

EMERGING TRENDS

EMERGING TECHNOLOGY

SOUTHERN CALIFORNIA ASSOCIATION OF GOVERNMENTS



TECHNICAL REPORT

ADOPTED ON SEPTEMBER 3, 2020

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TECHNICAL REPORT

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Emerging Technology

EXECUTIVE SUMMARY

The purpose of this technical report is to provide an overview of how SCAG researches a wide range of recent and emerging technologies associated, primarily, with light-duty vehicles that could potentially impact travel behavior and location choices in the region over the next 25 years. However, there are also references to emerging technology within the active transportation, goods movement and transit technical reports. For the purpose of this report the term “emerging technology” refers to a wide range of mobility related products and services either currently available to consumers, or projected to be available within the next ten years.

By providing more options for local and regional trips, emerging technologies may shift trips to less environmentally damaging modes, minimize 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 technology development and adoption of a wide range of public and private sector innovations.

SCAG considers three focus areas for research and policy development regarding emerging technology in the region:

1. What kinds of emerging technologies are in development and implementation?
2. What kind of data can be collected and how can advancements be modeled?

3. What kinds of policies should be recommended at the regional and local levels to ensure positive outcomes from these technologies?

The following report will describe how SCAG applies these focus areas in further detail. Subsequently, this report will identify how these three focus areas are applied to specific emerging technologies that impact travel choices, travel behavior and location choices. The following is a list of the technologies that are described in terms of existing conditions and policy recommendations.

EXISTING & NEAR-TERM EMERGING TECHNOLOGIES

- Alternative Fuel Vehicles
- Carshare
- Bike Share/Micro-mobility
- Neighborhood Electric Vehicles
- Smart Parking
- Transportation Network Companies
- Transit/TNC partnerships
- Microtransit
- Mobility as a Service (MaaS)
- Advanced Intelligent Transportation Systems (ITS) – Connected Vehicles
- Goods Movement Technologies

MEDIUM TO LONG TERM TECHNOLOGIES

- Connected/Automated Vehicles
- Hyperloop
- Vertical Take Off and Landing

This technical report provides an overview of emerging technologies in sections I and II. Section III follows with an examination of the policy areas impacted by emerging technologies and the challenges and opportunities SCAG faces in planning for them. In section IV the report will cite the regulatory framework for SCAG's approach to modeling selected emerging technologies. In section V the report will document the off-model analysis conducted on selected emerging

technologies to determine the vehicle miles traveled and greenhouse gas (GHG) reduction benefits of their deployment. Section VI will present existing conditions in the region for each of the emerging technologies identified in the introduction. Section VII will document recommended strategies to maximize the benefits and mitigate the negative outcomes from the list of emerging technologies. Sections VIII and IX will conclude the report with next steps and concluding observations.

INTRODUCTION

Emerging technology in transportation and mobility themes are threaded throughout Connect SoCal and numerous associated technical reports. The purpose of this technical report is to provide an overview of how SCAG analyzed a wide range of recent and emerging technologies principally associated with transportation that could potentially impact travel behavior and location choices in the region over the next 25 years. There are also references to emerging technology within the goods movement and transit industries. For the purpose of this report the term “emerging technology” refers to a wide range of mobility related products and services either currently available to consumers, or projected to be available within the next ten years.

SCAG recognizes that many of these new technologies provide consumer solutions and have made quantum leaps in public acceptance due to advancements in smartphones, mobile banking, navigational apps and social networking. Improvements in regional mobility will therefore be derived from how technology is used, rather than from any individual technological development. Moreover, strategies to harness the benefits of emerging technologies to advance Connect SoCal goals should be viewed through the lens of improving health, safety, equity and mobility outcomes for all the region's residents.

FUTURE COMMUNITIES INITIATIVE

Although this technical report is focused on emerging technology with regards to mobility, SCAG understands that “Big Data” and the rapid proliferation of

new technologies, outside of mobility services, are poised to transform and disrupt traditional policy making and planning within our local communities and across the Southern California region as a whole. Through improvements in data collection, analysis and technology, governments have the opportunity to be more efficient, innovative and transparent. To ensure that public agencies in Southern California not only keep up with the pace of innovation, but lead the nation, SCAG developed a short-term work plan, the Future Communities Initiative (FCI), proposed by SCAG staff to implement the framework. The FCI is a three year work program designed to facilitate early-actions, in partnership with other regional stakeholders, to implement strategies in the framework. Below is a summary of each element contained in the FCI.

Future Communities Pilot Program (FCPP): SCAG launched a new grant program to support the piloting and assessment of new and smart technologies to reduce transportation demand and improve government service provision. The eight pilot projects are expected to conclude in late 2020 and will identify innovative ways to reduce Vehicle Miles Traveled (VMT), quantify the impacts of technology based VMT reduction strategies, improve efficiency and reduce costs, and promote replicable projects and best practices.

Regional Data Platform: SCAG is developing a Regional Data Platform (Platform) to serve as a clearinghouse of public sector demographic, land-use, transportation and public opinion data updated on a transactional basis through bridging applications, data standardization and local-use applications. SCAG's Platform will be initially geared to assist jurisdictions with the establishment of local General Plans; there will be an emphasis on reducing the cost of administering plan updates, highlighting regional best practices from a sustainability perspective, and facilitating data-driven collaboration amongst public agencies and with the general public.

Policy Lab/Tool Builder: The Future Communities Policy Lab/Tool Builder (Lab) is focused on testing and promoting new approaches and partnerships for utilizing data and analytic platforms to improve regional and local planning. Through the Policy Lab/Tool Builder, SCAG aims to illustrate and help member agencies apply new methods for visualizing, dashboarding, and interpreting regional datasets alone or in combination with private, crowdsourced or open

data platforms to understand complex policy issues. This work will also include fostering research opportunities in partnership with regional university and international partners on common issues.

Data Science Fellowship: SCAG is partnering with regional fellowship programs to provide fellows for local agencies to initiate open data programs, conduct data analysis and accelerate the adoption of new technologies.

Future Communities Forum: SCAG will develop or partner on an annual event to showcase research, data tools and lessons learned from regional and international partners related to data and technology.

Advisory Committee: SCAG will develop an Advisory Committee consisting of elected officials and technical/policy experts on the topic to provide ongoing input and governance on Future Cities Initiative activities.

VISION

Emerging technology continues to have the potential to expand transportation choices and equity throughout the region. By providing more options for local and regional trips, emerging technologies may shift trips to less environmentally damaging modes, minimize 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 technology development and adoption of a wide range of public and private sector innovations.

SCAG considers three focus areas for research and policy development regarding emerging technology in the region:

1. What kinds of emerging technologies are in development and implementation?
2. What kind of data can be collected and how can advancements be modeled?
3. What kinds of policies should be recommended at the regional and

local levels to ensure positive outcomes from these technologies?

The following section will describe these focus areas in further detail. Subsequently, this report will identify how these three focus areas are applied to specific emerging technologies that impact travel choices, travel behavior and location choices.

What kinds of emerging technologies are in development and implementation?

Emerging technologies in transportation and mobility are primarily developed and advanced by the private sector, and it is important that public agencies monitor the development of such innovations. Sometimes related products and services progress from theoretical research projects through various stages of development until they are deployed in pilots and demonstration projects. Such is the case with automated vehicles (AVs). In other cases, services can suddenly emerge, as with Transportation Network Companies (TNCs) such as Lyft and Uber, and countless micro-mobility sharing entities. In order to stay informed on emerging technologies as they develop, SCAG regularly communicates with institutions of higher learning, metropolitan planning organizations (MPOs) from around the country, county transportation commissions (CTCs), local jurisdictions, economic development entities and chambers of commerce. In addition to researching emerging technologies SCAG strives to prepare the region and local jurisdictions to play an active role in encouraging companies that produce these products and services. **EXHIBIT 1** is a map provided by the Los Angeles Economic Development Corporation (LAEDC) of emerging technology companies in the SCAG region.

SCAG collaborates with county transportation commissions and local jurisdictions to stay informed about pilot programs and demonstrations that occur within the broader region. Examples include the grant funded Los Angeles Metropolitan Transportation Authority (Metro) Mobility on Demand Sandbox microtransit project, and the GO Monrovia program that subsidizes shared- and non-shared ridehailing within defined geographic boundaries. Another example of inter-agency collaboration is SCAG's participation in the Coalition for Transportation Technology. This coalition was formed by Metro, Caltrans, the County of Los Angeles and LADOT to improve inter-agency communication

regarding advanced Intelligent Transportation Systems (ITS), and connected vehicle and automated vehicle funding opportunities. These, and other pilot projects, will be discussed in further detail in section VI Existing Conditions.

Local universities have conducted significant research concerning emerging technologies. The University of California Los Angeles (UCLA) has a number of research centers that have focused on transportation behavior, Plug-in Electric (PEV) policies, electric charging station engineering and increasingly AV sensing technologies. UC Riverside has a long history of conducting research on the potential environmental benefits of connected vehicle technologies and eco-driving. UC Irvine has been a leading institution in the development of Hydrogen Fuel Cell technology, and planning for associated station siting.

