The State-of-the-Practice of GHG Emissions Considerations in Long Range Transportation Planning at Metropolitan Planning Organizations

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On-road vehicle travel accounts for a major part of the overall green house gas (GHG) emissions arising from transportation activities. Many state Metropolitan Planning Organizations (MPO) and planning agencies are planning to incorporate strategies addressing GHG emissions into their respective long range transportation plans (LRTP) and/or already have certain GHG control strategies in place. In this document, we summarize these plans and briefly discuss the methods, tools, and techniques for inventory development, and the approaches used to measure the effectiveness of different control strategies. A quick review of the state-of-the-practice suggests that while strategies to address GHG emissions are quite well documented, less information is available on how inventories are developed and even lesser information is available regarding the criteria and calculation of GHG control strategy effectiveness.

Table 1 provides a summary of the GHG reduction goals (column 3), GHG emissions incorporation in long-range transportation plans (LRTP) (column 4), and the methods/tools used for inventory development and GHG mitigation strategy effectiveness assessment (column 5) for 10 MPOs in the country (The MPOs are arranged in the table based roughly on their location when traversing the US from the East Coast to the West Coast). These ten MPOs were the ones for whom some level of information was readily available regarding GHG-related plans and targets. Several important observations may be made from Table 1. First, MPOs use different measures in their GHG reduction goals. While most MPOs target GHG reduction in a future year (such as 2030 or 2035) based on the percentage of GHG emissions from an earlier year (such as 2005), some characterize reduction goals in terms of a combination of the percentage reduction from what would have been the projected GHG emissions if no control actions were taken as well as percentage reduction from a base year (see the Metropolitan Washington Council of Governments of MWCOG). Some other MPOs do not appear to have an explicit GHG reduction target per se (for example, Genesee County MPC, NCTCOG, and H-GAC). Second, while six of the 10 MPOs do prepare a GHG inventory, four MPOs (Metropolitan Washington Council of Governments (MWCOG), Genesee County MPC, NCTCOG, and H-GAC) do not appear to have started developing GHG inventories. Third, several different GHG control or mitigation strategies are being considered for incorporation into the LRTP (see fifth column in Table 1). Even in regions where GHG mitigation is not expressly included in the LRTP, strategies are in place to reduce solo-auto travel and travel traffic delays/congestion, which contribute to GHG emissions reduction. Almost all MPOs include transit service improvements (building new high capacity transit facilities or transit station park-and-ride lots or other transit projects) as an important element of the LRTP. Other strategies include high occupancy vehicle/managed lane projects, rideshare coordination efforts, and bicycle/pedestrian projects (Durham-Chapel Hill-Carrboro (DCHC) MPO, Baltimore Regional Transportation Board or BRTB, Genesee County MPC, NCTCOG, HGAC, and SCAG), and traffic operation improvements such as intersection improvements and incident detection management (MWCOG, NCTCOG, HGAC, and SCAG). The California-based MPOs and DRCOG appear to be the ones who are particularly active in considering land-use strategies. In addition, SCAG is exploring VMT fee-based options, while BRTB and MWCOG include alternative fuel and electrification strategies. Fourth, many MPOs use their regional travel demand model outputs and an emissions model to predict GHG

emissions along with other mobile-source pollutants (see last column in Table 1). Thus, for example, Genesee County MPC and DRCOG combines their regional travel model outputs with EPA's MOBILE6.2 for GHG inventory development, while SCAG and SACOG combine their regional travel model outputs with California's EMFAC emissions model for GHG inventory development. On the other hand, DCHC and BRTB combine their regional travel model outputs with a more simple, but reasonably effective, GHG calculation tool labeled as the Clean Air and Climate Protection (CACP) software developed by the International Council for Local Environmental Initiatives (ICLEI). The software uses the following set of equations for estimating GHG emissions:

Emissions = VMT X Emissions per VMT (VMT obtained from travel demand model in a simple fashion, as VMT = (Person-Trips/Persons per Vehicle) X Trip Length (miles)

Emissions per VMT = Fuel Efficiency (i.e. MPG) X Emissions per Unit of Fuel (emission coefficient)

