National Capital Region
Transportation Planning Board

TPB Technical Committee
June 3, 2022
Item 4

MEMORANDUM

TO: Transportation Planning Board

FROM: Kanti Srikanth, TPB Staff Director

SUBJECT: Transportation Sector-Specific Climate Change Goals and Strategies for TPB's Plan and Planning Process

DATE: May 12, 2022

This memorandum provides the status of the TPB's ongoing discussions and efforts to establish a set of on-road, transportation-sector-specific, climate change goals and strategies that could be added to the policy element of TPB's long-range transportation plan, Visualize 2045, and to the TPB's transportation planning priorities. The information provides the context for the second work session of the TPB on the topic, which will take place on May 18, 2022. The expectation for the work session is to reach agreement on recommending a set of greenhouse gas (GHG) reduction goals and strategies at the May 18 TPB meeting, which, in turn, could be considered for adoption at the TPB's June 15, 2022 meeting.

BACKGROUND

The TPB has identified the following two elements for a climate change mitigation planning policy to consider adding to Visualize 2045 and the TPB's overall planning process:

1. A short- and long-term goal to reduce GHG emissions in the on-road transportation sector.
2. A set of multi-pathway, multi-modal transportation strategies that reduce on-road GHG emissions.

The TPB conducted, with consultant assistance, a technical study, the 2021 Climate Change Mitigation Study (CCMS),[1] which examined the GHG reduction potential of a set of on-road GHG reduction strategies, grouped into ten scenarios, to provide information to develop the above climate change mitigation policy elements. The TPB conducted a survey of its member jurisdictions/agencies, between February and April, to determine the current collective readiness of the TPB to adopt short- and long-term on-road GHG reduction goals and to endorse a set of on-road GHG reduction strategies at this time. Thirty-one of the TPB's 39 voting members (79%) completed the survey.

On April 20, 2022, the TPB held a special work session to review the results of the TPB member climate survey and determine the collective readiness to act on the two climate change mitigation elements. A second work session has been scheduled for May 18 to continue the discussion from April 20 and develop recommendations on actions the TPB could take on climate change mitigation

[1] ICF, Fehr & Peers, and Gallop Corporation, "TPB Climate Change Mitigation Study of 2021: Scenario Analysis Findings," Final Report (National Capital Region Transportation Planning Board, Metropolitan Washington Council of Governments, January 7, 2022), https://www.mwcog.org/tpb-climate-change-mitigation-study-of-2021/.

as part of its 2022 update of its long-range transportation plan, Visualize 2045. In May, the TPB's on-call consultant conducted an additional analysis of GHG reduction potential, which included two new scenarios [2] (the consultant report, minus its appendix, has been attached to this end of this memo):

- The seven GHG reduction strategies that appeared to have TPB support, using levels of implementation that were assumed in the TPB member survey.[3] (referred to as COMBO.6 in the consultant study)
- The seven GHG reduction strategies that appeared to have TPB support, using more modest levels of implementation than those assumed in the TPB member survey. (referred to as COMBO.5 in the consultant study).

One important distinction to make about both the CCMS and the May analysis: Both analyses estimated tailpipe GHG emissions from motor vehicles and electricity-generation emissions associated with the electricity that would be used by electric vehicles (EVs). By contrast, most other studies and initiatives focus solely on vehicle tailpipe GHG emissions. This means that one must be careful when comparing goals across different studies. For example, Maryland's 2016 Greenhouse Gas Emissions Reduction Act (GGRA of 2016) requires the state to achieve a minimum of a 40% reduction in statewide GHG emissions from 2006 levels by 2030 (sometimes referred to as the "40 by 30" goal), but the 2030 GGRA Plan does not mention inclusion of electricity used by EVs, so it appears to be counting only tailpipe emissions, which, again, is a common practice.[4] In this sense, the goal values calculated by the CCMS and the May analysis are more ambitious than many other studies. Thus, when comparing the on-road transportation emission reduction amounts for the goals and from the strategies being considered by the TPB with that of other entities, it is important to note this difference.

STATUS

The findings from the TPB member climate survey (including comments provided as part of the survey) and discussions during the April 20 TPB work session on the two climate change mitigation elements are noted below. The purpose of the May 18 TPB work session is to continue discussions aimed at developing an agreement on recommendations for climate change mitigation actions the TPB could take at its June 15 meeting as part of the 2022 update of Visualize 2045.

1. **Adopting short- and long-term GHG reduction goals for the on-road transportation sector**
   65% of the survey respondents felt that the TPB should adopt GHG reduction goals for the on-road sector for 2030 and 2050. However, based on survey comments, there was less agreement on the numerical values that should be tied to those goals, particularly for 2030. TPB member preferences regarding the level of GHG reduction, as noted from the comments in the survey and April 2022 work session discussion, have been grouped into three categories in the next section.

