SCAG's Technical Methodology for Estimating Greenhouse Gas Emissions for the 2016-2040 RTP/SCS (November 11, 2015)

Introduction

Prior to a Metropolitan Planning Organization (MPO) formally starting the public participation process required by SB 375, the MPO must submit to the California Air Resources Board (ARB) a description of the technical methodology it intends to use to estimate the greenhouse gas (GHG) emissions from its Regional Transportation Plan and Sustainable Communities Strategy (RTP/SCS) and, if necessary, its Alternative Planning Strategy (APS). SB 375 encourages the MPO to work with the ARB until the ARB Board concludes that the technical methodology operates accurately. [Government Code Section 65080(b)(2)(I)(i)]

The SCAG region's GHG reduction targets for the 2016-2040 RTP/SCS remain the same as those adopted by ARB for the last round of RTP/SCS—namely, an 8% GHG reduction per capita by 2020 and a 13% GHG reduction per capita by 2035 compared with the level in 2005.

Analysis Years for SB 375

YEAR	PURPOSE
2005	Base year for SB 375 target setting
2012	Base year for 2016 RTP/SCS
2020	SB 375 GHG target year
2035	SB 375 GHG target year
2040	2016 RTP/SCS horizon year

The following describes the technical methodology for SCAG's upcoming 2016 RTP/SCS, relating to the requirements of SB 375. SCAG's comprehensive technical methodology exists in tandem with the outreach, planning, forecasting, and the iterative scenario development process described below.

SCAG's comprehensive technical methodology for SB 375 implementation consists of the following elements:

- Developing the 2016 RTP/SCS
- Technical Methodology
- Data Development for the SCS
- Sustainable Community Strategies
- Models and Tools

A description of these elements is provided in the following sections.

Developing the Draft 2016 RTP/SCS

The 2016 RTP/SCS will have a horizon year of 2040 and the Final 2016 RTP/SCS is scheduled to be adopted by SCAG's Regional Council on April 7, 2016. To initiate the process, SCAG's Regional Council developed and approved updated goals to help carry out the vision for improved mobility, economy, and sustainability as described in the Draft 2016 RTP/SCS which is scheduled to be released by the Regional Council on December 3, 2015. Performance Measures were then developed to implement and monitor the vision and provide guidance throughout the technical process. The Performance Measures consider the following critical items:

SCAG's Performance Measures:

1) Location Efficiency
2) Mobility & Accessibility
3) Reliability
4) Productivity
5) Safety and Health
6) Environmental Quality
7) System Sustainability
8) Resource Efficiency

Technical Methodology

The methodology for estimating transportation-related GHG emissions associated with the 2016 RTP/SCS is primarily based on SCAG's Trip-Based Regional Transportation Demand Model and the ARB's EMFAC Model. The effects and impacts of various land use scenarios on GHG emissions were evaluated and accounted for by SCAG's SPM Model, the Trip-Based Model, and various off-model methodologies. An overview of the methodology is presented below:

1. Develop land use portion of SCS

Growth forecasts, particularly the local input based growth forecasts, were developed based on SCAG's bottom-up integrated growth forecasting process and were used as the basis and starting point to develop the SCS. SCAG's SPM Model was used to facilitate local input, develop and test land use scenarios, and evaluate potential impacts. The resulting datasets may or may not achieve the GHG reduction targets set by ARB. If additional strategies are necessary to achieve the targets, SCAG will work with its member cities and other stakeholders to develop a range of potential land use strategies for consideration in SCS development. Each of these strategies will be included in one or more draft scenarios and GHG emissions will be quantified to test their effectiveness. For the 2016-2040 RTP/SCS, in addition to the local input based growth forecasts, SCAG in collaboration with subregions and local jurisdictions developed two sets of growth forecasts/land use scenarios based on different emphasis of land use and investment strategies.

2. Identify related transportation investments/improvements and other RTP/SCS policies

The 2016 RTP/SCS will identify and examine new investments in transportation facilities, including toll facilities, HOV/mixed-flow, transit, rail, active transportation, etc., and improvements in TDM and TSM strategies as well as other relevant policies and strategies. These investments/improvements will be incorporated into the regional transportation demand model where feasible.

3. Analyze RTP/SCS through modeling

SCAG uses the Trip-Based and the EMFAC models to test GHG emission reduction scenarios as appropriate. The SCS and alternatives scenarios will be used as input to the regional transportation demand model for the RTP/SCS' air quality conformity and CEQA analyses.

4. Use off-model analyses to estimate VMT changes or GHG reductions, if necessary

Per the recommendations of the SB 375 Regional Technical Advisory Committee and ARB, SCAG will use off-model analyses as necessary and appropriate to account for any voluntary efforts or other strategies that are not captured by the regional transportation demand model. The off-model analysis methodology will be informed by the on-going collaboration among MPOs and between MPOs and the ARB on this subject, as well as discussions with applicable technical working groups. SCAG anticipates that the off-model analysis technique will be primarily used for quantifying voluntary efforts from cities/counties and the business sector, and those policies and practices that are not readily applicable for modeling analyses. Descriptions of off-model measures are provided on Page 7.

5. Run ARB's EMFAC Model

Pending U.S. EPA's approval of the emission model, SCAG will run EMFAC 2014 for baseline and SCS scenarios for the appropriate milestone years and GHG emissions will be calculated. Adjustments to EMFAC that account for recent state laws will be made per ARB direction.

6. Next Generation Tools

SCAG has committed considerable effort to develop working versions of both the Activity-Based Model and PECAS Land Use Model. These tools should be available for use in the 2020 RTP/SCS development and GHG evaluation. Both models require additional refinement, sensitivity testing, and review/outreach with modeling stakeholders before they will be available for use in RTP/SCS production.

