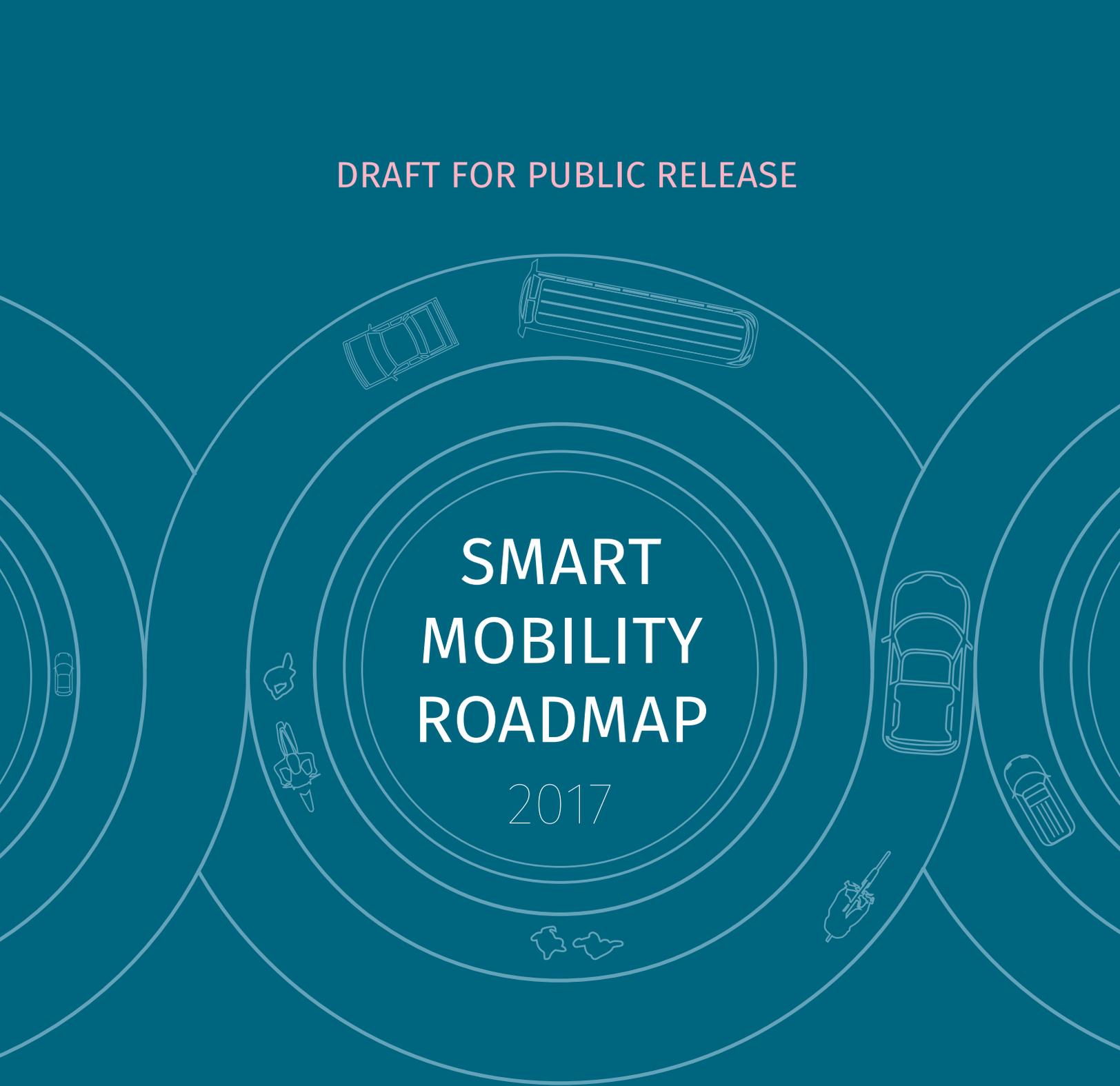# SMART MOBILITY ROADMAP

2017

AUSTIN'S APPROACH TO SHARED, ELECTRIC, AND AUTONOMOUS VEHICLE TECHNOLOGIES

Austin, Texas

CITY OF AUSTIN
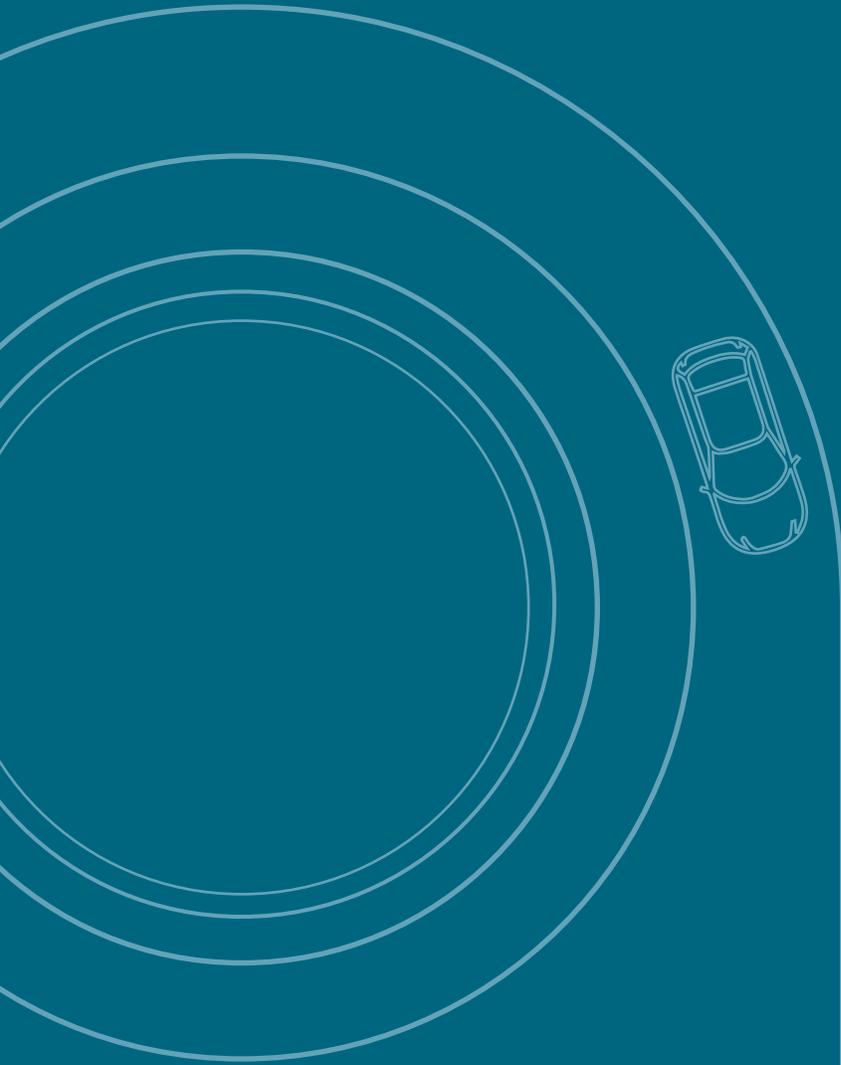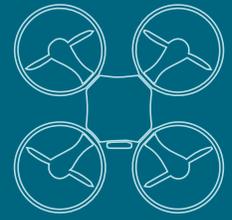
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EXECUTIVE SUMMARY

Mobility in a community can be an economic driver or divider. It can facilitate commerce or create barriers to accessing the full opportunities of the workforce. As Austin's growth curve continues on a rapid trajectory, nearly doubling the population in the city and the Austin region over the next two decades, the mobility challenges of sprawl, congestion, lack of access, safety, affordability and more – will likely double too.

With rapidly emerging and disruptive technologies for shared, electric, and autonomous vehicles on the short-term horizon, Austin is at an inflection point to learn how to direct and harness the new technologies' best attributes and reduce the risks of an uncertain future. For example, the advent of autonomous or "self-driving" vehicles on the horizon may help with some aspects, like safety and convenience, but may negatively impact congestion levels if consumers choose to ride alone.

THE CONVERGENCE OF SHARED USE, ELECTRIC AND AUTONOMOUS VEHICLES

Shared, electric and autonomous vehicle technologies each offer their own sets of benefits and challenges. Electric vehicles will decrease emissions over existing gas-powered vehicles, while autonomous vehicles can increase safety and provide mobility solutions for seniors, the disabled and people without driver's licenses. However, autonomous vehicles also have the strong potential to increase single-occupancy vehicle use and significantly increase vehicle miles traveled on city roadways.

Above: A legally blind man serves as a passenger in an autonomous Google (now Waymo) car in Austin's Mueller neighborhood in 2015.

Pairing electric motors with autonomous vehicles can bring these environmental, safety and accessibility benefits together. The challenges lie in motivating consumer behavioral changes, when the financial and convenience aspects of shared, electric and autonomous vehicles meet or exceed current technologies.

The biggest game changer for mobility, however, is in shared-use mobility which allows options to travel without needing to own a vehicle. Shared-use mobility can reduce congestion, greenhouse gas emissions and household transportation costs, even without the benefit of electric and autonomous vehicles, offering a more immediate way to shape the future with affordable, accessible and equitable multimodal options.

The convergence of shared, electric and autonomous vehicle services can offer a lower cost, more efficient and accessible, less polluting and less congested transportation system. Therefore, this plan will seek to address the synergy to incorporate all three platforms – shared, electric and autonomous – into a comprehensive strategy.

FOCUS ON OUTCOMES

The Austin City Council and the Capital Metropolitan Transportation Authority (Capital Metro) Board of Directors each requested their organizations create a roadmap for achieving smart mobility technologies and services for the Austin region, with resolutions Resolution 20170302-39¹, AI-2017-463, respectively. Each

organization focused on the outcomes the technologies can provide to their constituents – such as safety, mobility, access, affordability and equity – versus the technologies alone. The City of Austin and Capital Metro staff, supported by numerous agencies and institutions, prepared this joint initial roadmap, which will be available for public comment before a final document will be proposed.

As a strategic roadmap, this document does not commit to specific budgets or metrics but serves as a vision and communications document to capture a wide variety of viewpoints into Austin's mobility future. This roadmap will be incorporated into the larger Austin Strategic Mobility Plan to be finalized and approved at a future date. Critical to the development of the broader Mobility Plan will be an extensive analysis of the resource requirements for implementation of this shared, electric and autonomous vehicle (e-av) Roadmap. Only with an understanding of those requirements can appropriate decisions about resource allocation, cost assignment and project prioritization be made. Interim projects may be pursued through public–private pilots with little or no cost to the City or Capital Metro, or with specific authorization from City Council and Capital Metro for early projects or studies.

As such, the vision described in Imagine Austin, the City's comprehensive plan, was the starting point in developing this roadmap:

> ## "Austin is accessible. Our transportation network provides a wide variety of options that are efficient, reliable, and cost-effective to serve the diverse needs and capabilities of our citizens. Public and private sectors work together to improve our air quality and reduce congestion in acollaborative and creative manner."[2]
>
> - Imagine Austin

This shared, electric and autonomous vehicle roadmap is the start of a community discussion about the emerging mobility opportunities within the Austin region. That dialogue will be coordinated with the Austin Strategic Mobility Plan, Capital Metro's Project Connec, and will be shared with the Capital Area Metropolitan Planning Organization (CAMPO) for broader regional context.

Pilots, policies and programs are called out that may jump-start this vision, while continued in-depth planning and integration into the Austin Strategic Mobility Plan is needed to shape the opportunities ahead. The roadmap will evolve as the technologies and policies that it discusses continue to develop and are analyzed for their ability to support and accelerate our community's preferred mobility outcomes.

Today, the City of Austin is already home to some of the most advanced autonomous mobility testing. Google X chose Austin as its second city, after its home town of Mountainview, California to deploy its autonomous vehicles. Continuing a proactive and deliberate approach to these new mobility capabilities will ensure a future that is equitable, affordable, prosperous and data-driven.

The City of Austin and Capital Metro's Smart Mobility Roadmap encompasses five key areas:

- Shared-Use Mobility
- Electric Vehicles and Infrastructure
- Autonomous Vehicles
- Data and Technology, and
- Land Use and Infrastructure

The first section of this roadmap will provide insight into each of these areas as well as the convergence of technology. It also discusses national efforts related to shared, electric and autonomous mobility.

The second section looks at how this technology will affect Austin, through the lenses of equity, affordability and safety. Economic impacts and workforce implications are also investigated, especially as they relate to autonomous vehicles.

The final section encompasses the nuts and bolts of the roadmap, discussing the current Council and Board resolutions and initiatives. It uses historical data from Austin and other cities on how executing a plan like this relates to project and operational resources.

SHARED-USE MOBILITY

Shared-Use Mobility encompasses transportation services that are shared among users, including public transit; taxis and limos; bikesharing; carsharing (round-trip, one-way and personal vehicle sharing); ridesharing (car-pooling, van-pooling); ridesourcing/ride-splitting; scooter sharing; shuttle services; neighborhood jitneys; and commercial delivery vehicles providing flexible goods movement.[3] It is the use of any combination of shared mobility services, above, that have the effect of improving options to travel without a vehicle.

Promoting shared-use practices now will have immediate benefits of taking drivers off the road and reducing the congestion, greenhouse gas emissions and household transportation costs, even without the benefit of electric and autonomous vehicles, offering a more immediate way to shape the future with affordable, accessible and equitable multimodal options. Cultivating shared mobility practices now is important to start the behavioral shift towards a shared, electric autonomous vehicle future.

Image used with permission of Chariot, a division of Ford Smart Mobility.

Shared-use vehicle technology is already here and is rapidly advancing. Using public transportation service as the backbone of the transportation network, shared services can provide first and last mile options; or multi-passenger "micro-transit" options operated in areas where high-capacity transit is not feasible. The alternative, less desirable scenario—is one of individually owned and operated electric autonomous vehicles.

ELECTRIC VEHICLES AND INFRASTRUCTURE

Currently in the Austin area there are approximately 4,000 EVs that represent approximately 22 percent of the Texas EV market and a 55 percent annual EV growth rate over the last three years.[4] Global EV projections vary widely with some of the more aggressive models predicting EVs overtaking internal

"Shared-use mobility, from bike-sharing to ride-sourcing, car-sharing and public transit is part of a 'seismic shift' in mobile technology and changes in travel behavior, that is altering our transportation landscape."

- Sharon Feigon, executive director of the Shared-Use Mobility Center, a national clearinghouse for mobility research and policy development

combustion sales by as early as 2038. But regardless of source, each major model does predict a continued growth curve in EV sales.[5] The rate of adoption is important because the increased deployment of electric vehicles in lieu of internal combustion engine (ICE) technology is an important strategy to reduce emissions, total cost of ownership and energy usage in the transportation sector.

But the pairing of electric motors and autonomous vehicles is not a given.[6] In order for Austin to help accelerate EV adoption on a wider consumer scale beyond fleets, incentives and innovative policies to purchase and drive EVs will need to be complemented with increased electric charging infrastructure.