Emissions = (A/B) X C X D X E

where A is the number of person trips made using the vehicle type, B is the number of people per vehicle (occupancy factor), C is the trip length, D is the fuel consumption (in Gal/100miles), E is the emissions per unit of fuel (i.e. the fuel type factor)

The Oregon MPO task force is the only one that appears to use a single software for GHG emissions inventory development, based on their Greenhouse Gas State Transportation Emissions Planning model (GreenSTEP) to estimate GHG emissions from transportation sources and to model emission changes in response to different policy scenarios. GreenSTEP estimates vehicle travel and the associated GHG emissions at the household level, rather than at the roadway level. In other words, the emissions reported for a particular county or metropolitan area represent the emissions of households who reside in the area, regardless of where they travel. An advantage of this approach is that roadway-level assignment modeling is not needed for GHG estimation or policy analysis.

An important component of transportation planning, of course, is to be proactive rather than reactive. Thus, some MPOs have gone beyond inventory development to assessing the effectiveness of alternative GHG control strategies. In terms of the methods and tools used to estimate GHG emissions reductions, MPOs use the same approach that they use in inventory development. Thus, the effect of a control measure is measured by making appropriate changes to the travel component of the modeling systems, quantifying VMT and other related travel characteristics after "implementation" of the control strategy, and then using the GHG emissions procedures to translate the VMT to GHG emissions in the policy case. GHG emissions reductions are assessed from the base scenario to assess effectiveness. While such methods may appear reasonable, one issue with these techniques is that they do not examine the effect of GHG emissions reduction/mitigation measures over time in a cumulative fashion; rather, they focus on an "instantaneous" and "incremental" reduction for a specific year. An approach labeled as the "wedge approach" may be useful to incorporate cumulative effects as well as packages of strategies (see Pacala and Socolow, 2004, and Mui et al., 2007). Another consideration in evaluating GHG control/mitigation measures is the criteria to use in assessing effectiveness. This is still a rather unclear issue in practice, since most MPOs do not explicitly state what criteria they use for evaluating different strategies. For instance, while MPOs would ideally like to adopt the option that reduces the greenhouse gas emissions the most, cost becomes a big issue. Thus,

DRCOG has both a fiscally unconstrained plan, and a fiscally constrained plan. Ideally they would like to implement the total Metro Vision 2035 plan that they have, but the total cost is estimated at 133 billion dollars, but the current expected revenue is only 93 billion dollars.

To summarize, the criteria and methods used to evaluate GHG control/mitigation strategies is still not well documented and does not appear to be systematic. As a general guideline, EPA (see http://www.epa.gov/statelocalclimate/local/activities/ghg-inventory.html) suggests considering the following factors for successful implementation and evaluation of control strategies:

- *Multiple benefits and costs* – Some control strategies may provide a multi-dimensional array of benefits or may have many sources of costs. So, it is necessary to look at multiple costs and benefits instead of a single measure for evaluation.
- *Institutional capacity* – Local planning agencies must consider the costs of building additional infrastructure required for implementing some of the control strategies.
- *Measurability* – Quantifiable measures are more preferred to evaluate the effectiveness of different control strategies instead of qualitative comparisons.
- *Economic efficiency* – Planning agencies must consider policies that use resources most efficiently
- *Enforceability* – Some policies may be more difficult to enforce and need additional resources for implementation. The planning agencies must take enforceability into consideration while evaluating different strategies.
- *Legal constraints*
- *Social equity* - Some policies might be effective in realizing the goals set in terms of GHG emissions reduction but have adverse impacts on lower income sectors, which is not desirable. So, social equity issues must also be taken into consideration.
- *Political impact and feasibility*

References

Mui, S., Alson, J., Ellies, B. and Ganss, D. (2007) A Wedge of the U.S. Transportation Sector. Transportation and Climate Division Office of Transportation and Air Quality. U.S Environmental Protection Agency. April 2007. Available at: www.epa.gov/otaq/climate/420r07007.pdf

Pacala, S., and R. Socolow (2004) Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies. *Science*, 305, 968-972.