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[2] ICF, Fehr & Peers, and Gallop Corporation, "TPB Climate Change Mitigation Study of 2021: Additional Transportation Scenarios Analysis: TPB Survey Identified Scenarios," Draft Report (National Capital Region Transportation Planning Board, Metropolitan Washington Council of Governments, May 12, 2022).
[3] See, for example, Kanti Srikanth, "Climate Change Mitigation Planning Elements: Preliminary Proposal, For Consideration," 5, https://www.mwcog.org/events/2022/4/20/tpb-climate-work-session/.
[4] "Greenhouse Gas Emissions Reduction Act: 2030 GGRA Plan" (Maryland Department of the Environment, February 19, 2021), i, https://mde.maryland.gov/programs/Air/ClimateChange/Pages/Greenhouse-Gas-Emissions-Reduction-Act-(GGRA)-Plan.aspx.

2. **A set of on-road GHG reduction strategies as planning priorities for the TPB**
   There was general agreement that several of the on-road GHG reduction strategies featured in both the survey and the CCMS could be endorsed at this time (between 45% and 90% approval, depending on the strategy, according to survey respondents), with other strategies meriting a more comprehensive examination in the future (between 43% and 73% of the survey respondents indicating that further study was needed). The two sets of strategies are listed in the next section. Based on survey results, there also was a sense that the levels of implementation for some strategies were not practicable and ought to be reconsidered.

EXPECTATIONS FOR MAY 18 WORK SESSION DISCUSSIONS

Given that 1) the TPB is scheduled to adopt the 2022 update of Visualize 2045 at its June 15, 2022 meeting and 2) the TPB's previously stated interest in adding climate change mitigation elements to Visualize 2045, the primary purpose of this work session is to develop recommendations to the full board on: 1) adopting short- and long-term GHG reduction goals for the on-road sector and 2) finalizing the on-road GHG reduction strategies the TPB would adopt as planning priorities at this time. The intent is that any recommendations from the May 18 work session, held in the morning, will be reported to the full board during its May 18 meeting, held in the afternoon, for formal action at the TPB's June 15 meeting.

I. Adopting short- and long-term GHG reduction goals for the on-road transportation sector

Responses from the TPB member climate survey and discussions from the April 20 work session support the TPB adopting GHG reduction goals for the on-road sector. The survey and the discussions, however, have called for further discussion on the level of GHG reduction goals for the year 2030, noting that the 2030 goal of a 50% reduction in GHG emissions compared to 2005 levels is unrealistic.[5]

Based on comments from the TPB member survey and work session and board meeting discussions, staff has identified three potential GHG reduction levels for consideration. The three options are based on the TPB's CCMS, recent staff research of other comparable MPOs,[6] and a supplemental (May) analysis of two additional scenarios by the consultant, ICF.

Option A: Aspirational goals that are identical to region's overall (non-sector-specific) goals

- 2030: 50% below 2005 levels (2030 Climate and Energy Action Plan, or CEAP)[7]

[5] The 2021 CCMS found that none of the ten scenarios analyzed would be capable of attaining a 50% reduction in transportation-sector GHG emissions by 2030, compared to 2005 levels, and these ten scenarios contained GHG reduction strategies with very aggressive levels of implementation.
[6] Srikanth, Kanti, Erin Morrow, Dusan Vuksan, and Mark Moran. Memorandum to National Capital Region Transportation Planning Board. "Research on Peer MPO On-Road Transportation Greenhouse Gas (GHG) Reduction Targets." Memorandum, April 27, 2022. https://www.mwcog.org/events/2022/5/18/tpb-climate-work-session/
[7] "Metropolitan Washington 2030 Climate and Energy Action Plan" (Washington, D.C.: Metropolitan Washington Council of Governments, November 18, 2020),

- 2050: 80% below 2005 levels (2008 Climate Change Report)[8]

The means of achieving the above level of reductions are unclear since they have not been demonstrated in any study. The TPB's CCMS finds that a 50% reduction for 2030 would be unattainable, even with the most aggressive VMT reductions and clean vehicle fleet assumptions supported by a fully clean electric grid.

Option B: Ambitious and data driven goals, with the 2030 goal consistent with underlying assumptions for the transportation sector from the region's 2030 CEAP.[9]

- 2030: 32% below 2005 levels [10]
- 2050: 80% below 2005 levels

This option would include reduction levels, derived from the TPB's CCMS, which could be attained, in theory, with the most aggressive and unprecedented clean fuel and aggressive land use, teleworking, transit fares and travel pricing strategies to reduce VMT, without the requirement of a reliance on a fully clean electric grid (but a "reference case" electrical grid is still assumed. See footnote 11 for details).

