TPB Climate Change Mitigation Study of 2021

Scenario Analysis Findings
Executive Summary for the Final Report

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Executive Summary

Introduction and Purpose

The Metropolitan Washington Council of Governments (COG) set ambitious goals for reducing regional greenhouse gas (GHG) emissions across all sectors:[1] 50% below the 2005 level by 2030 and 80% below the 2005 level by 2050. While these are non-sector-specific regional goals, it is recognized that transportation contributes a large share of regional GHG emissions, with on-road mobile sources contributing about 34% of total regional GHG emissions, based on a recent regional inventory.[2] Consequently, the National Capital Region Transportation Planning Board (TPB), which is the metropolitan planning organization (MPO) for the metropolitan Washington region, is seeking ways to achieve significant reductions of on-road, transportation-related GHG emissions, commensurate with the overall regional goals for GHG reduction.

The purpose of this study is to help answer the question, "What would it take to reduce on-road, transportation-sector GHG emissions by 50% by 2030 and by 80% by 2050, compared to the 2005 level?" This study sought to answer this question through a scenario analysis that involved exploring the estimated GHG impacts of different on-road transportation strategies and combinations of strategies. The study found that none of the simulated scenarios would meet the study's 2030 goal of reducing GHG emissions to 50% below the 2005 level for on-road transportation sources. By contrast, the 2050 goal of reducing on-road transportation-sector GHG emissions to 80% below the 2005 level could be achieved in one scenario with the most aggressive combination of strategies under a reference electricity grid assumption (which accounts for implementation of existing "on the books" policies related to renewable fuels in the power sector). When assuming cleaner electricity grid emissions profiles, however, more scenarios can meet the study's 2050 goal, as long as they incorporate substantial shifts to electric vehicles (EVs). Note that although none of the 10 scenarios meet the study goal of a 50% reduction in on-road transportation-sector GHG emissions by 2030, four of the 10 scenarios were estimated to achieve a large enough GHG reduction to meet the level of on-road transportation sector GHG reductions assumed in COG's 2030 Climate and Energy Action Plan (CEAP).[3] For these four cases, a 50% reduction in regional GHG emissions by 2030 across all sectors could be achieved if other sectors also meet levels of GHG reductions assumed in the 2030 CEAP.

Figure ES-1 illustrates the strategies and pathways for reducing on-road transportation GHG emissions and how they relate to each other. In this study, on-road transportation GHG emissions are defined as tailpipe emissions

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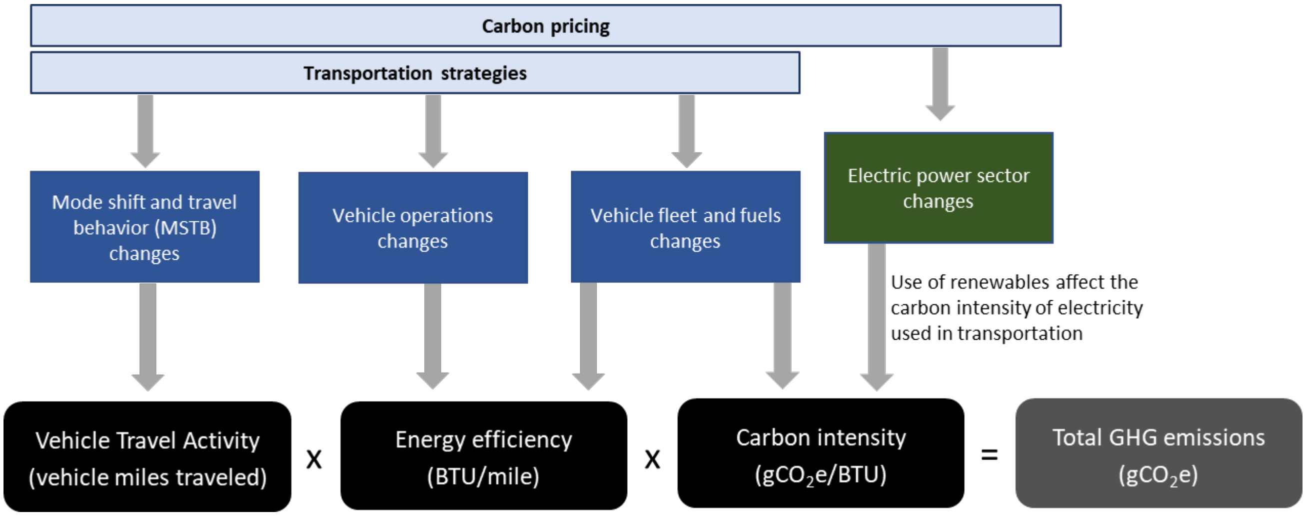
[1] This includes residential and commercial buildings, transportation and mobile emissions, wastewater treatment, agriculture, and solid waste treatment sectors.

