600 NE Grand Ave.
Portland, OR 97232-2736
503-797-1700
503-797-1804 TDD
503-797-1797 fax

Metro | *Memo*

Date: June 21, 2012

To: TPAC members and interested parties

From: Nuin-Tara Key, Senior Regional Planner
Kim Ellis, Principal Transportation Planner

Re: Climate Smart Communities: Phase 1 Metropolitan GreenSTEP scenarios sensitivity analysis

ACTION REQUESTED

This information provides additional background information to supplement the Phase 1 Findings report. As part of TPAC's discussion, staff will be requesting your input and recommendations on:

- What questions do these findings raise?
- How does this information influence your thoughts about potential scenario options and implementation of strategies in your community, the region and the state?
- How should this information be shared with the region's policymakers?

PURPOSE

To better understand the effectiveness of the individual strategies that make up the six policy areas within Metropolitan GreenSTEP, Metro staff conducted sensitivity analysis of individual strategies developed during Phase 1 of the Climate Smart Communities Scenarios Project. This memo summarizes the results of the sensitivity analysis.

BACKGROUND

Phase 1 of the Scenarios Project focused on understanding the region's land use and transportation choices by conducting a review of published research and testing 144 regional scenarios. Phase 1 was designed to accomplish two things: 1) to understand the GHG emissions reduction potential of current plans and policies and 2) to understand the combinations of plausible land use and transportation strategies that reduce GHG emissions from light duty vehicles to 1.2 MT CO2e per capita by 2035.

The Phase 1 Metropolitan GreenSTEP scenarios tested combinations of six different policy areas, each representing a number of individual strategies. Each of the six policy areas were tested at either two or three levels of implementation, or ambition, as shown in **Table 1**.[1]

[1] More information on the Phase 1 Scenarios can be found through the project website at http://www.oregonmetro.gov/climatescenarios.

Table 1: Phase 1 Scenarios input assumptions

Strategy		Reference case: 2010 Base Year (Reflects existing conditions)	2035 Level 1 (Reflects current plans and policies)	2035 Level 2 (Reflects more ambitious policy changes)	2035 Level 3 (Reflects even more ambitious policy changes)
Community design	Households living in mixed-use areas and complete neighborhoods (percent)	GreenSTEP calculates			
	Urban growth boundary expansion (acres)	2010 UGB	7,680 acres	7,680 acres	No expansion
	Bicycle mode share[1] (percent)	2%	2%	12.5%	30%
	Transit service level	2010 service level	2035 RTP service level	2.5 times RTP service level	4 times RTP service level
	Workers/non-work trips paying for parking (percent)	13% / 8%	13% / 8%	30% / 30%	30% / 30%
	Average daily parking fee ($2005)	$5.00	$5.00	$5.00	$7.25
Pricing	Pay-as-you-drive insurance (percent of households participating and cost)	0%	0%	100% at $0.06/mile	No change from Level 2
	Gas tax (cost per gallon $2005)	$0.42	$0.48	$0.18	
	Road use fee (cost per mile $2005)	$0	$0	$0.03	
	Carbon emissions fee (cost per ton)	$0	$0	$0	$50
Marketing and incentives	Households participating in eco-driving	0%	0%	40%	No Level 3
	Households participating in individualized marketing programs (percent)	9%	9%	65%	
	Workers participating in employer-based commuter programs (percent)	20%	20%	40%	
	Car-sharing in high density areas (target participation rate)	Participation rate of 1 member/100 people	Participation rate of 1 member/100 people	Double participation to 2 members/100 people	
	Car-sharing in medium density areas (target participation rate)	Participation rate of 1 member/200 people	Participation rate of 1 member/200 people	Double participation to 2 members/200 people	
Roads	Freeway and arterial expansion	2010 system	2035 financially constrained system	No expansion	
	Delay reduced by traffic management strategies (percent)	10%	10%	35%	
Fleet	Fleet mix (proportion of autos to light trucks and SUVs)	auto: 57% light truck/SUV: 43%	auto: 56% light truck/SUV: 44%	auto: 71% light truck/SUV: 29%	
	Fleet turnover rate (age)	10 years	10 years	8 years	
Technology	Fuel economy (miles per gallon)	auto: 29.2 mpg light truck/SUV: 20.9 mpg	auto: 59.7 mpg light truck/SUV: 41 mpg	auto: 68.5 mpg light truck/SUV: 47.7 mpg	
	Carbon intensity of fuels	90 g CO_2e/megajoule	81 g CO_2e/megajoule	72 g CO_2e/megajoule	
	Light-duty vehicles that are electric or plug-in electric vehicles (percent)	auto: 0% light truck/SUV: 0%	auto: 4% light truck/SUV: 1%	auto: 8% light truck/SUV: 2%	

Table 2 demonstrates the effect of applying each policy area at each level of implementation beyond the Reference Case (Level 1).

