EMERGING TRENDS

MOBILITY INNOVATIONS

SOUTHERN CALIFORNIA ASSOCIATION OF GOVERNMENTS

2016–2040 RTPSCS

APPENDIX

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APPENDIX

EMERGING TRENDS I MOBILITY INNOVATIONS

DRAFT DECEMBER 2015

MOBILITY INNOVATIONS STRATEGIES

Technology has emerged as a prevailing theme for the 2016 Regional Transportation Plan/ Sustainable Communities Strategy (2016 RTP/SCS), resonating with the public and elected officials. The purpose of this appendix is to provide an overview of how SCAG analyzed a wide range of innovations that could potentially impact travel behavior and locational choices in the region over the next 25 years. SCAG recognizes that many of these new technologies are existing solutions that have made a quantum leap in public acceptance because of advancements in smartphones, mobile banking and social networking. In other words, any improvement in regional mobility will come from how technology is used, rather than from any individual technological development. For this reason, the Plan and this appendix uses the term "innovations" instead of "technology." The specific objectives of this Appendix are to:

- Describe policy recommendations for maximizing the environmental benefits and social benefits of these innovations;
- Document the methodology used for analyzing specific mobility innovations;
- Summarize available research on a wide range of individual technological innovations related to transportation;
- Review these innovations for relevance to SCAG planning and modeling practices; and
- Describe selected innovations or packages of innovations that were recommended for further analysis by SCAG planning and modeling staff.

SCAG INNOVATION WHITE PAPER

In 2014 an internal SCAG working group analyzed the widest possible range of technological advancements related to the transportation system. The result of this effort was a white paper covering mobility innovations. Many of these new applications or transportation services are being discussed in the popular media, although they may have limited applicability in many parts of the SCAG region. The working group developed a matrix listing approximately 50 individual technological innovations and grouped them into 19 categories. The matrix was designed to evaluate the potential for each innovation to impact travel behavior and locational choice, and the potential for capturing these impacts in SCAG's modeling processes.

The working group prepared a catalo25 applications, innovations or packages of innovations that may have an impact on the transportation system. The working group then refined this list t11 innovations or applications that could be incorporated into the scenarios developed to analyze the 2016 RTP/SCS based on their impact. The full text of the catalog is in the following section. The innovations that were selected for further review may have a profound impact in a limited geography or a more diffuse impact over a wider geographic area within the region. Of the eleven innovations, SCAG identified six innovations that should be supported through investment plans and supportive policies. Two additional innovations were reviewed at a qualitative level, and the 2016 RTP/SCS recommends supportive policies. Following is the list of innovations:

- Innovations analyzed for potential greenhouse gas emissions reductions
  - Alternative Fuel Vehicles (Specifically Zero Emissions Vehicles)
  - Neighborhood Electric Vehicles (NEVs)
  - Shared Mobility Services including:
    - Car Sharing (roundtrip and one-way)
    - Ridesourcing (also known as Transportation Network Companies, or TNCs)
- Innovations supported through policy language and further research
  - Connected / Automated Vehicles
  - Open Transit Data (discussed in the Transit Appendix)
- Innovations analyzed for greenhouse gas emissions reductions but included in other program areas and appendices
  - Bike Sharing (discussed in the Active Transportation Appendix)
  - ITS Roadway (discussed in the Congestion Management Appendix)
  - Telecommuting and Work-at-home (discussed in the Congestion Management Appendix)

ANALYSIS METHODOLOGIES

To analyze these innovations, SCAG translated planning assumptions into analysis parameters. Based on the available research, SCAG used conservative time frames for deployment of the innovations identified for further analysis. The full methodologies are described in the SCS Appendix in the Off-Modeling section. Generally they can be described as follows:

- **Zero Emissions Vehicle Strategies:** SCAG applied a methodology developed by the Metropolitan Transportation Commission (MTC) for the Plan Bay Area 2013, refined and validated by the California Air Pollution Control Officers Association (CAPCOA), and used by the San Diego Association of Governments (SANDAG) for that agency's "San Diego Forward: The Regional Plan."

- **NEV Supportive Policies:** NEV usage was estimated based on existing studies and applied to defined Neighborhood Mobility Areas (NMAs). Usage rates were averaged across the population in the areas.
- **Shared Mobility Services:** These emerging modes were analyzed through off-model analyses of regional transportation model results, using various methodologies.
  - **Bike share:** (See the Active Transportation Appendix)
  - **Car Share:** SCAG again applied a methodology developed by MTC and CAPCOA, and used by SANDAG.
  - **Ridesourcing:** SCAG modified the methodology developed by MTC for Car Share based on land use characteristics derived from the Scenario Planning Model , and proprietary data provided by one of the two major TNCs.

TABLE 1 summarized the greenhouse gas emission reductions from these mobility innovations.

MOBILITY INNOVATIONS ANALYZED FOR REDUCTIONS IN GREENHOUSE GAS EMISSIONS

The following sections describe in more detail policy recommendations and the technical methodology for analyzing the mobility innovations analyzed in the 2016 RTP/SCS for their potential for reducing greenhouse gas emissions. The previous plan identified policies to support a number of best practices and technological innovations that were not fully analyzed at the time, such as alternative fuel vehicles and neighborhood electric vehicles. Additional new transportation innovations have been planned and deployed since 2012, such as car sharing, bike sharing and ridesourcing. The following sections describe the mobility innovations in more detail and present best practices for supportive policies and local infrastructure investment.

TABLE 1 GHG Reductions from Mobility Innovations

	2040
Zero-Emission Vehicle (ZEV)	1.0%
Neighborhood Electric Vehicle (NEV)	0.1%
Carsharing/Ridesourcing	0.9%
Total	2.0%

ZERO EMISSIONS VEHICLE STRATEGIES

The 2012 RTP/SCS contained policies that encouraged adoption of alternative fuel vehicles in the region. While SCAG's policies are technology neutral with regard to supporting zero and/or near-zero emissions vehicles, this section will focus on zero emissions vehicles. Specifically, the 2012 RTP/SCS called for alternative fuel station planning and fuel-neutral policy support vehicle adoption. SCAG has supported natural gas fleet vehicles by hosting and administering the Southern California Clean Cities Coalition. In addition, SCAG has met regularly with Hydrogen Fuel Cell industry partners.

SCAG has also provided specific planning and support for Plug-in Electric Vehicles (PEV) and electric vehicle charging stations (EVCS). Since 2012, the Governor's Office has released the 2013 and 2015 Zero Emissions Vehicle (ZEV) Action Plans. These plans identified coordinated state level funding to support implementation of PEV and Hydrogen Fuel Cell refueling networks. In addition, the California Air Resources Board (ARB) has provided aggressive growth projections in ZEVs throughout the state. As part of the 2016 RTP/SCS, SCAG analyzed PEV growth specific to Plug-in Hybrid Electric Vehicles (PHEV) in the SCAG region. 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 reductions in greenhouse gas emissions that will be achieved through increased usage of electric power relative to gasoline power.