Option C: Pragmatic goals, based on GHG reduction strategies that appear to be supported by the TPB in the member survey, at either the levels of implementation assumed in the survey or more moderate levels of implementation. These values are based on a supplemental analysis by the consultant (documentation in progress):

- 2030:
  - 29% below 2005 levels (Seven strategies supported by TPB at levels of implementation listed in the survey) **OR**
  - 23% below 2005 levels (Seven strategies supported by TPB at more modest levels of implementation than those listed in the survey)
- 2050: 80% below 2005 levels

For Option C, the levels of GHG reductions were estimated based on the May consultant analysis of the seven on-road GHG reduction strategies that appeared to have member support in the survey and on discussions at the April 20 work session. The first goal level for 2030 (29%) corresponds to the levels of implementation noted in the survey for a

https://www.mwcog.org/documents/2020/11/18/metropolitan-washington-2030-climate-and-energy-action-plan/.

[8] Climate Change Steering Committee for the Metropolitan Washington Council of Governments Board of Directors, "National Capital Region Climate Change Report," Final Report (Washington, D.C.: Metropolitan Washington Council of Governments, November 12, 2008), https://www.mwcog.org/file.aspx?A=R8%2FO7kehmpgZBhW7Z%2F6R7fLiQ4aIY28XTL33ZwEgoJo%3D.

[9] The purpose of the scenario developed for the 2030 CEAP was to estimate the technical potential for the region to achieve the region's total 2030 GHG reduction goal of 50% below 2005 levels. The CEAP was not intended to delineate sector-specific goals.

[10] COMBO.2 from the CCMS was estimated to achieve a 33% reduction in GHG emissions, assuming a reference case for the electrical grid, keeping in mind that the CCMS included GHG emissions due to electricity used to operate electrical vehicles (EVs). The strategies in COMBO.2 are more far-reaching than the seven strategies that, based on the TPB member survey, appear to have support from a majority of TPB members.

reference electric grid.[11] With a 100% clean electric grid by 2035, this goal value could be 35%. The second goal level for 2030 (23%) corresponds to more modest levels of implementation than those noted in the survey. It is also for a reference electric grid. With a 100% clean electric grid, this goal value could be 26%. Also note that although we are referring to the Option C 2030 goal values as "pragmatic," it will still be challenging to achieve these goals in only eight years.

II. Endorsing a set of on-road GHG reducing strategies

The TPB member survey and discussions from the April 20 work session supports the TPB adopting the following seven GHG reduction strategies for the on-road sector. Comments made in the member survey and during discussions, however, had questioned if the level of implementation for some of the seven strategies were too high.

The seven on-road GHG reducing strategies with a plurality or majority support of members are listed below at the levels identified in TPB's member survey and also, for some strategies, at a more modest level of implementation (reflecting the May consultant analysis):

1. Improve walk and bicycle access to all TPB identified high-capacity transit stations (survey question C9). The implicit assumption for the CCMS was that the access improvements would be done at all the high-capacity transit stations identified by the TPB by 2030. The consultant's May analysis tested both a 50% increase in bicycle usage and also a lower 25% increase in bicycle usage. However, the analysis found that there was no meaningful difference in the amount of GHG reduction between the two levels of outcomes.

2. Complete the TPB's National Capital Trail Network to (NCTN) to increase the walk and bike mode of travel (survey question C10). The implicit assumption for the CCMS was that the unbuilt portion of the NCTN (55%) would be completed by 2030. No changes to this assumption were analyzed.

3. Implement Transportation Systems Management and Operations (TSMO) measures at all eligible locations, including advanced ramp metering, enhanced incident management systems, active signal controls, and transit bus priority treatments (survey question C14). In the CCMS, this strategy included both TSMO and some level of connected and automated vehicle (CAV) technology to be implemented by 2050. For the May consultant analysis, the consultant tested two levels of implementation: 1) TSMO and CAV; 2) TSMO only. However, the analysis found that there was no meaningful difference in the amount of GHG reduction between the two levels of

[11] As noted on pp. 5-6 of the CCMS, a "Reference Case" incorporates all "on-the-books" policies, including renewable portfolio standards (RPSs) in the District of Columbia, Maryland, and Virginia. These policies include those defined in Virginia's Clean Economic Act (100% clean power by 2045, assuming Dominion as the dominant utility), Maryland's Renewable Portfolio Standard (50% renewable energy by 2030) and DC's Renewable Portfolio Standard (100% renewable energy by 2032). The CCMS notes that "the Reference Case assumes considerable reductions in the carbon intensity of electricity compared to current electric grid conditions."

implementation.

4. Develop an electric vehicle (EV) charging network in the region (survey question C2).[12] In the CCMS, this strategy was considered an enabling action for the clean fuel vehicle strategy C1. Thus, no GHG emissions amounts were estimated or attributed to this EV charging network strategy.

5. Convert light-, medium- and heavy-duty vehicles and buses to clean fuel, e.g., electric or hydrogen (survey question C1). There were several comments noting that the level of implementation, especially by 2030, identified in the TPB member survey was very ambitious and potentially unrealistic. The TPB consultant therefore tested a more modest level of implementation. This is the most effective strategy of the seven supported strategies identified in the TPB member survey, so most of the variation in 2030 GHG reduction goal values in the previous section (Options A, B, and C) is due to the variation of the levels of implementation of this strategy.

