How Far Can We Get?

A Study by the How Far Can We Get Oversight Committee of the Baltimore Regional Transportation Board

December 2015

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Summary

The *How Far Can We Get?* study was initiated by the Baltimore Regional Transportation Board as part of the FY 2014 UPWP. The purpose of the study is to understand:

- The level of existing and future greenhouse gas (GHG) emissions from the region's transportation system.
- How far we can reduce GHG emissions in our region through transportation emission reduction measures (TERMs).
- Options to address GHG's in the next long range transportation plan, *Maximize 2040*.

The purpose of this study was to understand the level of emission reductions that are achievable through a reasonable level of reduction measure implementation, and to inform the region's next long range transportation plan. The combination of measures chosen by the Committee, in consideration of feasibility of implementation, could potentially achieve a 2.84% carbon dioxide (CO_2) equivalent reduction in 2030 and a 9.8% reduction in 2040. The recommended combination includes the following assumed transportation emission reduction measures (TERMs) and participation levels:

> *The largest portion of the 9.8% reduction in CO2 eq. emissions by 2040 would result from extensive improvements in fuel efficiency of passenger vehicles beyond current federal standards.*

- A program that results in increasing the use of low rolling resistance tires to 25% of households.
- A program that results in increasing the proportion of households participating in eco-driving practices to 20%.
- A program that results in increasing the proportion of households that optimize their vehicle use to 25%. Vehicle use optimization means that households are choosing to drive their most fuel efficient vehicle for longer trips, and driving their least fuel efficient vehicle for shorter household-based trips.
- A household travel demand management marketing program focused on encouraging people to use travel alternatives other than driving alone (transit, biking, walking, ride-sharing). The program would have a goal of increasing participation in household travel demand management programs to 10% of households (with a 9% vehicle miles of travel reduction for participants).
- A program to increase participation in employer-based travel demand management programs to 25% of households (with a 10% VMT reduction for participants).
- A program to increase bike ownership from 30 to 40% of the driving-age population.
- A program to purchase idle reduction equipment for 200 heavy duty diesel trucks.
- A hypothetical corporate average fuel economy (CAFE) standard that would increase fuel economy by 2.5% on average annually from 2026 to 2040.

The largest portion of the 9.8% reduction in CO_2 equivalent emissions by 2040 would result from extensive improvements in fuel efficiency of passenger vehicles beyond current federal standards. Specific implementation measures to go along with the recommendations for achieving reductions in CO_2 and NOx emissions are described at the end of this report.

Introduction

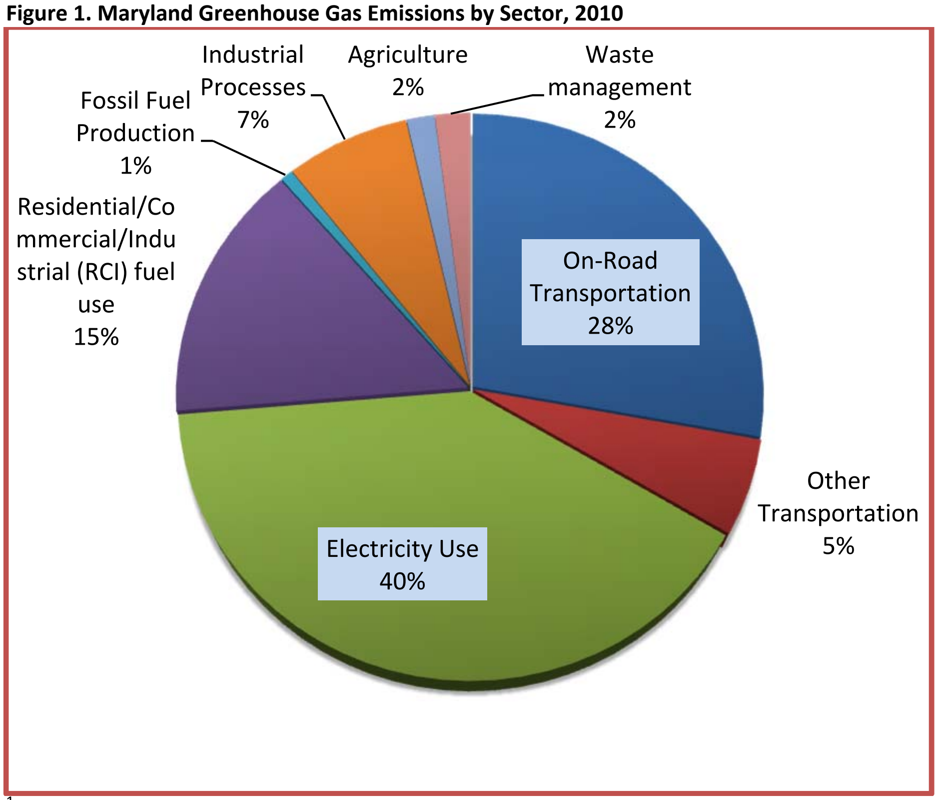
This study was initiated by the Baltimore Regional Transportation Board, as its members recognize the importance of protecting our health and our environment from the impacts of air pollution emissions. The purpose of the study is to understand the level of existing and future greenhouse gas (GHG) and nitrogen oxide (NOx) emissions from the region's transportation system, how far GHGs and NOx can be reduced through transportation emissions reduction measures (TERMs) and options for how to address GHGs in the next long range transportation plan.

Transportation and Greenhouse Gas Emissions

There is a strong link between vehicle miles traveled (VMT) and GHG emissions from the transportation sector. More miles traveled directly equates to the combustion of more gallons of fuel and the release of carbon dioxide.

Emissions of carbon dioxide, a key GHG, result from the burning of fossil fuels, like gasoline and diesel fuel. In 2010, 28% of the State's GHG emissions were from the on-road transportation sector (see Figure 1.) The entire transportation sector accounted for 33% of emissions in 2010 in the state, and represented the second largest source sector for GHGs in Maryland, behind electricity consumption at 40%.

Figure 1. Maryland Greenhouse Gas Emissions by Sector, 2010



[1]Source: Maryland's Greenhouse Gas Reduction Plan, Sept. 2013

GHG emissions that result from human activity are believed to contribute to global warming, which is the increase in average global temperature. Global warming is a result of an enhanced greenhouse effect, a naturally occurring process by which heat from the sun is radiated off the Earth's surface and then is trapped in the earth's atmosphere by GHGs, causing the Earth's surface temperature to increase. The Earth's surface temperature has increased by 1.4 degrees Fahrenheit over the past 100 years. According to the EPA, the average temperature at the Earth's surface could increase from 2 to 11.5°F in the next 100 years.

Global warming is just one aspect of climate change. Sea level rise, rainfall patterns, snow cover, and ice cover are also changing. The Fort McHenry sea level gauge in Baltimore, Maryland has recorded sea level rise at the rate of 1.03 feet every 100 years between 1902 and 2013.[1] The Maryland Climate Change Commission (Scientific and Technical Working Group) reports projections of sea level rise in Maryland of between 0.9 and 2.1 feet by 2050 and between 2.1 and 5.7 feet by 2100.[2] The Maryland State Highway Administration (SHA) is currently planning for changes in mean sea level in the Baltimore region of between 2.01 feet (Harford County, Baltimore County and Baltimore City) and 2.08 feet (Anne Arundel County) by 2050 and between 5.59 feet (Harford County, Baltimore County and Baltimore City) and 5.7 feet (Anne Arundel County) by 2100.

Sea level rise, increased temperatures, and other aspects of climate change are predicted to hinder efforts to clean up the Chesapeake Bay. According to the Maryland Greenhouse Gas Reduction Act Plan[3], increased runoff and rainfall events from climate change could affect the Bay through increased erosion and sediment loads. Higher peak stormwater flows also would mean greater amounts of nutrients transported downstream, degrading water quality. Additionally, climate change will likely cause a decline in biodiversity of plants and animals in the forests of Maryland. Increasing summer temperature will likely cause higher ozone levels and more frequent exceedances of the federal ozone air quality standard. Sea level rise will also require costly mitigation measures to protect the region's transportation infrastructure from higher water and damage caused by storm surges.

Transportation, Ground-level Ozone, and Nitrogen Oxides (NOx)

The US Environmental Protection Agency (EPA) sets national ambient air quality standards, or NAAQS, for certain air pollutants, called "criteria pollutants," to protect public health. The EPA then determines the areas of the country that do not meet the NAAQS. In 1997, the ground-level ozone NAAQS was set at a level of 0.08 parts per million (ppm). In 2008, it was strengthened to a level of 0.075 ppm. Most recently, in 2015, the NAAQS was lowered to a level of 0.070 ppm.

The Baltimore region has been working to reach federal air quality standards for more than two decades. During the past few years, MDE recorded air pollution levels below the 1997 and 2008 ground level ozone standards. However, the latest monitoring data shows pollution levels just above the newest 2015 NAAQS at two monitors in the region. The BRTB recognizes two important items: 1) the need to continue to work to reduce ground-level ozone pollution to reach the newest 8-hour ozone NAAQS; and 2) there is no guarantee that lower levels of ozone that we have experienced in the region will continue in future years. Lower temperatures during the past three summers (2012 to 2014) may be tied to lower rates of ozone formation.

EPA's strengthening of the ozone NAAQS was based upon extensive research and scientific studies on the effects of air pollution on humans. Research links ground level ozone pollution to cardiovascular problems including heart attacks, and aggravation of respiratory problems such as asthma.

According to estimates presented in the MDE 2013 Revised Baltimore Serious Nonattainment Area 0.08 ppm 8-Hour Ozone State Implementation Plan, on-road mobile sources were responsible for approximately 40% of daily NOx emissions in 2012. (See Figure 2.)

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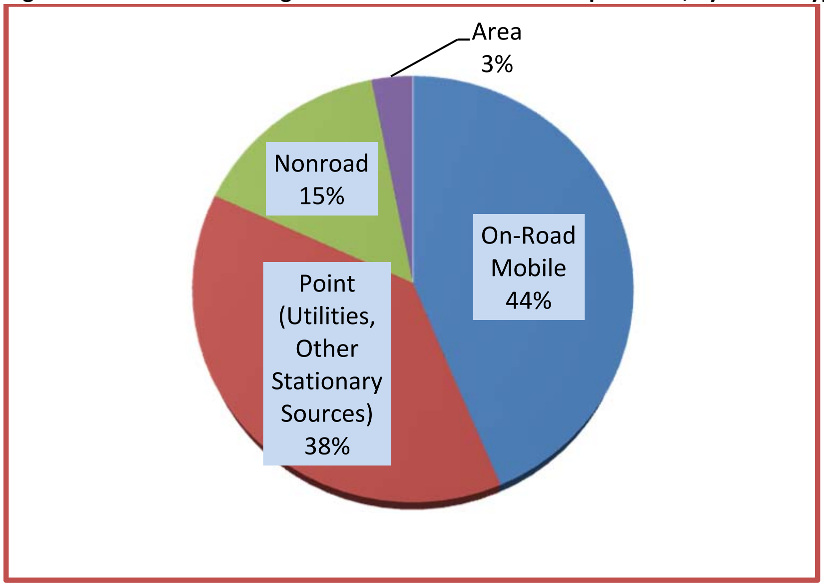
[1] http://tidesandcurrents.noaa.gov/sltrends/sltrends.html. Web site accessed April 29, 2015.

[2] Boesch, D.F., L.P. Atkinson, W.C. Boicourt, J.D. Boon, D.R. Cahoon, R.A. Dalrymple, T. Ezer, B.P. Horton, Z.P. Johnson, R.E. Kopp, M. Li, R.H. Moss, A. Parris, C.K. Sommerfield. 2013. Updating Maryland's Sea-level Rise Projections. Special Report of the Scientific and Technical Working Group to the Maryland Climate Change Commission, 22 pp. University of Maryland Center for Environmental Science, Cambridge, MD.