[2] "Metropolitan Washington 2030 Climate and Energy Action Plan" (Washington, D.C.: Metropolitan Washington Council of Governments, November 18, 2020), page 50, referencing the Community-Wide Greenhouse Gas Inventory, https://www.mwcog.org/documents/2020/11/18/metropolitan-washington-2030-climate-and-energy-action-plan/

[3] "Metropolitan Washington 2030 Climate and Energy Action Plan" (Washington, D.C.: Metropolitan Washington Council of Governments, November 18, 2020), https://www.mwcog.org/documents/2020/11/18/metropolitan-washington-2030-climate-and-energy-action-plan/

coming directly from combustion of fossil fuels in motor vehicles (called "on-road mobile sources" in most GHG inventories), plus GHG emissions from electricity associated with the operations of EVs. Note that while this study explored vehicle technology shifts to EVs charged through plugging into the electric grid, there are other forms of zero-emission vehicles (ZEVs) when considering only tailpipe emissions, such as hydrogen fuel cell electric vehicles.[4]

Figure ES-1. Strategies and Pathways for Reducing GHG Emissions from Transportation



As shown in Figure ES-1, on-road transportation GHG emissions are a function of vehicle travel, the energy efficiency of vehicles, and the carbon intensity of fuels used. The scenarios explored in this analysis included a broad array of strategies under **three primary pathways** for reducing GHGs from on-road transportation sources:

1) **Vehicle Technologies and Fuels:** Strategies to shift the fleet of motor vehicles to electric vehicles (EVs) and increase the share of lower carbon fuels (e.g., biofuels).

2) **Mode Shift and Travel Behavior (MSTB):** Strategies to reduce motor vehicle travel, typically measured as vehicle miles of travel (VMT), by shifting travel from driving alone to more efficient modes, such as transit, ridesharing, bicycling, and walking; reducing vehicle trip lengths, such as through land use strategies; or reducing trip-making entirely, such as through telework. These strategies primarily affect passenger travel, rather than freight.

3) **Transportation Systems Management and Operations (TSMO):** Strategies to optimize the efficiency of travel by reducing vehicle travel delay and/or encourage more eco-friendly driving patterns.

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[4] For simplicity, this study focused on EVs using the electric grid. Note that this analysis does not account for full fuel-cycle emissions, which would include the upstream emissions associated with the extraction, transport, and distribution of fuels used in transportation, and does not account for other emissions associated with transportation infrastructure development and maintenance, nor production of vehicles. It also does not account for emissions associated with non-road transportation sources, such as rail (e.g., Metrorail, commuter rail, freight rail) or aviation.

The use of renewable fuels in the electric power grid influences how much GHGs are emitted from EVs, and this study explored three different possible cases for future electric power GHG emissions factors, recognizing the movement toward a decarbonized power sector:

1. A Reference Case, which incorporates all "on-the-books" policies, including renewable portfolio standards (RPSs) in the District of Columbia, Maryland, and Virginia.
2. A Modified Reference Case, which is slightly more aggressive than the Reference Case, resulting in a near zero-carbon grid by 2040.
3. A Clean Grid Case, assuming a 100% carbon-free grid by 2035.

As transportation power sources move toward electricity, utility electricity grid emissions become increasingly important in decarbonization of the sector.

Carbon pricing – in the form of a fee on carbon emissions or market-based mechanisms such as cap-and-trade or cap-and-invest programs – has been identified as a potentially promising overarching strategy, but this study did not explicitly analyze carbon pricing. However, carbon pricing may be a mechanism that would help to support other strategies analyzed under this study, such as shifts toward EVs and less-carbon intensive modes of travel.