Projections of Electric, Semi-Autonomous and Fully Autonomous Vehicle Sales
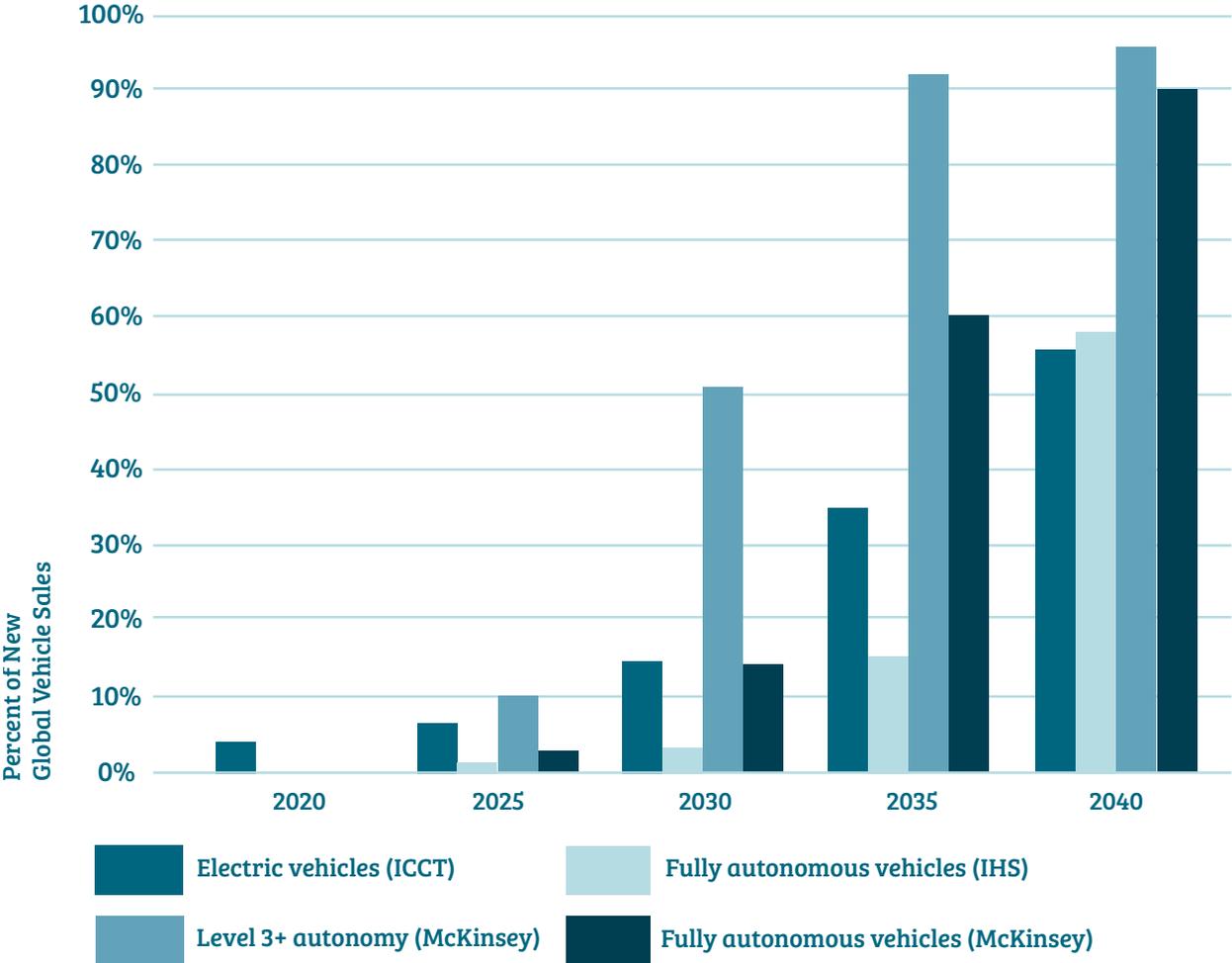
Graphic recreated with permission, from "New Mobility: Today's Technology and Policy Landscape," July 2017, International Council on Clean Transportation.

AUTONOMOUS VEHICLES

How quickly fully autonomous, or self-driving, vehicles are on our streets is widely debated amongst experts, with predictions ranging from 15 to 50 percent of sales by 2030. There is consensus that fleet services will be the first to use autonomous vehicles because of their ability to use the vehicle for longer periods to offset the higher technology-rich vehicle price. Expect to see semi- and fully autonomous vehicle fleet services as early as 2025.[7]

There will be numerous pilots, testing and controlled environment uses for AVs in the coming decade. Policies and actions, such as dedicated lanes, data collection and analysis, and human-centered engineering approaches will need to be considered so that semi- and fully automated cars can safely co-exist with human-driven vehicles in the interim period of 10 plus years.

The University of Texas and other research organizations have begun framing the types and magnitude of changes that will impact society due to the wide availability of AVs. From this research, various themes for further analysis are worth noting, including[8]:

- Expanded mobility options for all,
- Opportunities for system capacity gains,
- Opportunities for data-driven development,
- Potential increase in vehicle miles traveled,
- A potential threat to the viability of traditional transit services, due to the affordability and convenience that will likely accompany autonomous ridesourcing,
- A significant increase in roadway safety, with a corresponding reduction in crashes,
- An extended adoption period in which there will be mixed traffic (AVs and human-driven vehicles), lasting decades, due to the disruptive nature of new technologies, and
- Significant economic and social changes

DATA AND TECHNOLOGY

To manage transportation for specific access, mobility, affordability, safety and emission outcomes, city and regional partners need to rely on current, live, reliable data—the kind of data and analysis that we often lack today. The data of tomorrow for shared, electric and autonomous vehicles will be even more sophisticated, elaborate, voluminous and complicated.

Cities are starting to collect and manage data from a wide variety of sources including connected Dedicated Short Range Communications (DSRC) infrastructure, bluetooth and smart phone data, along with a host of new sensors that can measure air quality to road temperatures and conditions and more. Expansion of DSRC or 5G technology could be the connective tissue that delivers smart mobility, linking shared/EV/AV vehicle information to the infrastructure and to the cloud.

LAND USE AND INFRASTRUCTURE

From a land use perspective, autonomous vehicles have the potential to encourage individuals and households to move further away from the city center under the assumption that long drive times can be used for work or entertainment purposes. If those same vehicles were electric, it may reduce emissions, but not the area's congestion problem. To get ahead of this issue, the City of Austin will need the bold land use policies prescribed in the City's Imagine Austin comprehensive plan to be adopted into the CodeNEXT regulatory document that will encourage densification and discourage single-occupancy commuting options.

To achieve the maximum benefit of the emerging technologies and outcomes such as mobility, affordability, access and more, the City of Austin should pursue a collaborative process across disciplines, city, and regional partner systems. The City also plans to engage the public as Austin moves forward with various pilots and strategies to ensure that the community's needs are met.

While the price of this technology may reduce costs for personal mobility, autonomous vehicles will have an impact on city and agency budgets in significant ways. Examples of possible impacts and the opportunities to explore new revenue sources are discussed later in this document.

SHARED, ELECTRIC, AND AUTONOMOUS ROADMAP RECOMMENDATIONS

Shared-Use Mobility Services

RECOMMENDED ACTIONS:

1. Engage citizens, businesses and visitors on how this technology can meet their needs and address community issues
2. Incentivize alternative means of transportation
3. Provide on-demand service—accessed via smartphone app or call
4. Seek regional recognition of registered private mass transit vanpool/shuttle operators to access regional toll lanes for free
5. Expand bikeshare system(s); Launch shared e-bike system
6. Launch an electric scooter shared system
7. Develop a report card that requires an annual assessment of progress on action items
8. Test various first/last mile solutions with public and private transportation providers
9. Develop and promote a comprehensive Shared-Use Mobility Plan
10. Create multi-modal mobility hubs adjacent to transit stops to offer a variety of first-and last-mile options
11. Encourage public and private operators to accept pay-as-you-go cards
12. Pair regional park-and-ride lots with regular and on-demand shuttle service to major employment areas
13. Explore downtown transit "ride free" zone or shuttle route to encourage driverless commutes
14. Pursue regional integrated multi-modal transportation and payment platform, including cell phone app and integrated payment method

Autonomous Vehicles

RECOMMENDED ACTIONS:

1. Engage citizens, businesses and visitors on how this technology can meet their needs and address community issues
2. Hire an Executive level Officer of EV/AV Transportation
3. Develop a Master Plan roadmap for emerging electric – connected and autonomous vehicle (E-CAV) technologies
4. Create an interdisciplinary AV Work Group
5. Create an infrastructure task force to examine electric, technology and land use infrastructure requirements
6. Test Dedicated Short Range Communication (DSRC) technology for vehicle to infrastructure (V2I) reciprocal safety messages
7. Test 5G technology for vehicle to infrastructure (V2I) reciprocal safety messages; compare to DSRC
8. Increase public awareness of electric autonomous (E-AV) shuttles in various Austin locations through EV/AV pilots
9. Increase public awareness of last mile E-AV delivery robots
10. Establish an EV/AV Commercialization Opportunities/ Economic Development Work Group
11. Create Shared/EV/AV focused team
12. Increase public awareness of electric and autonomous vehicle benefits
13. Create a regional New Mobility Workforce Training task force for new job training and educational opportunities for those with legacy occupations

Electric Vehicles and Infrastructure

RECOMMENDED ACTIONS:

1. Engage citizens, businesses and visitors on how this technology can meet their needs and address community issues
2. Launch electric technology demonstrations; (See the Shared Mobility Recommendations section)
3. Adopt buy/lease "Electric First" or "Zero Emission" policy for all City fleet vehicles unless business case or technology limitations preclude early adoption
4. Deploy shared-electric mobility and charging infrastructure to include low income neighborhoods
5. Increase public awareness of EV benefits
6. Deploy 'smart' public, private and fleet charging infrastructure
7. Expand rapid charging station on-street network; Examine free parking options for EVs
8. Create electric vehicle-for-hire priority access incentives for Austin-Bergstrom International Airport (ABIA)
9. Conduct vehicle managed charge and grid integration pilots

Land Use and Infrastructure

RECOMMENDED ACTIONS:

1. Engage citizens, businesses and visitors on how this technology can meet their needs and address community issues
2. Allow reduced or zero parking requirements with TDM, on-site access to shared mobility guarantees
3. Establish market-based performance pricing for parking
4. Allow for shared parking between businesses
5. Enhance compact and connected land use along key urban transit/travel corridors and transit oriented developments using E-AVs
6. Create policies to actively manage the curb space on public streets
7. Unbundle parking costs from city building leases and purchases
8. Encourage adaptable parking garages for future re-use as residential buildings, office spaces and retail spaces
9. Implement building codes to support EV-ready and EV infrastructure requirements

Data and Technology

RECOMMENDED ACTIONS:

1. Promote community dialogue, public engagement and education on data and mobility innovations
2. Invest in and leverage technology to improve mobility through open data; Support traffic "Data Rodeo" collaboration
3. Promote public-private data partnerships for transportation information to optimize mobility options; Support Austin CityUP and community data hack-a-thons
4. Create a data analysis contract and grow internal capability
5. Examine kiosk technology for multi-modal transportation information; Wi-Fi access
6. Create "One System" regional integrated approach to traffic operations
7. Equip City fleet with DSRC technology and/or other vehicle sensors
8. Develop a technology-driven universal way-finding system to optimize parking assets and manage congestion
9. Reexamine curb and parking technology applications to actively manage use of curbs
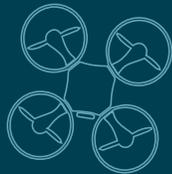10. Reexamine right of way technology applications to actively manage use of right of way

BACKGROUND ON EMERGING TECHNOLOGIES

SHARED-USE MOBILITY SERVICES

Shared-use mobility encompasses transportation services that are shared among users, including public transit; taxis and limos; bikesharing; carsharing (round-trip, one-way, and personal vehicle sharing); ridesharing (car-pooling, van-pooling); ridesourcing/ride-splitting(transportation network companies); scooter sharing; shuttle services; neighborhood jitneys; and commercial delivery vehicles providing flexible goods movement.[9]

It is the use of any combination of shared mobility services, above, that have the effect of improving options to travel without a vehicle. Promoting shared-use practices now will have immediate benefits of taking drivers off the road and reducing the congestion, costs and emissions associated with driving alone. Cultivating shared mobility practices now is important to start the behavioral shift towards a shared, electric autonomous vehicle future.

Capital Metro's RideShare program serves as a long-running example of shared mobility. Neighbors self-organize to form transit pools using technology and vehicles provided through the program. The cost is a fraction of driving alone, and a way to provide a flexible community-based transit service.[10]

PUBLIC TRANSIT AND SHARED-USE MOBILITY INTEGRATION

Public transit remains an essential piece of the mobility picture alongside shared AV taxis, micro shuttles and other ridesharing services, said a recent Bloomberg Philanthropies- Aspen Institute report.[11] "The latest simulation found that, when deployed alongside fixed-route mass transit networks, shared-ride AV taxis could all but eliminate the convenience advantage of personal autos."[12]

However, the report cautions, without a core of fixed-route mass transit, shared AV networks will actually lead to more vehicle miles traveled (VMT). Personal cars replaced with AVs could increase congestion and VMT as much as 35 percent due to AVs roaming empty to find cheap parking and the tendency of people to tolerate longer trips if they do not have to drive.[13]

Similarly, a highly publicized New York City study found that the services provided by Transportation Network Companies (TNCs) such as Lyft and Uber created a net increase of 600 million vehicle miles traveled in New York City during 2016, which was a three to four percent increase in traffic citywide.[14] Effective policy leading towards shared–use vehicles and services, and away from single occupancy uses, is needed to prevent worsening congestion. The Bloomberg report further states, that, in order to remain competitive, transit may need to operate on a dedicated route that bypasses congestion, during peak hours.

PUBLIC AND PRIVATE—FIRST AND LAST MILE SOLUTION INTEGRATION

High capacity transit – like rail and bus rapid transit – will continue to be the fastest, most efficient form of transportation for moving a lot of people in high-density areas, especially during peak hours. In low-density areas, low-capacity and low-frequency transit, such as buses or paratransit, may need to be enhanced or replaced in order to remain competitive.[15] Many public transit agencies are experimenting with private sector partnerships to determine whether other public or private partners can deliver mobility more cost-effectively, especially for the first-and last-mile of travel.[16]

Transit agencies have embraced pilot programs as a way to save money and, potentially, offer better service. For instance, the East Lake Connector bus, outside Tampa, cost the Pinellas Suncoast Transit Authority (PSTA) about $16 per person per ride. Riders paid $2.25 each. That route has since been discontinued. Instead riders pay $1 for an Uber, or a cab ride from anywhere in the county to the nearest bus stop. The transit agency will achieve the low fare by providing a $5-a-head discount.[17]

At the same time, transit agencies are conducting a comprehensive analysis of existing services maximize service efficiency and connectivity.[18]

"Future cities will need a range of transit vehicles. High-density, fixed-route corridors will still be served most efficiently by buses. Lower-density areas can achieve the point-to-point convenience of cars with shared shuttles or vans... Downsizing the vehicle based on the time of day and density of transportation makes sense."

- Susan Shaheen, UC Berkeley mobility expert[19]

Together with Capital Metro, the City will pursue other first-and last-mile pilots, such as E-bikes and E-scooter applications that connect to other mobility options, including transit. First-and-last mile pilots that serve transit-poor areas as well as low-income communities—where people are more than twice as likely to rely on public transit to get to work[20]—offer opportunities to augment the current system and quantify the benefits of the services .

First-and last-mile public infrastructure can also help neighborhoods retain residents and increase mobility. Cities and suburbs have found that walkable, mixed-use developments attract and retain residents and businesses. Infrastructure for walking and cycling offers people more mobility options thereby reducing emissions and the use of single-occupancy vehicles.

To that end, the City of Austin's 2016 Mobility Bond resolution from the City Council states: "In implementing the 'Corridor Construction Program,' the City Manager shall further emphasize making corridors livable, walkable, safe and transit-supportive and aligned with the principles and metrics in the Imagine Austin Comprehensive Plan, with the goals of reducing vehicle miles traveled, increasing transit ridership and non-vehicular trips, and promoting healthy, equitable and complete communities as growth occurs on these corridors." [21]

INCENTIVIZING SHARED-USE SERVICES

The City of Los Angeles set a goal to take 100,000 private cars, or two percent of their current vehicles[22], off the road in by 2021 by dramatically scaling up shared mobility, in concert with public transit. Working with local stakeholders and agencies, the Shared-Use Mobility Center (SUMC) helped prepare a multi-modal Action Plan for Los Angeles County to achieve their goals.

If the City of Austin were to set a goal to take 20 percent of personal vehicles, or 110,000 vehicles, off the road, the Shared-Use Mobility Center estimates how much a city's other shared mobility offerings would need to grow. The resulting personal and community benefits for the Austin area are shown on the next page. In order to reach such a goal, the City of Austin, Capital Metro and their stakeholders would need to develop

their own comprehensive Shared-Use Mobility Plan with actions specific to Austin's needs to reach those targets. A Shared-Use Mobility Plan would be developed in conjunction with the Austin Strategic Mobility Plan.

Shared Mobility Benefits Calculator

TO REDUCE PERSONAL VEHICLES BY 20% IN AUSTIN…

+

36,507
Transit Commuters

9,238
Carshare Vehicles

17,889
Rideshare/Carpoolers

6,748
Shared Bikes

=

1,140,027,400
Fewer miles traveled by personal vehicles

409,100
Fewer metric tons of GHG emissions related to personal vehicle ownership

$401,912,300
Saved in prsonal vehicle transportation costs

Graphic recreated, with permission, from "Shared Mobility Benefits Calculator," Shared-Use Mobility Center.

The Downtown Austin Alliance recently commissioned a downtown parking study, in part, to look at increasing traffic congestion. The study found that approximately 75 percent of employees in the downtown area get free or discounted parking today. Free parking is considered an enticement to drive to work and adds to traffic congestion.[23]

The study recommends new developments should be incentivized to:

- Establish shared parking opportunities,
- Create transportation amenities –such as **shuttles and bikesharing**—in order to reduce the number of parking spaces proposed,
- Deploy a **downtown circulator shuttle** to improve access to remote and **affordable park-and-ride lots** and improve options to travel without a vehicle, and
- Coordinate mobility services and options for employees – e.g. employers issuing transit and alternative mobility passes, or compensating employees not to drive[24]

Other shared-use mobility recommendations that the public and private sector can offer include:

- **Parking Cash-out programs** are another effective means for encouraging mobility alternatives by offering employees a clear economic choice. They also have been shown to reduce automobile travel by 10 to 30 percent.[25] Typically a company can offer its employees the option to pay for parking or receive money for using other means of commuting—like transit, biking, walking or carshare—in lieu of a guaranteed, and often, free parking spot. This allows an employer to manage their parking costs and provides employees a financial incentive to avoid driving alone to work.