Policy Recommendations

Zero Emissions Vehicle Strategies include the following policy recommendations:

- Policy Goal
  - Increase Plug-in Hybrid electric drive use by 10 percent over ARB standards.
- Continue support for ZEV rebates;
  - Encourage the state to continue current California Vehicle Rebate Program Funding is continued through 2035;
  - Facilitate Governor's Executive Growth Rate; and
  - Extend benefits for low-, moderate- and above moderate-income residents in disadvantaged communities, e.g. the Replace your Ride voucher program sponsored by the South Coast Air Quality Management District incentivizing EV purchases.
- Continue to assist local jurisdictions in seeking grant opportunities for ZEV charging and refueling stations;
  - Assist applicants for California Energy Commission (CEC) & ARB funding for Regional ZEV charging network; and

    - Encourage installation of 116 hydrogen stations by 2025, and market growth post 2025.
- Continue to promote local and regional efforts to implement Workplace and Multifamily Housing PEV charging stations;
    - Continue to secure funding for planning and education efforts; and
    - Increase Multi-Family housing EVCS access.

Regional Charging Station Network

SCAG proposes $274 million in regional charging station rebates to support the installation of 380,000 Level 1 & 2 new EV charging stations focused on workplaces and multi-unit housing units in Urban and Compact areas. This program will increase access to workplace and multifamily charging from .1 percent to 2.9 percent of households and employees in Urban and Compact Areas.

Analysis Methodology

SCAG applied a methodology developed by MTC to measure the GHG reductions achievable through providing support for a regional network of charging stations. The investment plan will support enough charging stations (1 EVCS for every 5 ZEVs) to increase the PHEV usage of electric power by 10 percent.

NEIGHBORHOOD ELECTRIC VEHICLE (NEV) POLICIES

NEV supportive polices were analyzed as part of the Neighborhood Mobility Areas strategy. Currently, a number of jurisdictions are actively conducting research, developing policies, pursuing funding and designing infrastructure to encourage the use of Neighborhood Electric Vehicles (NEVs). Examples include the South Bay Cities Council of Governments (SBCCOG) pilot program, the City of Huntington Beach NEV plan sustainability planning grant, and the Coachella Valley Association of Governments (CVAG) CV Link multi-modal path project. This 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 areas not served by high quality transit. In the U.S., nearly 40 percent of urban and suburban auto trips are less than two miles. In the SCAG region, 38 percent of trips are less than three miles. Specifically the 2016 RTP/SCS includes policies to encourage the planning and promotion of NEVs in NMAs. A short trip using a Neighborhood Electric Vehicle (NEV) would have positive net impacts due to negligible greenhouse gas emissions (based on energy production) and zero local pollution, though this travel mode would not bring a reduction of Vehicle Miles Traveled (VMT).

Policy Recommendations

NEV supportive policies include the following:

- Policy Goal
    - Replace 1.5 percent of all automobile trips less than 3 miles with NEV trips in NMAs.
- Apply complete street policies in NMAs that support both active transportation and NEVs;
- Provide shared bike/slow speed vehicle lanes on high speed arterials in order to bridge the gap between NEV accessible areas;
- Encourage the planning and implementation of dedicated active transportation/NEV infrastructure;
- Continue to encourage State and local rebates for Plug-in Electric vehicles, including support of NEV purchases; and
- Encourage local support for EV charging stations accessible to NEVs.

Analysis Methodology

SCAG prepared GIS maps of the region indicating areas with suitable local connectivity conducive to people walking, bicycling and using low speed electric vehicles such as NEVs for trips under three miles. These maps represent clusters of the highest ranked areas for walkability, pedestrian and bicyclist safety, NEV friendly areas and short trips. In order to avoid duplication of gains through other policies, areas within High Quality Transit Areas have been omitted. NMAs represent areas where local agencies should be encouraged to support reductions in greenhouse gas emissions through short trip replacement as a strategy that is not dependent on increased density or access to high quality transit. SCAG used a methodology based on various studies of observed NEV usage. In these NMAs it is assumed that NEVs can be used to replace 1.5 percent of all automobile trips less than three miles. This figure was based on studies of NEV usage in existing communities and the methodology has been documented by CAPCOA. The number of automobile trips less than 3 miles in NMAs can be directly calculated from SCAG's regional model output. VMT reduction is calculated as the number of substituted vehicle trips multiplied by 1.5 miles (average of 3 miles).

SHARED MOBILITY SUPPORTIVE POLICIES

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

- Car sharing (roundtrip, and point-to-point)
- Peer-to-Peer Car sharing
- Ridesourcing (also known as Transportation Network Companies)
- Dynamic On-demand Private Transit
- Vanpool & Private Employer Charters

- Bike sharing

For all these services, mobile computing and payment systems are reducing transaction costs and opening up traditional mobility services to a wider population of producers and consumers. Generally this trend is referred to as the "sharing economy," though in reality this new economy is based on micro-level buying and renting transactions. The net effect of these services on transportation mode choices and per capita vehicle miles traveled (VMT) is still to be determined, however preliminary research has demonstrated that the availability and use of these service does correlate with a reduction in individual vehicle ownership. This reduction in ownership does result in an increase in non-automobile modes for discretionary trips. In other words, if a person no longer owns a car they will be more selective in the car trips that person will choose to take.

The 2016 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 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.

Policy Recommendations

Shared mobility supportive policies includes the following:

- Policy Goals
  - Achieve 15 percent participation in Car share by all households in Urban TAZs, 5 percent in Compact TAZs and 1 percent in Other TAZs; and a 30 percent reduction of VMT for participating households; and
  - Achieve 15 percent participation in ridesourcing by all households in Urban TAZs, 5 percent in Compact TAZs and 1 percent in Other TAZs; and a 10 percent reduction of VMT for participating households.
- Encourage supportive sustainable land use planning that results in mixed-use compact walkable areas;
- Encourage public support of car sharing and ridesourcing;
- Encourage jurisdictions to implement and expand bike share networks;
- Encourage local reform of taxi, charter vehicle and ridesourcing regulations that maximize the environmental and social benefits of new modes; and
- Continue to engage in research to analyze the potential for shared mobility, including peer-to-peer car sharing in suburban areas.

Methodology for Car Sharing Analysis

SCAG classified TAZs to six main groups from 35 detailed place types from SPZs, based on land use characteristics such as density and diversity. SCAG applied a higher car sharing program participation rate to households located in place types with higher density and diversity of land uses. This assumption is consistent with the methodology applied by MTC and applied in Caltrans 2040 statewide plan. SCAG assumed a 30% reduction in VMT for households participating in car sharing based on empirical data noted in CAPCOA and ARB documents.