Data Development for the SCS

1. Socio-Economic Growth Forecast

The process for developing growth and economic forecasts includes:

- Initiate the SB 375 and 2016 RTP/SCS growth forecasting process (commenced June 2013)
- Convene a panel of experts for technical assistance and advisory role in June 2013
- Produce a range of growth forecasts
- Release the draft growth forecast to all local jurisdictions
- Build teams to conduct one-to-one meetings with local jurisdictions, subregions and all major stakeholders (February 2014 – January 2015)
- Develop SCAG's Draft Policy Growth Forecast; continue local and subregional review, comment, and input to refine and revise the Policy Growth Forecast (June 2015 – September 2015)
- Release the Draft Policy Growth Forecast (as revised) along with the Draft 2016 RTP/SCS and Draft PEIR for public review and comments
- Adopt final forecasts as part of finalizing the SCS process

2. SCS/RTP Datasets and Trend Baseline

To meet the requirements of SB 375 in developing a SCS by 2016, the following datasets were developed in collaboration with subregions, local jurisdictions, and CTCs:

- 2012 base year for 2016 RTP/SCS
- Trend baseline growth distribution and underlying land uses
- General plan based growth forecast and distribution
- Policy Growth Forecast/SCS

The "trend baseline" illustrates the most likely outcomes of growth distribution and land use in the absence of recent policy intervention, allowing the region and its jurisdictions to take credit for actions and policies adopted recently or in the near future. While the "trend baseline" is a technical projection that provides a best estimate of future growth based on past trends and assumes no recent general plan land use policies, the Policy Growth Forecast/SCS is derived using local input regarding their latest general plan land use strategies through a bottom up process, and also reflects additional local planning and regional policies.

3. Data and GIS Maps

Data/GIS maps have been provided to subregions and local jurisdictions for their review. These data include the 2012 base year population, employment, and households estimates and their projections for 2020, 2035 and 2040. GIS maps include existing land use for 2012, general plan land use and zoning, resource areas, and other important areas identified in SB 375.

The list of data/GIS maps provided to stakeholders includes:

1. Existing land use (2012)
2. General plan land use and zoning
3. Resource areas include:

   (a) All publicly owned parks and open space;

   (b) Open space or habitat areas protected by natural community conservation plans, habitat conservation plans, and other adopted natural resource protection plans;

   (c) Habitat for species identified as candidate, fully protected, sensitive, or species of special status by local, state, or federal agencies or protected by the federal Endangered Species Act of 1973, the California Endangered Species Act, or the Native Plan Protection Act;

   (d) Lands subject to conservation or agricultural easements for conservation or agricultural purposes by local governments, special districts, or nonprofit 501(c)(3) organizations, areas of the state designated by the State Mining and Geology Board as areas of statewide or regional significance pursuant to Section 2790 of the Public Resources Code, and lands under Williamson Act contracts;

   (e) Areas designated for open-space or agricultural uses in adopted open-space elements or agricultural elements of the local general plan or by local ordinance;

   (f) Areas containing biological resources as described in Appendix G of the CEQA Guidelines that may be significantly affected by the sustainable communities strategy or the alternative planning strategy; and

   (g) Areas subject to flooding where a development project would not, at the time of development in the judgment of the agency, meet the requirements of the National Flood Insurance Program or where the area is subject to more protective provisions of state law or local ordinance.
4. Farmland
5. Spheres of influence
6. High Quality Transit Areas (HQTA) and transit priority areas (TPA)
7. City/Census tract boundary with ID
8. City/Tier2 Transportation Analysis Zone (TAZ) boundary with ID

Elements of the Sustainable Communities Strategy

1. Land Use Component

The growth distribution, for SCS purposes, is the adopted growth forecast used for the RTP. SB 375 requires that this forecast be developed in such a way that it demonstrates reduced per capita GHG emissions due to land use strategies as compared to the per capita GHG level in 2005.

SCAG has worked and will continue to work with its member cities and other stakeholders to develop a range of potential land use strategies for consideration in SCS development. Each of these strategies will be included in one or more draft scenarios and GHG emissions will be quantified. Prior to incorporating any strategies into a final SCS, SCAG, in consultation with the applicable local government, will determine the political and market feasibility of said strategy.

It should be noted, however, that following the same approach used in the 2012-2035 RTP/SCS, the final adoption of growth forecast is at the jurisdictional level, subjurisdictional level socioeconomic data set or growth forecast is considered advisory and non-binding, and used solely for modeling and analysis purposes to demonstrate for the attainment of GHG reduction targets (See CEHD action in October 2015 regarding the guiding principles for the development of Policy Growth Forecast for the 2016-2040 RTP/SCS).

2. Transportation Investment

The transportation network consists of the existing and planned transportation projects. SB 375 requires the development of the future transportation network should proceed in such a way that it complements the anticipated growth strategy and distribution reflected in the SCS.

Development of a SCS presents an opportunity for developing approaches to system management and operational improvements, implementing pricing policies, developing comprehensive bikeway networks, using complete streets as an active transportation funding strategy and improving the coordination between transit services and active transportation (First/Last mile strategies), all with the goal of creating more livable communities. These efforts assume collaboration and voluntary participation among subregional stakeholders and CTCs in order to derive higher performance from the transportation system.

3. Transportation Demand Management / Transportation Systems Management

In addition to transportation projects, the RTP contains policies such as Transportation Demand Management (TDM) or Transportation System Management (TSM) policies. These include pricing, ride sharing, smart shuttles, preferential parking, freeway metering, etc. These policies can be layered with the other major elements of the SCS. It is anticipated that TDM/TSM policies will be used and applied particularly in locales that do not have substantial existing or planned transit infrastructure.

4. Other Economic Factors & Principles

The following factors and principles are reflected in the growth forecasts and land use data set:

- Align economic development with the land use and transportation investment strategies
- Promote job-housing supply balance
- Develop a "Land-use Strategy" that the market wants and can deliver

5. Technology and Local Voluntary Efforts (Off-Model Analysis)

In estimating emissions benefits from an SCS, the region may account for local voluntary efforts that result in reduced vehicle GHG emissions, not limited to strategies aimed at reducing VMT.

