Plan Bay Area: Technical Summary of Proposed Climate Policy Initiatives

Technical Report

Metropolitan Transportation Commission

May 4, 2012

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1 Introduction

This report presents a summary of the technical analyses of the proposed Climate Policy Initiatives undertaken in support of the Metropolitan Transportation Commission's (MTC's) 2013 Plan Bay Area. Part 2 provides a brief overview of why the Climate Policy Initiatives are included as part of the Plan Bay Area transportation investment strategy; and Part 3 presents a summary of the technical methods used in the analyses of a suite of climate policy initiatives recommended by MTC staff for inclusion in the transportation investment strategy.

In April 2012, MTC staff initiated an interagency consultation with the CARB to review and discuss the climate policy initiatives, including the analytic assumptions and methodologies. We expect ongoing consultation during the Plan process.

For detailed information regarding the broader Plan Bay Area effort, please see OneBayArea.org.

2 Overview

Senate Bill 375 Sustainable Communities Strategies requires the Association of Bay Area Governments and the Metropolitan Transportation Commission to prepare a Sustainable Communities Strategy as part of the long-range Regional Transportation Plan (RTP).

Plan Bay Area is the region's first long-range land-use/transportation plan prepared to meet the requirements of SB 375. As part of the Plan, the Bay Area must identify a future development pattern for the region, which, when integrated with the transportation network, and other transportation measures and policies, will reduce greenhouse gas emissions from automobiles and light-duty trucks to achieve, if there was a feasible way to do so, the greenhouse gas emission reduction targets approved by the California Air Resources Board (CARB). The per-capita greenhouse gas emission reduction targets set by the CARB for the Bay Area are a -7 percent reduction by 2020 and -15 percent reduction by 2035 from 2005 levels.

The Climate Policy Initiatives proposed are part of the overall land-use/transportation strategy to help the region meet and possibly exceed its 2020 and 2035 greenhouse emission reduction targets.

3 Climate Policy Initiatives

MTC, with consultant assistance from ICF International, prepared "off-model" analyses, or sketch modeling analyses, of various transportation-focused climate policy initiatives that may produce measurable per-capita greenhouse gas emission reductions. The focus was on clean vehicles, transportation demand management, behavior change programs, and active transportation strategies that would accelerate the adoption of clean vehicle technologies (above and beyond what's already assumed by the state in AB 32 Scoping Plan), encourage changes in how we drive, and promote alternative modes.

Primary inputs into the sketch modeling analyses were outputs from MTC's activity-based travel demand model for years 2005 and 2035, as well as emissions factors from the California Air Resources Board latest emissions model, EMFAC2011.

The climate policy initiatives that MTC staff has proposed for investment consideration are as follows:

1. Regional Charger Program for Plug-In Hybrid Electric Vehicles
2. Vehicle Buy-Back & Plug-In Hybrid Electric Vehicles or Battery Electric Vehicles Purchase Incentives
3. Car Sharing
4. Vanpools
5. Clean Vehicles Feebate Program
6. Smart Driving Strategy
7. Commuter Benefits Ordinance

For each climate policy initiative, a summary has been prepared, featuring the project objective, contextual background, assumptions and methodology, analytic steps and results. These summaries can be found in the following pages.

