Greenhouse Gas Emissions Analysis of Regional Transportation Plans with EPA's MOVES Model

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ABSTRACT

With growing interest in climate change issues nationally, Metropolitan Planning Organizations (MPOs) are beginning to face requirements for greenhouse gas (GHG) analysis of their regional long-range transportation plans. This paper starts with a summary of existing MPO planning responsibilities and a discussion of future policy and legislative initiatives that may lead to more widespread GHG analysis of transportation plans. Methodologies for regional on-road GHG analysis based on EPA's MOVES model and other approaches are summarized. Finally, the paper outlines methodologies for a comprehensive GHG emissions analysis, encompassing operational on-road emissions from the transportation network, construction and maintenance emissions, and fuel and vehicle lifecycle effects.

INTRODUCTION

Although transportation is a vital part of the economy and is essential for everyday activities, it is also a significant source of greenhouse gas emissions. In 2003, the transportation sector accounted for about 27 percent of total U.S. GHG emissions.[1] The transportation system is the second-largest contributor to GHG emissions in the United States, and the majority—approximately 72 percent—of the transportation sector's emissions are generated by road transportation, including both passenger and freight travel. The large and increasing GHG emissions from road transportation present a major policy challenge.[2]

Discussion of climate change is becoming more common in transportation planning documents. Many state DOTs and MPOs are recognizing the role that transportation policies and investments play in contributing to climate change and conversely, the potential impact of climate change on transportation systems. Long range transportation plans (LRTPs) in particular are highlighting climate change among a new generation of environmental and sustainability issues that shape transportation planning objectives.

At present, there is no federal regulatory requirement for state DOTs and MPOs to consider climate change in transportation plans. As such, agencies that are working on climate change are creating their own models for integrating climate change into their transportation plans. These models are reflected in the language that agencies use about climate change in their planning documents. Many agencies provide a robust explanation of why climate change is a transportation planning issue, context about latest developments in climate change policy, and establish new policies related to climate change.

The report 'Assessing Mechanisms for Integrating Transportation-Related Greenhouse Gas Reduction Objectives into Transportation Decision Making; NCHRP Project 20-24(64)' recommends and compares approaches for GHG analysis; emissions and vehicle miles travel. The report states "While transportation planning can play an important role in contributing to

GHG reductions, transportation agencies have limited control over many of the factors that influence GHGs, including changes in vehicles and fuels. The role of transportation agencies, therefore, needs to be considered in the context of the various factors that affect GHGs."[3] "In addition to efforts that focus on vehicles and fuels, there has also been growing interest in policies to achieve GHG emission reductions through transportation decision making.

MPO capabilities can also be useful as states develop or update climate action plans. MPOs can provide future estimates of transportation GHG emissions, based on local projections of land use, population, and employment. State DOTs that have travel modeling capability can also provide statewide estimates of future GHG emissions to support climate action plan development.

Existing Transportation Planning Process Responsibilities

At the state level, each of the U.S. states, Puerto Rico, and the District of Columbia have an agency or department with official transportation planning, programming, and project implementation responsibility for that state or territory, referred to as the state DOT. State DOTs are required to develop statewide transportation plans, although these plans do not have to be quantitative (they can be policy-based plans, with goals for meeting future transportation needs, but no specific future infrastructure or network identified).

A Metropolitan Planning Organization is a transportation policy-making body made up of representatives from local government and transportation agencies with authority and responsibility in metropolitan planning areas. Federal legislation passed in the early 1970's required the formation of an MPO for any urbanized area with a population greater than 50,000. Areas with populations greater than 200,000 are designated transportation management areas (TMAs). TMAs must have a congestion management process that identifies actions and strategies to reduce congestion and increase mobility.

The Clean Air Act (CAA) of 1990 identifies the actions states and MPOs must take to reduce emissions from on-road mobile sources in nonattainment and maintenance areas. Nonattainment" areas are geographic areas that do not meet the federal air quality standards, and maintenance areas are areas that formerly violated but currently meet the federal air quality standards. Transportation conformity is required for all ozone, carbon monoxide, nitrogen dioxide, and particulate matter nonattainment and maintenance areas. There is no formal scientific or regulatory link between conformity and GHG emissions; however, MPOs that have already faced requirements to conduct emissions analysis for conformity would find it easier to conduct GHG analysis, compared to MPOs that have never faced conformity requirements before.

