three types of employment associated with highway investment:

4. Construction oriented employment including all jobs created by construction firms that work directly on the project or those firms that provide materials such as asphalt, steel and concrete directly on site;
5. Supporting industries' employment which includes those jobs not on site but that benefit directly from the project such as factory jobs. An example would be a job that provides the sheet steel to make the guard rails used on the project; and
6. Induced employment which includes all of the jobs supported by consumer expenditures resulting from wages to "construction oriented" and "supporting industries" employment

This FHWA estimate does not incorporate the job creation benefits for the highway construction expenditures as estimated under the American Recovery and Reinvestment Act of 2009 (ARRA). As part of ARRA, Maryland is receiving $638 million directed toward formula funding for transportation. Maryland also received numerous discretionary grants through ARRA including $60.0 million in design funds to replace the Baltimore and Potomac Tunnel, $9.4 million for a new platform and fourth track at BWI Rail Station, $12.3 million to construct the Takoma/Langley Transit Center, and $2.5 million for priority bus corridor enhancements in Prince George's and Montgomery counties. Smaller grants were awarded to MTA for

[18] http://www.fhwa.dot.gov/policy/otps/pubs/impacts/index.htm

greenhouse gas and energy reduction improvements, and to MPA for port security work totaling $3.4 million.

MDOT infrastructure based transportation GHG reduction strategies presented in this plan through 2020 will result in job creation associated with:

1. Construction of new transportation facilities and rehabilitation of existing facilities,
2. Maintenance of new transportation infrastructure and vehicles,
3. Operation of new transit routes,
4. New jobs associated with expanded capacity of intermodal freight facilities,
5. Management of new intelligent transportation and traffic management facilities and technologies, and
6. Administration of new tolling, pricing, and travel demand management programs.

Net Economic Benefits of Policy Implementation in 2020

MDOT infrastructure based transportation GHG reduction strategies presented in this plan through 2020 will result in net economic benefits associated with:

1. Congestion reduction which could lead to economic benefits realized in the form of fuel savings and time savings for Maryland citizens and visitors,
2. Improved access to employment opportunities and services for low income households through expansion of public transit,
3. Enhanced intercity passenger rail level-of-service, providing time savings for business travelers, and high speed rail access to developing economic centers (such as development associated with BRAC at Fort Meade and Aberdeen Proving Ground),
4. Logistics cost savings for shippers in Maryland (the CSX National Gateway initiative forecasts $350 to $700 million in logistic cost savings in Maryland between 2010 and 2021),
5. Highway safety cost savings resulting from improved highway facilities, and
6. Enhanced residential and commercial development opportunities adjacent to existing and future transit stations, including the increased tax revenues from these development locations.

E. MDOT Program Summary Forms

Maryland Climate Action Plan - MDOT Draft 2012 Implementation Plan
Appendix E

Program Summary Forms (April 2011)
PART 1 – Overview

Agency Name: MDOT

1. *Total GHG reduction target for your agency per the 2008 Climate Action Plan:*

   MDOT = 6.2 $MMtCO_2e$

2. *List all of the new names of the policies you are developing or implementing. This is your chance to rename your suite of strategies – and separate your new "smarter" suite of strategies from the old Climate Action Plan terminology.*

   MDOT's 2020 transportation sector assessment will identify the GHG emissions reduction impact of:

   - ***New Vehicle Technologies, Fuels, and State and Federal Regulations including:***
     - The CAFE standard for Model Years 2008-2011.
     - The final Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2012-2016.
     - The Maryland Clean Car Program that incorporates the California emission standards for model years (MY) through 2020.
     - The proposed Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2017-2025.
     - The proposed Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles for Model Years 2014-2018.
     - The EPA's Renewable Fuel Standard Program (RSF2).
     - Low Carbon Fuel Standard, under development through MDE, a regional effort to reduce the carbon intensity of transportation fuels across an 11 state Northeast – Mid-Atlantic Region.
   - ***Transportation Plans and Programs – Funded and Committed Efforts that will Reduce GHGs***
     - Transportation projects, land use and travel forecasts data from approved transportation programs, including the Maryland CTP and MPO long range plans and transportation improvement programs, will be assessed to quantify the GHG emissions associated with the State's proposed transportation investments through 2020. The estimated total cost of the subset of projects within these planning documents through 2020 that contribute to a reduction in GHG emission is $13.0 billion. Table 1, below presents the total capital cost summary of Maryland plans and programs for 2011-2020 by TLU.