3.1 Regional Charger Program for Plug-In Hybrid Electric Vehicles

<table>
<tr><td>Objective</td><td>Establish a regional public charger network for plug-in hybrid electric vehicles</td></tr>
<tr><td>Context</td><td>Plug-in hybrid electric vehicles (PHEVs) have a hybridized powertrain which is fueled by chemical energy from a battery or by gasoline/diesel. A regional charger network provides an opportunity to increase the number of so-called electric miles for PHEVs.</td></tr>
<tr><td>Baseline Information</td><td>
EMFAC 2011 does not include baseline assumptions regarding the vehicle fleet as a result of the recent Advanced Clean Cars Program. This program impacts the percentage of zero emission vehicles (ZEVs) that original equipment manufacturers (OEMs) are required to sell in California out to 2025. The baseline was developed using EMFAC2011 with several modifications, based in part on information released by ARB. The baseline for GHG emissions was developed using well-to-wheels emission factors rather than the tailpipe emission factors reported in EMFAC.
The baseline fleet in EMFAC was modified to account for the ZEV Program to estimate the baseline penetration of plug-in hybrid electric vehicles (PHEVs), battery electric vehicles (BEVs) and fuel cell vehicles (FCVs) out to 2025. Beyond 2025, we assumed PEV sales as a percent of total vehicle sales would remain constant, since there is no regulatory driver of PEV sales in these years. See Table 1 for penetration rates reported as new vehicle sales.
Table 1. Percent new vehicle sales for Baseline
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The baseline vehicle penetrations for PHEVs, BEVs, and FCVs were calculated based on new vehicles sales in the Bay Area region. New vehicle sales were based on statewide projected sales in 2011 and sales data from the California New Car Dealers Association (CNCDA). The Bay Area accounts for approximately 20% of vehicle sales in California; furthermore, vehicles sales were estimated to increase at an annualized rate of about 1.4% out to 2035, based on growth rates extracted from EMFAC.
The baseline GHG emissions also account for the Low Carbon Fuel Standard (LCFS) by subtracting the GHG reductions attributable to PHEV, BEV, and FCV use in the Bay Area and adjusting the carbon intensity of gasoline to reflect the remaining reduction required to comply with the regulation.
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<table>
<tr><td>Assumptions & Methodology</td><td>
In the baseline, it was assumed that 30% of miles traveled by PHEVs would be in charge depleting mode or electric miles. Based on the increased availability of chargers throughout the Bay Area, this percentage is increased to 75%.
To increase the electric miles traveled by PHEVs, a regional network must provide drivers an opportunity to plug-in, particularly while at work, as this is where most vehicles will spend most of their time parked when not at home. Due to the focus on PHEVs, the regional charger network would provide incentives for the installation of Level 1 chargers (75%) and Level 2 chargers (25%).
With an upper limit of 16 kWh for the battery size of a PHEV, the time to recharge to full capacity is about 7 hrs and 3 hrs for a Level 1 and Level 2 charger, respectively.
Assumed costs of $1,000 for Level 1 chargers installed (high estimated) and $2,500 for Level 2 chargers installed (medium estimate).
There were no assumptions made regarding a shift in fleet make-up as a result of charger availability. It is conceivable that the increased availability of Level 2 chargers could increase the sales of BEVs; however, this is difficult to justify as fast chargers are more likely to induce demand than Level 2 charging. Similarly, there is a cap on the amount of credit that OEMs can earn as a result of selling PHEVs, so there is not a regulatory driver for increased PHEV sales beyond what was assumed in the baseline.
</td></tr>
<tr><td>Analysis Steps</td><td>Emissions

ICF developed an emissions calculator for the Bay Area; a simple modification of the percentage of miles traveled in charge depleting mode from 30% to 75% yields a GHG emissions reduction.
There were no changes made to the VMT.

Costs

On a strictly linear basis, approximately 75% of all PHEVs would require access to a charger at any given time to achieve the increased electrification goal of this strategy. However, by 2035, we assume that chargers will have improved capabilities and that it will be possible to plug-in multiple vehicles to a single charge point and stagger the charging so that each vehicle returns to full state of charge (SOC). We estimate a ratio of 1 charger for every 2 vehicles by 2035.
Multiply estimated number of chargers by installed charger costs.
</td></tr>
<tr><td>Results</td><td>Reduces 810 shorts tons of CO_2 daily in 2035; a 0.9% reduction in daily per capita emissions from 2005 levels. Total escalated cost estimated at approximately $240 million.</td></tr>
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3.2 Vehicle Buy-Back & Plug-In Hybrid Electric Vehicles or Battery Electric Vehicles Purchase Incentives

<table>
<tr><td>Objective</td><td>Establish a vehicle buy-back program where consumers may trade-in an older vehicle that meets a certain mpg threshold in exchange for the purchase of a PHEV or BEV.</td></tr>
<tr><td>Context</td><td>The vehicle buy-back program is designed as a trade-in program for older vehicles that meet a certain mpg threshold. The consumer is only eligible for the trade-in if the new vehicle being purchased is a PHEV or BEV. The incentive amount varies with the fuel economy of the vehicle being traded in (measured in mpg) as well as the vehicle type being purchased (e.g., PHEV or BEV).</td></tr>
<tr><td>Baseline Information</td><td>EMFAC 2011 does not include baseline assumptions regarding the vehicle fleet as a result of the recent Advanced Clean Cars Program. This program impacts the percentage of zero emission vehicles (ZEVs) that original equipment manufacturers (OEMs) are required to sell in California out to 2025. The baseline was developed using EMFAC2011 with several modifications, based in part on information released by ARB. The baseline for GHG emissions was developed using well-to-wheels emission factors rather than the tailpipe emission factors reported in EMFAC.

The baseline fleet in EMFAC was modified to account for the ZEV Program to estimate the baseline penetration of plug-in hybrid electric vehicles (PHEVs), battery electric vehicles (BEVs) and fuel cell vehicles (FCVs) out to 2025. Beyond 2025, we assumed PEV sales as a percent of total vehicle sales would remain constant, since there is no regulatory driver of PEV sales in these years. See Table 1 for penetration rates reported as new vehicle sales.

Table 2. Percent new vehicle sales for Baseline

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The baseline vehicle penetrations for PHEVs, BEVs, and FCVs were calculated based on new vehicles sales in the Bay Area region. New vehicle sales were based on statewide projected sales in 2011 and sales data from the California New Car Dealers Association (CNCDA). The Bay Area accounts for approximately 20% of vehicle sales in California; furthermore, vehicles sales were estimated to increase at an annualized rate of about 1.4% out to 2035, based on growth rates extracted from EMFAC.