Potential New Requirements

New requirements for transportation agencies to integrate greenhouse gas considerations into transportation decision making are currently being proposed and debated at both the national and state levels. Bills before the U.S. Senate and House of Representatives would require DOTs and MPOs to demonstrate effort to reduce GHG emissions as part of the statewide and metropolitan transportation planning process. Similar requirements have been proposed for the reauthorization of federal surface transportation legislation. Several states, including California, Washington, Oregon, and New York, have already adopted requirements to address GHGs in transportation planning. These requirements are being considered in the context of a range of potential national climate change policy statements.[3]

On the climate side, the American Clean Energy and Security Act of 2009 (HR 2454, House-passed) amends existing transportation planning processes to require states and MPOs in transportation management areas to develop targets and strategies for GHG emissions reductions. State and MPO plans must "contribute" to the achievement of the national emissions reductions targets. Likewise, the Clean Energy Jobs & American Power Act (Boxer/Kerry proposal) would amend existing transportation planning processes to require states and MPOs in TMAs to develop targets and strategies for GHG emissions reductions. MPOs must demonstrate progress in stabilizing and reducing GHG emissions to achieve state targets.

On the transportation side, the Surface Transportation Authorization Act Of 2009 (Oberstar proposal) would require states and MPOs in TMAs to set targets for GHG emissions reductions from surface transportation and incorporate strategies to meet targets into their plans. U.S. DOT, through performance measures, will verify that states and MPOs achieve progress towards national GHG goals. The Clean, Low-Emission, Affordable New Transportation Efficiency Act (CLEAN-TEA) S. 575, introduced March 2009 by Senators Carper and Specter, would require States and regional and local governments with a population over 200,000 to establish a goal of reducing emissions from the transportation sector and develop a transportation greenhouse gas reduction plan, with a prioritized list of projects within that plan, to meet the emissions goal. The plan would be integrated into existing state and regional transportation plans and approved by the USDOT and EPA. If enacted, any of the new federal requirements could have major implications for state DOTs and many MPOs. New requirements would likely necessitate enhancement to existing transportation analysis tools, especially for state DOTs and for MPOs that have not yet been subject to conformity, since neither have very much experience with areawide air quality analysis.

State legislatures are also beginning to impose GHG analysis requirements on planning agencies. California's SB 375 (signed in 2008) requires the state to set GHG reduction targets for California's 18 MPOs. MPOs must prepare long range plans that demonstrate how they will achieve the targets. Washington's HB 2815 (signed in 2008) requires the state to reduce light-duty vehicle miles traveled (VMT) per-capita 18% by 2020, 30% by 2035, and 50% by 2050. New York's State Energy Plan (adopted in 2002) calls for analyzing the energy and GHG emissions impacts of long range transportation plans and transportation improvement programs (TIPs). Oregon's SB 1059 (passed in 2010) lays the groundwork for smart and cost effective action by developing a state-level strategy to reduce greenhouse gases from transportation sources, developing a "toolkit" to assist local governments and metropolitan planning organizations, setting greenhouse gas reductions targets, and encouraging public education.

EXAMPLES OF CURRENT PRACTICE

Many MPOs have already conducted a GHG analysis of their transportation plan, reflecting a wide range of practice. The most simplistic method for assessing GHG emissions from the plan is to use vehicle miles travelled, or VMT, as a surrogate for GHG emissions. As VMT increases over time due to population and economic growth, GHG emissions would also be assumed to increase. Likewise, if one future scenario for the area's transportation network happens to produce more VMT than some other scenario, it would also be expected to have higher GHG emissions. A related approach has been to use future VMT projections, along with estimates of fuel economy, to estimate fuel consumption and GHG emissions. (Miles per gallon divided by miles of travel per day provides gallons of fuel consumed per day; estimates of the carbon content of fuel are then used to determine CO2 emissions per day.)

There are two flaws with using VMT as a surrogate for emissions. First, it ignores future improvements in vehicle fuel economy, unless fuel economy changes are accounted for using the approach above. The National Highway Traffic Safety Administration (NHTSA) adopted more stringent fuel economy standards for light-duty trucks in the early 2000's, and more recently, EPA and NHTSA promulgated a joint rulemaking imposing new fuel economy standards and first-ever GHG emissions standards for passenger cars and light trucks.[4] (Since GHG emissions are directly related to fuel consumption—the more hydrocarbon fuels consumed, the more carbon emitted—fuel economy and GHG emissions are closely related.) EPA and NHTSA are also beginning work on fuel economy/GHG standards for heavy trucks, and a second round of fuel economy/GHG standards for light-duty vehicles in model years 2017 and beyond. Thus, any approach that uses VMT as a surrogate for GHG emissions ignores the fact that GHG emissions rates will be decreasing. Also, this approach ignores any potential changes to fuel consumption and GHG emissions resulting from changes in speed and congestion. The relationship between fuel economy and speed has been well-understood since at least the 1970's, and transportation projects that improve fuel economy (by reducing congestion) will reduce GHG emissions, all else being equal. This is another important factor that is disregarded in a VMT-only approach.