  While the City of Austin has piloted parking cash-out programs for some of its employees in the past, our current Commute Connections Program provides paid time-off to employees who can document non-single-occupancy-vehicle trips taken during peak rush hours.[26]

- An "**Electric last mile**" transportation pilot is underway through a collaboration with Pecan Street energy research organization, Electric Cab Co,. Capital Metro and Austin Energy. The team was awarded $1 million by the U.S. Department of Energy to launch an innovative "electric last mile" transportation pilot in three Austin neighborhoods.[27] The pilot will use electric, low-speed vehicles and evaluate the use of semi-autonomous vehicles for first-and last-mile transit connection in three growing areas of the city. This public-private effort will collect data to assess its application in other parts of the city and region.

- Exploring "**mobility-as-a-service**" models that are electric, autonomous and reduce single occupancy vehicle trips, with both public and private transportation service providers.

These approaches have the effect of improving options to travel without a owning a vehicle. Putting these practices in place now will have the immediate benefits of taking drivers off the road and reducing the congestion, costs and emissions associated with driving alone. Cultivating shared mobility practices now is important to start the behavioral shift towards a shared, electric autonomous vehicle future.

In order to promote the integration of public mass transit and private sector services, the following technologies and policies can also help:

- **Creation of a series of mobility hubs** adjacent to transit stops to offer a variety of first and last mile options, from electric bikes, to car-share, to access to micro-shuttles, to taxis and TNCs. This approach was a key component of Austin's Smart City application and is being actively pursued by the City with agency and RMI partners. To futher the City's fleet and vehicle electrification goals, these hubs should be equipped with a variety of electric charging devices. They can also play a key role for testing new technologies, such as inductive charging.

  With more online shopping, more delivery vehicles—whether trucks, robots or otherwise—will be on our streets. Mobility hubs could incorporate delivery depot stations for customers to pick up packaged deliveries from a secured locker on their way home. This system would reduce the amount of deliveries to individual addresses. This is a key strategy from Austin's "Smart City" grant application

- **Dynamic pricing** for roadways to incentivize trips that use public transit/vanpooling and dis-incentivize trips that compete with public transit. Trip pricing may fluctuate depending on a combination of variables and pilot findings, including: origin and destination; number of passengers; level of congestion; environmental impact; and household income.[28] Dynamic pricing is being actively used on our area toll roads by the Central Texas Regional Mobility Authority (CTRMA) to manage traffic flow.

- **Creation of a universal app and payment method**. A key missing piece for shared mobility in cities is a ubiquitous shared mobility data platform to provide seamless, connected, public and private transportation information and options to travelers with an integrated payment system. There are promising models such as "Whim" in Helsinki and emerging models developing in Portland with Moovel (formerly Ridescout) and others.[29]

Using "Whim," one monthly payment gets you access to public transit, bike shares, rental cars and taxis

Image used with permission of MaaS Global Ltd, The Whim App

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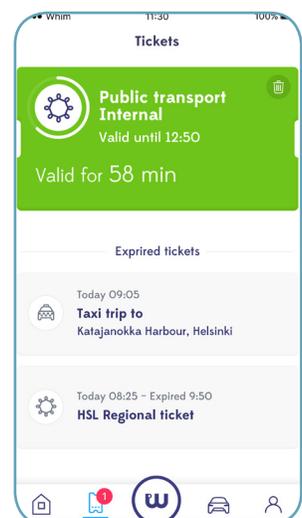
Towards that future, Capital Metro recently rolled out a beta version of personal traveler tools on a new mobile and web based transit app. The tools will provide travelers with the most up-to-date and connected information. The apps have been created in partnership with regional mobility providers—like B-Cycle, car2go, Ride ATX and others—and will provide integrated, one-stop trip planning tools. The apps will be rolled out for general use after the initial beta test. Future plans include: integrating more providers as data becomes available, developing adaptable, generation appropriate tools and providing a combined payment platform.

- **Community Kiosks as Traveler Tools**: Capital Metro will also pilot real-time commuter tools or kiosks as a demonstration in some key high-use transit hubs in the near future. These kiosks will provide trip planning information and other information that is useful to pedestrians and commuters.

Recommendations for Shared Mobility Services in Austin

|	TIME PERIOD	ACTIONS	POLICIES	PILOTS AND PROGRAMS
1.	On-going	Engage citizens, businesses and visitors on how this technology can meet their needs and help the City address community issues	Coordinate outreach/education program with other public and private organizations; Collaborate with ASMP and Project Connect outreach	Start dialogue with communities to be impacted by pilots; Extend communication across city
2.	On-going	Incentivize alternative means of transportation —carshare, car pooling, transit, bicycling, walking and tele-commuting to reduce auto travel	Implement employee parking cash out program; Create shuttle/other connections between transit and work sites; Set goals for an enhanced tele-commute policy; Invest in protected bicycle lanes and sidewalks for safer bike-ped commutes; Measure before and after results	Pilot employee parking cash-out program for downtown; Explore use of private sector providers for shuttles, last-mile solutions
3.	0-2 years	Provide on-demand service —accessed via smartphone app or phone call	Establish non-exclusive access and payment policy that encompasses all forms of communication and payments	Pickup—Capital Metro on-demand pilot, operating in Mueller and Windsor Park neighborhoods—offers a phone call service as well as the app
4.	0-2 years	Seek regional recognition of registered private mass transit vanpool/shuttle operators to access regional toll lanes for free	Seek regional recognition of registered private mass transit vanpool/shuttle operators to access regional toll lanes for free	All area toll roads; Partner with CAMPO, CTRMA, TxDOT
5.	0-2 years	Expand Bikeshare system(s); Launch e-bike share system	Review/Revise city/state ordinances for allowable vehicles on city streets, bike lanes and sidewalks, maintaining public safety, as a priority	Identify and attract technology funding partner for expanded bike share program; Work with B-Cycle; Launch an RFI or similar for a dockless bike share (including e-bike) system
6.	0-2 years	Launch an electric scooter shared system	Review/revise city ordinances related to use of right-of-way for bikestations, station-less bikes, esp. on sidewalks for electric scooters, maintain public safety priority, fund enforcement capabilities, as needed	Launch an RFI related to shared electric scooters; Work with companies to meet equity, accessibility and affordability goals; Coordinate with other shared technologies
7.	0-2 years	Develop a report card that requires an annual assessment of progress on action items	Examine Imagine Austin and Vision Zero for examples of ongoing report cards	
8.	0-4 years	Test various first/last mile and "mobility as a service" models with public and private transportation service providers	Create pilot or demonstration program guidelines that defer normal public/private partnership purchasing guidelines, if needed; Review cost-effectiveness of differing service providers	Test alternatives to bus only service, right-sized vehicles, on-demand v. fixed route and customer acceptance; Partner with Capital Metro, RMI

	TIME PERIOD	ACTIONS	POLICIES	PILOTS AND PROGRAMS
9.	2-4 years	Develop and promote a comprehensive Shared-Use Mobility Plan to serve everyone in our community	Direct and co- fund a community regional plan that includes affordability and access and integrates all modes of transportation; Optimizes efficiency and cost-effectiveness, recommends priority projects and funding; Minimizes zero-occupant VMT	Engage national firm to identify different community needs and priorities and develop programs to meet them; Leverage learnings from other cities; Engage Capital Metro and CAMPO, public and private sectors
10.	2-4 years	Create multi-modal mobility hubs adjacent to transit stops to offer a variety of first and last mile options and a complete trip experience; May include community kiosks as traveler tools	Study and assess feasibility of repurposing existing properties for mobility hubs, including costs of acquisition, redevelopment and infrastructure and service requirements; Based on that analysis, develop budgets and plans to co-fund and build infrastructure and technology access to support mobility hubs; Revise land use policies if needed; Provide outreach and education funding to promote; Review/revise the City's digital sign ordinance	Combine car sharing, bikes, e-bikes, and ride hailing, at mobility hubs to solve first- and last-mile issue based on community preferences, especially in low-income areas
11.	2-4 years	Encourage public and private operators to accept pay-as-you-go cards for payment for the unbanked	Create incentives for operators to accept cards; Develop card standards and test; Require all contracts with the City that involve transactions to accept the pay-as-you-go cards that satisfies the City's standards	Pilot use of account-based smart cards with multiple TNCs, car shares and transit providers; Create way for unbanked to reload their cards; Pilot in vulnerable neighborhoods
12.	2-4 years	Pair regional Park and Rides lots with regular and on-demand shuttle service to major employment areas	Allow flexibility in spending for park and ride facilities	Pilot shared parking lots with churches, grocery stores, community centers, etc. Pilot public-private shuttle/transit services
13.	2-4 years	Explore downtown transit ride free zone or shuttle route to encourage driverless commutes	Establish policy to not charge for trips within designated central business district; Co-fund pilot with public and private sector monies; Support with substantial outreach/communication funding	Create "ride free" pilot in the central business district for a period of at least one year; Clearly communicate the program, survey participants, evaluate results, and redesign to meet needs of community; Partner with Capital Metro
14.	4-6 years	Pursue regional integrated multi-modal transportation and payment platform, including cell phone app and integrated payment method	Pursue public-private partnerships to develop platform	Expand Capital Metro app to incorporate more services; Partner with other cities piloting this technology

**A set of performance metrics will be developed for each implemented action to assess the benefits and impacts of the given action.

ELECTRIC VEHICLES AND INFRASTRUCTURE

Currently in the Austin area there are approximately 4,000 EVs that represent approximately 22 percent of the Texas EV market and a 55 percent EV growth rate over the last three years[30] Global future EV projections vary widely with some of the more aggressive models predicting EVs overtaking internal combustion sales by as early as 2038. But regardless of source, each major model does predict a continued growth curve in EV sales.[31] The rate of adoption is important because the increased deployment of electric vehicles in lieu of internal combustion engine (ICE) technology is an important strategy to reduce emissions, total cost of ownership and energy usage in the transportation sector.

Austin-Area EV 3-Year Growth

Cumulative Registrations by Type
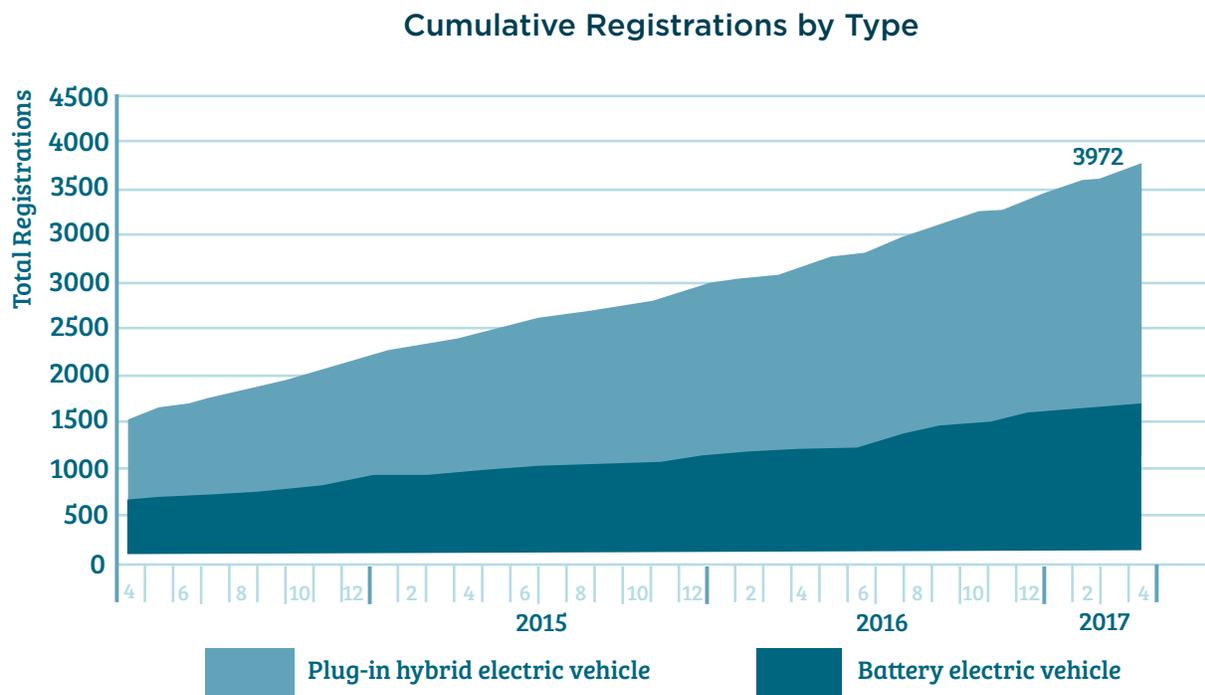
Data provided quarterly from EPRI for Travis and Williamson County.

Moving transportation from petroleum-based energy to electric-fuel also supports national fuel independence as electricity is generated regionally and not imported. In order for Austin to help accelerate EV adoption in the Austin area, policy incentives to drive an EV will need to be complemented with increased electric charging infrastructure.

Per Texas state law under the Public Utility Regulatory Act (PURA), Austin Energy has the sole responsibility and obligation to provide electric service within its service territory. Having a community- owned utility with this obligation to serve has allowed Austin to create a cohesive vision on public electric vehicle service equipment (EVSE) with a focus on affordability, clean air, climate protection and consumer experience. However, as the increasing cost of providing rebates and installing charging stations matches the growth rate of EV adoption, hard debates about appropriate cost allocation will be required to ensure appropriate cost recovery. Of particular importance will be analysis of the rate impacts and their effect on affordability.

The City of Austin to date has made significant strides in transportation electrification and is widely considered a national leader on this front. The City of Austin/Austin Energy is listed by the ICCT in the top 10 U.S. cities for public and workplace electric charging infrastructure, per million population.[32]

Recently, from City of Austin Fleet Services, Office of Sustainability and Austin Energy analysis, with support from the Electrification Coalition, predicts that the City will save $3.5 million over the course of 10 years by deploying 330 EVs through the year 2020.[33] Savings are expected to continuously improve, due to rapidly advancing battery technologies and lower manufacturing costs.[34]

Yet barriers to current electric vehicle adoption still exist and a combination of tools and actions are needed to grow the EV market adoption, including:[35]

- Policies, such as a Zero Emission Vehicle plan or free express lane access,
- Consumer purchase incentives,
- Widely available workplace and public charging points,
- EV car options (to include plug-in trucks and SUVs) and competitive price points, and
- Promotional and public awareness campaigns, including price incentives
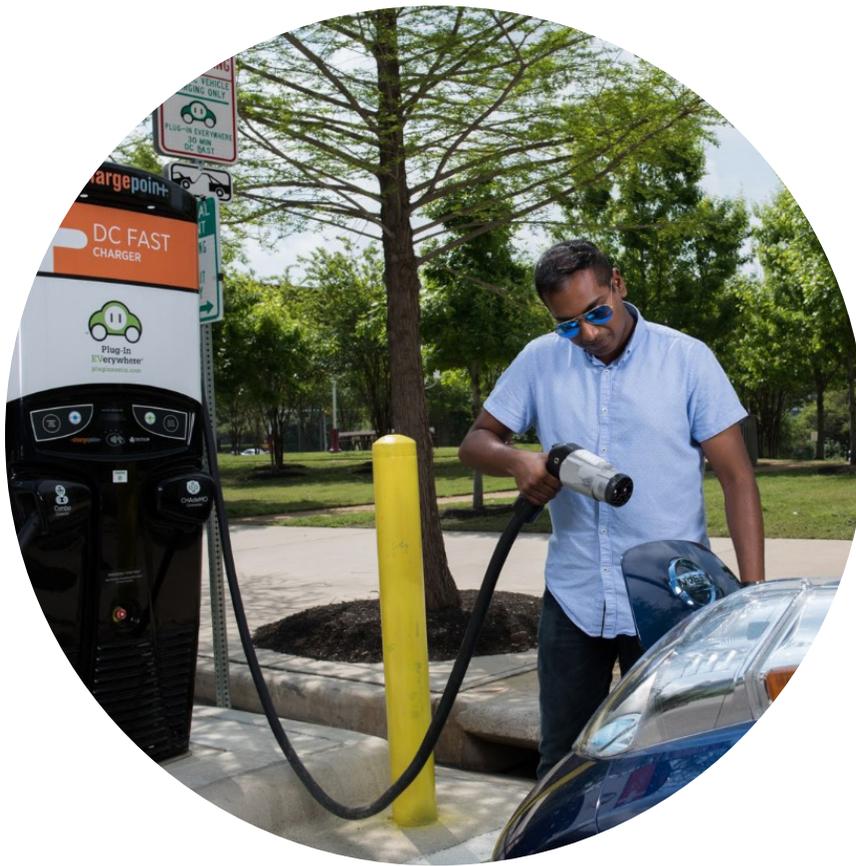
New fast-charging stations, like the one pictured here at Austin's Electric drive, refuel cars in minutes.