The estimated percent reduction represents the average reduction in per capita roadway GHG emissions for each policy area, while considering all possible combinations of policy areas. While this analysis demonstrates the relative effectiveness of each policy area, it does not address the extent to which each of the individual strategy options within each policy area is contributing to the percent reductions. In other words, the scale of the analysis does not facilitate an understanding of the primary drivers within each policy area.

Table 2.

Comparison of Phase 1 policy areas

Estimated reductions in roadway GHG emissions from current plans and policies

Policy area	Level	Estimated percent reduction from 1.8 $MTCO_2e$*
Community design	2	18%
Community design	3	36%
Pricing	2	13%
Pricing	3	14%
Marketing and incentives	2	4%
Roads	2	2%
Fleet	2	11%
Technology	2	14%

*$MT\ CO_2e$ percent change from 2035 Reference Case (current plans and policies)

To address this information gap and to help refine the scope and range of options to be considered in Phase 2, Metro staff completed sensitivity analysis for all policy strategies. These additional sensitivity runs provide estimates on the relative effectiveness of each strategy within a policy area.

Community Design

The Phase 1 community design strategy inputs demonstrated the greatest reduction in greenhouse gas emissions. These strategy options also represent some of the most investment intensive strategies for local and regional policymakers. To facilitate a regional conversation about implementation, while also considering relative cost effectiveness, it is

important to prioritize these strategy options in terms of their individual effectiveness on regional greenhouse gas emissions reductions.

Pricing
The combination of pricing strategies tested in the Phase 1 scenarios are attributed with the second largest emission reduction potential. These strategy options reflect a policy area that Metro and the region have not examined in great detail and more work is needed to understand their effectiveness and the potential benefits and impacts they bring, including effects on households of modest means and businesses. In addition, these strategies may provide an opportunity to explore potential revenue generation options. Given these considerations pricing strategies represent a priority area to focus attention.

Marketing and incentives
Relative to the other policy areas tested during Phase 1, the Marketing and Incentive policy area had the second smallest effect on reducing regional greenhouse gas emissions. Marketing and Incentive policy options still play a critical role in managing the region's transportation system.

Roads
Relative to the other policy areas tested during Phase 1, the Roads policy area in Metropolitan GreenSTEP had the smallest effect on reducing regional greenhouse gas emissions. Similar to marketing and incentive programs, roadway expansion and connectivity, as well as demand management programs, are all critical to managing the region's transportation system.

Fleet
The two policy options within the Fleet policy area are fleet mix and age. The analysis from both the Statewide and Metropolitan GreenSTEP scenarios demonstrate that transitioning to a greater proportion of light autos over trucks and increasing the fleet turnover rate both have a positive effect on reducing roadway emissions. However, these policy options are less directly within the sphere of control of Metro and local governments. While marketing and education campaigns can help to inform public opinion around these issues, and Metro and local governments can work to transition their own fleet over, it is ultimately a private consumer choice that will drive changes to these strategies.

Technology
The technology options tested in the Phase 1 scenarios represent the third greatest reduction potential of all policy areas. These policy strategies, similar to pricing, reflect a relatively new area for Metro and local governments. While efforts to influence light vehicle technology shifts will take international, federal, state and local actions, there are a number of activities Metro and local governments can take to influence changes in these areas (e.g. supporting a local EV charging network that connects to the West Coast Green Highway network, advocating for Federal CAFÉ standards and implementation of Oregon's

Low Carbon Fuel Standard). Also, given potential shifts in fuel economy and technology may help the region meet its greenhouse gas reduction target.

ANALYSIS RESULTS

All sensitivity runs evaluate the strategy inputs developed during Phase 1 of the Scenarios Project; *no policy strategy inputs were changed for this analysis*. The analysis results represent the effects of individual strategies in isolation and do not capture any variations that may occur from synergies between multiple policies.