The baseline GHG emissions also account for the Low Carbon Fuel Standard (LCFS) by subtracting the GHG reductions attributable to PHEV, BEV, and FCV</td></tr>
</table>

	use in the Bay Area and adjusting the carbon intensity of gasoline to reflect the remaining reduction required to comply with the regulation.

Assumptions & Methodology	• There are two aspects of a vehicle buy-back program which can reduce GHG emissions: the first is attributable to the accelerated turnover of vehicles and the second is due to the accelerated deployment of PEVs.
	  ◦ To estimate the GHG benefit of the accelerated turnover of vehicles as a result of the program, this analysis estimates a fuel economy improvement of 0.50%. The fuel economy improvement was estimated based on displaced older vehicles in the fleet (>10 years old).
	  ◦ To estimate the GHG benefits of the increased deployment of PEVs, the analysis starts with the question of how many vehicles would need to be deployed to achieve X% of GHG emission reductions? Based on the number of vehicles, it estimates the average annual increase in new vehicle sales that would be required to achieve the total PEV deployment.
	• Based on new sales of PEVs by about 15-22% annually compared to baseline new vehicle sales, this amounts to nearly 96,000 new PEVs on the road by 2035 as a result of this program (increased from about 450,000 estimated vehicles on the road in the Bay Are for the baseline scenario).
	• For the initial analysis, it is assumed that the deployed vehicles would be split 50/50 between PHEVs and BEVs.
	• It is assumed that the incentive level would average about $1,000 per PHEV and $2,000 per BEV.

Analysis Steps	**Emissions** 1. Decrease number of vehicles older than 10 years based on estimated PEVs deployed as part of program. 2. Estimate fuel economy improvement based on accelerated turnover. 3. Calculate GHG emissions of improved fleet fuel economy. 4. Calculate GHG emissions of increased PEVs deployed. **Costs** 1. Multiply number of PHEVs and BEVs deployed (assumed 50/50 split) as part of program by incentive level ($1,000 and $2,000, respectively).
Results	Estimated reduction of 721 short tons of CO_2 daily in 2035, a 0.8% reduction in daily per capita emissions from a 2005 baseline. Total escalated estimated costs of $180 million. Costs scale linearly if one holds the 50/50 split between PHEVs and BEVs constant over the life of the program. In other words, to achieve a 1.7% reduction, the cost would be an estimated $365 million.

3.3 Car Sharing

Objective	Encourage car share expansion through support of new support services in the North Bay and South Bay.
Context	Car sharing will continue to grow in the Bay Area, resulting in VMT reduction among car share members as well as lower emissions for travel in car share vehicles. In addition to growth among traditional car share services (City CarShare, Zipcar), new peer-to-peer and 1-way car share services are likely to attract additional users. MTC can encourage car share expansion through support for new support services in the North Bay and South Bay.
Assumptions & Methodology	• Membership in car share organizations has grown rapidly over the last 10 years and now totals approximately 60,000 in the Bay Area. However, the historic rapid growth rate cannot continue through 2035. To estimate car share membership in 2035, we rely on several sources that suggest that as much as 15% of the eligible population will become members. The eligible population is defined as adults (age 20-64) living in TAZs with population density greater than 10 persons per acre. The threshold of 10 persons per acre is selected based on the density of MTC superdistricts that currently support carsharing (1-4, 18, 19). • Research by Cervero[1] suggests that car share members drive 7 fewer miles per day than non-members. • When members drive in car share vehicles, their per-mile emissions are lower because car share vehicles are more fuel efficient than average. Research by Martin and Shaheen[2] suggests that the car share fleet uses 29% less fuel per mile, a difference we assume will persist to 2035.
Analysis Steps	**VMT reduction** 1. Calculate the 2035 population eligible for car share membership by summing the adult (age 20-64) population in TAZs with density greater than 10 persons per acre. (2,093,829 persons) 2. Calculate 2035 car share membership assuming 15% of eligible population becomes a member. (314,074) 3. Calculate VMT reduction assuming 7 fewer miles driven per day per member. (2,198,520 VMT eliminated) **Emissions** 4. Calculate emission benefit of VMT reduction using Bay Area fleet average 2035 CO_2 emission factor. (880 metric tons)

[1] Cervero, Golub, and Nee, "City CarShare: Longer-Term Travel-Demand and Car Ownership Impacts." *Transportation Research Record* 1992, 2007, pp. 70-80

[2] Martin and Shaheen, "Greenhouse Gas Emission Impacts of Carsharing in North America**",** MTI Report 09-11 , 2010.

	5. Calculate miles driven in car share vehicles using membership estimate and assumption of 1,200 annual miles per year, based on Martin and Shaheen[3]. Calculate emission benefit as 29% reduction from the emissions using the Bay Area fleet average CO2 factor. (120 metric tons) 6. Sum two sources of emission reduction. (1,101 short tons) **Costs** **7.** Assume MTC funding to establish car share offices in the North Bay and South Bay as support for car share pods in those areas. Start-up costs for each office is $1,769,000.
Results	Reduces 1,101 short tons of CO_2 daily in 2035. This reduces the daily per capita emissions reduction by 1.2% from 2005 levels. Total escalated cost is $4 million.