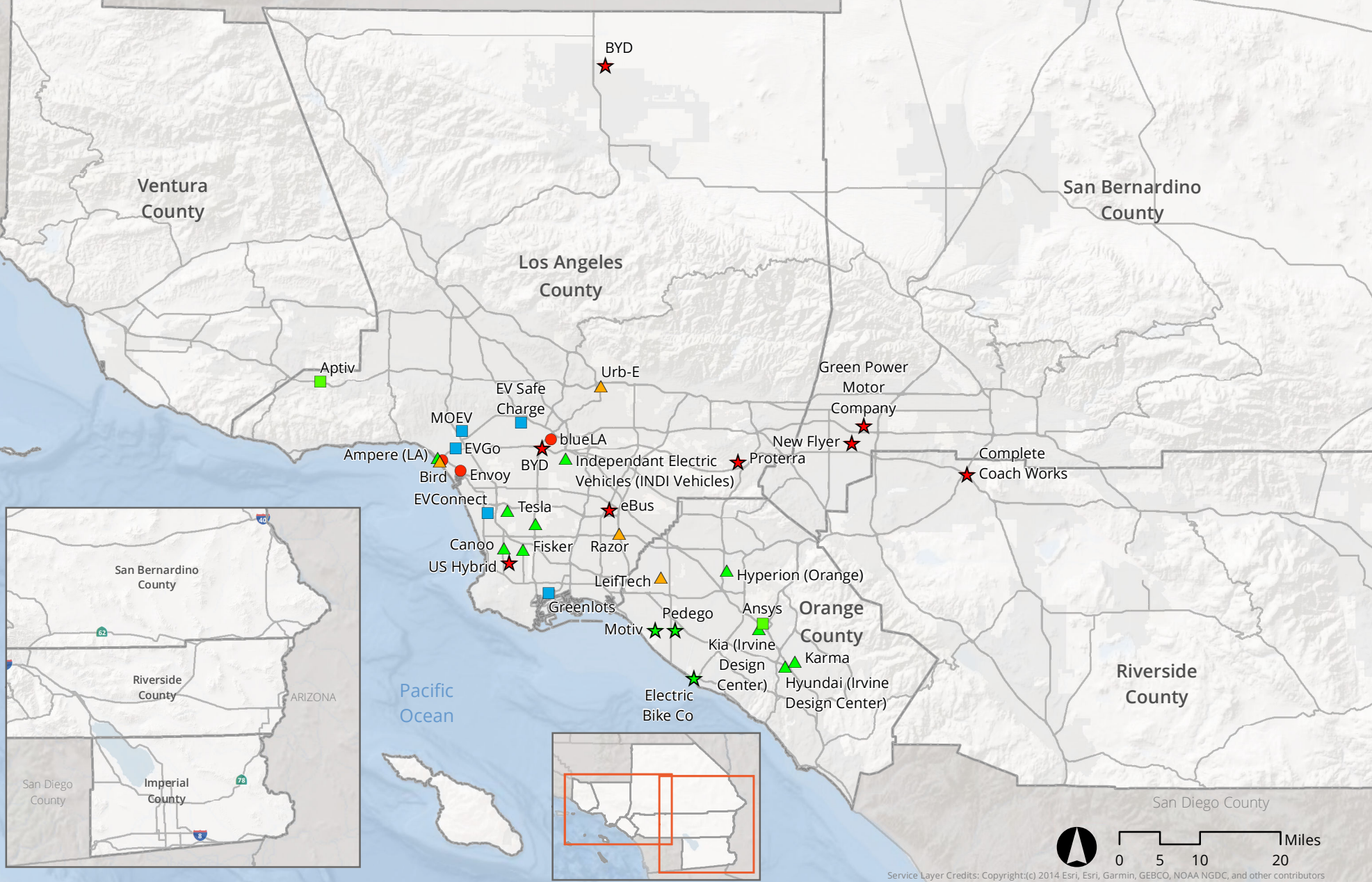
What kind of data can be collected and how can these advancements be modeled?

A limited number of the emerging technologies identified throughout this report have existed for sufficient duration for all travel data to be collected and analyzed. As noted above, the majority of emerging technologies are substantially developed by the private sector. For some emerging technologies, SCAG conducted analyses to determine the impact on vehicle miles traveled and GHG emissions. These include vehicle electrification, carshare, bike share/ micro-mobility, and transit/TNC partnerships. For the purposes of per capita GHG reduction strategies, SCAG translated planning assumptions into analysis parameters. These analyses are referred to as off-model methodologies and are described in greater detail below. As part of these research efforts SCAG formed a partnership with the other three large MPOs in the state called the 4MPO Future Mobility Research Partnership. Through this partnership SCAG has jointly funded various research projects looking at modeling methods and policy development relevant to regional planning.

What kinds of policies should be recommended at the regional and local levels to ensure positive outcomes from these technologies?

SCAG performed analyses on some of these emerging technologies, and therefore recommends policies to increase their benefits and mitigate their challenges. For example, research demonstrates that increased investment in

EXHIBIT 1 Emerging Technology Companies in SCAG Region by Industry



Companies by industry

- Automated Vehicles
- ★ Electric Bikes
- ▲ Electric Vehicles
- Shared Mobility
- EV Charging
- ★ Electric Bus
- ▲ Micromobility

Source: SCAG, 2019

Service Layer Credits: Copyright:(c) 2014 Esri, Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

electric vehicle charging stations increases adoption of electric vehicles, and ensures that plug-in hybrid vehicles then spend more time using electric power than gasoline powered engines. Additionally, robust user surveys show that within urban centers, carshare users will eventually sell a household vehicle, or forego a planned vehicle purchase, and instead adjust their daily trips using transit and active transportation.¹

Furthermore, based on academic research, the direction that some emerging technologies are pointing in regarding travel behavior and vehicle miles traveled is becoming clearer. For example, some public sector planners and academics were originally optimistic that TNC users in urban centers would adopt a car-free or car-lite lifestyle. However, research has indicated that TNC users are not foregoing personal vehicles in the same way that early carshare users had. Instead, they are predominantly using TNCs to supplement evening and weekend trip making.² Other research and sketch modeling indicates that upon broad availability of AVs, vehicle miles travelled will increase if AVs are purchased by individual households.³

Based on the foregoing findings and research, SCAG has identified strategies that can be adopted at the regional and local level to mitigate challenges that are likely to come from the adoption of emerging technologies. These strategies will be discussed at length in section VII Emerging Technology Strategies.

EMERGING TECHNOLOGY GUIDING PRINCIPLES

In order to evaluate emerging technology and innovations more uniformly and objectively, some cities and organizations have begun using “guiding principles” to steer their decisions. These principles encapsulate a city or organization’s values, provide a framework for assessing whether an emerging technology fits within those community values, and determines what types of regulations might be appropriate.

For example, the City and County of San Francisco adopted a policy called “Guiding Principles for Emerging Mobility Services and Technology”⁴ that lays out ten categories by which new transportation technologies will be evaluated, as well as the associated goals of the city. Each emerging technology or innovation can be measured against these goals and evaluated as to whether they would benefit the community, and what kinds of rules should govern them.

In addition to benefitting the communities and municipalities where these technologies are appearing on the streets, guiding principles can benefit the private-sector actors who are developing these technologies. Guiding principles provide a framework for how the private sector may be evaluated in a given jurisdiction. If a company has been given explicit direction about the values of a community, they can try to act in good faith to meet those community standards. SCAG recommends developing a similar set of guiding principles to inform decision-making processes related to new technologies in transportation.

ORGANIZATION OF THE REPORT

This technical report provides an overview of emerging technologies in this section. Section III follows with an examination of the policy areas impacted by emerging technologies and the challenges and opportunities SCAG faces in planning for them. In section IV the report will cite the regulatory framework for SCAG’s approach to modeling selected emerging technologies. In section V the report will document the off-model analyses conducted on selected emerging technologies to determine the vehicle miles traveled and greenhouse gas (GHG) reduction benefits of their deployment. Section VI will present existing conditions in the region for each of the emerging technologies identified in the introduction. Section VII will document recommended strategies to maximize the benefits and mitigate the negative outcomes from the list of emerging technologies. Sections VIII and IX will conclude the report with next steps and concluding observations.

1 Shaheen, S; Mallery, M; Kingsley, K (2012). Personal Vehicle Sharing Services in North America.
2 Schaller, B (2019). In a Reversal, ‘Car-Rich’ Households Are Growing.
3 Fehr and Peers. (2018). How will autonomous vehicles influence the future of travel?

4 San Francisco County Transportation Authority. (2019). Emerging Mobility 10 Guiding Principles.

RANGE OF EMERGING TECHNOLOGIES

EXISTING & NEAR-TERM EMERGING TECHNOLOGIES

ALTERNATIVE FUEL VEHICLES

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 (H2) vehicles. PEVs include both battery electrics and plug-in hybrid electrics. Battery electric PEVs feature electric drive engines powered by electricity stored in battery packs. Plug-in hybrid electric vehicles or PHEVs have gasoline powered engines that produce electricity in addition to their battery packs. As emergency public safety shutdowns (PSPS) of electric power become more common due to increased fire risks, consideration will need to be given to the impact on electric vehicles.

Although battery electrics have limited range, these ranges are being extended by a variety of auto and battery manufacturers, and 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 battery electrics purchased as a second vehicle often become 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).

CARSHARE

Carshare service is available in three varieties in the SCAG region: traditional roundtrip, one way and peer-to-peer carshare. Traditional roundtrip service provides vehicles at designated parking spaces called “pods” or “stations” depending on the provider. Cars must be returned to their pods at the end of the trip. One way vehicles can be picked up then dropped off at another station within the specified service territory. Peer-to-peer carshare is similar to roundtrip service except the vehicles are owned/leased by private individuals and the transaction is managed by a third-party operator, usually via a smart phone app. Potential GHG-reducing benefits associated with carsharing include reduced vehicle ownership rates, single occupancy vehicle trips and VMT, as trips shift to walking, bicycle and public transit due to reduced driving associated with reduced ownership rates. In addition, vehicles used for car sharing are often newer and less polluting, and replace older privately-owned vehicles. For more information on carshare in the region, see the Congestion Management Technical Report.

BIKE SHARE/MICRO-MOBILITY

Bike share and micro-mobility are modes of transport mobility that comprise fleets of bicycles, electric bicycles (e-bikes) and/or electric scooters (e-scooters) that are available for short term rental. There are three types of bike share: services that are comprised of docked bicycles, dockless bicycles or a hybrid. Docked bicycles are checked out from docking stations and must be returned to another docking station. Dockless bikes, which can be left anywhere within a service area that does not impede free and safe circulation, feature remote locking mechanisms - when a user checks out a bike using a smart phone app the wheel is released. A hybrid system features docking stations with self-contained locking mechanisms, and users are encouraged to return bicycles to the stations. However, they may be left locked to street furniture anywhere within the service area for a premium charge. E-Scooters are all operated as dockless systems. At night e-scooters are collected by companies and by individuals who are compensated, and charged in a variety of locations. More information on bike share/micro-mobility can be found in the Active Transportation Technical Report.