Table 1: Draft Cost Summary of Funded Maryland Plans, Programs and TERMs Funded Through 2020

Transportation Example Efforts	*Total Cost (2011-2020) (billions $)*
Public Transportation *Examples: Red line (Baltimore), Purple line (Washington DC suburbs), Corridor Cities Transitway (I 270 Corridor), LOTS capital procurement projects, capital funding support for WMATA*	$6.963
Intercity Passenger and Freight Transportation *Examples: MARC infrastructure and operations improvements, rail freight capacity improvements, highway capacity projects on interstate highway system routes and intermodal connectors.*	$3.085
Bike and Pedestrian *Examples: Projects supporting completion of the statewide transportation trails network, as well as improved bicycle and pedestrian access to transit facilities. Includes lighting, tree planting, and bicycle parking facility enhancements.*	$1.385
Pricing and Demand Management *Examples: Includes MdTA projects, primarily the ICC and I-95 Express Toll Lanes. Also includes state funded commute alternative incentive programs in Maryland.*	$1.397
Transportation Technologies *Examples: CHART, signal synchronization, MTA diesel-hybrid electric bus purchases, transit CAD/AVL system upgrades, and high speed tolling at 1-95 Fort McHenry toll plaza.*	$0.390
Total	**$13.219**

- ***Policy Options – Unfunded Implementation Strategies:***
  - Public Transportation
  - Intercity Passenger and Freight Transportation
  - Bike and Pedestrian
  - Pricing and Demand Management
  - Transportation Technologies (in consultation with MDE)
  - Evaluate the GHG Emission Impacts of Major Projects and Plans

3. What are the total 2020 emission reductions expected from this suite of policies?

- **5.30 mmt CO_2e**. This includes the GHG reduction of the 2008-2011 CAFE standard, EPA's Renewable Fuels Standard Program, and funded and committed transportation plans and program in Maryland through 2020. MDOT consulted with MDE on the

modeling methodologies and assumptions required for the MOVES modeling process supporting development of the 2020 emissions reduction estimate.

4. *What percentage of your agency's original total emission reduction target do your policies represent?*

   - **85 percent**

5. *What are your plans for making up any shortfall?*

   - MDOT has identified a comprehensive set of unfunded transportation sector GHG emission reduction strategies that could achieve a **1.14 to 3.14 mmt CO_2e** reduction by 2020. These additional reductions are estimated to require an additional capital investment of **$2.911 to $7.071 billion** through 2020.
   - Should additional funding become available, the combined reduction of the 2008-2011 CAFE Standard, RFS Program, and funded and committed Maryland plans and programs would total **6.44 – 8.44 mmt CO_2e**.

6. *What new legislation or funding is needed to meet the original targets?*

   - Unknown. The Maryland Blue Ribbon Commission on Maryland Transportation Funding is currently evaluating transportation funding shortfalls, identifying potential new revenue sources and any legislation required to jumpstart them, and potential uses for additional funds. The following potential primary transportation revenue sources are identified in the Commission's Report to the Governor and General Assembly:
     - Vehicle Titling Tax / Vehicle Sales and Use Tax
     - Motor Fuel (Gas) Tax
     - Vehicle Registration Fees
     - Driver's Licenses and Other MVA Fees
     - Sales and Use Tax
     - Corporate Income Tax

     In addition, the Commission identified environmental (climate change, water, and air quality), MTA expansion, and TOD/sustainable communities among the potential uses for any additional funds.

7. *What are your plans for proposing or implementing the new legislation or funding initiatives needed to achieve the original targets?*

   - Unknown. See number 6, above.

1. *Please describe any other complications you face in achieving the original reduction targets.*

   - Unknown.