Study Baseline Forecast

The baseline scenario for this study is based on the VMT and tailpipe GHG emissions projections consistent with TPB's Visualize 2045 Long-Range Transportation Plan (2018) and COG's 2030 CEAP. To calculate 2050 VMT and emissions, the 2045 passenger VMT (also referred to as car and light duty truck VMT) projections were extrapolated to 2050 using estimated population growth rates and forecast reductions in VMT per capita estimated for the period 2030 to 2045, extended to 2050. VMT from light-duty commercial trucks, heavy-duty trucks, and combination trucks was assumed to continue increasing at the same annual rate as the period between 2030 and 2045. Using this approach, a total increase in VMT between 2045 and 2050 of 2.5% was calculated across all vehicle types.

The GHG emissions estimates developed for the performance analysis of past TPB's long-range transportation plans, including Visualize 2045, include only tailpipe emissions, while this study also accounts for the emissions generated to charge EVs. The baseline estimates shown in Figure ES-2 are a sum of the tailpipe emissions plus electricity emissions, calculated based on the National Renewable Energy Lab (NREL) reference case penetration of EVs.[5]

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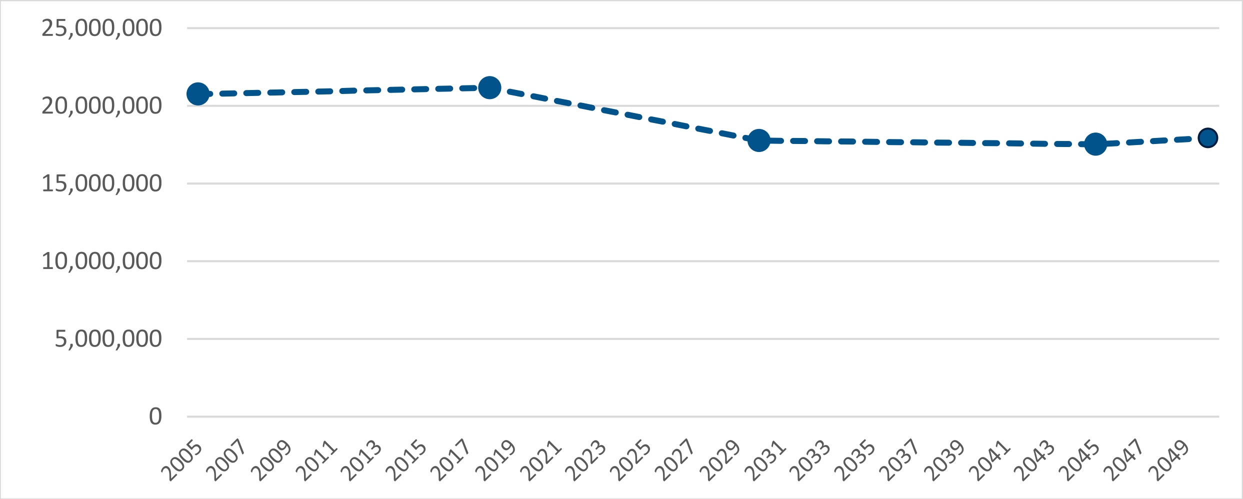
[5] NREL. (2018). Electrification Futures Study: Scenarios of Electric Technology Adoption and Power Consumption for the United States.

Figure ES-2. Baseline On-Road GHG Emissions ($MTCO_2e$)



The baseline GHG emissions totals show lower total emissions in 2030 and 2050 compared to 2005, approximately 14% lower in both cases. This is because the projected improvements in fuel economy, leading to decreased emissions per mile, are predicted to offset increases in VMT. Note that these reductions in on-road transportation GHG emissions are estimated to occur over a time when population in the region is projected to increase about 25% (to 6.25 million) by 2030 and about 43% by 2050 (to 7.15 million) compared to the 2005 level (4.76 million).

It is important to note that the baseline assumptions and subsequent scenario analyses are based on travel behavior and estimated behavioral responses to policy implementations that were observed prior to the COVID-19 global pandemic. With this consideration in mind, both the baseline forecast and the estimates of GHG impacts of scenarios in this study should be interpreted recognizing uncertainties about future travel behavior.