[3] Martin and Shaheen, "Greenhouse Gas Emission Impacts of Carsharing in North America**",** MTI Report 09-11 , 2010.

3.4 Vanpools

Objective	Increase MTC's 511 vanpool program incentive to be $400/month/van for as long as the vanpool operates.
Context	MTC has coordinated a vanpool program since 1981 to help encourage alternative commutes and reduce congestion and emissions. To date, MTC's 511 vanpool program recruitment has consisted of online passenger and driver matching, employer outreach, up to $500 for start-up fees, up to $100/year to encourage continued participation when a passenger is lost, free bridge tolls, and various other incentives. With these basic incentives there is an operational vanpool fleet in the Bay Area; however, there has been a significant decrease in the number of vans in recent years. The current fleet numbers 515 vans.
Assumptions & Methodology	• This analysis assumes that MTC's current 511 vanpool program will grow by roughly 9% with the implementation of a $400/month/van incentive. This growth rate is based upon the SANDAG's vanpool incentive program, which offers $400/month/van for as long as the vanpool operates. They have offered this monetary incentive to their vanpool participants since its inception in 1995 and have seen a 9% growth in their program. It is assumed that by offering the same incentive program the Bay Area will see the same growth rate as San Diego. This growth rate roughly matches the growth rate that the Bay Area vanpool program experienced between 1991 and 1996 which indicates that in times of strong economic growth it is likely that there will be large uptakes in vanpool program participants. Vanpool growth is also likely to be encouraged over the course of the Plan horizon due to increasing gas prices and an increase in vanpool amenities such as Wi-Fi, GPS, and travel information. • It is assumed that the current 10.8 passenger average per van and the average round trip of 116.4 miles are maintained through 2035. • It is also assumed that without the vanpool program the vanpool participants would reflect the mode share of the general population that travels more than 30 miles to work. Carpools that are represented as 3+ people in MTC's travel demand model are estimated to have an average of 3.5 people per carpool. • Vanpool participants are highly committed to their van as their mode of transportation for their commute trip. Therefore, it is assumed that the participants use the vanpool for their commute 250 days/year.
Analysis Steps	**VMT reduction** 8. Calculate the number of vanpools in 2035 using a 9% annual growth rate (1,526 vans) 9. Calculate the 2035 commute mode share for trips over 30 miles (67% SOV, 11% 2 Person HOV, 5% 3+ Person HOV, 17% GHG free modes) 10. Calculate the number of trips reduced in 2035 assuming vanpool participants would match the mode split identified in step 2 if there was no

	vanpool, 10.8 passengers/van (9.8 when the van driver is subtracted), 250 days/year (38,929 trips) 11. Calculate the VMT reduced assuming vanpool tours of 116.4 miles/day (321,304,832 miles) **Emissions** 12. Calculate emission benefit of trips and VMT reduction using EMFAC2011 2035 CO2 emission factors. (567 short tons daily) **Costs** **13.** Assume MTC funding for 2 year start-up costs for the new higher incentive and then NTD reporting funds will cover on-going costs of the program. ($6 million YOE)
Results	Reduces 567 short tons of CO_2 daily in 2035. This reduces the daily per capita emissions by 0.6% from 2005 levels. Total escalated cost of the program is $6 million.

