

**Greenhouse Gas Emission Measurement
in the Transportation Sector:
Status, Problems and Possible Solutions**

August 2007

Report by Jehan Sparks, Intern

Climate Protection Campaign

www.climateprotectioncampaign.org



Big Vision, Bold Action

Greenhouse Gas Emission Measurement in the Transportation Sector: Status, Problems and Possible Solutions

Table of Contents

	Page
I. Executive Summary	3
II. Introduction	4
III. Findings	
A. VMT Monitoring: Technical VMT Modeling using Databases	4
B. VMT Forecasting	5
C. VMT/GHG Emissions Modeling	5
D. Need for Better VMT Data at the Local Level	6
IV. Possible Solutions	7
V. Recommendations	8
VI. Appendices	
A. Interview Notes	9
B. Monitoring and Forecasting CO ₂ , Chuck Purvis	23
C. Letter to Metropolitan Transportation Commission from Berkeley Mayor Tom Bates	26
D. Skymeter: Vehicle Location Billing	27
E. Letter to California Transportation Commission from State Senator Don Perata	29
F. Transportation Contacts	31
G. Transportation Acronyms	32
H. About the Author	33

Acknowledgements

Many thanks to the following people who were essential to producing this report: Bill Allayaud, Sierra Club; Harold Brazil, MTC; Chris Brittle, MTC; David Burch, BAAQMD; Timothy Burroughs, City of Berkeley; Frances Dahlquist, PG&E; Irvin Dawid, Sierra Club; Ann Hancock, Climate Protection Campaign; John Holtzclaw, Sierra Club; Roland James; Doug Kimsey, MTC; Bob McCleary, CCTA; John Mikulin, CED; Chuck Purvis, MTC; Williard Richards; Bruce Riordan, Elmwood Consulting; Henk Schouten, PG&E; Joel Woodhull, SCTL; Anna Marie Young, CTC.

I. Executive Summary

Vehicle Miles Traveled (VMT) is a measure of the total distance traveled by motor vehicles in a certain geographical region over a specified period of time. Accurate VMT data is crucial for assessing the impacts of policies to promote climate protection. By tracking VMT accurately over time, jurisdictions (e.g., regions, counties, and cities) can evaluate the effectiveness of their transportation policies aimed at reducing greenhouse gas (GHG) emissions.

The Transportation Sector is responsible for approximately 50 percent of GHG emissions in the Bay Area¹. California's Global Warming Solutions Act, AB 32, established the goal of reducing GHG emissions to 1990 levels by the year 2020. Local governments taking on the climate protection challenge and striving to reduce GHG emissions in their jurisdictions have been thwarted in measuring the effectiveness of their policies in the transportation sector. However, new ideas and technologies can dramatically improve their measurement capabilities.

In California three databases are used to determine VMTs: the Highway Performance Monitoring System (HPMS), the California Bureau of Automotive Repair Biennial Inspection/Maintenance Data (BAR I/M Data) or Smog Check database, and the California Department of Motor Vehicle (DMV) registration database. VMT for the Bay Area is forecast using the Metropolitan Transportation Commission's (MTC) Travel Demand Model, which is based on many assumptions whose realism is questioned by experts in the field. GHG emissions are calculated using VMT data from the California Air Resource Board's (ARB) EMFAC emissions model, and the modeling software BURDEN, which estimates emissions at the county level. Because several different models are used to determine VMTs, it is very difficult to track GHG emissions in the transportation sector with minimal error and in a standardized manner. Currently no system is being used to measure directly the movement of vehicles within a region, and the current system magnifies estimation errors for smaller jurisdictions whose forecasts are based on data for larger regions.

There are very few VMT modeling experts, so the problem of coordinating efforts is not insurmountable. To date, however, little cross-pollination of ideas has occurred, and the field of experts is not close to reaching a consensus on how best to measure VMTs.

Those interviewed as part of this project suggested several improvements for tracking VMT. These suggestions include direct tracking of gas and diesel sales at the source, indirect tracking by improving our HPMS data or requiring the DMV to collect more information at yearly vehicle registration, and implementing a GPS system to track vehicle miles and movement for a representative sample of vehicles based on type of vehicle and type of commute (e.g., highway versus city streets).

This report encourages stakeholders to align and coordinate to improve VMT measurement. Transportation agencies are well positioned to assume responsibility for spearheading this effort, and leaders in the climate area should lend their encouragement and support.

¹ "Source Inventory of Bay Area Greenhouse Gas Emissions," Under GHG Emissions by Major Categories, BAAQMD, November 2006, http://www.baaqmd.gov/pln/ghg_emission_inventory.pdf

II. Introduction

Tracking emissions from transportation is crucial for climate protection because this sector is responsible for approximately 50% of greenhouse gas (GHG) produced in the Bay Area. Based on projected population, economy, and VMT growth, emissions from transportation will inevitably rise in the next few decades despite increased fuel efficiency (but less so, if new vehicle fuel efficiency standards are implemented, e.g. AB 1493, Pavley). The current VMT tracking system is based on multiple assumptions and future projections which lead to an inability to accurately monitor progress in reducing GHG emissions at various geographic levels, e.g., state, regional, and local. It would be particularly helpful to improve the local tracking mechanisms for cities and counties wishing to implement new green programs.

III. Findings

Speaking with experts at smaller Metropolitan Planning Organizations (MPOs), non-profits with passionate activists, and larger government-funded groups like the California Transportation Commission (CTC), I received a variety of complaints and many vague answers while probing how we measure VMT and the accuracy of this measure (Appendix A: Interview Notes). I conclude that the field of experts for modeling VMT is small and individuals at the various organizations appear to be motivated and informed by their surrounding colleagues and their area of expertise in climate protection with a transportation focus. Little cross-pollination of ideas has yet occurred and a broad consensus is not close at hand.

A. VMT Monitoring: Technical VMT Modeling using Databases

Transportation planner and analyst Chuck Purvis of the Metropolitan Transportation Commission (MTC) explains in his memo “Monitoring and Forecasting CO₂” (Appendix B), that monitoring GHG emissions implies tracking historical trends in recorded data from various databases. There are three main databases employed to record VMT data: Highway Performance Monitoring System (HPMS), California Bureau of Automotive Repair Biennial Inspection/Maintenance Data (BAR I/M Data), and the California Department of Motor Vehicle (DMV) Registration Database.

HPMS is a national statistical program used by Congress to determine and monitor road and highway conditions. VMT data is obtained from HPMS data, yet there are uncertainties in accuracy due to the sampling methodology for the HPMS system. Chris Brittle of the MTC thinks this uncertainty is a significant problem, and comments on the need to correct for the fact that some of the samples from HPMS are estimates. He suggests solutions like creating a more robust HPMS tracking system by expanding the number and type of roads sampled. This idea is discussed under Proposed Solutions.

BAR I/M Data is the Smog Check database. The California Air Resource Board (ARB) and the BAR created this database using BAR's biennial Smog Check odometer readings. John Mikulin of the California Environmental Dialogue elaborated on this issue by commenting that the VMT readings from vehicle odometers during biennial Smog Check inspections are accurate on an individual car basis, but problems arise when we try to determine total VMT for a state, region, or city. Legislation enacted in 2004 (SB 1107 and AB 2683) requires biennial smog checks for cars older than six years up to the 1976 model year². Because of these laws, many emissions are not accounted for, as newer cars are driven frequently and older cars have lower fuel economies. Furthermore, because the Smog Check database is solely an odometer reading, updating the system to include more detailed car information (e.g. low-emission vehicle technology) would be costly.

It is my understanding that the DMV's Registration Database is only released at the county level. The MTC suggests that the DMV, ARB, and California Energy Commission (CEC) work together to meet emissions data needs for the state, county, and municipal level. Currently, the ARB's BURDEN software is used to determine local VMT estimates, and issues with that model are discussed under VMT/GHG Emissions Modeling. It is important, as many of the experts I spoke with mentioned, to use two databases or methods for validating VMT data to ensure relative accuracy.

B. VMT Forecasting

The other element of VMT modeling is forecasting VMT and GHG emissions for future years. Forecasting is a projection of monitored data (from the above databases) for future years using socio-economic and travel demand models. Consequently, forecasting is subject to increased uncertainty because it contains additional assumptions. Databases are also used in the forecasting process of VMT and GHG emissions as well as in allocation of VMT and GHG emissions on a county or city level. Harold Brazil of the MTC described shortcomings of the MTC's forecasting database, the Travel Demand model. He stressed difficulty in determining the base year for VMT calculation, comparing Travel Demand Models to making wine, never completely uniform in output.