Methodology for Ridesourcing Analysis

For the analysis of ridesourcing, SCAG used the same six place type categories as in the car sharing analysis. SCAG, again, assumed a higher participation rate using of households using ridesourcing in place types with higher density and diversity of land uses. This assumption is consistent with the summary data provided by Lyft, one of the major ridesourcing companies. SCAG programed a 30 percent reduction in VMT for households participating in ridesourcing based on similar assumptions in the car sharing analysis.

AUTOMATED/CONNECTED VEHICLES

Automated / Connected Vehicle (ACV) technologies cover a range of enabling advancements that allow vehicles to operate without driver input and to coordinate with other vehicles to achieve improvements in safety, throughput and user experience. The term ACV covers on-board sensing capabilities, data integration and vehicle-to-vehicle (V2V) communication. ACV covers two distinct innovation paths: autonomous operation, where vehicles rely on digital maps and onboard sensing to operate without any driver input; and connected vehicle operation, where vehicles communicate with each other and with roadway infrastructure, such as signage gantries. However, these two paths are being developed simultaneously and may need to be integrated to achieve the full benefits promised by researchers in terms of safety and congestion reduction. Vehicle to Infrastructure (V2I) communication is another aspect that is covered under roadway ITS operations. It is important to note that vehicles capable of partially automated operation are already available to the public. The California and Nevada Departments of Motor Vehicles (DMV) have already licensed manufacturers for on-road testing and will be releasing consumer model permitting rules by 2016.

Due to the uncertainty regarding deployment timelines and the operational characteristics, initial research shows inconsistent impacts on travel behavior and locational choice. Conservative traffic simulations show that in the initial phases, ACVs may increase congestion, especially if safety features are mandated at the expense of system operational efficiency. In addition, if an incremental approach is taken by automakers, the result may be higher VMT as automated vehicles allow people to productively use their commute time. Alternately, if fully autonomous vehicles change the vehicle ownership paradigm, they may facilitate more on-demand transportation services and an increased reduction in household vehicle ownership.

Policy Recommendations

Automated/Connected Vehicle supportive policies include the following:

- Encourage federal and state financial support for testing and deploying increasingly automated passenger, freight and transit vehicles;
  - Promote the development of streamlined state, regional and local regulations for operation and insuring of vehicles;
- Position Southern California as a leader in Automated/ Connected Vehicle Deployment;
  - Encourage the development of regional demonstration sites;
  - Integrate ACV planning with High Occupancy Toll (HOT) lane network; and
  - Facilitate local planning and preparation for automated slow-speed vehicles (25 mph and under).

Post 2016 RTP/SCS Modeling Methodology

Only a limited number of agencies and firms have experimented with analyzing the impacts of partially and fully automated vehicles. Currently there is a growing body of journal articles and white papers on the impacts of automated vehicles on transportation modeling. SCAG is aware of performance simulations of a typical freeway segment under various scenarios. The Puget Sound Regional Council (PSRC), the MPO for the Seattle-Tacoma region, performed some sketch modeling using their transportation model. PSRC varied inputs such as perceived cost of travel, congestion and even parking prices to simulate various automated vehicle scenarios. Their results showed consistent increases in VMT across their scenarios.

After the 2016 RTP/SCS is completed, SCAG should test similar efforts to those performed by the PSRC. In order to estimate deployment of automated vehicles under an incremental scenario, SCAG can follow a methodology established by the Highway Loss Data Institute (HLDI) based on the deployment rates of other automotive innovations such as Anti-Lock Brakes, automatic transmission and seat belts. These innovations usually demonstrated a 30-year period from the initial introduction of the feature to widespread adoption. Using existing sales figures for high-end vehicles offering partially automated features, SCAG can project the percentage of the passenger vehicle fleet in the region that will have these features in 2035 and 2040.

MOBILITY INNOVATIONS WHITE PAPER

The following section provides overview of a wide range of innovations that could potentially impact travel behavior and locational choices in the SCAG region over the next 50 years. The innovations are considered over a time frame that extends past the planning horizon of the 2016 RTP/SCS in order to investigate technological advancements that may see only incremental deployment within the time frame of the next plan.

WHY STUDY THE IMPACT OF TECHNOLOGICAL TRANSFORMATION?

As noted earlier, technology as a theme resonates with the public, elected officials and transportation professionals. The 2015 SCAG General Assembly's focus on the topic elicited active participation and drew a variety of well-respected speakers. Technological innovations have the potential to make existing transportation choices more widely available and easier to use throughout the region. By providing more options for local and regional trips, technological innovations may shift trips to less environmentally damaging modes, lessen negative environmental externalities associated with current vehicle use, increase system efficiency, improve safety and reduce auto-related collisions and fatalities. However, realizing the potential benefits (and potential negative impacts), is dependent on the rate of development and adoption of a wide range of public and private sector innovations.

RESPOND TO NEW TRENDS

Young people graduating high school in 2016 were a mere nine years old when the first iPhone was released. This cohort is the same age as Microsoft's Windows 98 product, and most members likely do not remember hearing the din of dial-up Internet. The first Toyota Prius hybrid electric vehicle would have hit the consumer market just in time for this group's first birthday. These milestones illustrate that they will have an entirely different expectation of the role of technology in their everyday lives than generations past. Changing demographics and larger economic trends have led to a demand for more flexible transportation options, the expansion of the sharing/disruptive economy and calls for communities where people can live, work and play within a short distance.

ASCERTAIN LONG-TERM IMPACTS

The Plan also reflects the ever-expanding portfolio of transportation innovations that advanced technology can enable and their long-term, regional impacts. SCAG staff has examined the roles of technology and innovation in the transportation and land use arenas throughout the region. Private sector clean tech industries and mobile phone application developers outpace government in delivering technological innovation to the transportation sector. Recognizing this, SCAG seeks to understand the impact of such technological transformations and to decipher, through the lens of the 2016 RTP/SCS, what can reasonably be incorporated into our assumptions and modeling. Will a technology or innovation be amenable to only a small segment of the population, and/or will it be available for 10, 15 or 30 years? Are we at the outset of a major paradigm shift? Are tipping points just around the corner? Will the longstanding trend of the majority of travel trips taken by automobile persist?

UNDERSTAND PROCESS OF TECHNOLOGICAL INNOVATION

Enabling Technology

What is commonly referred to as "transportation technology" is actually "technology-enabled transportation." For example, bike share as a transportation option has existed for decades, but the infusion of information technology into the old bike share model has led to its surging popularity. Many innovations examined here are not fundamentally different in how they physically help people move about, but instead use technology to increase efficiency, enable wider access or provide more information.

