GREENHOUSE GAS EMISSIONS AND TRANSPORTATION: NEW REGIONAL PLANNING PROCESS AND MODELING PRACTICE IN SOUTHERN CALIFORNIA

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ABSTRACT

The paper discusses how California Senate Bill (SB) 375 changes the existing way of developing the regional transportation plan to achieve the regional Greenhouse Gas (GHG) emissions target. SB 375 relies on the existing framework of developing a regional transportation plan (RTP) to achieve the regional target emissions reduction. Sustainable communities strategy (SCS) or alternative planning strategy (APS) is a planning strategy that is intended to achieve a regional target emissions reduction. Two major findings from the recent SB 375 implementation process include: (1) Metropolitan Planning Organizations (MPO) and the California Air Resources Board (CARB) collaborated to implement the standard modeling practice (e.g., data and assumptions for transportation demand modeling) in preparation for regional target setting. (2) SCAG has made substantial progress in enhancing the current four step transportation demand model and developing advanced models (e.g., Production, Exchange, and Consumption Allocation System (PECAS), Activity Based Model (ABM) and Local Sustainability Planning Tool (LSPT)).

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1. INTRODUCTION

There have been increasingly organized international, scientific (e.g., The Intergovernmental Panel on Climate Change (IPCC)) and cooperative efforts among countries (e.g., Kyoto Protocol) in the world to address global climate change since the late 1980s. Cities and regions of selected countries have introduced a wide range of regulations and incentives (Kamal-Chaoui and Robert, 2009). California recently introduced two major laws to reduce Greenhouse Gas (GHG) emissions. The first bill (Assembly Bill (AB) 32: Global Warming Solutions Act) was signed by the Governor of California, Arnold Schwarzenegger, in September 2006. AB32 is intended to reduce GHG emissions to 1990 levels by the year 2020 and to 80 percent below 1990 levels by 2050. The 2009 PPIC survey revealed that most residents (66%) support the 2006 California law (AB 32) with a split opinion about whether the state government should take action to reduce emissions immediately (48%) or wait until the economy and state budget situation improve (46%) (Baldassare et al., 2009).

The California Air Resources Board (CARB) estimates that 2004 GHG emissions from automobiles and light trucks totaled 135 million metric tons. Automobiles and light trucks accounted for almost 30 percent of the GHG emissions in California. Given the significant contribution of the transportation sector in producing GHG emissions, Senate Bill (SB) 375 was passed by the state legislature and signed by Governor Schwarzenegger in September 2008. It became effective on January 1, 2009. It provides a means for achieving AB 32 goals from cars and light trucks. This bill shows a significant effort from the State of California to implement the global warming goals of AB 32.

SB 375 requires Metropolitan Planning Organizations (MPOs) in California to develop a sustainable communities strategy (SCS) as a major element of the Regional Transportation Plan (RTP) to reduce GHG emissions. SB375 acknowledges that the transportation sector contributes to the generation of GHG emissions. It recommends that MPOs develop a SCS to reduce GHG emissions from cars and light trucks through the integration of planning processes for transportation, land use, and housing. SB 375 offers local governments, regulatory relief and other incentives to encourage new development patterns and transportation alternatives.

A SCS includes the general location of diverse land uses, residential densities and building intensities as a land use element in the RTP. The SCS, however, is limited in its applicability, because planned land uses in local general plans don't have to conform to the SCS. The land use plan element and its relevant strategies in the SCS would encourage smart growth and sustainable development such as transit oriented development (TOD); mixed use development, provision of housing opportunities near job centers, job opportunities in housing-rich communities, the focusing of growth along transit corridors and nodes to utilize available capacity. As a result, transit use or walking becomes more popular, and the planned reductions of GHG emissions will be achieved by the target date. If the SCS still cannot meet the emission reduction targets, an alternative planning strategy (APS) should be prepared and would propose alternative

development patterns, infrastructure, or additional transportation measures or policies to reduce the target emissions.

TOD, as one of the travel demand management strategies, is a key land use development tool for achieving the GHG emission targets by the target year, as specified in SB375. TOD refers to residential and commercial centers designed to maximize access by transit and nonmotorized transportation, and with other features to encourage transit ridership (Victoria Transport Policy Institute, 2010). A typical TOD tends to be compact, mixed-use development near transit facilities and tends to maintain high-quality walking environments. The most direct benefit of TOD is reduced per capita motor vehicle travel (Kittleson & Associates, 1999; Rood, 1999; Cervero et al., 2004; Tumlin, et al., 2005; Evans and Pratt, 2007; Gard, 2007; Cervero and Arrington, 2008; Haas et al, 2010; Center for Transit-Oriented Development, 2010) and the associated revenue gains.

The paper (1) discusses the new planning approach of SB 375: the collaborative process and regional approach, integration of plans and programs, financial incentives and regulatory relief, (2) reviews the recent experience in developing the regional emission targets, (3) demonstrates the potential impact of land use scenarios on GHG emission reduction or urban form or transportation performance measures using new urban simulation models (e.g., 4 step transportation planning model, local sustainability planning tool (LSPT), production, exchange, and consumption allocation system (PECAS) model and activity based model (ABM)[1], and (4) concludes with the overall findings and the discussion of potential issues and challenges for effective SB 375 implementation.

2. SENATE BILL 375 AND NEW REGIONAL PLANNING PROCESS

2.1 Linkage of Local, Regional, and State Planning and Decision Making

With the introduction of SB375, local, regional, and state planning and decision making is more closely linked with each other. The Regional Targets Advisory Committee (RTAC) of CARB acknowledged the importance of collaboration among the MPOs and CARB for successful target setting under SB 375. RTAC further suggested that CARB/MPOs work with Caltrans and the California Transportation Commission to update modeling and RTP guidance. There has been a close interaction between CARB and MPOs during the research, analysis and modeling process of the land use/transportation sectors and emissions. MPOs formed and frequently held meetings of a technical working group, which included CARB staff, to coordinate the development of various land use and transportation policy scenarios for CARB's target-setting process. These scenarios were developed to test the effectiveness of implementing various transportation and land use policies. The MPOs discussed technical issues including: land use and transportation strategies that could be tested in the MPO scenarios, different approaches to interregional travel, travel cost assumptions, and future revenue assumptions. A number of MPOs provided the initial results of their scenario analyses

[1] The first two models are currently being used in the RTP/SCS development process, while PECAS and ABM are currently being developed.

and target-setting approaches to CARB and the public in time for the final RTAC meeting on May 25, 2010 (CARB, 2010). The frequent exchange of technical information and modeling results among CARB, MPOs, and other stakeholders helped to develop a standardized approach on how to do analysis and modeling, and to draft regional GHG emission reduction targets. The collaborative process is also strongly expected in the upcoming SCS development process. Extensive collaboration is required among local and regional stakeholders including CTCs, air districts, counties, cities, and others. The SCS development process was viewed in terms of a series of iterative discussions between MPO, counties, cities, and CTCs, with the collective goal of identifying GHG reduction strategies (SCAG, 2009).