C. VMT/GHG Emissions Modeling

The ARB uses a model called EMFAC to generate emissions factors and emissions inventories. The modeling software, BURDEN, that employs the EMFAC model to produce emission inventories at the county level, is also used by the ARB. Chris Brittle of the MTC has analyzed various GHG inventories. He notes that there are inconsistencies in calculations of GHG emissions using ARB's EMFAC model and BURDEN software, the Caltrans Motor Vehicle Stock and Fuel Forecast MVSTAFF, and a "Combined" method developed by Brittle which uses average on road vehicle fuel economies for different types of vehicles from MVSTAFF together with VMT for those vehicle categories from EMFAC.

Concerns with EMFAC include delays in availability of DMV data affecting assumptions about vehicle fleet mix, the effect of high speed freeway travel on vehicle emissions, the

² "Vehicle Model Year Subject to Smog Check," BAR, http://159.145.15.175/ftp/pdffacts/vehicle_model_years_subject_to_smog_check.pdf

ability of EMFAC to project changes in future vehicle GHG emissions when these vehicles have not yet been tested, the effect of introducing alternative fuels into the fleet, etc. It will also be important to understand how the 1990 baseline transportation emissions are established in terms of addressing the State's AB 32 goal of reducing GHG emissions to 1990 levels by 2020³ (Brittle, Modeling Issues). Chris Brittle elaborated on some of the concerns over a key part of the GHG calculation, knowing the true on road vehicle fleet fuel efficiencies. In his internal memo, "GW Inventory Summary"⁴, he explained that it is difficult to get a good handle on the actual on road fuel efficiency of the future vehicle fleet, comparing information from ARB, Caltrans, the CEC, and the US Energy Information Agency (EIA). These agencies typically start with existing vehicle registration data and age the fleet over time using numerous assumptions. As one example of how the results can differ, MTC's application of EMFAC estimates a slight worsening of average fuel efficiency for the entire Bay Area vehicle fleet (including trucks) between 2015 and 2030, which is inconsistent with estimates from other sources.

The Caltrans model, MVSTAFF, forecasts fuel consumption by cars and trucks with a stratified rate model to project vehicle turnover and future year fuel economies by vehicle type. GHG emissions are calculated by converting gallons of gasoline and diesel consumed into CO₂ emissions. MVSTAFF has a very clear expression of the assumed on road fuel efficiency by vehicle type, but the method for estimating on road (vs. CAFÉ) fuel efficiency cannot be explained because it is embedded in a model developed many years ago. Another major issue with MVSTAFF is that the VMT estimates are not consistent with the VMT used by the MTC for its long-range planning and air quality conformity analyses (as required by the ARB). Thus, there is considerable variation in GHG emission estimates derived from EMFAC and MVSTAFF.

The final "Combined" method used by Brittle assumes the on road vehicle fuel efficiencies for different vehicle categories from MVSTAFF are reasonable and combines this data with ARB-based VMT for these vehicle categories from EMFAC. The strength of this method for estimating future GHG emissions is that it is easy to estimate the impact of new vehicle fuel efficiency standards (like the Pavley legislation) or other proposed changes in vehicle fuel economy on total GHG emissions for the Bay Area. It is also consistent with VMT estimated used for air quality conformity analyses.

Thus, as many experts agree, there is currently no reliable and accurate way to measure VMT and GHG emissions. The best estimate will use consistent assumptions with the most agreement.

D. Need for Better VMT Data at the Local Level

While not every transportation expert I interviewed understood the nuances of the technical side of modeling, most expressed serious concerns and labeled VMT measurement as problematic. Timothy Burroughs of the City of Berkeley described Mayor Tom Bates' letter to the MTC as an outline of the problems and issues associated with VMT (Appendix C: MTC Letter). Mayor Bates stressed that Berkeley needs better

³ Brittle, Chris. "Modeling Issues," internal MTC memo, April 20, 2007.

⁴ Brittle, Chris. "GW Inventory Summary," internal MTC memo.

municipal-level data on VMT, fleet comparison, and average fuel economy. VMT data for cities is typically derived from a regional model that does not give accurate enough information at the local level to monitor efforts to reduce GHG emissions. Furthermore, VMT data is only updated when the regional model is run, which can be as much as three to five years apart when the official forecasts are prepared for the updating of a long range plan or for a new air quality conformity analyses.

The most significant problem expressed by experts for obtaining local VMT estimates is a lack of technology for tracking vehicle movement within and between cities inside the Bay Area. Without a method to track vehicle movement it is nearly impossible to apportion VMT and the implied GHG emissions to individual cities. With individual cities and counties leading the way in policy measures and activism, the need for accurate VMT and GHG emissions data is a necessity to determine the strengths and weaknesses of GHG reduction policy strategies. Cities want incentives to cut back on GHG emissions. Local incentives can be the motivation needed to initiate actions that will accomplish global climate change goals. As Irvin Dawid of the Sierra Club commented, escalating GHG emissions resulting from increased VMT are only one aspect of auto-dependency. Shifting to a land use paradigm of 'smart growth' which emphasizes accessibility rather than mobility will also result in decreased sprawl, increased conservation of open space and farm land as well as reduced energy and water consumption, and increased walking, biking, and public transit ridership.

IV. Possible Solutions

While the majority of this report has focused on serious problems with the databases used for modeling VMT, I spoke with experts who applauded my efforts and gave me hope for the future of our transportation sector. I was lucky enough to test-drive PG&E's Plug-in Hybrid around Oakland and Berkeley. I was amazed not at the number of stares I received, but at the enthusiasm of fellow drivers, several of whom asked only one question: Where can I get one? Numerous ideas for tracking and modeling to estimate VMT were generated through my interviews. Chris Brittle, in his internal MTC memo "GHG Tracking Ideas"⁵, outlines a very accurate method called Direct Tracking. Direct Tracking would obtain GHG estimates at the source by tracking fuel sold at gas stations. GHG emissions could be directly calculated knowing the type of fuel sold. Drawbacks to this method at the regional level are that some of the gasoline sold would be to vehicles from outside the region; however, this percentage is not likely to be very large and on a year-to-year basis this would give us a more accurate trend line than current estimates. The same problem would arise on a smaller scale when attempts are made to assign GHG emissions to cities and counties using this method.

The next tracking idea, called Indirect Tracking, is to simply improve some of the databases we currently use. Through this method, we could implement a more robust traffic monitoring system to improve HPMS estimates. Another idea is to get newer vehicles to submit vehicle odometer readings at yearly vehicle registration, to improve

⁵ Brittle, Chris, "GHG Tracking Ideas," internal MTC memo, May 18, 2007.

the Smog Check database by increasing the sample to cars less than six years of age. Lastly, the DMV could obtain odometer readings and zip codes at yearly vehicle registrations, which would aid in the effort to track vehicle trips and avoid the problems associated with the Smog Check method. These changes will be difficult to implement, and legislation may be needed to further efforts. A more accurate measure of on road fuel efficiency for cars and trucks would also be required in order to convert VMT into GHG emissions.

The last category of tracking ideas involves installing GPS or RF transponders in vehicles to accurately track vehicle movement. A Pay-As-You-Drive System has been used in pilot programs for insurance pricing purposes in Oregon, Washington, and Europe with great success. Initial research suggests that pricing insurance by the mile based on driving habits, miles driven, speed, and time of day can cut VMT by five to fifteen percent⁶ (Appendix D: Skymeter: Vehicle Location Billing). Specifically, this idea hopes to cut costs of implementing GPS systems by using a survey to determine proportions of non-commercial vehicles owned by people who live and work in the same city of a region (e.g. inside the Bay Area) versus people who live in one city in the region and work in another city in the region. The same type of survey could be done for commercial vehicles. The survey would determine a sample size of vehicle types that accurately reflected the region. The GPS monitoring device would track where people drive the vehicle and the total miles driven each year. From this data, it is easy to divide by the miles per gallon to attain gallons. Data for gallons would be used to determine GHG emissions, which would be allocated to the various cities where driving took place. Modifications to the GPS system could include the type of driving (freeway or street) and speed to get more accurate measurements. John Holtzclaw of the Sierra Club suggested a simpler method of placing a tracking device on the engine itself, to at least track VMT if not monitor vehicle movement. Major drawbacks to a GPS-like system are cost and invasion of privacy issues; however, using a voluntary sample may reduce these problems. There is also uncertainty in the methodology for determining real world MPG.