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, which can be operated on any public roadway with a posted speed limit of 35 mph or lower. Most NEVs look like golf carts but they 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.

SMART PARKING

Smart parking management techniques include real-time identification of open parking spaces, active wayfinding, adaptive pricing, and consumer facing apps for information and payment of parking. These management techniques pertain to on-street as well as public off-street parking. Private parking is not precluded, but likely is not incentivized to participate.

Parking management strategies aim to reduce GHG emissions by reducing vehicle trips and promoting alternative modes of transportation through methods such as pricing mechanisms, allowable hours of parking, shared parking or parking permits. These strategies can potentially improve and increase turnover rates for parking availability in impacted areas, and reduce parking search time and the associated VMT and GHG emissions.

RIDEHAILING/TRANSPORTATION NETWORK COMPANIES (TNCs)

Transportation Network Companies (TNCs) is the term used by the California Public Utilities Commission to refer to ridehailing companies such as Lyft and Uber. A TNC is a company that matches passengers with vehicles via mobile apps. TNCs exemplify the “sharing economy” because the passenger vehicle

is shared among sequential users. The sharing economy has also come to be referred to as the “gig economy”, because drivers are working on a part time on-demand basis instead of as employees. TNCs often permit ridesharing, also known as pooled trips, among consumers, which has the potential to greatly reduce GHG and VMT.

TRANSIT/TNC PARTNERSHIPS

Partnerships between public transit and TNCs create unique opportunities and challenges as both parties work toward mutually beneficial program models. For example, transit agencies and other public agencies sometimes partner with TNCs to provide service in areas where it is prohibitively difficult or expensive to provide traditional transit service. More information on Transit/TNC partnerships can be found in the Transit Technical Report.

MICROTRANSIT

Microtransit provides a service that resembles traditional transit service, but is different in that predetermined schedules, fixed routes or public operation is optional. Microtransit is typically provided by a small-sized bus or van that either complements traditional transit service or serves a ridership wholly separate from transit. More information on Microtransit can be found in the Transit Technical Report.

MOBILITY AS A SERVICE (MAAS)

MaaS is the concept that all segments of a trip should be planned and paid for simultaneously, regardless of which operator is providing any given segment. Traditionally, each provider (for example, a city bus, commuter rail or bike share) markets and sells its services separately. Increasingly, unified payment systems have made it easier for users to pay for different public transit services with one card or ticket, but non-transit modes are typically not included. MaaS would unify planning and payment for all transportation systems in a given city or on a given trip. For more information see the Transit Technical Report.

ADVANCED ITS

Intelligent Transportation Systems (ITS) and Connected Vehicles are not interchangeable, but have many overlapping elements. ITS is the series of technology systems that work to make our roadways, railways and other thoroughfares safer and more efficient. These can be older technologies like ramp meters, or newer ones like signal communications for large trucks. The latter is an example of Connected Vehicles – vehicles that are in digital communication with the infrastructure and/or the other vehicles around them. While ITS have been in place on our roads for decades, Connected Vehicles have only recently appeared and it is likely that they will eventually be fully automatic in the next few decades. These vehicles could operate as private single or multiple occupancy, public transit, or both. For more information on advanced ITS see the Congestion Management Technical Report.

GOODS MOVEMENT TECHNOLOGIES

The trucking market presents unique challenges due to heavy weights, operational performance requirements and high incremental costs. However, several reduced-emissions trucks are currently commercially available and many zero- and near zero-emission trucks are under development for future deployment.

Three categories of potential near-term improvements are combustion and aerodynamic improvements, trucks using a cleaner fuel such as natural gas, and hybrid-electric trucks. Greater use of renewable natural gas (RNG), natural gas produced from agricultural bi-products and waste, is an example of a fuel source made from the capture and reuse of gas that would otherwise escape into the atmosphere – SoCal Gas has set a target to include 20 percent renewable natural gas in their pipeline by 2025. Hybrid-electric trucks would have partial zero-emission use, combined with a differently fueled engine to extend the range. These near-term modifications would have greater efficiency and/or near zero emissions produced during operation. For more information see the Goods Movement Technical Report.

Goods movement vehicle automation is another area of emerging technology.

These technologies are intended to reduce truck headways (also known as platooning) 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 a more efficient manner. For more information about goods movement in the region, see the Goods Movement and Congestion Management Technical Reports.

MEDIUM TO LONG TERM TECHNOLOGIES

CONNECTED/AUTOMATED VEHICLES

Connected/Automated Vehicle (CAV) 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 CAV term covers on-board sensing capabilities, data integration and vehicle to vehicle (V2V) communication. CAV covers two distinct innovation paths: autonomous operation, where vehicles rely on on-board sensing to operate without any driver input, and connected vehicle operation, where vehicles communicate with each other and roadway infrastructure such as signals. However, these two paths are being developed simultaneously and need to be integrated to achieve the full safety and congestion reduction benefits.

Due to the uncertainty regarding deployment timelines and the operational characteristics of CAVs, initial research shows inconsistent impacts on travel behavior and location choice. Conservative traffic simulations show that in the initial phases CAVs may increase congestion, especially if safety features are prioritized over system operational efficiency. CAVs may increase automobile use by expanding the age profile of driving; providing access to populations who do not currently drive, such as children, the very elderly and the visually

impaired. In addition, if an incremental approach is taken by automakers, the result may be higher VMT as automated vehicles allow people to multitask and productively use their time during the commute. On the other hand, if fully autonomous vehicles change the vehicle ownership paradigm, they may facilitate more on-demand transportation services. For more information about automated and connected vehicles in the region, see the Congestion Management Technical Report.

HYPERLOOP

Hyperloops are trains or other vehicles that theoretically operate at very high speeds in sealed vacuum tubes. While no hyperloops are currently in public operation, several private companies have constructed segments for experimental use. One such company is Tesla's SpaceX in the SCAG region. Stakeholders anticipate that hyperloops will overcome technological and regulatory obstacles and will soon provide exceptionally fast transportation for the public and for goods movement both within cities and between them.

VERTICAL TAKE OFF AND LANDING (VTOL)

Vertical Take Off and Landing (VTOL) devices are aircraft that are capable of, as the name implies, taking off and landing vertically. Concept multi-rotor aircraft are similar in design to modern drones and are in development by major aircraft manufacturers such as Airbus and Boeing. Multi-rotor craft are theoretically easier to operate than helicopters and are seen as a pathway to unmanned aerial vehicles (UAV). Uber is the most prominent company planning on commercial operations of VTOL aircraft. They have announced plans to unveil their Uber Elevate service in Los Angeles in 2023. Uber is currently piloting Uber Elevate service using traditional helicopters in São Paulo, Brazil and New York City.

REGIONAL SIGNIFICANCE

Emerging technology is a topic of intense speculation and interest at the regional planning level. Numerous popular press and academic articles

have advanced the argument that the transportation sector is currently experiencing a period of changing transportation that has not been seen since the first decades of the previous century. Like that period, changes are now predominantly driven by private sector companies. In addition, the companies driving these changes are doing so through disruptive business models, using smart-phone apps to directly broker transactions between service providers and customers and redefining or circumventing traditional employment models.

POLICY AREAS

Emerging Technologies impact the following policy areas:

MOBILITY

Ridehailing, carshare, e-bike and e-scooters provide more choices, including a range of affordable mobility options for all travelers. There are also niche ridehailing companies that serve special markets such as children, health care transportation and concierge service for elderly customers. Integrated multi-modal trip planning and payment apps allow for users to plan and pay for their entire trip regardless of travel mode.

ACCESSIBILITY

Emerging technologies are already delivering on the promise of increased mobility. While redoubling efforts to reduce VMT and GHG emissions remains an essential regional priority, it is important to recognize that ridehailing and on-demand micro-transit improve access for people who are unable or choose not to drive and may not have access to transit, including the young, elderly and disabled. According to one study four percent of TNC riders reported that if they did not have TNC service they would not have taken a particular trip.⁵ When implemented as a first/last mile solution, emerging technologies facilitate

⁵ Henaio, A.(2017) University of Colorado at Denver, Thesis : www.alehenao.com/dissertation

access to transit for those with limited mobility options.

PUBLIC HEALTH/SAFETY

Vehicle electrification, when powered by renewable energy sources, not only reduces regional GHG emissions, but also improves local air quality by reducing nitrogen oxides (NOx) and particulate matter. Bike share and e-Bikes improve public health by increasing physical activity. Additionally, studies show that increasing the number of people riding bikes increases safety by increasing the visibility of cycling.⁶ Ridehailing reduces instances of driving under the influence citations by anywhere from 6.5 percent to 30 percent depending on the locale.^{7,8} Automated and Connected Vehicles will theoretically reduce accidents and fatalities (94 percent of accidents are due to human error⁹). Even current driver assistance features have the potential to reduce collisions and fatalities.

CLIMATE CHANGE

As noted above emerging technologies vary widely when it comes to their effect on VMT, and therefore GHG emissions. Some of these technologies, such as alternative fuel vehicles, micro-mobility, bikesharing and microtransit, have a mitigating influence on GHG emissions. Others, such as ridehailing and automated vehicles, will increase VMT and GHG emissions if their business models continue current travel behavior. Therefore it is vitally important to adopt strategies and policies that ensure shared vehicles, and pooled or shared rides.