Table 1: Incorporation of Greenhouse Gas Emissions in Long Range Transportation Planning: State of Practice

MPO	Region/ City	GHG Reduction Goals	Incorporation in Long Range Transportation Plans		GHG Inventory Development and Mitigation Effectiveness Estimation Method
			GHG Inventory Maintained?	GHG Mitigation Strategies Considered in LRTP	
DCHC MPO	Durham, NC	30% GHG Reduction from 2005 levels by 2030, 50% for local government operations	Yes	Increase Park and Ride Lots; Parking Fare Increases; DCHC (LRTP) - Transportation Improvement Projects; HOV Lanes on I-40 & NC 147; High Capacity Transit; Bike Lanes; TTA Rail	Regional travel demand model used for developing travel-related measures; The International Council for Local Environmental Initiatives's (ICLEI's) Clean Air and Climate Protection (CACP) software is used to calculate emissions.
Baltimore Regional Transportation Board (BRTB)	Baltimore, Maryland	Reduce 2006 GHG emission levels by 10% in 2012	Yes	Truck stop electrification, Incident management, Alternative fuel vehicle purchases, Park-and-ride lot improvements, Rideshare coordination, Tele-work promotion, Remote start devices for buses (which save idling time)	Regional travel model used for travel forecasts, and CACP 2009 developed by ICLEI Energy Services used for GHG emissions estimation.
MWCOG	Washington, D.C.	10% GHG Reduction below "BAU" (Business as Usual) by 2012; 20% Reduction below 2005 levels by 2020; 80% below 2005 levels by 2050	No	Currently not incorporated in the LRTP, but COG's Climate Change Steering Committee (CCSC) recommended establishing reduction goals for three target years. Recommended actions include increasing the use of clean-fuel vehicles, transit-oriented investments, and traffic management strategies	Not applicable, because GHG not estimated currently; EPA's MOBILE 6.2 model used for mobile-source emissions.
Genesee County MPC	Flint, MI	Doesn't appear to have any GHG goals; main aim is to decrease VOC and NOx levels to be in air quality attainment	No	Currently not incorporated in the LRTP, but MPO has several strategies that should contribute to GHG mitigation. These include non-motorized mode use promotion, and transit capacity building and improvements.	Regional travel demand model combined with 2005 Highway Performance Management System (HPMS) to get information on VMT, VHT, Average Speeds, then fed into EPA's MOBILE 6.2 for mobile-source emissions estimation.
DRCOG	Denver, CO	60% GHG Reduction from the transportation sector from 2005 levels by 2035, Reduce % of trips to work by single occupant vehicle to 65% by 2035, reduce VMT by 10% by 2035	Yes	$3.5 mil set aside for Transit Station area and urban center planning, $4.7 mil set aside for Regional Travel Demand Management Program pool, mixed land-use and urban center development	Uses their own regional travel model, called *Focus for* travel forecasts, and results fed into EPA's MOBILE 6.2

Table 1: Incorporation of Greenhouse Gas Emissions in Long Range Transportation Planning: State of Practice (continued)

MPO	Region/ City	GHG Reduction Goals	Incorporation in Long Range Transportation Plans		GHG Inventory Development and Mitigation Effectiveness Estimation Method
			GHG Inventory Maintained?	GHG Mitigation Strategies Considered in LRTP	
NCTCOG	Dallas-Ft. Worth, TX	Goals rely on stationary source control measures to demonstrate attainment. Transportation Control Measures are identified to reduce NOx emissions in the Dallas nonattainment area by 1.53 tpd and volatile organic compound (VOC) emissions by 1.61 tpd.	No	Currently not explicitly incorporated in LRTP, but several strategies in place for general traffic and mobile-source emissions reduction - Bicycle/pedestrian projects, Grade separation projects, High occupancy vehicle (HOV)/managed lane projects, Intersection improvement projects, Park and ride projects, Rail transit projects, Vanpool projects	Not applicable, because GHG not estimated currently; EPA's MOBILE 6.2 model used for mobile-source emissions.
H-GAC	Houston, TX	No explicit GHG reduction goals; however, if RTP is implemented, it is projected to lead to 8% reduction in VMT. One of the RTP goals is to increase transit, and promote a healthier environment. Also Houston-Galveston regions hopes that TIP and RTP will result in less VOCs and NOx	No	Currently not incorporated in the LRTP, but 2035 RTP has several strategies that should contribute to GHG mitigation. The strategies include substantial transit capacity building and investments, travel demand management strategies, operational strategies, and developing livable centers.	Not applicable, because GHG not estimated currently; The TTI suite of emissions software is used in conjunction with the latest version of EPA's MOBILE6 model to obtain other mobile-source emissions.
SCAG	Los Angeles, CA	13% GHG Reduction by 2035 (compared to 2005), additionally, AB 32 requires California to reduce GHG emissions to 1990 levels by 2020.	Yes	The RTP to be drafted in November, 2011 would focus on reducing VMT and encouraging more compact, complete, and efficient communities for the future. Strategies under active consideration include roadway operational improvements, transit improvements, high occupancy toll lanes, land-use changes, and VMT fee	SCAG's regional travel demand model to estimate travel forecasts, and ARB's EMFAC Model for estimating emissions