All results represent the estimated reduction in roadway GHG emissions compared to the Reference Case (Level 1). The sensitivity analysis results are grouped into two categories based on the overall effectiveness of the policy areas; the first category includes Community Design, Pricing and Technology and the second category includes Marketing and incentives, Roads and Fleet.

The following points should be noted when reviewing the sensitivity analysis results:

- A small reduction in annual per capita emissions should not be interpreted as ineffective; marginal per capita reductions resulting from the polices discussed below can result in significant absolute GHG reductions. For example, if the region's population is roughly 2 million in 2035, a per capita reduction of .01 MT CO_2e is the equivalent of an absolute reduction of 100,000 MT CO_2e.
- The results below are only presented through a climate lens. For example, if two policies result in the same GHG emissions reduction potential, it does not mean they have equivalent effects through other perspectives (e.g. through an equity or fiscal lens). For example, modeled results for Level 3 bike mode share may have the same GHG emissions reduction potential as a no UGB expansion policy, however these policies have significantly different economic, fiscal and equity implications. The following analysis does not address these additional dimensions; however, the economic, fiscal, environmental and equity implications will be evaluated as part of the Phase 3 analysis.

COMMUNITY DESIGN

Except for "households in mixed-use areas and complete neighborhoods", all of the policy strategies within Community Design were tested.[2] The modeled Base Case (2010) regional estimate for households in mixed use areas and complete communities is roughly 26 percent. The 2035 model estimates for the Reference case is roughly 36 percent. All additional future year scenarios range from roughly 36 – 37 percent.

[2] Because there is not a regionally endorsed approach for estimating the percent of population living in complete communities, the proportion of households living in mixed-use areas was estimated using Metropolitan GreenSTEP's internal land use characteristics model. The internal land use characteristics model uses population density to estimate the probability a household lives in a complete neighborhood or mixed-use area.

Urban growth boundary: because there is no change between Levels 1 and 2 only one sensitivity run was needed.

- Isolating Level 3, which represents a no expansion policy, results in a reduction of roughly two percentage points from the reference case.
- Per capita roadway emissions reduced from 1.8MT CO_2e to 1.77MT CO_2e.

Bike mode share: to isolate the difference between levels 2 and 3, two scenarios were run.

Level 2

- Isolating Level 2, which represents an increase in regional bike mode share from 2 percent to 12.5 percent, results in a reduction of roughly one percentage point from the reference case.
- With a Level 2 bike mode share modeled per capita roadway emissions decrease from 1.8 MT CO_2e to 1.78 MT CO_2e.
- *Bike mode share at Level 2 results in an almost comparable GHG reduction to a no UGB expansion policy.*

Level 3

- Isolating Level 3, which represents an increase in regional bike mode share from 2 percent to 30 percent, results in a reduction of roughly three percentage points from the reference case.
- With a Level 3 bike mode share, modeled per capita roadway emissions decrease from 1.8 MT CO_2e to 1.75 MT CO_2e.
- *Bike mode share at Level 3 results in an almost comparable GHG reduction to a no UGB expansion policy.*

Transit: six model runs were completed to isolate each of the transit model inputs. The inputs include the level of transit service as well as the percent of electricity-powered service.

Changes in transit fleet electrification do not affect light vehicle roadway GHG emissions. While, a change in electrification is assumed to affect transit emissions, this level of analysis was not included in the sensitivity analysis.

The following results reflect the changes in roadway GHG emissions resulting from changes in transit service levels.

Level 2

- Increasing transit service to two and half (2.5) times the 2035 RTP service level results in significant per capita GHG emissions reductions; an estimated 20 percentage point reduction from the reference case.
- With a Level 2 transit service level, modeled per capita roadway emissions decrease from 1.8 MT CO_2e to 1.49 MT CO_2e.

- *Transit Level 2 reductions are slightly greater than the reductions resulting from the assumed reductions from the State's recommended Technology and Fleet improvements, 1.49 and 1.5 respectively.*

Level 3

- Increasing transit service to four (4) times the 2035 RTP service level results in significant per capita GHG emissions reductions; an estimated 38 percentage point reduction from the reference case.
- With a Level 3 transit service level, modeled per capita roadway emissions decrease from 1.8 MT CO_2e to 1.21 MT CO_2e.
- *Transit Level 3 reductions yield the greatest reduction of any single strategy tested during Phase 1. Implementing this policy strategy alone would almost meet the region's GHG emissions target.*

Parking: To isolate the parking pricing factors three additional sensitivity runs were completed. The percent of trips—work and non-work—paying for parking (i.e. coverage) and the average daily parking fee were each isolated.