[3] Maryland Department of the Environment. 2013. Maryland's Greenhouse Gas Reduction Action Plan.

Figure 2. 2012 Baltimore Region NOx Emissions from Transportation, by Source Type



Source: Maryland Department of the Environment. 2013. Baltimore Serious Nonattainment Area 0.08 ppm 8-Hour Ozone State Implementation Plan.

Nitrogen oxides and volatile organic compounds combine in the presence of heat and sunlight in the atmosphere to create ozone pollution. These "precursor" gases are emitted from sources such as vehicle exhaust and power plants, in addition to various other smaller sources such as paint fumes and dry cleaners. Plans for addressing ozone pollution and the related Clean Air Act and Conformity Rule requirements of an MPO in a "nonattainment area" continue to drive the air quality work of the BRTB.

Long Range Transportation Plan Background

The BRTB is in the process of updating the long range transportation plan. Mitigation of greenhouse gas (GHG) emissions and reduction of nitrogen oxide (NOx) emissions is an important part of planning for transportation in the Baltimore region. As mentioned earlier, these emissions contribute to climate change and ozone pollution. To address these concerns, the region's next long range transportation plan, *Maximize2040: A Performance Based Transportation Plan*, will address the mitigation of these emissions, through its goals, performance measures, and project funding. One of the goals of the Plan that the BRTB has adopted is to "Preserve the Environment."

To address the need to reduce NOx and GHG emissions, the How Far Can We Get Oversight Committee has been tasked with developing a list of transportation emission reduction measures (TERMs) to recommend for inclusion in the long range transportation plan.

Study Oversight Committee

The How Far Can We Get Oversight Committee was formed to handle the decision making and oversight of the study, conducted by BMC staff. The study Oversight Committee consisted of representatives from the Maryland Departments of Transportation, Environment, and Planning, the Maryland Transit Administration, and each of the local jurisdictions in the Baltimore region (Annapolis, Baltimore City, and Anne Arundel, Baltimore, Carroll, Harford, and Howard Counties.) Meetings were held approximately every other month, starting with a kickoff meeting on June 5, 2014, and lasting until August 2015. Many decisions of the Committee were discussed at committee meetings (held both in-person and through GoToMeeting in the interest of reducing air quality impacts from commuting to meetings). After discussion, surveys were provided to Committee members to enable quick and clear feedback. Input received and decisions made by the Committee members covered the following topics:

- Which TERMs to analyze based on level of interest of the jurisdictions and agencies.
- Perception of feasibility (including cost) regarding each of the TERMs.
- A ranking of TERM category based on level of interest of the jurisdictions and agencies. The TERM categories included the following: Urban, Road, Vehicle/Fuels Technology, Marketing, Pricing, and Fleet.
- Modeling assumptions regarding the individual TERMs analyzed in Round 1 Scenario Testing.

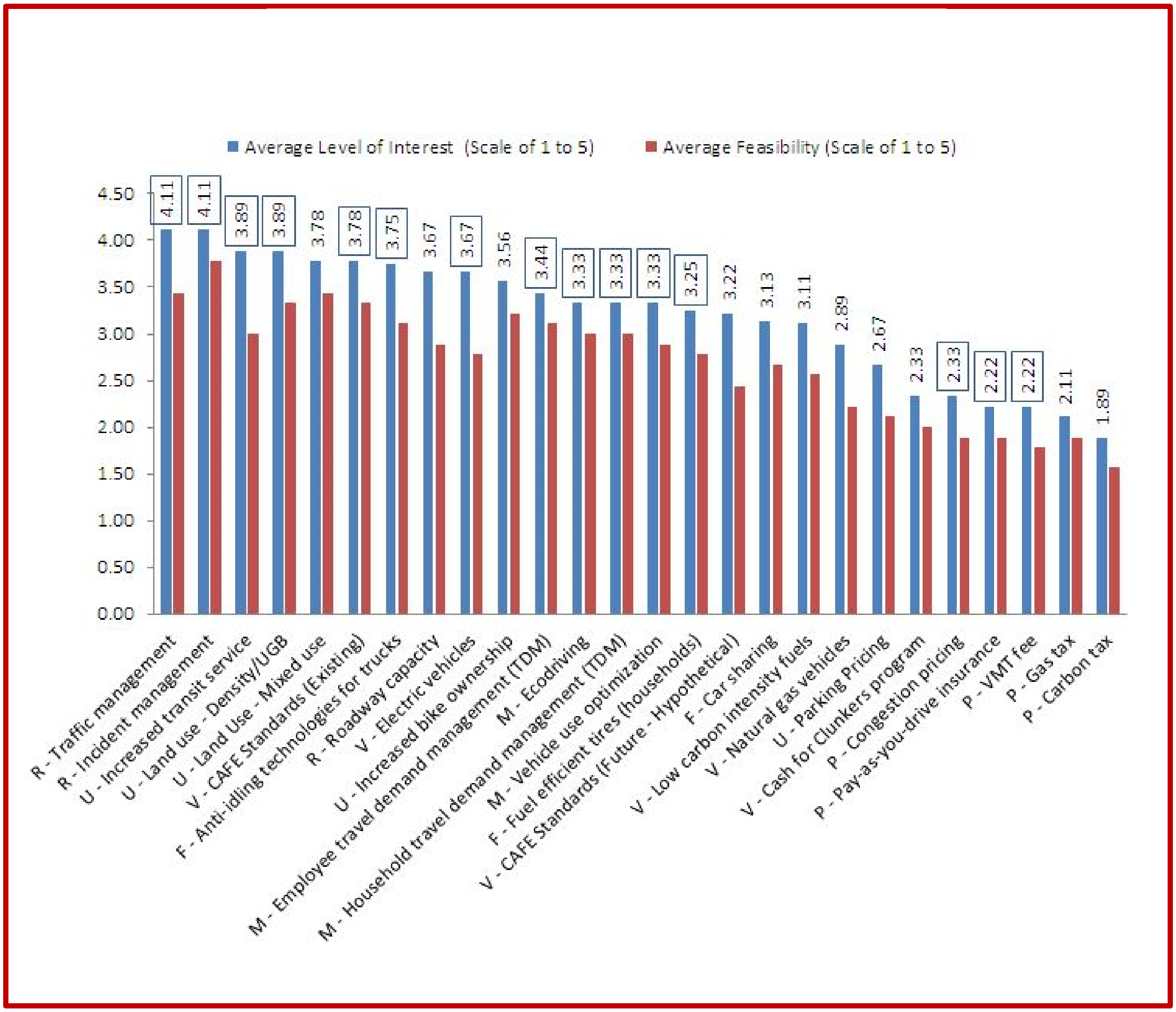
Results of the ranking of TERM categories are provided below.

Based upon a follow-up survey, the Committee decided to analyze and ask for staff to model the top two measures in each TERM category that scored the highest for level of interest, and not to consider feasibility ranking at that point in the study. The following graph displays the average level of interest for various emission reduction measures. The letter shown proceeding the TERM name indicates the category the measure falls into (R – road, U – urban, V – vehicle/fuel technologies, F – fleet, M – marketing, and P – pricing). In the case in which there were TERMs that tied for level of interest, all of the TERMs with that score were included in the list. The TERM level-of-interest scores that are boxed indicate the TERMs that were analyzed individually in the Round 1 analysis.

These TERMs that were agreed to for further exploration included:

- Congestion pricing
- Corporate Average Fuel Economy (CAFE) standards (existing)
- Eco-driving
- Electric vehicles
- Employee travel demand management
- Household travel demand management
- Incident management
- Increased transit service
- Land Use – Density/ Urban Growth Boundary
- Pay-as-you-drive insurance
- Traffic management
- Truck anti-idling technologies
- Use of low rolling resistance tires by households
- Vehicle use optimization
- VMT fee

Figure 3. Emission Reduction Measure – Committee-Reported Level of Interest



Study Process

The How Far Can We Get Study scope of work included the following four phases:

1) Develop Study Tools
2) Round 1 Policy Analysis – Individual TERM Scenario Testing
3) Round 2 Policy Analysis – Combination TERM Scenario Testing
4) Development of Recommendations

The following sections outline the study process, including the tools used by the Oversight Committee, the assumptions and results of two rounds of policy analysis, and the recommendations developed by the Oversight Committee.

Phase I: Develop Study Tools

Staff used several different tools to assist with the analysis of different transportation emission reduction measures, or TERMs. These tools included a staff-created TERM Policy Catalog, EPA's MOVES 2010 model, and the EERPAT model.

TERM Policy Catalog

BMC staff developed a catalog of transportation emission reduction measures (TERMs). The purpose of this catalog is to share information with state agencies and local jurisdiction (in particular members of the Oversight Committee) information on the range of TERMs available, their potential effectiveness at reducing greenhouse gas emissions and their cost effectiveness.

A catalog of transportation emission reduction measures (TERMS) was developed for use as a tool to assist the Oversight Committee in their study. The TERM policy catalog provides estimated emission reduction and cost effectiveness potential for a comprehensive list of TERMs. This data was gathered by staff from national and local studies. All of the TERM's in the catalog are separated into the following categories: Pricing, Roads, Marketing, Vehicle and Fuels Technology, Fleet, and Urban. A copy of the TERM policy catalog is included in the appendix.

MOVES 2010 Emissions Modeling

EPA's MOVES 2010 motor vehicle emissions model was used as one of the tools in the How Far Can We Get Analysis. It was used to get an overall picture of the sources of greenhouse gases and nitrogen oxide emissions, within the on-road transportation sector. The following disaggregate analysis of Baltimore region mobile source emissions was completed to provide information on mobile emissions source and process. The detailed level of information will assist in choosing emission reduction measures to include in scenario modeling, in order to produce meaningful outcomes.

The following analysis begins with the aggregate mobile source emissions (simulating all vehicle activity occurring within the Baltimore region), then proceeds to disaggregate results concluding with emissions from individual vehicles. Emission results were developed for source (vehicle) type and process (starting, running, resting loses, and idling) along with road type and vehicle speed travel activity. Emissions were calculated for 2018, 2025, and 2035 because these were the years that travel demand modeling networks had been created for federally required conformity determinations at the time the study began. For brevity, only results from 2018 are provided here for most of the graphs shown. Emission estimates were developed for the average July weekday, the same approach used for transportation conformity modeling purposes.

In developing the MOVES model, EPA collects real-world emission data to understand how motor vehicle characteristics such as body style and engine size explain differences in fuel use and tailpipe emissions. EPA's MOVES emission model "maps" Highway Performance Monitoring System (HPMS) classification to MOVES source (vehicle) types. The region's emission modeling process relies on locally collected classified traffic counts and MOVES model national defaults in converting simulated link traffic volume into the MOVES 13 source (vehicle) types. Classified traffic counts stratified by functional class and area type (urban/rural) are analyzed in estimating volume by four shares – motorcycle, 2 axles, buses, and 3+ axles. As an example, the HPMS classification count estimate of "Bus" is further "mapped" to MOVES source types of intercity, transit, and school bus. The MOVES 2010 emission model does not account for the emission benefits of the Model Year (MY) 2017-2025 light duty vehicle CAFE standard, so these effects will not be seen in this particular MOVES analysis.

As shown in Figure 5, much of the GHG emissions from on-road transportation result from passenger cars and light duty trucks. This is due in part to the much higher contribution of vehicle miles of travel (VMT) from these sources, shown in Figure 4. However, passenger cars and trucks provide a much smaller contribution of GHG's per VMT, compared to medium and heavy duty trucks.