Table 1: Incorporation of Greenhouse Gas Emissions in Long Range Transportation Planning: State of Practice (continued)

MPO	Region/ City	GHG Reduction Goals	Incorporation in Long Range Transportation Plans		GHG Inventory Development and Mitigation Effectiveness Estimation Method
			GHG Inventory Maintained?	GHG Mitigation Strategies Considered in LRTP	
SACOG	Sacramento	Reduction of VMT per household by 10 percent when compared with a no project alternative, and holds congested travel per household to less than a 5 percent increase.	Yes	Blueprint Program: The seven Blueprint principles are: (1) transportation choices, (2) housing diversity, (3) compact development, (4) mixed land uses, (5) use of existing assets, (6) natural resource protection, and (7) quality design.	Regional travel model used to estimate travel measures, and California Air Resource Board's (ARB's) EMFAC model used for GHG emissions estimation
Oregon MPO Greenhouse Gas Emissions Task Force	Oregon	Reduce emissions in 2020 to be 10 percent below 1990 levels; reduce emissions in 2050 to 75 percent below 1990 values. For 2035, a straight-line interpolation yields a value of 42.5 percent below 1990 levels.	Yes	No clear and documented plans in LRTP; general references to improved vehicle technologies, and land use-transportation strategies.	ODOT's GreenSTEP software used for travel forecasting and GHG inventory development

APPENDIX

The Durham-Chapel Hill-Carrboro (DCHC) MPO

GHG Reduction Goals:

- **30%** reduction from 2005 emissions levels by 2030 for the community and a **50%** reduction from 2005 emissions levels for local government operations.

How Goals will be achieved?: Incorporation in LRTP

- Increase Park and Ride Lots
- Parking Fare Increases
- DCHC (LRTP) – Transportation Improvement Projects
- High Occupancy Vehicle (HOV) Lanes in I-40
- High Occupancy Vehicle (HOV) Lanes in NC 147 (Durham Freeway)
- High Capacity Transit
- Bike Lanes

In addition to these plans, many other agencies in Durham also have several other measures in place ranging from plans to 1) encourage usage of alternate fuel vehicles, 2) make commute easier, 3) develop communities which are transit friendly and have mixed land use, and 4) increasing parking fare. A complete list of plans, monitoring authority and the anticipated reduction in emissions because of these plans is presented in Tables 1 and 2.

Emissions Inventory and Estimation Methods

- ICLEI Energy Services (the consulting division of ICLEI – Local Governments for Sustainability) helps Durham to develop a greenhouse gas (GHG) and criteria air pollutant (CAP) inventory, action plan and set a reduction target for the community and local governments of Durham.
- ICLEI uses the Clean Air and Climate Protection (CACP) software to estimate emissions.
- The triangle regional travel demand model provides the vehicle miles of travel needed as input to the CACP software.
- The CACP software then uses the following set of equations for estimating the impact of a particular measure or strategy for the transportation and vehicle fleet sectors on emissions of both greenhouse gases and air pollutants:

  Emissions = VMT X Emissions per VMT

  VMT = (Person-Trips/Persons per Vehicle) X Trip Length (miles)

  Emissions per VMT = Fuel Efficiency (i.e. MPG) X Emissions per Unit of Fuel (emission coefficient)

  Emissions = (A/B) X C X D X E

  where A is the number of person trips made using the vehicle type, B is the number of people per vehicle (occupancy factor), C is the trip length, D is the fuel consumption (in Gal/100miles), E is the emissions per unit of fuel (i.e. the fuel type factor)

- The CACP software is very powerful and sophisticated. However, it should be noted that calculating emissions from energy uses precisely is a very difficult task, since the model has a lot of assumptions. Also data can sometimes be very limiting. Therefore, any specific number generated by CACP, should be viewed as approximation, rather than an exact value.