V. Recommendations

A cost-benefit analysis of the possible solutions is needed to determine which method is most feasible and will have the largest impact. In particular, research on the GPS pilot programs in Oregon and Washington will be of great assistance. Coordination among city leaders, smaller MPO's, and larger government funded organizations promises to produce constructive solutions to the problems described in this report. Stakeholders need to agree on the definition and scope of the VMT problem. Agencies like the MTC, ARB, DMV/BAR, CEC, and CTC need to assume responsibility for solving the VMT measurement problem and devote time and resources to this pursuit. Leaders need to follow the examples set by Mayor Bates and Senator Perata and encourage responsible agencies to address these problems (See Appendix C and Appendix E.)

⁶ "Pay As You Drive Car Insurance." Sightline Institute. Seattle, WA, http://www.sightline.org/research/sust_toolkit/solutions/payd

VI. Appendices

Appendix A: Interview Notes

Interviews conducted by Jehan Sparks, Intern, Climate Protection Campaign

Allayaud, Bill:

Sierra Club, State Director

Thursday, July 26, 2007: 2:00PM via email

allayaud@sierraclub-sac.org

- Senate Bill 375 is an attempt to account for reduction in GHG gases through more compact development.

Brazil, Harold

MTC, Air Quality Planner/Analyst

Wednesday, August 8, 2007: 9:30AM

hbrazil@mtc.ca.gov

(510) 817-5747

- Expert on modeling in transportation and air quality planning
- Focus of MPO's (Metropolitan Planning Organizations), like the MTC:
 - Produce long range transportation plans (30 years)
 - Stakeholders and the public participate
 - Develop transportation improvement programs (3-4 years)
 - Use forecast demand model
 - Computer program simulates by applying a trip table (highway and transit)
 - 4-step process that all MPO's use
- Since early 1990's with the Clean Air Act and ISTEA (Intermodal Surface Transportation Efficiency Act), the EPA got more involved and required that emissions be consistent with travel demand model
 - SIP: State Implementation Plan
- Tools set up for purpose of doing analyses on plans and to prove conformity
 - Everything projected into the future
 - VMT (travel demand) model not created to calculate GHG emissions
- Travel demand models are like making wine, not consistent
 - ABAG socio-economic data is different every 2-3 years (they re-set the base)
 - MTC does a specific calibration based on ground counts (observed counts) for given year
 - Always updating forecast and always looking forward
 - Can't pick one year to use as model
- To solve problems with VMT travel demand model, we need to establish the methodology for calculating the base year
- Comment on direct tracking as a solution: good idea, but how do we count emissions in specific cities?

- Problems with observed traffic count data:
 - Function of city's money and resources
 - Poorer cities do not have robust traffic counts
- Vehicle mix is also an issue
 - Disclosure and quality issues with DMV
- Comment on VMT fee idea: great idea, but we still need better travel data
- Insurance GPS tracking idea: monitors what type of driving you do, rewards you for better driving
 - Need a pilot project: Do a survey on different vehicle types and model years, different areas/income areas
- Legislation is needed, especially to get vehicle mix from VMT
- Who is responsible? Who should take this on?
 - CARB, Caltrans, CTC, CEC, DMV/BAR, Air District, certain number of representatives from MPO's, city representatives for a group of cities and counties
- Important contacts: David Burch at BAAQMD, Chris Ganson and Matt Nickles at the City of Berkeley

Brittle, Chris:

MTC, Manager of Planning

Tuesday, July 31, 2007: 9:00AM

pnutbrit@comcast.net

(707) 731-0056

- GHG tracking ideas
 - Problem is at local levels and cities
 - Need to correct the fact that some of the samples from HPMS are estimates
 - "Hierarchy of streets": need enough samples on all types of streets
 - VMT estimates lead to an oversimplified calculation of GHG emissions
 - Odometer reading is our base in ARB planning
 - Estimating the age of fleet and forecasting VMT using odometer reading is complicated
 - Direct tracking system (gas/diesel sales: direct translation to CO2 (20lbs CO2=1gallon of gas)
 - Complications to keep in mind
 - Speed of driving is a major factor in climate change emissions that we need to model for properly
 - Driving habits
 - Real world MPG
 - Different types of vehicles: need VMT by different categories (ex: light duty vehicle)
 - Differentiating by vehicle type and efficiency
 - Legislation is an option
 - Get DMV to ask for MPG

- How do we determine how many vehicle miles to track in the Bay Area versus out? (Or in Berkeley versus out, etc?)
 - Someone is working on this idea, Bruce has contact information
 - Need to have interview with this person
 - We need to track VMT for more reasons than GHG emissions to make this system worthwhile
 - Road conditions, etc?
- Indirect (hybrid) tracking system
 - 1. Use an enhanced vehicle odometer-based database for current (“actual”) VMT
 - 2. Employ the ARB's EMFAC model to estimate CO2 emissions with the regional VMT above and current vehicle fleet mix for the Bay Area (from DMV data) as control totals for the Bay Area
 - ARB EMFAC model is used for regional (air basin) air quality analyses (smog, particulates) and also has the capability to generate CO2 emissions rates for vehicles
 - Would provide a good estimate of CO2 emissions from light duty vehicles and heavier trucks in the Bay Area
 - 3. Use the MTC travel demand model (and similar models from other regions) to provide estimates of vehicle speeds on the freeways and local arterials. This information gets entered into the EMFAC model and produces CO2 emissions that reflect the performance of the road network in the Bay Area
 - Vehicle speeds affect CO2
 - Each year there could be a new CO2 transportation calculation for the nine Bay Area counties, by combining the three elements above
 - Note: direct method (tracking gasoline sales) is still preferable, but may take longer to work out
- VMT fee
 - May be political and administrative problems with Irvin’s model
 - New model: Upfront fee- in depth info from Chris Brittle’s memo “GW Offsets”
 - Buyer would pay a fee based on the lifetime CO2 emissions of the vehicle. For example, for the model line of Toyota vehicles, there would be large variations in CO2 emissions depending on the model purchased
 - Ex: purchasers of a new Sequoia would pay twice the fee as those who purchased a new Corolla
 - Fee could be applied to new vehicles only or to all vehicles based on the miles driven each year.
 - If applied to new vehicles, it could be rolled into the purchase price and essentially pay to offset the lifetime emissions from a new vehicle

- Use money to offset CO2 (through a reliable offset company)
 - Offsets don't have to be transportation
 - Land Rover now offers a package that can be purchased with new vehicles that would offset CO2 emissions for the first 45,000 miles of travel
- Offset fees for older vehicles could be collected yearly as part of the vehicle registration fee
- Legislation may be needed to implement upfront fee or any type of VMT fee
- Working Problem Definition: Based on projected growth of the population, economy, and VMT, unaltered CO2 will clearly rise despite increased fuel efficiency. We need to bring CO2 to 1990 levels by 2020. The current VMT tracking system is based on multiple assumptions and future projections, which leads to inaccurate data and the inability to monitor our progress as we implement new greener programs.
- Next steps:
 - Find out which method/approach will have the biggest impact
 - Impact now is better than delayed impact in future
 - Need all environmental organizations involved to agree on one approach
 - Be conscious of funding and proposals
 - Interview 4-5 people, check in with Chris again, draft report, and send it to Chris to edit

Burch, Dave:

BAAQMD, Environmental Planner

Thursday August 9, 2007: 3:00PM

dburch@baaqmd.gov

(415) 749-4641

- No totally accurate way to calculate VMT
- We rely on travel demand model from MTC and emissions factors from ARB
 - Hostage to model
- SB375: Smart growth bill
- 2 issues:
 - 1. More accurate VMT data
 - Problem: VMT tracked region by region (better to do it statewide?)
 - 2. Fee (or some other policy measure) to reduce GHG emissions
 - Ex: CBATE-fee imposed upon fuel efficiency of car
 - May not reduce VMT, but at least will be driving miles in more efficient vehicles
 - Ex: Pay At the Pump-gas insurance
 - Problem: Major costs before a minor impact of emissions reductions
- Important to address both how to improve accuracy of VMT measurements and policy efforts to reduce emissions
 - Tracking and modeling are very complex: try to avoid

- Policy side is hot right now
 - Suggestion: Pick 2 or 3 things that seem promising and go into depth
- Who is responsible?
 - ARB, local MPO's

Burroughs, Timothy:

City of Berkeley, Climate Action Coordinator

Tuesday, July 31, 2007: 1:30PM

TBurroughs@ci.berkeley.ca.us

(510) 981-5437

- VMT measured by strips on the road that count traffic
- VMT measurement within city limits calculated by approximations from MTC and Caltrans data
 - Problems with city VMT
 - Not accurate
 - Methodology is in questions
 - Speed not taken into account
 - Fuel efficiency numbers taken from Air District
- Comments on direct tracking method suggested by Chris Brittle
 - Drawback is that people purchasing gas might not be residents of that city
 - Should they be counted in city's (ex: Berkeley) VMT if they buy gas in that city but live in another city?
- Question 1: Methodology
 - 3 frames
 - 1. Capture emissions within city limits
 - 2. Capture VMT by residents of city + when they travel out of city
 - 3. Capture all VMT by people traveling into city
- Question 2: Data Accessibility
 - We need MTC, BAAQMD, and CARB to get data we need
 - Limitation: Regional Model is only run every 5 years by MTC
- Short term goal: Conversation with ARB, MTC, and BAAQMD to see if we need legislation
- Problem definition: outlined in Mayor Bates' letter⁷
 - Need better municipal-level data on vehicle miles traveled, fleet comparisons, and average fuel economy
 - VMT data for cities is created from the regional transportation model that does not provide enough information at the local level for cities to track progress on efforts to reduce GHG emissions
 - VMT data is only available every five years, and is only updated and calibrated when the Regional Model is run, which creates

⁷ Tom, Bates. Mayor of Berkeley. Letter to Mr. Steve Heminger, MTC. 9 May 2007. Regarding the Need for Better Municipal-Level Data on VMT, Fleet Comparisons, and Average Fuel Economy as Cities Throughout the Bay Area Work on Reducing Greenhouse Gas Emissions. Oakland, CA.