   Assumed levels of implementation for 2030 in TPB survey:
   100% of new light-duty vehicles sold;
   50% of new medium/heavy-duty trucks, and
   100% of all buses on the road.

   Alternate 2030 option – Reduced yet ambitious levels of implementation:
   50% of new light-duty vehicles sold;
   30% of new medium/heavy-duty trucks, and
   50% of all buses on the road.

6. Add additional housing units, above current COG Cooperative forecasts (Round 9.2) near TPB-identified high-capacity transit (HCT) stations and in COG's regional activity centers (RAC) (survey question C3). The CCMS and the May analysis assumed 77,000 additional housing units by 2030 and 126,000 units by 2050. Compared to adding housing outside the region, which tends to lead to long commute trips, additional housing inside the region, particularly around transit and activity centers, should help reduce commute-related vehicle miles travelled (VMT). However, these added households will also result in new non-commute VMT. Although the May consultant analysis did not stratify VMT by trip purpose, the analysis found that, when accounting for both the additions to and subtractions from VMT, the new housing, even in transit-oriented areas, would result in a very small increase in VMT (on the order of 1%, which could also be considered within the noise of the modeling tools). At any rate, given that this strategy of adding additional housing units is a regional priority (for both COG and TPB, to better balance jobs and housing in the region and address the housing affordability challenge), this strategy was analyzed as originally proposed and no changes to the level of implementation for this strategy were examined.

7. Reduce travel times, relative to 2020, on all public transportation buses (survey question C8). The TPB member survey had assumed that bus travel times would be reduced by 15% between 2020 and 2030. There were some comments on the

[12] Sometimes referred to as Electric Vehicle Supply Equipment (EVSE).

ability to implement the various actions needed to achieve this by 2030, including increased bus service and bus-only lanes. For the May analysis, the consultant tested both the 15% reduction in travel times and a 10% reduction. However, the analysis found that there was no meaningful difference in the amount of GHG reduction between the two levels of implementation.

NOTE

The TPB member climate survey indicated a thorough examination of the implementation issues along with discussions with other departments at the local jurisdictional levels were needed before the TPB could consider adopting the following seven strategies as planning priorities to reduce GHG in the on-road sector.

1. Shift even more growth in jobs and housing from locations currently forecast to locations near TPB-identified high-capacity transit stations and in COG's Regional Activity Centers, within jurisdictional boundaries (survey question C4a).
2. Make all public bus transportation free by 2030 (survey question C5.
3. Make all public rail transportation free by 2030 (survey question C6).
4. Price workplace parking for employees in all regional Activity Centers by 2030 and at all workplaces by 2050 (survey question C7).
5. Convert a higher proportion of daily work trips to telework: 25% by 2030 and 40% by 2050 (survey question C11).
6. Charge a new fee per vehicle mile of travel (VMT) by motorized, private, passenger vehicles in addition to the prevailing transportation fees and fuel taxes (survey question C12)
7. Charge a "cordon fee" per motorized vehicle trip for all vehicles entering Activity Centers in the core of the District of Columbia by 2030 (survey question C13).

ATTACHMENT: CONSULTANT REPORT WITHOUT ITS APPENDIX

ICF, Fehr & Peers, and Gallop Corporation. “TPB Climate Change Mitigation Study of 2021: Additional Transportation Scenarios Analysis: TPB Survey Identified Scenarios.” Draft Report. National Capital Region Transportation Planning Board, Metropolitan Washington Council of Governments, May 12, 2022.




TPB Climate Change Mitigation Study of 2021

Additional Transportation Scenarios Analysis: TPB Survey Identified Scenarios

May 12, 2022

Prepared by

ICF

with support from
Fehr & Peers and
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Prepared for

National Capital Region
Transportation Planning Board

Additional Transportation Scenarios Analysis: TPB Survey Identified Scenarios

Background

The National Capital Region Transportation Planning Board's (TPB) Climate Change Mitigation Study of 2021 (CCMS) analyzed the types of greenhouse gas (GHG) reduction strategies that would be needed to achieve COG's 2030 and 2050 GHG emissions reduction goals (50% reduction by 2030 and 80% reduction by 2050, compared to 2005 levels) focused solely on the on-road transportation sector. It explored ten scenarios addressing transportation strategies across several pathways – vehicle technology and fuels (VT), mode shift and travel behavior (MS), and transportation systems management and operations (TSMO) – and combinations of these pathways, with various levels of strategy implementation. The results highlighted the need for a broad array of strategies to be implemented, since strategies with a combination of pathways showed the overall highest potential for GHG reduction. The study also highlighted the difficulty of meeting the region's goal levels for on-road transportation sources for 2030, since none of the scenarios were estimated to achieve more than a 43% reduction in GHG emissions in 2030, even under the most optimistic assumptions.