- Maintaining the 2035 RTP parking coverage assumptions (Level 1), but increasing the daily parking fee to Level 3, results in a roughly two percentage point reduction in roadway GHG emissions. Just increasing the daily parking fee to Level 3 results in a reduction of per capita GHG emissions from 1.8 MT CO_2e to 1.76 MT CO_2e; this is roughly equivalent to the reductions seen from a 12 percent regional bike mode share.
- Increasing the parking coverage area (Levels 2 and 3) but maintaining the Level 1 daily parking fee results in a roughly five percentage point reduction from the Reference Case, resulting in a per capita equivalent of 1.71 MT CO_2e.
- *Greater reductions are seen from increasing parking coverage than parking fees.*
- Combining an increase in both parking fees and parking management coverage results in greater reductions than from each parking policy individually; testing both policy strategies at Level 3 results in a roughly nine percentage point reduction, resulting in a per capita emissions rate of 1.66 MT CO_2e.
- *Parking pricing level 3 inputs yield a greater reduction than a 30 percent regional bike mode split or the no UGB expansion model runs. However, it is less than half the reduction seen from Transit Level 2.*

PRICING

Pay-as-you-drive insurance: Because there was no change from Level 2 to Level 3 only one additional model run was needed for pay-as-you-drive-insurance.

- Levels 2 and 3 reflect a 100 percent transition to pay-as-you-drive insurance, which results in a roughly seven percentage point change from the reference case.
- In per capita terms, this reduction is an estimated 1.68 MT CO_2e per capita.
- *Level 3 pay-as-you-drive insurance has slightly less of a GHG reduction effect than does parking pricing Level 3 (increased coverage and daily fee).*

Fuel costs: While fuel cost estimates were defined by using the State's assumptions from the first round of STS Scenarios (no regional changes) an additional sensitivity test was run

to isolate the affects of a fuel price increase. Fuel price changes were treated as a background condition that is not controlled by the region or the state.

- Two fuel price alternatives were embedded into the Phase 1 Scenarios. The Level 1 assumptions, which test a lower fuel cost scenario with current gas tax levels, was tested against a scenario that increases the fuel costs but maintains current gas tax levels. This increase in fuel costs results in a roughly six percentage point decrease in roadway GHG emissions.
- Increasing fuel costs to Level 2 is a per capita equivalent of 1.7 MT CO_2e .
- *Increasing 2035 fuel costs to $6.14 a gallon, up from an estimated $4.12 (in 2005 dollars) has a greater influence on roadway GHG emissions than Level 3 bike mode split or Level 3 UGB expansion; but less of an influence than the Level 3 parking pricing inputs.*

Road use fees: Two sensitivity runs were needed to isolate the effects of a road use fee: the road use fee was tested with both the "low" and "high" embedded fuel cost assumptions.

- Applying a road use fee (Level 2) with the low fuel cost assumption results in a roughly six percentage point reduction from the Reference Case.
- *Transitioning from a gas tax to a road use fee—with the low fuel cost background condition—has the equivalent effect of reducing per capita roadway GHG emissions to 1.70 MT CO_2e; just slightly less of a reduction than the Level 2 pay-as-you-drive insurance.*
- Applying a road use fee (Level 2) with the high fuel cost assumption results in a roughly nine percentage point reduction from the Reference Case.
- Transitioning from a gas tax to a road use fee—with the high fuel cost background condition—has the equivalent effect of reducing per capita roadway GHG emissions to 1.66 MT CO_2e; approximately the same affect as Level 3 parking pricing inputs.

Carbon fee: Two sensitivity runs were needed to isolate the effects of applying a carbon emissions fee: the carbon fee was tested with both the "low" and "high" embedded fuel cost assumptions.

- Applying a carbon fee (Level 3) with the low fuel cost assumption resulted in a one percentage point reduction from the Reference Case.
- *Applying the Level 3 input for a carbon emissions fee—with the low fuel cost background condition—has the equivalent effect of reducing per capita roadway GHG emissions to 1.78 MT CO_2e.*
- Applying a carbon fee (Level 3) with the high fuel cost assumption results in a reduction of just over nine percentage points from the Reference Case.
- Applying a carbon fee—with the high fuel cost background condition—has the equivalent effect of reducing per capita roadway GHG emissions to 1.65 MT CO_2e; approximately the same affect as Level 3 parking pricing inputs.