- significant obstacles as we try to monitor the impact of new policies or behaviors
 - Fleet composition and fuel economy data is provided BAAQMD at the county level, not for local communities
 - Consequence: benefit of Berkeley residents converting to more efficient vehicles is not visible in the data provided
 - Solution may require a coordinated approach from the MTC, BAAQMD, local governments, and state agencies like the Department of Motor Vehicles.
 - Legislation may be needed as well
- Who else should we talk to?
 - ICLEI: Brooke Lee
 - MTC: Harold Brazil-helpful for framing where data comes from
- Timothy is writing a letter to ARB asking for their help

Dahlquist, Frances

PG&E, Senior Project Manager, Clean Air Transport Group

Friday, August 3, 2007: 10:00AM

FxD8@pge.com

(415) 973-7854

- NHTS: National Household Transportation Survey
 - Has similar issues with VMT in data accuracy
 - Reid Ewing, Associate and Research Professor at the National Center for Smart Growth, University of Maryland, is knowledgeable about VMT and GHG
- PG&E working from side of lowering the carbon fuel standard (LCFS) vs. using less fuel
 - Trying to get manufacturers to build things that are good for the environment
 - Natural gas vehicles, electric vehicles, etc.
- Suggestion to not rely on users/drivers to do tracking
 - Always leads to inaccuracy
 - Need automatic system

Dawid, Irvin:

Sierra Club, Chair of Sustainable Land Use Committee

Tuesday, July 24, 2007: 5:30PM (and Thursday, August 9, 2007: 11:00AM)

irvindawid@hotmail.com

(415) 977-5500 *2017

- A type of VMT fee should be considered so it can:
 - Track (measure) emissions from vehicles
 - Earn transportation revenue - attracting the CTC as well as ARB.
- We need to determine where the CTC fits into our plans, as they decide which programs get funded and have genuine interest in this project
- We need to combine forces, ARB with CTC
- Questions: can we model for VMT? What are we doing right now?

- Letter from Don Perata indicates CTC is responsible for better VMT data among other things⁸
- Prop 42: deals with sales tax on gas for transportation
- There are so many huge problems with transportation
 - June 1990, Prop 111: last time we voted to raise gas tax incrementally
 - State gas tax has remained @ 18 cents since 1994
 - Need to work with transportation groups to raise the gas tax
 - If we want to dif ourselves out of problem we need to increase the operational costs of driving to get appropriate revenue to meet our transportation needs
 - Need a bill that would require odometer readings upon registration renewal every year

Hancock, Ann:

Climate Protection Campaign, Executive Director

Tuesday, July 24, 2007: 4:30PM

ann@climateprotectioncampaign.org

(707) 823-2665

- Described Cities for Climate Protection (iclei.org)
- Without accurate VMT measure, we cannot track our efforts to reduce GHGs
- Research Thousand Friends of Oregon: <http://www.friends.org/index.html>
 - Oregon: best plan to reduce VMT is LUTRAQ (Making the Land Use, Transportation, Air Quality Connection)/Congestion pricing
 - Shifts people to other transportation modes and reduces congestion, so traffic moves more quickly⁹
 - Modeling for VMT and congestion pricing details in “Appendix A: An Overview of The Modeling Process”¹⁰

Holtzclaw, John

Sierra Club, Chair of Transportation Commission

Thursday, August 9, 2007: 10:00AM

John.Holtzclaw@sierraclub.org

(415) 977-5534

- Study 9-12 years ago that looked at all travel analysis zones in LA, SF, and Chicago
 - Looked at density, proximity to work locations, transit service, average family size, median income, and bike/pedestrian friendliness
 - Determined how accessible houses were to each other
 - Autos available from census (auto ownership)

⁸ Perata, Don. Senator. Letter to the Honorable Marian Bergeson, Chair of CTC. January 5, 2007. Request to review transportation Plan Guidelines and ensure that plans utilize models that accurately measure benefits of land-use strategies aimed at reducing VMT. Sacramento, CA.

⁹ “Chapter 2: Transportation, Air Quality, Greenhouse Gas & Energy Analysis.” Thousand Friends of Oregon. <http://www.friends.org/goods/pdfs/vol5/chapter2.pdf>

¹⁰ “Appendix A: An Overview of the Modeling Process.” Thousand Friends of Oregon. <http://www.friends.org/goods/pdfs/vol5/appendix.pdf>

James, Roland

Saturday, August 4, 2007: 8:15AM via email

roland.james@gte.net

(707) 539-0547

- VMT fee/tax idea
 - Sliding scale sales tax of ~2% to 20% and sliding scale annual vehicle license tax from ~\$20 per year to \$5000 per year based on fuel efficiency (and majority alternative fuel use) for new non-commercial vehicles
 - Older vehicles remain on existing system
 - Revenue neutral or revenue positive (with excess going to mass transit or to reduce the state income tax)
 - Reconfigure every year or 2 based on changing technology and changing buying habits.
 - AZ Leg Council drafted this into law form for AZ in 2001
 - Would have to be drafted for each state specifically
 - Pat Wiggins and other CA legislators have been either hostile or non-committal
 - Idea for next year:
 - Use this in connection with Electricity Initiative (large tax during the solar window above a baseline amount together with a lowering of the state income tax) in the 21 states with statutory Initiative process in order to:
 - Generate public discussion
 - Provide 'cover' for presidential and congressional candidates running in 2008
 - To prime federal action
 - From Jim Hansen yesterday: "This Declaration is sufficiently specific that "well-oiled" candidates, subservient to special interests, will not be able to support it. Unless such specific questions are asked, the fact that global warming is being discussed in campaign debates now has little value, because most candidates are either making motherhood statements or mentioning specific policies that, even if of positive value, illustrate that they do not understand what is needed."
 - In the same way, this sliding scale sales and VLT idea doesn't have much value if trying to implement on the city or county level, or even in just 1 state

Mikulin, John

California Environmental Dialogue (CED), Project Manager

Friday, August 10, 2007: 6:40PM via email

johnm@cceb.org

(415) 512-7890

- How to measure VMT : Is VMT measurement a problem? Describe the nature of the measurement problem?
 - VMT is a fairly simple measurement that can be taken from any vehicle's odometer. Unless the odometer is tampered with, it

provides empirical data on VMT for an individual vehicle. However, determining a VMT within a state, region, or city can be extremely difficult given the lack of technology for tracking vehicle movement within and between geographic areas.

- What approaches are currently used for tracking VMT or what are your ideas about improving how we track VMT?
 - The California Department of Motor Vehicles (DMV) and the Bureau of Automotive Repair (BAR) collect VMT readings during a registered vehicle's biennial Smog Check inspection. This provides reliable data on how many miles the vehicle has been driven since its last inspection. However, there is no criterion within this inspection for determining the types of miles (i.e. city or highway), or where the miles were driven (i.e. what state, region, or city). The most effective way for tracking VMT within a specific geographic region is to install RF or GPS transponders in vehicles that indicate when the vehicle enters and leaves a region, while simultaneously transmitting an updated odometer reading . This way, the odometer VMT readout on individual vehicles can be cross checked with the transponder records to determine how many miles the vehicle drove while in the monitored region.
- What are the problems with the approaches?
 - The primary problem with the vehicle tracking/remote sensing approach is that it impinges on individual privacy, not to mention the significant infrastructure costs necessary to create a fully functional tracking network over a large geographic area.
- Does it matter? What are the implications of the measurement errors/differences?
 - As long as most VMT occurs within a single state, the standard odometer data is generally sufficient for determining the average VMT of a state's in-use, on-road vehicle fleet. However, this becomes problematic from an air quality planning perspective when you consider vehicles that travel between states on a regular basis.
- What are the next steps?
 - For the time being, obtaining regular odometer readings from registered vehicles should provide sufficient VMT data to generate a reliable VMT average for the in-use, on-road vehicle fleet. However, when considering the incorporation of the transportation sector into a GHG emissions trading market, there will likely need to be much more dependable data in order to provide market assurance that transportation GHG emission reductions are being obtained within the desired/regulated area.

