The following document was provided by Robert Johnston, Emeritus Professor, University of California Davis, for consideration by the committee.

**Some Ideas for ARB Staff and RTAC on GHG Reduction Metrics, Target Setting, Model Benchmarking, and Model Oversight**

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**A. Basic Metric for GHG Reduction**

1. Travel models generate trips from households and attract trips to employment (or employment floorspace). Productions and attractions must balance, including trips going into, or coming out of, the county or region. Every trip has these two ends.

2. So, the basic form of the GHG metric should be:
**GHG/(resident population + total employment)**
both for quantities within the county or MPO region.

3. This form accounts for both ends of all trips, equally. So, in the worst cases, Emeryville counts almost all employment and Woodside counts almost all households, and so they get a denominator of about half of what a fully balanced (jobs/housing balance) county or region would, for any given number of trips. This is appropriate, since only about half of the trip lengths are in those jurisdictions.

4. Population is known by city, county, and region annually. The best count is in census years (2000, 2010). I believe employment is known fairly accurately with InfoUSA data, which is by street address of establishment. Since 1997, they say they have employees at the actual workplace, not the headquarters office, a long-time problem with employment data. Our statewide data for 1997 and 2003 seem to be spatially stable, in terms of address points in GIS. The average of these two years is within 3% of census 2000 county totals for all Calif. counties, so we think they are reasonably accurate totals. A few counties are missing local govt employment, but this can be added in, from other sources. It is a small percentage, except for small-population counties, which are not involved in this process.

5. For the Baseline year, I'd use the year 2000. Most MPOs still have their model data for that year and it predates almost all MPO GHG-reduction efforts.

6. Re. measurement of GHGs. You can't measure GHGs and so it is best to report VMT/(pop + empl). This allows us to keep the Pavely and Low-carbon Fuels effects separate from the SB375 analysis. I'd add a requirement to use odometer data in validating the modeled VMT. Fuel data, even by retail sales site address, will always present interpretation problems re. interregional and interstate VMT, heavy truck VMT, passenger vehicle out-of-MPO VMT, etc. The odometer data will give us hard data, at least for the place of residence. HPMS data are not accurate, especially for small-population counties.

**B.  Need to Distinguish Between Existing and Future Activities in Setting Targets**

1.  In doing our statewide land use model, PECAS, I have come to believe that it is residential and nonresidential floorspace we should be looking at, as specific measures of land development.  Floorspace represents households and employment by density and location and so lets us categorize our ability to service these populations with transit and the basic walkability of neighborhoods.  Also, local govts think in terms of floorspace, at least for nonresidential development.  We have generated a rough Year 2000 basemap of all floorspace in the State, by 15 activity types, in 50-m gridcells (about half an acre, or parcel-like in size).  We will develop an improved version of this map in late 2009.  One could also use households by density and employment by density as the measures of activity.  Density of land uses and mix of land uses will be important indicators of walkability and ability to service with transit.

2.  Then, we need to distinguish between Existing Floorspace and Future Floorspace.  Existing Floorspace can not be moved.  When buildings are renovated, they are at the same density and location.  This occurs at a rate of about 5%/year, for residential and nonresidential.  On the other hand, when buildings are demolished and rebuilt, higher density usually results.  This occurs at about 2%/year, for nonresidential and 1% for residential.  These numbers are increasing, however, due to poor modern construction practices.  However, most of the surrounding land uses usually stay at the same density, so a density increase for a whole census tract or neighborhood takes decades and is hard to predict.  This set of facts, though, leads us to see the importance of focused redevelopment of TODs and transit corridors, within existing neighborhoods, especially of commercial and multifamily areas.  We should, then, set a low target for reducing GHG/(pop  + empl) for Existing Floorspace.  <u>A fair and realistic policy baseline would be that Existing Floorspace could be redeveloped at the rate of 1%/year into transit nodes and corridors.</u>  Converting 20% of Existing Floorspace currently at low-densities into Future Floorspace at medium or high densities, over a 20-year period, would have a large impact on transit travel, according to my past modeling exercises in the Sacramento region, <u>if</u> transit service is adequate.  <u>We could expect a 20% decrease in VMT/(pop + empl) in these infill redevelopment areas.</u>