Scenario Approach

The study involved **two different types of analysis**:

1) Three "top-down" scenarios were developed and analyzed to identify what level of vehicle miles traveled (VMT) would need to be reduced, or what level of EV adoption would be needed, to meet the 50% and 80% reduction goals by 2030 and 2050, respectively; and
2) Ten "bottom-up" scenarios were developed to assess how much GHG reduction might be expected with implementation of different sets of strategies in order to determine which scenarios could meet the 2030 and 2050 GHG reduction goals.

The **"top-down" analysis** explored three key questions: 1) What level of VMT reduction would be needed to meet the regional 2030 and 2050 goals if VMT reduction were the sole focus of efforts? 2) What level of electric vehicle (EV) adoption would be needed to meet the regional 2030 and 2050 goals if vehicle technology were the sole focus of efforts? 3) What level of VMT reduction would be needed to meet the regional 2030 goal assuming vehicle technology assumptions in COG's 2030 Climate and Energy Action Plan (2030 CEAP)?

The **"bottom-up" analysis** involved development and analysis of ten scenarios: six focused on individual pathways (e.g., vehicle technologies and fuels alone, MSTB alone, or TSMO alone), and four involving combinations of the other scenarios. Table ES-1 lists the ten scenarios that were explored. Each scenario was defined to incorporate an aggressive set of strategies or assumptions about changes in the vehicle fleet, fuels, or travel behavior (e.g., levels of telework) corresponding with aggressive strategy implementation. While each scenario was defined to be potentially feasible, they were generally designed with high-end assumptions (both in the base scenarios and amplified scenarios), without regard to political feasibility, and some with very optimistic assumptions about shifts in technology.

Table ES-1. Ten Scenarios Studied in "Bottom-Up" Analysis

Pathway	Scenario	Key Components / Assumptions
Vehicle Technology (VT) and Fuels	VT.1: Vehicle Technology and Fuels Improvement Scenario	Shifts to EVs (50% of new light-duty [LD] vehicle sales are EVs in 2030, with 100% by 2040; 30% of new medium/heavy-duty [M/HD] truck sales are EVs in 2030, with 100% by 2050; 50% of buses on the road are EVs in 2030, 100% in 2050; biodiesel/renewable diesel makes up 10% of diesel fuel use in 2030 and 20% in 2050)
	VT.2: Amplified Vehicle Technology and Fuels Improvement Scenario	More aggressive shifts to EVs: 100% of new LD vehicle sales are EVs in 2030; 50% of new M/HD truck sales are EVs in 2030, with 100% by 2040; 100% of buses on the road are EVs by 2030; biodiesel/renewable diesel makes up 20% of diesel fuel use in 2030 and 30% in 2050
Mode Shift and Travel Behavior (MSBT)	MS.1: Mode Shift Scenario	Land use changes focused on redistribution of future growth to activity centers and areas better served by transit across jurisdictions and 77,000 new households in the region by 2030 and 126,000 new households in the region by 2050 to support jobs-housing balance; enhanced bike/pedestrian/micromobility environment; transit fares reduced 50% by 2030 and 75% in 2050; all workplace parking in activity centers priced by 2030; transit enhancements (10% reduction in transit travel time by 2030 and 20% by 2050); 25% telework
	MS.2: Mode Shift Scenario + Road Pricing	Same strategies as MS.1, plus DC cordon pricing of $10 to enter downtown, and VMT-fees of $0.05 per mile in 2030 and $0.10 per mile in 2050
	MS.3: Amplified Mode Shift Scenario + Road Pricing	MS.2 with amplified strategies, including free transit; all workplace parking priced by 2050 (not just in activity centers), further transit enhancements (15% reduction in transit travel time by 2030 and 30% by 2050); 40% telework4F[6]
Transportation Systems Management & Operations (TSMO)	TSMO: Operations Improvement Scenario	Optimized operations through intelligent transportation systems (ITS) including ramp metering, incident management, active signal control, and active transportation demand management; assumed operational benefits from connected/automated vehicles (CAVs) in 2050
Combined Pathways	COMBO.1: Combined Scenario	VT.1 + MS.1 + TSMO
	COMBO.2: Combined Scenario with More Aggressive Technology Emphasis	VT.2 + MS.1 + TSMO
	COMBO.3: Combined Scenario with More Aggressive Mode Shift Emphasis	VT.1 + MS.3 + TSMO
	COMBO.4: Combined Scenario with Aggressive Actions Across All Pathways and Shared CAV Future	VT.2 + MS.3 + TSMO + shared CAV assumptions

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[6] Since it is estimated that about 50% of jobs in the metropolitan Washington region are telework capable, 40% telework implies that 80% of employees who work in telework-capable jobs would be teleworking on a typical workday, which is a very aggressive assumption.