Figure 4. Baltimore Region Mobile Source VMT, by Source Type in 2018

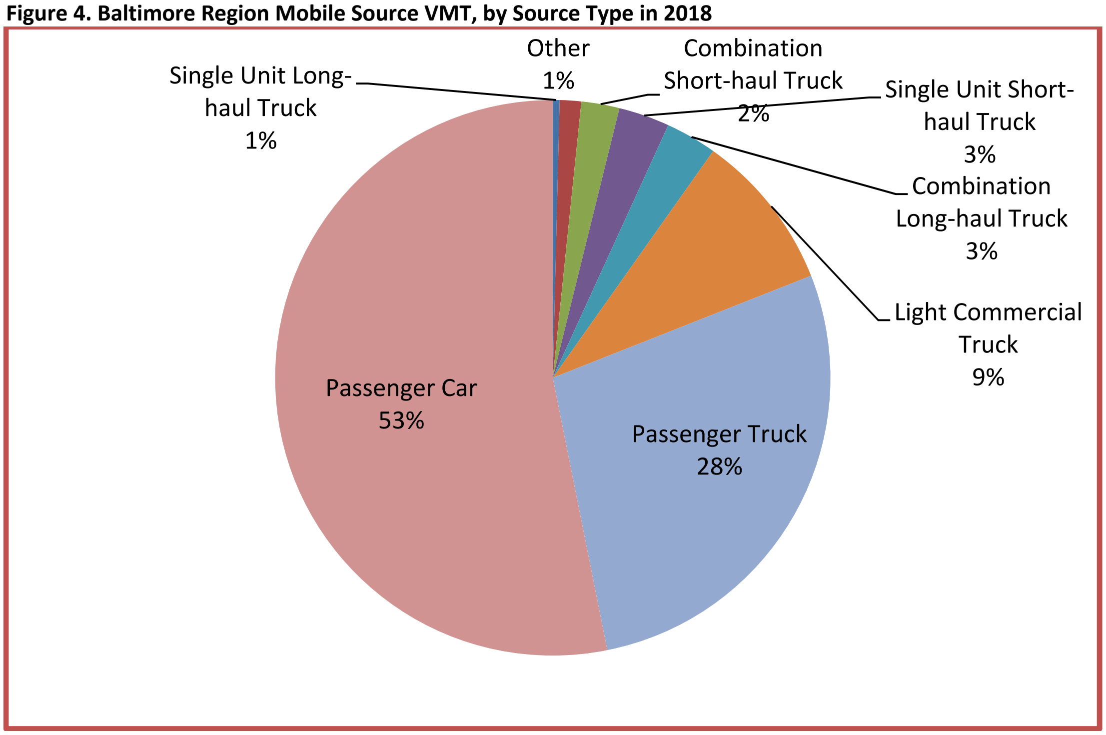
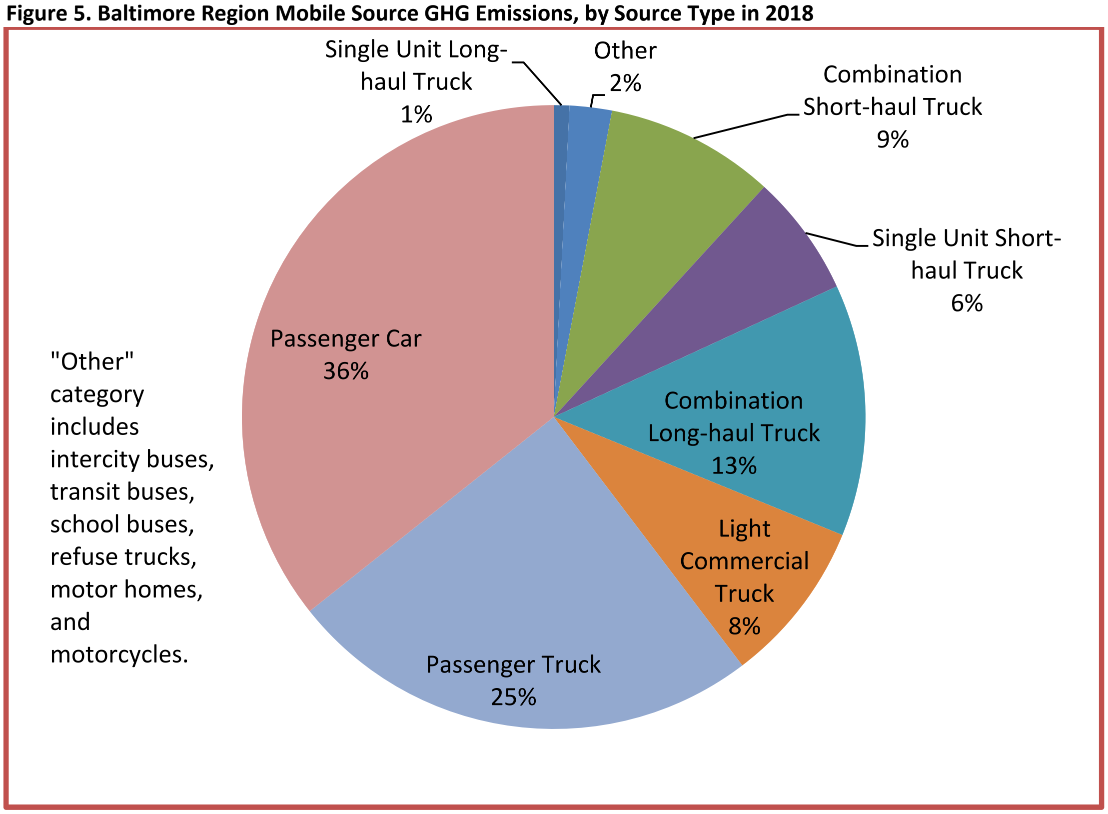
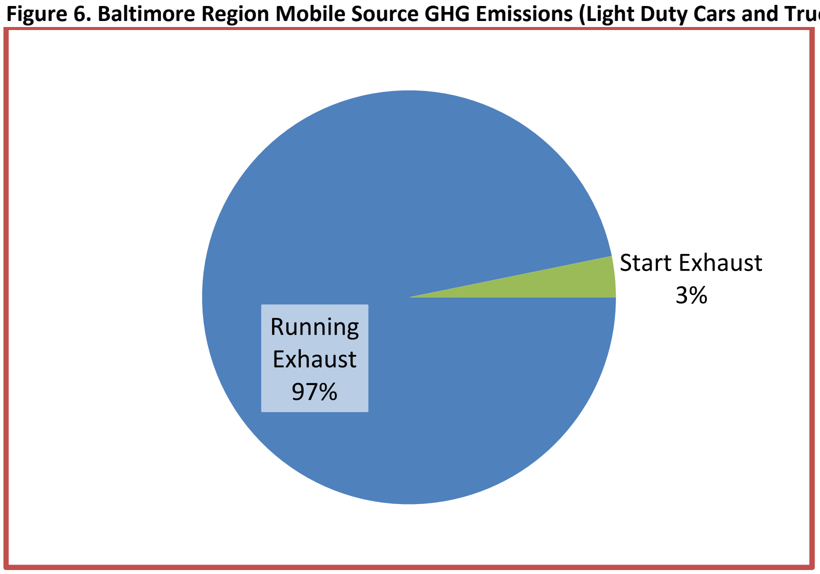


Figure 5. Baltimore Region Mobile Source GHG Emissions, by Source Type in 2018



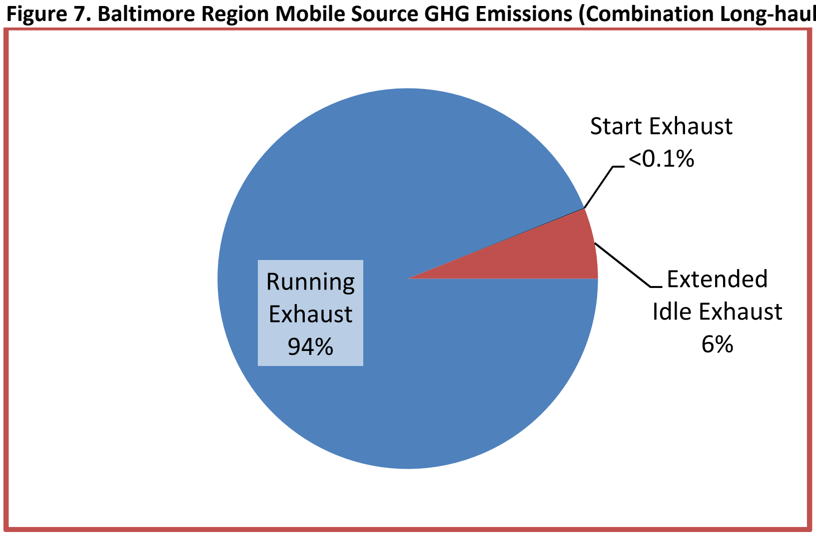
Through MOVES modeling, it was determined that light duty passenger car and truck GHG emissions are largely from engine running exhaust, as shown in Figure 6. Only 3% of these emissions are from start exhaust. As a result, emission reduction measures focused on GHG emissions from light duty vehicles should focus on running emissions.

Figure 6. Baltimore Region Mobile Source GHG Emissions (Light Duty Cars and Trucks), by Process Type in 2018



It was also determined that combination long-haul truck GHG emissions are produced mainly through running exhaust, as shown in Figure 7. However, about 6% of the GHG emissions are from extended idling, and can be reduced through measures that curb overnight idling during driver rest periods.

Figure 7. Baltimore Region Mobile Source GHG Emissions (Combination Long-haul Truck), by Process Type in 2018



The MOVES 2010 model was also used to determine the contribution of nitrogen oxide, or NOx, emissions from different on-road mobile sources and process types. Combination long-haul trucks are estimated to produce a disproportionate amount of NOx emissions compared to the proportion of regional VMT they participate in (See Figures 4, 8 and 9). Not only is the contribution of emissions from combination long-haul trucks relatively large, it will increase in the future from 25% in 2018 to 29% in 2035. Additionally, through MOVES modeling, it was determined that combination long-haul truck NOx emissions are produced from both running exhaust (46%) and extended idling emissions (54%). (See Figures 10 and 11.) The contribution of extended idling emissions to overall NOx emissions from combination long haul trucks will increase into the future from 46% to 66%.