RTAC recommended that CARB and MPOs use a "bottom up" approach to develop parameters for preparing sensitivity analyses and multiple scenarios to test the effectiveness of various approaches. The bottom up approach emphasizes the importance of input from regional and local officials and stakeholders. The local and regional input based parameters would help identify the most ambitious and achievable GHG emission reduction strategies for 2020 and 2035. Local input has been instrumental in identifying the land use scenario for development of the regional transportation plan. By using local input, the most current land use assumptions are implicitly incorporated in the regional transportation plan as mandated by the federal law. MPOs had active participation in developing the regional GHG emission reduction targets as CARB's partner agency. Although SB 375 put CARB in charge of developing the "statewide" GHG emission, CARB uses a bottom-up and regional approach toward developing the statewide GHG emission reductions target. MPOs have been working closely with local jurisdictions and stakeholders to find a technically sound approach and politically acceptable solution for target setting and SCS development.

SB 375 specifies the detailed public outreach processes for MPOs during the SCS development. The specific outreach requirements include: (1) the MPOs must conduct one or two informational meetings in each county for members of the board supervisors and councils on the SCS and APS, if any. (2) each MPO must adopt a public participation plan, for development of the SCS and APS, if any, that includes outreach efforts and workshops. (3) two or three public hearings on the draft SCS or APS must be held. Local governments and the general public are expected to provide meaningful input during the planning process in an active way. As required by SB 375, each MPO must prepare a SCS, subject to the requirements of the Federal Transportation and Clean Air Acts, including the requirement to utilize the most recent planning assumptions considering local general plans and other factors. Local governments would play a key role in developing successful SCS through the availability of the most current general plans reflecting the most recent planning assumptions and in implementing successful SCS related TOD projects through the flexible updating of existing general plans

2.2. Integration of Land Use, Housing, Transportation, and Environment

Traditional regional planning efforts focus on improving regional mobility and other related performance measures. As part of the federal transportation funding requirements,

the RTP must also conform to the regional emission requirements. The Clean Air Act (CAA) was amended in 1990. It intends to reduce smog and air pollution by establishing air quality standards and planning requirements for various air pollutants. The amended CAA requires federally supported highway and transit project activities to meet federal air quality requirements. Under the U.S. Department of Transportation (DOT) Metropolitan Planning Regulations and U.S. Environmental Protection Agency's (EPA) Transportation Conformity Rule requirements, the MPO's RTP needs to pass a regional emission analysis test. The analysis should demonstrate a conformity finding.

In addition to the federal efforts to improve both the regional mobility and air quality associated with the emissions of light and medium vehicles, California has focused on two major regional planning efforts: the Regional Housing Needs Allocation and the Regional Blueprint. The Regional Housing Needs Allocation (RHNA) is intended to improve housing affordability for residents through the RHNA process and the resulting local housing element updates for several decades. The RHNA process establishes minimum housing development capacity that cities and counties are to make available via their land use powers to accommodate growth within a short-term planning period. RHNA numbers are assigned to four income categories as guideposts for each community to develop a mix of housing types for all economic segments of the population.

The Regional Blueprint planning program was introduced to help MPOs develop alternative growth scenarios in the early 2000s. The program was intended to utilize previously unallocated federal funding, as well as to improve the comprehensive level of transportation/land use planning. The Regional Blueprint Planning Program is a voluntary, discretionary grant program that provides seed funding to MPOs to conduct regional blueprint planning. The program contributes to the vision of improved quality of life within California by addressing future growth on a twenty-year horizon through the integration of transportation, housing, land use, environmental resources, other infrastructure, and services (Sollenberger and Klein, 2007). The regional blueprints are not required to be part of the RTP. Their impact on transportation funding decisions has, thus far, been limited.

Although two major federal programs (RTP and conformity analysis), two state programs (RHNA and Blueprint), and local general plans were loosely interlinked before SB 375, SB 375 strengthened the relationship among the five programs (see Figure 1). The development pattern in an SCS must comply with federal law, which requires that any pattern be based upon "current planning assumptions" that includes the information in local general plans and sphere of influence boundaries. The SCS will not directly affect local land use decisions. The SCS does not in any way supersede a local general plan, local specific plan, or local zoning. SB 375 does not require that a local general plan, local specific plan, or local zoning be consistent with the SCS. An SCS is understood as a regional version of the local general plan **(**Choi and Choi, 2010)

3. EMISSION TARGET SETTING PROCESS

There are three ways of reducing emissions from cars and light truck: greater fuel efficiency, reducing the carbon content of fuels, and the changes in growth patterns that reduce overall driving (Fulton, 2008). SB 375 requires CARB to develop a GHG emissions reduction target for cars and light trucks for California's MPOs by September 30, 2010. According to a scoping plan adopted by CARB, the recommended regional transportation-related GHG target (measure No. T-3) is to reduce GHG emissions statewide by 5 million metric tons of carbon dioxide equivalent (MMTCO2E) in 2020(California Air Resources Board, 2008). The potential benefits of this measure that can be realized by 2020 as shown above were estimated after accounting for the benefits of overall fuel efficiency improvements from improved emission standards and low carbon fuels from changes in fuel composition in the plan. A regional GHG reduction target to each of the State's 18 MPOs throughout California will be used as the benchmark for development of the SCS. SB 375 requires the CARB to set regional targets for the purpose of reducing GHG emissions from passenger vehicles for 2020 and 2035. Through a few major milestones, CARB officially released the approved regional GHG reduction targets in February 2011.