Enabling technology includes hardware innovations and new software platforms and applications. Examples of hardware, such as smart cards as fare media and WiFi may be implemented by public or private entities. Examples of software include the whole host of applications that operate on smart phones and tablets. Many of these innovations, such as mobile banking, real-time mapping, travel information and peer-to-peer technologies, are facilitating a marketplace for existing "sharing" services such as car share or bike share – in other words, short-term rental services.

Disruptive vs Sustaining Innovation

Much like other parts of the economy, the transportation sector is seeing the emergence of disruptive innovations. Disruptive innovations, such as transportation network apps like Lyft and Uber, help create a new market and value network and result in the disruption of an existing market and value network, in this case taxi services. Conversely, sustaining innovations, such as electronic media fare payment and goods movement warehousing automation, are models or services that fit more neatly into existing markets and networks and feed into those systems. Within this model, disruptive technologies are often dismissed at first because of poor performance when measured against the performance of existing products and services. However, the disruptive innovation can tap into a new market demand unrealized by existing providers. SCAG has given consideration to both disruptive innovations and sustaining innovations.

EVALUATING MOBILITY INNOVATIONS

SCAG created a list of more than 50 individual technological innovations that may have some impact on the transportation system. Many of these new applications or transportation services are being discussed in the popular press, although they may have limited applicability in many parts of the SCAG region. Others have been known to transportation planning professionals for years or even decades, but have only recently been noted in popular culture as major breakthroughs. A matrix was created to evaluate the potential for each innovation to impact travel behavior and locational choice and the potential for capturing these impacts in SCAG modeling processes.

LITERATURE REVIEW

SCAG conducted research into existing academic journals, press articles and findings from recent and ongoing SCAG planning activities to answer the following questions:

- How may the mobility innovation impact travel behavior?
- Can these travel behavior impacts be captured by SCAG models?
- What other impacts will the innovation have on SCAG's modeling work and/or other analysis platforms? Is there a need for additional data?
- What are the cost impacts of the innovation considering both the public and private sector?
- Should this innovation or set of innovations be further analyzed for potential modeling and inclusion in the 2016 RTP/SCS?

SCREENING CRITERIA

SCAG used the questions on travel behavior impacts, modeling, data availability and cost to develop a descriptive narrative and make a preliminary conclusion about whether the innovation should be considered for inclusion in the list of Plan strategies. The narratives are meant to provide information on the availability of data and the ability of the innovation to be modeled within existing SCAG modeling parameters. Modeling staff also provided insight into the types of assumptions that could be modified in the transportation model, which assisted in the screening process.

CATALOG OF INNOVATIONS & APPLICATIONS

This section summarizes SCAG's findings regarding specific groups of technologies. This catalog is not intended to encompass all the ways that technology is incorporated into the 20 RTP/SCS.

ACTIVE TRANSPORTATION INNOVATIONS

Expanding motor vehicle capacity (both on our roadways and our parking) in our increasingly populated areas continues to become more expensive. Planning for biking and walking, as well improving transit access, can slow the need for increasing motor vehicle capacity. Growth in active transportation can be fueled by enabling technological innovations such as bike share, first/last mile strategies, complete streets and safe routes to school.

Bike share

Technology-enabled bike share uses advanced technology to help with bicycle reservation/drop-off, membership, payment management and information tracking. This innovation does have potential to impact travel behavior by increasing bicycle mode share rates for short trips as people use the more readily available bicycle option and shift away from transit or driving their car, or forgoing the trip altogether.

Some programs have reported a notable mode shift after the introduction of bike share. For example, a Washington DC survey showed that 16 percent of bike share trips would have otherwise been made by car. In Washington D.C., bike share is treated as an integral part of a transit system, not as an added bicycle "amenity." Bike share may lead to changes in overall travel behavior, as bike share commuters may be more likely to use the system or their own bikes to replace other local trips and to choose to live in denser areas where more amenities are within walking and biking distance.

First/Last Mile Strategies

These strategies examine treating a certain radius around transit stations, much like transit stations themselves, with planning for how people can more easily walk or bike to the transit stations. Smartphone applications, kiosks, bike share/bike-parking, wayfinding signage and physical improvements to sidewalks/surrounding areas are all geared integrating the local area with the transit station, making it easier and less stressful to walk to a transit station. In the SCAG region, OCTA, Metro and SANBAG have all completed first/last mile studies.

Modeling for first/last mile investments at the regional level will require additional research to determine the possible system-wide impacts. Initial calculations by Metro as part of their First/Last Mile Strategic Plan indicate that first/last mile improvements could increase ridership in the station areas studied by 1 percent to 4 percent. Similarly, BART in the San Francisco Bay area has recently released a tool for calculating impacts with a goal of doubling access to their station by bicycles.

Electric Bicycles

Electric Assist Bicycles (eBikes) have been available for a number of years as aftermarket modifications to manually powered bicycles, but they have not been very popular due to the cost and the extensive weight that the battery pack adds when in manual operation. Over the past five years, bicycle manufacturers have entered the marketplace and new electric assist engines have been developed with lower weight, better frame placement and a more natural feel. In addition, the prices of eBikes have come down to the same range as high-end road and mountain bikes. Regionally, eBike distributors have reported increased sales to baby boomers, in areas with well-connected off-road pathways. eBikes have the potential to increase the mode split for bicycling trips by extending the comfortable range for commuters, increasing bike trips among less physically fit populations and increasing trips in areas with challenging topography. The combination of electric assist motors with affordable cargo bike designs, opens up biking as an option for more shopping trips and chauffeuring younger children to school.

Other Active Transportation Strategies

Common applications like Google Maps are becoming more useful in determining bikeways and bike friendly streets, making it easier for bicyclists to navigate more than short distances or to connect to transit. Similar smart phone applications can also provide information on transit routes and times, promoting walking to transit.

ALTERNATIVE FUEL VEHICLES (PASSENGER)

Alternative Fuel Vehicles (AFVs) include automobiles and light-duty trucks with engines that can be primarily powered by energy sources other than petroleum gasoline. Alternative powertrain technologies that are the main focus of regional efforts include natural gas, electricity and hydrogen. Compressed natural gas (CNG) and liquefied natural gas (LNG) vehicles are primarily in service in public and private fleets. Most retail consumer vehicle manufacturers are focusing efforts on Plug-in Electric Vehicles (PEVs) and Hydrogen fuel cell (H_2) vehicles. PEVs include both battery electrics such as the Nissan Leaf and Tesla Model S and plug-in hybrid electrics such as the Chevy Volt, Ford Fusion Energi and Toyota Plug-in Prius.