Figure 8. Baltimore Region Mobile Source NOx Emissions, by Source Type in 2018

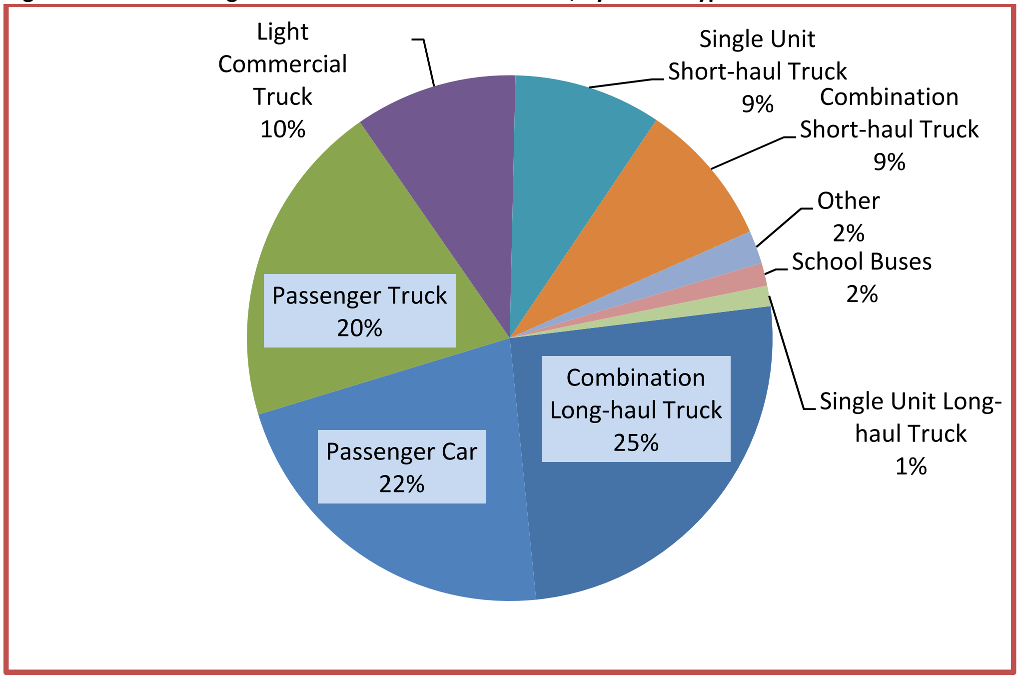


Figure 9. Baltimore Region Mobile Source NOx Emissions, by Source Type in 2035

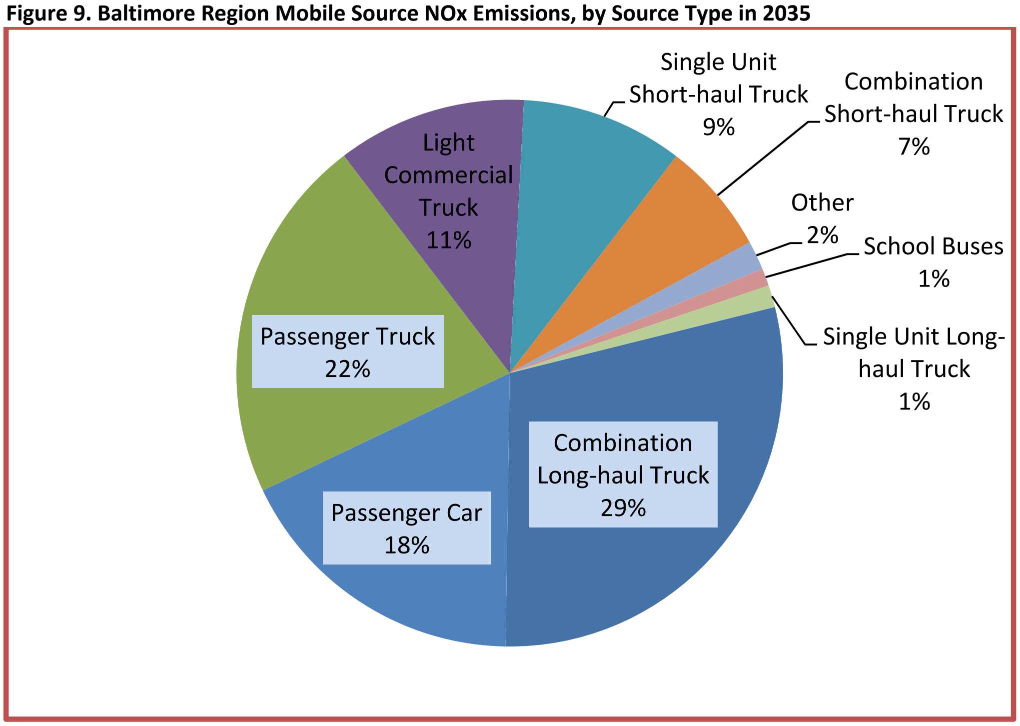


Figure 10. Baltimore Region Mobile Source NOx Emissions (Combination Long Haul Trucks), by Process Type in 2018

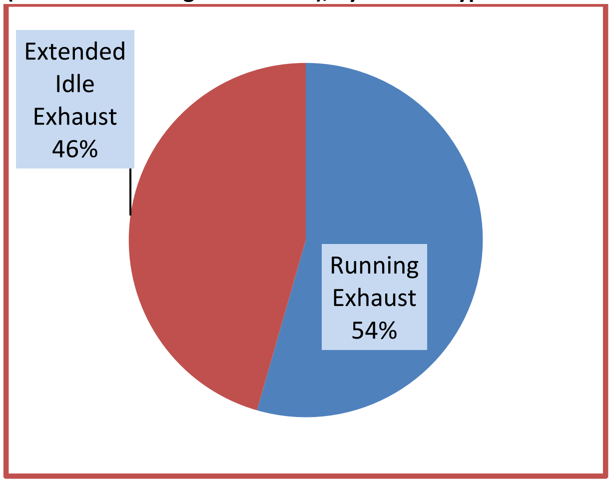
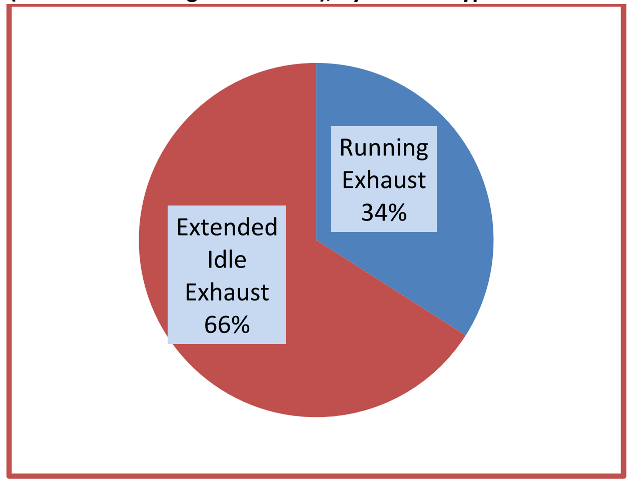
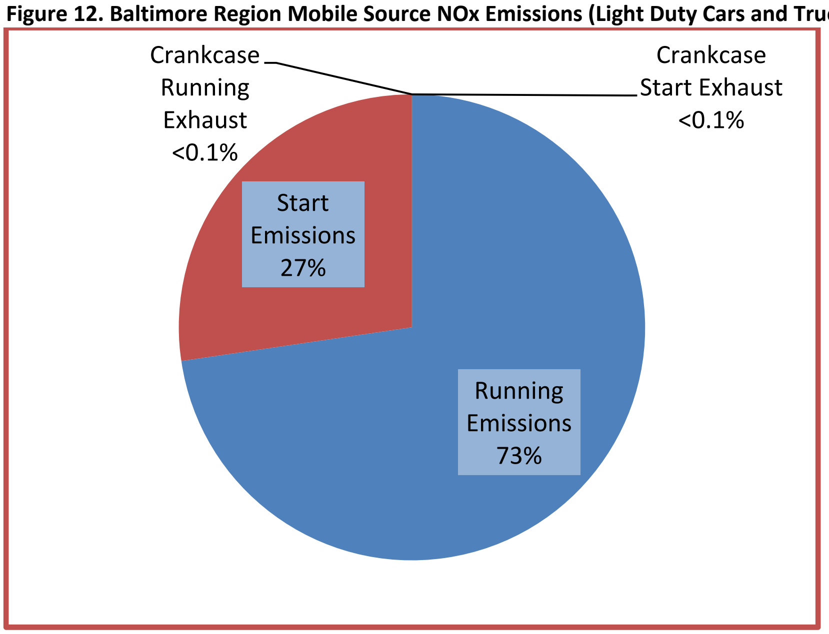


Figure 11. Baltimore Region Mobile Sources NOx Emissions (Combination Long Haul Trucks), by Process Type in 2035



As shown in Figure 12 below, running emissions make up the largest part of NOx emissions from light duty cars and trucks in 2018.

Figure 12. Baltimore Region Mobile Source NOx Emissions (Light Duty Cars and Trucks), by Process Type in 2018



When considering methods to reduce NOx emissions from onroad vehicles, it is important to note the expected benefits of the EPA's Tier 3 Motor Vehicle Emissions and Fuel Standards program. Beginning in 2017, there will be stricter standards for vehicle emissions and the allowed sulfur content of gasoline will be lowered. There will be reductions in both tailpipe and evaporative emissions allowed from vehicles, including passenger cars, light duty trucks, medium duty passenger vehicles, and some heavy duty vehicles. The tailpipe emission standards will phase in between 2017 and 2025.

Reducing the sulfur content of gasoline will reduce emissions from both existing and future vehicles. The emission reduction benefits from the overall Tier 3 program should be significant. According to the EPA:

> *"Compared to current standards, the non-methane organic gases (NMOG) and nitrogen oxides (NOX), presented as NMOG+NOX, tailpipe standards for light-duty vehicles represent approximately an 80% reduction from today's fleet average and a 70% reduction in per-vehicle particulate matter (PM) standards. The heavy-duty tailpipe standards represent about a 60% reduction in both fleet average NMOG+NOX and per vehicle PM standards."*

EERPAT Model Background, Calibration, and Testing

The Energy and Emissions Reduction Policy Analysis Tool (EERPAT) model was used to perform two rounds of scenario testing of different TERMs. The EERPAT model enables rapid scenario evaluation of alternative emission reduction policy scenarios. It produces results of emission reduction and VMT change at the county, regional, metropolitan and state level. Staff was able to extract this information for the Baltimore region for each emission reduction scenario that was tested. EERPAT model development, calibration for the state of Maryland, and pilot testing are described below.

The EERPAT model is applied at the state level and is based on Oregon DOT's GreenSTEP model. The model was originally developed in Oregon based on national study findings and national datasets. The Maryland Department of Transportation (MDOT) partnered with FHWA on an agreement to bring the EERPAT pilot project to Maryland. In order to prepare the FHWA EERPAT tool to use in Maryland, staff took advantage of the FHWA-sponsored MDOT pilot project to adapt EERPAT to Maryland. A key feature of EERPAT is that it's a highly disaggregated household level model. It reflects how household members' behavior responds to land use, vehicle, fleet, transportation supply, and policies. The outputs are aggregated to four levels: county, regional, metropolitan and state. Staff worked with state agencies to collect data for Maryland. Staff worked from August 2013 to the middle of 2014 to calibrate the EERPAT model for use in Maryland. Model estimates were compared with HPMS data as part of the calibration process.

The state level pilot project, which preceded the How Far Can We Get modeling involved both data input and calibration in addition to sensitivity testing. Two state-level scenarios were tested as part of the pilot project scenario testing. Once calibration was complete, the EERPAT model for Maryland was distributed to Maryland state agencies. Through the EERPAT model, the model user can change the assumptions within multiple input files to reflect different transportation emission reduction measures.

Phase II: Round 1 Policy Analysis – Individual TERM Scenario Testing

The first round of policy testing began in August 2014, once EERPAT model calibration was completed. From the results of the survey process mentioned earlier, a total of 15 emission reduction measures receiving the most votes were evaluated individually for this first round of testing through the EERPAT model (with the exception of heavy duty diesel truck idle reduction.)

The development of the input assumptions for emission reduction measures was guided by several different sources including the draft 2012 Oregon Statewide Transportation Strategy and the Maryland Greenhouse Gas Act Plan. Staff received input from the Oversight Committee on the assumptions that went into the Round 1 individual measure analysis. After feedback from the Oversight Committee was received and compiled, three of the measures were refined and re-run.

The following measures that were evaluated in Round 1 are described below along with their implementation assumptions for modeling purposes.

Congestion Pricing

Congestion pricing works by shifting purely discretionary rush hour highway travel to other transportation modes or to off-peak periods. By removing a fraction of the vehicles from a congested roadway, pricing enables the system to flow much more efficiently, allowing more cars to move through the same physical space.