Scenario Analysis Results

Top-Down Analysis: What would it take to reach the GHG reduction goals solely through VMT reduction or EV adoption?

The "top-down" analysis of what it would take to reach the 2030 or 2050 goals highlights how challenging it would be to reach the goals within the on-road transportation sector, particularly for 2030, through either VMT reduction alone or shifts to EVs alone. The analysis also highlights the challenge of meeting the 2030 goal even with vehicle technology assumptions in the 2030 CEAP. To meet the 50% emissions reduction goal by 2030 through VMT reduction alone, passenger VMT would need to drop by an estimated 57% from the 2018 level. This is an unprecedented level of VMT reduction that would mean traffic volumes in the region would need to shrink to the level seen at the height of the COVID-19 stay-at-home orders during April 2020 and not rebound, despite a forecasted 12% increase in regional population between 2018 and 2030.

Similarly, meeting the 2030 goal is extremely ambitious with vehicle technology improvements alone. To achieve the 50% emissions reduction goal by 2030 using vehicle technology alone, approximately 75% of vehicles on the road would need to be EVs by 2030 using "reference grid case" electric power assumptions (which assumes increases in use of renewable fuels consistent with existing policies) and about 48% would need to be EVs assuming a "clean grid case." These levels appear extremely difficult, given the length of time people generally hold onto vehicles, and would likely require immediate shifts to all new vehicles sold as EVs, combined with aggressive incentives to accelerate vehicle turnover and/or carbon or fuel pricing. The small number of years between today and 2030 means there is very limited time to achieve the large shifts in fleet technology that would be required to meet the goal for 2030.

Looking at combining technology enhancements with VMT reduction still provides an intense challenge for meeting the 2030 goal within the on-road transportation sector. Even with the 2030 CEAP technology assumptions,[8] passenger VMT would need to drop by about 49% from the 2018 level, which is an unprecedented level of VMT reduction over a sustained time and would likely require that vehicles be subject to high levels of pricing (road, parking, and/or fuel), nearly complete telework, and restrictions on driving. There simply is too little time for the vehicle fleet to turn over with enough EVs to allow for a more moderate level of reduction in VMT, particularly given that medium- and heavy-duty commercial vehicles made up about one-quarter of on-road transportation GHG emissions in 2018, and that there is limited potential to reduce VMT by commercial/freight vehicles, due to the necessity of freight and goods movement, combined with relatively limited opportunities to shift these vehicles to EVs on a broad scale in the near-term.

Challenges remain for meeting the 2050 goal. Based on the ICF analysis, it would not be possible to attain the 80% reduction goal through passenger VMT reduction alone since estimated medium- and heavy-duty vehicle

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[7] See, for example, Brad Plumer, Nadja Popovich, and Blacki Migliozzi, "Electric Cars Are Coming. How Long Until They Rule the Road?," *The New York Times*, March 10, 2021, sec. Climate, https://www.nytimes.com/interactive/2021/03/10/climate/electric-vehicle-fleet-turnover.html

[8] The 2030 CEAP assumed that in 2030, 34% of light duty passenger car VMT, 17% of light duty passenger truck VMT, 34% of transit bus VMT, 7% of medium-duty truck VMT, and 6% of heavy-duty truck VMT would be driven by EVs.