The MOBILE6.2 model was another potential tool for estimating GHG emissions. Many MPOs already use MOBILE6.2 to estimate regional emissions for purposes of transportation conformity. MOBILE6.2 included a simplistic methodology for estimating CO2 emissions; it contained a table of fuel economy values by model year, and this plus the fractions of VMT by vehicle type and age were used to calculate a fleet average fuel economy value and CO2 emissions rate. However, these emissions rates were not sensitive to speed. Also, the table of fuel economy values was assembled in the late 1990's; future improvements to the fuel economy standards were not incorporated.

GHG reporting systems, like the Climate Registry, have adopted emissions protocols for mobile sources based on fuel consumption. While this is useful for developing estimates of current emissions, it is not particularly helpful for developing estimates of future emissions. It is in the context of developing future emissions projections, and plans for reducing these emissions, that an MPO's ability to project future VMT and speeds becomes most important.

EPA's Motor Vehicle Emissions Simulator (MOVES) model has been another tool for estimating GHG emissions. In fact, the first version, MOVES2004, only estimated energy consumption and GHG emissions. Successive versions of MOVES—MOVES Demo (2007), DraftMOVES2009 (April 2009), and MOVES2010 (December 2009)—have included various improvements to its energy and GHG emissions estimation methodology, along with capabilities for modeling criteria pollutants and mobile source air toxics. MOVES2010 is discussed in more detail below. Puget Sound Regional Council in Seattle, Washington used MOVES to develop GHG emissions in its evaluation of packages of projects selected in its LRTP (*Transportation 2040*) to analyze the GHG emission implications of alternative transportation investments and land use strategies contained in the Plan.[5]

USING MOVES FOR GHG ANALYSIS OF TRANSPORTATION PLANS

EPA's MOVES model replaces the MOBILE6.2 model. MOVES will be used for transportation conformity analyses, State Implementation Plan (SIP) development, and analysis of highway and transit projects in environmental review documents. Much more information about MOVES, including the model itself, supporting documentation, and guidance for use of the model, can be found at EPA's MOVES web site.[6]

MOVES represents a significant improvement over MOBILE6.2 for energy and GHG analysis. The MOVES model develops energy consumption and emissions estimates based on speed and vehicle power output, unlike MOBILE6.2, which reported the same fuel economy and CO2 emissions estimates regardless of speed. The model estimates emissions of three GHGs—carbon dioxide, methane, and nitrous oxide. It can also model emissions of black carbon (elemental carbon), though these are not treated as GHGs in EPA's current emissions inventories. It currently only models emissions from on-road mobile sources (cars, trucks, buses and motorcycles), but EPA plans to add non-road emissions sources to the model in the future.

Users can calculate emissions inventories for transportation networks or individual projects. In this case, travel data, including total VMT and the population of vehicles, are entered into the model, and MOVES will produce an emissions estimate reflecting that traffic data. MOVES can also produce emissions rates. These are similar to the emissions rates produced by MOBILE6.2, but different in format. Emissions rates for running emissions (vehicles operating on roadways) take the form of a speed lookup tables of energy consumption and GHG emissions in 5 mph increments, on a mass per distance basis (e.g., grams per mile). Emissions rates for engine starts (the excess emissions from starting the engine at the beginning of a trip) are reported on a mass per vehicle basis. Emissions rates can also be generated for vehicles in extended idle mode (e.g., heavy trucks idling at a truck stop or rest area), also on a mass per vehicle basis.