Riordan, Bruce:

Elmwood Consulting, Transportation consultant

Tuesday, July 24, 2007: 5:00PM

bruce@elmwoodconsulting.com

(510) 655-0939

- Problem: we won't be able to tell that we've done anything to combat climate change without accurate VMT

- Need new, expensive, honest to goodness system
 - Wish list: system including VMT and other measurements like air pollutants; data on a regular basis (more than once a yr); local, regional, and state level data; accurate modeling
- Next steps: need good definition of problem; agreement of problem from contacts; agreement that MTC and ARB will take this on; options/recommended next steps
- 2nd part of problem: vehicle mix with assumptions
- 3rd part of problem: actual modeling of speed

Schouten, Henk

PG&E, Supervising Fleet Analyst

Friday, August 3, 2007: 11:00AM

Hws3@pge.com

(415) 972-5796

- PG&E uses TEAMS model to calculate VMT in PG&E fleet
 - TEAMS - Total Equipment Asset Management System. PG&E's internal system for managing maintenance and tracking mileage.
 - A mainframe system, customized with the vendor and converted recently to a web based application for "clients" to add their mileage and other information via the PG&E intranet.
 - A MCNS project that captures mileage from various different methods for all PG&E cars. MCNS: the name of the actual vendor software PG&E uses for TEAMS aka Fleet Focus MCMS
<http://assetsolutions.maximus.com/fleet.cfm>
 - 1. Manual entering from TRAK: mileage from odometer entered daily
 - TRAK simply stands for the name of the company (TRAK Engineering) out of Florida PG&E uses for its internal fuel tank dispenser hardware/software for tracking unleaded & Diesel and mileage capture. This is the internal system that PG&E employees would enter their PIN number and the mileage for the PG&E vehicle they are fueling.
 - 2. Fuel card program through vender: credit card function at pump and mileage uploaded daily into TEAMS
 - TEAMS is part of PG&E's preventative maintenance system: vehicle oil changes, etc.
 - VIS: Vehicle Information System- web-based application on fleet services page
 - USPs: Utility Standards Practices- policy as a regulated utility
 - Must report commute miles and travel miles for company vehicles
 - Used to compute GHG emissions among other things
 - Some PG&E fleets have zero emissions
 - CNG, bio-diesel, electric: limited manufacturers

Willards, Richard

Saturday, August 4, 2007: 9:25AM via email

willard@sonic.net

- Ways to decrease GHG emissions in transportation sector:
 - Restore the vehicle license fee that Gray Davis cut in half, then restored, and that Arnold Schwarzenegger again cut in half
 - Restore the purchasing power of the CA fuel excise tax to the level when it was last increased, and then index that tax
 - Apply the great majority of the proceeds to expanding transit, including regional rail and high-speed rail.
 - Each of these measures could bring in about \$4 billion per year
 - Encourage the purchase of smaller and more fuel-efficient vehicles and expand the availability of transit.
 - Availability of transit is the most important factor determining whether or not people use it instead of the automobile
 - MTC has the power to increase the fuel excise tax in the 9-county Bay Area

Woodhull, Joel

SCTLC, Chair

Friday, August 3, 2007: 3:00PM

woodhull@sonic.net

(707) 578- 2084

- Need to focus on VMT measurement: everyone is guessing; actual data is very small and then many assumptions are implemented
 - Can say something accurate about whole county, but not neighborhoods
 - Need accurate VMT for feedback to see how well we are doing
 - Main complication to getting accurate data may be invasion of privacy issues
- Methodology comments
 - Two basic ways to count VMT
 - 1. At street level: count people going by and know length of road and average number of cars at different times of day
 - 2. Start with vehicles
 - Odometer readings (John Holtzclaw has worked on this successfully)
 - Car registration
 - Principle: if you don't have a good way to get information, use two methods and cross-check data
- Upfront VMT fee comments:
 - How do we know how much a new vehicle will travel? Is it fair to charge an active hybrid driver less of a fee than another car owner that rarely drives?
- Solutions/Next Steps:
 - Legislation: Yes, we need it but first we need to agree on what we want it to do.

- Need at least 3 state agencies to work carefully with the DMV
- Holtzclaw's work was a turning point for getting good data for a major part of fleet (He worked primarily with odometer readings)
 - "Cutting Commute Driving: An Environmental Tool Kit"¹¹
 - Outlines direct incentives to reduce SOV
 - Outlines least-cost (or "integrated") transportation planning and funding
 - "Curbing Urban Sprawl to Curb Global Warming"¹²
 - Outlines strategies for reducing the impacts on Global Warming in the transportation sector, including federal and state actions to promote implementation
 - "Using Residential Patterns and Transit to Decrease Auto Dependence and Costs."¹³
 - Study confirms and extends the results of a number of previous studies that suggested household density as the major factor responsible for variations in VMT and annual transportation costs
 - A first attempt to measure reductions in automobile usage and personal transportation costs resulting from different characteristics of a neighborhood
- Can use smog checks as corroboration for annual registration self-reading of odometer
 - Need a back-up plan (ie: 2 ways to get data)
- PAYD: Pay As You Drive
 - Telematic car insurance
 - Costs of driving (including car insurance and road pricing) are dependent upon vehicle and VMT
 - Programs/research in Oregon, British Columbia, Europe
 - Legislation could help promote this in CA
 - Todd Litman: The Victoria Transportation Policy Institute
 - "Review of U.S. and European Regional Modeling Studies of Policies Intended to Reduce Motorized Travel, Fuel Use, and Emissions" by Robert A. Johnson, UC Davis, VTPI¹⁴
 - Summarizes findings and data from U.S. VMT reduction studies in Arizona, SF Bay Area, Southern CA, Portland, etc.

¹¹ Bicker, Kate, Stuart Cohen, James Corless, Tom Graff, and John Holtzclaw. "Cutting Commute Driving: an Environmental Tool Kit." Stop Sprawl (1998). Sierra Club.

<http://www.sierraclub.org/sprawl/transportation/commute.asp>

¹² Holtzclaw, John. "Curbing Sprawl to Curb Global Warming." Stop Sprawl. Sierra Club.

<http://www.sierraclub.org/sprawl/articles/warming.asp>

¹³ Holtzclaw, John. "Using Residential Patterns and Transit to Decrease Auto Dependence and Costs."

Smart Growth Resource Library (June 1994).

<http://www.smartgrowth.org/library/articles.asp?art=190&res=1024>

¹⁴ Johnson, A. Robert. Professor, UC Davis Department of Environmental Science and Policy. "Review of U.S. and European Regional Modeling Studies of Policies Intended to Reduce Motorized Travel, Fuel Use and Emissions." Victoria Transport Policy Institute (August 2006). <http://www.vtpi.org/johnston.pdf>

- Generally evaluated modest growth management policies with no pricing of parking, fuels, or roadways. These results may be viewed as lower bounds on VMT reductions within studied scenarios.
- Summarizes findings from Europe
 - Significant policies evaluated: higher taxation of fuels, larger auto purchase and registration fees, and tolling of roadways (all-day and for peak periods), as well as urban limit lines, and density increases. We can view these projections as the upper bounds of what could be achieved in most regions in the U.S.

Appendix B: “Monitoring and Forecasting CO₂,” Chuck Purvis

Monitoring and Forecasting On-Road Mobile Source Emissions at the City Level Discussion Notes for San Francisco Bay Area Cities

1. Concepts and Definitions

- a. Monitoring is the tracking of historical trends from observed databases. For mobile source carbon dioxide emissions the monitoring data should start from 1990 if not earlier.
- b. Forecasting is the projection of data, based on socio-economic and travel demand models, to future years. MTC’s travel forecasts will typically follow the sequence of ABAG socio-economic forecasts, in terms of five year intervals out to the year 2035.
- c. EMFAC 2007 is the California Air Resources Board’s (CARB) emission factor model system. The software can be used to generate emission factors (e.g., grams per mile of travel) or for emissions inventories (e.g., tons per day in county or air basin.)
- d. BURDEN is CARB’s model to apply the EMFAC model and produce emission inventories at the county-level or air basin-level.