Subsequently, at the January 19, 2022 meeting of the TPB, it was proposed that the TPB should: 1) explicitly adopt GHG reduction goals for the on-road transportation sector; and 2) explicitly endorse a set of multi-pathway strategies to reduce on-road GHG emissions and commit to implementing them in an equitable and expeditious manner. To help in this process, the TPB members received a Climate Change Mitigation Goals and Strategies Questionnaire, and the TPB members were given the opportunity to consider their support for adopting on-road transportation GHG reduction goals and strategies to adopt. The results indicated that most respondents supported formally adopting GHG reduction goals for the on-road transportation sector commensurate with the region's multisector goals. Also, a majority or plurality of respondents expressed support for adopting seven GHG reduction strategies as follows:

1. **Convert vehicles to clean fuels.** In 2030, 100% of new light duty vehicles sold; 50 percent of new medium/heavy duty trucks, and 100% of all buses on the road will be clean fuel vehicles. In 2050, 100% of new light duty vehicles sold, 100% of new medium/heavy duty trucks sold, and 100% of all buses on the road will be clean fuel vehicles.
2. **Develop an electric vehicle charging network** in the region to support an accelerated shift of light-duty passenger cars and trucks to electric vehicles.
3. **Add additional housing units**, above current COG Cooperative Forecasts, (approximately 77,000 by 2030 and 126,000 by 2050) near TPB-identified high-capacity transit stations and in COG's Regional Activity Centers.
4. **Reduce travel times (relative to 2020) on all public transportation bus services**. In 2030, travel times are reduced by 15 percent, and in 2050, travel times are reduced by 30 percent.
5. Implement projects or programs to **provide walk/bike access to all TPB identified high-capacity transit stations**.
6. **Complete the TPB's National Capital Trail Network** to increase walk and bike trips throughout the day.
7. **Implement traffic operational improvement measures** at all eligible locations, including advanced ramp metering, enhanced incident management systems, active signal controls, and transit bus priority treatments.

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At the TPB Climate Work Session held on April 20, 2022, the participants expressed a desire to explore what would be the likely impacts of implementing these seven strategies. They also expressed interest in considering possible variations of the assumptions associated with the strategies defined in the survey, particularly for converting vehicles to clean fuels, since the level of clean vehicle fuels (e.g., electric vehicles) assumed in the survey may not be realistic. This document summarizes the results of that analysis.

Additional Scenarios Analyzed

To support an understanding of the likely effects of implementing the seven strategies, and implications for developing a realistic goal for on-road transportation GHG reduction levels that might be achieved by 2030 and 2050, ICF conducted an analysis of two additional scenarios addressing implementation of the seven strategies:

1. Implementation at the levels defined in the survey; and
2. Implementation at levels considered more realistic or moderate.

To conduct this analysis, ICF built on the scenario work conducted for the CCMS, and explored two combination scenarios, referred to as COMBO.5 (implementation at levels considered more realistic or moderate) and COMBO.6 (implementation at levels defined in the survey), since the original study had four combination scenarios (COMBO.1 to COMBO.4).

The assumptions associated with the two levels of implementation are noted below in Table 1. For most of the strategies, two separate sets of assumptions were used for the two scenarios. However, under both scenarios, the same assumptions were used for two strategies: add additional housing units and complete the TPB's National Capital Trail Network. The strategy to develop an electric vehicle charging network was not modeled separately as it was assumed to be a necessary part of the overall strategy to convert vehicles to clean fuels. fuels

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Table 1: Strategies and assumptions

Strategy	Assumptions under COMBO.5	Assumptions under COMBO.6
Convert vehicles to clean fuels	**Same as original VT.1 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)	**Same as original VT.2 scenario**: 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
Develop an electric vehicle charging network	Not explicitly analyzed; assumed to be supportive of the conversion of vehicles to clean fuels.	Not explicitly analyzed; assumed to be supportive of the conversion of vehicles to clean fuels.
Add Additional Housing Units	Add additional housing units, above current COG Cooperative Forecasts, (approximately 77,000 by 2030 and 126,000 by 2050) near TPB-identified high-capacity transit stations and in COG's Regional Activity Centers.	
Reduce Travel Times on all Bus Services	**Same as assumptions within original MS.1 scenario:** Reduce travel times (relative to 2020) on all public transportation bus services. In 2030, travel times are reduced by 10 percent, and in 2050, travel times are reduced by 20 percent.	**Same as assumptions within original MS.3 scenario:** Reduce travel times (relative to 2020) on all public transportation bus services. In 2030, travel times are reduced by 15 percent, and in 2050, travel times are reduced by 30 percent.
Provide Walk/Bike Access to all high-capacity transit stations	Implement projects or programs to provide walk/bike access to all TPB identified high-capacity transit stations (lower impact assumption)	Implement projects or programs to provide walk/bike access to all TPB identified high-capacity transit stations (higher impact assumption)
Complete the TPB's National Capital Trail Network	Complete the TPB's National Capital Trail Network to increase walk and bike trips throughout the day.	
Implement traffic operational improvement measures	**Same as original TSMO scenario but without assumption of connected/automated vehicle (CAV) benefits:** Implement traffic operational improvement measures at all eligible locations, including advanced ramp metering, enhanced incident management systems, active signal controls, and transit bus priority treatments	**Same as original TSMO scenario:** Implement traffic operational improvement measures at all eligible locations, including advanced ramp metering, enhanced incident management systems, active signal controls, and transit bus priority treatments; assumed operational benefits from CAVs in 2050.