Examples of such efforts may include local neighborhood electric vehicle programs, local incentives for the purchase or use of electric or other alternative fuel vehicles (e.g. preferential parking), or increase in active transportation investments and capital projects. Any local voluntary effort to reduce emissions that are accounted for in the SCS should demonstrate additional benefits beyond what is already required in State law.

In accounting for the benefits of such efforts, SCAG may rely on any local analysis to determine emissions savings. In lieu of locally derived data, SCAG may use off-model analyses as necessary and appropriate to account for any voluntary efforts or other strategies that are not captured by the regional transportation demand model. SCAG has developed off-model tools and methodologies to estimate trip reductions related to active transportation improvements, zero emissions vehicle strategies, neighborhood electric vehicles policies, and shared mobility programs. Descriptions of measures that are considered are the following:

- ***Active Transportation / Proximity***

  <u>SCAG's Active Transportation Programs</u>
  The 2016 RTP/SCS contains 11 strategies designed to increase active transportation, as a share of all transportation modes. These strategies are established in four categories:

  - Regional Trip Strategies
    - Regional Bikeway Network
    - Regional Greenway Network: designed to increase walking and biking for recreation, making use of available open space, such as rivers, drainage canals, cycle tracks and utility corridors.
  - Transit Integration Strategies
    - First/Last Mile
    - Livable Corridors
    - Bike Share
  - Short Trip Strategies
    - Sidewalk repair and upgrading
    - Local Bikeway Networks
    - Neighborhood Mobility Areas (integrated with NEV short-trip concept)

- Education and Encouragement
    - Safe Routes to School
    - SCAG Encouragement and Safety Campaigns

SCAG staff conducted GIS analysis to create a regional bike lane network, first/last mile areas, livable corridors, and neighborhood mobility areas. The GIS data and shape files are used to create active transportation infrastructure input for off-model analysis.

Methodology – Active Transportation Tool

SCAG developed a methodology to analyze the impact of active transportation infrastructure enhancement (AT enhancement) on mode share and VMT. A mode share model was developed based on 2012 California Household Travel Survey (CHTS) and zonal data from SCAG's Scenario Planning Zones (SPZs). A multinomial logit model was estimated with following modes: auto, transit, walk-to-transit, walk-to-activity, and bike. Independent variables of the mode share model include: 1) individual and household socioeconomic characteristics from CHTS; 2) neighborhood land use characteristics by SPZs; and 3) neighborhood built environment and active transportation infrastructures by SPZs (including bike lane density, street density, and percent of roadways with sidewalks). The model will calculate the changes in mode share as well as the number of trips by modes by different AT infrastructure inputs. The number of walk and bike trips is expected to increase with enhanced AT infrastructures, such as bike lanes and sidewalks. Furthermore, AT enhancement programs near transit stops or stations, such as first mile/last mile programs, that enhance accessibility to transit service will increase the use of transit services. Since the methodology focuses on mode choice, it is assumed that increased AT trips and transit trips substitute for automobile trips (total trips remain the same). The reduction of vehicle trips and VMT is equal to the increased trips and travel distance by non-automobile modes.

- ***Zero-Emission Vehicle***

Zero Emissions Vehicle Strategies

SCAG has also provided specific planning and support for Plug-in Electric Vehicles (PEV), and electric vehicle charging stations (EVCS). Since SCAG adopted the 2012 RTP/SCS, the Governor's Office released the Zero Emissions Vehicle (ZEV) Action Plan for 2013 and 2015. These plans identified state level funding to support the implementation of Plug-in Electric Vehicle (PEV) and Hydrogen Fuel Cell refueling networks. ARB has provided aggressive growth projections for all ZEVs throughout the State. As part of the 2016 RTP/SCS, SCAG modeled PEV growth specific to Plug-in Hybrid Electric Vehicles (PHEV) in the SCAG region. These are electric vehicles that are powered by a gasoline engine when their battery is depleted. The SCAG program proposes a regional charging network that will increase the number of PHEV miles driven on electric power. This will allow SCAG to derive regionally specific GHG reductions that will be achieved through increased usage of electric power relative to the gasoline power.

Methodology
SCAG applied a methodology developed by the Metropolitan Transportation Commission (MTC) in the Bay Area to measure the GHG reductions achievable through providing support for a regional network of charging stations. The investment plan will support enough charging stations to increase the PHEV usage of electric power by 10%.

- ***Neighborhood Electric Vehicle (NEV) Policies***

The 2016 RTP/SCS Neighborhood Mobility Areas (NMAs) strategy presents a set of State, regional, and local policies to encourage the use of alternatives to full size internal combustion engine vehicles for short trips. In the U.S., nearly forty percent of urban and suburban auto trips are less than two miles. In SCAG region, thirty eight percent of trips are less than three miles. Specifically the 2016 RTP/SCS include policies to encourage planning and promotion of Neighborhood Electric Vehicles (NEVs) in NMAs. A short trip using a NEV would have positive net impacts due to negligible GHG emissions (based on energy production) and zero local pollution, though this travel mode would not bring a reduction of VMT.

Methodology
SCAG prepared a New Mobility Areas Map that represents areas where local agencies should be encouraged to support short trip replacement. SCAG used a methodology based on various studies of observed NEV usage, such as methodology documented by the California Air Pollution Control Officers Association (CAPCOA) and ARB. Within the Short Trip Concept areas, it is assumed that NEVs can be used to replace 1.5% of all automobile trips less than 3 miles of trip length. The number of automobile trips less than 3 miles in Sort Short Trip Concept TAZs can be directly calculated from SCAG regional model output. VMT reduction is calculated as the number of substituted vehicle trips multiplying 1.5 miles (average of 3 miles).