Baltimore Regional Transportation Board (BRTB), Maryland

GHG Reduction Goals:

- Maryland's Climate Action Plan calls for a State-wide GHG emissions inventory and asks local governments to set targets for reductions as well as an outline for actions to achieve these targets.
- Following the State's Lead, Baltimore has set goals to reduce GHG emissions by 10% by 2012, following a 2006 baseline.
- They aim to make individual strategies for reductions in each sector, beginning with the transportation sector, since it is one of the biggest emitters. BRTB hopes that these strategies will not only reduce carbon dioxide and meet the 10% goals, but will also have a short pay-back period or give a high return on investments.

How Goals will be achieved?: Incorporation in LRTP

The transportation plan of BRTB does not specifically address how these reduction goals will be met. Some generic strategies are given, which are:

- Truck stop electrification
- Incident management
- Alternative fuel vehicle purchases
- Park-and-ride lot improvements
- Rideshare coordination
- Tele-work promotion
- Remote start devices for buses (which save idling time)

Emissions Inventory and Estimation Methods

- The Community Analysis Module within CACP software developed by ICLEI Energy Services is used for the emissions inventory of all Baltimore County activities. The Module considers emissions from six sectors – Residential, Commercial, Industrial (RCI), Transportation, Waste and Other.
- The equations used to calculate emissions from the transportation sector are based on VMT, and is already described in the DURHAM MPO section.
- All greenhouse gas emissions are aggregated and reported in equivalent carbon dioxide units. For example, methane's greenhouse gas potential is 21 times more potent than Carbon dioxide, so one ton of methane emissions is reported as 21 tons of carbon dioxide equivalent.

Metropolitan Washington Council of Governments (MWCOG)

GHG Reduction Goals:

- COG's Climate Change Steering Committee (CCSC) recommended establishing reduction goals for three target years to force early action, a medium range goal (to encourage expansion of policies and programs) as well as a long range plan (to motivate research into technologies and clean fuels).
- The goals are to reduce greenhouse gas emissions by:
    - 10 percent below BAU levels by 2012
    - 20 percent below 2005 levels by 2020
    - 80 percent below 2005 levels by 2050.
- Furthermore, CCSC recommends reassessing goals every three years to reflect policy changes and updates in science and technology.

How Goals will be achieved?: Incorporation in LRTP
Currently, GHG emissions reduction is not incorporated in the LRTP. However, CCSC recommended development of a regional transportation plan making GHG reduction a stated goal. Some of the other recommendations of the committee are:

- Increase Fuel Efficiency and Use of Clean-Fuel Vehicles (such as adopting regional green fleet policy)
- Reduce Vehicle Miles Traveled (VMT) (by Transit Oriented Development)
- Increase Travel Efficiency (Traffic Management Strategies)
- Improve Land Use

Examples of Regional Initiatives already in place for Reducing Transportation Emissions

- The metropolitan Washington region has been working to reduce VMT since the early 1970s, when the Commuter Club (now known as Commuter Connections) was formed. Commuter Connections promotes a variety of programs to reduce the number of single-occupancy vehicles on the road and to promote mass transit.
- Employers are encouraging public transit by identifying employees' home locations served by public transit, keeping current transit schedules on hand and posted, as well as arranging meetings with public transit operators to assist them in developing transit support programs (Guaranteed Ride Home, SmartBenefits, etc.). These employer incentives, coupled with energy price trends, an increase of mixed land use and more walkable community projects, has resulted in an increase of transit ridership.
- In 2004, COG and the Greater Washington Board of Trade called for an aggressive 20 percent telecommuting goal for the public and private sectors. Already in 2007, more than 450,000 workers (>18%) in the region were teleworking at least one day a week, reducing traffic congestion and air pollution.
- Biking/Pedestrian initiatives, transit oriented development and mixed land use is also being promoted.

Emissions Inventory and Estimation Methods

- The MWCOG use version 6.2 of the MOBILE model to calculate emissions. However, they have constituted a task force to facilitate the transition to MOVES for developing emissions inventory and conformity analysis.