Whether to use an inventory approach or rates approach is up to the preference of the user. The primary advantages of using MOVES in inventory mode are that the model generally runs faster, and the user does not have to calculate an emissions inventory outside of the model. The primary advantage of using MOVES in rates mode is that the emissions rates can be used with existing travel model post-processing software, although some modifications would be needed. First, while the running exhaust rates are reported on a per-mile basis, the other rates (for GHGs, start and extended idle emissions) are reported on a per-vehicle basis. Since most travel models generally do not report the number of vehicles in the area, post-processing software would need to be modified to include this variable. Second, rates vary by temperature, and in some cases, time of day, so the post-processing method would have to be configured to accurately apply these rates. Finally, the amount and types of input data needed for MOVES are identical for either approach. Given these constraints, an inventory approach in MOVES may be simpler and less error-prone for most users. It certainly would be the preferred approach for MPOs that are new to air quality or GHG analysis (e.g., they have not previously had to conduct AQ analysis for any reason, and do not already have travel model post-processing software designed to calculate emissions inventories). (Note that these constraints affecting use of emissions rates are not unique to GHGs, but are a consideration for any pollutant estimated using the model.)

In addition to producing emissions inventories or emissions rates, MOVES can also be run at any of three scales: national, county, or project. National scale runs involve all national defaults (local data can be entered, but do not have to be), and all necessary inputs can be accomplished through the MOVES graphical user interface. MOVES is pre-populated with all necessary data for all counties of the United States, and inventories can be prepared for individual counties, groups of counties, entire states, or the entire country. National-scale runs are a quick way to get started with the model and produce information about national trends, but much of the internal data represents national averages, or national data sub-allocated to the county level, and would not generally be representative of a particular area's growth rate or other trends.

EPA's Technical Guidance states that the County scale is the appropriate scale for SIP emissions inventory development and transportation conformity analysis. It is the ideal approach for regional GHG emissions inventories as well. In County runs, the user must provide certain types of data for the model to run. These data are:

- Age Distribution
  - Age fractions of the vehicle fleet by age and source type
- Fuel Supply
  - Market share of fuel blends
- Fuel Formulation
  - Composition of fuel blends (volatility, sulfur, oxygenates, etc.)
- Meteorology
  - Temperature and humidity inputs by hour
- Inspection/Maintenance (I/M) Programs
  - Description of vehicle emissions I/M program(s), if any
- Average Speed Distribution
  - Speed distribution by road type, hour and vehicle type
- Ramp Fraction (optional input)
  - Fraction of freeway vehicle hours of travel (VHT) occurring on ramps
- Road Type Distribution
  - Fraction of VMT by vehicle type on different road types
- Vehicle Type VMT
  - Total annual VMT by HPMS vehicle type
- Month VMT Fraction, Day VMT Fraction, Hour VMT Fraction
  - Allocation factors to distribute annual VMT by month, day type (weekday versus weekend), and hour
- Source Type Population
  - Number of vehicles by vehicle type operating in the area (important for start and evaporative emissions)

The first eight items on this list, along with the hourly VMT fraction, will be familiar to modelers with MOBILE6 experience, and are quite similar to their MOBILE6.2 counterparts. Annual VMT, along with monthly and weekday/weekend allocation factors, were not used in MOBILE6 directly, but were used outside of the model to calculate emissions inventories. The sole new input in MOVES is the source type (vehicle type) population, which is used primarily to determine total start emissions for all pollutants, and evaporative emissions when modeling hydrocarbon pollutants. EPA's MOVES User Guide and Technical Guidance explain how to assemble and format these items of input data.[6]

These data are "entered" into the MOVES model using a tool known as the County Data Manager (CDM). The data themselves are developed and stored in spreadsheet form. In the CDM, the user first creates a MySQL database to hold the data, and then imports individual data items from the base spreadsheets into database tables. This procedure can be automated to speed up the process for repetitive runs. When MOVES runs, it reads the MySQL database and substitutes information in the default database with data that the user has provided through the CDM for the duration of that run.

The list of data items above may seem daunting, but in actuality, the input requirements for a MOVES-based emissions inventory are not appreciably different than those for a MOBILE6-based inventory. MPOs that will need to use MOVES to develop SIP emissions inventories and/or conduct regional conformity analyses can generate GHG inventories at the same time, using the same input data, simply by specifying GHG emissions when setting up the MOVES run. When modeling multiple years and/or scenarios (for example, multiple alternative scenarios of a new transportation plan), some of these inputs would remain the same, and some would differ. Age, meteorology, fuel, and I/M inputs would generally remain the same, while most of the travel activity measures (with the probable exception of the month and day VMT fractions) would change.

The remaining available scale in the MOVES model is the Project scale. Here, rather than estimating emissions for a county or group of counties, the modeler can evaluate emissions for the individual roadways links associated with a transportation project. This is the scale at which MOVES will be used for project-level conformity analysis, and it could also be used for project-level energy or GHG analysis. However, it would not be practical for an MPO to model the hundreds or thousands of roadway links in an entire roadway network at this scale; the County scale is much more efficient for regional analysis.

