

Sacramento Area Council of Governments
Technical Methodology to Estimate Greenhouse Gas Emissions--Revised

NOTE: This document was originally submitted to CARB March 2015. Revisions were in response to CARB requests made on July 24, 2015 and September 16, 2015.

Process Overview: Updating the Metropolitan Transportation Plan and the Sustainable Communities Strategy

SACOG's Metropolitan Transportation Plan /Sustainable Communities Strategy (MTP/SCS) update is proceeding on three tracks: framing assumptions and constraints, public participation and input, and technical tools and data.

Framing Assumptions and Constraints

Regional Growth Projections

The total amount of growth in the region through 2036 is one of first components needed to develop the MTP/SCS. These projections of total employment, population, and households are based on the 2012 MTP/SCS for the horizon year (2035). The interim years from 2014 to 2036 has a similar trend as that Plan, although the early years have slower growth that accounts for the effects of the Great Recession. By the new horizon year of 2036 the growth rates increase so the cumulative totals are the same as the current Plan.

The horizon year projections are endorsed by the SACOG Board of Directors to be used in the Plan development. Final adoption of the projections including interim year projections will occur at the conclusion of the process, in order to provide flexibility in the planning process and to incorporate new data as it comes available. The major theme of the 2016 Plan development is implementing the 2012 Plan, with emphasis on the interim year trends.

For the GHG analysis required by SB375 SACOG will produce CO₂ per Capita for 2005, 2020, 2035, and 2036. With the Plan update's change in horizon year from 2035 to 2036, an additional analysis year is required. The 2035 analysis will use land use data interpolated between 2020 and 2036 as the basis of the travel and emissions calculations.

Another aspect of setting regional growth projections is to update the base year of the plan analysis to 2012. Updating the base year data is required by Federal regulations. However, the base year for the GHG performance metric remains at 2005 as required by the SB375 statutes.

The table below compares these regional data to the current SCS.

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Regional Growth	2012 SCS	2016 SCS
Population (thousands)		
Base Yr 2008/12	2,215	2,250
2020	2,520	2,480
2035/6	3,086	3,086
Housing (thousands)		
Base Yr 2008/12	885	902
2020	1,004	951
2035/6	1,188	1,188
Employment (thousands)		
Base Yr 2012	966	900
2020	1,073	1,042
2035/6	1,327	1,327

Household income projections have a more prominent role in this MTP/SCS process. In particular the distribution across the income range from poverty level to upper income has been changed by three factors: a) the continuing effects of the Great Recession, b) the importance that income plays in transportation decisions for many households, and c) the impact of employment sectors growth rates within the regional economy. The table below compares the percent of households in five income ranges to the current Plan.

2012 SCS					
	< \$20k	\$20-39k	\$40-59k	\$60-99k	\$100k +
Household Income					
Base Yr 2008	13%	18%	17%	25%	28%
2020	13%	17%	17%	25%	28%
2035	11%	16%	21%	23%	29%
2016 SCS					
	< \$20k	\$20-39k	\$40-59k	\$60-99k	\$100k +
Household Income					
Base Yr 2012	17%	21%	17%	21%	24%
2020	17%	21%	17%	21%	24%
2036	17%	21%	17%	21%	24%

The regional growth projections provide the starting point for alternative scenarios that form the basis of the learning and evaluation process that are being used in the MTP/SCS update. As with the 2012 Plan three scenarios are developed to test the impacts of development patterns and transportation projects through the planning period to 2036. The MTP/SCS scenarios provide findings for the much broader planning requirements and policy goals. The evaluation of residential growth patterns is critical to the scenarios and to the pace of growth as well. The evaluation process for housing development projects, summarized for the planning partners and the Board of Directors, includes the

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balancing of future demand with the supply of proposed plus approved but unbuilt housing. The existing approved but not yet built housing projects in the region are significantly larger than the projected housing growth. Therefore a thorough evaluation process is used to allocate housing in the region.