PART 2 – Program-by-Program Summaries

Agency Name: MDOT
New Policy Name: New Vehicle Technologies, Fuels, and State and Federal Regulations

Linkage to old Climate Action Plan terminology:

- The CAP did not include all of the technology improvements outlined in this summary. The Maryland Clean Car Program was included under TLU-10, Transportation Technologies. Renewable fuels were included under TLU-4, Low Greenhouse Gas Fuel Standard, which was removed from the CAP pending further analysis and technological innovation.

1. Describe the policy, including all programs/initiatives/etc involved

- Vehicle fuel economy standards are a key consideration in estimating future GHG emissions. The 2020 GHG inventory projection considers current CAFE standards as well as potential legislation that will further improve vehicle fuel economy and/or average vehicle GHG emissions per mile. The technology improvements include:
    - The final Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2012-2016 finalized in the May 7, 2010 joint rulemaking by USDOT and EPA, and
    - The Maryland Clean Car Program that incorporates the California emission standards for model years through 2020.

  Assuming federal approval, there are two federal proposals on additional vehicle standards that would affect fuel economy and potential greenhouse gas emissions prior to 2020. These include:

    - The proposed Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2017-2025.
    - The proposed Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles for Model Years 2014-2018.
- Low Carbon Fuel Standard, under development through MDE, a regional effort to reduce the carbon intensity of transportation fuels across an 11 state Northeast – Mid-Atlantic Region.
- For fuels, The EPA issued the renewable fuel standard program (RFS2) final rule in March 2010, which mandates the use of 36 billion gallons of renewable fuel annually by 2022. The revised statutory requirements include allowable GHG performance reduction thresholds for the renewable fuel categories.

2. *For your agency's 2020 GHG reduction commitment, summarize total reductions from the above program*

   - **2.51 mmt CO_2e** for the 2008-2011 CAFE standard and EPA RFS Program.
   - **6.41 mmt CO_2e** for the 2012-2016 National fuel economy program, Maryland Clean Car and/or the proposed National fuel economy standard for MY 2017-2025, proposed MY 2014-2018 medium/heavy duty standard, and low carbon fuel standard.

3. *Identify how your agency will measure and track the success of this policy. How can that be used to calculate or estimate GHG reductions related to this policy?*

   - Assumptions have been made on each vehicle program based on the best available information at the time of the analysis. Legislative action or further program refinement could change or modify assumptions used to complete the GHG emission estimates.

4. *Identify estimated 2020 job creation information for this policy*

   - Unknown.

5. *Identify 2020 net economic benefit information for this policy.*

   - It is difficult to estimate the net economic benefits of all of the vehicle technology improvements and the RFS2; however, residents of the state can expect some savings in fuel consumption resulting from increased fuel economy.

PART 2 – Program-by-Program Summaries

Agency Name: MDOT
New Policy Name: Transportation Plans & Programs – Funded and Committed Strategies

Linkage to old Climate Action Plan terminology:

- The CAP did not include the benefits of funded and committed TLU strategies.

1. *Describe the policy, including all programs/initiatives/etc involved*

- Transportation projects, land use and travel forecasts data from the following list of approved transportation programs were used to assess and quantify the GHG emissions of the State's proposed transportation investments through 2020.
    - MDOT 2011-2016 CTP
    - MWCOG 2011-16 TIP and 2010 CLRP adopted 11/17/10
    - BRTB 2011-14 TIP adopted 7/27/10 and Transportation Outlook 2035 (adopted 11/07, amended 2/24/09)
    - Hagerstown/Eastern Panhandle MPO 2010-2013 TIP adopted 6/16/10 and 2035 LRMTP adopted 4/28/10
    - Salisbury-Wicomico MPO 2010-2013 TIP adopted 9/28/09 and Draft 2010 LRTP scheduled for adoption in October 2010
    - Cumberland Area MPO 2010-2013 TIP adopted 10/15/09 and Draft 2010 LRTP schedule for adoption in October 2010
    - WILMAPCO DRAFT 2012-2015 TIP and 2040 RTP (adopted 10/10)
    - Modal Plans including – Maryland Area Regional Commuter (MARC) Growth and Investment Plan, Port of Baltimore Regional Landside Access Study, Maryland Statewide Freight Plan, Washington Metropolitan Area Transit Authority (WMATA) Capital Plan, Maryland Aviation Administration (MAA) Capital Plan.