Although battery electrics have limited range, extensive data from the California Alternative Fuel Vehicle Rebate Program demonstrates that owners quickly adapt to taking advantage of frequent recharging opportunities. In addition, many households report that the battery electric was purchased as a second vehicle and often becomes the preferred vehicle for many trips. Planning and incentive efforts are currently focused on increasing workplace and multifamily housing charging opportunities. With the increasing preference for plug-in hybrid vehicles, this innovation will not result in lower VMT, but rather in a transfer of greenhouse gas emitting gasoline VMT for lower greenhouse gas emitting electric VMT (eVMT).

AUTOMATED/CONNECTED VEHICLES

Automated / Connected Vehicle (ACV) technologies cover a range of enabling advancements that allow vehicles to operate without driver input and coordinate with other vehicles to achieve improvements in safety and throughput. The ACV term covers on-board sensing capabilities, data integration and vehicle to vehicle (V2V) communication. ACV covers two distinct innovation paths: autonomous operation, in which vehicles rely on on-board sensing to operate without any driver input, and connected vehicle operation, in which vehicles communicate with each other and roadways. However, these two paths are being developed simultaneously and need to be integrated to achieve the full benefits promised by researchers in terms of safety and congestion reduction. Vehicle to Infrastructure (V2I) communication is another aspect that is covered below under the ITS–Roadway section.

Due to the uncertainty regarding deployment timelines and the operational characteristics of ACVs, initial research shows inconsistent impacts on travel behavior and locational choice. Conservative traffic simulations show that in the initial phases, ACVs may increase congestion, especially if safety features are mandated at the expense of system operational efficiency. In addition, if an incremental approach is taken by automakers, the result may be higher VMT as automated vehicles allow people to productively use their commute time. On the other hand, if fully autonomous vehicles change the vehicle ownership paradigm, they may facilitate more on-demand transportation services.

CARPOOLING/VANPOOLING

Smartphone-based and social networking-based carpooling platforms are designed to help users find other commuters in their area more easily. In addition, both Uber and Lyft, transportation network companies (TNCs) described below have introduced features to make their systems more available for enhanced carpooling vanpooling. This section deals with new innovative platforms for forming and joining carpools and vanpools. Carpooling and vanpooling have generally been commute-trip focused. A better understanding of the existing data and further research is needed to better understand how many trips were simply adding a passenger to a trip that would have already taken place, hence inducing travel, or were actually taking a vehicle off the road.

CAR SHARE (ROUNDTRIP AND ONE-WAY)

Roundtrip car share is best known in the U.S. as membership-based programs in which 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. Zipcar, recently acquired by Avis, is one of the more popular roundtrip platforms. One-way car share allows members to take a vehicle and leave it at a different station, or anywhere within the allowed boundaries (roughly city boundaries). Zipcar recently added one-way service and has expanded service at transit stations in partnership with LACMTA (METRO).

The most often quoted analysis of car share's impact showed that 9 to 13 vehicles are taken off the road for each car sharing vehicle. As with bike share, initial research suggests that car share users may become more selective with their own automobile usage. However, this may be a result of initial users being more inclined to choose non-automobile options in the first place and this observation is limited to car sharing implementations in dense urban areas.

ECO-DRIVING: DRIVING FEEDBACK ADVICE TOOLS

Driving-feedback advice tools are in-vehicle information systems (IVIS) that can either be integrated as part of the vehicle, or found in an ancillary device, such as a smart phone. They analyze drivers' behaviors such as accelerating and breaking and provide feedback on the level of efficiency. This way, drivers can train themselves to drive in a style that saves energy and fuel.

There is consensus among researchers that modified driving behavior can lead to vehicle fuel savings of around 10 percent per driver. However, such a reduction in fuel use is contingent on ideal road conditions, especially the lack of congestion. Also, eco-driving has no effect on VMT and the recommended slow accelerations may worsen congestion. Additionally, several studies and programs reveal that technology alone cannot lead to significant fuel savings. Public education, regulatory actions, economic and policy incentives and social marketing are additional factors necessary to make a significant difference.

GOODS MOVEMENT INNOVATIONS

Alternative Fuel Vehicles (Goods Movement)

Currently, several alternative fuels for goods movement are being considered mostly in their ability to reduce certain pollutants (especially nitrogen oxides and particulate matter associated with diesel fuel use) from tailpipe emissions. Zero Tailpipe Emission trucks include Hybrid Electric, Battery Electric and Fuel Cell trucks. Where applicable, these trucks may be charged through wayside power systems. These systems provide a source of power as a vehicle travels on a corridor equipped with wayside power infrastructure. Often the vehicle must be equipped with a receptor technology. The Southern California Zero-Emissions Truck Collaborative is currently demonstrating a one-mile wayside power system in the City of Carson, similar to the near-term demonstration project described in the 2012 RTP/SCS. Natural Gas is considered to be a Near-Zero Tailpipe Emissions fuel.

The impact of this group of technologies is primarily limited to the types of fuels used by trucks. As such, it is anticipated that the technologies would allow business practices to remain consistent and therefore would not be likely to impact VMT or travel behavior. However, emissions would decrease.

Goods Movement Vehicle Automation

These technologies are intended to reduce truck headways and increase truck flow rates and could also lower crash rates. Currently three distinctive stages in the development of this technology are identified: Stage 1: Adaptive Cruise Control, Stage 2: Multi-Truck Communication and Stage 3: Truck Automation with Corridor-Wide Optimization. This technology would be likely to increase truck VMT, mostly as a result of improved corridor utilization and operational efficiency gains. At this point, however, it is uncertain whether the technology induces the growth in truck VMT, or the increase in truck volumes is a result of accommodating the growth in more efficient manner.

Other Goods Movement Innovations

In addition to vehicle-based technologies that would likely impact the regional truck VMT, truck facility utilization and regional truck emission, there are other technologies that are anticipated to impact the development of the 2016 RTP/SCS and beyond.

Trucking companies that provide port drayage service and port container terminal operators have been examining ways to optimize drayage route options and appointment-based terminal container pick-up systems to increase efficiency in overall drayage industry. Various routing software are currently in development. There have been several attempts at port terminals to implement appointment systems with constant improvements being implemented.

Increased warehouse automation rates and improvements in drayage operations are both expected to improve operational efficiency such that increased number of trucks may be accommodated on the regional transportation system. Drayage route optimization and port terminal appointment-based pick-up systems are expected to improve traveler safety, reduce truck-involved incidents, fuel consumption and truck emissions.

INTELLIGENT PARKING

Intelligent parking is primarily focused on providing parking guidance to assist travelers in finding open parking spots. Automated parking systems increase parking supply on surface level streets and within structures by minimizing spaces needed for each individual parking spot.