Revenue Estimates

Revenue estimates for the transportation investments are an important part of the MTP/SCS update. The draft preferred scenario including the revenue estimates is scheduled for action by the SACOG Board in April 2015. The revenue estimates correspond with the projected regional population growth, given that most of the revenue programs are linked to the size of the region.

Framework and Schedule

The schedule for this MTP/SCS update calls for action by the Board of Directors in February 2016. Leading up this date of adoption, public outreach is conducted to solicit comments and suggestions for plan alternatives, performance measures, and policy objectives. The SACOG Board of Directors adopted this framework and schedule in December 2013.

Public Participation and Input

The SACOG Public Participation Plan (PPP) is used to guide our outreach efforts throughout the MTP/SCS update. SACOG utilizes its standing advisory committees, a multi-sector stakeholder working group, public workshops and online workshop, and public hearings to fully comply with, not only state and Federal requirements, but also regional needs and policies on equitable and accessible public engagement. The primary purpose of the workshops was to get public participation in a workshop survey, which focused largely on soliciting from respondents their biggest transportation challenges today and the plan performance outcomes most important to them. The scientific public opinion telephone poll was conducted to provide the SACOG Board with scientifically valid public perspectives on the region's transportation challenges and the policy themes for the plan update. In addition, all stakeholder and local government input was conducted in order to educate all parties on the purpose and policy themes of the plan update, solicit input at critical points in the development of plan assumptions, and provide transparency of process to all interested parties.

The PPP is available on SACOG's online at www.sacog.org/involved/Public_Participation_Plan_2013.pdf. The application of the PPP to the RTP update was approved by the SACOG Board¹.

Technical Tools and Data

Starting with its landmark regional "Blueprint" project, SACOG has developed a reputation for data-driven, technically based transportation planning, with an emphasis on using state-of-the art modeling and analysis tools to inform the planning process. These tools and data are the foundation of connecting the land use policy, transportation system

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development, and transportation-source GHG emissions. The section below provides details on these tools and data, and how they relate to the update of the MTP and development of an SCS for the region. Two important adjustment processes are included here that are necessary to take account of changes in the model for the travel and emissions metrics.

¹ SACOG Board on August 15, 2013.

Technical Tools, Models and Data for MTP

SACOG maintains and uses several technical planning and analysis tools to address three key components of transportation-source GHG production in the region.

- Land use planning and scenario analysis tools
- Travel demand modeling tools
- Emissions estimation tools

In addition to planning and analysis tools, regional monitoring and data programs provide a basis for establishment of analysis base years, tracking of growth and trends in the region, and validation and sensitivity testing of planning and analysis tools.

Base Year Update Process

SACOG systematically updated its land use and transportation monitoring datasets, and used these monitoring data to update the base year of its forecasting tools to Year 2012. Housing, employment and schools inventories were updated, using a range of data sources (Census data, building permits, commercially and publicly available employment datasets, aerial photos, county assessors' data, and other sources). SACOG's regional GIS street and bikeway centerline file, published transit schedules and maps, and aerial photos were used to update the highway and transit datasets for SACOG travel demand models to Year 2012. Traffic counts and transit passenger volume datasets were updated, and will be used for validation of travel demand modeling tools. Data sources for the base year update are included in Appendix A.

Scenario Planning and Development Tools

SACOG is transitioning from I-PLACE³S software to a new platform, UrbanFootprint. However, due to greater than anticipated development issues, it was not ready for production on a schedule compatible with the 2016 MTP/SCS. Standard GIS and database tools are used instead. The fact that the Plan's emphasis is on implementing the 2012 MTP/SCS meant that much of data could be transferred rather than created.