2. Databases for Monitoring VMT/CO₂

- a. HPMS (Highway Performance Monitoring System) The HPMS program is a national-level statistical program used in providing Congress information about the level of travel and pavement conditions for the nation’s streets and highways. The HPMS data is also a source of VMT data for apportioning formula-based FHWA funds to the States.
 - i. HPMS data on pavement conditions and average daily traffic (ADT) is submitted by city and county public works staff to the MTC (Ben Espinosa, MTC Planning). MTC staff submits the completed data to Caltrans. Caltrans adds information on the pavement condition and travel characteristics on the state highway system. Caltrans then submits the data to FHWA for final processing.
 - ii. MTC staff can extract Average Weekday Daily VMT, by City and County, from HPMS for years 1990-2005. The 2006 data should be available by mid-summer 2007.
 - iii. MTC staff can apply the EMFAC 2007 software to produce county-specific carbon dioxide emission factors for years 1990-2005. Emission factors can then be multiplied by the VMT estimates to generate on-road mobile source emission inventories at the county and city level.
 - iv. There are strengths and weaknesses to this approach, mostly due to the sampling methodology for sample segments in the HPMS data.
- b. BAR I/M Data (California Bureau of Automotive Repair Biennial Inspection/Maintenance Data, aka Smog Check databases) The CARB and the BAR have created databases using BAR’s biennial Smog Check odometer information to create disaggregate, vehicle level databases. In

early 2006, MTC staff analyzed a specially produced 2001/2003 BAR/CARB database to analyze the VMT “annual accrual rates” by age of vehicle for Bay Area vehicles.

- i. Concerns are that the data is by county-of-inspection, not the county-of-registration.
- ii. It is uncertain whether this data could be produced at the city-of-inspection, or the city-of-registration (residence), or at an even finer-grained geographic level (e.g., zip code-of-inspection).
- iii. Data quality is very good but not flawless. Negative accrual rates and excessive accrual rates (> 54,000 miles/year) are a challenge.
- iv. Data is very sparse for younger model year vehicles. For example the 2001/03 BAR/CARB database had zero data for model year 2003 vehicles, and 93 sample vehicles (out of 357,000 registered vehicles) for model year 2002. This makes sense since younger model vehicles have not been on the road long enough to be subject to the Smog Check program.
- v. The BAR/CARB database does not include detailed vehicle technology (e.g., low-emission autos, ultra-low-emission autos) that may be useful in refining a city or county emission inventory.
- vi. MTC’s efforts in analyzing this BAR/CARB database was fairly modest. We don’t know how much effort is needed to create this database by the State Government.

c. California Department of Motor Vehicle (DMV) Registration Databases. MTC staff is not aware of DMV databases that are released at below than county level. Perhaps this is where a DMV program could be developed that tabulates California’s fees paid (and fee exempt) vehicles by county-of-registration, city-of-registration (and perhaps) zip code-of-registration.

- i. This possible DMV data summary could tease relevant information from the Vehicle Identification Number (VIN) as relevant to CO₂ emissions estimation, including: make, model, year, detailed fuel technology, and EPA-rated fuel economy. The EPA-rated fuel economy may need to be acquired from commercial data sources before merging with DMV records.
- ii. DMV, CARB, and the California Energy Commission would need to collaborate on a coherent strategy to meet the needs at the statewide, county and municipal level.
- iii. This DMV data product could be merged with any BAR/CARB database to provide an independent estimate of VMT/vehicle and CO₂/vehicle based on the county or city-of-registration.

3. Databases for Forecasting VMT/CO₂

a. MTC Travel Forecasts Monitoring databases such as the HPMS, BAR, and DMV can only be used in tracking historical VMT and CO₂ emissions. For projections of VMT and CO₂ we typically use regional travel demand model systems. MTC produces travel forecasts that are typically consistent with the five year forecast intervals produced by the Association of Bay Area Governments (ABAG). Data is summarized at

the county and air basin level for use in the CARB's EMFAC 2007 / BURDEN software.

- i. MTC typically analyzes VMT and mobile source emissions by county-of-occurrence. This is necessary for the Regional Transportation Plan EIR analysis, and for conformity analysis of the RTP and TIP to the Bay Area's emission budgets.
 - ii. MTC also analyzes household VMT/ CO₂ by the travel analysis zone-of-residence. This is very useful in showing/mapping the transportation efficiency by neighborhood within the Bay Area.
 - iii. MTC's travel analysis zones (TAZ) are based on census tract geography. This means that household VMT by zone-of-residence can be easily aggregated to city-of-residence in certain cities (San Francisco, Berkeley, Albany, Oakland, Alameda) but cannot be easily aggregated in other cities (San Jose).
 - iv. MTC is also producing running emissions factors, based on EMFAC2007, that can be used to evaluate on-road, link-level emissions for criteria pollutants (e.g., ROG, NO_x, CO, CO₂, PM_{2.5} and PM₁₀). These factors can be applied to travel model, link-level traffic volumes to estimate emissions densities at the corridor or city level.
- b. Alameda County CMA Travel Forecasts The Alameda County CMA's model system is similar in design and structure to the MTC model system, but at a much finer-grained zonal system within Alameda County. This means that the CMA model system can provide the same measures of VMT/households by zone-of-residence. The primary difference is that the MTC model system would generate more "intra-zonal" VMT (trips that start and end in the same zone) compared to the Alameda CMA model system.

Appendix C: Letter to the Metropolitan Transportation Commission from Berkeley Mayor Tom Bates

May 9, 2007

Mr. Steve Heminger
Metropolitan Transportation Commission
Joseph P. Bort MetroCenter
101 Eighth Street, Oakland, CA 94607

Dear Mr. Heminger:

I am writing to follow up on our discussion and to ask for your assistance regarding the need for better municipal-level data on vehicle miles traveled, fleet comparisons, and average fuel economy as cities throughout the Bay Area work on reducing greenhouse gas emissions.

In Berkeley, nearly 50% of our greenhouse gas emissions come from transportation. However, our ability to monitor transportation emissions and track the efficacy of new policies is significantly limited by the current data. In discussions with my staff, there appear to be a few key problems.

First, vehicle miles traveled (VMT) data for the City of Berkeley is created from the regional transportation model that does not provide enough information at the local level for us to track progress on our greenhouse gas efforts. Second, the VMT data is only available for every five years, and is only updated and calibrated when the Regional Model is run, which creates significant obstacles to our ability to monitor the impact of new policies or behaviors. Third, fleet composition and fuel economy data is provided by the Bay Area Air Quality Management District (BAAQMD) at the county level, not for local communities like Berkeley. Therefore, the benefit of Berkeley residents converting to more efficient vehicles is not visible in the data provided.

I understand how difficult it is to provide accurate and regular information on something as complicated and diffuse as people's driving habits. But if we are serious about reducing greenhouse gas emissions, we need to be able to see what works and what doesn't in our efforts to reduce transportation-related emissions.

Please let me know if I can be of any assistance in addressing these issues. From my perspective, a solution may well require a coordinated approach from the MTC, BAAQMD, local governments, and state agencies like the Department of Motor Vehicles.

If you or a member of your staff would like to discuss this further, please contact me directly or the City's climate action coordinator, Timothy Burroughs at 510-981-5437. I look forward to speaking with you about this issue soon.

Sincerely, Tom Bates Mayor

Appendix D: Skymeter: Vehicle Location Billing



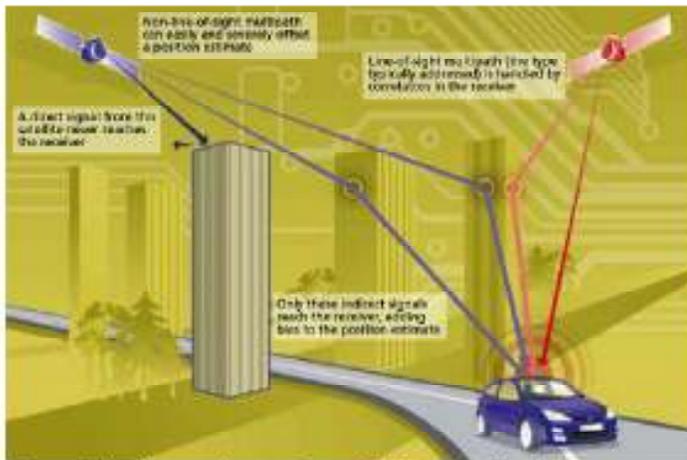
EXECUTIVE SUMMARY

Traffic congestion is choking major cities everywhere, and Skymeter is poised to lead the booming international market for solutions.