- ***Shared Mobility Programs***

Shared Mobility Programs include both new mobility paradigms as well as old models that are finding new markets and delivery methods thanks to new technology platforms. Shared Mobility encompasses a wide range of services including the following:

  - Return Trip Carsharing (e.g., Zipcar, Enterprise)
  - Point-to-Point Carsharing (e.g., Car-to-Go)
  - Peer-to-Peer Carsharing (e.g., Relayrides)
  - Ridesourcing (e.g., Lyft, Uber, also known as Transportation Network Companies)
  - Dynamic On-demand Private Transit (e.g., Bridj, Leap)
  - Vanpool & Private Employer Charters

The 2106 RTP/SCS includes policies to encourage Shared Mobility, and to guide the region in maximizing the benefits and minimize the potential for negative effects. The off- model methodology described below is the beginning of an ongoing process to develop modeling and off-model processes to achieve a better understanding of the costs and benefits that Shared Mobility services in particular will have in the SCAG region. For the 2016 RTP/SCS

scenario development process, SCAG focused on geographic locations where Shared Mobility services are expected to accelerate, and on the attendant VMT reductions that will be realized through potential reduction in personal vehicle ownership.

Roundtrip carshare is most known in the US as membership-based programs where individuals can sign up to have hourly access to a pool of vehicles and then return them to the same place where they were picked up. Unlike traditional car rentals, vehicles can be picked up at designated spots around the city, usually in public parking lots. One-way carshare allows members to take a vehicle and leave it at a different station, or anywhere within the allowed boundaries (roughly city boundaries).

Ridesourcing is a term coined by researchers at UC Berkeley to refer to the provision of rides sourced from application enabled networks of ride providers. This term is useful in distinguishing this innovation from carsharing, and from carpooling. For legal purposes, the California Public Utilities Commission defines the entities, referred to as "Transportation Network Companies" (TNC) "as a companies or organizations, operating in California that provides transportation services using an online-enabled platform to connect passengers with drivers using their personal, non-commercial, vehicles". Essentially, TNCs add two new aspects to the vehicle for hire service model – peer drivers and smartphone dispatch.

Methodology for Carsharing Analysis

SCAG classified Transportation Analysis Zones (TAZs) to six main groups from 35 detailed place types from SPZs, based on land use characteristics such as density and diversity. SCAG applied higher carsharing programs household participation rate for place type with higher density/diversity. This assumption is consistent with methodology applied by MTC and applied by the California Department of Transportation (Caltrans) for its 2040 statewide plan. SCAG assumed a 30% reduction in VMT for households participating in carsharing based on empirical data noted in CAPCOA and ARB documents.

Methodology for Ridesourcing (TNC's) Analysis

For the analysis of Ridesourcing, SCAG used the same six place type categories as Carsharing analysis. SCAG assumed higher percent of households using TNC's for place type with higher density/diversity. This assumption is consistent with confidential summary data obtained by SCAG from Lyft, one of the major ridesourcing companies. SCAG programed a 30% reduction in VMT for households participating in ridesourcing based on similar assumption from Carsharing analysis.

6. Outreach/Stakeholder Input

A collaborative and inclusive bottom-up process is the key to ensure a successful development of SCAG's 2016 Regional Transportation Plan and Sustainable Communities Strategy (RTP/SCS). The following are the major tasks and associated objectives that SCAG has undertaken since 2012 to move the process forward to address the requirements of SB 375.

a. Program Setup (March 2013 – December 2013)

- Conduct SB 375 workshops throughout the region and provide information on requirements and concepts of SB 375, introduce different elements of the RTP/SCS, plus carry out the Conceptual Land Use Scenario exercise
- Conduct initial outreach strategy kick-off
- Develop and adopt Guidelines and Public Participation Plan
- Finalize roles and responsibilities among regional partners, particularly subregions and County Transportation Commissions (CTCs)

b. RTP/SCS Scenario Development (December 2013 – June 2015)

- Review and gather local input on general plans, including growth forecast/distribution and land use for 2020, 2035, and 2040
- Set-up four scenarios for stakeholders to analyze and compare various policies and to provide their feedback:
    - Trend
    - 2012 Plan Update
    - "Policy A"
    - "Policy B"
- Determine and review RTP base year (2012) conditions
- Develop growth projections for the four scenarios above for years 2020, 2035, and 2040
- Develop outreach materials based on different elements of the RTP/SCS that were included in the scenarios
- Develop survey questions for public feedback
- Conduct outreach open house sessions based on SB 375 requirements
- Publish materials online for broader outreach
- Provide a summary of public input to SCAG's Regional Council

c. Draft RTP/SCS Development (July 2015 – November 2015)

- Continue to collect input on additional local planning efforts
- Outreach to develop policy assumptions for the Draft RTP/SCS
- Perform technical analyses, including quantification of GHG reductions achieved by the SCS
- Develop and release the Draft RTP/SCS