Based on the macro-level analysis of the overall fiscally constrained transportation infrastructure investment through 2020 and the associated local land use policies, statewide growth in VMT is forecast to be 1.4 percent annually. This represents a slower rate of growth than was included in the Maryland Climate Action Plan, developed in 2007.

The reduced forecasted rate of growth in VMT will contribute to a reduction in GHG emissions by 2020 compared to the 2020 base forecast. The infrastructure investment that affects travel and congestion documented in the Maryland 2011-2016 CTP and MPO TIPs and LRPs represent an estimated **$13.219 billion** in investment through 2020.

A complete list of the Funded Maryland Plans, Programs and TERMs, grouped by representative transportation improvements, can be made available upon request and will be included in the December 31, 2011 draft plan.

2. *For your agency's 2020 GHG reduction commitment, summarize total reductions from the above program*

   - **2.79 mmt CO_2e**. MDOT consulted with MDE on the modeling methodologies and assumptions required for the MOVES modeling process supporting development of the 2020 emissions reduction estimate.

3. *Identify how your agency will measure and track the success of this policy. How can that be used to calculate or estimate GHG reductions related to this policy?*

   - MDOT will continue to track the fiscally constrained transportation infrastructure investment through 2020 and the associated local land use policies and travel forecasts in the state's transportation plans and programs.

4. *Identify estimated 2020 job creation information for this policy*

   - It is difficult to estimate the impacts that transportation plans and programs will have on job creation. However, it is likely that any new investment will result in some increase in direct (construction) and indirect (supporting services) labor.

5. *Identify 2020 net economic benefit information for this policy.*

   - Similar to job creation, net economic benefits resulting from the implementation of the state's plans and programs are complex to estimate. Any new investment in transportation infrastructure can be assumed to result in increased consumer expenditures as a product of job creation. In addition, transportation system improvements resulting in reduced congestion could realize benefits in the form of fuel savings and time savings, such as more efficient consumer and business operations through reduced operating costs and travel times. Table 1, below presents the total capital cost summary of Maryland plans and programs for 2011-2020 by TLU.

Table 1: Draft Cost Summary of Funded Maryland Plans, Programs and TERMs Funded Through 2020

Transportation Example Efforts	***Total Cost (2011-2020) (billions $)***
Public Transportation *Examples: Red line (Baltimore), Purple line (Washington DC suburbs), Corridor Cities Transitway (I 270 Corridor), LOTS capital procurement projects, capital funding support for WMATA*	$6.963
Intercity Passenger and Freight Transportation *Examples: MARC infrastructure and operations improvements, rail freight capacity improvements, highway capacity projects on interstate highway system routes and intermodal connectors.*	$3.085
Bike and Pedestrian *Examples: Projects supporting completion of the statewide transportation trails network, as well as improved bicycle and pedestrian access to transit facilities. Includes lighting, tree planting, and bicycle parking facility enhancements.*	$1.385
Pricing and Demand Management *Examples: Includes MdTA projects, primarily the ICC and I-95 Express Toll Lanes. Also includes state funded commute alternative incentive programs in Maryland.*	$1.397
Transportation Technologies *Examples: CHART, signal synchronization, MTA diesel-hybrid electric bus purchases, transit CAD/AVL system upgrades, and high speed tolling at 1-95 Fort McHenry toll plaza.*	$0.390
Total	**$13.219**

PART 2 – Program-by-Program Summaries

Agency Name: MDOT
New Policy Name (Unfunded): Public Transportation

Linkage to old Climate Action Plan terminology:

- Public Transportation was included under TLU-3, Transit.

1. *Describe the policy, including all programs/initiatives/etc involved*

- This policy option identifies public transportation strategies to reduce on-road mobile source transportation GHG emissions. The strategies are designed to help Maryland meet a goal of doubling transit ridership by 2020, and continuing that same growth rate beyond 2020. In order to achieve this growth, actions to increase the attractiveness and convenience of public transportation, improve the operational efficiency of the system, and increase system capacity are required. Policies also involve supportive actions with regard to land use planning and policy, pricing (disincentives to auto use), and bike and pedestrian access improvements. Policies to reduce GHG produced by public transportation services are also included.