3.  Future new (greenfield) floorspace physically and legally could <u>all</u> be focused into transit-oriented development of walkable/bikeable neighborhoods.  Practically, the market for multifamily living in medium-density neighborhoods (20-40 units per acre) is about half of those looking for a new residence in national surveys (1/3 to 2/3, depending on wording of questions and interpretation of responses).  Since household incomes for the bottom 4 quintiles by income in California have been falling for about 20 years, we can expect relative demand for multifamily units to increase.  Also, the aging of the population and the rapid increase in households with no children, with retirees, and with single occupants will greatly increase multifamily demand in areas served by transit.  <u>So, it is probably fair and realistic to set a baseline expectation that 50% of all Future new (greenfield) floorspace development could be in transit-based areas through the development of new urban villages.</u>  Nelson (JAPA, 2009) thinks there will be an

absolute drop in demand for suburban single-family housing nationwide, over the next 40 years.  I think this will not occur in most California regions, due to our immigrant populations with larger households.  We can expect a 30% reduction in VMT/(new pop + new empl) for new (greenfield) floorspace, as these new areas can be planned for transit and walking with appropriate densities and mixes of activities over large areas.

## C.  Overall 3-Step Target-Setting Process: Need for Benchmark Scenarios

1.  The 3-step process recommended by the ARB staff is a vague process susceptible to politics, in that some MPOs may game it with lowball targets.

2.  Step 1.  ARB sets targets.  The uniform targets will be set based on past studies, using regional models, or empirical evidence of actual changes.  I have done a review of regional modeling studies all over the world, as has Caroline Rodier.  Hers is in the RTAC record.  This system ignores the fact that Existing Floorspace will not move and will only be expanded into higher densities at a slow rate (2%/yr. nonresidential and 1%/yr. residential). On the other hand, New (greenfield) floorspace could all be developed in TODs and transit corridors and served by transit, resulting in about a third reduction in VMT/(new pop + new empl).  The ARB method needs to account for differences in growth rates of floorspace or (pop + empl), for infill development v. new development of floorspace.  My assertions here are sufficient to determine a fair set of targets for all MPOs, if you know their growth rates for pop and empl.

This is similar to the reasoning in Jerry Walters' comments of 7/20/09. His examples are very useful tests of this approach.

The per cent reduction in VMT/(new pop + new empl) needs to be discussed.  I assume rapid investment in bus, BRT, trolley/LRT, and heavy rail transit systems. The current economic situation and the State legislative attempts to redirect local transit funding, however, may necessitate a lower assumption for percent VMT reductions.

3.  Step 2.  MPOs Identify Adjustments.  The ARB draft method allows the MPOs to model whatever policy scenarios they want.  This results in two severe problems:
1. The ARB staff will be comparing dissimilar policies and so conclusions will be hard to draw, and
2. The MPOs can select scenarios that produce low VMT reductions, for argument purposes.

It would be much better if the ARB (RTAC) required a standard set of Benchmark Scenarios of all MPOs.  From my extensive experience modeling VMT-reduction scenarios on the Sacramento region (12 papers, using travel models and land use/travel models), I think the best set of scenarios would be:
      1) Land use density and mix, with urban growth boundary
      2) Land use plus very strong transit spending
      3) Land use plus pricing of auto parking and/or VMT tax or fuel tax
      4) Land use plus transit plus pricing

These are among the most-effective policies modeled in other countries.

The ARB staff would still have to deal with small differences among the MPO scenarios, but this list would limit the range of differences. These are strong scenarios and so would set a baseline for what is legally possible. These scenarios also require that the MPO modelers and planners learn how to model land use, pricing, and transit policies. Also, this exercise introduces the MPO boards and local interest groups to what could be accomplished, even if they were only used in APS's.

4. Step 3.  ARB Proposed Modified Targets.  The MPO staffs have far more expertise than does the ARB on travel modeling and land use modeling.  The ARB will not be able to meet any standard burden of evidence in calling for model changes and GHG target changes.  I have experience challenging MPO travel modeling and urban modeling methods in several lawsuits across the U.S. in the past 20 years and it is quite difficult, as the agencies can hide their biased assumptions and calculations in model code.

So, the ARB should place RSG, Inc., and/or Smart Mobility, Inc., both in Vermont, on long-term contract to review the MPO modeling exercises. I suggest these two firms, as they are unique in having expertise in both travel modeling and land use modeling and have worked for environmental groups in the past, critiqueing MPO modeling.  They are from far away and are not influenced by MPO contracts in California. Their work should be supervised by an expert panel composed of MPO modelers from outside of California, academics, and other experts.  It might be best to have Caltrans manage this process, as it is in their realm of expertise.