AUSTIN ENERGY'S EV PROGRAM HIGHLIGHTS:

EV Charging Network—In 2011, Austin Energy installed the first EV charging infrastructure in the region. Today, Austin Energy has over 600 EV charging ports at 172 locations, including retail, workplace, multifamily and fleet locations throughout the city.[36] Austin Energy is adding 8-10 DC Fast Chargers to the network beginning in 2018. The fast chargers will recharge a vehicle within 15 minutes and are slated to be positioned along major transportation corridors. Additionally, the Plug-In EVerywhere network is powered by clean, renewable wind energy via Austin Energy's GreenChoice Program and the cost to Plug-In EVerywhere customers is only $4.17 per month for unlimited electric "fill-ups." [37]
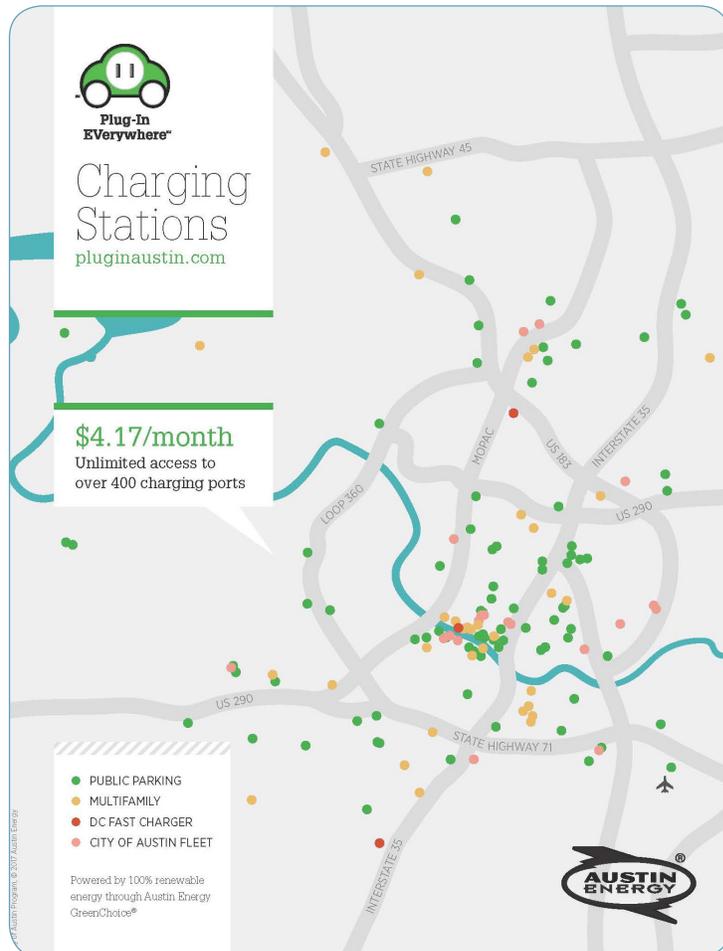
On Electric Drive, in the heart of downtown, Austin Energy has also developed a showcase for sustainable transportation. Electric Drive includes a DC fast charger that meets both global standards for EV fast charging, as well as universal level 2 charging for customers to use while they are downtown. A solar powered kiosk with integrated battery storage includes level 1 charging for electric bikes, scooters, motorcycles and mopeds. Electric Drive is an integral part of the downtown redevelopment known as the Seaholm EcoDistrict, which features sustainability innovations.[38]

Capital Metro and Austin Energy are also reviewing opportunities to install EV charging infrastructure, including additional DC fast charge stations, at public facilities such as metro park and rides, metro transit centers and metro transit oriented developments. Both organizations will jointly develop a strategy for identifying priority public charging station installations.

- **A Focus on Multi-Family Properties and EV Charging** – Given that over 40 percent of Austin's population lives in multi-family properties[39] and that the number of electric vehicles is rapidly growing in the Austin area, Austin Energy is working to encourage adoption of electric vehicles by multi-family residents. Over the past two years, Austin Energy has expanded the network of public EV charging infrastructure by supporting installation of EV chargers at 43 multifamily properties serving more than 25,040 residents.[40]

    With support from the philanthropic 11th Hour Project, Austin Energy will lead a new effort to identify and develop EV sharing programs for low-to moderate-income communities.[41] Given unique challenges at multi-family properties—factors such as charging station siting, occupant

turnover, security, safety, billing and parking protocols—the effort will also aim to better understand the needs of electric vehicle charging habits at multifamily properties in order to continue providing the appropriate infrastructure for increased EV adoption.

- **Home Charging Rebates** – Even though Austin Energy offers extensive and affordable public charging, the majority of plug-in electric vehicle (PEV) charging will be conducted at home. For many electric vehicle drivers, standard existing electrical outlets will meet their needs. However, for those who want to charge more quickly, Austin Energy offers a 50 percent rebate—up to $1,500—towards the hardware and installation of a level 2 fast charger[42]

- **EV360 Time-of-Use Rate Pilot Program** – Austin Energy has launched an EV-specific time-of-use rate pilot program called EV360. EV drivers can have unlimited off-peak charging at home and public charging stations for a flat rate of $30 per month.[43] This not only gives drivers a consistent fuel charge for driving their EV, but also encourages off-peak charging to promote affordability and climate protection goals.

- **"EVs are for Everyone"** - is a new Austin Energy initiative to conduct electric vehicle outreach, program development and deployment with a focus on low to moderate income communities.

- **Two-Wheel E-Ride Rebates** – Austin Energy also offers rebates on electric bikes, scooters and motorcycles as an additional way to promote electric transportation. These rebates are available to individuals and to businesses and organizations offering these e-vehicles in fleets ranging in size from 5 to 25 vehicles.[44] The non-profit Bike Texas is Austin Energy's lead community partner in this effort, and through Austin Energy's rebate program, Bike Texas has secured 25 electric bikes that they use to provide public demonstrations to encourage adoption of e-bikes.[45]

- **EV-Share Pilots** – The Austin Transportation Department is also preparing to launch public/private initiatives for electric bikeshares, electric scooters, and electric pedicabs

- **Studying and Managing the Impact of EVs on the Grid**
  In the long run, electric AVs will be a crucial technology for managing loads on power grids fueled by renewable energy sources. AVs will supply valuable data that will enable utilities to predict future demand for electricity as well as automatically schedule vehicle recharging and efficiently move vehicles around to spread the load more evenly.[46] Austin Energy is integrating electric vehicle charging into their demand-response programs and has successfully conducted a pilot to demonstrate that plug-in charging can be centrally managed, further improving grid reliability. Funded by the U.S. Department of Energy, Austin Energy's 'Austin SHINES' project is using an open standards-based approach to integrating photovoltaic solar and storage into the grid.[47] The lessons learned from the SHINES project can be applied so that in the future EVs can more readily serve as a distributed energy resource asset to support grid reliability, reduce fuel cost and

maximize the reduction in CO_2 emissions by timing charging with the most efficient and clean generation of electricity. Austin Energy also launched a pilot time of use rate called EV360 to incentivize EV customers to charge off grid peak at home.

In the future, further study of this issue would be beneficial, along with additional pilots that will validate other evolving charging and storage opportunities. In particular, examination of impacts on distribution infrastructure, including upgrades to maintain reliability and expansion to accommodate increasing needs for facilities will be critical to understanding how best to roll out new programs.

MUNICIPAL FLEET ELECTRIFICATION

In May 2016, Council passed a resolution directing the City Manager to develop an assessment to determine the benefits, timeline and feasibility of increasing electric vehicle adoption into the City's Fleet, and deliver recommendations for opportunities to the Council Mobility Committee by October 5, 2016.

In response, Fleet, Austin Energy and the Office of Sustainability, worked with RMI, Vulcan and the Electrification Coalition to research and analyze options, develop cost models and develop recommendations. To assess feasibility, staff examined the strengths, weaknesses, opportunities and threats that exist in the current automotive and equipment industry, as well as the resources required and prospects for success.

Based on this, the following recommendations were delivered in October 2016:

- Add 330 plug-in electric vehicles to the City fleet by 2020,
- Expand City Fleet charging stations to support city fleet EV adoption,
- Fund electric vehicle acquisitions through municipal leases (lease-to-own), when feasible,
- Fund charging infrastructure through an interdepartmental fuel surcharge, and
- Total cost of ownership savings of $3.5 million to the City of the 10 year life-cycle of the new EV fleet[48]

In August, Council approved the first installment of vehicles associated with this initiative. Fleet will be ordering 28 Chevy Bolts to be used by various departments. Council also authorized the purchase of an electric employee shuttle bus that should begin operations in the next few months.

As this roll-out of EVs into the City's fleet occurs, staff will be monitoring and analyzing areas of increased adoption based on cost savings and new technologies to include availability of electric trucks and SUVs.

Capital Metro is also working with the City of Austin's Fleet Operations and Austin Energy to deploy a fleet of electric vehicles for employee fleet use. Staff is coordinating opportunities for joint purchasing and procurement. Charging infrastructure is being installed at Capital Metro facilities in coordination with Austin Energy's EV infrastructure plan, for both fleet vehicles and personal EVs.

ELECTRIC VEHICLE (EV) CHALLENGE

A regional group of stakeholders is developing a shared electric vehicle proposal, should the Central Texas region receive funds as part of the legal settlement that was approved as mitigation for Volkswagen's emissions-cheating scandal. As a result of the settlement, Texas is eligible for almost $192 million, if the governor accepts the funds, and the Travis County-area could be eligible for some $29 million, if funds are

dispersed geographically according to the number of vehicles that had been altered.[49, 50] This "EV Challenge" group includes a number of City departments—the Intergovernmental Relations Office, Office of Sustainability, Austin Energy, Austin Transportation and Fleet Services—and Capital Metro. The group is advancing ways to work with other Texas cities to conduct a group/bulk-buy of electric vehicles to bring prices down and spur related economic development throughout the state.

TRANSIT SYSTEM ELECTRIFICATION

Many transit systems around the country are moving swiftly to replace their gasoline or diesel powered fleets with electric buses. The Antelope Valley Transit Authority (AVTA), serving a 450,000 resident community in northern Los Angeles County, set a goal to convert all of its aging diesel buses to a 100 percent battery electric bus fleet, by purchasing up to 85 new all-electric buses in three years to be "100% Green by 2018."[51] This spring Seattle's King County Metro Transit announced plans to acquire 120 all-electric battery buses by 2020, creating the largest all-electric transit fleet in the nation.[52]

Research has shown that the total lifecycle cost of an electric bus is commensurate with the total lifecycle cost of a diesel bus, with operating cost savings from electric power offsetting the higher capital outlay to purchase the vehicle and associated charging equipment.[53] New York City Transit conducted an analysis that compared its current fleet of buses to electric buses. The study found that the cost savings associated with fuel and bus maintenance more than offset the higher cost of electric buses including the cost of charging infrastructure over the lifetime of a bus.[54] Electric buses cost approximately $300,000 more than diesel buses. Annual savings are estimated at $39,000 per year over the 12-year lifetime of the bus, totaling a $468,000 in savings per bus, over the lifetime of the bus.[55]

These savings exclude the health care cost benefits associated with reduced levels of air pollution. Switching to electric buses eliminates the air pollution caused by diesel bus fuel combustion. The resulting health benefit to the population of the city from the reduction of respiratory and other diseases is estimated at $150,000 per bus based on EPA data.[56] When health benefits and financial benefits are combined, total savings exceeds $600,000, based on these estimates.

Capital Metro is planning and preparing to integrate electric buses into its fleet, concurrent with the implementation of the Connections 2025 Plan and the next procurement cycle for new buses in FY 2021. In support of that deployment, the following activity is underway:

- Coordination between finance, planning and operations departments to identify an appropriate funding mechanism to fund the increased capital cost of an electric bus program using a total cost of ownership model,
- Reviewing available grant funding opportunities for potential revenue to support the electrification of the fleet, and
- Installing basic infrastructure for electric buses at the North Operations and Maintenance facility. By early 2019 the bus yard at that facility will be "electric bus ready" and include parking configurations and electric service necessary to support the implementation of electric buses

ELECTRIC BATTERIES, PUBLIC AND PRIVATE CHARGING STATIONS

In order to support the increasing electric vehicle market and reduce range anxiety, more public and private electric charging stations should be supported. These technologies will also benefit autonomous personal and commercial vehicles, including a rise in land delivery bots and a projected surge in electric bikes, or e-bikes.

New EV fueling stations will also likely need to be co-located with other modes of mobility such as public transit stations, car-sharing services, bike-sharing services and ride-hailing pick-up and drop-off points or parking spaces. What these new mobility hubs of the future look like will be important from an urban design standpoint.

Battery technology and charging infrastructure is simultaneously experiencing rapid advances that may change what infrastructure is needed where. For example, roadway electrification is being tested in several European countries and could impact the way vehicles are recharged.

Recommendations for Electric Vehicles and Infrastructure in Austin

	TIME PERIOD	ACTIONS	POLICIES	PILOTS AND PROGRAMS
1.	On-going	Engage citizens, businesses and visitors to understand how this technology can meet their needs and help the City address community issues	Coordinate outreach/education program with other public and private organizations	Start dialogue with communities to be impacted by pilots; Extend communication across city
2.	On-going	Launch electric technology demonstrations; (See the Shared Mobility Recommendations section)		
3.	0-2 years	Adopt a buy "Electric First" or "Zero Emission" policy for all City vehicles (and consider lease instead of buy); Unless business case or technology limitations preclude early adoption	Establish "buy electric first" policy for all city vehicles; Encourage City to accelerate vehicle conversion or vehicle count elimination (above current 330 vehicles by 2020) through lease or purchase by 2020; Develop reasonable exceptions policies which recognize the longer timeframe required for certain heavy-duty work vehicles and trucks	Review costs of leases v. purchase; Expand EV charging stations at COA, Capital Metro other properties
4.	0-2 years	Deploy shared electric mobility and charging infrastructure to include low-income neighborhoods	Continue Austin Energy rebate incentives to support e-bike fleets; Allocate funds to support pilot programs and marketing	Austin Energy EV deploy car share pilot program with charging infrastructure (fleet of EVs provided by a third party vendor); Identify low-income neighborhoods; Pilot E-bike stations
5.	0-2 years	Increase public awareness of electric vehicle benefits	Increased budget for outreach/marketing, as needed; Direct staff to assist creation of E-AV demonstration	Create an Aautonomous and/or electric vehicle showcase at a major Austin-based event
6.	2-4 years	Deploy 'smart' public, private, and fleet charging infrastructure	Direct use of integrated communications and controls to proactively manage charging stations to include station reliability and enable consumer mobile apps to remotely locate and check availability of station access	Expand interactive map or application that shows the location of chargers and, current use status
7.	2-4 years	Expand rapid charging station network on-street (at curb/parking spaces); Examine free parking options for EVs	Assess feasibility and costs of expanding right of way for public charging infrastructure; Provide designated parking spaces for chargers; Consider reduced parking fees for EVs; Explore utility pole charging stations	Develop deployment plan with Austin Energy; Review/revise any related parking code necessary to implement
8.	2-4 years	Create Electric vehicle-for-hire priority access incentives for ABIA	Create permit system to allow priority access to ABIA for electric vehicles for hire	Electric chargers placed at ABIA; Create priority access pick-up and drop off locations. Partner with ABIA and AE

	TIME PERIOD	ACTIONS	POLICIES	PILOTS AND PROGRAMS
9.	2-4 years	Conduct vehicle managed charge and grid integration pilots	Conduct additional distributed energy resource studies in integrating electric vehicle charging into demand-response programs; Allocate funds for such studies	Leverage Austin SHINES project to access viability of EVs as a Distributed Energy Resource (DER) asset to support grid reliability, reduce fuel cost, and CO_2 emissions

**A set of performance metrics will be developed for each implemented action to assess the benefits and impacts of the given action.
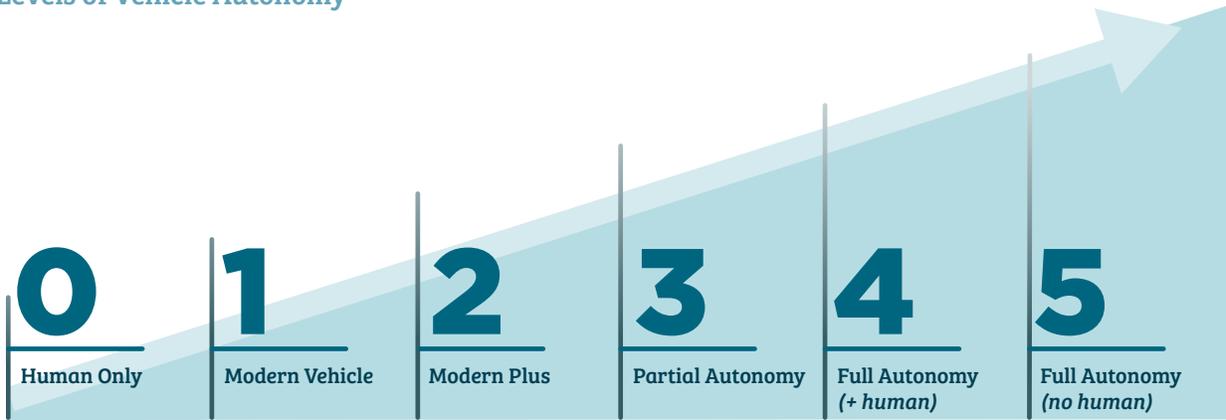
AUTONOMOUS VEHICLES

Many are wondering how and when autonomous vehicles and services will make an impact for the Austin community and how to hasten the benefits to the people.