3.5 Clean Vehicles Feebate Program

<table>
<tr><td>Objective</td><td>Create a feebate program that offers a rebate on the purchase of a vehicle that emits less on a grams per mile basis than a standard and applies a fee to any vehicle that emits more than the standard.</td></tr>
<tr><td>Context</td><td>Originally coined in the 1990s, feebate programs have typically been used to shift buying habits in the transportation and energy sectors. MTC proposes to use a feebate program to incentivize consumers to scrap older vehicles and purchase higher performing, cleaner vehicles.</td></tr>
<tr><td>Baseline Information</td><td>
EMFAC2011 does not include baseline assumptions regarding the vehicle fleet as a result of the recent Advanced Clean Cars Program. This program impacts the percentage of zero emission vehicles (ZEVs) that original equipment manufacturers (OEMs) are required to sell in California out to 2025. The baseline was developed using EMFAC2011 with several modifications, based in part on information released by ARB. The baseline for GHG emissions was developed using well-to-wheels emission factors rather than the tailpipe emission factors reported in EMFAC.
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The baseline GHG emissions also account for the Low Carbon Fuel Standard (LCFS) by subtracting the GHG reductions attributable to PHEV, BEV, and FCV use in the Bay Area and adjusting the carbon intensity of gasoline to
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	reflect the remaining reduction required to comply with the regulation.
Assumptions & Methodology	• Analysis draws heavily from results reported by Bunche & Greene analysis for ARB[4]. The major benefits of the feebate programs analyzed by Bunch & Greene are attributable to the first several years of the program. From p16 of the report: "In later years the level of GHG emissions reduction relative to the standard diminishes as the standard becomes more stringent." • This analysis assumes that the feebate program is introduced in 2020. It does not assume any increases in fuel economy standards at the state- or national-level after 2016. • To maintain consistency with the Bunch & Greene study, this analysis assumes a $20 per g/mi feebate rate in a single benchmark system. Based on a sensitivity analysis performed by Bunch & Greene, an increase to $30 per g/mi feebate rate will yield a 50% increase in the GHG reductions. • This analysis also assumes that the program is designed to be revenue neutral, but that administrative costs are covered by MTC. Bunch & Greene estimate about $4.6-$6.5 million annually for a statewide program with an additional $2-$4 million in startup costs. The program largely scales linearly with the total fees collected, estimated at about 1% of total fees collected. This analysis assumes that the Bay Area represents about 21% of the entire California market.
Analysis Steps	**Emissions** 1. Estimate the improvement in fuel economy (back-calculated based on grams per mile estimates) of the new vehicle fleet due to feebate program. Maximum improvement at the outset of the program is about 4.2%; by 2035, the improvement is reduced to 2.3%. 2. Based on vehicle turnover, estimate modified fuel economy of entire fleet after change to improved fuel economy of new vehicles as of 2020 due to feebate program. 3. Calculate differential in well-to-wheels emissions of modified fleet versus baseline fleet. **Costs** 1. Estimate initial start-up costs. Start-up costs assumed to be comparable to Bunch & Greene analysis. 2. Estimate annual costs by scaling statewide costs to size of Bay Area market, assuming that the cost of the program scales with the total fees collected.
Results	Estimated 635 shorts tons per day of CO2, yielding a 0.7% reduction in daily per capita emissions from a 2005 baseline. Total escalated cost estimated at $25 million.

[4] Greene, David L. & Bunch, David S., "Potential design, implementation, and benefits of a feebate program for new passenger vehicles in California", Prepared for the California Air Resources Board, Contract UCD 08-312, February 2011.

3.6 Smart Driving Strategy

Objective	Implement a Smart Driving Strategy that includes a) social marketing campaign, b) tire pressure cap rebate program, and c) in-vehicle fuel economy meters rebate program.
Background **Behavior Change**	Changing unwanted behavior isn't easy, but our country has been successful at changing ingrained habits before. Over the past four decades, we have seen smoking rates decrease and recycling rates increase, through awareness, government involvement, and application of tools to assist with the desired behavior. Driving, like recycling, is a habit ingrained through years of unconscious action. Smart driving is a shift in our ingrained driving behavior through conscious choice, creating change that may one day become as natural as recycling a Diet Coke can. Researchers have estimated that it is possible to affect significant and swift reduction in emissions through behavior change, producing an even steeper reduction in emissions than through other means, such as manufacturing more fuel-efficient vehicles or transitioning to renewable energy, as these changes will take time to accomplish. This behavioral wedge, they argue, buys us time as we put in place policies that will significantly reduce future emissions[5]. Smart driving is a good example of how behavior change can quickly reduce emissions. Smart driving behaviors are easy-to-implement actions (e.g., change in driving style, vehicle maintenance, etc.) that any driver can do. The concept of smart driving behaviors actually impacting fuel efficiency and emissions is starting to catch-on both in and out of the United States. Fiat's 2009 European study[6] and a 2011 San Diego study[7] conducted by a smart driving technology company are examples. In both studies, steady acceleration, efficient deceleration, maintaining an average steady speed, all contributed to fuel efficiency, by as much as 22%. The studies found that training of the driver, awareness of driving style, and technology that can assist the driver while driving, can contribute the most. How do we begin to change ingrained habits as a community? Increasingly,

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[5] Community Based Social Marketing website, Fostering Sustainable Behavior, http://www.cbsm.com/pages/guide/fostering-sustainable-behavior/, accessed April 26, 2012

[6] Eco-driving Uncovered, Fiat Motor Company, 2009

[7] Businesswire website, New SmartDrive Study Reveals Techniques to Improve Fuel Economy 18.7% in Public Transit Fleets, http://www.businesswire.com/news/home/20120329005452/en/SmartDrive-Study-Reveals-Techniques-Improve-Fuel-Economy, accessed April 27, 2012