Genesee County Metropolitan Planning Commission

GHG Reduction Goals

- To Improve Air Quality in Genesee County
- To Stay in Air Quality Attainment for the new 8-hour Ozone Standard

How Goals will be achieved?
The necessary action steps for the first goal:

- Increased regional multi-use non-motorized trail development and promotion of non-motorized trails as an alternative mode of transportation.
- Collaboration with community partners, local governments, and state governmental agencies to build coalitions for transportation alternatives and provide educational resources for alternative transportation development.
- Supporting transit as a viable alternative to the automobile and supporting alternative fuel development such as the MTA and Kettering University project focused on the development of alternative energy and clean diesel transit buses.

The necessary action steps for the second goal:

- To take all LRTP, TIP and STIP amendments as well as any regionally significant transportation projects through the Interagency Work Group (IAWG) for air quality conformity determination and to identify the projects that will need air quality modeling.
- To use programs such as MOBILE 6.2 to analyze air quality impacts of local and state transportation projects in Genesee and Lapeer Counties.
- To have a defendable and well calibrated urban travel demand model to identify congested areas and to use the Congestion Management Process to assist in mitigation of congestion.

Emissions Inventory and Estimation Methods

- Socio economic data developed by Genesee County MPC, Lapeer county RC and Michigan DOT for the years 2002, 2008, 2015, 2020 and 2030 are the basis for forecasting in the travel demand models. The urban travel demand forecast model adopts TransCAD for the travel forecasting purpose.
- The above procedure generates inputs required for the air quality conformity analysis. These inputs are the amount of travel expressed as vehicle miles of travel (VMT) and average speed by National Functional Classification (NFC) by county.
- HPMS (Highway performance monitoring system) universe data provides estimates of VMT stratified by NFC. To maintain consistency between HPMS and modeled VMT and among the milestone years, HPMS VMT by NFC (for the year the travel demand model is calibrated) is compared to the model calibrated year VMT by NFC (for the calibration year) to produce scaling factors.
- For each conformity analysis year, these factors are multiplied to each travel demand model's VMT to produce a scaled VMT by NFC. Then the scaled VMT by NFC is collapsed into four groups, to meet the input requirements of Mobile6.2. These groups are:1) rural interstate, 2) rural major & minor arterials/collectors/local streets, 3) urban interstate/freeway, and 4) urban principal & minor arterials/collectors/ local streets.

Initiatives already in place

Genesee County has focused on the following types of projects to actively address air quality through different types of solutions and allocated levels of funding for each category shown below for CMAQ in FY 2009-2011:

- Signal Interconnection, Modernization and Optimization Projects (40%)
- Transit Projects (40%)
- Non-motorized Pathway
- Construction (15%)
- Ridesharing Program (5%)

Denver Regional Council of Governments (DRCOG)

The 2035 Metro Vision Regional Transportation Plan (MVRTP) provides the transportation aspects of the Metro Vision.

GHG Reduction Goals

- Increase the rate of construction of alternative transportation facilities
- Reduce the percent of trips to work by single-occupant vehicle to 65 percent by 2035
- Reduce regional per capita VMT 10 percent by 2035
- Reduce per capita greenhouse gas emissions from the transportation sector 60 percent by 2035

How Goals will be achieved?: Incorporation in LRTP

- Development of transit station area and urban center planning. About $3.5 million has been set aside for this purpose.
- Increased funding for the Regional Travel Demand Management (TDM) Program pool. About $4.7 million has been allotted to this program which is almost 60 percent increase from the current TIP. Also, 2% of the funding initially allotted for road capacity expansion projects will be added to the Regional TDM Program pool.
- Many other policies for developing urban centers with mixed land use.

Emissions Inventory and Estimation Methods

- DRCOG's regional travel model "FOCUS" is used to perform the travel forecasting. The results of this model are then fed into EPA's Mobile software (version 6.2) for calculating emissions. They are currently working on shifting to MOVES for doing all the emissions estimation and conformity analysis.