Scenario Results

The estimated on-road transportation GHG reductions associated with implementation of the seven strategies, compared to 2005 levels, are shown in Table 2 below under the three electric grid cases explored in the CCMS. Note that under baseline assumptions, on-road transportation GHGs are estimated to be about 14% below 2005 levels in both 2030 and 2050. These figures account for both tailpipe emissions from motor vehicles and electricity-related emissions associated with use of electric vehicles (not emitted directly from vehicles but by electric utilities).

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Table 2: Summary of GHG Reductions Estimated for New 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
COMBO.5	Combination with strategies identified by the TPB survey with lower or more realistic levels	-23%	-23%	-26%	-71%	-77%	-85%
COMBO.6	Combination with strategies and levels identified in the TPB survey	-29%	-30%	-35%	-77%	-84%	-94%

Results of these scenarios in relation to the original scenarios analyzed are displayed in Table 3 and Table 4. The strategy to convert vehicles to clean fuels corresponds with the original VT.1 and VT.2 scenarios and the operational improvements strategy corresponds with the original TSMO scenario. However, the mode shift and travel behavior strategies that received plurality/majority support were only a subset of the original set analyzed. Consequently, ICF developed two separate scenarios, MS.4 and MS.5 to reflect the four mode shift and travel behavior strategies (Add Additional Housing Units, Reduce Travel Times on all Bus Services, Provide Walk/Bike Access to all high-capacity transit stations, and Complete the TPB's National Capital Trail Network) supported in the survey under levels identified in the survey and with lower or more realistic levels. These scenarios were then layer together to yield the COMBO.5 and COMBO.6 results. A comparison of the reductions in GHG emissions from all COMBO scenarios assessed to date is shown in Figure 1.

COMBO.6: Levels of implementation selected by TPB in survey

The COMBO.6 scenario encompasses the identified levels of implementation for the strategies reflected by the TPB member survey. With the reference grid using on-the-books power sector policies, the COMBO.6 scenario is projected to reduce CO_2e emissions with respect to 2005 levels by 29% in 2030 and by 77% in 2050. Assuming the clean grid, this scenario is anticipated to reduce CO_2e emissions with respect to 2005 levels by 35% in 2030 and by 94% in 2050.

The bulk of the GHG emissions reductions for this scenario are due to the clean fuels strategy. The mode shift and travel behavior strategies (modeled in isolation as scenario MS.5) are estimated to yield a less than 1% reduction in on-road transportation GHG emissions in 2030 compared to the baseline levels. The operations improvements also have small effects, estimated at about a 1% reduction in 2030. These effects remain small in 2050, with the cleans fuel strategy yielding most of the benefits.

COMBO.5: Lower or more realistic levels of implementation

The COMBO.5 scenario encompasses lower or more realistic levels of implementation for several of the strategies reflected by the TPB member survey. With the reference grid using on-the-books power sector policies, the COMBO.5 scenario is projected to reduce CO_2e emissions with respect to 2005 levels by 23% in 2030 and by 71% in 2050. Assuming the clean grid, this scenario is anticipated to reduce CO_2e emissions with respect to 2005 levels by 26% in 2030 and by 85% in 2050.

As with COMBO.6, in COMBO.5, the bulk of the GHG emissions reductions are due to the clean fuels strategy. The mode shift and travel behavior strategies (modeled in isolation as scenario MS.4) are estimated to yield less than 1% reduction in on-road transportation GHG emissions in 2030 compared to the baseline levels, and the operations improvements also have about a 1% reduction impact, and these impacts remain small through 2050.

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Figure 1: Comparison of all COMBO scenarios