CHALLENGES AND OPPORTUNITIES

There are numerous challenges and opportunities that emerging technology

poses for the SCAG region. Some of these challenges are unique to specific modes or new technologies, however, there are many challenges that are shared across the technologies analyzed in this chapter including:

- Uncertain pace of development and deployment
- Challenges obtaining data from the private sector
- Impact of TNCs on transit and active transportation usage
- Lack of permanence in public/private service agreements
- Increase in VMT due to TNCs and vehicle automation
- Finding a balance between regulation and innovation
- Avoiding inequitable, two-tiered access.

On the other hand there are opportunities that emerging technology brings that include:

MOBILITY AS A SERVICE BRINGS MORE CHOICES AND MAKES MULTI-MODAL TRAVEL EASIER

Mobility as a Service, or “MaaS,” is the concept that mobility, like other things we pay for, can be a cohesive service, rather than a series of individual payments to disparate providers. Rather than thinking of a bus ticket and an e-scooter ride as two wholly individual purchases and experiences, MaaS lets us think of them as part of the same trip, and therefore as one combined service. The “service” being the mobility of getting from Point A to Point B on that given trip.

Integral to MaaS is the ability to find, schedule and pay for these trip segments in one action, on one platform. This makes the trip segments more cohesive and transferring more coherent, as well as having the potential to save money for the users.

The main benefit of MaaS on a collective level is its potential to transform the way we use non-SOV (single-occupancy vehicle) travel modes. Many people find trip-chaining daunting and confusing due to the myriad providers, distinct schedules and non-compatible payment systems. For example, if a traveler wants to take a train to a bus to a bike in the SCAG region, they may need to

6 International Transport Forum (2013), Cycling, Health and Safety, ITF Research Reports, OECD Publishing, Paris.
7 Mothers Against Drunk Driving. (2015). New Report from MADD, Uber Reveals Ridesharing Services Important Innovation to Reduce Drunk Driving.
8 Moll Law Group. (2017). Ride-Sharing Impact on Drunk Driving.
9 US Department of Transportation, National Highway Traffic Safety Administration (NHTSA). (2015). Critical Reasons for Crashes Investigated in the National Motor Vehicle Crash Causation Survey.

research two schedules on two different websites, find out where bikes are located on another website and provide three payments, perhaps in three different forms. Many would choose to simply drive instead. MaaS, whether provided by one of the transportation companies/agencies, or a third-party application/platform, would allow the traveler to research, book and pay for all three segments in one place and with one click.

While MaaS has not been thoroughly tested in the United States, it is easy to imagine this increasing ridership on transit and other non-SOV forms of transportation. Denver, Columbus, Ohio and other cities are embarking on MaaS systems this year, and the results in Europe, although preliminary, are promising. In Helsinki, Finland, users were influenced to drive less when using the MaaS mobile application, due to multiple factors that could be replicated in Southern California. For more information on this, see the Public Transportation Technical Report.

THE POTENTIAL FOR DECLINE IN COLLISIONS AND DEATHS FROM CONNECTED AND AUTOMATED FEATURES

As noted previously, 94 percent of crashes are attributed to “driver-related critical reasons”. However this figure can be broken down further, for example, over 25 percent of all traffic collisions were attributed to speeding.¹⁰ In fact, a number of the contributing factors in collisions that are tracked by the National Highway Traffic Safety Administration (NHTSA) are receptive to being addressed by connected and automated features. These include alcohol and drug impairment, speeding, drowsy driving and driving too fast for roadway conditions. As driver assist features are introduced, such as adaptive cruise control and lane keeping assistance, it is expected that collisions and fatalities will go down. Some automakers have already introduced automated driving features, although at this stage they require human monitoring.

¹⁰ Ibid

PUBLIC/PRIVATE TRANSIT PARTNERSHIPS REPLACE LOW-PERFORMING ROUTES.

Many cities and agencies around the country have begun partnering with private transportation providers to develop more efficient and appealing services than some public agencies are able to provide. Some examples of this in the SCAG region include the City of Monrovia partnering with Lyft to provide discounted rides between a light rail station and the city’s central business district, and LA Metro partnering with Via to provide last-mile rides in parts of the eastern San Fernando Valley and San Gabriel Valley.

While these partnerships should never be thought to replace entire public transportation systems in our metropolitan areas, they can complement such services in areas where demand is too low to merit a dedicated transit line, where riders have special mobility needs or where ridership demand is unpredictable. Many agencies and providers struggle to provide “last-mile” services for sparsely populated or geographically disparate areas, and private partners could fill this gap that is a hurdle to many would-be transit riders.

REGULATORY FRAMEWORK

STATUTORY REQUIREMENTS

There are various layers of federal and state regulations that apply to the emerging technologies described in this technical report. Electric vehicles, including PEVs and hydrogen fuel cells, have benefited from extensive incentives at both the federal and state level. The federal government provides up to a \$7,500 tax rebate depending on the type of PEV. California provides up to an additional \$7,000 rebate through the Clean Vehicle Rebate Program (CVRP). Additionally, during his tenure Governor Brown issued two executive orders, B-16-12 and B-48-18 establishing targets for PEV fleet penetration. The former called for 1.5 million PEVs by 2025, and the latter called for five million by 2030. Executive Order B-48-18 also included targets for state government vehicle fleets. In addition to incentives for vehicles, the state legislature passed AB-1236 Local Ordinances: Electric Vehicle Charging Stations, which requires

that local jurisdictions streamline permitting and inspection procedures in order to avoid disincentivizing charging station deployment. Finally, in 2018, the California Air Resources Board (CARB) adopted the Innovative Clean Transit Regulation, which will transition, in phases, to a requirement that 100 percent of new transit bus purchases in 2030 be zero-emissions vehicles.

Another important regulatory framework is the California Public Utilities Commission (CPUC) rulemaking 12-12-011, which governs the operation of TNCs within the state of California. Filed Dec. 20, 2012, this rulemaking proceeding was initiated to avoid a patchwork of municipal regulations of ridehailing providers. The CPUC was determined to be the correct state agency because of its role in regulating chartered limousine services. The CPUC issued Decision 13-09-045 on Sept. 19, 2013 that defined a TNC as an entity “that provides prearranged transportation services for compensation using an online-enabled application (app) or platform to connect passengers with drivers using their personal vehicles.” Additionally the decision established requirements that each TNC obtain a permit, require criminal background checks, implement a driver training program, maintain a zero-tolerance policy on drugs and alcohol, and insurance coverage.

Since 2013 the CPUC has collected detailed travel information from all of the TNCs operating in the state. Two important developments related to this rulemaking are proposed changes to the data collection and reporting, and a proposed decision authorizing automated vehicle passenger but service with required safety drivers. The first development is of particular importance to public transportation planning agencies such as SCAG. SCAG submitted a letter supporting more data sharing on the part of the CPUC so that MPOs in particular can have access to travel patterns relevant to regional planning. The second development indicates the movement that TNCs are making in regards to rolling out automated vehicle services in the state. SCAG will continue to monitor, and when relevant, comment on both aspects of the open rulemaking process.

As noted above, most of the emerging technologies described in previous sections of this report that have been deployed, have principally gained mass adoption within the past decade. While some of these mobility applications

have been piloted previously, it is only within the past ten years with the advent of smart phones that they have become viable consumer services. For this reason, and the fact that many of the technologies have been developed by the private sector, there is limited data on which to base analyses. CARB’s Final Draft Sustainable Communities Strategy Program and Evaluation Guidelines recognizes this and included an Appendix E: Quantifying Greenhouse Gas Emission Reductions from Off-Model Strategies.¹¹ Off-model strategies are defined as “travel demand management and vehicle technology-based GHG emissions reduction strategies that are not included and evaluated within an MPO’s travel demand model.”

¹¹ CARB (2019) Final Draft Sustainable Communities Strategy Program and Evaluation Guidelines Appendices.

ANALYTICAL APPROACH

The following section describes the methods used to analyze the VMT and GHG reducing capabilities of selected emerging technologies. The details of the implementation programs are provided in the section Emerging Technology Strategies below. These analyses are referred to as off-model methodologies because they involve calculations, often in Excel spreadsheets, instead of the SCAG travel demand model. These methodologies are based on data inputs and assumptions that are documented in the following subsections. **TABLE 1** summarizes the GHG emissions reductions achieved through each of the off-model methodologies, which represent various emerging technology implementation programs.

VEHICLE ELECTRIFICATION

EV CHARGING INFRASTRUCTURE

The analytical approach to calculating potential GHG reductions from increasing Electric Vehicle charging is to determine the increased PHEV mileage shifted

TABLE 1 Off-Model GHG Reductions from Emerging Technologies Programs

GHG Reductions	2035
EV Charging Infrastructure	1.2%
EV Incentive Program	0.6%
Bike Share/Micro-mobility	0.3%
Carshare	0.4%
Transit/TNC Partnerships	0.04%
Total	2.54%

Source: SCAG

from gasoline to electricity (e-miles) due to PHEV workplace charging at EV charging connectors installed by the strategy.

The estimate of GHG emissions reductions from increased PHEV e-miles due to the implementation of the strategy can be based upon two different initial approaches of the strategy:

- Set up of the strategy based on the number of EV charging connectors installed:

Estimate the number of PHEVs in region >> Estimate the number of PHEVs per charging connector >> Estimate the number of PHEVs in the region that could use workplace EV Charging Connectors >> Estimate average VMT shift per PHEV from gas to electricity (e-miles) >> Estimate total regional VMT shift from gas to electricity (e-miles) >> Estimate CO2 emission reductions from PHEV e-miles.

- Set up of the strategy based on the number of PHEVs in the region that could use installed EV charging connectors:

Estimate population of PHEVs in region >> Estimate number of PHEVs per charging connector >> Estimate number of EV Charging Connectors to install >> Estimate VMT shift from gas to electricity (e-miles) >> Estimate CO2 emission reductions from PHEV e-miles.”