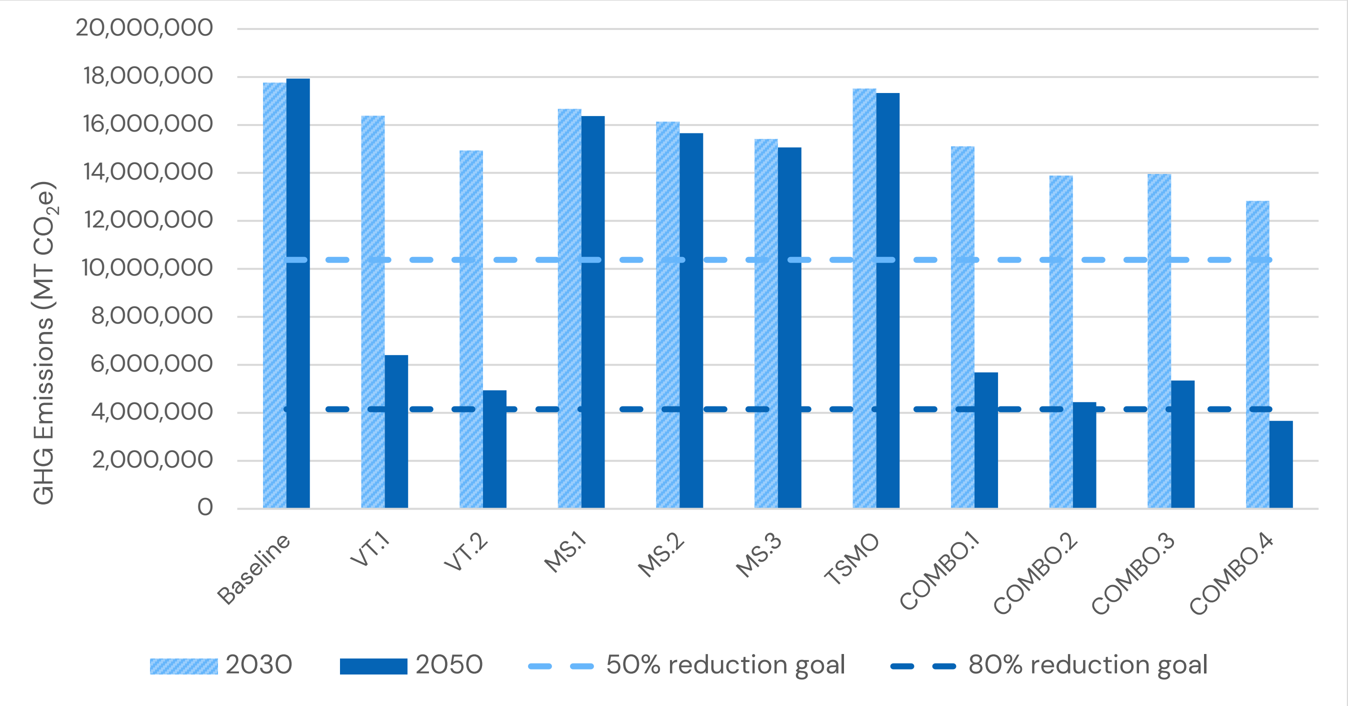
emissions exceed the goal level in 2050. Similarly, the 2050 goal cannot be achieved even if all vehicles were converted to EVs under "reference case" assumptions for electricity carbon intensity. However, the goal could be met with a completely carbon-free electric grid if about 79% of vehicles on the road were EVs in 2050. These findings highlight the importance of large-scale shifts to EVs (zero emissions from the tailpipe) combined with a clean electric power grid in order to decarbonize the on-road transportation sector.

Bottom-Up Analysis: Which scenarios achieve the goals?

In short, none of the simulated scenarios meet the study's 2030 goal of reducing on-road transportation-sector GHG emissions to 50% below 2005 levels, and only one scenario provides enough emissions reductions to meet the study's 2050 goal of 80% below 2005 levels under the "reference case" electric grid. When conducting the analysis with cleaner electricity grid emissions profiles, more scenarios were predicted to meet the 2050 goal of 80% below 2005 levels; however, still no scenarios were able to meet the study's 2030 goal of 50% below 2005 levels. This finding is consistent with results of the "top-down" analysis, which showed the challenge of meeting the 2030 goal within the on-road transportation sector. However, as noted earlier, four of the 10 scenarios were estimated to achieve a large enough reduction in on-road transportation-sector GHG emissions to match the level assumed in the 2030 CEAP, suggesting that the region could meet its overall multisector goal for 2030 if other sectors also yield reductions in GHGs at levels assumed in the CEAP.