  The following strategies defined by the public transportation working group were identified to address the expected gap in meeting the transit ridership goal defined in the Climate Action Plan (e.g. a doubling of 2000 transit ridership by 2020). The intent is for these strategies to complement and support funded MTA and WMATA plans and programs identified for implementation by 2020 in the 2011-2016 CTP and MPO TIPs and long-range plans.

  - Additional Capacity on Existing Transit Routes
  - Increase Frequencies of Transit Services Statewide
  - Expanded Park and Ride Capacity
  - Increase Coverage of Transit Services – New Commuter / Intercity Bus Routes
  - Increase Coverage of Transit Services – New Local Bus Routes
  - Implement Bicycle and Pedestrian Improvements to Support Transit
  - Reduce GHG Emissions from Transit Vehicles
  - Bus Priority Improvements
  - Plan Transit in Conjunction with Land Use

2. *For your agency's 2020 GHG reduction commitment, summarize total reductions from the above program*

- **0.39 – 0.62 mmt CO_2e**. MDOT consulted with MDE on the modeling methodologies and assumptions required for the MOVES modeling process supporting development of the 2020 emissions reduction estimate.

3. *Identify how your agency will measure and track the success of this policy. How can that be used to calculate or estimate GHG reductions related to this policy?*

   - MDOT will continue to track transit ridership and average vehicle occupancy trends, which will assist in tracking GHG reductions related to this policy.

4. *Identify estimated 2020 job creation information for this policy*

   - This policy could result in the creation of new jobs due to an increase in routes, frequency of service, and construction of new / expanded facilities.

5. *Identify 2020 net economic benefit information for this policy.*

   - This policy could result in reduced congestion. Economic benefits could be realized in the form of fuel savings, time savings, and improved access to employment.
   - The unfunded portion of this policy has an estimated cost of implementation of **$1,214-$1,765 million** through 2020.

PART 2 – Program-by-Program Summaries

Agency Name: MDOT
New Policy Name (Unfunded): Intercity Passenger and Freight Transportation

Linkage to old Climate Action Plan terminology:

- Intercity Transportation was included under TLU-5, Intercity Travel: Aviation, Rail, Bus, and Freight.

1. *Describe the policy, including all programs/initiatives/etc involved*

- This policy option enhances connectivity and reliability of non-automobile intercity passenger modes and multimodal freight through infrastructure and technology investments. For intercity passenger modes, this includes expansion of intercity passenger rail and bus services as well as improved connections between air, rail, intercity bus and regional or local transit systems. For freight movement, this includes expansion and bottleneck relief on priority truck and rail corridors and enhanced intermodal freight connections at Maryland's intermodal terminals and ports.

  The intercity transportation working group identified improving passenger convenience for intermodal connections at airports, rail stations, and major bus terminals as the primary pre-2020 unfunded intercity transportation strategies. Two primary strategies are assessed for intercity passenger transportation in Maryland by 2020: (1) improve passenger access, convenience, and information across all modes at BWI Airport, and (2) improve travel times, reliability and overall level of service on the MARC Penn Line and Amtrak NE Corridor consistent with the MARC Growth and Investment Plan, and Northeast Corridor Infrastructure Master Plan.

  The intercity transportation working group did not recommend specific freight strategies in addition to projects identified in implemented and adopted transportation plans and programs for consideration before 2020. Recent developments and Maryland strategic involvement in the CSX Transportation National Gateway initiative will result in implementation of freight rail projects in Maryland and the mid-Atlantic region that will help reduce truck VMT in Maryland by 2020. Funding for the National Gateway is a public-private partnership between the federal government, six states and the District of Columbia, and CSX. The benefit of the National Gateway is assessed in this report.

  The benefits of Norfolk Southern's Crescent Corridor initiative is not assessed in this report as direct GHG emission reduction benefits to Maryland are unknown and a level of support and funding commitment from Maryland has not been recommended to date.