	those who develop and deliver programs to promote behavior change are turning to community-based social marketing (CBSM) for assistance. This kind of marketing emphasizes direct, personal contact among community members and the removal of barriers (i.e., "roadblocks" to behavior change) since research suggests that such approaches are often most likely to bring about changes in behavior[8]. MTC has begun our own CBSM smart driving program, which, if implemented fully, will greatly contribute to our greenhouse gas emission reduction target. We are in the process of implementing the following three smart driving pilots using: 1) In-vehicle devices, using miles per gallon (MPG) savings devices that will be installed into participants' vehicles, displaying MPG information for vehicle acceleration and deceleration, and showing MPG savings in real-time; 2) Tire pressure caps, to encourage timely inflation, improving MPG and driver safety; and 3) MPG mobile apps, similar to the in-vehicle device pilot in a telephone app. format. This pilot will be conducted in conjunction with ITS-Davis. Each pilot will be evaluated for its ability to effect change in pilot participant's behavior and, ultimately, reduce GHG emissions.
Context	Smart driving, also called eco-driving, refers to techniques drivers can use to maximize their mileage while saving fuel and minimizing tailpipe emissions. Simple maneuvers include accelerating slowly, avoid sudden braking, keeping tires properly inflated, and maintaining a steady speed. University of California researchers estimate that smart driving techniques can cut fuel use by 10 to 20 percent. Furthermore, University of Michigan researchers found that vehicle selection and factors that a driver has control over (such as vehicle maintenance, route selection, and driver behavior) can contribute a total of 45 percent in the on-road fuel economy per driver[9]. The Smart Driving Strategy proposed by MTC involves the following program elements: • **Social Marketing Campaign**: A smart driving campaign focuses on changing behavior of drivers so that they may drive more efficiently, maintain their vehicles, and drive less. • **Tire Pressure Caps**: Proper tire inflation improves fuel efficiency. Tire pressure caps are simple devices that screw onto tire valves and

[8] Natural Resources Canada website, An Overview of Community Based Social Marketing, http://oee.nrcan.gc.ca/communities-government/transportation/municipal-communities/7867, accessed April 26, 2012

[9] Sivak, M., and Schoettle, B., "Eco-Driving: Strategic, Tactical, and Operational Decisions of the Driver that Improve Vehicle Fuel Economy", UMTRI-2011-34, August 2011

	visually display to vehicle owners when tire pressure is low. • **Fuel Economy Meters**: In-vehicle MPG meters display to drivers their real-time fuel economy as they are driving. This allows drivers to understand that behaviors such as sudden accelerations and speeding reduce their fuel efficiency and teaches them to reduce or eliminate those behaviors from how they drive.
Assumptions & Methodology	**Social Marketing** • Rapid acceleration and deceleration, and speeding can lead to fuel economy reductions from 5% on city streets to 33% on freeways[10]. On average it is assumed that residents that adopt this behavior will improve their fuel efficiency by 20%. Reducing aggressive driving should become a habit but there will always be situations where drivers feel rushed and do not follow the advice. For this reason it is assumed that reducing aggressive driving is only practiced 50% of the time. • Linking trips is the practice of combining several trips into one larger trip by not returning home (or back to work) between locations. This smart driving technique focuses on eliminating vehicle miles traveled rather than improving fuel economy. It is assumed that the driver links 3 shopping trips per week (effectively reducing 2 trips). • MTC currently offers several trip planning tools through www.511.org. For drivers, there is a real time and predicted future traffic information page which allows drivers to plan their trips to avoid congested routes. By avoiding congested routes and eliminating idling in traffic it is assumed that drivers can improve their fuel efficiency by 10% which is on the low end of research conducted by Facanha[11]. Trip planning is difficult to practice 100% of the time since it requires access to the internet or traffic news and advance planning; therefore, it is assumed that drivers plan their trips only 50% of the time. • This campaign would be implemented through a traditional media format as well as social marketing. Preliminary estimates indicate $1million of advertising can purchase 4,000,000 TV views, 5,000,000 radio listeners and 15,000,000 online hits. • The public needs to see/hear an advertisement multiple times before recognizing the message and being able to practice the requested behavior change. It is assumed that 12 views are needed before the resident will internalize the message. • After a message is internalized the viewer must decide if this behavior is one that they could practice with their lifestyle. In February 2011 MTC conducted a Baseline Climate Initiatives Survey which asked Bay Area

[10] US Department of Energy, Office of Energy Efficiency and Renewable Energy, US Environmental Protection Agency, *Model Year 2005 Fuel Efficiency Guide*, DOE/EE-0302

[11] Cristiano Facanha, "Effects of Congestion and Road Level of Service on Vehicle Fuel Economy", Transportation Research Board's 88th Annual Meeting, Paper 09-0268, Washington, D.C. National Academy of Science, 2009.

residents about the ease of adoption of various emission reducing behaviors[12]. All of the smart driving strategies that this campaign will implement were tested for ease of adoption in the survey. It is assumed that the same percentage of the population that stated in the survey that the given behavior would be “easy” or “very easy” to adopt could adopt the behavior after viewing the advertisements.

- In order to adopt the desired behavior a resident must not only view the campaign and find the behavior easy to adopt but also be motivated to make a change (assuming that they were not practicing the desired behavior before viewing the campaign). Due to these limiting factors this analysis assumes that in the first year only 10% of people who viewed the campaign and stated that the behavior adoption would be easy actually adopt the behavior. Over the course of the campaign it is assumed that an additional 5% adopt the behavior. This leads to the assumption that in 2035 a total of 15% of the targeted market would be practicing the behavior.
- After a strong five year campaign the annual funding would be reduced from $5 million/year to $3 million/year.