MOVES does not estimate emissions from non-road vehicles, including rail transit and ferries, and other sources of information would be needed to estimate emissions from these modes. Rates for electric rail/bus could be based on local energy consumption record for these modes and information the carbon emissions from state electricity sources. Emissions rates for diesel rail and/or ferries could be based on fuel consumption records for these vehicles.

MOVES' estimates of energy consumption have been validated against national fuel sales data. The model performs quite well at estimating national-level energy consumption, suggesting that its GHG emissions estimates are also reasonably accurate. Information on MOVES validation is included in the report "MOVES2004 Validation Results".[7]

When it comes to GHG analysis, the MOVES model is a vast improvement over past tools, but is still a work in progress. Some past issues with the model, most notably the tendency of MOVES to predict improving fuel economy for vehicles no matter how fast they drive, have been corrected. In addition to this correction, MOVES2010a, released in September 2010, incorporates the most recent fuel economy and GHG emissions standards for light-duty vehicles. However, some work remains. MOVES does not yet account for the effects of biofuels like E85 and biodiesel (ethanol blends of up to 10% can be modeled). MOVES includes placeholders for hybrid and fuel cell vehicles, but these are not yet active. Earlier versions of MOVES included the ability to model "well-to-pump" effects (the upstream energy and emissions associated with fuel production and transportation), but these are not present in the more recent versions. Even with these limitations, however, MOVES is clearly the most advanced available tool for on-road mobile source GHG analysis.

USING OTHER LOCAL DATA FOR A COMPREHENSIVE GHG ASSESSMENT

Most transportation agencies' experience with air quality to date (to the extent that they have had to deal with it at all) has been in dealing with episodic air pollution problems—wintertime carbon monoxide problems, summertime ozone problems, etc. GHGs are different in that they represent our first *cumulative* air pollution problem. Climate change is attributed to the growing concentration of GHGs in the atmosphere; these concentrations are growing not just because emissions are growing, but because GHGs have long atmospheric lifetimes (on the order of decades to centuries for the more common transportation-related GHGs).[8] Thus, when it comes to looking at the GHG emissions impact of an activity, it is important to consider the full lifecycle emissions impacts of that activity.

In addition to presenting a comprehensive picture of GHG impacts, lifecycle analysis can answer many questions of interest to decisionmakers, including: "How long does it take before the energy savings from operational improvements offset the energy associated with construction equipment, materials, and delay created by the work zones?" "Is a transit-oriented plan alternative more efficient than a HOV-oriented alternative if the energy associated with construction is considered?" "Would a more congested plan alternative still result in lower overall energy use if it results in more compact land use (and less VMT) over time?"

In the transportation GHG context, lifecycle analysis is generally taken to mean that the following contributing activities should be considered and evaluated:

- Changes in operation (hopefully, improvements in operation) of the transportation system as a result of implementing the plan
- Construction emissions associated with implementing the plan
- New maintenance needs as a result of the increases in infrastructure
- Other sources of roadway emissions
- Upstream/Downstream emissions from vehicles and fuels

Changes in operation, either for a single roadway or an entire transportation network, can be evaluated with the MOVES model, as discussed above. The following sections provide suggestions regarding how the other aspects of lifecycle emissions can be evaluated in the context of a transportation plan. One useful source of information in this regard is the recent National Cooperative Highway Research Program report, "Greenhouse Gas Mitigation Measures for Transportation Construction, Maintenance, and Operations Activities."[9]

Construction emissions

A few simple methodologies currently exist for evaluating construction emissions in the planning process. These emissions include both construction activity, and the embodied energy/GHG emissions in the materials used. These methodologies generally take the form of a top-down approach (using the dollar value of total construction as a surrogate for total construction emissions) or a bottom up approach (estimating the construction emissions for individual projects, and then adding them together). Modelers can also quantify the emissions effects of delays/detours during construction, if data or model results are available.

New York State DOT has developed methodologies for regional and project-level energy and GHG analysis that serve as one useful example. For roadway construction, the methodology uses factors of energy consumption per lane-mile of activity, and then the energy consumption estimates are converted to CO2 estimates. (A "lane-mile" is one lane of roadway one linear mile long—a new 4-lane roadway, 10 miles long, would constitute 40 lane-miles.) The recent analysis for the Buffalo, New York transportation plan provides an example application of the New York procedures.[10] To evaluate the GHG emissions associated with construction of the projects outlined in a transportation plan, the MPO would simply add up the lane-miles associated with each type of activity, multiply by the appropriate GHG emissions factor, and then sum across all activity. Somewhat different procedures are defined for estimating construction emissions from rail transit projects.