These approaches are described in more detail in CARB’s Final Draft SCS Program and Evaluation Guidelines Appendices.¹²

EV VEHICLE INCENTIVES

The overall goal of the Electric Vehicle Incentive strategy is to help facilitate the purchase of new PEV’s by offering incentives in the form of rebates to offset the additional cost versus non-PEVs. SCAG has identified an incentive program where rebates could be provided to consumers for the purchase of a new ZEV. The Electric Vehicle Incentive program would be separate from CARB’s Clean Vehicle Rebate Project (CVRP), which is designed to promote the purchase of

¹² Ibid. 78-83.

battery electric, plug-in hybrid electric, and fuel cell electric vehicles through rebates for the purchase or lease eligible vehicles. As of November 2018, the CVRP has over \$23 million in funds remaining.

The overall approach to quantifying reductions from the Electric Vehicle Incentive strategy is to first establish the total funding allocated to the subsidy/rebate program established by the MPO, as well as the amount(s) offered for individual subsidies/rebates. Once these two values have been set, the total number of new ZEV's that may be purchased under the incentive program can then be estimated. Based on the number of vehicles purchased under the incentive program and average trip lengths for the region, total VMT associated with the incentive program can be calculated. Based on the estimated future purchase price of the average EV, SCAG calculated the fraction that purchase covered by the incentive for SCAG region. The MPO may not claim the credit for an EV's lower emissions. Only the fraction of the cost that the MPO provided. Finally the GHG reduction is based on equivalent ZEV VMT and emissions rate.

CARSHARE

For determining GHG emissions reduction from a carshare program SCAG has utilized the methodology laid out in the CARB Final Draft SCS Evaluation Guidelines Appendices.¹³ This methodology works on the premise of identifying different geographies where carshare vehicles will be operating, identifying a number of carshare vehicles within those geographic areas and assigning a participation rate within those respective areas. Or as CARB describes it "Key factors staff considers when quantifying GHG emission reductions from car sharing strategies, are a Population, an Adoption Rate, and VMT."¹⁴ SCAG has used density as a key factor to identify Transportation Analysis Zones (TAZ) in which carshare is expected to attract enough subscribers or users. Within those TAZs, SCAG has utilized an adoption or participation rate to calculate the number of users.

¹³ Ibid. 69-74.

¹⁴ Ibid. 107-108

Once the number of users is determined the methodology calls for estimating VMT reductions based on the number of vehicles that are shed, in other words sold or vehicle purchases that are not made by the carshare users. This factor is provided by CARB and supported by extensive research across the US. In other words GHG emissions reductions are derived based on changes in travel behavior related to changes in vehicle access. Next, the methodology calls for calculating the VMT that users cover in the carshare vehicles. However, these VMT account for lower GHG emissions than the vehicles shed because carshare vehicles tend to be newer, and more fuel efficient than the vehicles owned by the participating population. Then the total change in GHG emissions is determined by subtracting the reduction in GHG emissions due to shed vehicles from the GHG emissions from carsharing trips.

BIKE SHARE/MICRO-MOBILITY

For determining GHG emissions reductions from a bike share/micro-mobility program SCAG has, again, utilized the methodology laid out in the CARB Final Draft SCS Evaluation Guidelines Appendices. This methodology, also, works on the premise of identifying different geographies where micro-mobility devices, likes bikes and e-scooters will be operating, identifying a number of micro-mobility devices within those geographic areas and assigning a shift of trips from automobiles to micro-mobility devices within those respective areas. Or as CARB describes it, GHG emissions reductions are a "result of VMT reductions due to mode shift from vehicle trips to non-motorized trips." SCAG has used density, existing and planned service areas as key factors to identify transportation analysis zones (TAZ) in which micro-mobility is expected to attract enough subscribers or users. Within those TAZs, SCAG has utilized an adoption or participation rate that, in this case, is a number of daily bike share trips per 1,000 residents in each area. The rate CARB has approved is derived from the Institute for Transportation and Development Policy (ITDP).

Once the rate of trips is determined, the number of daily micro-mobility trips in each service area is calculated by multiplying the number of residents in each service area by the number of daily micro-mobility trips. The methodology then calls for multiplying the total daily bike share trips by the average population growth for the scenario year to estimate future total daily bike share trips. The

SCAG transportation model provided an average bike trip length, and staff used research data to estimate the average e-scooter trip. By multiplying the daily micro-mobility trips by the trip length averages, SCAG was able to calculate VMT reductions due to mode shift from private automobiles to micro-mobility devices. These VMT reductions are then converted to GHG emissions reductions using calculations provided by CARB.

TRANSIT/TNC PARTNERSHIPS

This strategy is based on the GoMonrovia program, a partnership between the City of Monrovia and Lyft to provide mobility service within the city in general, and particularly as a first/last mile connection to the city's Metro Gold Line light rail station. This program would reduce GHG emissions by encouraging use of pooled TNC rides as a substitution for short trips in single occupancy vehicles. Based on data shared by the City of Monrovia regarding their program, the SCAG program would seek to subsidize transportation network company (TNC) rides as a first last mile strategy, as well as a mobility service for short trips within circumscribed areas. In order to accurately reflect the data provided by City of Monrovia staff, the SCAG program would be applied to service areas similar in size and urban form as the GoMonrovia service area. For the methodology below, SCAG has applied the program to all Los Angeles Metro Rail and Bus Rapid Transit (BRT) stations in Los Angeles County.

For determining GHG emissions reductions from transit/TNC partnerships, SCAG used Monrovia data to calculate the rate of actual pooled rides per 1000 residents. A two mile buffer area was created around rail and BRT station in 2035 to simulate service areas. SCAG assumed that residents living in each service area are potential TNC riders. SCAG calculated a total number of potential riders across the transit system. The calculation used substitution rates based on three types of auto users changing to service users: vehicle drivers, car pool passengers, and those driving to transit. SCAG calculated the VMT replacement of the service while factoring in the deadheading between picking up riders, using reported rates from other regions. Based on the VMT replacement, SCAG calculated GHG emissions reductions.

EXISTING CONDITIONS

This section will describe existing pilots, demonstration projects and deployments of selected emerging technologies.

ALTERNATIVE FUEL VEHICLES

In this technical report we primarily discuss light duty EV passenger vehicles since they fall under the regulatory framework of SB375. However, SCAG has programs that encourage vehicle electrification and alternative fuel usage in both the light duty and heavy duty sectors. For example, SCAG has administered the US Department of Energy funded Southern California Clean Cities Coalition since 1996. This program focuses on resource sharing and documenting petroleum fuel use reductions in the region. In the light duty sector the biggest opportunities for the SCAG region are the increase in EV sales, and the broad increase in the number of different EVs and PHEVs available to the consumer. Currently there are 48 electric vehicle models available for sale in California and more being introduced every year. Cumulative sales in California have reach 594,918 units since 2011 (as of June 2019).¹⁵ However to meet our climate goals we need to have 1.5 million EVs on the road by 2025, and five million by 2030.¹⁶ Currently, EVs are only seven percent of new car sales – although the growth is healthy. In 2013 EVs made up only 2.4 percent of all new car sales statewide; in 2017 that number increased to 4.9 percent.

A dramatic increase in EV charging stations from two large investments is expected, which is important because the region needs extensive affordable public charging in the densest most challenging parts of the region to support EV charging for multi-family residents. First, Electrify America is currently investing \$800 million across all of California, and will continue to until 2027. Although this is a program mandated by CARB, and thus SCAG cannot factor it into the category of local investments, its potential regional benefits are noteworthy. Second, Southern California Edison (SCE) is seeking approval

¹⁵ Veloz. (2019). PEV Sales Dashboard.

¹⁶ CARB. (2017). California's 2017 Climate Change Scoping Plan.

from the California Public Utility Commission (CPUC) to invest \$760 million incentivizing 48,000 charging stations exclusively in Southern California.

In the heavy duty sector, Southern California is already a leader in CNG transit fleets. LA Metro and the Orange County Transportation Authority (OCTA) are two of the largest transit fleets in the country and both have transitioned to 100 percent CNG from diesel. The SCAG region is also home to some of the most aspirational transit agencies when strategizing to deploy electric buses. Sunline Transit, in the Coachella Valley, has been a pioneer in piloting hydrogen fuel cell electric buses since the year 2000, and has 14 buses in service. Foothill Transit in the San Gabriel Valley, the first transit agency in the nation to deploy battery electric buses in 2010, has committed to a 100 percent electric fleet by 2030, and already has 30 electric buses in operation. Antelope Valley Transit has also made that commitment and already has 29 electric buses in service. Recently other agencies have received or placed orders for hydrogen fuel cell and battery electric buses including Long Beach Transit, OCTA, LA Metro, Los Angeles Department of Transportation (LADOT), Gardena Transit and Anaheim Resort Transit (ART).

CARSHARE

Currently there are five carshare providers in the SCAG region. Zipcar provides roundtrip service and primarily serves university and college campuses in the region, except in the central Los Angeles area where they have numerous locations. Metro has an existing partnership with Zipcar that consists of 13 vehicle pods at eight stations. Blue LA is a one-way provider that specifically serves low-income disadvantaged communities. Finally there are three peer-to-peer carshare providers: Getaround, Turo and Maven. Additionally, Metro recently announced that it will provide 110 parking spaces for Getaround vehicles at 25 transit station parking lots, and two park-and-ride lots.

BIKE SHARE/MICRO-MOBILITY

In the SCAG region, LA Metro operates docked bicycles in downtown Los Angeles, Venice and San Pedro. Jump Bikes (formerly Social Bikes), which

features a hybrid system, has operating agreements with the cities of Santa Monica, Beverly Hills and West Hollywood. Finally, there are numerous new entrants into the dockless bike share space including: Jump, Lime Bike and Spin. There are also numerous new entrants into the e-scooter share space including: Lime, Jump, Spin, Bird, Razor, Skip and others. More details on current deployments can be found in the Active Transportation Technical Report.

NEIGHBORHOOD ELECTRIC VEHICLES

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 households 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.