Tire Pressure Caps

- Research by Energy and Environmental Analysis, Inc.[13] showed that “for every 1 psi drop in the pressure of all four tires, fuel economy declines by 0.3 percent.” Subsequent research by Pearce and Hanlon[14] indicated that in Cranberry, Pennsylvania the average under inflation in all 4 tires of vehicles was 2.639 psi. Due to a lack of local data it is assumed that this same average under inflation is applicable to the Bay Area. This is a conservative assumption since it is common for only one or two tires to be underinflated which would reduce fuel efficiency but in this analysis only vehicles that were under inflated in all four tires were included.
- It is also assumed that with tire pressure caps installed vehicle owners will keep their tires properly inflated 100% of the time.
- Tire pressure caps cost an average of $20/vehicle so 150,000 tire pressure caps could be distributed for a $3 million program. ($4 million YOE)
- Tire Pressure Sensors are required in new vehicles; however, they do not have the ability to alert the driver as to which tire is low. By identifying which tire has low pressure the owner is more likely to fill the tire. Additionally, the in-vehicle tire pressure monitors are a new technology that our model does not take into account which will offer even greater benefits to the region then this analysis is claiming.

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[12] MTC conducted a Baseline Climate Initiatives Survey in February 2011. It was a 15 minute random digit dial and cell phone sample of Bay Area driving age residents. It was offered in English, Mandarin, and Spanish and had an overall margin of error of ±3.5%.

[13] Energy and Environmental Analysis, Inc., Owner Related Fuel Economy Improvements, Prepared for: Oak Ridge National Laboratory, December 2001

[14] Joshua M. Pearce and Jason T. Hanlon, "Energy Conservation From Systematic Tire Pressure Regulation", *Energy Policy*, 35(4), pp. 26732677, 2007.

	Fuel Economy Meters • There is currently very little research completed on the long term effectiveness of fuel economy meters but the National Renewable Energy Laboratory (NREL)[15] has prepared a study on the potential fuel saving effectiveness of various driver feedback devices. Under this program MTC would offer a $100 rebate to consumers who purchase an OBD-connected after-market device. The NREL study estimates a potential fuel savings of 5.6% with these devices. • Assuming that MTC offered a $100 rebate 1,500,000 in-vehicle devices could be deployed for a $150 million program ($176 million YOE).
Analysis Steps	**Social Marketing:** 1. Calculate the annual number of advertisement views assuming 8,000,000 TV views, 5,000,000 radio listeners and 15,000,000 online hits per $1,000,000 spent advertising each strategy. In the first 5 years $2 million would go to advertising both reducing aggressive driving and trip linking while $1 million would be spent on trip planning. 2. Calculate the number of targeted impressions assuming 12 views are needed/impression. 3. Of the targeted impressions, calculate the number that view the behavior as “easy” or “very easy” based on MTC’s Baseline Climate Initiatives Survey. These are referred to as the potential adopters. 4. Of the potential adopters, calculate the number of behavior adopters assuming 15% of the potential adopters adopt the behavior by 2035. (392,000 aggressive driving eliminators, 420,000 trip linkers, 199,500 trip planners) **Trip Linking:** 5. Multiply the number of trip linking behavior adopters by the number of trips they are assumed to eliminate per week (2 trips/week) by the number of weeks per year (50 weeks). 6. Multiply the number of eliminated trips by the average shopping trip length (4.2 miles) from MTC’s travel demand model to determine the annual VMT reduced from trip linking (176,789,559 miles/year) **Emissions Reductions** 1. **Trip Linking:** a) Calculate emission benefit of trip and VMT reduction using EMFAC2011 2035 CO_2 emission factors. (81,968 short tons annually) **2. Aggressive Driving, Trip Planning, Tire Pressure Caps, In-Vehicle MPG Meters:** **a)** Calculate the average daily miles per vehicle [VMT per day per

[15] Jeffrey Gonder, Matthew Earleywine, and Witt Sparks, “Final Report on the Fuel Saving Effectiveness of Various Driver Feedback Approaches”, National Renewable Energy Laboratory, NREL/MP-5400-50836, March 2011