TECHNOLOGY

Fuel economy: One sensitivity run was needed to isolate the effects of increased fuel economy for light autos and trucks.

- Increasing the fuel efficiency of both light trucks and autos to Level 2 input values results in a roughly six percentage point reduction in roadway emissions from the Reference Case.
- *Level 2 inputs for fuel efficiency yield a per capita roadway emissions equivalent of 1.71 MT CO_2e; this is approximately the equivalent of the Level 2 road use fee.*

Carbon intensity of fuels: One sensitivity run was needed to isolate the effects of a lower carbon content in fuel.

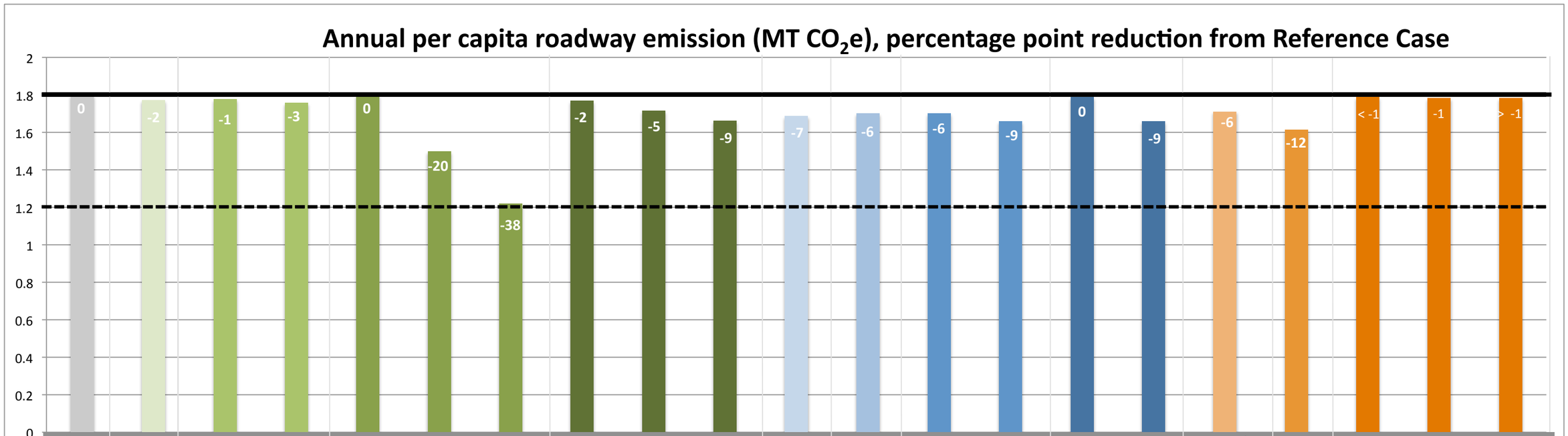
- Decreasing the carbon content of fuel to the prescribed Level 2 input value results in a roughly twelve percentage point reduction in roadway emissions from the Reference Case.
- *Level 2 inputs for fuel efficiency yield a per capita roadway emissions equivalent of 1.61 MT CO_2e; this is reduction greater than the road use fee, Level 2 pay-as-you-drive insurance, and the Level 3 parking pricing factors. After the Levels 2 and 3 transit inputs, the modeled reduction in the carbon content of fuels has the third greatest affect on roadway GHG emissions.*

Electric vehicle (EV) and plug-in hybrid electric vehicle (PHEV) market share: Three sensitivity runs were needed to isolate the effects of the modeled increases in efficiency and market share of EV and PHEV vehicles.