The SB 375 target setting process requires three major steps: (1) pre-preparation, (2) preparation, and (3) adoption. The pre-preparation step focuses on developing the target setting process and factors (including methods and tools). Its key elements include RTAC appointment and recommendations. The RTAC was appointed by ARB on January 23, 2009. The 21 RTAC members include representatives of metropolitan planning organizations, local transportation agencies, air districts, the League of California Cities, the California State Association of Counties, and other organizations involved with planning, the environment, environmental justice and affordable housing. RTAC provided recommendations on the target setting process, methods and tools, and implementation to CARB on September 30, 2009. Recommendations included factors to be considered and methodologies to be used in CARB's target setting process.

The preparation step focuses on the research, analysis and modeling efforts of the 18 MPOs to quantify the impacts of alternative land use and transportation scenarios on GHG emissions between October 1, 2009 and June 30, 2010. After the 9 month joint effort of CARB and the MPOs, CARB released the draft regional GHG reduction targets for further review and adopted the regional targets.

The adoption step focused on the adoption of the regional emission target between July 1, 2010 and September 30, 2010. As mandated by SB 375, CARB released a proposed target range for 2020/2035 of all of three groups of MPO regions on September 23, 2010 and adopted a proposed target range (see Table 1). Based on the information provided by MPOs, CARB adopted a 2020 target range of a 7-8% per capita reduction in GHG emissions from 2005 levels and a 2035 target range of a 13-16% per capita reduction in GHG emissions from 2005 levels for the four largest MPOs in California.

4. NEW MODELING PRACTICE FOR MEASURING THE POTENTIAL IMPACT OF LAND USE SCNENARIOS ON GHG EMISSION REDUCTIONS AND TRANSPORTATION PERFORMANCE MEASURES

The Southern California Association of Governments (SCAG) is the Metropolitan Planning Organization (MPO) and Council of Governments (COG) for Imperial, Los Angeles, Orange, Riverside, San Bernardino, and Ventura Counties. SCAG is the lead agency responsible for the development and maintenance of travel demand forecasting models for the SCAG Region SCAG has been developing and improving these travel demand forecasting models since 1967. SCAG applies the models to provide state of the practice quantitative analysis for the Regional Transportation Plan (RTP), the Regional Transportation Improvement Program (RTIP), and Air Quality Management Plans (AQMPs). The Travel Demand Model and supporting data are also used to evaluate other land use planning projects and studies and many local projects. The modeling area covers the entire SCAG Region that encompasses six counties, 56 Regional Statistical Areas (RSAs), 302 Community Statistical Areas (CSAs), and 4109 Traffic Analysis Zones (TAZs). In May 2008, the California Transportation Commission (CTC) adopted an addendum to the RTP Guidelines that advised that the RTP should address climate change and GHG emissions. The RTP Guidelines recommend that the largest State MPOs create new activity-based models and micro-economic land use models. In addition, the RTP Guidelines recommend that commodity flow models be developed including truck and van tour capabilities. According to the recent passage of California SB 375, travel demand models used by MPOs to develop RTPs must assess the effects of land use decisions, transit service, and economic incentives.

To meet these new planning requirements, including the need to meet GHG standards through the development of a SCS or APS, SCAG has embarked on an ambitious model improvement program. SCAG has taken the long-term view towards the development of fully functional regional integrated tour/activity-based models while at the same time pursuing improvements to the existing travel demand model to ensure compliance with SB 375. Accordingly, all of SCAG's modeling tools and supporting databases are being updated and new analytical tools are being developed. This includes development of next generation land use and activity-based models. These two components will be run interactively to form SCAG's new integrated land use and transportation modeling methodology.

4.1. Traditional Transportation Demand Model and Emission Impact Model

A transportation model and an emission model produce a variety of transportation and air quality performance measures, which are used to evaluate alternative land use scenarios (see Figure 2). The traditional four step travel demand model and the emission impact model measure the impacts of land use scenarios on transportation performance measures (e.g., vehicle miles traveled (VMT), vehicle hours traveled (VHT), vehicle hours delayed (VHD), speed, etc.) and air quality measures (e.g., vehicle emissions) by considering the emission factors for vehicle type and age (Johnston, 2004). The paper demonstrates how to measure the effects of land use forecast scenarios on GHG emissions (e.g., VMT) through the existing SCAG's regional transportation modeling process.

Table 2 shows the relative impacts of 2035 Land Use Scenarios on Per Capita VMTs relative to the current base year (2003) and the future base year (business as usual)[2]. According to Table 2, the per capita VMT ranged from 23.3 in the current base year for 2003 to 21.7 for the 2035 Envision Scenario. Following the RTAC recommended base year approach, the Trend Scenario increased the per capita VMT by 2.1% over the current base year, while the Locally Preferred Scenario reduced the per capita VMT by 1.3% over the current base year. The other alternative scenarios reduced per capita VMT by 5%-7% over the current base year. The business as usual approach using the Trend Scenario as the reference data shows a consistent VMT reduction pattern of the alternative scenarios over the Trend Scenario.

4.2. New Modeling Practice

4.2.1. Local Sustainability Planning Tool (LSPT)

SB 375 requires SCAG to provide the public with the information and tools necessary to provide a clear understanding of the issues and policy choices that the region has in developing the SCS. This is accomplished by conducting public workshops structured to allow discussion and dissemination of information about SB 375 and the various policy choices relevant to the development of an SCS. At these workshops, an urban simulation computer modeling tool will be used to create visual representations of the SCS. SCAG has developed the parcel-based LSPT, a sketch planning tool that local jurisdictions and members of the public can utilize to analyze the impact of different land use scenarios on vehicle ownership, VMT, mode-use, and their associated effects on GHG emissions. The LSPT serves to help local jurisdictions, local elected officials and members of the public to visualize their thought processes as it relates to various land-use strategies, and also envision the effects of certain policy choices "on the ground". The tool was developed to display instant results estimating directional and order-of-magnitude VMT and emissions reductions as a result of community design, and other land-use decisions made by stakeholders (SCAG, 2010).

According to the preliminary model results from the application of the LSPT for 2008 base year and 2020 local input scenario, the parcel-based LSPT reduces 2008 probability of making a vehicle trip per household by 0.3% and 2008 per household VMT by 6.7% (see Table 3). The VMT of the parcel-based LSPT is more sensitive to land use variables than that of the TAZ-based LSPT. The parcel-based model results in the lower VMT per household than the TAZ-based model. The % difference of per household VMT from the TAZ-based model would be -4.6%, while there is no change in the probability of making a vehicle trip.