The results of the "bottom up" scenario analysis conducted under the "reference grid" case are shown in Figure ES-3. As expected, the scenarios that combine multiple types of strategies (COMBO scenarios) are more effective than those that simply focus on individual strategies.

Figure ES-3. On-Road Transportation GHG Emissions Estimated for the Reference Grid Case



Note: The Reference Grid Case is based on current "on-the-books" power sector policies in the District of Columbia, Maryland, and Virginia, and represents a reduction in carbon intensity compared to the current electric power grid.

Table ES-2 shows the full result of the analysis of each of the ten bottom-up scenarios (and the baseline scenario) performed under the different electric grid scenarios. In the case of a clean electric grid, which assumes 100% carbon free grid by 2035, the GHG emissions from the vehicle technology and fuels improvement scenarios are reduced further since there are no off-setting electricity emissions from EVs. Under these assumptions, both the VT scenarios meet the 80% reduction goal. Under the clean grid assumption, MSTB strategies have limited additional effects since most passenger vehicles are assumed to be 100% clean and TSMO enhancements generate small additional benefits for the remaining largely medium- and heavy-duty vehicles that are not EVs.

The on-road transportation GHG emission reductions across all scenarios range from 16% (TSMO) to 38% (COMBO.4) in 2030 (note that, in the baseline forecast for this study, on-road transportation GHG emissions are estimated to be 14% below the 2005 level in 2030). As mentioned above, COG's 50% reduction goal is a multisector goal for the region, with assumed contributions from residential and commercial buildings, waste, aviation, and other sectors. Several of the combination scenarios provide estimated on-road GHG emission reductions at levels assumed in COG's multisector 2030 CEAP, suggesting that the multisector goal could potentially be met with these levels of on-road transportation GHG reductions if other sectors also implement aggressive strategies. In Table ES-2, cells with values that meet the study's GHG reduction goals are shaded light green, and table cells with values that meet the level of on-road transportation sector GHG emissions reductions assumed in the 2030 CEAP are shaded in yellow.

In 2050, only the most aggressive scenario with a combination of the most aggressive strategies across each pathway – COMBO.4 – provides enough emission reductions to reach the 80% reduction goal, assuming the reference electric grid case. Among the individual scenarios, the amplified vehicle technology and fuels improvement scenario – VT.2 – gets the closest to the 2050 goals by providing a 76% GHG emission reduction, demonstrating the importance of vehicle technology improvements. Under the VT.2 scenario, by 2050, nearly all light-duty vehicles are estimated to be EVs, and over three-quarters of all medium- and heavy-duty vehicles are EVs, resulting in a dramatic (approximately 93%) reduction in on-road tailpipe and evaporative emissions. While the reference grid case assumes a substantial increase in renewable electricity consistent with existing "on-the-books" standards, the offsetting electricity-related emissions mean that even this level of conversion to EVs is not enough to meet the goal. While the emissions benefit for every VMT reduced is much lower in 2050 than today, the most aggressive scenario for VMT reduction is also needed in combination with the technology improvements to meet the goal.

Table ES-2. Summary of GHG Reductions Estimated for All Transportation Scenarios Under all Electric Grid Cases (% Reductions from 2005 Level)