SMART PARKING

In Southern California, the earliest example of a public sector smart parking program is LA Express Park. It debuted in downtown Los Angeles, and is now in operation in Hollywood and Westwood. Express Park uses block-by-block, and even side of the street, variable pricing to tailor prices to demand. Additionally, Express Park features a smart phone app that allows users to find open parking spaces, and to pay for them remotely. Users can also extend their time remotely. The system integrates the metered street parking with the garages owned and operated by LADOT. As of June 29, 2019, in the three deployment areas, 7,904 of the 36,592 metered parking spaces in the City of Los Angeles are managed under the Express Park program.

TNCS

There are two primary TNCS operating in the SCAG region, Lyft and Uber. There are eighteen other TNCS still registered with the CPUC, however some

of these have gone out of business or provide niche services. Other services which operate in Southern California include Wingz that specializes in advanced bookings and highlights airport trips on its website. Provado, based in Orange County, provides services for health care trips and is registered with various health plans. Hop Skip Drive is a service that is licensed to transport children under 18 years of age. The service is registered with Trustline, which includes a fingerprint-based background check and meets the same criminal history record criteria as licensed childcare providers.

TRANSIT/TNC PARTNERSHIPS

There have been a number of pilots, demonstrations and programs that bring together transit agencies and TNCs. The primary purpose of these partnerships is to determine if TNC services can be used to more efficiently provide mobility to residents in areas where traditional bus transit is costly and/or underused. One example is the partnership between the City of Monrovia and Lyft to provide mobility service within the city, and especially as a first/last mile connection to the city's Metro Gold Line light rail station. Within the city fares were 50 cents and the city subsidized the remainder of the cost. The Lyft rides averaged \$6 per ride. The city re-allocated \$640,000 from its \$1 million Dial-A-Ride budget. The city was still required to operate Dial-A-Ride vans since Lyft could not accommodate wheelchair access. In February 2019, the city changed the fare structure to \$1 per ride for the Lyft shared ride, \$3.50 for the classic Lyft ride, and it kept the fare at 50 cents for a ride to the Gold Line station.

The City of Santa Monica launched its MODE (Mobility On-Demand Everyday) service in July 2018 to provide dial-a-ride service for seniors (60 years and older) in its Big Blue Bus operating area. The MODE service was budgeted at \$2.4 million — \$600,000 per year for four years. As part of the service the city was able to reduce its dial-a-ride vans from six to two vans and supplemented the service with subsidized Lyft rides. The Lyft rides cost 50 cents, the average total cost is \$4.25 per person, and are available to destinations within the City of Santa Monica and selected destinations outside Santa Monica such as UCLA and the Kaiser Medical Buildings in West Los Angeles. More information on transit/TNC partnerships can be found in the Transit technical report.

MICROTRANSIT

Microtransit pilots may feature any of the following characteristics: app-based ridehailing, on-demand service, service by smaller shuttles or vans, and service operated by private sector companies. There are three examples of demonstration projects underway in the SCAG region. In Los Angeles County Metro has contracted with Via, a Mercedes Benz subsidiary, to provide app-based on-demand service using Mercedes Benz Sprinter Vans. The demonstration project is funded by a US Department of Transportation Mobility-on-Demand grant to provide first/last mile service within areas around the North Hollywood, El Monte and Artesia stations. Via rides are free during the pilot phase. LADOT is operating a demonstration project called LA Now, using shuttle buses to provide on-demand pick-ups and drop-offs within a service area that covers the Palms, Mar Vista, Venice and Del Rey neighborhoods in West Los Angeles. The service area also includes Palms light rail station on the Exposition Line. LA Now fares are \$1.50 for a one way trip. The third example is the Orange County Transportation Authority's OC Flex service that operates Ford Transit vans in two areas. One service area covers parts of Huntington Beach and Westminster and includes the Goldenwest Community College. The other service area covers parts of Aliso Viejo, Laguna Niguel and Mission Viejo, and includes the Laguna Niguel/Mission Viejo Metrolink Train Station. OC Flex costs \$4.50 and includes unlimited rides for that day. More information on microtransit pilots can be found in the Transit technical report.

MOBILITY AS A SERVICE (MAAS)

While no comprehensive MaaS system yet exists in Southern California, the TAP program could be considered an early iteration of or a foundation for a fully-fledged MaaS system. TAP cards, distributed by Los Angeles Metro, are reloadable transit fare cards that can be used on 25 transit systems in Southern California, as well as Metro's bike share program. This allows customers to not worry about buying or knowing about fares for every provider they might encounter on a multi-segment transit trip. Additionally, Metro will be rolling out TAP Wallet and an associated mobile application that will allow payment by phone and GPS-enabled trip planning. Taken together, it is possible to see how the TAP program could evolve into a MaaS system with some planning and

coordination with other stakeholders.

ADVANCED ITS – CONNECTED VEHICLES

In Los Angeles County, Metro has a number of initiatives that are laying the ground work for advanced ITS implementations. Metro is also one of the lead partners in convening the Coalition for Transportation Technology. This consortium also includes SCAG, Caltrans, the County of Los Angeles and LADOT. The consortium was formed in order to respond more quickly to federal or state funding for connected vehicle pilots. Some of the projects conducted by Metro and local agency partners include: Drayage, Freight, and Logistics Exchange (DrayFLEX); Signal Phase and Timing (SPaT) pilot demonstrations (Eco-Drive, Metro Orange Line); Partial Automation of Truck Platooning; and Predictive Data-Driven Vehicle Dynamics and Powertrain Control.

GOODS MOVEMENT TECHNOLOGIES

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. 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.

CONNECTED/AUTOMATED VEHICLES

The automobile is going through its most significant transformation in its history, and a number of driver assist features, adaptive cruise control and

automatic lane keeping models are available. While the high expectations that fully automated vehicles would be rapidly deployed within the 2020-2025 timeframe have been tempered with real world experience, there are already commercially available, fully automated ridehailing services in use in Phoenix, Pittsburg and Las Vegas. In October 2018 Waymo announced that its automated vehicles had driven a total of 10 million miles on public roads across 25 cities including their headquarters in Mountain View, other cities throughout California and in Phoenix, where they are operating a pilot program providing automated rides to over 400 pre-screened users.¹⁷ In May 2019, Lyft's automated vehicle pilot, operated by Aptiv, had already surpassed 50,000 rides given in Las Vegas.¹⁸

EMERGING TECHNOLOGY STRATEGIES

This section will describe strategies and policies recommended for deploying various emerging technologies. This section draws on two sources for locally relevant policy recommendations. The first is the City of Los Angeles *Urban Mobility in a Digital Age* published in 2016 by LADOT.¹⁹ The second is *The Three Revolutions: Steering Automated, Shared, and Electric Vehicles to a Better Future*, edited by Professor Daniel Sperling published in 2018.²⁰ Both sources reflect forward thinking institutions grappling with the question "How do we provide mobility services while maintaining private sector innovation and public sector accountability?"

GENERAL EMERGING TECHNOLOGY STRATEGIES

At the state, regional and local levels, public agencies have begun to develop and implement policies that encourage technological innovation, and concurrently set boundaries regarding public safety, use of the public right-of-way and more transparency with regards to data sharing. Larger cities in

17 Korosec, K. (2018). Waymo's Self-driving Cars Hit 10 Million Miles.

18 Fisher, C. (2019). Lyft has completed 55,000 self-driving rides in Las Vegas.

19 Los Angeles Dept. of Transportation. (2016). *Urban Mobility in a Digital Age*.

20 Sperling, D. (2018). *Three Revolutions: Steering Automated, Shared, and Electric Vehicles to a Better Future*.

particular have learned valuable lessons since the sudden advent of TNCs took them completely by surprise. Many large cities across the state are working together on data platforms, which facilitate partnerships between technology innovators and the public sector. LADOT Urban Mobility in a Digital²¹ Age proposes the following pillars for a municipal policy framework:

1. Build a solid data foundation
2. Leverage technology and design for a better transportation experience
3. Create partnerships for more shared services
4. Establish feedback loops for services and infrastructure
5. Prepare for an automated future

Jurisdictions in the SCAG region should work on developing similar customized frameworks for working with and anticipating technological change such as this. Other examples include the City of San Francisco's set of guiding principles discussed earlier. These frameworks allow cities and other public agencies to meet with emerging technology providers and assess whether the service benefits the jurisdiction beyond the novelty factor of hosting a new product. Cities in the SCAG region should continue to consider how these new services benefit residents.

One example of how this approach can be operationalized is the development of the Mobility Data Specification (MDS), an open source protocol for tracking and reporting mobility devices. Starting in 2015, LADOT began hiring new staff to explore the relevance of technology to transportation. Since then they have continued to expand their capacity by hiring data scientists to better collect, aggregate and analyze transportation data. With the advent of micro-mobility this expertise led to the development and publication of the MDS that, among other things, is a file format that standardizes location and travel data from any enabled device. LADOT worked in partnership with the City of Santa Monica, which was the first jurisdiction to use MDS as a component of their micro-mobility device pilot program. MDS has facilitated pilot projects and successful

²¹ Los Angeles Dept. of Transportation. (2016). Urban Mobility in a Digital Age.

collaboration between LADOT and a broad range of micro-mobility providers.

The other set of general policies concern automobiles, and specifically the future of automobile transportation. Currently, TNCs are the best analog for how people will respond to the availability of shared automated vehicles. In the past few years, academic researchers and public sector transportation planners have been able to assemble enough data that indicates that TNCs contribute to congestion, and increase VMT and therefore GHG emissions. TNCs rightly emphasize that their pooled services continue to grow, and that they have just begun to implement policies that encourage fuel efficient and electric vehicles. On the other hand when considering a future with individually owned automated vehicles, research shows^{22,23} that increases in VMT are certain. This is due to two factors: lower burden of travel time, and increase in zero-occupancy miles as the individually owned vehicle parks itself or travels to another household member between trips.