4.2.2. Production, Exchange, and Consumption Allocation System (PECAS) Model

[2] The analysis is primarily based on existing land use forecast scenarios used for the large-scale land use and transportation plan development process during 2007 (SCAG, 2007). The trend scenario is independently developed to understand the potential difference with other land use forecast scenarios. The baseline transportation network is assumed unchanged to measure the net effects of the land use forecast scenarios on VMT.

PECAS (Hunt, 2003) is one of the most sophisticated integrated land use models (e.g., MEPLAN by Echenique et al, 1990, and UrbanSim by Waddell, 2002) that includes land use policy and market variables (e.g., amount of zoned land by use and intensity, land prices, sewer and water availability), and often contains economic underpinnings as well (e.g., economic input-output tables) rather than simple gravity models. As one of the most advanced models, PECAS has been introduced into planning practice in the U.S. SCAG is developing the SCAG PECAS (Production, Exchange, Consumption, Allocation System) land use model that will integrate land use and transportation models to meet the modeling requirements of AB32/SB375 and RTP Guidelines (California Department of Transportation, 2010).

The preliminary SCAG PECAS model has been completed. A couple of scenarios were applied to determine if there is any significant impact on urban form and rent. The first scenario is to increase the allowable FAR within the 0.5 mile radius of major transit stations in Los Angeles County by 2,000% to see if there is any impact on the urban sprawl pattern of the baseline model. The scenario results in an increase of 1.5% in developed areas (see Figure 3). The scenario shows a very limited impact on the overall urban form in the SCAG region. The rent impact of the expanded capacity of available developable land within the TOD area is not confined to the specific area (e.g., Los Angeles County), but is apparent across the region. The second scenario is to test the impact of an increased gasoline tax on vehicle miles traveled. The current gasoline tax, $0.36 per gallon, is assumed to increase by 10% to $0.4 per gallon in 2020. Since the increased gasoline tax directly affects auto operating costs, the travel distance of workers and goods would be negatively affected. With the introduction of the gasoline tax increase between 2007 and 2020, the model expects that average travel distance for commuting, goods, and shopping will increase from 32.5 miles to 32.8 miles (an increase of 0.8%), which is 1.5% lower than the percent change of the average distance of travel in the trend scenario (see Table 4).

The preliminary model results indicate that the SCAG PECAS model has a potential strength of assessing complex interactions of proposed changes in land use, economic, and transportation systems, by analyzing the dynamic relationship between transportation and land use. There is ongoing research on the model calibration process and other elements.

4.2.3. Activity Based Model (ABM)

The traditional trip-based approach to travel demand modeling is limited in modeling complex travel patterns involving multipurpose and multistep travel (Meyer & Miller, 2001). The current trip-based travel demand models are also not able to address a variety of policies at multiple geographical and social scales, such as pricing policies, high occupancy vehicle (HOV) and car-pooling options, telecommuting, travel demand management (TDM) measures, land use strategies, etc. The activity-based travel demand forecasting model is based on the concept that travel is a derived demand resulting from

the need to participate in diverse activities. This approach projects travel demand from a thorough understanding of travel behavior, and takes trip chain into consideration.

California Transportation Commission adopted an "Addendum to the 2007 Regional Transportation Plan (RTP) Guidelines," suggesting that the largest four MPOs in California should develop ABMs in order to improve modeling assessment on key policy options for reducing GHG emissions during the RTP process.

California SB 375 reiterated the importance of advancing the current travel demand modeling practice in order to assess the effects of land use decisions, transit service, and economic incentives on travel. To analyze these important policy issues, SCAG is in the process of developing an activity-based travel demand model for the region, known as Simulator for Activities, Greenhouse Emissions, Networks, and Travel (SimAGENT). The overview and selected details of SimAGENT will be presented at the 2012 Annual Meeting of the Transportation Research Board (Bhat et al, 2011; Goulias et al, 2011; Pendyala et al, 2011).

5. CONCLUSION

The paper discusses how SB 375 changes the existing way of developing regional plans to achieve the regional GHG emissions target. SB 375 relies on the existing framework of developing a regional transportation plan to achieve the regional target emissions reduction. SCS as a required element of a RTP or APS independent of a RTP are major planning strategies to achieve a regional target emissions reduction. There has been progress in SB 375 implementation. As SB 375 emphasized, regional MPOs and CARB collaboratively worked together to implement the standard modeling practice (e.g., data and assumptions for transportation demand modeling) in preparation for a regional target setting. This kind of a close collaboration among regional and state agencies was made available due to the introduction of SB 375. As a result of a collaborative process and a bottom-up approach, MPOs developed a "draft" regional emissions target, and CARB adopted a (higher) regional emissions target based on the draft target.

SB 375 mandates the four largest MPOs in California to actively utilize diverse and complex modeling capabilities to measure and monitor the impacts of land use on transportation and GHG emissions, and vice versa. The Strategic Growth Council (SGC) was created as a cabinet level committee to coordinate the activities of state agencies. One of those activities is to assist state and local entities in the planning of SCS and meeting AB 32 goals. The SGC awarded SCAG with one million dollars to develop data, models and other tools necessary to comply with SB 375. SCAG has made good progress in enhancing the current four step transportation demand model and developing PECAS, ABM, LSPT, etc. According to the traditional four step transportation demand model, the TOD scenario would produce less per capita VMT than the Trend Scenario or the Locally Preferred Scenario as expected. There have been modeling efforts to measure the impact of the TOD scenario or pricing on VMT or GHG emissions using the newly developed models. Although it is in its early stages, the PECAS model tested the potential impact of the increased land use capacity on the county distribution of the household forecast.

There was a marginal impact on the spatial distribution. The PECAS model tested the potential impact of the gasoline tax increase on the average distance of travel. There was a visible impact on the average distance of travel. The newly developed parcel-based LSPT has a great potential for future use due to its sensitivity to land use changes.