Autonomous vehicles are developing on a gradual level. Current technologies offer some levels of autonomy such as navigation lane departure warnings and parallel parking assist while full scale autonomy, operating independent of humans, is still developing. Massive adoption of fully automated vehicles is likely 15-20 years away, according to the Boston Consulting Group, with just six percent of fully autonomous vehicles operating worldwide by 2025 and 40 percent autonomous cars by 2040.[57] Other analysts' predictions of fully autonomous vehicle adoption are similar.

The industry definitions of autonomous vehicles are important to understanding what the future holds. Level 0, as documented in the graphic below, requires full-time performance by a human driver in all aspects of driving.[58] Many of today's vehicles are equipped with cruise control, considered a Level 1, and there is extensive testing in the 2-4 range levels of autonomy. Full automation, a Level 5 autonomous vehicle, likely will have no steering wheel or foot pedals for humans to operate.[59]

Levels of Vehicle Autonomy

0	1	2	3	4	5
Human Only	Modern Vehicle	Modern Plus	Partial Autonomy	Full Autonomy (+ human)	Full Autonomy (no human)

Source: SAE J3016™
Graphic recreated, with permission, from "Future Autonomous Vehicle Driver Study," September 2016, Kelley Blue Book.

The advent of autonomous vehicles is made possible by the increasing sophistication of a variety of technologies and sensors such as radar, LiDAR (Light Detection and Ranging), and camera systems. These myriad of data generators coupled with dedicated short range communications (DSRC) wireless technology, make it possible for vehicles to "talk" to other vehicles (V2V), to the signal infrastructure (V2I) or to pedestrians (V2P) and the cloud (V2X). Wireless technologies such as DSRC or the emerging 5G applications enables vehicles to send and receive bits of information about their location, direction and speed within a short-to medium-range. Exchanging this data is key to collision avoidance, and numerous other safety features, traffic and driver assisted functions.

Autonomous vehicles also have the potential to increase the amount of public right of way infrastructure needed significantly beyond today's requirements. The amount and placement of roadside units required to send and to receive V2I communications about traffic signal phases or other vital transportation messages, along with data management and analysis systems, will need to be determined. Wireless, small-cell facilities will be needed to support integrated communications systems to ensure even, reliable coverage. Additional electric utility infrastructure may be needed to serve those systems.

Another concern to cities is that while autonomous vehicles have the ability to open up mobility, economic opportunities and improvements to quality of life, they also have the strong potential to increase single-occupancy vehicle use and significantly increase vehicle miles traveled on city roadways.

Yet still, the saturation of autonomous vehicles can also be very positive. For example, people without cars can have more freedom to travel around the city, the cost of transporting goods could drop dramatically and same-day delivery services could become more commonplace.

Public policies for autonomous vehicles, such as promoting shared mobility, can direct and harness the new technologies' best attributes.

EARLY ADOPTERS OF AV TECHNOLOGY

Technology and automotive companies are preparing to launch autonomous vehicles within three to five years, with fleet operators and ride-sourcing companies likely to be early adopters, according to a recent McKinsey & Company report.[60]

The most likely types of autonomous vehicles to enter the market first are pictured below. The Austin area has already experienced all of these types of autonomous vehicles except freight/software trains:

TRANSPORT PEOPLE

⚙ Uber, GM/Lyft, nuTonomy
◉ 4
🔒 4,000-6,000 lbs
👤 4-6 passengers
⏱ 25-35 mph
📍 Pittsburgh, San Francisco, Singapore

⚙ Navya, Local Motors, Easymile, Auro Robotics
◉ 4
🔒 6,000-8,000 lbs
👤 10-12 passengers
⏱ 25-35 mph
📍 Lyons, Helsinki, Washington D.C.

Autovot/Taxibot
✓ Has been tested in Austin

Driverless Shuttle
✓ Has been tested in Austin
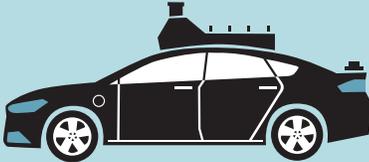
Autovot: AV taxi providing sequential private rides **Taxibot**: AV taxi shared simultaneously by several passengers
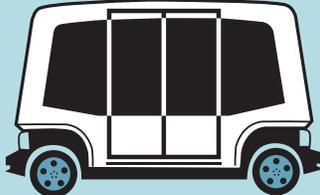
Automated minibus for carrying groups of people over short distances, usually on pre-mapped routes

TRANSPORT FREIGHT

⚙ Starship Technologies
◉ 6
🔒 40-55 lbs
👤 0 passengers
⏱ 4 mph
📍 Talinn, London, Bern, Redwood City, CA, Washington D.C.

⚙ Otto (Volvo), Scania
◉ 18
🔒 33,000 lbs
👤 44,000 lbs cargo
⏱ 55 mph
📍 Colorado, Rotterdam, EU (various)

Deliverybot
✓ Has been tested in Austin

Software Train
✓ Has been tested in Texas

AV cart providing last-mile light goods distribution
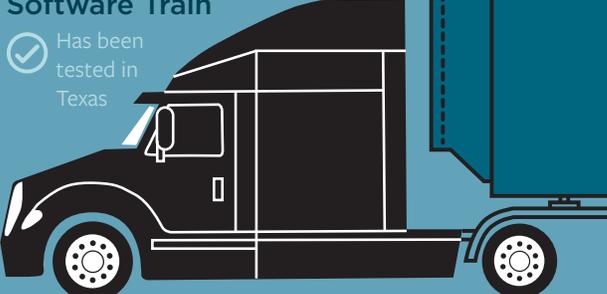
Single or platooned tractor-trailer providing long-haul freight transport

Graphic recreated, with permission, from "Taming the Autonomous Vehicle: A Primer for Cities," March 2017, Bloomberg Philanthropies.

Consumer adoption will likely begin in the late 2020's and build over time. Research scientists and sociologists tend to give more conservative estimates:

> "AV technology won't be fully mature for another ten years, and it could be 40 years until they truly own the roads. In the long interim, autonomous vehicles will need to navigate among and around us imperfect humans, so their ability to dramatically reduce congestion will be limited."
> – Raj Rajkumar, expert in vehicular information technology from Carnegie Mellon University[61]

INCENTIVIZING AUTONOMOUS VEHICLE DEVELOPMENT AND OPERATIONS

Austin's U.S. DOT Smart City Challenge response was chockful of ideas to pilot shared, electric and autonomous vehicles, particularly when packaged together. Austin is continuing its efforts to test drive AV technology in the following ways:

- Hiring an Executive Officer to lead Shared, Electric and Autonomous programs

- Austin Transportation and Capital Metro are preparing for a pilot of Direct Short Range Communications (DSRC), the current communication standard proposed by the federal government. This technology is capable of electronically conveying basic safety messages between vehicles, signal infrastructure and traffic operations. The pilot will yield valuable learnings about the applicability of the technology to corridor improvements that can also support the deployment of automated vehicles. The pilot is being pursued with private sector partnership and will set the stage for other infrastructure and vehicle pilot deployment opportunities.

- Austin Transportation, Capital Metro and the Rocky Mountain Institute (RMI) are also teaming up to pilot automated shuttles in the Austin area. A first effort will improve public awareness of the coming technologies and allow evaluation of its capabilities for use in multiple settings. The applications can range from first and last mile to support transit needs, to airport or large development transportation. A Request for Information from AV manufacturers is currently being prepared. The approach will be technology agnostic, meaning a variety of vehicles could be used or co-mingled to meet the needs of each pilot project.

- The Austin City Council recently approved the use of sidewalks for the priority of delivery bots. Pilots will test delivery robots in select neighborhoods to determine use rates and identify infrastructure issues.

- Explore "mobility as a service" options that are both electric and autonomous and that reduce single occupancy vehicle trips.

- In support of fleets of autonomous vehicles, whether for passenger or freight transportation, Austin is reviewing the possibilities and technologies related to curb access, electric recharging at on-street parking spaces, multi-modal transportation hubs and creating designated areas for AVs between uses to reduce unnecessary circling.

While developing policies that support new technologies and services, officials should consider how autonomous vehicles can help:

- Provide value to the community in the form of new mobility options, shared data and help with affordability, equity and economic development goals,
- Emphasize safety as a priority—from new technology testing to investing in sidewalks and bike lanes for safe passage to and from new mobility services, and
- Focus on moving people versus cars—through management of the built environment and right-of-way with future mobility oriented development and active use of curb space

Capital Metro, UT- Center for Transportation Research, and McDonald Transit recently collaborated to bring an Easy Mile autonomous shuttle to Austin for a multi-day demonstration and learning event. Capital Metro and Austin Transportation will continue to work with technology providers to research and demonstrate the feasibility of autonomous vehicles that enhance current public transportation options.

As AV demonstrations and discussions are occurring across the nation, City officials are cooperating with other cities, industry, research and government experts to develop best policies and practices for our region. The City of Austin is collaborating with leading world cities through the Bloomberg Institute to formulate model AV policy for consideration. The City also participates in NACTO, Transportation for America and the Texas Innovation Alliance.

REGIONAL AND STATE COLLABORATION ON AVs

As part of Austin's on-going Smart City efforts, Austin Transportation is collaborating with partners such as the University of Texas—Center for Transportation Research, Capital Metro, CTRMA, Texas Innovation Alliance, RMI and other experts to monitor AV development trends across the country and around the world. The team continues to work in conjunction with the Texas Innovation Alliance, TxDOT and other city, state and national organizations to conduct pilots, share lessons and ensure the adoption of AV results in a net benefit to Austin community as a whole.

Recommendations for Connected and Autonomous Vehicles in Austin

	TIME PERIOD	ACTIONS	POLICIES	PILOTS AND PROGRAMS
1.	On-going	Engage citizens, businesses and visitors to understand how this technology can meet their needs and help the City address community issues	Coordinate outreach/education program with other public and private organizations	Start dialogue with communities to be impacted by pilots; Extend communication across city; To focus on safety and accessibility
2.	0-2 years	Hire an Executive level Officer of AV/EV Transportation	Support funding for new positions to support new mobility direction	Existing Assistant Director position will be used for new position; Work plan to come
3.	0-2 years	Develop a Master Plan roadmap for emerging electric–autonomous vehicle (E-AV) technologies to pursue	Co-fund master plan by the City and Capital Metro; Direct long-term technology policy development, private sector engagement/ partnership strategy with national experts and community resources	Current small scale pilots for AVs and EVs will help inform larger, long-term strategies and needs, help develop successful processes for engagement with private sector; Report to recommend priority AV/EV pilot projects to pursue. Allocate funding for report
4.	0-2 years	Create an AV interdisciplinary Work Group	Direct staff to create workgroup to examine policies across all departments and agencies that supports safe, shared and equitable AV development	Work with leading cities and organizations to help craft policies and practices
5.	0-2 years	Test Dedicated Short Range Communication (DSRC) technology for vehicle to infrastructure (V2I) reciprocal safety messages	Approve demonstration project to test DSRC safety messages pilot	Test DSRC and V2I technologies for safety messages, communications effectiveness, data analysis and future applications
6.	0-2 years	Test 5G technology for vehicle to infrastructure (V2I) reciprocal safety messages; Compare to DSRC	Approve City and partners grant application to National Science Foundation for 5G demonstration project in Austin	Test emerging 5G V2V and V2I technology, safety messages; communications effectiveness, data analysis and future applications
7.	0-2 years	Increase public awareness of electric autonomous shuttles in various Austin locations through EV/AV pilots	Create fund for purchase of vehicles, infrastructure equipment and outreach/marketing, as needed	Issue RFI to Pilot electric autonomous shuttles near 1) ACC Riverside Campus 2) Domain retail area 3) Airport (ABIA) parking lots
8.	0-2 years	Increase public awareness of last mile EV/AV delivery robots	New city Resolution No. 20170810-012 approved by Council established policies for delivery bots	Test delivery robots in select neighborhoods to determine use rates and identify infrastructure issues; Issue RFI for private sector to deploy the robots and for the City or a university partner to evaluate the results

	TIME PERIOD	ACTIONS	POLICIES	PILOTS AND PROGRAMS
9.	0-2 years	Establish an EV/AV Commercialization Opportunities/ Economic Development Work Group	Direct staff to facilitate public, private and tech community alliance workgroup to create an EV/AV technology business development and recruitment strategy	Build on existing economic development processes and groups
10.	0-5 years	Create Shared/EV/AV focused team	Fund creation of new dedicated positions supplemented with existing staff; Co-fund shared staff with Capital Metro	Use Fellow programs, opportunities to support current efforts while building internal staff capabilities
11.	2-4 years	Increase public awareness of electric and autonomous vehicle benefits	Increased budget for outreach/ marketing, as needed; Direct staff to assist creation of EV/AV and/or E-AV demonstration	Create an autonomous and/or electric vehicle showcase at a major Austin-based event
12.	2-4 years	Create a regional New Mobility Workforce Training task force for new job training and educational opportunities for developing new technology skills sets and retraining those with legacy occupations	Direct creation of a multi-department, agency and private sector and citizen task force to recommend best practices nationwide and approaches for City of Austin and region	Facilitate workgroup to determine opportunities; Pilot new technology classes and internships between technology and area educational institutions; Promote emerging industry sectors to raise awareness

**A set of performance metrics will be developed for each implemented action to assess the benefits and impacts of the given action.

THE CONVERGENCE OF SHARED-USE, ELECTRIC AND AUTONOMOUS VEHICLES

Shared, electric and autonomous vehicle technologies each offer their own sets of benefits and challenges. As previously discussed, electric vehicles will decrease emissions over existing gas-powered vehicles, while autonomous vehicles can increase safety and provide mobility solutions for seniors, the disabled and people without driver's licenses. Pairing electric motors with autonomous vehicles can bring these environmental, safety and accessibility benefits together. The challenges lie in motivating consumer behavioral changes, when the financial and convenience aspects of shared, electric and autonomous vehicles meet or exceed current technologies.

The biggest game changer for mobility, however, is in shared-use mobility which allows options to travel without needing to own a vehicle. Shared-use mobility can reduce congestion, greenhouse gas emissions and household transportation costs, even without the benefit of electric and autonomous vehicles, offering a more immediate way to shape the future with affordable, accessible and equitable multimodal options.

These impacts will be even more pronounced in the future. A recent Department of Energy report from their Vehicle Technologies Office showed that the disruption that connectivity and automation brings to the transportation sector could result in a potential 200 percent increase in 2050 baseline energy consumption, or a 60 percent decrease in energy use.[62] Increases could be caused by many factors, including easier travel and more accessibility, whereas harnessing connected and automated technologies to enable ride sharing, drive smoothing, and vehicle resizing, could decrease energy consumption. Austin will continue to follow their research to better understand how to make use of the technologies to make mobility more energy efficient.

The convergence of shared, electric and autonomous vehicle services can offer a lower cost, more efficient and accessible, less polluting and less congested transportation system. Wrangling all three of these technologies and services together requires a dedicated effort that focuses on data, governmental policies and incentives, technology applications, testing and multiple touchpoints with the community. Cultivating shared mobility practices now is important to start the behavioral shift towards a shared, electric autonomous vehicle future.

> "The age of shared autonomous electric vehicles is upon us and now is the time for automakers, suppliers, and cities to begin taking the bold steps necessary to thrive in this rapidly changing world."
>
> –Justin Rose, Partner at The Boston Consulting Group and Global Leader of BCG's Digital Efforts for Industrial Companies.[63]

The Austin City Manager's Office recently approved a position for an Executive Officer within the Austin Transportation Department dedicated to these tasks. The drive to fundamentally change the way people approach mobility will take a community-wide effort.