To avoid a future in which the SCAG region suffers from increased congestion and GHG emissions, reduced active transportation and compromised livable communities, the region should encourage adoption of policies that encourage what has been described as the Three Revolutions: Electrification, Sharing, and Automation.²⁴ The following are four broad policies that are proposed to ensure that vehicles are increasingly electrified; that future TNC trips are shared and pooled; and that to the extent possible, automation becomes a feature of ridehailing service instead of individually owned vehicles:

1. **User Incentives** – to choose pooled mobility services over individual ownership
2. **Pooling and EVs** – encourage mobility services to promote pooling and EVs, and motivate automakers to design vehicles for these services
3. **Equity and Transit** – encourage transit operators and mobility

²² Fagnant, D, Kockelman, K. (2015) Preparing a nation for autonomous vehicles: opportunities, barriers and policy recommendations, Transportation Research Part A: Policy and Practice, Volume 77, Pages 167-181, ²³ Fehr and Peers. (2018). How will autonomous vehicles influence the future of travel? ²⁴ Sperlring, D. (2018). Three Revolutions: Steering Automated, Shared, and Electric Vehicles to a Better Future. Island Press

services to collaborate

4. **Land Use** – redesign cities for a transportation system that uses less parking and fewer roads and is more conducive to pooling, active transportation and affordable living

This framework is just one example that can guide more specific policies to ensure that these emerging technologies do not result in increased negative outcomes in terms of congestion and overall livability.

TECHNOLOGY SPECIFIC STRATEGIES

SCAG has prepared a set of recommended policies that SCAG could assist local jurisdictions in adopting as part of implementation of the plan. These policies are recommendations that would need to be studied, customized and adopted by local jurisdictions to fit the local context. For example, they would apply differently in urban areas than in suburban areas. **TABLE 2** identifies all the recommended policies. They have been organized into three policy areas:

- **Land Use Policies** – reflect collaborative ideas, incentives and regulations that local jurisdictions could adopt to shape how emerging technologies interact with the built environment and urban design.
- **Street Design Policies** – reflect concepts that local jurisdictions and transportation agencies could partner to implement, which would guide how emerging technologies operate in the public right of way, including the curb zone, as part of a comprehensive curb space management system.
- **Pricing and System Management Policies** – comprise the most effective and challenging policies for influencing how users will choose to use emerging technologies in different urban and suburban settings.

ALTERNATIVE FUEL VEHICLES

The goal of the electric vehicle (EV) charging infrastructure strategy is to increase the number of workplace, multi-family housing and destination EV chargers in the region. Currently, the potential average all-electric range (AER) of the PHEV fleet in California is approximately 33 miles per day per vehicle (mi/d/

veh), while the actual average PHEV electric-drive range for this fleet is only 20 e-mi/d/veh. This difference between AER and average PHEV electric-drive range suggests that PHEV drivers operate their PHEVs in gasoline operating mode rather than electric operating mode for part of their work commutes.

As PHEVs can operate in gasoline and electric operating modes, the strategy would serve to maximize PHEV operation in electric operating mode and minimize their operation in gasoline mode, thereby reducing tailpipe CO2 emissions. Providing EV chargers at employee workplaces would help to extend the electric operation range of PHEVs used by employees who use EVs for commuting. Specifically, the strategy assumes PHEV batteries are fully charged prior to an employee beginning a commute trip to their workplace from home, as most PHEVs charge at home, where the owner can qualify for low-cost night time charging which makes the electricity cheaper than gasoline. To facilitate PHEVs operating in electric mode on the employee's return commute trip to their home from workplace, the PHEV batteries are "topped off" during work hours through the EV charging infrastructure installed under this strategy. In addition, while the strategy is not limited to employees where EV vehicle charging infrastructure is installed, it is anticipated the strategy would not affect PHEVs driven by the general public and would not lead to induced VMT nor trips. As part of this strategy, the following financial incentives would be provided: a) a one-time financial subsidy offered to employers for the purchase and installation of workplace EV charging infrastructure b) concentrate charging station rebates on publicly available charging sites including on-street parking spaces.

The goal of the Electric Vehicle Incentive strategy is to help facilitate the purchase of new PEV's by offering incentives in the form of rebates to offset the additional cost versus non-PEVs. SCAG has identified an incentive program where rebates could be provided to consumers for the purchase of a new ZEV. The Electric Vehicle Incentive program would be separate from CARB's Clean Vehicle Rebate Project (CVRP), which is designed to promote the purchase of battery electric, plug-in hybrid electric, and fuel cell electric vehicles through rebates for the purchase or lease eligible vehicles.

Additionally, SCAG will pursue the following initiatives by providing information

and services to assist member jurisdictions with local efforts to promote electric vehicle infrastructure.

- Providing information on the costs and barriers of electric vehicle infrastructure
- Providing information on funding opportunities for vehicles and infrastructure
- Identifying legislative strategies for the region and jurisdictions to support electric vehicle infrastructure
- Exploring development and dissemination of model ordinances for electric vehicle infrastructure

- Analyzing data about electric vehicles and infrastructure, including spatial patterns of their deployment
- Collaboration with utilities to provide information and resources to member jurisdictions to promote electric vehicle readiness

CARSHARE

Although there have been deployments of carshare 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, and whether its use results in the theoretical reductions in overall vehicle ownership and

TABLE 2 Local Government & Transportation Agencies Emerging Technology Policy Matrix

	Land Use	Street Design	Pricing / System Mgmt.
Vehicle Electrification - light duty electric vehicles (EV) and charging stations.	Encourage EV charging at public fast charging locations, workplaces, and multi-family housing.	Encourage curbside EV charging stations and parking.	Provide rebates for charging stations and EVs.
Carshare - Cars that can be rented for a short period, either return-trip or point to point parking.	Encourage Carshare vehicles and parking as Transportation Demand Management (TDM) strategies at workplaces, and multi-family housing.	Provide more on-street parking spaces or "pods" for car share vehicles.	Include car share as a service available on a Mobility as a Service (MaaS) platform. See below for definition of MaaS. Encourage carshare use as an alternative to single occupant vehicles (SOV) in a congestion charging zone.
Micro-mobility (including Bikeshare) - combination of docked and dockless shared bikes, ebikes, and escooters.	Increase designated parking areas for micro-mobility devices.	Expand protected slow speed lanes for bikes and micro-mobility devices.	Include micro-mobility as a service available on a MaaS platform as a SOV alternative in congestion charging zones.
Smart Parking Systems - combination of variably priced metered parking, signs that indicate parking availability, and smartphone apps-for payment and navigation.	Decrease cost of long term off-street pricing relative to on-street parking to encourage turn-over of on-street parking.	Implement smart, dynamicly priced on-street parking with app based navigation in more urban areas.	Dynamicly price parking by location, time of day, and even parking purpose (package delivery, v. passenger parking).
Transportation Network Companies (TNCs) - also called ridehailing, refers to companies like Lyft and Uber.	Reduce parking minimums for new developments based on research that demonstrates reduced parking need due to TNC usage. Consider how TNCs might support TDM at workplaces, and multi-family housing (e.g., guaranteed ride home, first/last mile).	Designate more pick-up and drop-off parking spaces, particularly at popular destinations to avoid dangerous double parking. Implement parking protected slow speed lanes to reduce conflicts with pick-up and drop-offs.	Include ridehailing as a service available on a MaaS platform. Use pricing (fees) on TNCs rides to encourage more pooled (multi-passenger) TNC rides.

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. In order to support and encourage carshare, including peer-to-peer carsharing, local jurisdictions should dedicate on-street parking spaces to carshare. Carshare should also be used to satisfy local Transportation Demand Management (TDM) requirements. In addition, workplace and multi-family building managers should be able to implement carsharing in exchange for a reduction in minimum parking spaces.

BIKE SHARE/MICRO-MOBILITY

Local jurisdictions in the SCAG region should work with micro-mobility companies and increase designated parking areas on sidewalks for micro-mobility devices. Jurisdictions should work to expand protected slow speed lanes in order to encourage safe operation of micro-mobility devices in the street right of way. As county transportation commissions develop MaaS platforms, they should pursue the option of adding micro-mobility services to the universal fare media. Additionally, jurisdictions should partner with LADOT and the City of Santa Monica to continue to use and improve MDS as part of a well-supported micro-mobility licensing program.

As well as policies that encourage the proliferation and use of micro-mobility

TABLE 2 Local Government & Transportation Agencies Emerging Technology Policy Matrix - Continued

	Land Use	Street Design	Pricing / System Mgmt.
Transit/TNC Partnerships - arrangements where public transit agencies subsidize TNC trips as a replacement for low ridership routes or expensive dial-a-ride services.	Design transit/TNC partnerships to encourage trips to and from transit and selected destinations, such as downtowns, employment centers.	Same as above but tailored to the goals of the partnership.	Continue experimenting with partnerships in order to supplement low performing routes or provide first/last mile service.
Microtransit - on demand transportation service ordered through smartphone apps and provided by vans or shuttles.	Work with large building owners to designate locations around their property for physical and virtual stops. Encourage subsidized microtransit service as a TDM strategy at workplaces, and multi-family housing.	Designate more pick up & drop off spaces for "virtual" shuttle stops. Implement parking protected slow speed lanes to reduce conflicts with pick-up and drop-offs.	Include microtransit on a MaaS platform, particularly with regards to transfers on universal fare media, as an SOV alternative. Allow microtransit vehicles to use bus-only lanes.
Mobility as a Service (MaaS) - a combination of a universal fare payment system with multi-modal navigation provided on a smart phone app.	Work with large building owners and employers to include traveler information screens in popular locations.	Provide wayfinding and arrival time information at physical and virtual stops.	Support development of a MaaS platform to plan and pay for multi-modal travel options. Use a MaaS to encourage alternatives to SOV use in congestion charging zones.
Connected/Automated Vehicles - also known as self-driving, or autonomous vehicles, these are vehicles that can navigate under certain conditions without human input.	Reduce parking minimums based on research that demonstrates reduced need due to shared vehicle usage. Implement smart growth policies to discourage AV induced sprawl. Identify parking, storage and charging areas for AVs near workplaces and popular destinations to avoid extensive deadheading (empty miles).	Designate more pick & drop off parking spaces, particularly at popular destinations to avoid dangerous double parking. Implement parking protected slow speed lanes to reduce conflicts with pick-up and drop-offs.	Implement pricing, such as Vehicle Miles Traveled (VMT) fees, and experiment with layered pricing, including zero occupancy fees to discourage deadheading (empty vehicles).

