UCLA
SCHOOL OF PUBLIC AFFAIRS
The Ralph & Goldy Lewis Center for Regional Policy Studies
Program on Local Government Climate Action Policies

Measuring Vehicle Greenhouse Gas Emissions for SB 375 Implementation

Measurements of greenhouse gas emissions from city or regional vehicle travel should be accurate, consistent, and transparent. Ensuring the consistency and accuracy of these measurements will allow for apples-to-apples comparison across sectors, such as power generation. This may necessitate the creation of a consistent measurement framework that will allow for policymakers and researchers to be reasonably certain that measured emissions from one region are meaningful when compared with measurements from other regions. Transparency serves to assure third parties that measurements are accurate and consistent.

Ideally, vehicles would be able record and report fuel type, instantaneous fuel consumption, and location in order to attribute actual CO_2 emissions to a city or region. In the case of newer vehicles, much of this data is already being collected. Instantaneous fuel economy data is available as a feature on a number of vehicles. Built-in or stand-alone GPS devices are becoming ubiquitous. The integration of these two systems, through a wired or Bluetooth connection, could associate instantaneous emissions with a specific geographical location, time, and route. While the reporting of vehicle travel data is not yet commonplace, the proliferation of pay-as-you-drive insurance and congestion pricing will drive adoption.

While vehicle-based greenhouse gas measurement and reporting is feasible for new vehicles, widespread saturation of such technology may be decades away. In the meantime, data from a sample of vehicles to validate regional greenhouse gas emissions models. The first generation of these models will rely on data that is currently available, including vehicle miles traveled (VMT). However, relying on vehicle miles traveled (VMT) as an input to SB 375's regional transportation greenhouse gas emissions models is potentially counterproductive. Especially in congested areas of California, VMT is an inadequate proxy for vehicle greenhouse gas emissions. Additionally, VMT and GDP are closely linked[1], and policies which seek to reduce VMT may hinder economic growth without reducing emissions.

VMT is not an ideal proxy for vehicle greenhouse gas emissions

Fuel consumption is directly related to CO_2 emissions at a rate of 8.81 kg CO_2 per gallon of motor gasoline[2]. Vehicle CO_2 emissions account for 99.4%[3] CO_{2}-e of non-refrigerant vehicle greenhouse gas emissions. VMT is used to calculate N_2O and CH_4 emissions, which account for the remaining .6%[4]. VMT is used because the EPA and CARB calculate emissions from criteria pollutants and other gasses on a per mile basis, based on vehicle control technology. The link between VMT and greenhouse gas emissions is dependent on actual vehicle fuel efficiency, which varies based on driving

[1] See http://www1.eere.energy.gov/vehiclesandfuels/facts/2004/fcvt_fotw347.html for an example of the relationship.
[2] The Climate Registry. *General Reporting Protocol v. 1.0* (2008)
[3] Based on the City of Austin's 2007 emissions
[4] While vehicles also emit N_2O, CH_4, and high global warming potential gasses, these emissions account for a small fraction of total vehicle emissions and can be best addressed by policies other than those authorized under SB 375.

behavior, average speed, vehicle maintenance (tire inflation, engine condition), and variance of speed (starts and stops which require acceleration).

Relationship between two metrics and greenhouse gas emissions

	VMT	**Gallons of Fuel Combusted**
Relationship to Vehicle GHG emissions	Directly related to 0.6% of vehicle GHG emissions (CH_4 and N_2O)	Directly related to 99.6% of vehicle GHG emissions
Relationship is dependent on	Vehicle emissions control technology	Actual vehicle fuel efficiency

Vehicle greenhouse gas emissions resulting from traffic congestion are significant

Traffic congestion reduces vehicle fuel economy versus uncongested travel. Greenhouse gas emissions resulting from traffic congestion in the Los Angeles area account for approximately 3.4 $MMTCO_2$ per year[5], or roughly two-thirds of the 5 $MMTCO_2e$ reduction goal for SB 375 implementation from the AB 32 Scoping Plan. Statewide, congestion accounts for nearly 6 $MMTCO_2e$ of greenhouse gas emissions. These emissions would not be measured by a model that relied solely on VMT and ignored congestion.

Not all vehicle greenhouse gas emissions are created equal

Greenhouse gas emissions from congestion are the result of an activity that hinders economic productivity. Because of vehicle idling and vehicle speed variance reduce fuel economy, vehicle CO_2 emissions in congested conditions are *higher per VMT* than emissions resulting from uncongested travel. These emissions are unique in that they are *negatively correlated* to economic activity. Although traffic congestion is a symptom of economic success, it also serves to limit growth by imposing a deadweight loss in the form of travel delays. Even ignoring the environmental effects of congestion, a reduction in congestion would produce a net social benefit.

Greenhouse gas emissions from vehicle travel at free-flow speeds are the result of an activity that creates value and fosters economic growth, and this respect are similar to emissions from electricity generation in that a reduction requires a net non-environmental social cost. When accounting for the environmental effects of greenhouse gas emissions, such reductions should produce a net social benefit.