Although SB 375 is arguably the most monumental regional planning law to integrate land use, transportation, and housing for GHG emissions reductions in California, it presents several issues and challenges to address in the future. SB 375 might not produce a revolutionary impact, but rather an incremental change (Fulton, California Planning & Development Report, 11/18/2008). The major reason is that SB 375 is not linked with local planning. According to SB 375, SCS can be developed considering local general plans as part of the RTP, but local general plans do not need to be influenced by SCS. The best case scenario is that the TPP designation in the SCS with land use densities and building intensities different from the existing planned land use in the local general plan would be reflected in the upcoming update process of the existing local general plan. As long as the TPP designation meets a variety of environmental and land use requirements specified in SB 375, CEQA exemption/streamlining would be available for the TPP project development. However, the TPP designation in the SCS is most likely impossible without the revision of the local general plan. It takes a considerable amount of time to go through the review and revision process of the local general plan. Planning staff, planning committees, city councils, residents, and other stakeholders of local jurisdictions need to extensively discuss the TPP designation of the proposed station area. Local general plans are still the major guide for the future growth and development of communities with or without SB 375. In order to allow for TPP designation in the SCS before updating the local general plan, the active and meaningful participation and approval of the elected officials as well as local planners in the TPP designation process would be a requirement.

There is also a large discrepancy in the socioeconomic and land use data and modeling capability among MPOs, even among the largest MPOs in California. Although there has been a joint effort of MPOs/CARB to use the standardized assumptions for running a four step transportation model and an emission model for the emission setting process, the model results should be interpreted in a cautious way. For example, even the largest MPOs maintain a different amount and quality of socioeconomic and land use data at different levels of geography (e.g., parcel, block group, census tract, etc.) for the modeling practice. The model has the potential to show different levels of sensitivity to land use or relevant policy impact.

SB 375 is “an unfunded state mandate for local governments to reduce emissions from cars and light trucks in land use and transportation planning and programs” (Southern California Leadership Council, 2010). A limited amount of financial funding would limit the effectiveness of the SB 375 implementation. SB 375 indicates that federal funding might be linked to TPP development, but it might not be sufficient to promote TOD as a major GHG emissions reductions strategy. Additional funding would be needed from the state, but financial incentives from the state for TOD would be unavailable during the period of economic recession. As the California Planning & Development Report (11/18/2008) observed, “only three weeks after insisting that California should encourage

dense development near transit lines, state lawmakers have approved a budget that yanks funding from transit and redevelopment." The financial incentives are available through the consistency requirement of the financial element of the RTP (e.g., allocation of transportation funds) with the SCS, its land use plan, and transportation policies targeting GHG emissions reductions. The regulatory relief, such as CEQA exemptions and streamlining, is also available for certain projects (e.g., TOD). The beneficial impact of the financial incentives and the regulatory relief for the effective implementation of TOD through the SCS is still to be demonstrated.

Finally, the economic impacts and cost of SB 375 implementation might be too high and would require a more careful analysis of the economic benefit and cost of proposed SB 375 targets. As the 2009 PPIC survey indicated, 46% of respondents suggested to wait until the economy and state budget situation improved. On September 17, 2010, the Republican leaders of both the California Senate and Assembly sent a letter to the members of CARB regarding the proposed SB 375 emission reduction targets. The letter indicated that "the SB 375 target ranges proposed by CARB staff would lead to unacceptable new costs and taxes that would devastate an already struggling economy". Using the analysis from the Bay Area Metropolitan Transportation Commission, to meet the proposed targets, the letter introduces a wide range of local policy efforts including "a Vehicle Miles Traveled (VMT) tax, congestion pricing, toll roads, parking fee increases and gasoline prices of more than $9 per gallon, and the increase of annual travel costs by 460 percent".

REFERENCES

Baldassare, M., D. Bonner, J. Paluch, & C. Peteket. (2008). *Californians and the Environment*. San Francisco, California: PPIC Statewide Survey, Public Policy Institute of California. Accessed online on December 4, 2010 at: http://www.ppic.org/main/pressrelease.asp?p=965),

Bhat, C.R., K.G. Goulias, R.M. Pendyala, R. Paleti, R. Sidharthan, L. Schmitt, and H. Hu. (2011). A Household-Level Activity Pattern Generation Model for the Simulator of Activities, Greenhouse emissions, Energy, Networks, and Travel (SimAGENT) System in Southern California. *Paper Submitted for Presentation at the 2012 Annual Transportation Research Board Meeting and Publication in the Transportation Research Record.* http://www.ce.utexas.edu/prof/bhat/ABSTRACTS/IntrahouseholdInteractions_unabridged.pdf

California Air Resources Board. (2008). *Climate Change Scoping Plan: A Framework for Change*. Pursuant to AB 32 The California Global Warming Solutions Act of 2006, Sacramento, California, December 2008. Accessed online on December 4, 2010 at: http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf

California Air Resource Board. (2010). *Regional Greenhouse Gas Emission Reduction Targets Pursuant to SB 375 Resolution 10-31*, September 23, 2010. Accessed online on December 4, 2010 at: http://www.arb.ca.gov/cc/sb375/final.resolution.10.31.pdf

California State Association of Counties. (2008). *SB 375 (Steinberg) Addressing Greenhouse Gas Emissions from the Transportation Sector via Regional Transportation Plans – CSAC Analysis*. 2008. Accessed online on December 4, 2010 at:http://www.counties.org/images/users/1/SB%20375%20CSAC%20Fact%20Sheet%20-%20FINAL_10.17.08.pdf

California Transportation Commission. (2010). *California Regional Transportation Guidelines.* Accessed online on December 4, 2010 at: http://www.catc.ca.gov/programs/rtp/2010_RTP_Guidelines.pdf

Center for Transit-Oriented Development. (2010). *Transit-Oriented Development: Tools for Metropolitan Planning Organizations*, Center for Transit-Oriented Development and Reconnecting America (www.reconnectingamerica.org). Accessed online on December 4, 2010 at http://reconnectingamerica.org/public/display_asset/ctod_mpotod_final.

Cervero, R., et al. (2004). *Transit-Oriented Development in the United States: Experience, Challenges, and Prospects*, TCRP Report 102, Transit Cooperative Research Program, Transportation Research Board. Accessed online on December 4, 2010 at: http://gulliver.trb.org/publications/tcrp/tcrp_rpt_102.pdf.

Cervero, R., and G. B. Arrington. (2008). Vehicle Trip Reduction Impacts of Transit-Oriented Housing. *Journal of Public Transportation*, Vol. 11, No. 3, pp. 1-17. Accessed online on December 4, 2010 at www.nctr.usf.edu/jpt/pdf/JPT11-3.pdf.

Cho, S. (2011). Preliminary SCAG-PECAS Model Result on Gas Tax Increase and Average Distance (October 30, 2011).