Intelligent parking can reduce travel time, VMT and emissions by helping drivers find available parking spots quickly, while potentially improving safety at the local street level. To effectively manage available parking supply, this strategy is dependent on pricing. Pricing and advance information about parking availability may encourage mode shift as drivers may determine the price to be too high or learn in advance the challenge in finding available parking. Conversely, knowledge of potential parking opportunities may encourage additional trips due to the likelihood of successfully finding parking at an acceptable price.

Automated parking can improve the efficiency of a parking structure by increasing the real-time capacity versus a conventional parking structure. Increasing parking supply alone would likely result in an increase in personal vehicles trips. However, automating parking can act as a foil to increasing supply through efficient turnover in high parking demand areas—potentially freeing space for other uses. Automated parking systems can be implemented together with parking guidance information and pricing to minimize negative externalities associated with increasing parking supply.

INTELLIGENT TRANSPORTATION SYSTEMS (ITS)

Intelligent Transportation Systems (ITS) encompass a variety of different technology based systems that fall into two broad categories: intelligent infrastructure systems and intelligent vehicle systems. SCAG currently maintains the Southern California Regional ITS Architecture, to ensure that ITS systems are able to communicate with each other and ensure eligibility for federal funding.

Intelligent Transportation Systems make use of advanced detection, communications and computing technology to improve the safety and efficiency of the multi-modal surface transportation network. ITS is a program of technology applications and integration that allows system operators and users to better manage and optimize the use of system capacity. It allows for the use of information technologies to collect data about the performance of the system, and integrates that data in ways that affect and improve the efficiency of the system. ITS strategies have been demonstrated to improve safety, reduce congestion and improve travel times and result in much higher benefit-to-cost ratios than traditional capacity improvements. The 2016 RTP/SCS sets forth a regional strategy of travel system management (TSM), a multi-pronged approach to address congestion that includes ITS as a key element of transportation management systems and strategies such as active traffic management, incident management and traveler information systems.

ITS-Roadways

Roadway ITS covers a broad range of technological innovations that have been in deployment for the past 20 years. These include basic features like signal timing, ramp metering, variable message signs and other means for electronically controlling and communicating traffic conditions. Dynamic ITS innovations allow these technologies to be centrally controlled and to respond automatically to changing conditions such as collisions and other incidents. Innovations being currently deployed such as integrated corridor management (ICM), involve programs that allow for dynamic inter-agency coordination among Caltrans, cities and transit operators to actively manage a transportation corridor as an integrated asset to improve travel time reliability and predictability, help manage congestion and empower travelers through better information and more travel choices.

Roadway ITS have already achieved measurable gains in reducing congestion on local arterials and regional highways. The next generation of ITS innovation involves vehicle to infrastructure (V2I) communication that will allow signals to send information directly to vehicles to improve traffic flow, reduce congestion and avoid collisions. In 2014, US DOT announced a rule-making process to mandate V2I communications features in all new vehicles.

ITS-Transit

Transit agencies have employed a number of different technologies to supplement or enhance the transportation services they offer to the public. For instance, Computer Aided Dispatch Automatic Vehicle Location (CAD/AVL) is the package of ITS Applications that has the most potential to impact how transit agencies monitor and control their operations. AVL consists of a GPS unit that tracks vehicles, integrating their locations with GIS systems for display and analysis purposes. This auto-location technology provides the data that are used for almost all location-based transit ITS applications. AVL shows promise for emergency response, better timing transfers, transit signal priority and real-time passenger information systems. Other applications include transit signal priority, predictive arrival systems and maintenance management systems.

The existing literature does not suggest great potential for travel behavior changes. While AVL potentially affects transit vehicle speeds, transit vehicle speeds are not currently captured in SCAG modeling. However, these applications can reduce travel time uncertainty for passengers and can be used a cost containment strategy for transit providers

NEIGHBORHOOD ELECTRIC VEHICLES

Neighborhood Electric Vehicle (NEV) is a federally designated class of roadway passenger vehicle usually designed to have a top speed of 25 miles per hour that can be operated on any public roadway with a posted speed limit less than 45 mph. NEVs must meet enhanced safety regulations and operators must be licensed and insured. While most local trips in the SCAG region are well within the operating range of NEVs, full sized automobiles typically fill this role. To date, NEVs have become popular primarily in retirement communities and areas with large populations of senior citizens. Because NEVs are restricted from operating on wider higher speed arterials, many areas would need to plan for ways to connect isolated islands of NEV usage.

South Bay Cities COG conducted an extensive pilot of NEVs and found that many of the pilot households replaced more auto trips with an NEV than anticipated. They also found that the key barriers to more robust NEV penetration are the price and quality of commercially available NEVs. NEVs are priced in the $10,000 to $15,000 range and most household reported that they would have to be in the $5,000-$8,000 range to be considered as a third vehicle. Coachella Valley COG has made NEVs a cornerstone of their mobility strategy, including their CV Link NEV/Active Transportation Corridor.

OPEN TRANSIT DATA

Open data practices are growing rapidly among the largest transit systems. Researchers found that in 2010, about 85 percent of transit passenger miles were on systems with open data, and 49 of the 50 largest providers of passenger miles are supplying open data feeds. At this point, there is very little empirical evidence for the role of transit data in increasing transit ridership. A University of Washington stated preference study found that riders reported making 10-15 percent more trips, but real time passenger information systems have proven difficult to assess via stated preference methods. Academic research has concluded that there is no observed evidence yet that real-time data leads to major increases in ridership, or "market penetration". An enormous variety of third party applications use open transit feeds to push schedule data to passengers' computers or mobile phones. Map applications have been especially popular; Google maps have been the most expansive and successful. In the SCAG region, more than 30 transit providers provide open data to Google via an open feed. There is no feasible way to model data transmission in a travel demand model.

ROADWAY PRICING

Roadway pricing refers to a user fee for use of a roadway. Although forms of roadway pricing have been employed since the first roads were built in the U.S., incremental innovations in roadway pricing are considered herein. Innovations can facilitate dynamically setting pricing levels based on congestion levels, time of day, location, facility type, type of vehicle, number of occupants, or other factors. SCAG has considered various pricing strategies including express lanes, smart parking pricing and mileage-based user fees. Roadway pricing strategies included in the 2012 RTP/SCS, including express lanes and mileage-based user fees, are assumed to continue in the 2016 RTP/SCS.

User Fee

Roadway pricing has been a part of Southern California's transportation system for nearly three decades, and numerous expansion efforts are underway regionally. Aside from the generation of sustainable transportation revenues, proponents of road pricing cite the user fee's potential to reduce wasted time, fuel and emissions associated with traffic congestion. SCAG recommends continued commitment to research, development and deployment of a mileage-based user fee system to replace the gas tax. Impacts associated with roadway pricing have been incorporated in SCAG's Regional Travel Demand Model from previous RTP development efforts.