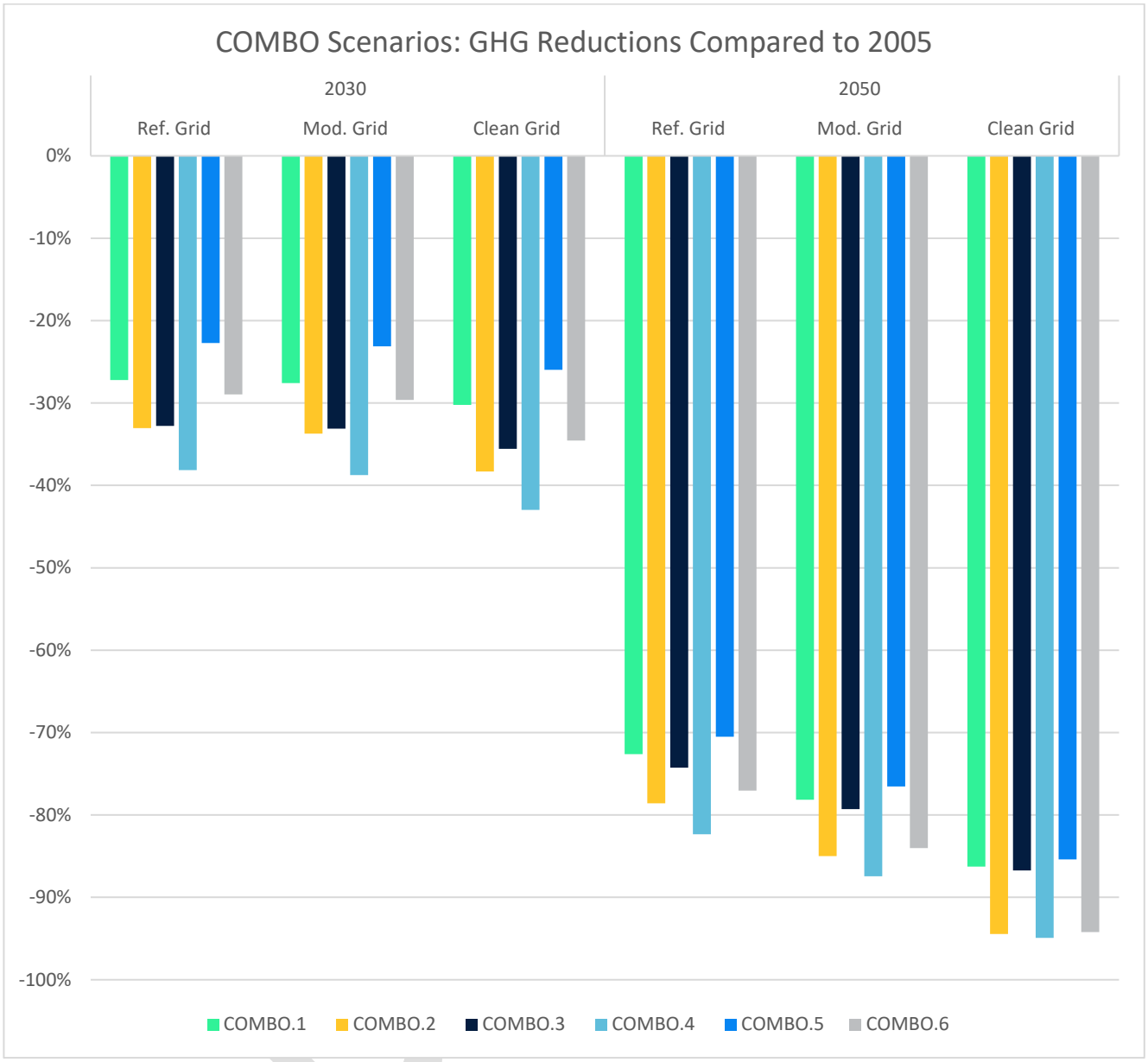

Table 3: Summary of GHG Reductions Estimated for All Transportation Scenarios Under all Electric Grid Cases (% Reductions from 2005 Level)

Scenario	Key Components	2030			2050		
		Ref. Grid	Mod. Grid	Clean Grid	Ref. Grid	Mod. Grid	Clean Grid
Baseline	Base assumptions from Visualize 2045	-14%	-14%	-14%	-14%	-14%	-14%
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; reduction in vehicle trips to school	-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%
MS.4	Includes a revised land use strategy, transit improvements (10% and 20% reductions in transit travel time in 2030 and 2050), increase in bike+transit (25% increase) and walking+transit trips at high capacity transit stations, and the completion of the National Trail Network.	-15%	-15%	-16%	-14%	-15%	-15%
MS.5	Includes a revised land use strategy, amplified transit improvements (15% and 30% reductions in transit travel time in 2030 and 2050), amplified increases in bike+transit (50% increase) and walking+transit trips at high capacity transit stations, and the completion of the National Trail Network.	-15%	-15%	-16%	-14%	-15%	-15%
TSMO	Optimized ITS/TSMO	-16%	-16%	-17%	-15%	-15%	-16%
TSMO + CAV	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+CAV+additional sharing	-38%	-39%	-43%	-82%	-87%	-95%
COMBO.5	Combination with strategies identified by the TPB survey with lower or more realistic levels: VT.1 + MS.4 + TSMO	-23%	-23%	-26%	-71%	-77%	-85%
COMBO.6	Combination with strategies and levels identified by the TPB survey: VT.2 + MS.5 + TSMO + CAV	-29%	-30%	-35%	-77%	-84%	-94%

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Table 4: Summary of GHG Reductions Estimated for All Transportation Scenarios Under all Electric Grid Cases (% Reductions from Baseline Forecast Level for 2030 and 2050)