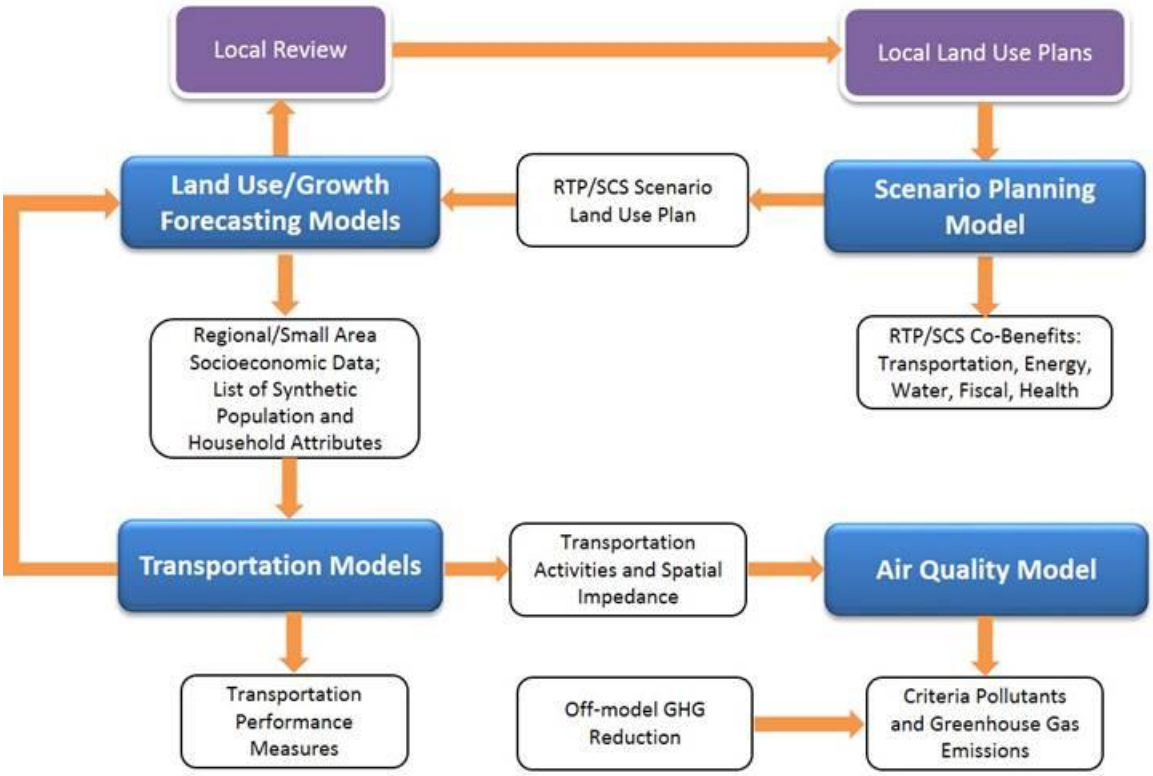
d. Final RTP/SCS Development and Approvals (December 2015 - April 2016)

- Develop the final RTP/SCS
- Develop the final PEIR
- SCAG Regional Council adoption
- Submittal of final RTP/SCS to ARB

Models and Tools

The diagram below provides an overview of SCAG's modeling system and how the various tools will be applied in the modeling of the 2016 RTP/SCS.

SCAG's Integrated Modeling & Forecasting Framework



Scenario Planning Model

The SCAG Scenario Planning Model (SPM) is a web-based scenario development, modeling, and data organization tool developed to facilitate informed and collaborative planning among counties/subregions, local jurisdictions, other stakeholders, and the public. The SPM includes a suite of tools and analytical engines that help to quickly illustrate alternative plans and policies and to estimate their transportation, environmental, fiscal, public health, and community impacts. Moreover, SPM provides a common data framework within which local planning efforts can be easily integrated and synced with regional plans.

SCAG's SPM is built using UrbanFootprint, a scenario development and modeling platform based on open source software and tools, developed by Calthorpe Analytics. Several of the major MPOs in California are developing different facets of UrbanFootprint for their planning needs. Enhancement and customization of the UrbanFootprint system for SCAG's application involves local level data review, edit and management functionality via a web-based user interface, and regional-scale scenario development and modeling capacity. In order to make the

tool more useful to subregions and local jurisdictions, SCAG formed a Working Group that included representatives from all counties and subregions in the SCAG region to direct the tool's development. The SPM Working Group serves as an advisory peer group to SCAG staff and provides technical input on the aspects of the tool's functions and operations.

SPM will serve as a common platform for communications between SCAG and local jurisdictions in the process of local input and public outreach, providing local planners advanced analytical capabilities. Within SCAG's integrated modeling and forecasting system, SPM serves as a conduit between local jurisdictions and key SCAG models. SPM analytical engines produce a range of critical metrics that allow for meaningful comparisons across different land use and transportation scenarios. Scenarios are run through model engines to measure their performance for the following co-benefits:

- mobility
- public health
- fiscal impacts
- energy usage
- water usage
- land consumptions

The SPM will be the tool used to develop and analyze future land use scenarios for the 2016 RTP/SCS.

Land Use/Growth Forecasting

SCAG's growth forecast is developed using a series of computer programs and outreach to forecast growth first at the regional/county level and then disaggregate the county growth to the city/TAZ level. The following description provides an overview of SCAG's growth forecasting process.

1. Regional Growth Estimation

The Regional Growth Forecast is the basis for developing the Regional Transportation Plan (RTP), Sustainable Communities Strategy (SCS), Program Environmental Impact Report (PEIR), and the Regional Housing Needs Assessment (RHNA). SCAG's 2016-2040 RTP/SCS growth forecast includes six counties' jurisdictional level population, household, and employment for years 2012, 2020, 2035, and 2040.

The following major data sources are considered and used in the development of the growth forecast:

- California Department of Finance (DOF) population and household estimates;
- California Employment Development Department (EDD) jobs report by industry;
- Regional Housing Needs Assessment (RHNA) growth projections for years 2014-2021;
- 2012 existing land use and General Plans from local jurisdictions;
- 2010 Census and the latest American Community Survey (ACS) data; and
- 2011 Business Installment data from InfoGroup.

SCAG's Regional Growth Forecast includes three major indicators: population, households, and employment. SCAG's forecast maintains a balance between employment, population, and households at the regional level, given their interrelationship. SCAG computes regional employment based on the SCAG region's share of the Nation's employment. Future population is calculated by adding or subtracting to the existing population the number of group quarters population, births, migration, deaths during a projection period. Households are projected by applying headship rates, based on age-gender-racial/ethnic breakdowns, to the projected population. A panel of experts reviewed and provided input to the Regional Growth Projections for the 2016-2040 RTP/SCS (June, 2013). The regional forecast was then presented to SCAG's Community, Economic and Human Development (CEHD) Committee on August, 2013 for their consideration and endorsement.