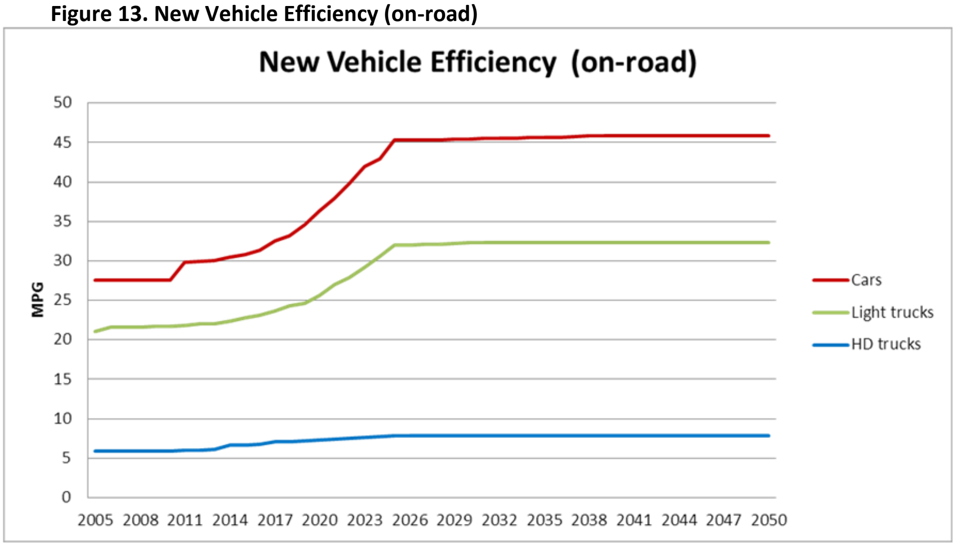
- Assumptions: In the Business as Usual (BAU) scenario, there is assumed to be no congestion charge. Implementation of this measure assumes that a price of 10 cents per mile is charged on all extremely and severely congested freeways.
- Results: Implementation of this measure results in a 1.16% reduction in GHG emissions in 2030 and 1.19% reduction in 2040. It also reduces NOx emissions by 0.0648 short tons per day in 2030 and 0.0296 short tons per day in 2040. This results directly from a 1.36% VMT reduction in 2030 and a 1.42% VMT reduction in 2040.

Corporate Average Fuel Economy (CAFE) Standard MY 2017-2025

The Corporate Average Fuel Economy, or CAFE, Standard is a federal requirement that vehicle manufacturers must follow, that specifies the average required fuel economy of a manufacturer's passenger car and light truck fleet produced for sale in a given model year (MY). The National Highway Traffic Safety Administration (NHTSA) sets CAFE standards, and the U.S. EPA sets CO_2 standards.

- Assumptions: Implementation of this measure reflects the federal CAFE standard that was finalized in 2012. It affects new light duty cars and trucks with model years 2017 to 2025. Fuel economy will be raised to the equivalent of 54.5 miles per gallon by 2025. Standards are met through a combined average fleet-wide fuel economy for new vehicles. The CAFE standard is reflected in EERPAT modeling by changing the average miles per gallon fuel efficiency. This number is corrected for credits that can be obtained by manufacturers, which results in allowances for slightly lower average fuel efficiencies. It was decided that this CAFE standard, because it is has already been finalized, will be included in the BAU scenarios in Round 2 of this study.
- Results: Implementation of this measure results in an 11.7% reduction in GHG emissions in 2030 and 17.6% reduction in 2040. This measure results in the largest reduction of all of the individual measures. As stated earlier, it is included in the BAU Scenario because it is a federal standard that has previously been finalized.

Figure 13. New Vehicle Efficiency (on-road)



Source: U.S. Energy Information Administration – Annual Energy Outlook 2014

Eco-driving

Marketing of eco-driving measures consists largely of sharing tips for personal vehicle fuel efficiency through methods of driving and car maintenance/up-keep. Measures include: properly inflating tires, using cruise control, no jack rabbit starts, getting regular oil changes, removing unnecessary loads in the trunk, etc.

- Assumptions: The BAU scenario assumes that zero percent of the population is using eco-driving practices. Implementation of this measure assumes that 20% of households participate in eco-driving practices.
- Results: Implementation of this measure results in a 0.45% reduction in GHG emissions in 2030 and 0.42% reduction in 2040.

Electric vehicles

Electric vehicles include plug-in "battery electric vehicles" (BEVs), and plug-in hybrid electric vehicles (PHEVs). BEVs use battery power for propulsion rather than an internal combustion engine. PHEVs are able to use either battery power or fossil fuels for propulsion.

- Assumptions: In 2012, 1.7% of vehicles sold in the Baltimore region were plug-in electric and 9.8% were hybrid electric vehicles (HEV). In the BAU Scenario, it is assumed that these percentages would continue into the future. Under the implementation scenario, 7.2% of vehicles sold in the region would be plug-in electric (either PHEV or BEV) and another 15% would be HEV. The 7.2% percentage is based upon the State's goal of 60,000 electric vehicles on the road by 2020.
- Results: Implementation of this measure results in a 1.21% reduction in GHG emissions in 2030 and 1.51% reduction in 2040. While it is known that a wider use of electric vehicles in the region could greatly reduce tailpipe emissions of NOx, the ability to model the NOx reduction benefits of this measure were beyond the scope of the study.

Employer TDM programs

Employer-based TDM programs encourage employees to commute to work in a way other than driving alone (transit, telecommuting, biking, walking, ridesharing) or allows flexible work schedules. They can include Guaranteed Ride Home programs, vanpool programs, and commuter benefits programs.

- Assumptions: In the BAU scenario, it's assumed that (1) 5% of employees in the region participate in employee commute option programs and (2) there is a 5.4% reduction in VMT by households participating in the employee commute option programs. Implementation of this measure assumes that beginning in 2020 (and continuing until 2040), 25% of employees participate in employee commute option programs and this results in a 10% VMT reduction in daily commute VMT by the participating households.
- Results: Implementation of this measure results in a 0.31% reduction in GHG emissions in 2030 and 0.41% reduction in 2040. It also reduces NOx emissions by 0.022 short tons per day in 2030 and 0.012 short tons per day in 2040. This results directly from a 0.47 % VMT reduction in 2030 and a 0.56% VMT reduction in 2040.

Household TDM programs

Household TDM programs (also called individualized TDM) encourage people to use travel alternatives other than driving alone (transit, biking, walking, ridesharing). Programs vary, but could include providing personalized information about different travel options, providing guided walks or rides, or a rewards program for traveling by alternate modes.

- Assumptions: In the BAU scenario, it is assumed that zero percent of households participate in household TDM programs. Implementation of this measure assumes that beginning in 2020, 10% of households participate in an individualized marketing program, which reduces participating household VMT by 9%.
- Results: Implementation of this measure results in a 0.29% reduction in GHG emissions in both 2030 and 2040. It also reduces NOx emissions by 0.022 short tons per day in 2030 and 0.0092 short tons per day in 2040. This results directly from a 0.45% VMT reduction in 2030 and a 0.44% VMT reduction in 2040.

Incident Management

Incident management is the routine planned and coordinated use of resources (responders and technology) to reduce the duration and impact of incidents. It improves the safety of motorists, crash victims, and responders. Incident management reduces emissions from idling vehicles resulting from incident-related delay. EERPAT reflects incident management programs through a level of effectiveness input, on a scale of 0 to 1.

- Assumptions: In the BAU scenario, it was assumed that the level of effectiveness is 0.24. Implementation of this measure assumes a 0.40 level of effectiveness out of 1.
- Results: Implementation of this measure results in a slight increase in GHG emissions in 2030 and a less than 0.01% reduction in 2040. This measure reduces NOx emissions by 0.0004 short tons per day in 2040.

Increased Transit Service

With increased transit service, public transit becomes a more viable option for a certain portion of the population. As single occupant vehicle (SOV) trips are replaced with transit trips, overall emissions can be reduced, assuming minimum levels of transit ridership are achieved.

- Assumptions: In the BAU scenario, the Baltimore metropolitan statistical area transit revenue miles grow at 88% the rate of population growth. In other words transit revenue mile growth is slower than population growth. Implementation of this measure assumes that transit revenue miles grow at a rate equal to population growth.
- Results: Implementation results in a 0.29% reduction in GHG emissions in 2030 and 0.28% reduction in 2040. It also reduces NOx emissions by 0.0287 short tons per day in 2030 and 0.0131 short tons per day in 2040.

Land Use – Density

In general, land use density refers to the number of people living within an area per acre. Focusing more development within higher-density metropolitan areas improves accessibility by reducing travel distances, and allows for more of the population to commute by bicycle, walking, or transit. Within the EERPAT model, land use density assumptions can be altered by defining growth in metropolitan area growth boundaries and population growth in metropolitan, town, and rural areas.

- Assumptions: In the BAU scenario, it's assumed that (1) metropolitan area growth boundaries grow at the same rate as population growth (unconstructed) and (2) the percentages of the population that move into the region is split into urban, rural, and town areas based upon the urban/town/rural split reflected in 2010 Census data. In the implementation scenario, it's assumed that metropolitan growth boundaries expand at 1/10th the rate of population growth. Population growth in urban/town/rural based on the 2000-2010 Census data.

- Results: Implementation results in a 0.48% reduction in GHG emissions in 2030 and 0.62% reduction in 2040. It also reduces NOx emissions by 0.0428 short tons per day in 2030 and 0.0255 short tons per day in 2040.

Land Use – Mixed-Use

Policies that encourage households to be in mixed-use areas help to reduce VMT in a metropolitan area. VMT is reduced because trip lengths are shorter in mixed-use areas as destinations get closer to households. Access to public transit can become easier as well. Initially, mixed-use land use was not tested individually for TERM emission benefits. However, through Committee discussion, it was decided that this measure would be added to the Round 1 analysis.

- Assumptions: Two different levels of mixed-use land use were analyzed individually: one in which 50% of households in the metropolitan area are located in mixed-use areas and another where 75% of households in the metropolitan area are located in mixed-use areas. In the BAU scenario, 24% of households in the metropolitan area are in mixed-use areas.
- Results: Implementation at the 50% level results in a 0.21% reduction in GHG emissions in 2030 and a 1.82% reduction in 2040. It also reduces NOx emissions by 0.025 short tons per day in 2040. In 2030, there is a slight increase in VMT and NOx emissions. Implementation at the 75% level results in a 4.12% reduction in GHG emissions in 2030 and a 4.03% reduction in 2040. It also reduces NOx emission by 0.296 short tons per day in 2030 and 0.133 tons per day in 2040.

Land Use – Mixed-Use + Density

When there is a diversity of land uses located next to each other, such as housing, shopping, and jobs, less vehicle trips are necessary, and vehicle trips may be shortened. It also allows for use of alternative modes of travel. Adding the effects of mixed-use land use to more compact development could increase overall GHG reduction. In order to determine whether the combination of mixed-use land use practices and increased density (more compact development) has a synergistic effect in reducing GHG emissions, both measures were modeled together in EERPAT at two different levels of implementation.