Choi, H. & Choi, S. (2010). Climate Change and Regional Land Use Planning: The Formulation of California Senate Bill No. 375. *Journal of Environmental Policy.* 9(1). pp. 3-29.

Choi, S., H. Hu, and S. Yoon. (2009). Searching the Optimal and Acceptable Urban Form for Regional Sustainable Planning. *50th Annual Association of Collegiate Schools of Planning Conference*, Crystal City, Virginia, October 1-4, 2009. 50th Anniversary ACSP Conference 2009.

Echenique, M.H., Flowerdew, A.D., Hunt, J.D., Mayo, T.R., Skidmore, I.J. and Simmonds, D.C. 1990. The MEPLAN Models of Bilbao, Leeds and Dortmund. *Transportation Reviews* 10: 309-322.

Evans, J. E. and R.H. Pratt. (2007). *Transit Oriented Development; Chapter 17, Travel Response To Transportation System Changes*, TCRP Report 95, Transportation Research Board (www.trb.org). Accessed on December 4, 2010 at www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=1034.

Fulton, W. (2008). SB 375: It's An Incremental Change, Not A Revolution. *California Planning & Development Report*, 23(11).

Gard, J. (2007). Innovative Intermodal Solutions for Urban Transportation Paper Award: Quantifying Transit-Oriented Development's Ability To Change Travel Behavior. *ITE Journal* (www.ite.org), Vol. 77, No. 11, November 2007, pp. 42-46.

Goulias, K.G, C.R. Bhat, R.M. Pendyala, Y. Chen, R. Paleti, K.C. Konduri, T. Lei, D. Tang, S. Yoon, G. Huang, H. Hu. (2011). Simulator of Activities, Greenhouse Emissions, networks, and Travel (SimAGENT) in Southern California. *Paper Submitted for Presentation at the 2012 Annual Transportation Research Board Meeting and Publication in the Transportation Research Record.* http://www.ce.utexas.edu/prof/bhat/ABSTRACTS/SIMAGENT_Goulias_etal.pdf

Haas, P., G. Miknaitis, H. Cooper, L. Young, A. Benedict. (2010). *Transit Oriented Development and The Potential for VMT-related Greenhouse Gas Emissions Growth Reduction.* Center for Neighborhood Technology (www.cnt.org) for the Center for Transit Oriented Development; Accessed on December 4, 2010 at www.cnt.org/repository/TOD-Potential-GHG-Emissions-Growth.FINAL.pdf.

Hun, H. (2011). Preliminary SCAG's Parcel-Based LSPT Result (October 30, 2011).

Hunt, J.D., and Abraham, J.E. (2003). Design and Application of the PECAS Land Use Modelling System. *Paper Presented at the 8th International Conference on Computers in Urban Planning and Urban Management*, Sendai, Japan.

Johnston, R. (2004). The Urban Transportation Planning Process, Hansen S. and G. Giuliano (eds), *The Geography of Urban Transportation, Third Edition*, New York: The Guilford Press.

Kamal-Chaoui, Lamia and Alexis Robert (eds). (2009). *Competitive Cities and Climate Change*, OECD Regional Development Working Papers No 2, 2009, OECD Publishing, OECD. Accessed on December 4, 2010 at: www.oecd.org/dataoecd/30/36/44232251.pdf

Kittleson & Associates. (2003). *Transit Capacity and Quality of Service Manual, 2nd Edition,* Transit Cooperative Research Program 100. Accessed on December 4, 2010 at: http://www.trb.org/Main/Blurbs/Transit_Capacity_and_Quality_of_Service_Manual_2nd_153590.aspx

Meyer, M.D., E.J. Miller.(2001).*Urban Transportation Planning, Second Edition*. Boston: McGraw Hill.

Pendyala, R.M., C.R. Bhat, K.G. Goulias, R. Paleti, K.C. Konduri, R. Sidharthan, H. Hu, G. Huang, and K.P. Christian. (2011). The Application of a Socio-Economic Model System for Activity-Based Modeling: Experience from Southern California. *Paper Submitted for Presentation at the 2012 Annual Transportation Research Board Meeting and Publication in the Transportation Research Record.* http://www.ce.utexas.edu/prof/bhat/ABSTRACTS/CEMSELTSPopGenApplicationResultsinSCAG_July29.doc

Rood, T. (1999). *Local Index of Transit Availability (LITA),* Local Government Commission (www.lgc.org)

Southern California Association of Governments. (2007). *2008 RTP Lessons Learned & Policy Choices*. Accessed on December 4, 2010 http://www.scag.ca.gov/rtptac/pdf/2007/tac081607_4_1_1_GrowthVisioningScenario.pdf

Southern California Association of Governments. (2009). *Draft Sustainable Communities Strategy Collaborative Process*. Accessed on December 4, 2010 at: http://www.scag.ca.gov/sb375/pdfs/SCS_CollaborativeProcess102709.pdf

Southern California Association of Governments. (2010). *Sustainability Tool Desktop ver. 2.0. – Detailed User Guide*. July 2010.

Sollenberger, J., & L. Klein. (2007). *Regional Transportation Plan Guidelines Work Group Meeting*. June 28, 2007.

Tumlin, J., J. Walker, J. Hoffman, and R. Hutabarat. (2005). Performance Measures for the Urban Village Transit Network, Transportation Research Board 84th Annual Meeting (www.trb.org).

Victoria Transport Policy Institute. (2010). Transit Oriented Development in *TDM Encyclopedia, 2010*. Accessed on December 4, 2010 at: http://www.vtpi.org/tdm/tdm45.htm

Waddell, P. (2002). UrbanSim: Modeling Urban Development for Land Use, Transportation and Environmental Planning. *Journal of the American Planning Association,* 68 (3), 297-314.