2. *For your agency's 2020 GHG reduction commitment, summarize total reductions from the above program*

- **0.11 mmt CO_2e**. MDOT consulted with MDE on the modeling methodologies and assumptions required for the MOVES modeling process supporting development of the 2020 emissions reduction estimate.

3. *Identify how your agency will measure and track the success of this policy. How can that be used to calculate or estimate GHG reductions related to this policy?*

   - MDOT will continue to track passenger-miles for trips to and from BWI Marshall Airport, Amtrak boardings at intercity rail stations and changes to freight-rail activity, which will assist in tracking GHG reductions related to this policy.

4. *Identify estimated 2020 job creation information for this policy*

   - Unknown. New jobs will be generated associated with the expanded capacity of intermodal freight facilities.

5. *Identify 2020 net economic benefit information for this policy.*

   - This policy could result in reduced congestion. Economic benefits could be realized in the form of fuel savings and time savings for intercity passengers, and logistics cost savings for shippers.
   - The unfunded portion of this policy has an estimated cost of implementation of **$748 million** through 2020.

PART 2 – Program-by-Program Summaries

Agency Name: MDOT
New Policy Name (Unfunded): Bike and Pedestrian

Linkage to old Climate Action Plan terminology:

- Bike and Pedestrian was included under TLU-8, Bike and Pedestrian Infrastructure.

1. *Describe the policy, including all programs/initiatives/etc involved:*

- The policy option includes infrastructure design and construction policies and funding, regulatory, and land use strategies improving bike and pedestrian amenities, and education and marketing measures. Increasing the number of trips made on foot or bicycle will reduce the number of vehicle trips, resulting in a reduction in GHG emissions. This policy also recognizes that local governments are responsible for the design and maintenance of approximately 80 percent of roads in Maryland.

  The following unfunded strategies were recommended for possible implementation prior to 2020 by MDOT's Bike and Pedestrian working group:

  - Promote use and regular review/updates to existing manuals and design standards
  - Complete Streets – improve bike/pedestrian access through corridor retrofits and new roadway construction projects
  - Update existing land use policy guidance and zoning/development standards to include provisions for bike and pedestrian supportive infrastructure
  - Bike facility and supportive infrastructure placement at strategic locations, including transit stations and government facilities
  - Provide funds for low-cost safety solutions
  - Education, safety programs, and marketing programs to encourage bicycle travel

  The focus of the analysis of the unfunded Bike and Pedestrian strategies is to determine the mode shift and resulting GHG emission reductions of building out the Maryland Trails plan. A secondary analysis considers the mode shift and resulting GHG emission reductions from a comprehensive improvement in pedestrian infrastructure on urban roadways in areas adjacent to activity centers, transit stations and schools.

  Maryland Trails: A Greener Way to Go is Maryland's coordinated approach to developing a comprehensive and connected statewide, shared-use trail network. This plan focuses on creating a state-wide transportation trails network. The Maryland Trails plan identifies approximately 820 miles of existing transportation trails and 770 miles of priority missing links (160 trail segments) that, when completed will result in a statewide trails network providing travelers a non-motorized option for making trips to and from work, transit, shopping, schools and other destinations.

2. *For your agency's 2020 GHG reduction commitment, summarize total reductions from the above program*

   - **0.16 mmt CO_2e**. MDOT consulted with MDE on the modeling methodologies and assumptions required for the MOVES modeling process supporting development of the 2020 emissions reduction estimate.

3. *Identify how your agency will measure and track the success of this policy. How can that be used to calculate or estimate GHG reductions related to this policy?*

   - Under development. MDOT will continue to track mode share, population densities, and the increased availability of bicycle and pedestrian infrastructure, which will assist in tracking GHG reductions related to this policy.

4. *Identify estimated 2020 job creation information for this policy*

   - This policy could result in the creation of new jobs due to construction of new / expanded facilities.

5. *Identify 2020 net economic benefit information for this policy.*

   - This policy could result in reduced congestion. Economic benefits could be realized in the form of fuel savings and time savings.
   - The unfunded portion of this policy has an estimated cost of implementation of **$598-$817 million** through 2020.