- Increasing the *fuel efficiency* of EV's to Level 2, but maintaining the Level 1 market share of four percent results in a less than 1 percentage point reduction in roadway GHG emissions.
- Per capita roadway emissions reduced from 1.8MT CO_2e to 1.788 MT CO_2e; this is roughly half the influence of increasing the regional bike mode share to Level 2 (12.5 percent).
- Increasing the *market share* of EV's to eight percent (Level 2) , but maintaining the level 1 fuel efficiency results in a roughly one percentage point reduction in roadway GHG emissions.
- Per capita roadway emissions reduced from 1.8MT CO_2e to 1.784 MT CO_2e; this is almost half the influence of increasing the regional bike mode share to Level 2 (12.5 percent).
- Increasing *both the efficiency and market share* of EVs to the Level 2 assumptions, results in a slightly greater than one percentage point reduction in roadway GHG emissions.
- Per capita roadway emissions reduced from 1.8MT CO_2e to 1.783 MT CO_2e; similar to the other EV sensitivity runs, this is almost half the influence of increasing the regional bike mode share to Level 2 (12.5 percent).

Figure 1 provides the relative GHG emissions reduction potential for three policy areas (Community Design, Pricing and Technology). The modeled Reference Case—existing plans and policies—is estimated to reduce annual per capita GHG emissions to 1.8 MT CO_2e (bolded line). This is a reduction from an estimated 2005 per capita emission rate of 4 MT CO_2e. However, to meet the region's 20 percent reduction target the annual per capita emissions rate needs to get down to 1.2 MT CO_2e (dotted line). While no single policy input tested in the Phase 1 Scenarios meets the reduction target on its own, the Level 3 transit input almost provides enough reduction potential to meet the region's target; the Level 2 transit input also provides significant emissions reductions potentials.

Figure 1: Sensitivity analysis results for Community Design, Pricing and Technology, annual per capita roadway emissions



Note: Values above represent the percentage point reduction from the Reference Case.

MARKETING AND INCENTIVES

All of the policy strategies within Marketing and Incentives were tested. These include three categories of policies: (1) eco-driving practices (use of low-rolling resistance tires, eco-driving behavior change, and vehicle use optimization); (2) travel demand management programs (individualized marketing programs and employer-based commute programs); and (3) participation in market-based car-sharing programs (in medium and high-density areas)

Eco-driving: to isolate all eco-driving program areas four model runs were completed.

Low-rolling resistance tires

- Isolating the use of low-rolling resistance tires at level 2, which reflects a participation rate of 40 percent, results in a reduction in roadway greenhouse gas emissions of roughly one percentage point from the reference case.
- Per capita roadway emissions reduced from 1.8MT CO_2e to 1.78 MT CO_2e.

Eco-driving behaviors

- Isolating the effect of an increased participation rate of motorist implementing eco-driving behaviors results in a reduction in emissions of roughly two percentage points from the reference case. Level 2 reflects a 40 percent participation rate for households that reduce fuel consumption by avoiding rapid starts and stops, matching driving speeds to synchronized traffic signals and avoiding idling.
- Per capita roadway emissions reduced from 1.8 MT CO_2e to 1.77 MT CO_2e.

Low-rolling resistance tires and eco-driving combined

- An additional sensitivity run was completed to test the effect of both low-rolling resistance tires and eco-driving behaviors combined. Increasing participation in both of these activities to 40 percent (level 2) results in a reduction in emissions by slightly more than two percentage points from the reference case.
- Per capita roadway emissions reduced from 1.8 MT CO_2e to 1.76 MT CO_2e.
- *Level 2 eco-driving participation rates result in an almost comparable GHG reduction to a no UGB expansion policy.*

Vehicle optimizations

- Isolating vehicle optimization at level 2 (40 percent participation rate), which represents an increase in the proportion of households that optimize their use of vehicles by putting the most miles of travel on the vehicle that gets the highest fuel economy, results in a roughly three percentage point reduction from the reference case.
- Per capita roadway emissions reduced from 1.8 MT CO_2e to 1.75 MT CO_2e.

Travel demand management: three scenarios were run to isolate the difference between the individualized marketing (IM) and employer-based commute programs.

Individualized marketing

- Isolating Level 2, which represents an increase in the percent of households participating in an IM program to 65 percent, results in a reduction of roughly three percentage points from the reference case.
- Per capita roadway emissions decrease from 1.8 MT CO_2e to 1.756 MT CO_2e.

Employer-based commute programs

- Isolating Level 2, which represents an increase in the percent of employees participating in an Employee Commute Options (ECO) program to 40 percent, results in a reduction of roughly one percentage point from the reference case.
- Per capita roadway emissions reduced from 1.8 MT CO2e to 1.785 MT CO2e.