A focus on reducing VMT might encourage congestion and create additional greenhouse gas emissions

An increase in congestion may be an unintended consequence of a performance metric focused on reductions in VMT. Transportation is an intermediary economic good that facilitates economic transactions and social interactions. Regionally aggregated VMT is a collection of individual trips that produce some net benefit to the trip maker. The net benefit is the difference between the benefit to the trip maker (either monetary in the case of work trips and shopping trips or nonmonetary in the

[5] Texas Transportation Institute. 2007 Annual Urban Mobility Report. Data for 2006 – 383,674,000 gallons of gasoline wasted because of congestion 383,674,000 gallons *& 8.81 kg CO2/gallon = 3,380,167 MTCO2 = 3.38 MMTCO2.

case of social trips) and the costs of the trip (monetary costs such as vehicle ownership, gasoline, and nonmonetary costs such as time). Some of these trips, such as a trip to work or to the airport, have a high a high benefit to the trip maker, and are often occur even when roads are congested and the time-cost of travel delay erodes the net benefit to the trip maker. Trips with a marginal benefit, such as a shopping trip for non-essential goods, may be deferred until congestion subsides and the time-cost of travel delay decreases, or these trips may cancelled. Any action that imposes an additional cost on travel, monetary or nonmonetary, will reduce the demand for travel. Congestion increases the time-cost of travel, reducing travel demand and VMT. An increase in congestion would have the desired effect of reducing VMT but at the expense of increasing greenhouse gas emissions per vehicle mile traveled.

What does SB375 attempt to do?

SB375 attempts to increase transit accessibility by concentrating opportunities for economic activity and social interaction near the regional transit network. One intended effect is to reduce the cost of using transit with respect to the status quo. With more activity located near transit, the "last mile" problem (walking to destination) will decrease and people will take more trips using transit, leading to a virtuous cycle of improved service that attracts more riders to transit. As demand for transit increases, so should supply, increasing service frequency and inducing investments in projects that reduce trip time and trip time variability. These service changes will reduce the cost of using transit, creating new trips and inviting some trip makers to switch from other modes.

A co-benefit of such land use planning would be that a variety of uses become concentrated, and this may decrease the distance of some trips. A decrease in distance will result in fewer VMT as (1) vehicle trips are shorter, and (2) non-motorized modes (walking, biking) become more attractive these shorter distances.

Why might a policy that reduces the cost of using public transit fail to reduce VMT and greenhouse gas emissions in congested areas?

As trip makers move from private vehicles to transit, traffic congestion will decrease. As traffic congestion decreases, the time-cost of travel decreases, causing the cost of travel to decrease. The quantity demanded goes up, leading to a rebound in VMT. This phenomenon is unique to congested areas where there is latent travel demand, but it is in such areas where transit is most successful in attracting drivers from private vehicles.

A VMT-based greenhouse gas metric does not account for regional differences in carbon content of fuels or vehicle fuel efficiency

A municipality or region may elect to pursue strategies that produce additional investment in alternative fuels infrastructure or highly efficient vehicles. These local strategies may lead to additional reductions in anthropogenic greenhouse gas emissions than would occur under state actions alone. Local governments can wield land use control to stimulate the development of a local alternative fueling network. A VMT-based metric would not credit local governments for such efforts when they produce reductions that are more aggressive than the state as a whole.

VMT-based metrics appear to have many problems. Why is the focus on VMT?

The data is currently available through existing planning processes. Metropolitan Planning Organizations produce this data through regional models that both forecast demand on specific routes and measure vehicle miles traveled. Measurements that are more appropriate for AB32 scoping plan implementation, such as CO_2-e/Passenger Mile Traveled, are not currently available.

Many state and national initiatives to reduce greenhouse gas emissions from transportation have employed on a top-down three legged stool approach. The three legged stool approach implies that reductions in greenhouse gas emissions from the transportation sector are based on three factors:

- Carbon Content of Vehicle Fuels. The introduction of low carbon fuels which reduce anthropogenic greenhouse gas emissions per gallon of fuel consumed. The AB 32 Scoping Plan expects California's Low Carbon Fuel Standard to reduce greenhouse gas emissions by 15 $MMTCO_2$-e in 2020.
- Vehicle Fuel Efficiency. An increase in the number of miles a vehicle can travel on one gallon of gasoline, ethanol, or other transportation fuel. The AB 32 Scoping Plan expects California's AB1493 vehicle fuel efficiency standards to reduce emissions by 4.5 $MMTCO_2$-e in 2020.
- Vehicle Miles Traveled. A reduction in vehicle miles traveled will reflect a reduction in consumed fuel. The AB 32 Scoping Plan expects SB 375 implementation will reduce emissions by 5 $MMTCO_2$-e in 2020.

The three-legged stool implies that, on a state level, greenhouse gas emissions from light duty vehicles can be calculated using the following formula:

$$Average\ Carbon\ Content\ of\ Dispensed\ Fuels\ \times Average\ Vehicle\ Fuel\ Efficiency\ \times Vehicle\ Miles\ Traveled$$

Average carbon content of dispensed fuels can be easily measured using samples and volumetric data from motor vehicle gasoline tax collections. Average vehicle fuel efficiency can be estimated using the weighted average of measured fuel efficiency by vehicle from EPA and registration data. Vehicle miles traveled are estimated using regional transportation demand models.

However, actual transportation sector greenhouse gas emissions are calculated as follows: $\sum GHG\ Content\ of\ Fuel_i \times Gallons\ Dispensed\ of\ Fuel_i$, for each fuel i, assuming all gallons dispensed are combusted.

If average vehicle fuel efficiency does not account for sub-regional differences in congestion, then actual greenhouse gas emissions will be higher than those calculated using a three-legged stool model.

Conclusion

Measuring regional greenhouse gas emissions from transportation incorrectly could create incentives counter to those intended by SB 375. If the goal is to reduce greenhouse gas emissions by addressing connections between land use and transportation, then there are better methods of measuring performance that would improve incentives for local governments. These methods will account for sub-regional differences in vehicle fuel economy and congestion, and a deeper understanding of a local government's control over trip generation.

The Lewis Center for Regional Policy Studies Program on Local Government Climate Action Policies will seek to identify measurement methods over the coming months through a series of expert symposia and papers. For more information, see http://www.lewis.ucla.edu/climate or contact Program Director Juan Matute at jmatute@ucla.edu.