North Central Texas Council of Governments

GHG Reduction Goals & How Goals will be achieved?: Incorporation in LRTP

NCTCOG seems more concerned with ozone attainment than carbon dioxide and other greenhouse gas emissions. The NCTCOG has identified some Transportation Control Measures (TCM) that need to be implemented in order to reduce GHG. By 2009, the SIP estimated that these TCMs will reduce NOx emissions in the Dallas nonattainment area by 1.53 tpd and volatile organic compound (VOC) emissions by 1.61 tpd.

These TCMs included:

- Bicycle/pedestrian projects
- Grade separation projects
- High occupancy vehicle (HOV)/managed lane projects
- Intersection improvement projects
- Park and ride projects
- Rail transit projects
- Vanpool projects

The recommendations to reduce GHG's include

- ITS
- Parking Cash-Out Program
- Roadway Peak-Period Pricing (I-30 value pricing pilot study)
- Arterial/Freeway Bottlenecks (reduce vehicular delays and travel time)
- Traffic Signal Improvements
- Sustainable Development
- Pay-as-you-drive Insurance Pilot Program

Examples of Current Regional Initiatives for Reducing Transportation Emissions

In response to the increasing public awareness about the harmful effects of increasing GHG emissions, some voluntary transportation programs have been started at the state and local level. By engaging the public to make voluntary changes that will result in reducing mobile source emissions, these programs hope to gain additional reductions beyond the mandatory level regulated by the Federal Clean Air Act. These examples include:

- Market based incentive programs

- Trip reduction programs
- Growth Management Strategies
- Ozone Action Programs
- Targeted Public Outreach.

The new Dallas voluntary commitments under the 2007 SIP revision included an employee trip reduction program. The estimated 2009 benefit of the employee trip reduction program is 0.43 tpd NO_x and 0.28 tpd VOC.

Emissions Inventory and Estimation Methods
MOBILE6.2 is used to develop 2009, 2019, 2025, and 2030 vehicle emission factors.

Houston-Galveston Area Council (H-GAC)

GHG Reduction Goals
H-GAC currently does not have any emissions reduction goals in place. However, the Houston-Galveston region hopes that the 2008 - 2011 Transportation Improvement Plan (TIP) and the 2035 RTP will lead to 8% reduction in VMT and thus result in less volatile organic compounds (VOC) and nitrogen oxides (NOx) than established and approved by EPA for the base year and each horizon years (2009,2019, 2025 and 2035).

The 2035 RTP Goals are summarized here:
- Improve mobility, less congestion and cost.
- Build stronger communities.
- Increase transit.
- Preserve floodplains for water detention and recreation.
- Healthier environment.

How Goals will be achieved?: Incorporation in LRTP
The five goals recommended in the 2035 RTP can be achieved through the four major strategies:
- System Capacity - increasing highway and transit capacity
- Demand Management - for peak-period travel
- Operations Management – improving the efficiency of existing facilities
- Livable Centers – coordinating land use and transportation investments

Potential Benefits of implementation of 2035 RTP:
- Lead to a reduction of 33 % in the amount of fuel and money lost due to delay time
- 8% reduction in VMT
- A doubling of transit usage from current levels if higher density development patterns are coupled with the RTP projects.
- A healthier environment through improved air quality from reduced on-road emissions and expansion of programs such as the Clean Cities program,
- More travel options through expansion of the Commute Solutions and regional Bicycle and Pedestrian programs.
- Almost $ 400 million annual reduction in the cost of vehicle crashes.

Emissions Inventory and Estimation Methods
The Travel Demand Modeling at H-GAC is done using the EMME/2 model with a special post-mode choice speed model in order to find the region's total VMT. The TTI suite of emissions software is used

in conjunction with the latest version of EPA's MOBILE6 model to find the appropriate emissions factors. Total emissions are then calculated by multiplying the VMT by the emission factors for each of the analysis years. Efforts of transition to MOVES are still by far only in the preliminary stages.

California

In compliance with the State law and Senate Bill 375, the Air Resources Board (ARB) is required to establish greenhouse gas reduction goals for each of the 18 MPOs in the California region. Table 3 shows the GHG emissions reduction targets of four major MPOs of the total 18 in California.

South California Association of Governments (SCAG)

GHG Reduction Goals

- 13% greenhouse gas emissions reduction target by 2035.