Based on the regional growth forecast, SCAG then projects jurisdictional level population, household, and employment. The latest jurisdictions' existing and general plan land use serve as the basis for future year population and household allocations. Household growth rates and household size are estimated based on historical trends and the developable capacity from the local jurisdiction's general plan. Population projections are calculated based on household growth and household size. Future employment is estimated based on the jurisdiction's employment share of the county's employment by sector, using 2012 jobs data. Employment is further adjusted to account for population serving jobs, such as Retail and Service, which are highly correlated with population growth.

After the initial growth forecast was developed, SCAG's staff conducted one-on-one meetings with 197 jurisdictions to review the forecast and receive local input. This local input process provided an opportunity for jurisdictions to offer their local knowledge and input to inform SCAG's regional datasets. SCAG evaluated the comments and incorporated the adjustments into the population, household, and employment growth distributions. The resulting Draft 2016 RTP/SCS growth forecast will serve as the basis for the initial 2016 RTP/SCS evaluation. Additional refinements to the growth forecast may be made through the scenario planning process in the development of the final 2016 RTP/SCS growth alternative.

2. Small Area Growth Forecasting

The goal of the small area growth forecasting methodology is to allocate jurisdictional level population, household, and employment into the smaller Transportation Analysis Zones (TAZs) utilized by SCAG's Transportation Model. The jurisdictional level household and employment are developed using an independent projection methodology and review process with SCAG's cities and counties. Population projections are tied to household growth. The city's forecast and the projection year are often referred to as the "control total" and the "target year", respectively.

The geographic levels utilized in the growth forecasting process range from the SCAG region as a whole to Tier 2 Transportation Analysis Zones. Each lower level is consistent with higher aggregation levels (i.e., the values of cities when collectively summed for their respective county will equal the county projection). Similarly, the combination of city boundaries and Tier 2 (T2) zones when summed to their respective city total must be consistent with their city's projections.

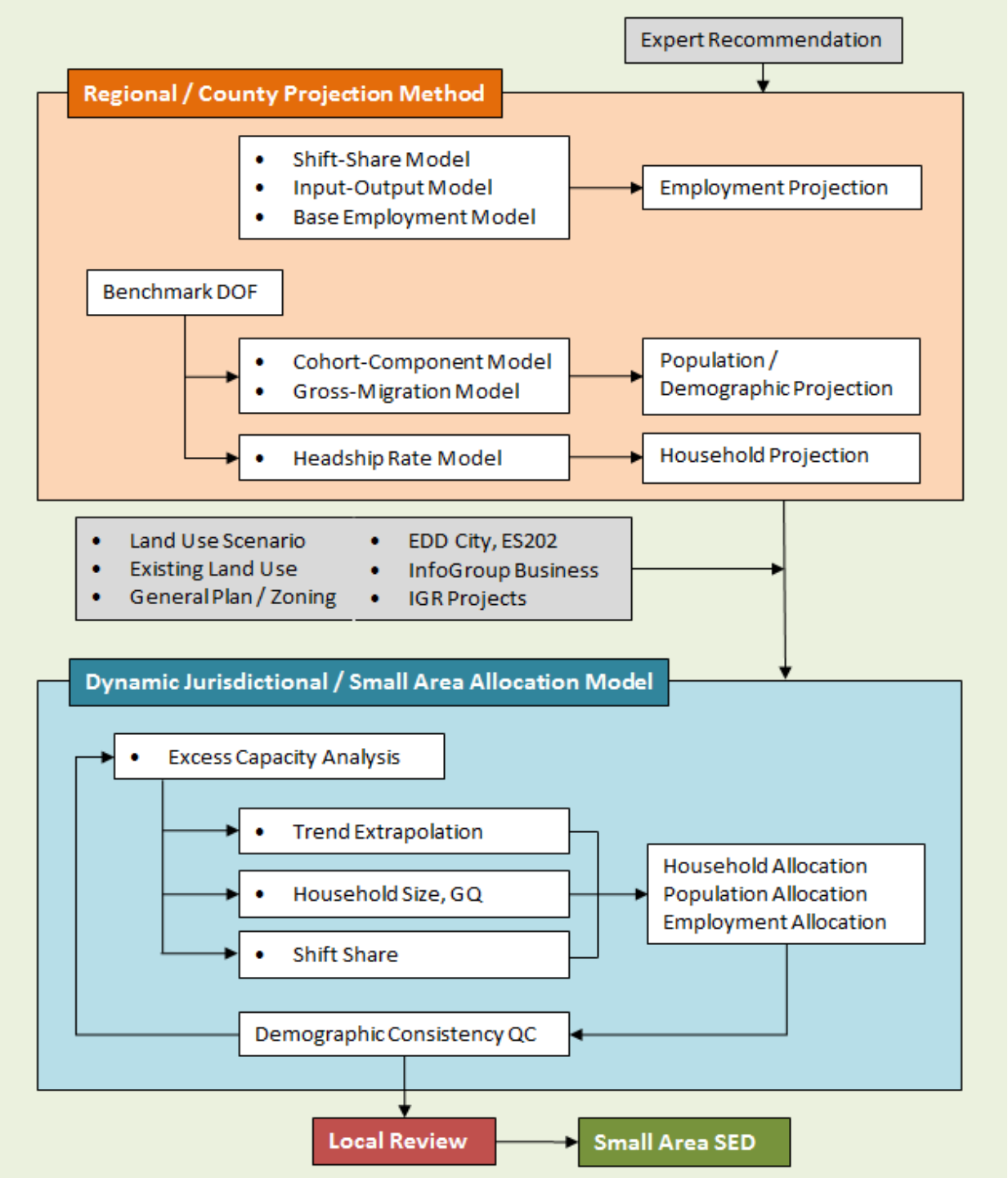
SCAG's small area growth forecasting process is applied to develop base year and future year socio-economic data at the Tier 2 zone level. Below is a list of the data sources incorporated in the process.