Table 1. Greenhouse Gas Reduction Targets for 2020 and 2035
(Percent Reduction in Per Capita Emissions Relative to 2005) [1]

MPO Type	MPO Name	2020	2035
Largest (4) (83%[2])	Metropolitan Transportation Commission (MTC)	7%	15%
	Sacramento Area Council of Governments (SACOG)	7%	16%
	San Diego Association of Governments (SANDAG)	7%	13%
	Southern California Association of Governments (SCAG)	8%	13%
San Joaquin Valley MPOs (8) (10%*)	Council of Fresno County Governments (COFCG) Madera County Transportation Commission (MCTC) Merced County Association of Governments (MCAG) Kern Council of Governments (KCOG) Kings County Association of Governments (KCAG) San Joaquin Council of Governments (SJCOG) Stanislaus County Council of Governments (StanCOG) Tulare County Association of Governments (TCAG)	5%	10%
Remaining MPOs (6) (5%*)	Association of Monterey Bay Area Governments (AMBAG)	0%	5%
	San Luis Obispo Council of Governments (SLOCOG)	8%	8%
	Santa Barbara County Association of Governments (SBCAG)	0%	0%
	Shasta County Regional Transportation Planning Agency (SCRTPA)	0%	0%
	Butte County Association of Governments (BCAG)	1%	1%
	Tahoe Metropolitan Planning Organization (TMPO)	7%	5%

Note: 1. RTAC recommends that ARB express the targets in terms of a percent reduction in per capita greenhouse gas emissions from 2005 levels. This metric is preferred for its simplicity, since it is easily understood by the public, can be developed with currently available data, and remains a widely used metric by MPOs today. In addition, this form of metric has the advantage of directly addressing growth rate differences between MPO regions (CARB, 2010). 2. Percent of State's greenhouse gas emissions and vehicle miles traveled from passenger vehicles (CARB, 2010).

Table 2. Impacts of 2035 Land Use Scenarios on Per Capita VMT: SCAG Region

	Per Capita VMT	Business As Usual Approach		Base Year Approach	
		Difference from Trend	% Difference from Trend	Difference from 2003	% Difference from 2003
2003	23.3				
Trend[1]	23.8			0.5	2.1%
LP[2]	23.0	-0.8	-3.4%	-0.3	-1.3%
TOD[3]	22.2	-1.7	-6.7%	-1.1	-4.7%
Center[4]	22.0	-1.8	-7.6%	-1.3	-5.6%
Envision[5]	21.7	-2.1	-8.8%	-1.6	-6.9%

Note: 1: a technical projection that provides a best estimate of future growth based on past trends; 2: the local input by county reflecting the current general plan as a desired future of the communities forms the foundation of the Locally Preferred (LP) Scenario; 3: assign greater housing and employment capacity to areas around transit stations (e.g., Bus Rapid Transit (BRT), Metro Rail (Light Rail), MetroLink (Commuter Rail);4: focus development in urban centers and existing cities; 5: focus growth toward Centers, Transit areas and the more utilization of mixed-use development
Source: Choi, Hu, Yoon, 2009

Table 3. Comparison of Impacts on Per Household VT & VMT: TAZ-Based Model vs. Parcel-Based Model.

	2008	2020				
	TAZ-Based	TAZ-Based	% Difference from 2008 Model Result	Parcel-Based	% Difference from 2008 Model Result	% Difference from 2020 TAZ-Based Model Result
VT*	92.7%	92.5%	-0.3%	92.5%	-0.3%	0%
VMT	51.99	50.88	-2.1%	49.15	-6.7%	-4.6%

Note: * the probability of making a vehicle trip per household.
Source: Hsi-Hwa Hu, Preliminary SCAG's Parcel-Based LSPT Result, October 30, 2011.

Table 4. Impacts of Gas Tax Increase on Average Distance in 2020: SCAG Region

	Average Distance (Mile)	Business As Usual Approach		Base Year Approach	
		Difference from Trend	% Difference from Trend	Difference from 2007	% Difference from 2007
2007	32.517				
Trend	33.257			0.740	2.3%
Gas Tax	32.776	-0.481	-1.5%	0.259	0.8%

Source: Sungbin Cho, Preliminary SCAG-PECAS Model Result on Gas Tax Increase and Average Distance, October 30, 2011.

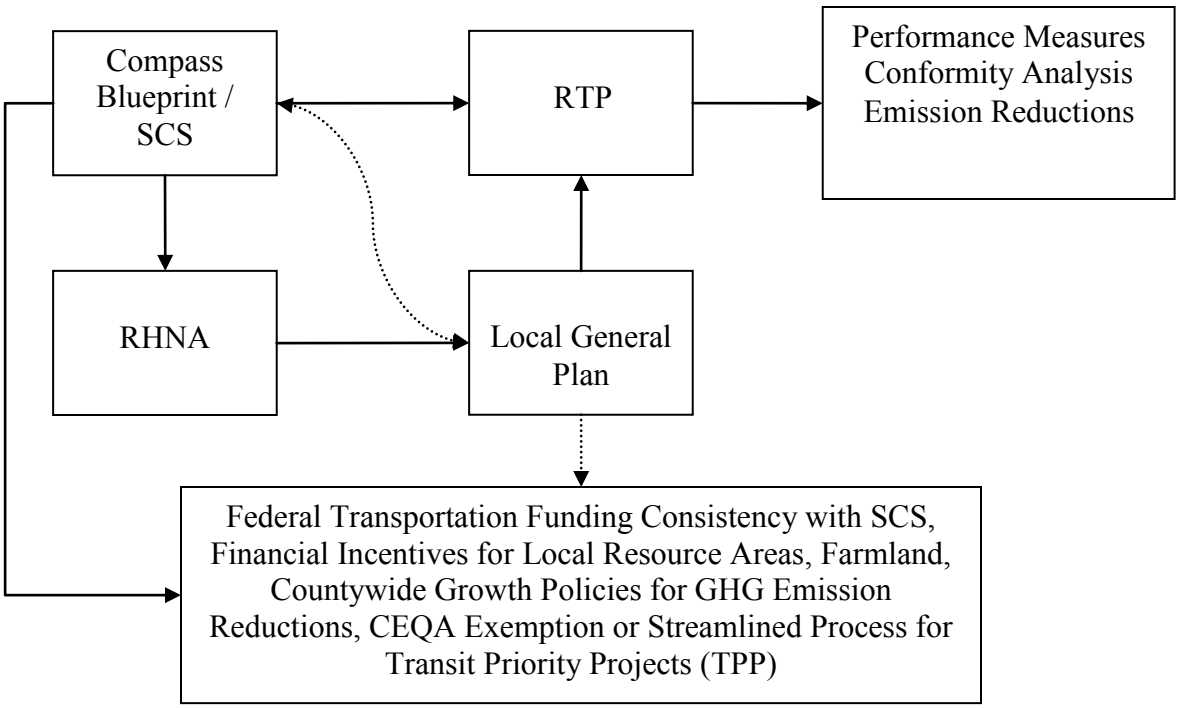

Figure 1. Relationship of Major Plans and Programs: After SB375 (Choi and Choi, 2010).