The New York approach is readily transferable to other MPOs, since most MPOs already have information on new lane-miles of roadway from assembling their travel model networks; this is not new data they would have to gather. In terms of reporting, the procedures provide an estimate of the total emissions associated with construction of each project, so emissions from each project could be reported in the year in which it was completed, or the emissions from all projects could be "annualized" over the life of the transportation plan.

It would also be possible, and useful, for individual states to develop state-specific information reflecting construction practices in their states. This could be carried out by reviewing detailed project construction logs for energy (fuel) use information. The information could be broken out by project elements: lane miles for roadways, lanes and length for bridges, surface area for parking lots (e.g, park and ride lots). These procedures could also consider state practices for construction (concrete versus asphalt pavements for new construction, use of recycled versus virgin materials, etc.).

Maintenance emissions

This paper defines maintenance as work that is done to a roadway between the time it is first constructed and the time that a major reconstruction occurs. This would include activities such as sweeping, striping, periodic repaving, patching potholes, snow and ice removal in cold areas, drainage maintenance, etc.—activities that would change in extent if additional roadway lanes were built. (The next category, other activities, reflects activities that would generally not change if additional lanes were built.)

Probably the best source of information for assessing these emissions is information from the area itself. State and local roadway maintenance departments keep records of fuel and materials used in maintenance activities. One very easy way for an MPO to calculate these emissions would be for each state and local agency to report the amount of diesel fuel used in the last year on maintenance activities in the MPO area. This can be divided by the lane miles in the current roadway network to develop a "gallons per mile" maintenance factor, which in turn can be converted to a GHG "pounds per mile" emissions factor using EPA conversion factors.[11] Maintenance factors would also be needed for rail transit in areas that have such infrastructure; maintenance electricity/fuel consumption could be provided by the responsible transit agencies. Future improvements here could include going beyond looking at just fuel consumption, and also considering GHG emissions content of materials like asphalt patching and resurfacing materials, road sand and salt, etc.

Then, when evaluating future roadway networks, the MPO can apply these factors to the number of lane miles in the future network. If the transportation plan envisions construction of 400 lane miles of additional roadway, those additional lane miles would require maintenance over and above the existing system, and using the factors calculated above, MPOs could determine the GHG emissions associated with this. Repaving and reconstruction would normally be treated as maintenance, and separate repaving factors for surface maintenance could be calculated using local records; total reconstruction would generally be treated as a new construction project.

Other emissions

This category would include emissions from lighting, landscaping, maintenance of the roadway or transit right of way (mowing, watering, etc.). These emissions generally would not change with the number of lanes. Here, it would be useful to develop emissions rates based on centerline miles, again using local maintenance and electricity consumption records.

Upstream/Downstream emissions

This category includes emissions associated with manufacture and disposal of vehicles (the energy/emissions required to build and deliver vehicles that will use the facility, and then disposal of them at the end of their useful life), and "well to pump" emissions associated with fuels. These emissions can represent around 40% of emissions on a per-vehicle-mile basis. The easiest way to estimate these emissions is to use emissions factors from EPA's national report "Greenhouse Gas Emissions from the U.S. Transportation Sector, 1990-2003." Appendix B of this report lists adjustments by vehicle type.[1] These values would need to be prorated based on local VMT mix. Since these emissions are calculated relative to emissions from vehicle travel in EPA's report, they would be applied as an adjustment to the operational portion of the inventory.

Reporting Lifecycle GHG emissions

GHG emissions can be reported on a daily or annual basis for selected years during the period of the transportation plan, similar to current practice for transportation conformity analysis, or can be reported as cumulative emissions over the life of the plan. Given the cumulative nature of GHG emissions, cumulative emissions over the life of the plan is probably the most meaningful way to report emissions. Yearly "snapshots" would not fully capture the overall impacts of implementing the transportation plan.

CONCLUSIONS

As MPOs and state DOTs begin to face new requirements for GHG analysis of their transportation plans, the MOVES model provides a powerful new tool for on-road mobile source GHG analysis. With speed-sensitive emissions rates and the ability to capture the effects of the new fuel economy and GHG emissions standards, MOVES is a major improvement over MOBILE6.2 when it comes to GHG analysis. Other methods are available to estimate emissions from other aspects of the transportation system—construction, maintenance, and other sources of related emissions.

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