SACSIM Travel Demand Modeling Tools

SACOG uses the Sacramento Activity-Based Travel Demand Simulation model (SACSIM) for analysis of travel demand associated with land use and transportation alternatives. SACSIM is a state-of-the-art regional travel demand model. It is unique in its use of parcel/point-level land use input data, and was the first activity-based, demand simulation models for a regional long range plan and emissions analysis, for its 2008 MTP. SACSIM was the subject of a rigorous peer review in 2008, underwritten by the USDOT "Travel Model Improvement Program"². Detailed documentation on the model was submitted to ARB for the 2012 MTP/SCS, including data sources, model specifications, and functionalities. Since the adoption of the 2012 MTP/SCS, SACSIM has been improved, through updating of the basic software modules used to run

² The peer review report is available on:
http://tmip.fhwa.dot.gov/resources/clearinghouse/docs/tmip/peer_review/sacog/sacog_report.pdf

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the model, improvement of transit network representation, and improvements to the process of spatially distributing demographic and population data. Collectively, these enhancements have been rolled into SACSIM15, which is the model version proposed for use in evaluation of the 2016 MTP/SCS.

- SACSIM15 transit networks, path-building, and skimming are now accomplished using Citilabs® Public Transport (PT) software, and upgrade from the older, simpler TRNBLD software. PT provides more flexibility in representation of fares, allows for more time periods to be modeled, and has additional features built into path-building and skimming.
- SACSIM15 base year spatial demographics continue to rely on American Community Survey tract-level 5-year sample data for controls on household size, workers per household, income and age distributions. For future years, SACSIM15 utilizes a two-stage process, in which demographics of growth areas are based on placetype average distributions on key demographic variables, and then regional distributions are globally adjusted to match regional targets established through the regional growth projections discussed above.

For the 2012 MTP/SCS, SACOG performed multiple sensitivity tests to land use variables, fuel prices and auto operating costs, added highway capacity, and transit fares. Because SACSIM15 utilizes the same basic activity-based travel demand simulation sub-model which was used in SACSIM11 (DAYSIM11), SACOG is proposing to do minimal additional sensitivity testing for the SACSIM15 model documentation. Limited, confirmatory testing of the factors already tested will be performed and reported. Additionally, due to a higher degree of interest in demographic and generational factors, some additional cross-sectional analysis of age as a factor in explaining travel behavior will be performed and documented. The results of additional sensitivity testing will be reported in model documentation submitted to CARB as part of the GHG reduction documentation.

Against this background related to the SACSIM travel demand model, a number of other factors relevant to travel demand modeling have changed since the first round MTP/SCS. CARB has issued a new version of EMFAC (discussed in greater detail below), which must be used for the 2016 MTP/SCS evaluations throughout the State. CARB has provided an update to the valuable research on land use and transportation policies and factors, which provides additional information on which to judge reasonable sensitivity of travel demand models, and to establish bounds on off-model adjustments (also discussed in greater detail below). The approach to utilizing SACSIM for the 2016 MTP/SCS is intended to simultaneously utilize the enhanced tools and research for evaluation, while also remaining reasonably consistent with the technical work used to establish the SB375 targets and to evaluate the 2012 MTP/SCS.

Emissions Modeling Tools

SACOG is using EMFAC2011 to estimate transportation-source carbon dioxide (CO₂) for the 2016 MTP/SCS. EMFAC software is developed and maintained by CARB, and is

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required for use in various emissions analyses SACOG performs (e.g. air quality conformity analyses for ozone pre-cursors, carbon monoxide, PM-10, and PM-2.5).

Vehicle activity input files for EMFAC2011 will be developed using SACSIM15, consistent with the approach used for development of regional emissions budgets and air quality conformity analysis. In addition to being the required software for regional emissions modeling in the SACOG region, EMFAC2011 is the only tool available for quantifying the “passenger vehicle” portion of GHG emissions, as required by SB375 and the GHG reduction target. However, EMFAC2011 estimates different levels of passenger vehicle CO₂ than EMFAC2007, for the same vehicle activity inputs. CARB has developed a methodology for estimating a technical adjustment to the SB375 passenger vehicle CO₂ reduction percentage which accounts for this difference (see attached “Methodology for MPOs to Adjust the Change in CO₂ Emissions Rates_03272014.pdf”), which SACOG proposes to use for the 2016 MTP/SCS CO₂ reduction calculation.