5. Tables of Policies (p. 6).  Performance indicators, top box: delete lines 1, 3-7, and add a line for Land use mix (retail, office, residential).  Indicators second box: Third item should be per capita.  Fourth item delete and replace by Number of intersections per sq. mi.  This is a standard indicator of a walkable grid.

6. Same table and page, bottom policy box:  Traffic smoothing measures may increase VMT more than they reduce GHG/vehicle-mile, but this is a close call.  ITS, incident management, timed signals, etc. will have small effects on throughput and VMT.


**D.  Methods for Modeling the Benchmark Policy Sets**

1.  One can use very basic sketch planning models, such as iPlaces and UPlan, both in use in many California counties, or other traditional MPO methods, to input such development assumptions into a regional travel model.  Only a 5-step travel model with land use variables in the mode choice equations for transit, walk, and bike can represent the effects of such land use density and mix very accurately, so the 4Ds methods, described in a recent Caltrans report, can be used for post-processing of travel model results, in most regions.  This practice is encouraged in the CTC RTP Modeling Guidelines addendum of 5/29/08.  This exercise (modeling the Benchmark Scenarios) can

be performed before the MPOs have their land use models in operation, a major benefit of this approach.

2.  If we assume that we can cut GHG/(pop + empl) for greenfield development  by 30% (Growing Cooler) through new development of floorspace at higher densities at these rates, with pricing measures and transit development, and that we can cut GHG/(pop + empl) by 20% for infill redevelopment, then we can project GHG reduction targets for each region, depending on growth rates for households and employment (or floorspace for them), and my other assumptions about rate of development and redevelopment.  The RTAC could set these targets and then compare them to the results from the MPO modeling of the standard benchmark policies for each region.  This uniform procedure would greatly inform the negotiations between the MPOs and the ARB Board.

As it is not just density that matters, but also mix, overall size of TODs and transit corridors, level of transit coverage and service in the base year and in the out year, the MPO results will not just follow these averaged projections.  All MPOs should be given the chance to model their own outcomes, but starting with these policies.


## E.  MPO Model Input Assumptions

1.  The ARB and Caltrans need to get the MPOs to agree on one set of pop. and empl. assumptions for all counties, for 2020 and 2035, the two SB375 target years.  Also agreement is needed on demographic details such as income distribution for households; family size, number of school-age kids,  and age of head of HH; and employees by type of employment, at least in general 2-digit SOC classes.  These are all important for trip generation.  Also, the price of gas and diesel fuel, vehicle costs as affected by the Pavely rules, and housing costs, at least in general terms.

2.  Re. performance measures, VMT by vehicle class is necessary, as well as GHGs by vehicle class. VMT by time of day, trip purpose, and facility class are useful, for model checking.  These data go from the travel model into the California emissions model.

I would also like to see Traveler Welfare, by household income class, which can be gotten from the mode choice model.  Many VMT-reducing policies increase economic welfare for households of all incomes.   Lower-income HHs get better transit service and so can own fewer cars and pay less for travel.  Middle- and upper-income HHs benefit from faster travel speeds on highways.  This is a consumer surplus measure, specifically the compensating variation measure, and was developed by Small and Rosen decades ago, and applied by Rodier and Johnston in several of our Sacramento region modeling papers.  The economic benefits measure allows one to validate the scenario results against urban economics theory and against other such studies done in the past.  It is also the best summary measure of the combined effects of changes in mode shares, number of trips, travel times, VMT, etc.

**F. First Round Start-Up Issues**

1.  RTAC member Barry Wallerstein suggests two tracks, for the first round of target setting, an idea proposed by me a couple of months ago and sent to the ARB staff and to Dan Sperling. I don't know if Wallerstein has seen my proposal. MPOs may choose to forego the modeling and just adopt policies off of a list with points, to get to a set total of points. I had suggested a list of policies with points, derived from my modeling experience and my review of other regional modeling in the U.S. and other countries. He calls the policies BMPs, taking off of U.S. AQ and WQ law.

I think this is a good idea and buys us time to get the MPO models going. Of the 4 large MPOs doing household activity-based travel models, only SACOG has theirs running. The MTC model may be going in a few months. SANDAG and SCAG are a year off, or more, I think. Re. the PECAS land use models, SACOG will have theirs running in a few months, SANDAG needs a year or more, and ABAG and SCAG two years or more.