Data Sources:

- SCAG's existing land use data
- SCAG's General Plan Database, processed based on jurisdictional General Plans
- SCAG's 2012 RTP/SCS growth forecast
- SCAG's Draft 2016 RTP/SCS jurisdictional level population, household, and employment
- 2013 Longitudinal Employer-Household Dynamics, Origin-Destination, Employment Statistics from the Census Bureau
- Employment Development Department (EDD) 2012, 3rd quarter jurisdictional jobs by sector
- 2011 InfoGroup firm-based employment data
- SCAG Intergovernmental Review (IGR) data
- Digital Mapping Product (DMP) parcel data (2010-2012) and new construction data (2010-2012)
- 2010 Decennial Census Summary File 1 (SF1)

The above approach distributes jurisdictional level population, household, and employment into city/T2 level zones (15,000+ city/T2 zones), which work with SCAG's current databases and zonal systems. It creates the first cut of the small area forecast. The draft Tier 2 level forecast is then shared with SCAG jurisdictions for further review and comment. Secondary variables, such as population/household characteristics, needed for various models, were developed using SCAG's population synthesis tool (POPsyn). Below is a graphic providing an overview of SCAG's growth forecasting process.

Overview of SCAG's Growth Forecasting Methodology



Trip-Based Regional Transportation Demand Model

SCAG's trip-based regional transportation demand model will be the primary transportation modeling tool utilized to evaluate the 2016 RTP/SCS's performance. The model was peer reviewed and updated based on the 2012 California Household Travel Survey. A comprehensive model validation was also performed to ensure the model properly replicates base-year (2012) travel conditions.

The model calculates vehicle miles and vehicle hour traveled (VMT and VHT), speeds and delay, and other performance measures for both passenger car and heavy-duty vehicles. The enhanced model utilizes TAZs that are comparable to Census Block Groups as the analysis unit for most model components. There are 10,569 Census Block Groups and 11,267 Tier 2 TAZs in SCAG modeling area. Inter-regional and ports related travel are also included in the Model.

Model and Data Enhancements

The trip-based model which is being utilized to analyze the 2016 RTP/SCS is basically the same model used in the RTP/SCS 2012. The model framework is identical to the previous model with enhancements to selected modules, recalibrated using the 2012 Travel Survey, and validated to Year 2012 to replicate 2012 travel conditions. Below is a listing of the Trip-Based Model and data enhancements:

1. Model enhancements include:

- Comprehensive calibration and validation to 2012 travel conditions,
- Trip market strata defined by car sufficiency and household income groups used throughout the entire demand models,
- Re-estimated auto ownership model, sensitive to transit and non-motorized accessibility, multi-dwelling family housing, and residential and employment mixed use densities,
- Updated trip production cross-classification models,
- Re-estimated destination choice model, replacing the previous gravity models for all purposes except home-based college and school trips,
- Re-calibrated nested mode choice model,
- All cost variables updated to 2011 dollars, and
- Updated the Heavy-Duty Truck Model,

2. Major Data Development and Acquisitions Include:

- 2012 CHTS and SCAG Travel Surveys,
- Highway Network updated to 2012 base year conditions,
- Transit Network developed using the 2012 LA Metro's TripMaster database,

- Transit Level of Service Data obtained from the region's transit agencies,
- Working with other MPOs, updated auto operating costs,
- Year 2012 Screenline Count Database created, contains 640 traffic counts on the arterials and 33 video traffic counts on freeways,
- HPMS data from Caltrans for estimating regional and sub-air basin VMT,
- HERE / Google data for real-time network speed verification, and
- Airsage Data for alternative source of regional travel patterns.

Household Classification and Population Synthesizer

This module classifies zonal households into several household segments. Prior to the application of Auto Ownership module, households are classified across the following four attributes:

1) Household Size (4 categories): the number of one-person households, two-person households, three-person households, and four or more person households.
2) Number of Workers (4 categories): the number of households with no worker, with one worker, with two workers, and with three workers or more.
3) Household Income (4 categories): the number of households with annual household income (in 2011 dollars) less than $35K (Low), $35K-$75K (Medium), $75K-$150K (High), and $150K or more (Very High).
4) Type of Dwelling Unit (2 categories): single-family detached, and multi-family/attached and group quarters.

For Home-Based-Work (HBW) trip generation, households are aggregated across the dwelling unit type and size attributes, and then further disaggregated into four Age of Head of Household groups (18 to 24 years old, 25 to 44 years old, 45 to 64 years old, and 65 years old or older).

The Population Synthesizer (PopSyn) is a module that generates a synthetic population by expanding the existing disaggregate sample data (from Census PUMS data) to mirror known aggregate distributions of household and person attributes (from SCAG zonal data). The control variables used in the population synthesizer are the above-mentioned four household variables. A synthetic population is generated for the entire SCAG region using this procedure.

Auto Ownership Model

The auto ownership model predicts the number of households by auto ownership level (0, 1, 2, 3, 4 or more available vehicles) for each zone. This information is used in trip generation models to estimate zonal person trips. The auto availability model uses indicators for household size, household income, number of workers, residential and employment density, and transit and non-motorized accessibilities. The models were estimated in multinomial logit form. This is the very first model applied in the model chain.

Trip Generation Model

Trip generation is the process of estimating daily person trips generated (i.e., trip production) and attracted to (i.e., trip attraction) by each TAZ on an average weekday. The trip generation model contains 9 trip purposes: home-based work (HBW); home-based school (HBSC); home-based college/university (HBCU); home-based shopping (HBS); home-based social-recreational (HBSR); home-based serving-passenger (HBSP); home-based other (HBO); work-based other (WBO): and other-based other (OBO) trips. HBW trips are further split into 8 types based on two trip categories ("Direct" versus "Strategic") and four income categories: less than $35K, $35K-$75K, $75K-$150K, and $150K or more. "Direct" home-work trips go directly between home and work. "Strategic" home-work trips include one or more intermediate stops between home and work. In total, there are 16 trip types: 8 types for home-based work, and one type for each of the other 8 trip purposes.