Scenario	Key Components	2030			2050		
		Ref. Grid	Mod. Grid	Clean Grid	Ref. Grid	Mod. Grid	Clean Grid
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	-8%	-8%	-11%	-64%	-71%	-81%
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	-16%	-17%	-23%	-72%	-81%	-92%
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; reduction in vehicle trips to school	-6%	-6%	-7%	-9%	-9%	-10%
MS.2	MS.1 + DC core cordon pricing + VMT-fees of $0.05 per mile in 2030 and $0.10 per mile in 2050	-9%	-9%	-10%	-13%	-13%	-14%
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	-13%	-13%	-14%	-16%	-16%	-17%
MS.4	Includes a revised land use strategy, transit improvements (10% and 20% reductions in transit travel time in 2030 and 2050), increase in bike+transit (25% increase) and walking+transit trips at high capacity transit stations, and the completion of the National Trail Network.	0%*	-1%	-2%	-1%	-1%	-2%
MS.5	Includes a revised land use strategy, amplified transit improvements (15% and 30% reductions in transit travel time in 2030 and 2050), amplified increases in bike+transit (50% increase) and walking+transit trips at high capacity transit stations, and the completion of the National Trail Network.	0%*	-1%	-2%	-1%	-1%	-2%
TSMO	Optimized ITS/TSMO	-1%	-2%	-2%	-1%	-2%	-3%
TSMO + CAV	Optimized ITS/TSMO, with benefits from connected/automated vehicles (CAVs) by 2050	-1%	-2%	-2%	-3%	-4%	-5%
COMBO.1	Combined scenario: VT.1+ MS.1 + TSMO + CAV	-15%	-15%	-19%	-68%	-75%	-84%
COMBO.2	Combined scenario with more aggressive technology emphasis: VT.2 + MS.1 + TSMO + CAV	-22%	-23%	-28%	-75%	-83%	-94%
COMBO.3	Combined scenario with more aggressive mode shift emphasis: VT.1 + MS.3 + TSMO + CAV	-21%	-22%	-25%	-70%	-76%	-85%
COMBO.4	Combined scenario with aggressive actions across all pathways and shared CAV future: VT.2+MS.3+TSMO+additional sharing	-28%	-28%	-33%	-80%	-85%	-94%
COMBO.5	Combination with strategies identified by the TPB survey with lower or more realistic levels: VT.1 + MS.4 + TSMO	-10%	-10%	-14%	-66%	-73%	-83%
COMBO.6	Combination with strategies and levels identified by the TPB survey: VT.2 + MS.5 + TSMO + CAV	-17%	-18%	-24%	-73%	-81%	-93%

*Rounded, reflects less than 0.5% reduction from baseline

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Conclusion

The seven strategies that received plurality/majority support in the TPB member survey are estimated to reduce on-road transportation GHG emissions by 23% to 29% in 2030, and by 71% to 77% in 2050, compared to 2005 levels, under a reference grid case. They achieve larger reductions with clean grid assumptions, enabling attainment of the 80% reduction goal in 2050 but still well short of the 50% reduction goal in 2030.

In both cases, the **Convert vehicles to clean fuels** strategy is by far the most impactful when compared to other mode shift and travel behavior or TSMO pathway strategies contained in the package of strategies. (Although the **Develop an electric charging network** strategy was not modeled because the outcomes of this strategy are supportive of the outcomes of the Convert vehicles to clean fuels strategy, an electric charging network is a necessary step to support electrification of the fleet in the region.) It should be noted that the assumptions presented in the survey for the conversion of vehicles to clean fuels (e.g., electric vehicles) is extremely aggressive, and even the more moderate assumptions will require a very large change in the vehicle fleet within a very short window of time through 2030.

Although the mode shift and travel behavior strategies analyzed did not show large impacts in terms of reducing GHG emissions, these strategies have many co-benefits, including potential improvements to physical and social health, equity, and mobility, which are not captured in this analysis. It should be noted that while the strategy to Add Additional Housing Units to the region will yield on-road transportation GHG reduction benefits from the perspective of individual households who now are able to take shorter trips and have more choices for using transit, bicycling, walking, and other non-driving options, this analysis estimated a small overall increase in VMT and on-road transportation GHG emissions within the COG region when adding these additional households. These households reduce long-distance trips into the region but also generate local trips within the COG region that would have occurred outside of the region's boundaries.

The addition of new households to Activity Centers and areas with high-capacity transit stations were estimated to increase the total number of households in the region by 2.50% in 2030 and 3.51% in 2050, while meanwhile yielding about a 1% increase in regional passenger auto VMT in 2030 and 1.35% increase in 2050. As a result, the placement of new housing in the region reduces VMT per capita within the region. While this strategy yields a small increase in VMT and GHG emissions within the region's boundaries, it overall should provide GHG emission benefits when taking into account emissions outside of the region (not counted in this study).

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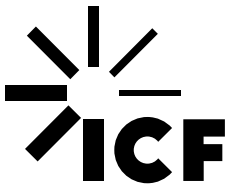

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