"11 companies whose breakthroughs will change everything"
 – Business 2.0, October 2006

"I think [Skymeter] is a hell of a good idea and the way the world is going to go"
 – Maurice Anderson, President, Toronto Parking Authority, Toronto Globe & Mail, May 5, 2007

"There is no alternative [to road pricing]."
 – UK's Eddington Report, 2006



Skymeter is the only company known to have cracked the critical problem of urban canyons, where tall buildings interfere with GPS signals. There is a similar effect on roads with tree cover.

Skymeter Executive Summary, page 7 (confidential) © Skymeter Corp, 2007

"In no other major area are pricing practices so irrational, so out of date, and so conducive to waste as in urban transportation."

– Nobel-prize winning economist William Vickrey, American Economic Review, 1963

"Waste" = Greenhouse Gases

TRANSPORTATION INFRASTRUCTURE: PAY BY TAX OR PAY BY USE?

Traffic clogs our streets, wastes our time, stifles our economies, and fills the atmosphere with greenhouse gases. Is this an insoluble curse of modern prosperity? No, just the result of irrational pricing.

A comprehensive solution to traffic congestion, Vickrey explained, would simply implement three pricing mechanisms:

- charge all drivers a variable rate for each mile they drive
- charge variable rates for curb parking
- meter delivery vehicles

Bold cities around the world, such as Singapore, London and Stockholm, have spent hundreds of millions of dollars to build infrastructure-intensive systems that only roughly approximate Vickrey's principles. These cities got instant results from their investments: traffic speeds increased 30%, saving time and lubricating the economy.

Everyone agrees that **GPS is the ultimate solution for road pricing**, and that the technology will be ready around 2012.

Skymeter can do it today.

We solve the three problems that have stopped GPS road pricing being implemented:

- the 'urban canyon' problem
- generating an evidentiary record from GPS
- protecting user privacy

At the same time, Skymeter maximizes the net revenues to government, allowing a 50% increase in revenues over current urban tolling solutions.

Reduce emissions someday, or right now?

Switching to pay-by-use roads results in instant –same day!– drops of 15% in greenhouse gas emissions.

"Congestion pricing is a proven success."
 – US Department of Transport, Dec. 2006

"Mileage-based auto insurance is the biggest free lunch around in reducing greenhouse gas emissions."
 – Dean Baker, Center for Economic and Policy Research

"By 2010 GPS with wireless will dominate the [road pricing] market"
 – Frost & Sullivan, March 2006

ALTERNATIVES TO SKYMETER

"The technology for implementing UK-wide road pricing does not exist."
 -Sir Rod Eddington, December 2006

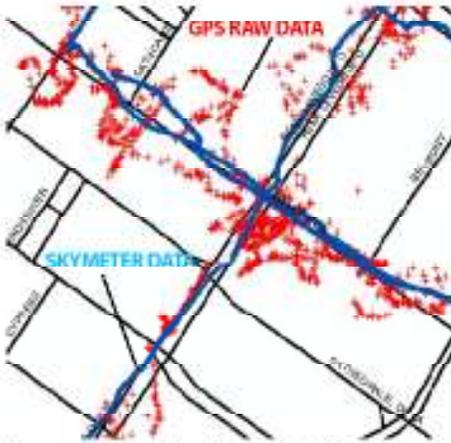
The industry today has two kinds of offerings. Existing tolling technologies are expensive, complicated, and limiting. They are still used, because the systems from GPS tolling suppliers (i.e., the 14 European companies who failed London's summer 2006 trials) just don't work.

**SKYMETER DELIVERS:
 Accuracy, Proof, Cost Leadership**

Today's GPS has two fatal flaws: it only delivers 98-99% urban accuracy, and it doesn't prove position. Why does this matter? A 1% billing error rate means tens of thousands of monthly errors; no proof means successful court challenges; together, an unworkable system.

Skymeter has solved both issues. Our patented* RAMM™ method (Receiver Autonomous Multipath Mitigation™) solves the 'urban canyon' problem, leading to accurate positions in cities or tree cover. The results of our beta software are shown below. An additional step (not shown) gives second-by-second proof of accuracy for each satellite reading.

Skymeter's third innovation is a patented* 'zonelog.' Contenders in the GPS road charging market are split between 'thin' (map in datacentre) and 'thick' (map onboard) models. Skymeter's distributed



Skymeter corrects multipath errors in GPS chip readings.
 Skymeter Executive Summary, page 2 (sck61n6) © Skymeter Corp, 2007

model splits the map from the processing. This gives reliability AND scalability ... at a fraction of the cost of competing models.

PRICING AS A SERVICE

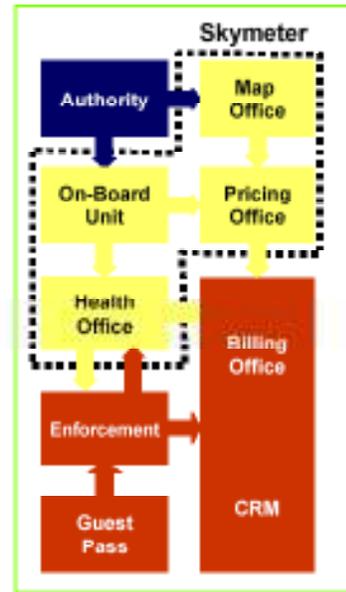
Skymeter's distributed processing model involves us across the pricing system. We have therefore developed a 'pricing as a service' business model, where we provide the hardware and do all pricing activities. This removes the high risk of the new pricing technology from government, leading to a system model as shown. It also allows us to generate revenues in parallel markets simultaneously.

In our discussions, the Netherlands has shown interest in this model, since it reduces their capital commitment (and risk), and replaces it with an ongoing payment of a percentage of revenues collected. Skymeter has already had early indications of interest from financing and other required partners.

MARKET SIZE AND PROGRESS

Skymeter is in early discussions with the Ministry of Transport for the Netherlands on a nation-wide contract that could give Skymeter over 8,000,000 subscribers. The Netherlands like our 'pricing as a service' model, will pay \$75 annually per subscriber (\$600M annual revenues) ... and are only a mid-sized country. Add in parking, pay-per-use insurance (both of which would increase the NL contract size) and delivery vehicles - all three equally well served by Skymeter - and you have a market in the tens of billions of dollars.

Immediate revenues (starting late 2007) will come from paid government trials. The lead story on June 7th's New York Times was the \$1.1 billion that the US Department of Transport (DOT) is giving out this fall to fund 'congestion pricing' trials. Skymeter is in serious discussions with three of the nine finalists to be included in their proposals. We help fill one of the DOT's six selection criteria: 'demonstrate innovative and potentially far-reaching technology applications'



Skymeter's role in road pricing.

Other markets include Singapore - where Skymeter has met the full road pricing team, and has been invited to give an early technology demonstration in July - and London, UK, in a similar state.

EFFECTIVE PARTNERS

Skymeter uses partnerships with experienced, larger firms to enable us to deliver superior results in accelerated timeframes.

GPS PROGRAMMING: a 50-person firm with 10 years expertise in GPS and an international reputation.

HARDWARE: design specialists that do US military, medical, and award-winning consumer electronics devices, and have links with Taiwanese and Chinese manufacturers.

GOVERNMENT RELATIONS: one of the top 10 firms in the US.

**info@skymetercorp.com
 416-673-8406**

*Skymeter has one UK and US patent already issued, and two further US patents pending that qualify for PCT.

Appendix E: Letter to the California Transportation Commission from State Senator Don Perata

SACRAMENTO OFFICE
STATE CAPITOL, ROOM 205
SACRAMENTO, CA 95814
TEL (916) 651-4009
FAX (916) 327-1997

DISTRICT OFFICE
1515 CLAY STREET, SUITE 2202
OAKLAND, CA 94612
TEL (510) 286-1333
FAX (510) 286-3885

California State Senate

SENATOR DON PERATA
PRESIDENT PRO TEMPORE

COMMITTEES:

RULES
CHAIRMAN



A handwritten signature in blue ink, appearing to be "D. Perata".

January 25, 2007

The Honorable Marian Bergeson
Chair, California Transportation Commission
1120 N Street, Room 2233 (MS-52)
Sacramento, CA 95814

Madame Chair:

In recent years the legislature and each of the last two governors have enacted landmark legislation to reduce the emission of greenhouse gases and to mitigate the ill-effects of global warming in California and around the world.¹

According to a report issued last March by the state's Environmental Protection Agency (Cal-EPA)², statewide more than 40 percent of greenhouse gas emissions in California come from the transportation sector. In the area of the state I represent, the Bay Area, it is estimated that more than 50 percent of greenhouse gas emissions emanate from motor vehicles. In its report to the legislature, Cal-EPA noted that strategies like smart land use decisions and increased transit availability "can provide substantial climate change emission reductions." The report called for incorporating such energy efficiency and climate change emissions reduction measures in state transportation and regional planning documents.