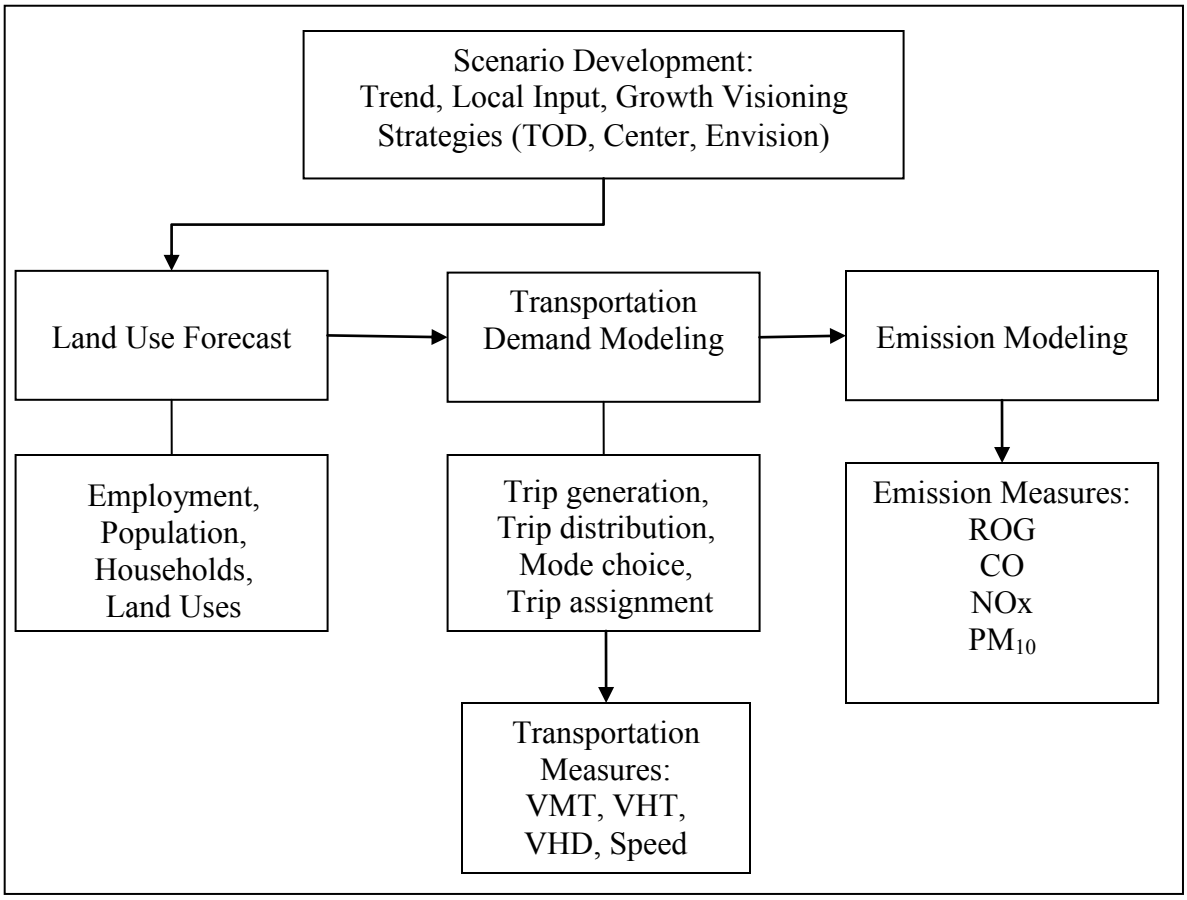

Figure 2. Transportation Demand and Emission Modeling Process (Choi and Choi, 2010)

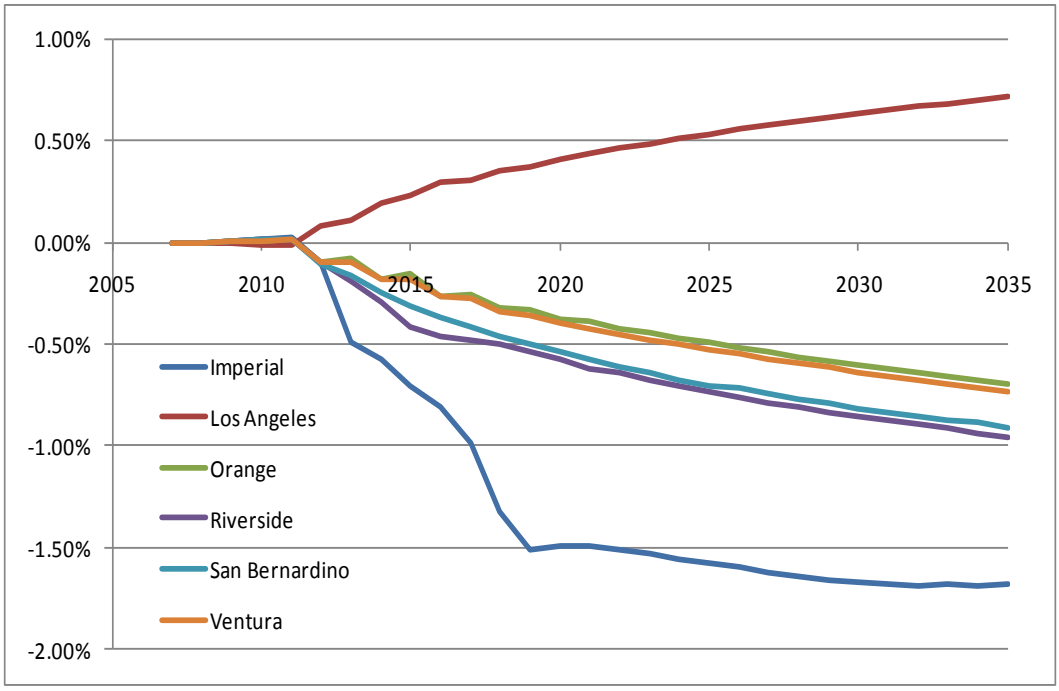

Figure 3. Impacts of TOD (with 2000% Increase of FAR within 0.5 Miles of the Major Transit Stops in Los Angeles County Only) on Household Forecasts by County in the SCAG Region Relative to the Baseline Household Forecasts.