FLEETS AS EARLY ADOPTERS

Shared E-AVs are expected to appear first in fleets—TNCs and vehicles for hire— for financial reasons: like labor costs, maintenance and fuel, as well as the ability to continually use the vehicle, and monetize the asset. The move to shared E-AVs will be gradual, starting in the 2020s.[64] The transition is likely to begin in cities—like Austin—where the population exceeds one million people and fleet utilization is high while congestion and the costs of private vehicle ownership are pain points for residents.[65]

This shift of miles driven from private vehicles to shared E-AVs results from reduced transportation costs. Shared E-AVs have the ability to cut transportation costs by up to 60 percent[66] By some estimates, using

shared E-AVs for people who own a car and drives 10,000 miles a year have the potential to cut the cost of transportation from around $1.20 per mile to around 50 cents per mile. Over the course of a year, that could put more than $7,000 in that driver's pocket.[67] Congestion and parking pressure can also be reduced with shared E-AVs. Most private vehicles sit unused for 95 percent of the time. Numerous studies have shown cars circling for parking in a city center can amount to 30 percent of the areas' congestion.[68] Today, shared fleet vehicles have a utilization rate of 50 percent to 60 percent.[69]
.

INCENTIVES AND POLICIES RECOMMENDED

The Boston Consulting Group found that even in larger cities—where shared E-AVs—would offer the greatest benefits, many people remain skeptical of the technology or are unwilling to give up the conveniences of a private vehicle.[70] Transparent cost expectations need to be developed so consumers and businesses can weigh the advantages of moving toward a shared E-AV community. To reach a desired outcome of less congestion, fewer emissions and more affordability, the City of Austin and other stakeholders should create a menu of incentives, fee impacts and policies that promote the adoption of shared E-AVs.

The ICCT and the Institute for Transportation & Development Policy recommend:

- Policies, such as a Zero Emission Vehicle plan or free express lane access,
- Consumer purchase incentives,
- Widely available workplace and public charging points,
- Promotional and public awareness campaigns, including price incentives,[71]
- Electricity decarbonization policies such as carbon taxes or cap-and-trade systems,
- Vehicle travel fees tied to vehicle occupancy that could vary in length of trips, vehicle carbon intensity, or level of congestion,
- Encourage bike or e-bike sharing systems,
- Urban planning investments in walking, cycling, and public transit infrastructure, and
- Implement compact, mixed-use, land use policies focused on linking development zones through and public transit and featuring cycling and walking zones, to shorten the length of trips[72]

DATA AND TECHNOLOGY

Although the focus of this report is on shared, electric and autonomous vehicle services, there is another component to this future mobility vision: data management. Data management is part and parcel of a smart city mobility solution, yet the biggest challenge today for aspiring smart cities is, data, specifically the lack of it.

After reviewing the U.S. Department of Transportation June 2017 report "Smart City Challenge Lessons Learned" and examining the Smart City Challenge Dataset,[73] Thomas Grogan, of Vergys, opined in an ENO Center for Transportation Op-Ed that the top two data challenges cities face are:

- Limited data to monitor the transportation system, and
- Limited tools to support data-driven decision-making.

To manage transportation for specific access, mobility, affordability, safety and emission outcomes, city and regional partners need to rely on current, live, reliable data—the kind of data and analysis that we often lack today. The data of tomorrow for shared, electric and autonomous vehicles will be even more sophisticated, elaborate, voluminous and complicated.

INCREASE IN DATA NEEDS AND ANALYSIS

Cities are starting to collect and manage data from a wide variety of sources including connected DSRC, bluetoot and smartphone data, along with a host of new sensors that can measure air quality to road temperatures and conditions and more. Expansion of DSRC or 5G technology could be the connective tissue that delivers smart mobility linking shared/EV/AV mobility to the infrastructure and to the cloud.

Connected vehicles, using DSRC technology, exchange data between vehicles, infrastructure and smartphones. Accessing the data can help the City perform its functions more efficiently. For example, knowing that safety-related messages are passed between vehicles frequently at a certain location will enable City staff to identify and remedy an unsafe condition. The City can also disseminate information more easily to travelers in a connected environment. Rather than placing physical dynamic message signs around town that alert drivers to certain situations, the messages could be delivered directly to vehicles or to smartphones, allowing for a more customized and effective alert system.

"Autonomous vehicles could be the most important opportunity in history for cities to expand the scope and quality of data they collect about what's going on," according to a recent Bloomberg Philanthropies – Aspen Institute report.[74] The movement of AVs will provide crucial insights for street and curb space management. AV taxis will provide vital clues about transportation demand. Properly equipped with the right sensors, AVs would be ideal platforms for noise and air quality monitoring, pavement monitoring and performance

COLLABORATION IS KEY

The National Association of City Transportation Officials (NACTO) issued City Data Sharing Principles[75] to integrate new technologies into the management of city streets. They encourage data exchanges between the city and private mobility providers to allow for more data-driven transportation planning.

NACTO further recommends transportation planning at all levels should refocus on modernizing existing expressways with instrumentation for new technology. Adding sensors, video equipment, and new DSRC and 5G technologies along roadways will improve the quality of the data collected. It will also allow for better active

traffic flow management. Interoperable electronic data exchanges with other agencies, mobility providers, and connected and autonomous vehicles will provide richer travel information to the public and transportation management services, through transportation apps.

A new report by the Brookings Institution cites the challenges of government playing catch up to the rate of data innovation, and observes that,

> "Google—via its mapping division—now knows more about where people move on a daily basis than their peers in local government who build the roads, rails, and sidewalks that facilitate such travel."[76]
>
> - Report, Modernizing Government 's Approach to Transportation and Land Use Data

The integration of public-private data sharing can offer clear advantages to the public sector by capitalizing on data already collected, the authors conclude.[77]

DATA PLATFORMS

It is expected that platforms will play a vital role in the smart city. Platforms form the basis on which smart technology is built—for example, operating systems, chipsets and communication protocols.[78]
New technological possibilities are driven by data. And data is managed through platforms, driven by algorithms, and designed with a set of rules that can include or exclude people, populations or areas.

In a new mobility world, the public sector will need to collaborate with the private sector for an array of services. A city or regionally managed transportation platform operated by the private sector can help assure city values are met and private sector know-how is maximized. The public sector needs to build its knowledge about the use and management of data in order to collaborate with the private sector across platforms and manage projects and services for intended outcomes.

USES OF DATA

Evaluating "big data" that comes from a variety of sources will help mobility planners know better how people move. That data can be employed to evaluate a variety of scenarios and needs, such as optimizing transit and travel demand, use of curb space, to understanding bicycle and pedestrian travel patterns, and helping prioritize sidewalks and bicycle lanes.

As a practical example, the Smart State Transportation Initiative (SSTI) collaborated with Sacramento on the first study to advance best practices in the use of two emerging technologies: accessibility metrics and trip-making data from mobile devices. This study brings together these technologies and tests their application in identifying opportunities to improve first- and last-mile connections to light rail transit in Sacramento.[79] The data can also inform other uses such as guiding transportation- and land use-related decisions.

As programs and pilots develop, it will be important to make sure citizens data is protected, anonymized and minimized through policies vetted with the public and rules of engagement that are straight forward and publicized. This will be an ongoing conversation with the Austin public. Getting data practices and policies in place now can help with the transition to autonomous vehicles.

ONE SYSTEM

On a broader level, the Austin Transportation Department is championing a "**One System**" integrated approach to traffic and data management with our regional transportation partners, (Texas Department of Transportation, Capital Metro and Central Texas Regional Mobility Authority.) Plans to co-locate traffic management center operations as an interim measure are currently underway. The larger piece of data integration in a **Data Rodeo**, a data commons, will require some policy action to create cooperative data agreements to support transportation efficiencies, faster emergency response, multi-modal support and transportation demand management, all enhanced with the combined use of sensors, real-time data, analysis and predictive analytics. This **One-System** approach is considered a vital first step to managing data across siloes, and preparing for more robust integration with the private sector.

DATA RODEO

The Data Rodeo, which works in concert with the **One System Traffic Management Center**, is a City of Austin and University of Texas – Center for Transportation Research collaboration to make transportation data more accessible to professionals, the public and private companies. By making data more accessible, not only can it be used to improve transportation operations and planning, but innovation through the creation of technology tools and apps becomes possible.

Recommendations for Data and Technology in Austin

	TIME PERIOD	ACTIONS	POLICIES	PILOTS AND PROGRAMS
1.	On-going	Promote community dialogue, public engagement and education on data and mobility innovations	Co-fund multi-year, coordinated outreach/education program with other public and private organizations; Collaborate with ASMP and Project Connect outreach	Start dialogue with Riverside corridor and extend across city on data privacy, cyber security; Transportation technology advances
2.	On-going	Invest in and leverage technology to improve mobility; Support traffic "Data Rodeo" collaboration	Create inter-local data sharing agreements; Adopt standards for data organization and data types that promote open data	Manage city data sets to be interoperable with other data sets in the public or private sector
3.	On-going	Promote public-private data partnerships for transportation information to optimize mobility options; Support Austin CityUP and community data hack-a-thons	Establish public priorities and private incentives and standards for data sharing	Create enhanced traveler information system and technology tools that connect transportation options
4.	0-2 years	Create a data analysis contract and grow internal capability	Invest in city data development and analysis; Fund initial contract; Support funding for future internal data staffing requests	Contract with private sector to measure pilot programs impact; Applicability of technology offerings
5.	0-2 years	Examine kiosk technology for multi-modal transportation information; Wi-Fi access	Review/revise community standards for signs, advertising in public right of way	Capital Metro pilot on Capital Metro property to determine usage of kiosks
6.	2-4 years	Create "One System" regional integrated approach to traffic operations	Create inter-local agreements with agencies and organizations to share traffic management technology, infrastructure and staff; Develop mutually agreed upon operating objectives	Provide real-time data to traffic operations and public; I-35 Integrated Corridor Management Program
7.	2-4 years	Equip city fleet with DSRC technology and/or other vehicle sensors	Fund technology applications to use city fleet as transportation sensors; Require all City vehicle purchases to come equipped with connected vehicle technology	Set up program to track and analyze data gathered from connected vehicles
8.	2-4 years	Develop a technology-driven universal way-finding system for public and private parking to optimize parking assets, manage congestion	Consider market rate variable on-street parking pricing to promote an integrated system	Pilot with limited public and private garages; Pursue low-income worker parking and shuttle options simultaneously
9.	2-4 years	Reexamine curb and parking technology applications to actively manage use	Establish public priorities for curb and parking access for all transportation modes	Test applications of curb and parking prioritization

TIME PERIOD	ACTIONS	POLICIES	PILOTS AND PROGRAMS
10. 2-4 years	Reexamine right of way technology applications to actively manage use of right of way	Create public priorities for right of way access for all modes of transportation	Test applications of right of way prioritization

**A set of performance metrics will be developed for each implemented action to assess the benefits and impacts of the given action.

LAND USE AND INFRASTRUCTURE

The City of Austin needs to consider how these disruptive technologies may affect the physical landscape in the coming five, 10 and 15 years, and how we prepare for it. From a land use perspective, as many experts have opined, autonomous vehicles have the potential to encourage individuals and households to move further away from the city center under the assumption that long drive times can will turn into long ride times that can be used for work or entertainment purposes. If those same vehicles were electric, it may reduce emissions, but not the area's congestion problem. In addition, redevelopment of land for shared mobility use or for infrastructure needed to support EVs and AVs could put increasing price pressure of property values, especially in neighborhoods located proximal to downtown Austin and to regional transit hubs.

IMAGINE AUSTIN

Our community's comprehensive plan, Imagine Austin, reflects the following key land use guidance:

- Higher density – promoting a compact and connected community, including density along key urban transit/travel corridors, enhances shared mobility outcomes of affordable and accessible transportation because operating costs for providing services are lower,
- Transportation options – a transportation network that provides a wide variety of options, which are efficient, reliable, and cost-effective to serve the diverse needs of our citizens, and
- An integrated transportation system – that is well-maintained, minimizes negative impacts on natural resources, and remains affordable for all users

Based on research of disruptive technologies and interviews with metropolitan planning organizations across the country, Dr. Erick Guerra, a Planning professor at the University of Pennsylvania advises:

- Don't envision a "perfect future where the technology totally or immediately eliminates huge problems like congestion, crashes, or pollution,"
- Develop plans that can be adapted to evaluate "a range of potential outcomes, and"
- "Pursue investments that make sense with or without driverless cars"[80]

LAND USE POLICIES AND INCENTIVES

Parking and Curb Use: Parking and the use of curb space will be significant policy deliverables for cities with shared, electric and autonomous vehicles. The advent of automated vehicles will not eliminate parking, but the vehicles will likely be programmed to avoid paid or expensive parking structures. The City should look proactively at policies to actively manage the curb space on our public streets, what to require of new developments coming online, and how to reuse existing parking spaces and garages that become obsolete. Ideas include:

- **Curb Space** - As mobility on demand becomes more commonplace, will pick-up and drop-off zones become what parking is today? Should drop-off and pickup spaces be located on-street in recaptured parking spaces or designated in off-street mobility hubs? Increasingly, the allocation of curb space will be more important and a lever for policy makers to encourage specific outcomes, such as, priority for transit and shared vehicle usage, etc. Various pilots on dynamic pricing and prioritization of curb space are occurring in other cities that Austin can learn from.

- **Market-Based Performance Pricing for Parking** – The low price of on-street parking in Austin, relative to the cost of private off-street garages in the downtown area, incentivizes drivers to circle the block, hunting for street parking space, a recent downtown parking study advises.[81]

  This is despite available off-street parking. The study reported that there are more than 71,000 parking spaces downtown, but only about 6,400 spaces of those are on-street parking. And about 25 percent of all parking is not open to the public.[82]

64%
Private Parking

TOTAL PARKING SUPPLY

36%
Public Parking

Majority is **Off-Street**

Majority is **On-Street**

$3.65
Average Hourly Rate

$1.20
Average Hourly Rate

Demand for Parking

Demand for Parking
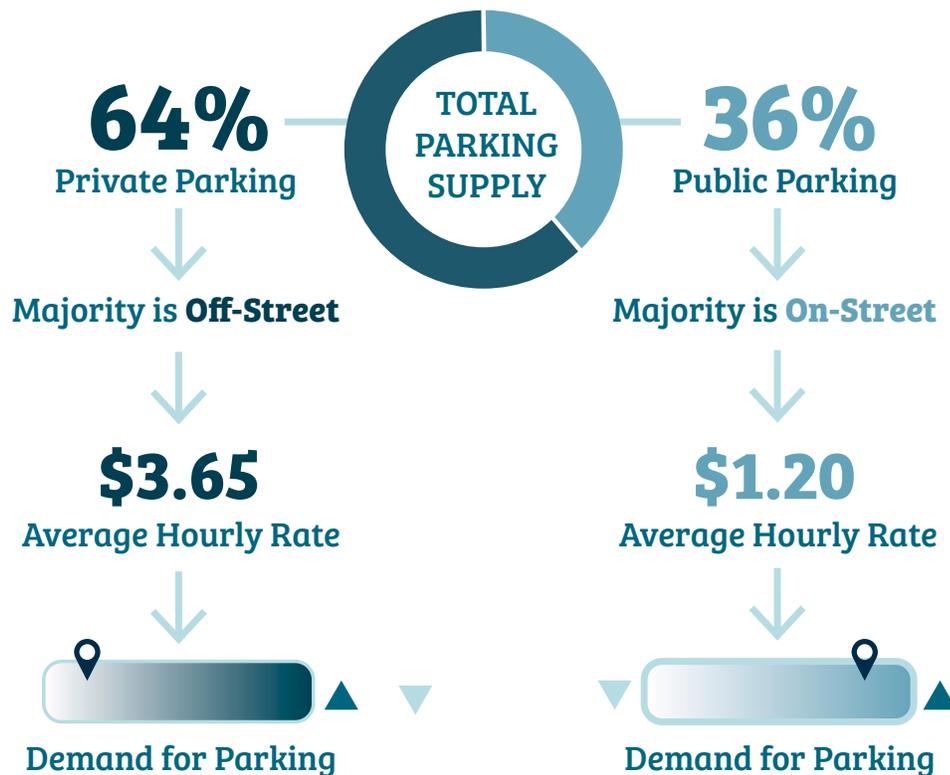
Graphic recreated, with permission, from, "Downton Austin Parking Strategy," June 2017, Downtown Austin Alliance.

The report recommends adjusting pricing/regulations for on-street spaces based on an 85 percent target occupancy rate so that spaces are consistently available.[83] Applying the true market cost of a parking space also has the effect of reducing traffic and emissions and allows travelers to make informed decisions on transportation choices and costs.

- **Allowing for shared parking between businesses** enables more efficient use of existing parking facilities, the downtown parking study also suggested. A study by the Victoria Transport Policy Institute advises parking requirements could be reduced by ten percent with shared parking and as many as 100 employees could share as few as 60 to 80 parking spaces.[84] Destinations that share patrons, can shift demand, or have peak periods (e.g. restaurants in the evening, churches on the weekends) are ideal opportunities. Changing zoning rules to allow shared parking is a key recommendation of the Downtown Austin Parking Study.[85]

- **Allow conversion of parking for public uses**, such as parklets, or outdoor cafes that enhance walkability and the vibrancy of the street scape. The Austin Transportation Department recently issued new sidewalk cafe and street patio handbooks to assist businesses seeking a conversion of uses, including parking spaces.