The California Transportation Commission (CTC) must play a pivotal role in seeing these measures included in state and regional planning documents. Section 14522 of the Government Code provides the commission with the statutory authority to "*prescribe...guidelines for the preparation of the regional transportation plans (required by Section 65080 of the Government Code).*" Regional Transportation Plans (RTP's) identify regional priorities that ultimately form the basis for requests for state funding through the State Transportation Improvement Plan (STIP) process, as well as other processes that distribute state and federal transportation funds.

¹ AB 1493 (Pavley, Chapter 200, Statutes of 2002) and AB 32 (Nunez, Chapter 488, Statutes of 2006)

² "Climate Action Team Report to Governor Schwarzenegger and the Legislature," (March, 2006)

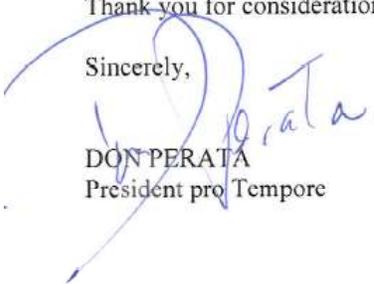
Today, neither the commission's guidelines nor current law require RTP's to achieve quantifiable reductions of greenhouse gas emissions. Moreover, some suggest that the modeling used to produce today's RTP's does not accurately predict the benefits of the best strategies—like increased infill and transit-oriented development—to reduce vehicle trips and achieve greenhouse gas reductions. At a time when many urban areas in California cannot simply build their way out of congestion, land use strategies that reduce automobile trips are a necessary component in any sound transportation plan.

Herein, I request the commission use its current statutory authority to immediately begin a review of its regional transportation plan guidelines in order to incorporate the kind of climate change emission reduction measures called for in the Cal-EPA report. Your process should also ensure that the plans utilize models that accurately measure the benefits of land use strategies aimed at reducing vehicular trips. I would hope the commission could commence this review immediately, provide interim reports to the legislature regarding any necessary statutory changes, and issue revised guidelines in time for the next round of regional transportation plan updates. Legislation will likely be introduced this Session to make any necessary statutory changes.

The post-AB 32 era provides an important opportunity and challenge for policymakers in the area of transportation. The challenge here is to ensure the implementation of policies that accommodate the state's growth, while preserving those things that make California a great place to live—mobility, open space and clean air.

Thank you for consideration.

Sincerely,



DON PERATA
President pro Tempore

Appendix F: Transportation Contacts

Allayaud, Bill	Sierra Club	allayaud@sierraclub-sac.org
Brazil, Harold	MTC	hbrazil@mtc.ca.gov
Brittain, Anna	Community Pulse	abrittain@gmail.com
Brittle, Chris	MTC	pnutbrit@comcast.net
Burch, David	BAAQMD	dburch@baaqmd.gov
Burroughs, Timothy	City of Berkeley	TBurroughs@ci.berkeley.ca.us
Cohen, Stuart	TALC	stuart@transcoalition.org
Dahlquist, Frances	PG&E	FxD8@pge.com
Dawid, Irvin	Sierra Club	irvindawid@hotmail.com
Droettboom, Ted	MTC/ABAG/Air District Joint Policy Com	Tedd@abag.ca.gov
Eaken, Amanda	NRDC	aeaken@nrdc.org
Erickson, Dave	Climate Protection Campaign	jdaviderickson@comcast.net
Fitzgerald, Garrett	ICLEI	garrett.fitzgerald@iclei.org
Garry, Gordon	SACOG	ggarry@sacog.org
Gilbertson, Annette	CTC	Annette_Gilbertson@dot.ca.gov
Goldstein, David	NRDC	dgoldstein@nrdc.org
Guardino, Carl	CTC	cguardino@svlg.net
Hancock, Ann	Climate Protection Campaign	ann@climateprotectioncampaign.org
Holtzclaw, John	Sierra Club	John.Holtzclaw@sierraclub.org
James, Roland		roland.james@gte.net
Kimsey, Doug	MTC	dkimsey@mtc.ca.gov
Kortum, Bill	SCCA	blkortum@sbcglobal.net
Lovaas, Deron	NRDC	dlovaas@nrdc.org
Mark, Jason	Energy Foundation	jason@ef.org
McCleary, Robert	CCTA	rmccleary-7@ccta.net
Mikulin, John	CED	johnm@cceeb.org
Nation, Joe	Joe Nation	joe@joenation.com
Purvis, Chuck	MTC	cpurvi@mtc.dst.ca.us
Replogle, Michael	Environmental Defense	mreplogle@environmentaldefense.org
Richards, Willard		willard@sonic.net
Riordan, Bruce	Elmwood Consulting and MTC	bruce@elmwoodconsulting.com
Rome, Victoria	NRDC	vrome@nrdc.org
Schouten, Hank	PG&E	HWS3@pge.com
Sparks, Jehan	Climate Protection Campaign	jas2166@columbia.edu
Woodhull, Joel	SCTLC	woodhull@sonic.net
Yee, Albert	MTC	ayee@mtc.ca.gov

Appendix G: Transportation Acronyms

AB 32	California Global Warming Solutions Act
ABAG	Association of Bay Area Governments
ARB/CARB	California Air Resources Board
BAAQMD	Bay Area Air Quality Management District
BAU	Business as usual
CAFÉ	Corporate Average Fuel Economy
CCAP	Community Climate Action Plan
CNG	Compressed Natural Gas Vehicles
COP	Conference of the Parties
EER	Energy economy ratio
EMFAC	EMission FACTor
EPA	Environmental Protection Agency
FEG	Fuel Economy Guide
GHG	Greenhouse gases
REET	Greenhouse Gases, Regulatory Emissions, and Energy Use in Transportation
GVWR	Gross Vehicle Weight Rating
HEV	Hybrid Electric Vehicle
HPMS	Highway Performance Monitoring System
ICEV	Internal combustion engine vehicles
ICLEI	International Council for Local Environmental Initiatives
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
LCFS	Low Carbon-Fuel Standard
LDV	Light duty vehicle
LEV	Low emissions vehicle
LUTRAQ	Making the Land Use, Transportation, Air Quality Connection
MTC	Metropolitan Transportation Commission
MTP	Metropolitan Transportation Plan
MVSTAFF	California Motor Vehicle Stock, Travel and Fuel Forecast
NRDC	Natural Resources Defense Council
PAYD	Pay As You Drive
PZEV	Partial zero emissions vehicle
RGGI	Regional Greenhouse Gas Initiative
RTP	Regional Transportation Plans
SACOG	Sacramento Area Council of Governments
SCTLC	Sonoma County Transportation and Land Use Coalition
STIP	State Transportation Improvement Plan
TAC	Transportation Advisory Committee
TALC	Transportation and Land Use Coalition
TASAS	Traffic Accident Surveillance and Analysis System
TDM	Transportation Demand Management
TOD	Transit Oriented Development
TTW	Tank-to-wheel emissions
UNEP	United Nations Environment Program
UNFCCC	United Nations Framework Convention on Climate Change
USDOT	U.S. Department of Transportation
VMT	Vehicle Miles Traveled
VTPI	Victoria Transport Policy Institute
WMO	World Meteorological Organization
ZEV	Zero emissions vehicle

Appendix H: About the Author

I feel motivated by an urge to understand the world around me. I have always believed that the process of learning and interacting with others (in the classroom and in real-world experiences) adds meaning to life. My work during this volunteer internship is an exposition of my love for learning, academia, and critical thought.

The issue I tackled, improving the measurement of Vehicle Miles Traveled (VMT), is very different from anything I encountered during my studies at Columbia University in New York. I spent this three week internship immersed in a stream of climate change and transportation hieroglyphics, in one-on-one conversations with technically astute experts who spoke in acronyms, in dinner-table conversations with my family of environmentalists, and in hours of research in my solar-powered house. My hope is that despite my novice experience in climate protection, I may have motivated lobbyists and experts to take this issue on and see it through to a resolution.

When I am not studying in Butler Library on Columbia's campus, I can often be found running in Central Park as I train for a future New York City Marathon, downtown enjoying New York's incredible variety of cuisines with friends, or daydreaming about the Bay Area's weather over a cup of coffee with my twin sister, Naomi. I grew up and reside over most of the summer with my family in Piedmont, California.



Jehan Sparks