PART 2 – Program-by-Program Summaries

Agency Name: MDOT
New Policy Name (Unfunded): Pricing and Demand Management

Linkage to old Climate Action Plan terminology:

- Pricing was included under TLU-9, Incentives, Pricing and Resource Measures.

1. *Describe the policy, including all programs/initiatives/etc involved:*

   - This policy option addresses transportation pricing and travel demand management incentive programs. It also tests the associated potential GHG reduction benefits of alternate funding sources for GHG beneficial programs. These strategies amplify GHG emission reductions from other strategies by supporting Smart Growth, transit, and bike and pedestrian investments. The draft MDOT policy design, developed by the pricing working group in Phase I, considers four strategy areas combined with an education component for state and local officials.

     The detailed definitions of the four strategy areas are listed below:

     - **Maryland motor fuel taxes or VMT fees –** There are two primary options for consideration: (1) an increase in the per gallon motor fuel tax consistent with alternatives under consideration by the Blue Ribbon Commission, and (2) establish a GHG emission-based road user fee (or VMT fee) statewide by 2020 in addition to existing motor fuel taxes. Both options would create additional revenue that could be used to fund transportation improvements and systems operations to help meet Maryland GHG reduction goals.
     - **Congestion Pricing and Managed Lanes –** Establish as a local pricing option in urban areas that charges motorists more to use a roadway, bridge or tunnel during peak periods, with revenues used to fund transportation improvements and systems operations to help meet Maryland GHG reduction goals.
     - **Parking Impact Fees and Parking Management –** Establish parking pricing policies that ensure effective use of urban street space. Provision of off-street parking should be regulated and managed with appropriate impact fees, taxes, incentives, and regulations.
     - **Employer Commute Incentives –** Strengthen employer commute incentive programs by increasing marketing and financial and/or tax based incentives for employers, schools, and universities to encourage walking, biking, public transportation usage, carpooling, and teleworking.

2. *For your agency's 2020 GHG reduction commitment, summarize total reductions from the above program*

- **0.24 – 2.01 mmt CO_2e**. MDOT consulted with MDE on the modeling methodologies and assumptions required for the MOVES modeling process supporting development of the 2020 emissions reduction estimate.

3. *Identify how your agency will measure and track the success of this policy. How can that be used to calculate or estimate GHG reductions related to this policy?*

   - Under development. MDOT will track the deployment of the pricing mechanisms outlined under this strategy, which will assist in tracking GHG reductions related to this policy.

4. *Identify estimated 2020 job creation information for this policy*

   - This policy could result in the creation of new jobs necessary to manage and administer the strategies.

5. *Identify 2020 net economic benefit information for this policy.*

   - This policy could result in reduced congestion. Economic benefits could be realized in the form of fuel savings and time savings.
   - The unfunded portion of this policy has an estimated cost of implementation of **$300-$3,690 million** through 2020.

PART 2 – Program-by-Program Summaries

Agency Name: MDOT
New Policy Name (Unfunded): Transportation Technologies

Linkage to old Climate Action Plan terminology:

- Transportation Technologies was included under TLU-10, Transportation Technologies.

1. *Describe the policy, including all programs/initiatives/etc involved:*

- This policy option aims to reduce GHG emissions from on and off-road vehicles/engines through the deployment of technologies designed to cut GHG emission rates per unit of activity through such measures as idling reduction, engine/vehicle replacements, and the promotion of fuel efficient technologies. This policy option also encompasses improvements to transportation system efficiencies through measure such as traffic signal synchronization/optimization and active traffic management.

  The following strategies were identified for further analysis and possible implementation under this policy option:

  - **Active Traffic Management (ATM) / Traffic Management Centers** – Provide real-time, variable-control of speed, lane movement, and traveler information (for drivers and transit users) within a corridor and conduct centralized data collection and analysis of the transportation system. System management decisions are based on inroad detectors, video monitoring, trend analysis, and incident detection (currently performed by CHART).
  - **Traffic Signal Synchronization / Optimization** – Traffic signal operations are synchronized to provide an efficient flow or prioritization of traffic, increasing the efficient operations of the corridor and reducing unwarranted idling at intersections. The system can also provide priority for transit and emergency vehicles. Specific performance measure is "reliability." Traffic Signal Synchronization is currently performed by SHA and local jurisdictions.
  - **Marketing and Education Campaigns –** Initiate marketing and education campaigns to operators of on-and off-road vehicles.
  - **Timing of Highway Construction Schedules –** Consider requiring non-emergency, highway and airport construction be scheduled for off-peak hours that minimize the delay in traffic flow. Include incentives for completing projects ahead of schedule.
  - **Green Port Strategy –** Develop and implement a "Green Port Strategy" consistent with industry trends and initiatives including EPA's Strategy for Sustainable seaports.