- Assumptions: As mentioned above, initially mixed-use land use was not analyzed. However, after additional input from the Committee, it was decided that mixed-use land use would be tested, as described above. In addition, two different combinations of increased density and increased levels of mixed-use were analyzed, as follows:
  - Land Use (Mixed-Use +Density) Scenario #1: The metropolitan growth boundary grows at 1/10th rate of population growth; 50% of the metropolitan area is mixed-use
  - Land Use (Mixed-Use +Density) Scenario #2: The metropolitan growth boundary grows at 1/10th rate of population growth; 75% of the metropolitan area is mixed-use
- Results: Implementation of the Land Use (Mixed-Use +Density) Scenario #1 results in a 3.18% reduction in GHG emissions in 2030 and a 3.25% reduction in 2040. It also reduces NOx emissions by 0.23 short tons per day in 2030 and 0.11 tons per day in 2040. Implementation of the Land Use (Mixed-Use +Density) Scenario #2 results in a 5.14% reduction in GHG emissions in 2030 and a 5.11% reduction in 2040. It also reduces NOx emissions by 0.38 short tons per day in 2030 and 0.17 tons per day in 2040.

Low rolling resistance tires

These tires are designed to decrease rolling resistance in order to increase fuel efficiency of the vehicle. New vehicles are typically equipped with tires that have lower rolling resistance than their after-market replacement, in order to meet CAFE standards. Most hybrid vehicles and electric vehicles are equipped with low-rolling resistance tires.

- Assumptions: Implementation of this measure assumes that 25% of households use low rolling resistance tires, which are assumed to have a 1.5% fuel economy improvement over other tires.[4] This is in comparison to the assumption of zero percent in low rolling resistance tires in the BAU scenario.
- Results: Implementation results in a 0.17% reduction in GHG emissions in 2030 and 0.12% reduction in 2040.

Pay-as-you-drive insurance

Pay-as-you-drive (PAYD) insurance is a type of automobile insurance in which the cost of the insurance is dependent upon distance driven. Mileage would likely be calculated dynamically through the vehicles odometer, or through a GPS device. This insurance would provide an economic incentive to customers to reduce unnecessary trips, or choose destinations that are closer, thereby reducing emissions.

- Assumptions: Implementation of this measure assumes that 10% of households purchase PAYD insurance, compared with zero percent in the BAU scenario. It also assumes that insurance would cost 3 cents per mile.
- Results: Implementation of this measure results in a 0.21% reduction in GHG emissions in 2030 and 0.24% reduction in 2040. It also reduces NOx emissions by 0.014 short tons per day in 2030 and 0.0065 short tons per day in 2040. This results directly from a 0.29% VMT reduction in 2030 and a 0.31% VMT reduction in 2040.

Traffic Operations Management

Traffic operations management includes measures such as ramp metering, incident management, traffic signal coordination, and access management. Incident management benefits were modeled separately from traffic operations management. As traffic operations management measures assist with reducing delay and congestion, vehicle fuel use and related emissions are reduced. The EERPAT model reflects implementation of this measure through effectiveness on a scale of 0 to 1.

- Assumptions: Two levels of implementation were analyzed: 5% effectiveness and 100% effectiveness. It is assumed that the BAU effectiveness is zero percent.
- Results: Implementation at a 5% effectiveness level results in an increase in GHG emissions in 2030 and a negligible effect on emissions in 2040. As with the incident management TERM, the level of effectiveness in emission reduction could partially result from an increased or “induced” demand resulting from increased vehicle flow from congestion reduction. Implementation at a 100% effectiveness level results in a 0.33% reduction in GHG emissions in 2030 and a 0.26% reduction in 2040.

Truck anti-idling technologies

Drivers of diesel trucks often idle their engines overnight during federally-mandated rest breaks. They use the main diesel engine’s power for heating or cooling equipment, to keep the engine warm, or to provide electric power for appliances. However, there are technologies that can be used in place of these larger diesel engines, to provide for these needs, such as auxiliary power units, or APU’s and direct-fired heaters.

- Assumptions: Implementation of this measure assumes that 200 heavy duty diesel trucks parked overnight during an 8 hour rest period no longer idle engines.
- Results: Implementation results in a reduction of NOx emissions by 0.32 short tons per day in 2030 and 0.32 short tons per day in 2040.

[4] Cambridge Systematics, Inc. 2009. Moving Cooler: An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions. Urban Land Institute: Washington, D.C.

As mentioned earlier, since most of the NOx emissions produced by combination long haul trucks in the future are from extended idling, only NOx emissions are highlighted here. However, it is important to note that the resultant fuel savings with idle reduction will provide some GHG benefits.

Vehicle use optimization

A vehicle use optimization program would encourage drivers to choose the most fuel efficient vehicle in their household for the longer trips that household members make. This could mean switching from using a conventional vehicle to an electric vehicle when both are available in the same household.

- Assumptions: Implementation of this measure assumes that 25% of households choose the most fuel efficient vehicle when taking longer trips, compared with zero percent of households optimizing in the BAU scenario.
- Results: Implementation results in a 0.47% reduction in GHG emissions in 2030 and 0.38% reduction in 2040.

VMT fee

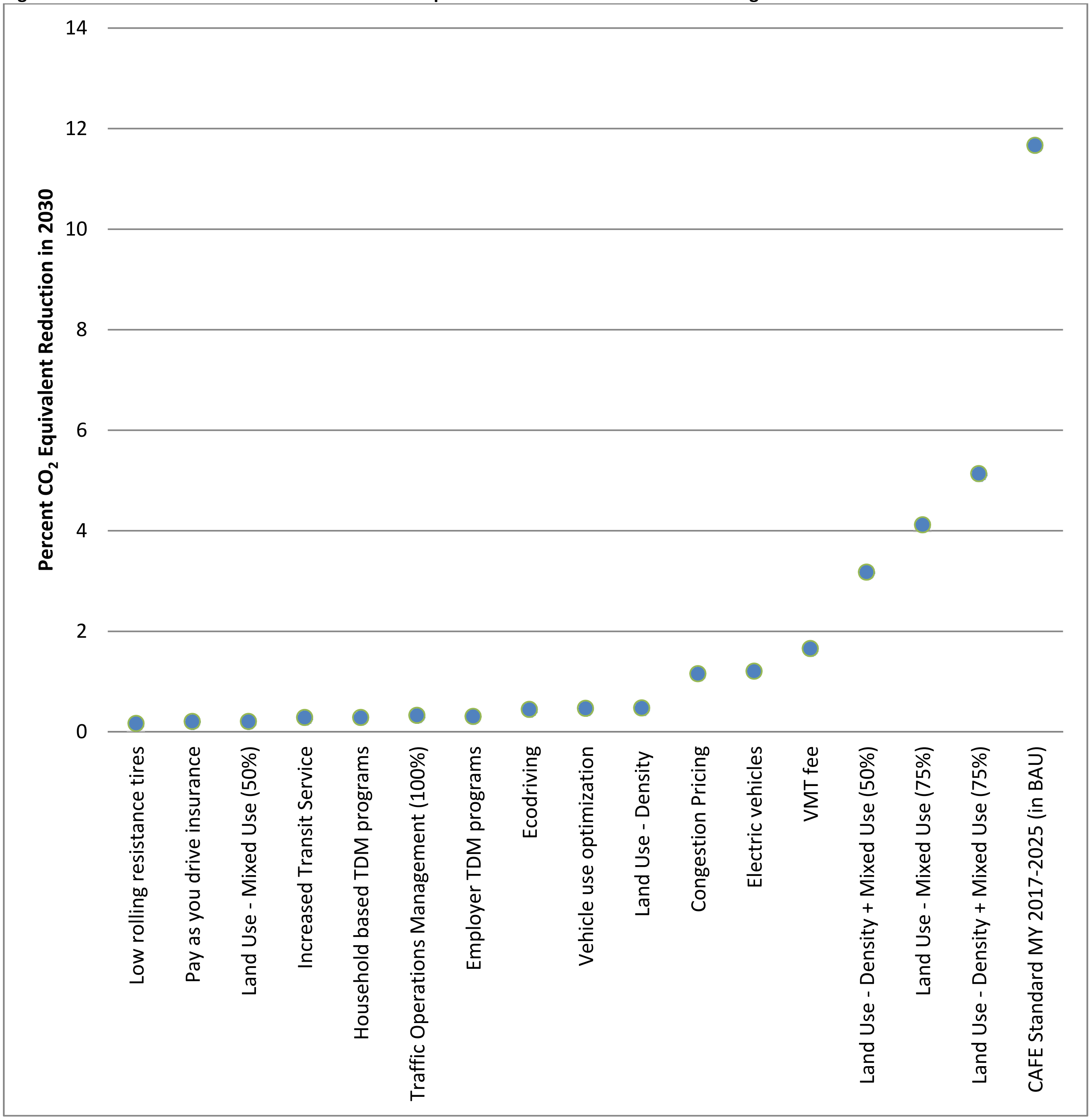
Vehicle miles traveled (VMT) fees are a way to charge users of roadways based on mileage, as an alternative (or add-on) to fees based on gasoline used.

- Assumptions: Implementation of this measure assumes that a 2 cent fee would be charged on every mile traveled in the region, compared with no charge in the BAU scenario.
- Results: Implementation of a 2 cent per mile VMT fee results in a 1.66% reduction in GHG emissions in 2030 and 1.47% reduction in 2040. It also reduces NOx emissions by 0.106 short tons per day in 2030 and 0.0428 short tons per day in 2040. This results directly from a 2.24 % VMT reduction in 2030 and a 2.05% VMT reduction in 2040.

The results of the individual TERM scenario testing are presented on the following pages in Figures 14 through 16. Figure 14 shows the percent reduction in carbon dioxide equivalents (CO_2eq) for 2030, compared with the business as usual (BAU) scenario in the same year. Figure 15 show the percent reduction in CO_2eq for 2040, compared with BAU. The emission benefits of the Model Year 2017-2025 CAFE standard are provided in these graphs, however, this CAFE standard was assumed to be in place in the BAU scenario