Scenario	Key Components	2030			2050		
		Ref. Grid	Mod. Grid	Clean Grid	Ref. Grid	Mod. Grid	Clean Grid
Baseline	Projects, programs, and plans in the Visualize 2045 plan; base assumptions for vehicle technology; population growth through 2050	-14%	-15%	-15%	-14%	-14%	-15%
VT.1	50% of new LD vehicle sales are EVs in 2030, with 100% by 2040; 30% of new M/HD truck sales are EVs in 2030, with 100% by 2050; 50% of buses on the road are EVs in 2030, 100% in 2050; biofuels/renewable diesel make up 10% of diesel fuel use in 2030 and 20% in 2050	-21%	-21%	-24%	-69%	-75%	-84%
VT.2	100% of new LD vehicle sales are EVs in 2030; 50% of new M/HD truck sales are EVs in 2030, with 100% by 2040; 100% of buses on the road are EVs by 2030; biofuels/renewable diesel make up 20% of diesel fuel use in 2030 and 30% in 2050	-28%	-29%	-34%	-76%	-83%	-93%
MS.1	Land use changes, including new housing in the region; transit fares reduced 50% by 2030 and 75% in 2050; all workplace parking in activity centers priced by 2030; 10% reduction in transit travel time by 2030 and 20% by 2050; 25% telework; increased bike/ped/mobility	-20%	-20%	-20%	-21%	-21%	-22%
MS.2	MS.1 + DC core cordon pricing + VMT-fees of $0.05 per mile in 2030 and $0.10 per mile in 2050	-22%	-22%	-23%	-25%	-25%	-25%
MS.3	MS.2 with amplified strategies, including free transit; all workplace parking priced by 2050 (not just in activity centers), 15% reduction in transit travel time by 2030 and 30% by 2050; 40% telework	-26%	-26%	-26%	-27%	-28%	-28%
TSMO	Optimized ITS/TSMO, with benefits from connected/automated vehicles (CAVs) by 2050	-16%	-16%	-17%	-16%	-17%	-18%
COMBO.1	Combined scenario: VT.1+ MS.1 + TSMO	-27%	-28%	-30%	-73%	-78%	-86%
COMBO.2	Combined scenario with more aggressive technology emphasis: VT.2 + MS.1 + TSMO	-33%	-34%	-38%	-79%	-85%	-94%
COMBO.3	Combined scenario with more aggressive mode shift emphasis: VT.1 + MS.3 + TSMO	-33%	-33%	-36%	-74%	-79%	-87%
COMBO.4	Combined scenario with aggressive actions across all pathways and shared CAV future: VT.2+MS.3+TSMO+additional sharing	-38%	-39%	-43%	-82%	-87%	-95%

Note: Cells shaded in green highlight figures that meet the study's goal level of emissions reductions. Those shaded in yellow meet the level of on-road transportation GHG reductions assumed in the 2030 CEAP.

Implications and Policy Considerations

The scenario analysis results emphasize the difficulty of meeting the study's 2030 goal of reducing on-road, transportation-sector GHG emissions by 50%. The results, however, suggest that combining vehicle technology, MSTB, and TSMO strategies together results in the largest emissions benefits, and could achieve levels of emissions benefits that are consistent with assumptions in the 2030 CEAP at a level that would be needed to meet the overall regional goal, if other sectors contribute at levels consistent with the estimates in the 2030 CEAP. The study suggests that both rapid shifts toward lower emissions vehicles/fuels and vehicle travel reduction strategies are needed to achieve the near-term goal. **By 2050, shifts to EVs and a clean electric grid are expected to be the most important factors in meeting the 80% reduction goal**, and MSTB strategies will be less important in meeting the goals if the vehicle fleet becomes nearly carbon-free. That said, MSTB strategies likely will play a valuable role over the intervening years and would be helpful in case the vehicle fleet does not convert to zero-emissions as quickly; MSTB strategies could also help to reduce the potential that shifting to EVs and/or connected and automated vehicles (CAVs) might encourage more vehicle travel if the cost or burden of driving is decreased.

Many of the transportation strategies explored in the scenarios have co-benefits for the region, including improving air quality, providing more travel options, and improving the reliability and safety of the transportation system. In particular, many MSTB strategies, including land use efforts to bring jobs and housing closer together, transit enhancements, free or reduced-cost transit, and bicycle/pedestrian/micromobility enhancements also offer significant potential to enhance equity by supporting more equitable access to jobs and other opportunities across racial, ethnic, and income levels. At the same time, some potentially effective MSTB strategies such as road pricing may be regressive, unless designed appropriately to consider equity, by taking factors such as household income into account and using funds for transit and equity-focused services. Telework is not a viable option for workers in many lower-income service industries and may have adverse impacts on businesses with low-income workers, such as restaurants and some services, particularly in downtown areas.

In moving forward, it will be important for the region's policy makers to consider the roles of regional, state, and federal government policy, as well as the private sector. Intergovernmental cooperation and working together with the private sector will likely be critical to achieving the goals, as spurring adoption of EV technology and clean energy is so vital in this process, and land use and telework policies are dependent on decisions by the private sector and employers. Policy makers will need to consider the costs, revenue implications, benefits, and equity implications of policy actions, and consider how transportation investments can best move toward GHG reduction goals while supporting the region's accessibility, mobility, safety, economic, community, and other environmental goals.

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