High-Occupancy Toll Lanes

Many of the innovations discussed in this appendix are enabling technologies that facilitate new platforms for establishing pricing markets by enabling variable pricing based on location, distance, or time of day. SCAG is already recommending continued commitment to research, development and deployment of a regional express lane network. While innovations may enhance these strategies, it is the pricing itself that is the primary driver of travel and locational impacts. Further, related ongoing efforts and studies build upon the pricing strategies included in the 2012 RTP/SCS, and those findings are incorporated as applicable in the 2016 RTP/SCS.

Pay-as-you-drive insurance

Also called "usage-based insurance" or "green insurance," Pay-as-you-Drive (PAYD) insurance uses technology such as vehicle plug-in devices and smart phones to collect and communicate data on an individual's driving habits, namely number of vehicle miles traveled. The individual's insurer then uses that data to adjust the insurance premium. For low-mileage drivers, PAYD insurance can result in significant savings as drivers switch from thinking of insurance as a fixed cost to a variable cost, also incentivizing less driving. A 2009 pilot study by the North Central Texas COG and Progressive Auto Insurance found that the average participant reduced VMT by 5 percent, amounting to 560 miles per year.

SMARTPHONE TRAVEL AND TRANSIT APPLICATIONS

Smartphone navigation and transit applications with location-aware, real-time transportation information like Waze and NextBus are increasingly popular. However, they are relatively new to the market and few studies look into their effect on travel behavior. While it is currently difficult to model, SCAG will track this innovation as it is so new and information will likely be published within the next couple of years.

From an ITS perspective, the goal for these applications would be to provide real-time multi-modal route optimization. For example, a user could identify their origin, destination and time of day and the system would compare auto, transit and active transportation options and adjust them in response to system wide traffic. Additionally, the system could provide alternatives once en-route to adjust for auto or transit incidents.

TELECOMMUTING

While telecommuting has existed as a transportation option for decades, it is difficult to quantify or model its effects on transportation behaviors and demand. This is largely because there is no universal definition of "telecommuting." Recent studies have shown that telecommuting may actually increase VMT, and there is no direct evidence of telecommuting reducing grenhouse gas emissions. Some studies show that telecommuting may have a "complementary" effect on personal travel, thus incentivizing people to travel further distances when they are off work. Currently, work-at-home and telecommuting are already accounted for in the SCAG Modeling and Transportation Conformity Analysis as VMT reduction strategies since they remove peak travel. It is premature to modify the assumptions used for previous cycles, but it should be noted as a consideration in moving forward.

TRANSIT FLEXIBLE SERVICE

Flexible transit routes are those where vehicles' routes change according to passenger needs to meet their particular origin or destination. Often, routing needs can be communicated to dispatch and to the vehicle operator via telephone, text message, or web based applications. Regardless, the ridership on flexible route services would likely be too low to justify assuming an effect on overall VMT.

RIDESOURCING [OR TRANSPORTATION NETWORK COMPANIES (TNC)]

Ridesourcing is a term coined by academics 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 car sharing and from carpooling. For legal purposes, the California Public Utilities Commission defines the entities, referred to as Transportation Network Companies (TNC) "as companies or organizations, operating in California that provide 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. Lyft, Uber and Sidecar are examples. As TNCs have only provided service for two years and publicly available data are limited, it is too early to tell how they will impact travel behavior. Initial research suggests that households, involved in car sharing maintain fewer per capita vehicles than other households and there is reason to believe that this pattern may extend to households patronizing TNCs. At this point, modeling of TNCs might require SCAG to begin to explicitly model taxi trips. This has not been done in the past because it represents a small share of regional travel.

INNOVATIONS RECOMMENDED FOR FURTHER ANALYSIS

The following section identifies packages of innovations from the extensive catalog above that SCAG determined would be relevant to planning work. The catalogue above covers a wide range of innovations and SCAG considered numerous ways of evaluating them. Some of these innovations are already being deployed, while others are still in planning stages. Some of these innovations will have wide applicability across the entire region, while others will only be feasible in denser more urban areas. Additionally, some of the innovations will become available to residents regardless of public policy decisions; some will be more or less feasible depending on supportive policy and land use; and still others are only feasible with coordinated public agency action. As noted earlier, SCAG evaluated the impact of the innovation on travel behavior, impact on SCAG policy goals and the feasibility of analysis through existing SCAG modeling.

In order to determine how SCAG could continue to monitor and evaluate the implementation of transportation innovations in the region and consider how to include them in RTP/SCS development, SCAG grouped the aforementioned technological innovations into the following categories:

- **Included in 2016 RTP/SCS scenarios:** Innovations in this category will likely result in a change in travel behavior or locational choices. These changes show potential for a quantifiable change in congestion, greenhouse gas emissions, collisions, or other harmful impacts from changes in per-capita VMT or another performance metric that SCAG is monitoring. Finally, there is a potential source of data that can be either measured or derived, which enables a form of modeling.
- **Included Supportive Policy Language:** These innovations demonstrate an arguable change in travel behavior or locational choices. However, any changes in greenhouse gas or VMT are inconsistent or theoretical, due to uncertainty regarding implementation or market forces. Available data is likely from small sample sizes, pilot programs, or limited in geographic or socio-economic applicability.

INCLUDED IN 2016 RTP/SCS SCENARIOS

The innovations included in this category are already being deployed or are on the verge of deployment. In some cases, they are already being captured in modeling efforts either in the aggregate or as input assumptions.

Alternative Fuel Vehicles

Other Metropolitan Planning Organizations (MPOs) in California are investigating methods for relating growth in PEV penetration to reductions in greenhouse gas emissions. The focus here is on the potential increases in lower (greenhouse gases and criteria pollutant) emission vehicles as a percentage of overall fleets that could be achieved from specific RTP/SCS actions, which could be achieved over and above those resulting from CAFE and Pavley 2. MPOs now have access to sufficient data to justify conducting an off-model analysis that quantifies conversion of VMT to eVMT, based on increasing the percentage of miles that PHEVs are powered by their electric engines.

Bike share

After attempts at individual city-by-city deployments, Metro is investigating opportunities to develop a county-wide bike share program for individual cities to partner with. Due to the extensive deployments in North America, operational and usage data is increasingly available. Bike share trips can potentially be modeled either as bike trips or as transit trips, as the system may provide a first/last mile solution and should contribute to reductions in VMT. Questions will remain as to the geographic extent of the system deployment until planned systems for Santa Monica, Long Beach and Los Angeles are deployed in 2016.

Car share (Roundtrip and One-Way)

Although there have been deployments of car share in the region, the results have been negligible because operations have been limited to university campuses and select urban locations. More data is required to determine whether the systems result in one-to-one replacement of VMT, or whether its use results in the theoretical reductions in overall vehicle ownership and usage described by existing academic research. This data will determine how the innovation impacts travel behavior and how these changes should be incorporated into modeling processes. Initial studies point to a reduction in vehicle ownership, but this may or may not account for changes in household travel behavior.