In part to focus the calculation of the EMFAC adjustment to just EMFAC version differences, and to eliminate changes and differences in the SACSIM model to be used for the 2016 MTP/SCS, SACOG proposes to implement the CARB EMFAC adjustment methodology using land uses, transportation network assumptions, and demand modeling using the most current estimates and models, and to apply that adjustment to the SACSIM15 modeled results for the 2016 MTP/SCS. This approach fully implements the CARB EMFAC adjustment methodology as described in the attached documentation, and meets the CARB’s stated goal of focusing the adjustment solely on differences between EMFAC2007 and EMFAC2011, by eliminating any differences in vehicle activities which would spring from the SACSIM15 enhancements.

Off-Model Adjustments and Post-Processing

Through the SB375 GHG reduction target-setting process, and in the 2012 MTP/SCS evaluation, each MPO in the state performed a self-assessment of modeling capabilities³. Through that process, SACOG identified several key exogenous and policy variables for which SACSIM is not reasonably sensitive. Where this determination was made, SACOG used the following 5 step process for the 2012 MTP/SCS to estimate an off-model adjustment, to be added to the SB375 GHG reduction calculation:

- 1) determine if the MTP/SCS includes a program which would implement the subject policy, or for exogenous factors, whether evidence exists of a change in the factor over the life of the MTP/SCS;
- 2) determine the most likely deployment level and geographic coverage of the program based on implementation of the MTP/SCS;
- 3) estimate through research a reasonable range of program or policy effects on passenger vehicle GHG generation (or failing that, on VMT), based on the documented effectiveness of similar programs elsewhere;
- 4) combining results of steps 2 and 3, estimate a range of likely program effects on GHG generation for the MTP/SCS;
- 5) combine all estimated program effects into one off-model adjustment, to be added to the modeled reduction calculated from SACSIM results.

This process was thoroughly documented in the attached “CARB_Submittal_Revised GHG Reduction Calc_01feb2012.docx” submitted to CARB as part of SACOG’s 2012

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MTP/SCS technical review. SACOG proposes to use the same basic process, with updates where needed, for the 2016 MTP/SCS.

A new segment is added to the off model adjustments. Electric vehicles (EV) are a new technology entering the vehicle fleet. In the emissions modeling there is a forecast of the market penetration of EVs in the fleet mix for passenger vehicles into the future. SACOG is conducting programs to maximize the adoption of EVs throughout the region. Our projections from the programs indicate a much higher growth than is built into the EMFAC model. The increment of GHG benefits over and above the EMFAC model output is included as an off model benefit. The EMFAC 2011 has a very low growth rate of EVs, almost a zero growth rate. Rather than use EMFAC 2011 EV growth rate SACOG used the more up to date growth rate in the EMFAC 2014. Compared to the almost zero growth rate the newer emissions model has a base forecast of 13% of the fleet by 2036. The GHG benefits are the growth increment above 13% by 2036 and a similar comparison for 2020.

EV share of vehicle fleet

	2012	2020	2036
EMFAC2011	0.1%	0.1%	0.1%
EMFAC2014	0.2%	1.8%	12.6%

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Appendix A – Data Sources for Base Year Update from 2008 to 2012

Data sources for housing, employment, and land use base year updates 2012

Data Item	Description
Housing Inventory	2010 Census housing counts (block level)
	2010 and 2011 building permits acquired via individual jurisdictions within the SACOG Region
	Aerial photography
	Google research generally for specific large apartment complexes in confirming unit numbers
Employment Inventory	2012 InfoUSA (aka InfoGroup) employer level data
	K-12 Schools – California Department of Education (DOE) Dataquest
	State Government – California State Controller’s Office, some ground-truthing and online research to confirm locations of employees
	City and County Government – City and County FY 2011-2012 Budget documents, some ground-truthing and online research to confirm locations of employee
	Colleges and Universities – SACOG staff contact with major colleges and universities to obtain 2012 employment counts by campus/location; online research to supplement
	Hospitals and major medical – SACOG staff contact with large Healthcare providers to obtain 2012 employment counts by major location; online research to supplement; Sacramento Business Journal
	Large Employers – Sacramento Business Journal; online research to supplement
	Shopping Centers/Large stores/Full-Service Restaurants – online research to supplement
Land Use	Large Business Parks – online research and ground-truthing
	2012 county assessor parcel files
	Development project status from cities and counties, as available, collected in 2013
	Adopted and proposed land use plans from cities and counties collected during 2013 and 2014