- **Reducing or eliminating parking requirements** - Removing the burdensome cost of parking for new developments will allow for more desirable mixed-use, walkable developments to be built.

A typical parking structure costs $25,000 to $45,000 per space depending on location and design (e.g. above ground, underground). In a high-rise building, parking can take up to 20 percent of construction costs and can also make new development financially infeasible without a public subsidy... According to a national study by the Sightline Institute, parking adds an average of approximately $225 a month to the rent of an apartment, a substantial amount to pay for the convenience of a walkable, mixed-use development.[86]

Reduced parking expectations can be combined with transportation demand management and shared-use mobility requirements and amenities that reduce single-occupancy vehicle needs. This strategy could also be combined with fees in-lieu for parking as the cost-equivalent for the cost of constructing the parking spaces.

- **Unbundling Parking Costs**– There are significant costs incurred with constructing parking– whether for residential or commercial development and for developments ranging from single-family homes to downtown high-rises. However, these costs are often opaquely passed through to tenants and can affect affordability. Allow the market to determine need and quantity of parking.

By unbundling parking costs from other development and housing costs and providing transparency about the cost of parking, the tenant would be given valuable information that they could use to make the best economic choice for themselves.

This is an approach that has been used in recent years as the West Campus-area near the University of Texas has become so densely redeveloped. The City should study that experience and further explore the issue in order to determine whether to require that the cost of parking be separated or itemized in lease agreements from other residential housing costs.

Mobility Hubs: Mobility hubs will be located at key high demand community transit areas that provide multi-modal options. The mobility hubs will provide amenities to support a successful new mobility system such as EV charging stations, shared-AV access spots, bike and pedestrian access, connected traveler information and multi-modal shared transit options.

Commensurate with enhancement of shared ride and shared parking opportunities will be the repurposing or redevelopment of land dedicated to this new function. Costs of land acquisition and redevelopment will need study as well as any potential for downstream impacts on land values and property taxes, which may negatively impact one component of affordability tests.

Mobility Innovation Zones: Mobility Innovation Zones are designated areas within Capital Metro's Connections 2025 Plan. Mobility Innovation Zones will act as incubators to demonstrate public transit services such as shared services, autonomous services and partnerships with private service providers.
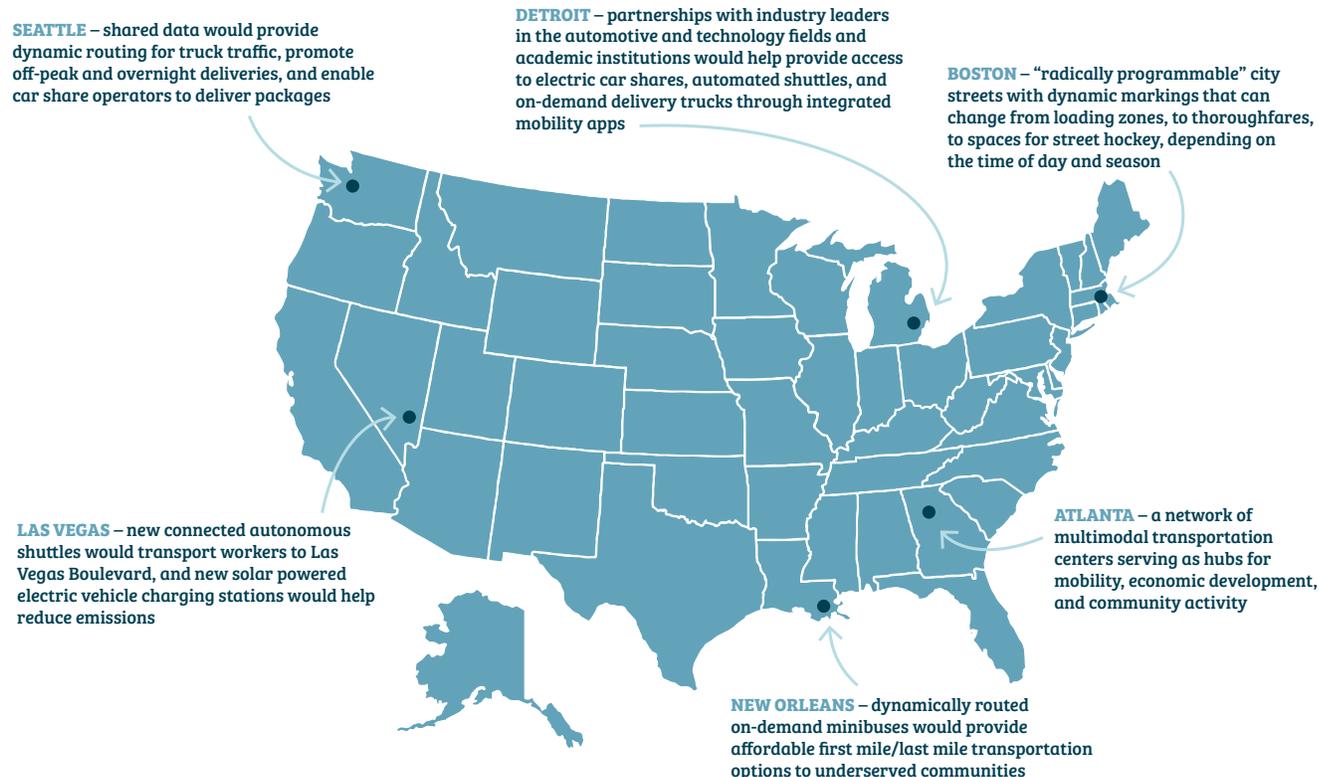
Recommendations for Land Use/Infrastructure

	TIME PERIOD	ACTIONS	POLICIES	PILOTS AND PROGRAMS
1.	0-2 years	Engage citizens, businesses and visitors on how this technology can meet their needs and help the City address community issues	Coordinate outreach/education program with other public and private organization; Collaborate with Austin Strategic Mobility Plan and Imagine Austin/CodeNEXT	Start dialogue with communities to be impacted by pilots; Extend communication across city
2.	0-2 years	Allow reduced or zero parking requirements with TDM, on-site access to shared mobility guarantees	Direct CodeNEXT to allow proactive TDM programs in lieu of parking requirements	Application of code citywide
3.	0-2 years	Establish market-based performance pricing for parking	Direct adjustment of pricing/regulations for on-street spaces to market rate to reduce traffic and emissions and allow travelers to make informed decisions on transportation choices and costs	Pilot shared garage use with limited public and private garages to optimize parking availability; Pursue low-income worker parking and shuttle options simultaneously
4.	0-2 years	Allow for shared parking between businesses	Establish new rules and incentives in CodeNEXT for shared parking requirements; Establish rules for time of use in mixed-use spaces	Pilot shared parking in mixed use spaces—such as businesses with different hours or shifts or evening residential parking
5.	2-4 years	Enhance compact and connected land use along key urban transit/travel corridors and transit oriented developments using E-AVs	Direct CodeNEXT to allow dense development along key Urban Transit/Travel Corridors and MODs	Application of code citywide; Analyze and monitor effectiveness of site-specific TDM strategies to achieve redistribution of trips to other modes
6.	2-4 years	Create policies to actively manage the curb space on public streets	Establish public priorities for curb and right of way access for all transportation modes	Test applications of curb, parking and right-of-way prioritization; Consider options for vehicle for hire drop off and pick up points
7.	2-4 years	Unbundle parking costs from city building leases and purchases for transparency	Direct study to determine city building v. parking costs for employees; Analyze employee travel demand	Develop transportation options package that discourages driving; Create a model that could be used by other businesses and agencies
8.	2-4 years	Encourage adaptable parking garages for future re-use as residential buildings, offices and retail spaces	Promote and incentivize the creation of adaptable parking garages through CodeNEXT	Review existing code developments in other cities for models
9.	2-4 years	Implement building codes to support EV-ready and EV infrastructure requirements	Adopt commercial and/or residential building codes in CodeNEXT to support EV-ready and EV infrastructure requirements	Review existing commercial and/or residential code developments in other cities for models

**A set of performance metrics will be developed for each implemented action to assess the benefits and impacts of the given action.

NATIONAL EFFORTS TO ADOPT SHARED/ EV/AV SERVICES

Different cities are experiencing different levels of success on a variety of efforts to adopt shared, electric, and autonomous technology or services. No city has a complete combination of all the solutions. The U.S. DOT Smart City Challenge Lessons Learned report[87] highlighted several innovative ideas from cities across the nation depicted in the graphic below.

What We Learned from Across America

SEATTLE – shared data would provide dynamic routing for truck traffic, promote off-peak and overnight deliveries, and enable car share operators to deliver packages

DETROIT – partnerships with industry leaders in the automotive and technology fields and academic institutions would help provide access to electric car shares, automated shuttles, and on-demand delivery trucks through integrated mobility apps

BOSTON – "radically programmable" city streets with dynamic markings that can change from loading zones, to thoroughfares, to spaces for street hockey, depending on the time of day and season

LAS VEGAS – new connected autonomous shuttles would transport workers to Las Vegas Boulevard, and new solar powered electric vehicle charging stations would help reduce emissions

ATLANTA – a network of multimodal transportation centers serving as hubs for mobility, economic development, and community activity

NEW ORLEANS – dynamically routed on-demand minibuses would provide affordable first mile/last mile transportation options to underserved communities

Graphic recreated, with permission, from "Smart City Challenge," U.S. Department of Transportation

The Austin Transportation Department also conducted research of leading cities in the areas of shared, electric and autonomous vehicle services. A summary of findings is listed in the appendix. In the various arenas, there is a lot of experimentation across the nation. Promising programs include:

SHARED MOBILITY

The City of Los Angeles partnered with the Shared-Use Mobility Center to create the Shared Mobility Action Plan for Los Angeles County. The plan stipulates a two percent vehicle reduction in vehicles on the road—approximately 100,000 vehicles—by 2021. Public transit and shared-use mobility, in the form of bikeshares, carpooling, and carsharing will help accomplish this goal.[88]

Florida's Pinellas Suncoast Transit Authority (PSTA), partnered with Uber and a local taxi company to provide subsidized late-night rides for low-income users between 9 p.m. and 6 a.m., when buses are not available. The

service expanded to include "Direct Connect," a program that allowed all passengers catch a TNC or taxi ride for just $1 to the bus stop, for the first or last mile of a trip. Passengers used a promotional code to receive the subsidy. The program expanded from two zones to eight zones that encompass the whole county.[89]

ELECTRIC MOBILITY

Los Angeles created an EV carsharing pilot in disadvantaged communities. This 100-vehicle pilot is serving areas of Central Los Angeles that ranked within the top 10 percent of needy communities according to the CalEnviroScreen index. As a part of this program, carshare operators committed to ensuring that 80 percent or more of their vehicles were electric. Approximately 110 Level 2 chargers were installed to support EVs in the pilot areas.[90]

A peer-to-peer carsharing pilot for low-income residents is up and running in Portland. Three used EVs and supporting chargers have been installed at an affordable housing complex in Northeast Portland. Community residents rent the cars on Turo.com, a peer-to-peer carsharing website.[91]

AUTONOMOUS MOBILITY

Two 12-passenger buses from EasyMile have been testing in a San Francisco Bay Area office campus parking lot. The shuttles carry select workers to the surrounding office complexes. If all goes well, the shuttles may be open to ferry all workers from remote parking lots to their offices. The shuttles could be testing on nearby streets by the end of 2017 or beginning of 2018.[92]

Hillsborough Area Regional Transit Authority (HART), in the Tampa Bay area, is preparing to launch a 2-3 year AV shuttle pilot. The shuttle will run along a closed stretch of road near one of HART's main hubs. The shuttle is meant to soothe parking pressures in the area and gauge community reactions to AV technology.[93]

SECTION 2

TECHNOLOGIES IN THE COMMUNITY
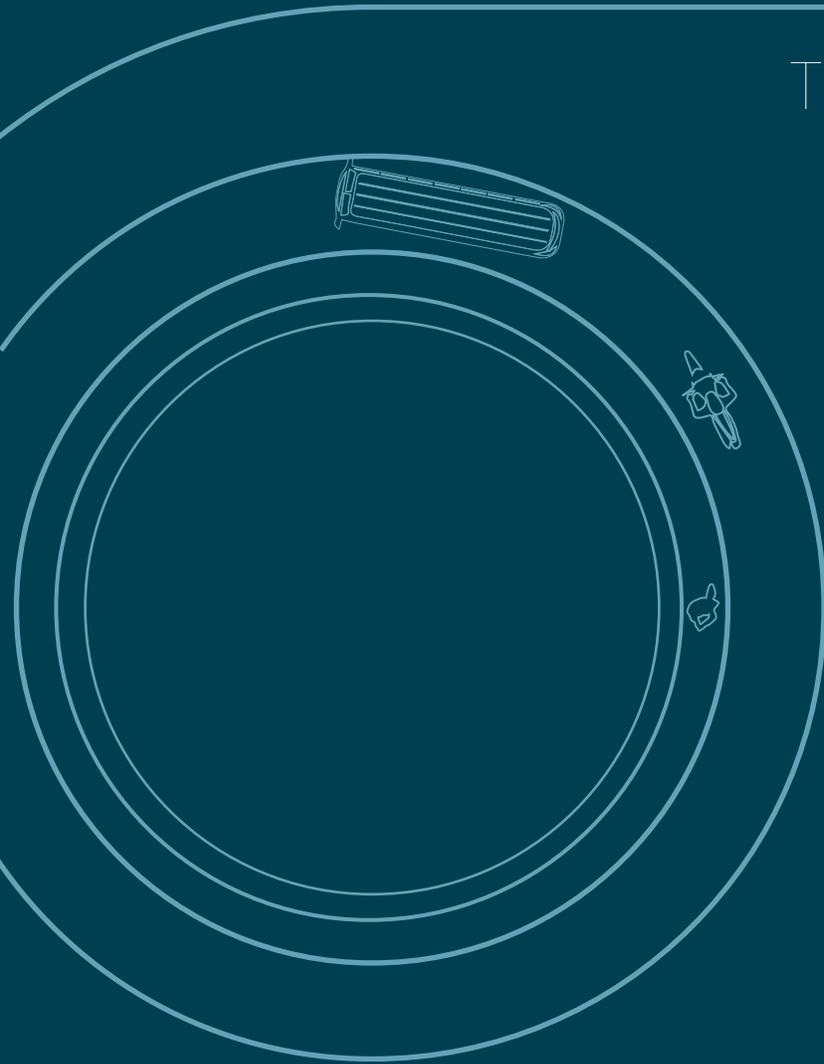
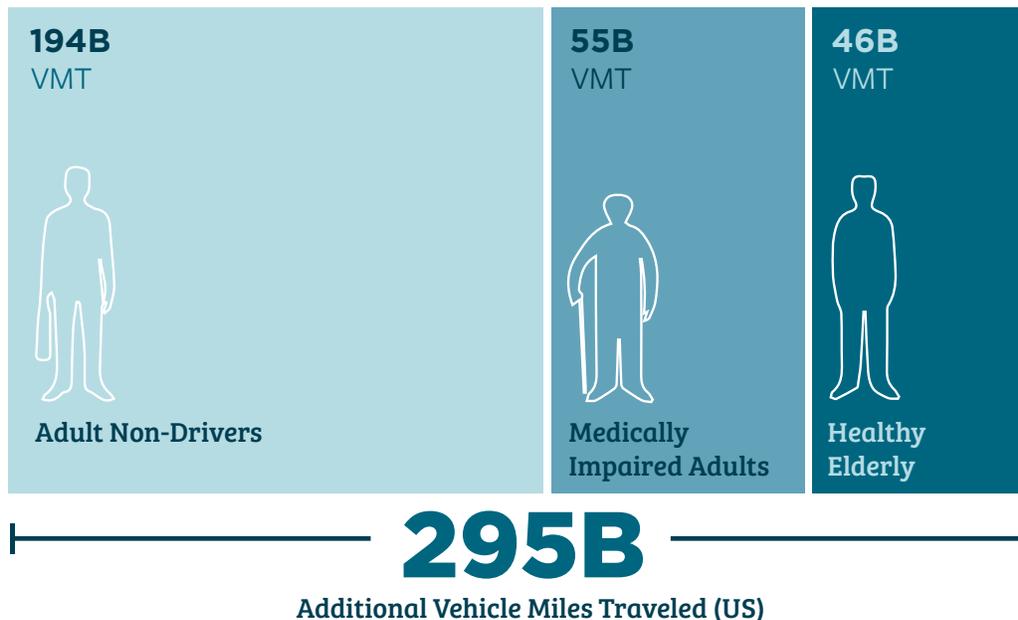# HOW THESE TECHNOLOGIES WILL IMPACT THE AUSTIN COMMUNITY

While the impact of new mobility technologies and services is not fully clear, industry and academic research forecasts provide hopeful possibilities, stark realities and policies to consider in the equity, affordability and safety arenas. This is an introduction of the topics and not an exhaustive analysis.