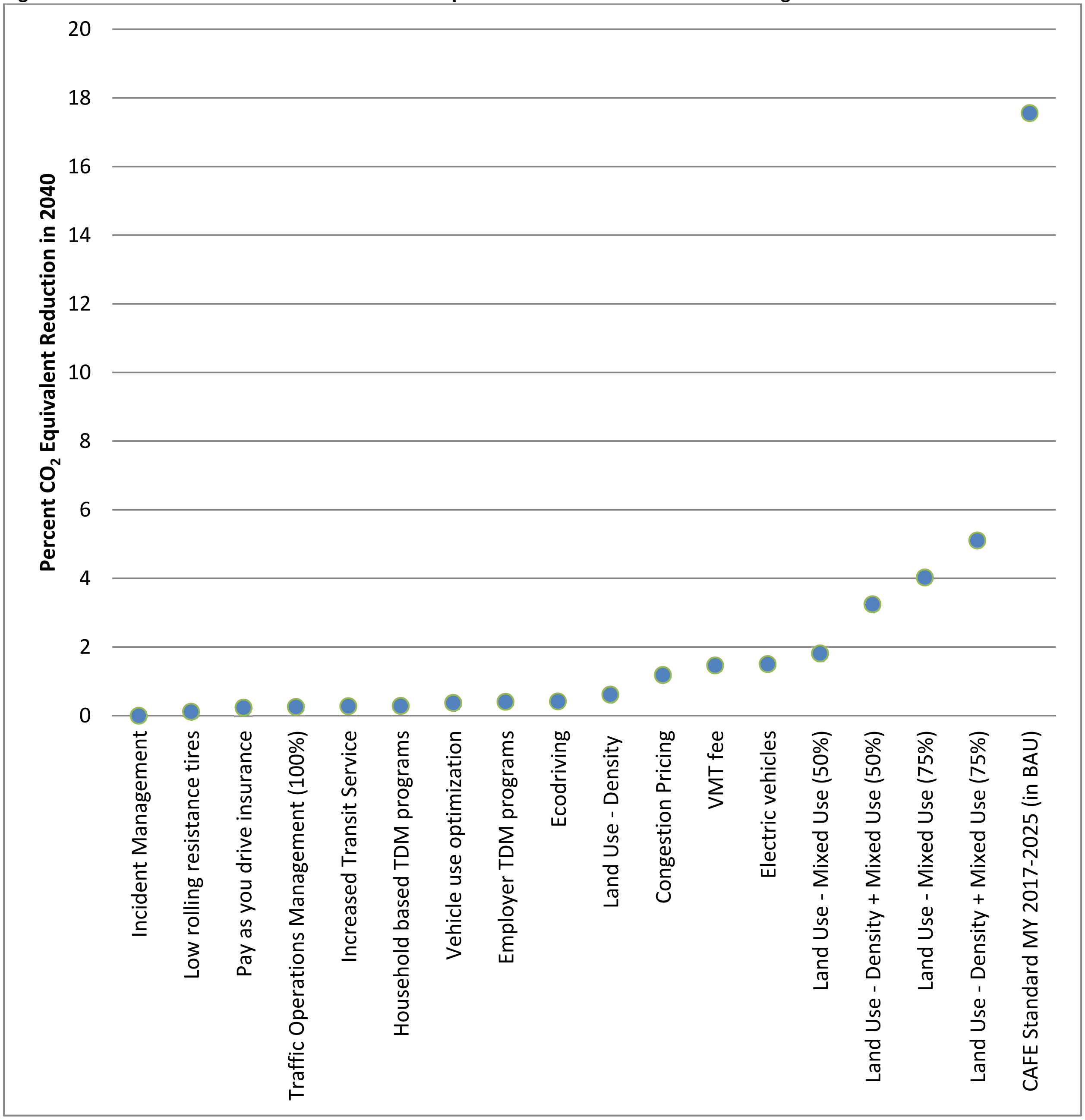
Figure 16 displays the ton per day reduction in emissions of nitrogen oxides (NOx) in both 2030 and 2040, compared with the BAU scenario. The results presented above and in these three figures reflect the results of the final list of individual measures and the assumptions as refined and finalized by the Oversight Committee.

Figure 14. Round 1 Results – Individual TERM CO2 Equivalent Emission Reduction Percentage in 2030



Note: A 5% level of traffic operations management and the incident management measure both result in an increase in GHG emissions according to the EERPAT modeling in 2030.

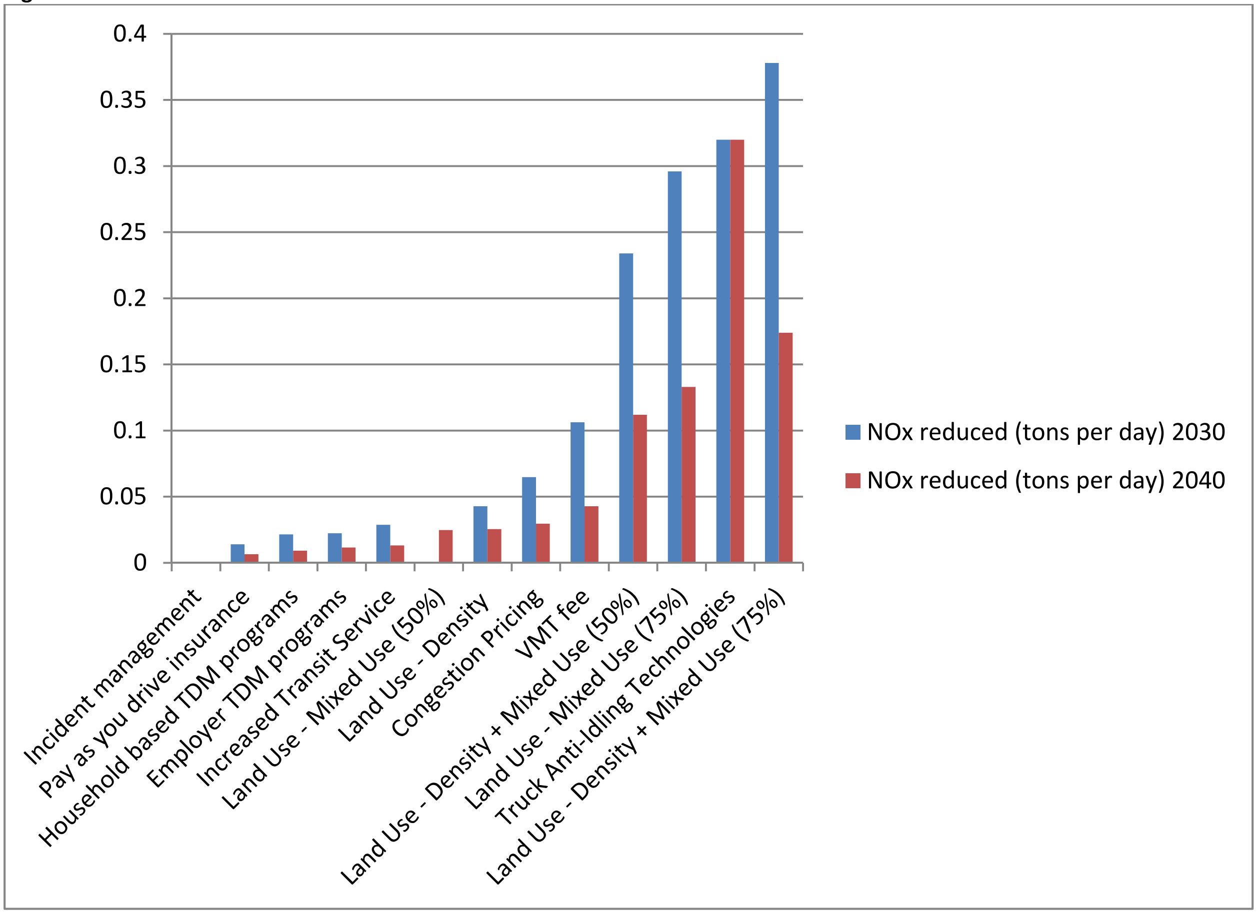
Figure 15. Round 1 Results – Individual TERM CO2 Equivalent Emission Reduction Percentage in 2040



Note: In 2040, traffic operations management has a negligible effect on GHG emissions.

While the federal fuel economy standard reduces GHG emissions significantly more than other available measures, the next most impactful set of TERMs are 3 different variations of mixed-use land use TERMS, combining land use density and mixed-use practices. These reduce emissions up to 5% in 2030 and 2040. Other individual TERMs including electric vehicles, congestion pricing, and a VMT fee could reduce emissions by around 1% in 2030 and 2040. The other TERMs reduce GHG emission under 1%.

Figure 16. Round 1 Results – Individual TERM NOx Emission Reduction in 2030 and 2040



Phase III: Round 2 Policy Analysis – Combination TERM Scenario Testing

In November 2014, modeling scenarios were developed around themes in which combinations of transportation emission reduction measures (TERMs) could be assessed for their joint benefit. There may be multiple interactions within the EERPAT model, encouraging people to drive more or less, so that looking at combinations of measures run together gives a more holistic view of the full benefit of multiple measures, rather than simply adding the emission reductions together. The development of these scenario themes was somewhat modeled upon the draft 2012 Oregon Statewide Transportation Strategy, but the measures included differ substantially.

BMC staff modeled seven separate combination scenarios, to enable comparisons between emission of these scenarios compared with a business as usual (BAU) scenario, and then to compare the percent reduction of each combination scenario with the others. While it is important to understand which is most impactful at reducing emissions, other impacts should be considered. Staff evaluated changes in transit use, VMT, and household travel costs that could result. The base scenario includes the Corporate Average Fuel Economy Standard for light duty vehicles (Model Years 2017 to 2025).

Pricing Scenario

The Pricing Scenario uses a market-based approach to reduce emissions by encouraging people to use modes of travel other than passenger vehicles, and through congestion charging, encourages people to change the time of day or route they travel, to less congested periods or routes. The Pricing Combination incorporates a VMT fee and a congestion pricing fee, along with pay-as-you-drive (PAYD) insurance to make the amount of money a household pays to travel better reflect the full cost of the transportation system, including the cost of negative externalities (e.g. road wear, others' cost of time spent on congested roadways, climate change, and air pollution). The intent is for households to change their behavior regarding transportation, whether it means taking fewer trips, or using a different mode of travel. The VMT fee is set at a level that is equivalent to the gas tax, but would be incorporated on top of the gas tax. The congestion tax would only apply to roadways that are congested, and would encourage off-peak travel, or travel on other modes. The VMT fee and PAYD insurance would encourage people to drive less in general and reduce unnecessary travel. This reduction in unnecessary travel and change to other modes of travel that are less resource-intensive will result in lower GHG emissions.

- Assumptions: Implementation of this measure assumes a 2¢ per mile vehicle miles of travel (VMT) fee, a 10¢ per mile congestion pricing charge on extremely and severely congested roadways, and 10% participation level in PAYD insurance. (This is in addition to any existing gas tax.)

- Results: Implementation results in a 3.16% reduction in GHG emissions in 2030 and 2.95% reduction in 2040.

System/Mode Optimization Scenario

The System/Mode Optimization Scenario places an emphasis on transportation operations management, vehicle use optimization, and eco-driving. Also included are increased transit service and TDM programs. The focus is on optimizing travel on the road network, and optimizing travel among the different modes – cars, biking, walking, and transit. Additional capacity on transit will be provided and people will be encouraged to manage their travel effectively by changing modes or working from home when they can. When the road system is optimized and travel is shifted away from SOV travel to other modes, GHGs will be reduced.

- Assumptions: Implementation of this measure assumes the following:
  - Vehicle use optimization by 25% of households
  - Traffic operations management, 15% effectiveness
  - Transit growth equal to population growth
  - Travel Demand Management - Employer, 25% participation, 10% VMT reduction for participants
  - Travel Demand Management - Household, 10% participation, 9% VMT reduction for participants
  - Eco-driving, 20% participation
- Results: Implementation results in a 1.92% reduction in GHG emissions in 2030 and 1.82% reduction in 2040.

Urban Scenario

The Urban Scenario is centered on increasing density of where people live, which makes the miles they have to travel for daily activities lower, and provides for greater opportunities for alternative modes of travel, rather than single occupant vehicles. Increased density is achieved through infill development in already-populated areas, rather than increasing development outside of growth boundaries. This increased density is reflected in the model by expanding the growth boundaries at a slower rate compared to the population growth, than in the BAU scenario. Additional transit capacity, travel demand management marketing and education, and having programs that charge by the mile for car insurance also help to encourage people to use a less carbon-intensive mode of travel. This scenario allows for a better understanding of the synergies that can result from the implementation of land use, transit, and travel demand management measures together.

- Assumptions: Implementation of this measure assumes the following:
  - Metropolitan area growth boundaries expand at one tenth the rate of population growth. Population split is based on the split in population growth (2000-2010) between urban, town, and rural areas.
  - Transit growth equal to population growth
  - Travel Demand Management - Employer, 25% participation, 10% VMT reduction for participants
  - Travel Demand Management - Household, 10% participation, 9% VMT reduction for participants
  - 10% participation level of PAYD insurance

- Results: Implementation results in a 1.86% reduction in GHG emissions in 2030 and 1.85% reduction in 2040.

Urban Scenario Plus

The Urban Scenario Plus includes all of the assumptions of the Urban Scenario with the addition of a mixed-use measure in which 50% of the metropolitan areas in the region are mixed-use, compared with 24% in the BAU and Urban Scenario. As shown below, the addition of the mixed-use measure greatly enhances the benefits of the overall scenario.