Source: SCAG

devices, local jurisdictions should also adopt policies that mitigate some of the shortcomings of these systems. Jurisdictions should conduct pilot/demonstration projects with strict equity, and parking requirements. Equity in particular is an important aspect that jurisdictions should, and are well within their rights, to require. Examples include requirements that devices be distributed within disadvantaged communities, that outreach and advertising be designed to target those communities, and that vendors accept payment from non-banked residents. Parking requirements and enforcement are of particular concern to mobility impaired residents. While poorly parked devices on the sidewalk or other public right of way are a nuisance for able-bodied business owners and pedestrians, they can pose a significant barrier for the elderly and mobility impaired if they are blocking their path. Often times, sidewalks in particular only have a limited usable area free of street furniture like light poles and utility cabinets, therefore an e-scooter laying on its side can block passage for wheelchair and mobility scooter users.

SMART PARKING

Local jurisdictions throughout the region should follow LADOTs lead and implement smart parking programs wherever they face increased demand for parking. By decreasing the cost of long term off-street parking relative to on-street parking, smart parking programs increase the efficiency and turnover rate of valuable on-street assets. Jurisdictions should implement dynamically priced on-street parking with app based navigation and physical wayfinding signage. The purpose of these systems is to manage parking demand and to ensure that there is a regular supply of available parking on each block. This supply will reduce the amount of time that drivers circle the block looking for parking, and thereby reduce VMT.

NEV

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 (CO₂) 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 through the use of ten foot wide slow speed lanes. In addition, the business case for NEVs is challenging as the price point is currently too high for mass appeal. A regional rebate program would compensate for the relatively high cost.

TNCS

Since 2016, TNCs have expanded from operating in more urban areas to be available throughout the region. However, the majority of trips are still taken in more urban areas. Data regarding their use and associated travel behavior is still very limited at this point. However, initial observations suggest they operate similarly to taxi services, with the associated empty or “deadhead” miles between customers. Initial optimism regarding the disruptive nature of the booking systems is being replaced by research that indicates that TNC usage result in increases in VMT. As more ridesourcing trip data becomes available over time, SCAG will incorporate reliable assumptions about average trip length, average deadhead length, and possible ridesourcing impacts on transit ridership and active transportation. Local jurisdictions should identify more dedicated pick and drop off zones to avoid dangerous double parking. In addition, research is needed to identify the potential for pricing mechanisms to encourage more pooled rides.

TRANSIT/TNC PARTNERSHIPS

SCAG can support and encourage agencies and cities in the region to develop productive partnerships with TNCs by convening stakeholders to develop a guide for establishing such partnerships. This could include the aforementioned guiding principles, or perhaps create a similar framework. It's no surprise that the existing partnerships are in communities with more resources, and it would be an opportunity for SCAG to help marginalized communities establish partnerships that benefit them.

MICROTRANSIT

SCAG can encourage implementation of microtransit around the region in a similar fashion to TNC partnerships by establishing a framework of standards and resources, but could also go a step further in providing funding for certain activities. While it would be unlikely that SCAG could provide funding for the operation of microtransit, we could fund research and development of such a program, as well as the evaluation of them. Agencies and cities could use our funding and expertise to develop and analyze programs that they might not otherwise have the resources to pursue. Local jurisdictions and transportation providers should also work with microtransit firms to designate both physical and virtual stops to optimize curb space management.

MOBILITY AS A SERVICE (MAAS)

SCAG could establish a store of MaaS best practices from around the country and globe, for use by agencies within the region. Additionally, SCAG could convene stakeholders, such as cities, transit agencies, community interest groups and private partners, to anticipate and alleviate potential challenges that might be faced in implementing a MaaS program in Southern California.

ADVANCED ITS – CONNECTED VEHICLES

SCAG can work with agencies who implement roadway infrastructure to coordinate improvements to the roadway technology networks that they manage. Some examples might be LADOT, LA Metro, Caltrans, and the Ports of Long Beach and Los Angeles. Additionally, SCAG could monitor and compile information regarding connected vehicle implementation in jurisdictions where it is moving forward, to assist other areas that are lagging behind.

GOODS MOVEMENT TECHNOLOGIES

The long-term goal for goods movement technology, with regards to alternative fuels, is to develop and deploy a fleet of zero-emission trucks. Two broad categories of trucks are under development to meet this goal including battery-

powered electric and fuel cell. Several zero-emission trucks are currently in use, primarily for shorter range operations like local delivery. Depending on the truck design and compatibility, wayside power solutions may be used to extend the range of these configurations. In Germany, an overhead catenary system is being tested on a six mile stretch of the Autobahn.²⁵

As cleaner vehicles are deployed, supporting charging and fueling infrastructure must also be deployed. Many questions must be answered for these systems to be deployed at scale, such as ownership, operation, location, and compatibility between systems and how fueling and charging times might impact operations. In addition to developing zero-emission vehicles, charging and fueling infrastructure is also a consideration that must be planned over the long term.

Please see the Goods Movement Report which describes a Technology Advancement Plan, progress to date, regional targets, and partner roles and responsibilities. This plan was developed to accelerate the deployment of zero and near zero emission technologies.

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. Numerous model year 2019 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. If, as some technologists theorize, full automation is introduced on a disruptive platform similar to TNCs in more

²⁵ Bostock, B. (2019) Germany opens first electric highway that lets trucks draw power from overhead cables.

dense environments, the results are more uncertain. SCAG should continue to conduct research into the effects of connected/automated vehicles on the regional roadway network. Local jurisdictions should already begin to reduce parking in structures in anticipation of the emergence of the automated TNC business model. In addition, SCAG can work with local jurisdictions to analyze the potential fiscal impacts of reduced parking fees on municipal finances.

NEXT STEPS

As this technical report demonstrates emerging technology represents a broad area of research and policy development. Some of the technologies identified in this report are currently deployed in urban areas in the region, while others are being introduced across the region. SCAG should provide support through its technical assistance program to emerging technology planning efforts. Since 2012 SCAG has maintained a web-based PEV atlas that provides planning-level visualizations indicating prime locations for PEV charging station implementation. In the 2018 Sustainable Communities Program Call for Applications, SCAG included a PEV planning category that will allow jurisdictions to apply the PEV atlas at the local level to encourage PEV charging stations.

In order to enhance SCAG's understanding of emerging technology, staff should continue to seek funding for research efforts. In 2016, the Bay Area Metropolitan Transportation Commission (MTC), the San Diego Association of Governments (SANDAG), Sacramento Council of Governments (SACOG) and SCAG formed a partnership called the Future Mobility Research Program, in order to collaborate on research into emerging technology. The four MPOs have jointly funded three rounds of research and modeling efforts. In 2018 SANDAG, in partnership with MTC and SCAG successfully applied for a Caltrans SB1 Sustainability Grant to conduct transportation surveys of residents to learn more about TNC usage in each of the respective regions.

SCAG staff will continue to support the Emerging Technologies Committee and its mandate to research and identify new and emerging technologies that play an important role in the RTP/SCS; and for the three policy committees (CEHD, EEC and TC) to utilize the Emerging Technologies Committee as a resource. The committee was formed to identify technological and societal

trends (e.g. mobility as a service; zero emissions, automated and connected vehicles; smart cities and ITS; and the future of work) that may fundamentally alter the use of the region's transportation system and land use patterns. The research contained in this technical report will assist the committee to frame potential policy considerations to enable the region to harness the benefits of emerging technologies that reduce sprawl, Vehicle Miles Traveled (VMT), and greenhouse gas (GHG) emissions. One area that needs additional research and policy development is to highlight opportunities for under-represented, disadvantaged communities to utilize emerging technologies. Finally, the partnerships identified throughout this report are intended to explore technologies which, while in a nascent or testing stage, remain relevant to the future of the region's transportation system.

CONCLUSION

This technical report provided an overview of emerging technologies that will effect mobility in the SCAG region. Section III provided an examination of the policy areas impacted by emerging technologies and the challenges and opportunities SCAG faces in planning for them. In section IV the report cited the regulatory framework for SCAG's approach to modeling selected emerging technologies. In section V the report documented the off-model analyses conducted on selected emerging technologies to determine the Vehicle Miles Traveled (VMT) and greenhouse gas (GHG) reduction benefits of their deployment. Section VI presented existing conditions in the region for each of the emerging technologies identified in the introduction. Section VII documented recommended strategies to maximize the benefits and mitigate the negative outcomes from the list of emerging technologies. Sections VIII concluded the report with next steps.



MAIN OFFICE

900 Wilshire Blvd., Ste. 1700
Los Angeles, CA 90017
Tel: (213) 236-1800

REGIONAL OFFICES

IMPERIAL COUNTY

1405 North Imperial Ave., Ste. 104
El Centro, CA 92243
Tel: (213) 236-1967

ORANGE COUNTY

OCTA Building
600 South Main St., Ste. 741
Orange, CA 92868
Tel: (213) 236-1997

RIVERSIDE COUNTY

3403 10th St., Ste. 805
Riverside, CA 92501
Tel: (951) 784-1513

SAN BERNARDINO COUNTY

1170 West 3rd St., Ste. 140
San Bernardino, CA 92410
Tel: (213) 236-1925

VENTURA COUNTY

4001 Mission Oaks Blvd., Ste. L
Camarillo, CA 93012
Tel: (213) 236-1960



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