- **Reduce Idling Times –** Reduce idling time in light duty vehicles, commercial vehicles (including the use of truck stop electrification), buses, locomotive, and construction equipment.
- **Technology Improvements for On-highway Vehicles –** Promote and incentivize fuel efficiency technologies for medium and heavy-duty trucks (on-highway vehicles).
- **Incentives for Low-GHG Vehicles –** Provide incentives to increase purchases of fuel-efficient or low-GHG vehicles / fleets.
- **Technology Advances for Non-highway Vehicles –** Encourage or incentivize retrofits and/or replacement of old, diesel-powered non-highway engines, such as switchyard locomotives, with new hybrid locomotives.
- **Incentives for Low-Carbon Fuels and Infrastructure –** Incentivize the demand for clean low-carbon fuels and the development of infrastructure to provide for increased availability/accessibility of alternative fuels and plug-in locations for electric vehicles.

2. *For your agency's 2020 GHG reduction commitment, summarize total reductions from the above program*

- **0.24 mmt CO_2e**. MDOT consulted with MDE on the modeling methodologies and assumptions required for the MOVES modeling process supporting development of the 2020 emissions reduction estimate.

3. *Identify how your agency will measure and track the success of this policy. How can that be used to calculate or estimate GHG reductions related to this policy?*

- Under development. MDOT will continue to track the success of active traffic management programs in the state and the deployment / availability of new, aftermarket emission reduction technologies and electric vehicle charging stations, which will assist in tracking GHG reductions related to this policy.

4. *Identify estimated 2020 job creation information for this policy*

- The implementation of these strategies is anticipated to result in minimal to no job creation in the state.

5. *Identify 2020 net economic benefit information for this policy.*

- This policy could result in reduced congestion. Economic benefits could be realized in the form of fuel savings and time savings.
- The unfunded portion of this policy has an estimated cost of implementation of **$51 million** through 2020.

PART 2 – Program-by-Program Summaries

Agency Name: MDOT
New Policy Name (Unfunded): Evaluate the Greenhouse Gas Emission Impacts of Major Projects and Plans

Linkage to old Climate Action Plan terminology:

- This policy option was included under TLU-11, Evaluate the GHG Emissions from Major Projects.

1. *Describe the policy, including all programs/initiatives/etc involved:*
    - This policy option focuses on the process of evaluating GHG emissions of all state and local major projects. The goals of this policy are to understand the impacts of new, major projects on the Governor's GHG reduction commitment; and to develop guidance for the state and other major project sponsors to use. MDOT's working group identified three potential unfunded implementation strategies for this policy option:
        - Participate in Framing National Policy
        - Evaluation of GHG Emissions through the NEPA Process
        - Evaluation of GHG Emissions through Statewide/Regional Planning

2. *For your agency's 2020 GHG reduction commitment, summarize total reductions from the above program*
    - The strategies under this policy option are assumed to contribute to the overall goal of reducing GHG emissions from the transportation sector; however, it is unclear what the GHG emissions impact of implementing these strategies will be at this time.

3. *Identify how your agency will measure and track the success of this policy. How can that be used to calculate or estimate GHG reductions related to this policy?*
    - MDOT will continue to participate in the national discussion on evaluating the impact of major projects on climate change and investigate the potential for including the impact of GHGs on major capital projects through the current NEPA decision-making process. However, as stated in question 2, it is unclear what the GHG emissions impact of implementing these strategies will be at this time.

4. *Identify estimated 2020 job creation information for this policy*
    - Unknown.

5. *Identify 2020 net economic benefit information for this policy.*
    - Unknown.