Individualized marketing and employer-based commute programs combined

- Isolating both IM and ECO programs at Level 2 results in a reduction of roughly three percentage point from the reference case.
- With a Level 2 bike mode share modeled per capita roadway emissions decrease from 1.8 MT CO_2e to 1.753 MT CO_2e.
- *Combining IM and ECO programs results in a slightly greater reduction than IM programs alone.*

Car-sharing: to isolate the difference between increased participation in car-sharing in medium and high-density areas, three scenarios were run.

High-density areas

- Isolating Level 2, which represents an increase in participation in car-sharing programs from 1 to 2 people per every one hundred in high-density areas, results in a reduction of slightly less than one percentage point from the reference case.
- Per capita roadway emissions decrease from 1.8 MT CO_2e to 1.78 MT CO_2e.

Medium-density areas

- Isolating Level 2, which represents an increase in participation in car-sharing programs from 1 to 2 people per every one hundred in medium-density areas, results in a reduction of slightly less than one percentage point from the reference case.
- Per capita roadway emissions decrease from 1.8 MT CO_2e to 1.78 MT CO_2e.

High and medium density areas combined

- Isolating both high and medium-density participation rates, results in a reduction of slightly less than one percentage point from the reference case.
- Per capita roadway emissions decrease from 1.8 MT CO_2e to 1.78 MT CO_2e.
- *Participation in car-share programs alone does not have a significant emissions reduction effect at a regional scale. However, it should be noted that this market-based*

strategy may have more significant affects when combined with the community design policy strategies.

ROADS

All of the policy strategies within Roads were tested. These include two categories of policies: (1) freeway and arterial expansion; (2) delay reduction from traffic management strategies

Roadway expansion: to isolate all roadway expansion policies, three model runs were completed. Level 2 for both the freeway and arterial expansion tested the effects of a no-expansion policy, in affect this tests the implications of not implementing the regionally adopted 2035 financially constrained system.

Freeway expansion

- Isolating level 2, which reflects a no-expansion policy, results in an *increase* in emissions by roughly one percentage point from the reference case.
- Per capita roadway emissions increased from 1.8MT CO_2e to 1.802 MT CO_2e.

Arterial expansion

- Isolating level 2, which reflects a no-expansion policy, results in an *increase* in emissions by roughly one percentage point from the reference case.
- Per capita roadway emissions increased from 1.8MT CO_2e to 1.812 MT CO_2e.

Freeway and arterial expansion

- Isolating both freeway and arterial expansion at level 2, which reflects a no-expansion policy, results in an *increase* in emissions by just over one percentage point from the reference case.
- Per capita roadway emissions increased from 1.8MT CO_2e to 1.826 MT CO_2e.
- *The increase in emissions seen from Level 2 may be attributable to the increases in congestion associated with a no-expansion policy. However, two considerations should be made; first, Metropolitan GreenSTEP does not model "mode shift" as a result on congestion, therefore it is possible these results do not capture the potential effects of this behavior change. Second, "expansion" not only includes system expansion but also connectivity and network improvement projects. Because these different roadway expansion project types are combined into a single input (roadway lane miles), Metropolitan GreenSTEP is not sensitive to the potential differences between expansion and connectivity projects.*

Delay reduction

- Isolating level 2, which reflects an increase in delay reduction by 35% due to traffic management strategies, results in a decrease in emissions by roughly four percentage points from the reference case.
- Per capita roadway emissions reduced from 1.8MT CO_2e to 1.74 MT CO_2e.

FLEET

Fleet policy assumptions include fleet mix (proportion of light trucks to light autos) and fleet turnover rate (the rate at which new vehicles replace existing vehicles).

Fleet mix: two sensitivity runs were needed to isolate the effects of reducing the proportion of light trucks as a share of the total light duty fleet.

- Decreasing the share of light trucks as a portion of the *commercial service fleet*, from 45 percent to 30 percent, results in a roughly one percentage point reduction in roadway emissions from the Reference Case.[3]
- Per capita roadway emissions reduced from 1.8MT CO_2e to 1.78 MT CO_2e.
- Decreasing the share of light trucks as a portion of the *total fleet*, from 43 percent to 29 percent, results in a roughly six percentage point reduction in roadway emissions from the Reference Case.
- Per capita roadway emissions reduced from 1.8 MT CO_2e to 1.7 MT CO_2e, a reduction comparable to implementing the level 2 road use fee.