- Assumptions: Implementation of this measure assumes the following:
  - Land use - Density, Metropolitan area growth boundaries expand at one tenth the rate of population growth. Population split is based on the split in population growth (2000-2010) between urban, town, and rural areas.
  - Land use – 50% of metropolitan area is mixed-use
  - Transit growth equal to population growth
  - Travel Demand Management - Employer, 25% participation, 10% VMT reduction for participants
  - Travel Demand Management - Household, 10% participation, 9% VMT reduction for participants
  - 10% participation level in PAYD insurance

- Results: Implementation results in a 4.50% reduction in GHG emissions in 2030 and 4.48% reduction in 2040.

Vehicle Technology Scenario

The Vehicle Technology Scenario is centered on a substantial inflow of electric vehicles into the region's passenger fleet. This is based on the State's goal of having 60,000 plug-in electric vehicles (PEVs) on the road by 2020. With increased use of electric vehicles, in place of gasoline, comes higher fuel efficiency and lower per mile emissions of GHG's.

- Assumptions: Implementation of this measure assumes that 7.2% of vehicles sold in the region would be plug-in electric (either PHEV or BEV) and another 15% would be hybrid electric vehicles (HEV). As of May 2015, there are over 3,000 electric vehicles in Maryland, as seen through the number of electric vehicle state tax credits claimed. It also assumes that 25% of households use low rolling resistance tires, which have a 1.5% fuel economy improvement over other tires.

- Results: Implementation results in a 1.33% reduction in GHG emissions in 2030 and 1.64% reduction in 2040.

Vehicle Technology Plus Scenario

The Vehicle Technology Plus Scenario is based upon the premise that there will be substantial advances in technology such that fuel efficiency of passenger vehicles will be able to improve beyond the requirements of the Model Year 2017-2025 CAFE Standard, and improvements will be made up to the 2040 model year. As vehicles become more and more fuel efficient the GHG emissions per vehicle mile traveled decrease.

- Assumptions: Implementation of this measure assumes that there would be in place a hypothetical corporate average fuel economy (CAFE) standard that would increase fuel economy by 2.5% annually from 2026 to 2040. It also assumes that 25% of households use low rolling resistance tires, which have a 1.5% fuel economy improvement over other tires.

- Results: Implementation results in a 1.13% reduction in GHG emissions in 2030 and 8.35% reduction in 2040.

Vehicle Technology Plus/Marketing Scenario

The Vehicle Technology Plus/Marketing Scenario was based upon a preliminary set of TERMS agreed to by the Oversight Committee at their February 2015 meeting. This scenario combines the vehicle technology plus scenario, with additional TERMS as described below.

- Assumptions: Implementation of this measure assumes the following TERMs:
    - A hypothetical corporate average fuel economy (CAFE) standard that would increase fuel economy by 2.5% on average annually from 2026 to 2040.
    - It also assumes that 25% of households use low rolling resistance tires, which have a 1.5% fuel economy improvement over other tires.
    - 20% participation rate in an eco-driving program
    - 25% participation rate in vehicle use optimization
    - Travel Demand Management - Employer, 25% participation, 10% VMT reduction for participants
    - Travel Demand Management - Household, 10% participation, 9% VMT reduction for participants
    - 200 heavy duty diesel trucks parked overnight during an 8 hour rest period no longer idle their engines.

- Results: Implementation results in a 2.86% reduction in GHG emissions in 2030 and 9.78% reduction in 2040.

Phase IV: Development of Recommendations

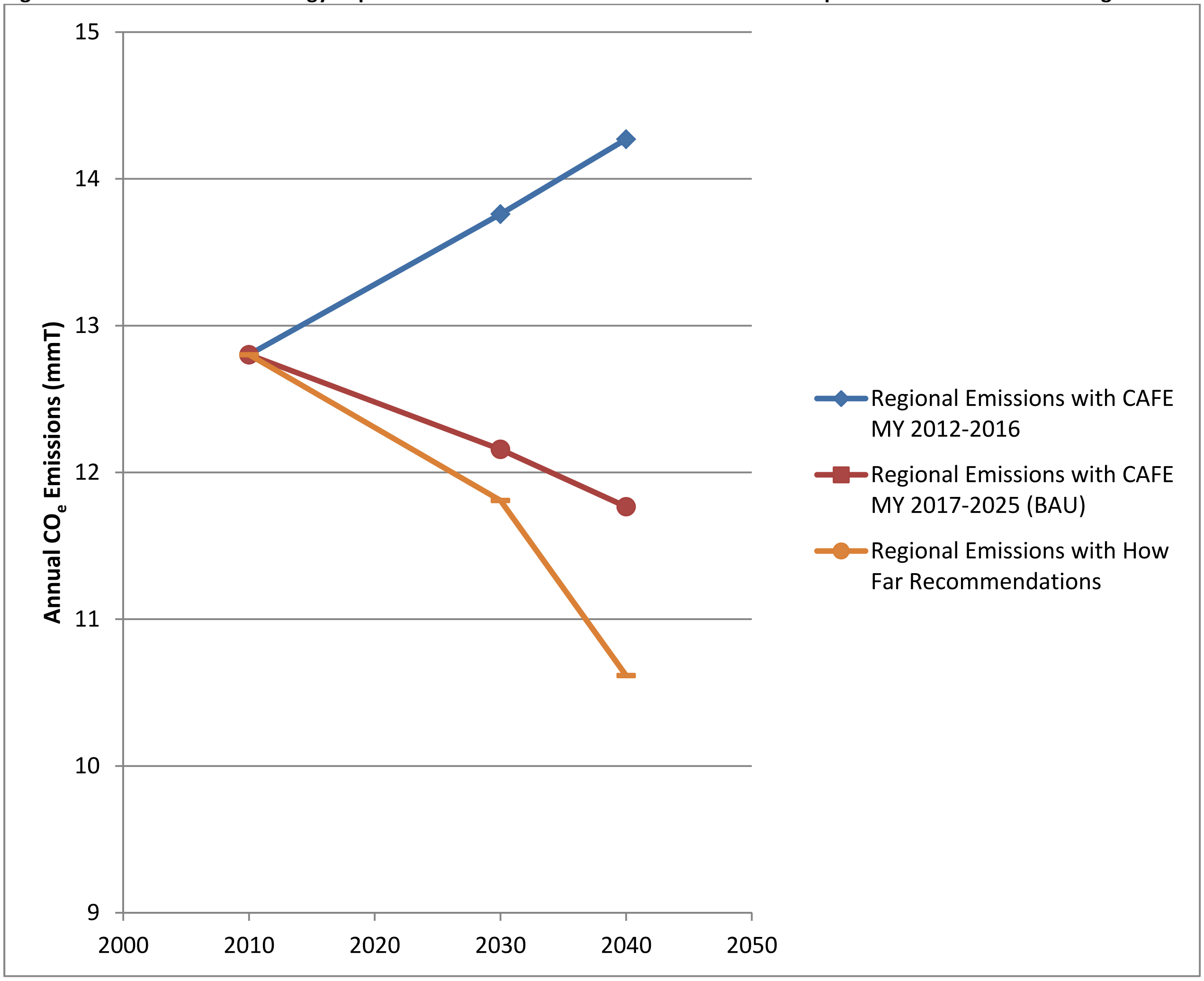
The following list of transportation emission reduction measures was developed directly as a result of Oversight Committee analysis of both the expected contributions of each TERM in reducing air pollution emissions and the various costs and feasibility factors. Beside each recommended TERM is a potential action as a next step in implementing that measure.

Table 1. Oversight Committee Recommended TERMs and Related Actions

Measure	Potential Action
Post 2025 CAFE standard (hypothetical)	- Support/promote future national and state programs to improve corporate average fuel economy standards.
Low rolling resistance tires	- Explore the feasibility of a low rolling resistance tire rebate pilot program (California South Coast Air Management District currently exploring this idea)
Educational program: - Eco-driving - Vehicle use optimization	- Pilot an eco-driving training program to teach drivers how to use less fuel when driving (proposed use in fleets of light duty vehicles); follow up with participants to determine effects - Eco-driving training as part of a drivers' education curriculum in the region - Marketing program to encourage eco-driving, vehicle use optimization, and trip-chaining
Electric vehicles	- Existing state incentives: Measures such as the Maryland excise tax credit of up to $3000 for plug-in electric vehicle purchase; supply equipment rebate - Existing federal incentives: Federal tax credit of up to $7500 for plug-in electric vehicle purchase - Explore local incentives
Employer and household travel demand management	- Further promote rideshare programs throughout the Baltimore region; TeleworkBaltimore.com; Guaranteed Ride Home; Commuter Choice Maryland
Idle reduction for heavy duty trucks	- Provide additional funding to the Maryland Idle Reduction Technology Grant Program (for the existing program, awards are made for 50% of the installed cost of the technology, up to $3000)

The TERMs above reflect the Vehicle Technology Plus/Marketing Scenario described earlier. The graph below depicts the greenhouse gas emission reductions achievable through this scenario, as modeled with EERPAT. It compares Business As Usual (BAU) emissions in 2030 and 2040 with implementation scenario emissions for the Vehicle Technology Plus/Marketing Scenario. Also on the graph are emissions that would have occurred in the absence of the Model Year (MY) 2017-2025 CAFE standard for light duty vehicles.

Figure 17. Recommended Strategy Implementation Results – GHG's from Onroad Transportation in the Baltimore Region



It is important to acknowledge the potentially significant emission reductions expected from programs not assessed in this study, such as the proposed Phase 2 Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium and Heavy-Duty Engines and Vehicles, announced in June 2015. The U.S. EPA and the U.S. DOT National Highway Traffic Safety Administration (NHTSA) have together proposed this new phase of standards. The Phase I standards are being implemented in the 2014 to 2018 models years, and are reducing greenhouse gas emissions and fuel use using off-the-shelf technologies. The Phase II standards would begin implementation with the 2021 model year (2018 for trailers) and phase in to the 2027 model year. They are considered by EPA to be ambitious yet achievable. The standards are performance-based and allow for use of different technologies to achieve compliance. As compared with implementation under the Phase I standard, CO2 emissions and fuel consumption under the Phase II standard for combination tractors, heavy duty pickup trucks and vans, vocational vehicles, and diesel tractor engines are expected to be reduced as follows, under full implementation. (See Table 2.)

Table 2. Benefits of Proposed EPA NHTSA Joint GHG Standards for Medium and Heavy-Duty Engines and Vehicles[5]

Vehicle Type	Percent Reduction (Phase II compared with Phase I)
Combination Tractors	Up to 24%
Trailers	Up to 8% (compared with Model Year 2017 trailer)
Vocational Vehicles	Up to 16%
Heavy-duty Pickup Trucks and Vans	~ 16%
Diesel Tractor Engines	Up to 4%

Conclusion

This study identifies several transportation emission reduction measures (TERMs) that members believe feasible and have potential interest in promoting. The federal fuel economy and Tier 3/low sulfur fuel programs for light-duty vehicles from 2017-2025 can reduce GHG emissions 11.7% in 2030 and 17.6% in 2040. Additionally, the recommended strategies from this report, the Vehicle Technology Plus/Marketing Scenario, estimate a 2.9% reduction in 2030 and a 9.8% reduction in 2040. When combined these strategies may result in up to a 15% and 27% reduction in GHG emissions in 2030 and 2040, respectively.

[5] U.S. Environmental Protection Agency. *Regulatory Announcement: EPA and NHTSA Propose Standards to Reduce Greenhouse Gas Emissions and Improve Fuel Efficiency of Medium- and Heavy-Duty Vehicles for Model Year 2018 and Beyond*. June 2015. EPA-420-F-15-901.