Data Sources for Demographics Used in Travel Modeling

Data Item	Description
Dwelling Unit Occupancy	2012 ACS 5-year sample data by tract
Householder Age Distribution	“
Household Income Distribution	“
Household Number of Persons Distribution	“
Household Number of Workers Distribution	“
Person Age Distribution	“

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Data Sources for transportation system base year updates 2012

Data Item	Description
Roadway Configuration	2012 aerial photographs used for confirmation of lane configurations on surface streets.
Roadway Configuration	2012 Caltrans District 3 “Lane Configuration Diagrams”, used for confirmation of freeway , ramp, and other state highway lane configurations.
Roadway Configuration	Project descriptions used for identifying locations of change in roadway configuration since prior base year (2008).
Transit Network	2012 Google Transit Feed Specification files, used to identify transit route alignments and service headways
Transit Network	2012 transit routes and service headways, used to identify transit route alignments and service headways, primarily for operators with no available GTFS files.
Roadway and Bikeway Configuration	2012 SACOG regional street centerline file. Primarily used to identify alignment of roadways and bike lanes added since prior base year (2008).
Bikeway Configuration	Most recent published bikeway maps from local agencies. Assembled by SACOG.
Traffic Counts	2005, 2008—Electronic counts for Caltrans permanent count stations in SACOG portion of District 3 area, acquired through Teal Data Center
Traffic Counts	2012—PeMS counts for Caltrans permanent count stations and other loop detectors in SACOG portion of District 3 area
Traffic Counts	2005, 2008, 2012—Traffic counts taken by local agencies within the SACOG region. Counts assembled, processed and coded by SACOG.
Traffic Counts	2005, 2008, 2012—Published counts in Caltrans “Traffic Volumes” report series. For key state highway locations without PeMS data available.
Traffic Counts	2005, 2008—Published counts in Caltrans’ “Ramp Volumes” report series.
Traffic Counts	2005, 2008, 2012—Published counts in Caltrans’ “Truck Volumes” report series.
Vehicle Miles Traveled	2005, 2008, 2012—Published VMT by county in Caltrans’ “Public Road Data” report series.
Congestion and Delay	2005, 2008, and 2012—Published aggregate delay estimates for District 3 area state highways in Caltrans “Mobility Performance Report” data series.
Congestion and Delay	2005, 2008, and 2011—Published aggregate delay estimates for urbanized area in Texas Transportation Institute “2012 Urban Mobility Report”.
Transit Passenger Boardings	2008, 2012—Passenger boardings by line taken by transit operators within the SACOG region. Data assembled, processed and coded by SACOG.
Transit Vehicle Service Hours	2008, 2012—Vehicle service hours by line calculated by transit operators within the SACOG region. Data assembled, processed and coded by SACOG.
Transit Trip Data	2005/6 on-board passenger survey.
Transit Trip Data	2010 on-board passenger survey (Sacramento Regional Transit District

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Data Item	Description
Household Travel Survey	2001 SACOG household travel survey—person and household level trip and tour level data used for model development and calibration.
Household Travel Survey	2009 National Household Travel Survey—aggregate trip and travel rates used for model calibration and reasonable-ness checking

³ See the final documentation of the self-assessment, prepared by SACOG staff for presentation to the RTAC in May 2009. <http://www.arb.ca.gov/cc/sb375/rtac/meetings/050509/mposassessmentupdate.pdf>