How Goals will be achieved?: Incorporation in LRTP

- SCAG has developed five scenarios to achieve the GHG emissions reduction targets. Each of these scenarios include a range of changes to one or more of the following seven components: 1) Land Use Pattern, 2) Transportation Network, 3) Transportation Demand Management (TDM), 4) Transportation System Management (TSM), 5) Public Transit Network, 6) Non-motorized Transportation Network, and 7) Pricing
- The range of options they are considering vary from reduction of home-based work trips, increasing the speeds and capacities, reduction in headways of transit facilities, high occupancy toll lanes, and VMT fee. They are still evaluating various options to bring about these changes.
- Depending on the intensity of changes, especially in the land use and transportation system components, these five scenarios are ordered from "achievable" to "ambitious". Table 3 shows the five scenarios in the increasing order of intensity of changes to each of the seven components.
- SCAG also has a planning program named Compass Blueprint focusing on development of mixed land use communities with better transit and walk facilities. The main idea of the program is to encourage community participation in the planning process and support the growth plans of SCAG by providing tools and services to work more effectively towards realizing the emissions reduction goals.

Emissions Inventory and Estimation Methods

- SCAG uses ARB's EMFAC (EMission FACtor) model to estimate GHG emissions using the outputs from the trip-based regional transportation demand model.

Sacramento Area Council of Governments (SACOG)

GHG Reduction Goals:

SACOG began with a Blueprint Program. What SACOG found is that by 2035, the Blueprint Preferred Growth Scenario as embodied in the Metropolitan Transportation Plan (MTP) for 2035 reduces VMT per household by 10 percent when compared with a no project alternative, and holds congested travel per household to less than a 5 percent increase.

How Goals will be achieved?: Incorporation in LRTP

Under the Blueprint program of SACOG, all future investment decisions would be based on the following set of seven principles are: transportation choices, housing diversity, compact development, mixed land uses, use of existing assets, natural resource protection, and quality design.

As a part of initiatives already in place to achieve the GHG reduction goals, SACOG is working on the development of a Regional Climate Change Action Plan that will:

- Discuss climate change's effects on the Sacramento region, and especially on MTP facilities.
- Calculate a baseline inventory of total 2005 GHG emissions produced directly or indirectly by MTP activities.
- Calculate total MTP GHG emissions per capita in 2005 based on the 2005 baseline inventory and the 2005 regional population.
- Compare the global climate change impacts of future MTP scenarios and current conditions.
- Create enforceable, viable GHG emissions reduction strategies to reduce total MTP GHG emissions per capita.

Emissions Inventory and Estimation Methods

- SACOG uses EMFAC for estimating all emissions under different scenarios.

Oregon Department of Transportation (ODOT)

GHG Reduction Goals

The targets for GHG emissions reductions in Oregon are:

- 10 percent below 1990 levels in 2020
- 75 percent below 1990 values in 2050
- 42.5 percent below 1990 levels in 2035 (found using straight line interpolation since statute does not directly establish a goal for 2035)

The focus is to reduce GHG emissions from light motor vehicles of 10,000 pounds or less and consider contribution of improved vehicle technologies and fuels.

How Goals will be achieved?: Incorporation in LRTP

There are no exact plans in place or laid out for achieving the emissions reduction. There is only a vague description of proposed course of actions that need to taken. Some of them are:

- A task force will study and evaluate alternative land use and transportation scenarios for MPO areas to accommodate the planned population and employment, while keeping GHG reduction goals in mind.
- Furthermore, the task force should consider reductions in vehicle emissions which will likely result by 2035 from the development of improved vehicle technologies and fuels.
- The task force will also identify resources needed for implementing these land use and transportation scenarios, and evaluate potential problems that can arise during execution of strategies.
- Lastly, the task force will recommend legislation to interim Legislative assembly committees to establish a process for adopting and implementing GHG emissions reductions plans.

Emissions Inventory and Estimation Methods

ODOT (Oregon Department of transportation) developed the Greenhouse Gas State Transportation Emissions Planning model (GreenSTEP) to estimate GHG emissions from transportation sources and to model emission changes in response to different policy scenarios. GreenSTEP estimates vehicle travel and the associated GHG emissions at the household level, rather than at the roadway level. In other words, the emissions reported for a particular county or metropolitan area represent the emissions of households who reside in the area, regardless of where they travel.