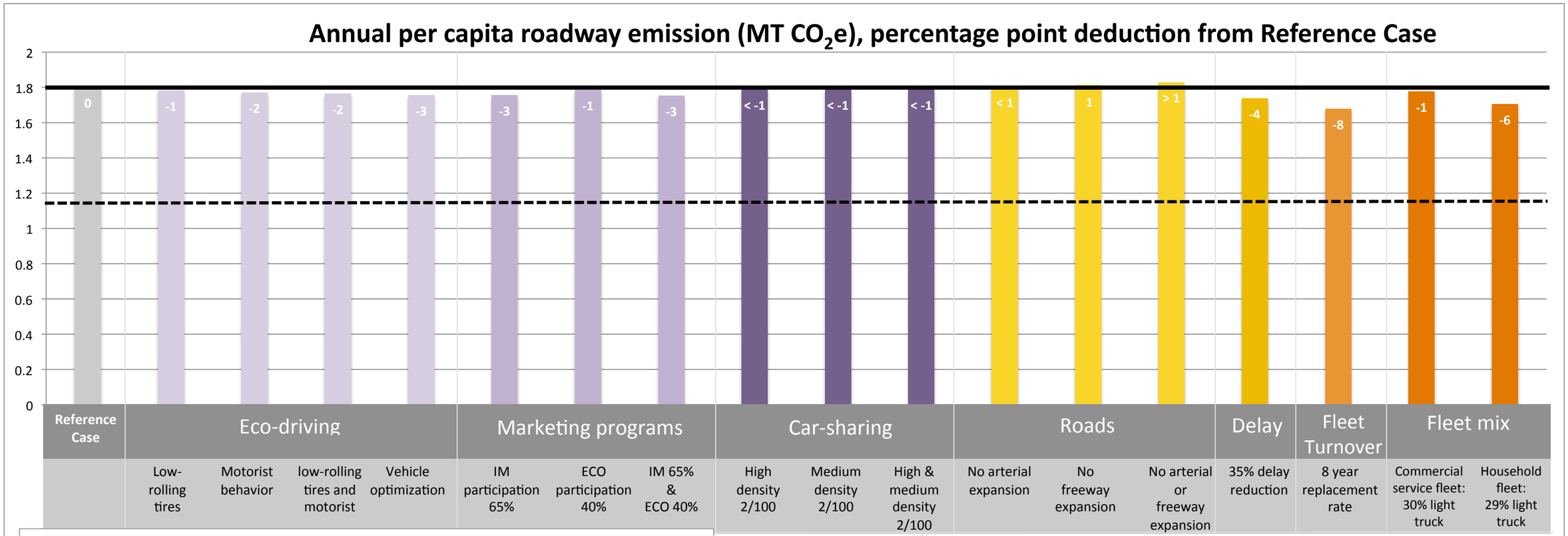
Fleet turnover rate: One sensitivity run was needed to isolate the effect of increasing the rate at which new vehicles replace older vehicles.

- Level 2, which increases the average replacement rate for light vehicles from 10 year to 8 years, results in a roughly eight percentage point reduction in roadway emissions from the reference case.
- Per capita roadway emissions reduced from 1.8 MT CO_2e to 1.67 MT CO_2e, a reduction comparable to Level 2 pay-as-you-drive insurance.

[3] Commercial Service vehicles are light duty trucks and autos that are owned and operated by businesses within the Metro region. Commercial service vehicles were split out s as a separate market component from household vehicle travel. This enables different vehicle characteristics to be applies to commercial service vehicles. For example, many commercial service vehicles are good candidates for powering by compressed natural gas (CNG) or electricity because they are operated as fleets that can have the support for these power sources and because they have relatively short travel ranges.

Figure 2 provides the relative GHG emissions reduction potential for three policy areas (Marketing and Incentives, Roads and Fleet). The modeled Reference Case—existing plans and policies—is estimated to reduce annual per capita GHG emissions to 1.8 MT CO_2e (bolded line). This is a reduction from an estimated 2005 per capita emission rate of 4 MT CO_2e. However, to meet the region's 20 percent reduction target the annual per capita emissions rate needs to get down to 1.2 MT CO_2e (dotted line). No single policy input tested in the Phase 1 Scenarios meets the reduction target on its own.

Figure 2: Sensitivity analysis results for Marketing and Incentives, Roads and Fleet, annual per capita roadway emissions



Note: Values above represent the percentage point reduction from the Reference Case.