First /Last Mile Strategies

First/last mile strategies focus on increasing the accessibility to high quality transit stations. Deploying a range of strategies–from sidewalk repair, bike share and wayfinding–in coordination with social media, smartphone applications and coordinated land-use, can increase the number of pedestrians and bicyclists accessing transit. Modeling would involve increasing the number of linked bike or walk to transit trips based upon the implementation of these strategies.

Neighborhood Electric Vehicles

Several studies conclude that NEVs are a viable option to reduce greenhouse gas emissions when used to replace short gasoline-powered vehicle trips. Depending on regional factors, NEVs can reduce carbon dioxide (CO_2) emissions per mile by 50 percent to 88 percent when compared to gasoline-powered emissions. The potential for adoption is promising, as demonstration studies have shown that NEV mode share fulfilled an average 46 percent of all round trips. However, because of NEV speed limitations–56 kilometers per hour (35 miles per hour)–many areas would need to plan for ways to connect isolated islands of NEV usage. In addition, the business case for NEVs is challenging as the price point is currently too high for mass appeal.

Ridesourcing [or Transportation Network Companies (TNC)]

TNCs are predominantly operating in more urban areas, therefore the impact will only be applicable in certain parts of the region. Data regarding their use and associated travel behavior are very limited at this point. However, initial observations suggest they operate similarly to taxi services. Initial optimism regarding the disruptive nature of the booking systems is being replaced by a realization of the necessity of regulation which may bring operations and pricing in line with traditional taxi companies. From the perspective of treating ridesourcing as a transportation mode, it is yet to be determined whether these trips replace automobile trips or transit trips, or whether they are treated as occasional trips. As more ridesourcing trip data becomes available over time, SCAG will incorporate reliable assumptions about average trip length, average deadhead length and possibly ridesourcing impacts on vehicle ownership rates into the travel demand modeling process.

ITS Roadway

Roadway ITS features are currently monitored and are input into the transportation demand model as a basic assumption regarding increased throughput and reduced impacts of system incidents. Current innovations being deployed include comprehensive inter-agency corridor management programs, dynamic signal timing and demand responsive traffic management. SCAG supports the advancement of these and other system management strategies in the 2016 RTP/SCS. New innovations that have not been analyzed and incorporated include vehicle to vehicle (V2V) and V2I communications. These features are included in the category Connected/Automated Vehicles below. The US DOT has announced a rule-making process to require safety related communications equipment on vehicles. These features could have an additional impact on incident reduction on arterials as well as separated roadways. They may improve overall throughput by improving corridor average speed.

Telecommuting and Work-at-Home:

Previous RTPs and the past 2012 RTP/SCS have incorporated telecommuting and work-at-home into regional planning assumptions. Telecommuting and work-at-home options appear to be growing as they provide more flexible workflow and travel options. SCAG continues to support this TDM strategy and uses the modeling assumptions that have already been vetted.

INCLUDED SUPPORTIVE POLICY LANGUAGE

Some of the innovations and applications included in this category are already being deployed or are on the verge of deployment. Data is limited, however, and often based on small sample sizes collected and analyzed in academic studies. Based on the data there is a limited understanding of the impacts, and SCAG does not have the tools to quantify these innovations. SCAG will continue to do more research on this topic, but it is too early in the development cycle to identify solid impacts. Put simply, the technologies in this category make travel in the region "smarter" and directly help people get around. These innovations are established enough that they are addressed in the Plan narrative, and thought has been given to determining a path forward for data collection and post-2016 modeling approaches.

Connected / Automated Vehicles

Although full automation is projected to take up to 30 years to permeate the regional vehicle fleet, partially automated features such as adaptive cruise control, automated lane centering and collision avoidance have been available on higher-end luxury vehicles since 2013. Model year 2016 vehicles are available with fully automated highway driving modes. However, the automakers require the vehicle operator to monitor operation and assume liability for any abuse of the vehicle's capabilities. A small number of MPOs across the country are making investigative modeling assumptions based on the theoretical changes in travel behavior. Current research indicates that incremental advancements can be captured by activity-based demand models by assuming conservative changes to the perceived cost of travel time and the capacity of the system. Sketch model runs conducted by the Puget Sound Regional Council, the MPO for the Seattle region, indicate that if the innovation deploys as a series of sustaining innovations introduced by automakers, the result is likely to be increased VMT on the order of 3 percent to 5 percent between 2015 and 2050. If, as some technologists theorize, full automation is introduced on a disruptive platform in more dense environments, the results are more uncertain.

ITS for Transit/Open Transit Data:

Public transportation providers in the SCAG Region have historically been at the forefront of adopting ITS applications to streamline operations and enhance passengers' experiences. Ventura County's interoperable smart fare media and Los Angeles County's predictive arrival and transit signal priority applications were groundbreaking when they were implemented. While research shows that these applications may do very little to alter travel behavior, they can be an operations and maintenance cost containment strategy, or a way of reducing travel time uncertainty for passengers.

SCAG can assist the region's providers in staying at the forefront by assisting in the transition from closed data systems to open data systems. To do this, SCAG can:

- Promote interoperable data standards such as General Transit Feed Specification (GTFS), and work with county transportation commissions and providers of public transportation to make existing system level data. This includes Metro's Trip Master Database, which is compatible with GTFS or other standards.
- Ameliorate the very real safety, security and legal concerns that transit providers have with the provision of open data by monitoring ongoing dialogues at the US DOT's Joint Program Office on ITS and sharing results with providers via the Regional Transit Technical Advisory Committee.
- Partnering with operators to explore the financial and operational impacts of implementing ITS applications.

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SOUTHERN CALIFORNIA
ASSOCIATION of GOVERNMENTS

MAIN OFFICE

818 West 7th Street, 12th Floor
Los Angeles, CA 90017
(213) 236-1800

www.scag.ca.gov

REGIONAL OFFICES

Imperial County
1405 North Imperial Avenue, Suite 1
El Centro, CA 92243
Phone: (760) 353-7800
Fax: (760) 353-1877

Orange County
OCTA Building
600 South Main Street, Suite 906
Orange, CA 92868
Phone: (714) 542-3687
Fax: (714) 560-5089

Riverside County
3403 10th Street, Suite 805
Riverside, CA 92501
Phone: (951) 784-1513
Fax: (951) 784-3925

San Bernardino County
Santa Fe Depot
1170 West 3rd Street, Suite 140
San Bernardino, CA 92410
Phone: (909) 806-3556
Fax: (909) 806-3572

Ventura County
950 County Square Drive, Suite 101
Ventura, CA 93003
Phone: (805) 642-2800
Fax: (805) 642-2260

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APPENDIX

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