Trip Distribution Model

The SCAG model includes two types of trip distribution models that estimate the number of trips from each TAZ to other TAZs. Destination choice models are developed for HBW, HBS, HBSR, HBSP, HBO, WBO, and OBO trip purposes while a gravity model approach is used to distribute trips for school related purposes (HBSC and HBCU trip purposes). For each of the 9 trip purposes, the productions and attractions are split into both peak and off-peak periods. The destination choice models are stratified by the car sufficiency/income market segments and estimated in multinomial logit form. The following variables were examined and proved to be significant in the utility functions: mode choice logsum, distance between production and attraction zones, intra-zonal indicator and the mix of employment and households.

Mode Choice Model

Mode choice is the process of taking the zone-to-zone person trips by trip purpose from the trip distribution model, and determining how many of these trips are made by various travel modes. The SCAG mode choice model is a nested logit model. The top branch of the nesting structure includes Auto, Transit, and Non-Motorized. The branch under Auto includes Drive Alone and Shared Ride which is further split into 2-person carpool, 3-person carpool, and 4-or-more person carpool. The branch under Transit includes Local Bus, Rapid Bus, Express Bus, BRT, Transit Way, Urban Rail, Commuter Rail, and HSR. The branch under Non-Motorized includes Walk and Bicycle. Separate mode choice models are estimated for each trip purpose and time period. Mode choice is a function of level of service attributes (in-vehicle travel time, out-of-vehicle travel time, fares, parking fees, roadway tolls, and auto operating costs); household attributes such as income; and zonal attributes such as residential and employment densities.

Network Assignment Model

Prior to assignment, the mode choice output is converted from peak/off-peak production-attraction (PA) format to time-of-day (OD) format. The time-of-day procedure, employed for the 2016 RTP/SCS development, is based on trips-in-motion diurnal factors. Network assignment is the process of loading vehicle trips onto the appropriate networks. For highway assignment, the Regional Model consists of series of multi-class simultaneous equilibrium assignments for seven classes of vehicles (drive alone, 2-person carpool, 3-person carpool, 4 or more-person carpool, light HDT, medium HDT, and heavy HDT) and for each of the five time periods. During this assignment process, trucks are converted to Passenger Car Equivalent (PCE) for each link and each truck type based on: 1) percentage of trucks, 2) percentage of grade, 3) length of the link, and 4) level of congestion (v/c ratios). Transit vehicles are also included in the highway assignment. For transit trip assignment, the final transit trips from the last loop mode choice models are aggregated by access mode and time period, and then assigned to transit networks for each time period. The vehicle trip tables obtained from mode choice, Airport, and Heavy-Duty Truck models are aggregated to the 4,109 zone system (Tier-1 zones) prior to network assignment.

Model Convergence

In order to maintain consistency between the speeds predicted by the highway assignment and the travel times input to the entire travel demand model chain, the predicted speeds are used to re-compute highway and transit travel times, and the entire model sequence are repeated until input and output speeds are consistent with each other.

Heavy-Duty Truck Model

The Heavy-Duty Truck (HDT) Model produces forecasted trips for each of three HDT weight classes with gross vehicle weight (GVW) ranging from 8,500 to 14,000 lbs. for light-heavy HDT, 14,001 to 33,000 lbs. for medium-heavy HDT, and more than 33,000 lbs. for heavy-heavy HDT. Below is an overview of the various HDT Model components:

- Internal HDT Model: This includes the development of all HDT trips that have both an origin and destination within the six-county modeling area. This component of the HDT Model estimates trip tables for intra-regional truck trips. Trip generation is based on trip rates (number of trips per employee or household) for 10 different land uses/industry sectors at the trip ends. The trip distribution process is based on a matrix of factors that indicate the trip interchange relationships among different land use types (i.e., what fraction of trips originating at a land use such as manufacturing sites go to warehouses vs. other manufacturing sites, etc.).

- External HDT Model: This includes how the external HDT trips are captured in the HDT model that come into, go out of, and pass through the region. This component estimates the trip table for all interregional truck trips based on commodity flow patterns that link Southern California with the rest of the nation. The model uses a commodity flow database obtained from outside sources and procedures for converting annual tonnage

flows at the county level to daily truck trips at the TAZ level. Seaport and airport related truck trips were included as special generator truck trips.

- Port Related Truck Trips: The Port of Long Beach (POLB) and Port of Los Angeles (POLA) have developed detailed models to forecast port related truck trips. SCAG obtains outputs (trip tables) from the Port Model which predict the HDT trips coming out of and going into the San Pedro ports, which includes the POLB and POLA.

- Intermodal Trip Tables: This includes the intermodal trip tables which are integrated into the HDT Model.

- Time-of-Day Choice: This includes the derivation of time-of-day factors from various sources. The daily truck trips by truck types are allocated to five time periods and merged with the auto trips in trip assignment step.

EMFAC Model

The ARB's EMFAC2014 (short for "EMission FACtor", anticipated to be approved by U.S. EPA in Fall 2015) Model is a computer model capable of estimating both current year, as well as back-cast and forecasted emission inventories for calendar years of 2000 to 2050. EMFAC estimates the emission rates of 1965 and newer vehicles, powered by gasoline, diesel or electricity. Emissions inventory estimates are made for over two hundred and seventy seven different technology groups and are reported for fifty one broad vehicle classes segregated by usage and weight.

EMFAC calculates the emission rates of HC, CO, NOx, PM, lead, SO2 and CO2 for 45 model years for each vehicle class within each calendar year, for twenty four hourly periods, for each month of the year, for each district, air basin, county and subcounty in California. EMFAC2014 can report the grams per mile emission rates of a single technology group or the ton per day inventory for the entire 37,000,000 vehicle California fleet.

To determine regional and air basin emissions, SCAG runs the ARB's EMFAC Model using the outputs from the trip-based regional transportation demand model including the HDT Model.

In order to compare with the regional GHG emissions targets derived using EMFAC2007, the EMFAC2014 model GHG emissions outputs have been converted to EMFAC2007 equivalents applying ARB's adjustment methodology.