	passenger vehicle] using MTC's travel demand model (35.62 miles). b) Calculate the daily miles that will be affected by the program component by multiplying the number of vehicles adopting the program component by the average daily miles. (Aggressive Driving: 13,963,040; Trip Planning: 7,106,190; Tire Pressure: 5,343,000; MPG Meter: 53,430,000). c) Calculate the daily CO2 emissions from those miles using EMFAC2011 2035 CO2 emission factors (Aggressive Driving: 6,157; Trip Planning: 3,134; Tire Pressure: 2,356; MPG Meter: 23,562) d) Solve the equation below for y substituting the expected percent increase in fuel economy of the various program elements for x (Aggressive Driving: 16.46%; Trip Planning: 8.49%; Tire Pressure: 0.05%; MPG Meter: 4.59%). **Greenhouse Gas Emissions and Fuel Economy Relationship Curve Equation**[σ] $y = -0.0062x^2 + 0.9832x - 0.7206$ **x** = % increase in fuel economy **y** = % reduction in fuel consumption or CO_2 emissions e) Calculate the daily emissions reductions by applying the percent reduction in fuel economy/CO2 (y) to the original daily CO2 emissions from the vehicles [step c] (Aggressive Driving: 1,014; Trip Planning: 266; Tire Pressure: 1; MPG Meter: 1,082) f) Reduce the daily emissions reductions by the percent of trips that drivers are expected to practice the program element (Aggressive Driving: 50%, 507 tons; Trip Planning: 50%, 133 tons; Tire Pressure: 100%, 1 tons; MPG Meter: 100%, 1,082 tons) **Costs** 1. **Social Marketing Campaign:** Initial advertising costs for the campaign are assumed to be $5 million/year for advertising and program management/development. After five years the campaign spending can be reduced to $3 million/year to remind Bay Area residents to continue practicing the elements of the original campaign ($50 million YOE). 2. **Tire Pressure Caps:** 150,000 tire pressure caps would require a $3 million program. ($4 million YOE) 3. **In-Vehicle MPG Meters:** MTC's $100 rebate could deploy 1,500,000 in-vehicle devices for $150 million. ($176 million YOE)
Results	Reduces 1,957 short tons of CO_2 daily in 2035. This reduces the daily per capita emissions reduction by 2.2%. Total escalated cost of the program is $230 million.

3.7 Commuter Benefit Ordinance

Objective	A Commuter Benefit Ordinance (CBO) would establish a requirement for all employers above some minimum threshold size to provide commuter benefits to their employees. Options for employers to meet the ordinance would include providing free or subsidized transit passes, providing the option to purchase transit passes using pre-tax income, and providing shuttles for employees from transit stations and/or residential areas to the worksite. This CBO is modeled on the recent successful implementation of the same requirement by the City and County of San Francisco in 2008 and proposed legislation SB 1339.
Assumptions & Methodology	• The ordinance would apply to all employers with 50 or more employees. • Assumes a unilateral shift from SOV to modes that do not generate new vehicle trips: sharing a ride in a vanpool or personal vehicle already on the road, taking transit, or using non-motorized modes. • Some employers already offer the types of benefits mandated by the CBO. In San Francisco, 46% of employers already offered one of the required benefits before implementation of that city's ordinance.[16] Accordingly, this anaysis estimates that 46% of employees in the Bay Area would not receive any new benefit as a result of the ordinance. This is a conservatively high estimate when applied to areas outside of San Francisco. • Approximately 80% of employers in San Francisco who are subject to the ordinance offer only a pre-tax transit benefit. This is the lowest cost option for employers and is therefore assumed to be the compliance path that most employers will choose. To be conservative, we assume that 100% of employers choose the pre-tax transit benefit. This option allows employees to purchase transit passes using pre-tax income—a discount of roughly one third for a typical employee. • Empirical research indicates that the long term elasticity of auto trips with respect to transit fares is between 0.15 and 0.3. These figures are synthesized by Litman from several research studies.[17] They represent average effects in a variety of urban contexts. To be conservative, the low end of the range is used here. With transit costs reduced by one third, 5% of drivers would be expected to switch to transit. • Annual impacts were estimated assuming 250 working days per year. This method conservatively assumes that commuter benefits programs have an effect only during the standard work week, and not for workers commuting on weekends or holidays.

[16] Data supplied by San Francisco Department of Environment

[17] Litman, Todd, "Transit Price Elasticities and Cross-Elasticities," Journal of Public Transportation, vol. 7, No. 2, 2004, p 53

Analysis Steps	**VMT Reductions** 1. Calculate baseline estimates of daily commute tours by employment location (MTC superdistrict) and travel mode from MTC's travel demand model. 2. Estimate the percentage of employers (and employees) that meet the 50 employee threshold with data from Zipcode Business Patterns (ZBP) (2008 was used). 3. Match employer data from ZBP for each zipcode to MTC superdistricts using GIS software to get the number of employers that meet the 50 employee threshold within each superdistrict. 4. Reduce the number of commute tours for employers subject to the size threshold and not previously providing a commuter benefit by 5% 5. Calculate the average trip lengths by mode and superdistrict, generated by MTC's travel demand model. 6. Calculate the reduction in VMT from the reduced commute tours and the average trip lengths (578,758 miles) Emissions Reductions 1. Calculate emission reductions using per mile and trip end emission factors from EMFAC2011. 2. Calculate annual impacts assuming 250 working days per year. Cost 1. MTC needs not bear any costs after assisting the ordinance legislation to be passed.
Results	Reduces 226 short tons of CO_2 daily in 2035. This reduces the daily per capita emissions reduction by 0.3%. There are no implementation costs for MTC.