EQUITY

Autonomous vehicles will open up new mobility options for many underserved groups, including non-drivers, the elderly and the disabled. Yet at the same time, the new options can increase one measure of congestion, the total number of vehicle miles traveled in our community. Carnegie Mellon University predicts the rise in VMT could be as much as 14 percent for these groups with access to autonomous mobility on demand.[94] The study did not include the possible effects of increased shared vehicles in this scenario.

Who Will Travel More with AVs

AVs will potentially grow the total VMT by 14 percent, totalling up to 295 billion additional VMT

194B VMT — Adult Non-Drivers

55B VMT — Medically Impaired Adults

46B VMT — Healthy Elderly

295B
Additional Vehicle Miles Traveled (US)

Source: Carnegie Mellon University, Department of Civil and Environmental Engineering (2016).

Graphic recreated, with permission, from "Taming the Autonomous Vehicle: A Primer for Cities," March 2017, Bloomberg Philanthropies.

Capital Metro's Pickup is a new ride hailing demonstration in East Austin that runs as an on-demand service that takes passengers anywhere within its service zone. Through this partnership between Capital Metro and a private technology provider, people can request a ride directly from their phone. Pickup and similar services will be expanded as demand and budget allow.

With the new access to on-demand services, cities can invest in sidewalks and bike lanes to promote alternative transportation and protect our most vulnerable residents getting to and from these new services.

Private sector transportation companies are experimenting with changing its door-to- door pick up practices to one of designated pick up and drop off points at public intersections that more closely resemble a transit operation.[95]

Pricing and the use of dynamic pricing can be a key lever to assist economically distressed riders' trips or underserved areas. These options can include subsidizing rides for low-income passengers from the nearest transit station to home or work during commuting hours[96] Private businesses, property owners, housing authorities and health clinics can help provide funds and services to achieve specified outcomes. Those policy goals set by policy leaders can include: percent of rides taken by disadvantaged riders and percent of rides originating or ending in a low-income neighborhood that must be met or exceeded.

Recently, the Community Care Collaborative, Dell Medical School and RideAustin announced a new partnership that will bring rideshare services to low-income residents of Travis County to help them access health care. The plan comes out of a Transportation Empowerment Fund grant from Capital Metro. The pilot program will provide patients with free transport to medical appointments and pharmacies–targeting those with the greatest needs.[97]

National experts, such as the Shared-Use Mobility Center (SUMC), can provide guidance for developing additional successful pilots, learning from other cities, and leveraging the U.S. DOT "Mobility on Demand" grant programs.

AFFORDABILITY

Finding the right balance between privatization, subsidies for underserved populations, and maintaining a strong central transit system will be a great challenge. The City of Austin, Capital Metro, Austin Energy and the Rocky Mountain Institute are currently researching and developing various pilots to test in the Austin market, particularly centered on low-income or underserved areas.

Due to the high cost of living in Austin, nearly half of all residents who rent homes are housing cost-burdened, as illustrated in the graphic on the next page. Fifty-five percent of Austin residents rent their homes and apartments, as opposed to owning the dwellings.[98, 99] The U.S. Department of Housing and Urban Development considers a family housing cost-burdened when they spend more than 30 percent of their income on housing and may have difficulty affording necessities such as food, clothing, transportation and medical care.[100]

The Austin region has long been described as a "drive to qualify" mortgage environment–meaning the further you are away from the city center, the more affordable your housing becomes. Families who cannot afford to live in Austin live in the surrounding communities, creating the inevitable tradeoff of having to spend more on transportation.

An approximate 150,000 commuters travel into Austin proper each day from outside the city limits.[101] The Center for Housing Policy found for every $1 saved on housing costs, the family spends 77 cents in added transportation costs. When a person's commute exceeds 12-15 miles, housing savings are wiped out by increased transportation costs.[102]

According to the Housing and Transportation (H+T) Affordability Index, transportation costs are considered affordable if they consume 15 percent or less of household income.[103] Gas costs are only a fraction of total

Percent of Owner and Renter Households that are Housing Cost-Burdened, 2015
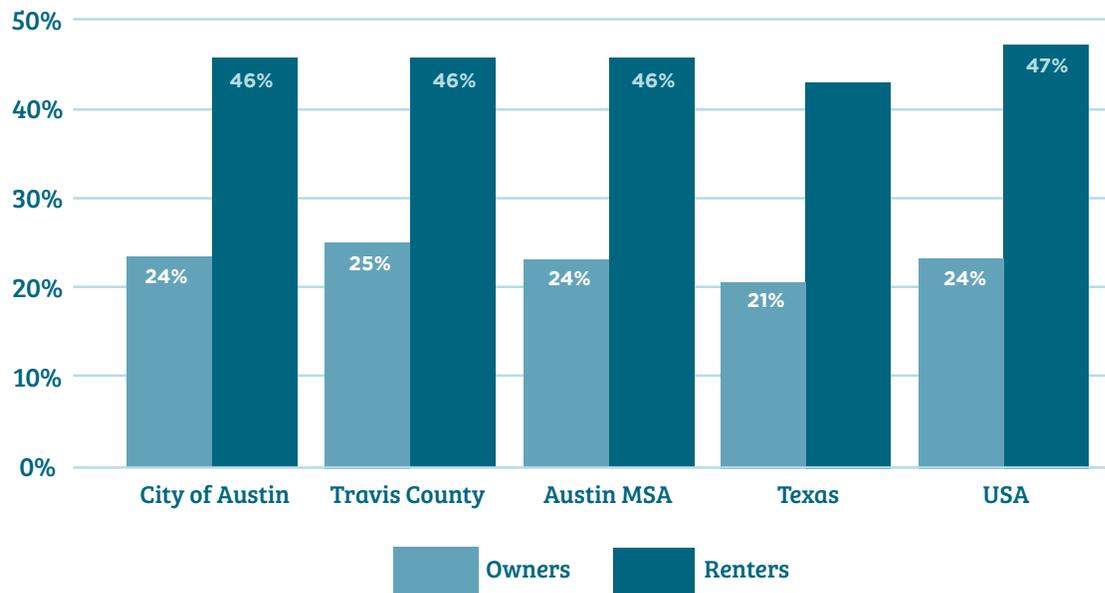
Source: American Community Survey

Graphic recreated, with permission, from "Dashboard 2017: Key Economic Indicators for Greater Austin and Travis County," May 2017, Community Action Network.
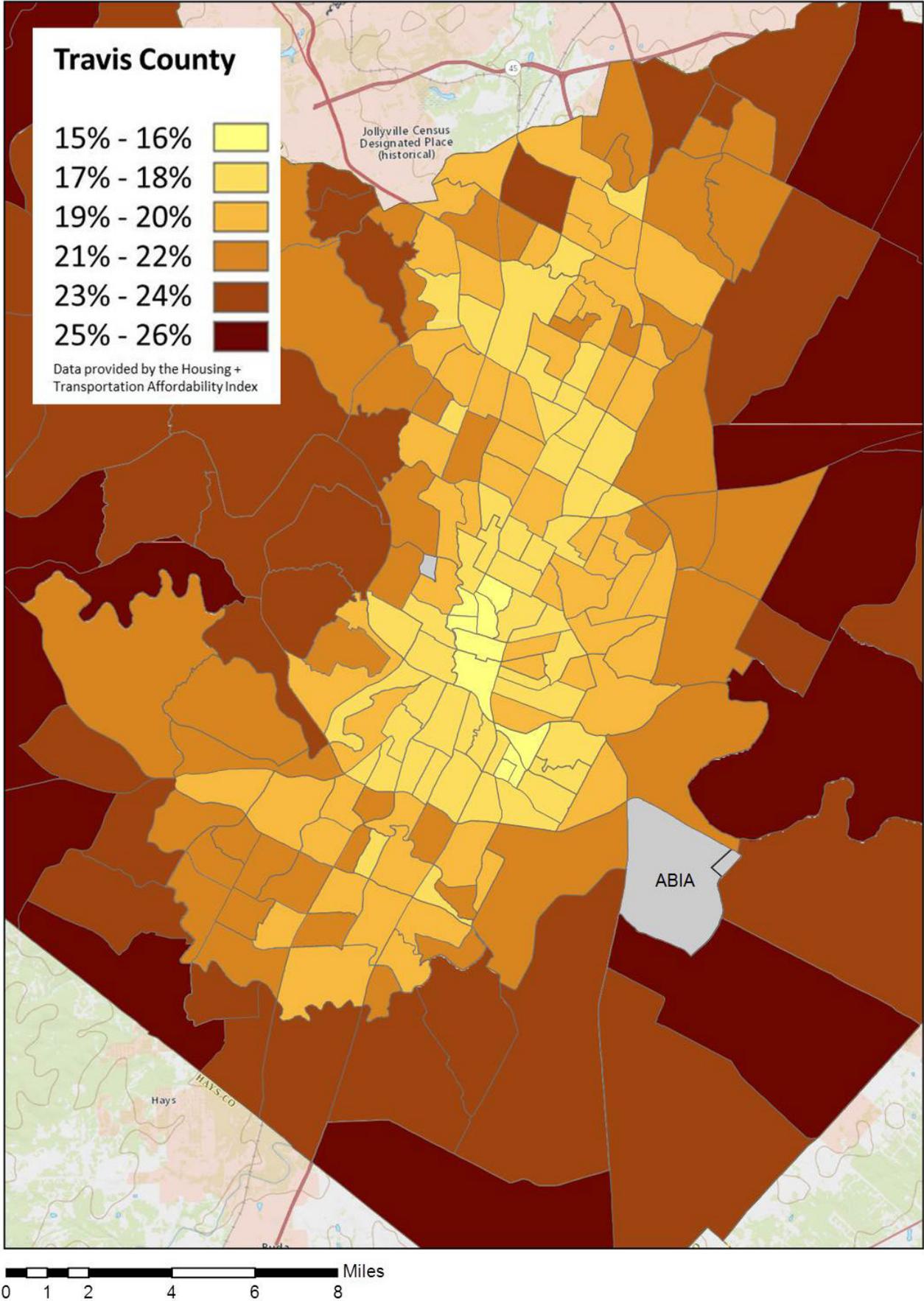
driving costs. The majority of costs are due to owning and maintaining cars. The graphic on page 48 illustrates that the farther a person lives from the downtown core—a hub of employment—the more likely that person is to be transportation cost-burdened.

The graphic shows that as an individual moves farther east or west, the percentage of their income that must be dedicated to transportation increases. The dark brown and red colors highlight where the percent of income spent on transportation is highest. However, the map fails to show that households situated in West Austin generally have much higher incomes and access to vehicles than households in East Austin. Certain sectors of East Austin house low-income populations which are typically more reliant on public transit and have access to fewer transportation alternatives, due to strained incomes. People who live in transit deficient low-income areas are more than twice as likely to rely on public transit to get to work.[104]

First-and last-mile pilots encompassing shared, electric and autonomous vehicles may be needed to address Austin's mobility issues as the regional population continues to grow outside the city limits. People are moving away from the city center seeking more affordable housing, but in doing so, residents increase commute times to employment centers in the metro area, thereby increasing transportation costs. While public transit is expanding into some of our neighboring suburban communities, limited revenue streams call for innovative options from the public and private sector where traditional buses are not currently the most efficient option. First-and last-mile pilots that serve transit deficient areas as well as low-income communities offer opportunities to augment our current system and infrastructure.

While housing may be considered a fixed cost, the advances of shared, electric and autonomous vehicles are expected to offer some financial relief for transportation expenses. Shared vehicles can provide immediate relief to those with high transportation cost burdens. Carpooling and carsharing programs disperse costs among multiple riders and may alleviate the burden of car ownership altogether, if on-demand services are prevalent enough to make giving up a private vehicle feasible.

Transportation Costs and Percent of Income

Travis County

- 15% - 16%
- 17% - 18%
- 19% - 20%
- 21% - 22%
- 23% - 24%
- 25% - 26%

Data provided by the Housing + Transportation Affordability Index

ABIA

One innovative approach to improve affordability is to use driverless vehicles in a shared environment to support more affordable housing, as deliberated at a May 2017 National Summit on Design and Urban Mobility in Philadelphia.[105]

Participants discussed that with shared fleets of AVs, it may be possible for developers to eliminate parking from new housing developments, saving them money, which in turn could potentially lower tenants' rent. Developers could work with AV operators to guarantee a pool of cars for residents use. Cities could incentivize policies through zoning, or other means.[106] GM Maven began its service in New York City by allowing residents of certain luxury apartment complexes in NYC to share Maven vehicles. In 2017, Maven expanded its service to the general public, deploying more than 80 vehicles in Manhattan.[107]

On a more basic level, while most of the emerging mobility services require a smartphone, internet or banking services, many in our community still lack access to the internet or a credit card. For example, in 2014, 86 percent of Austin residents owned a smartphone, and 92 percent identified themselves as an internet user, according to a report published by the City's Digital Inclusion Program.[108] With this level of smartphone ownership and internet usage, Austin remains above the national average. However, it is worth noting that cost is the top reason that non-internet users say they do not use the internet. The median family income in District 2 and District 3 ranges between $36,000[109] and $42,000[110] —meaning that the costs of transportation, smartphone ownership and data and internet usage could likely be a very sizable portion of a District 2 and District 3 family's income.

With this in mind, the City will need to encourage public and private operators to accept pay-as-you-go cards as payment for the unbanked, or partner with local credit unions to provide financial services, as bikeshares in New York and D.C. have done.

And for those without smartphone or internet access, City policy and practices should encourage private operators or third-party services to provide alternative means (such as Dial-A-Ride) that can hail a ride on behalf of riders.

The City of Seattle is developing a strategy in its New Mobility Playbook to deploy digital equity solutions to ensure everyone has access to app-enabled mobility options, including establishing a targeted public Wi-Fi hotspot program and providing low cost smart phone devices that are served by free Wi-Fi.[111]

As fully autonomous vehicles are not likely to be widely used for another decade[112], the use of shared, electric vehicles can still be used in the interim phase. The City of Austin, Capital Metro and the Rocky Mountain Institute are exploring such pilot opportunities for shared, electric vehicle programs with low-income housing areas in Austin.

SAFETY

With complete or near complete automation, and elimination of driver error, Vision Zero traffic fatalities and injuries could be realized. Yet the path to automation is gradual and full implementation is more than a decade away.[113]

The safety of pedestrians, our most vulnerable roadway users, will be the primary consideration in the promotion and adoption of new technologies.

NACTO has some additional specific safety recommendations relating to autonomous vehicles[114]:

- Pedestrians and cyclist crossings should be the primary goal of modeling and software development for autonomous vehicles and supporting infrastructure,

- NACTO cautions allowing partially automated vehicles, (NHTSA Level 3 vehicles) on the road because the interplay between machines and humans is imperfect – humans slow to react to take over when necessary. However, Texas state law now supersedes a municipalities' ability to mandate safety parameters for autonomous vehicles on our streets, and
- In addition, they recommend setting a maximum speed limit of 25 mph on city streets in mixed traffic in order to support Vision Zero goals

While significant research, evaluation and testing is still needed for autonomous vehicles to become ubiquitous, even the National Highway and Traffic Safety Administration (NHTSA) acknowledges that an autonomous vehicle's sensory, communication and vehicle-handling capabilities can surpass those of a human driver. Per NHTSA, 94 percent of crashes can be tied to human choice or error.[115] Thus, one can easily see why autonomous vehicles hold so much promise to improve safety.

In a transportation system in which all the vehicles and infrastructure are connected, NHTSA has projected over an 80 percent reduction in unimpaired crashes.[116] Both autonomous and connected vehicles hold great promise for improving safety. Currently, however, no technology exists that has been certified to retrofit existing vehicles with these safety systems. Considering that the lifespan of the average car on the roadway is 11 years, adoption of these new technologies through car turnover could take at least a decade or more.

By testing and investing in connected and autonomous technologies, data and supportive infrastructure, the City of Austin can advance the adoption timeline of advanced vehicles and the safety benefits they can offer.

SAFETY AND CYBERSECURITY ISSUES WITH AVS

On a related front, one of the biggest threats that society will face as transportation transforms in the coming years is vehicle cybersecurity, says Rob Toews, co-founder of the Stanford/Harvard Forum on the future of transportation (SHFFT) in an opinion piece for TechCrunch.[117]

This threat can be anything from the release of personal data to hacking into and disrupting vehicle or infrastructure information systems and their operations. As today's connected technologies evolve into autonomous vehicles, these large computers on wheels can be targets for malicious attacks.
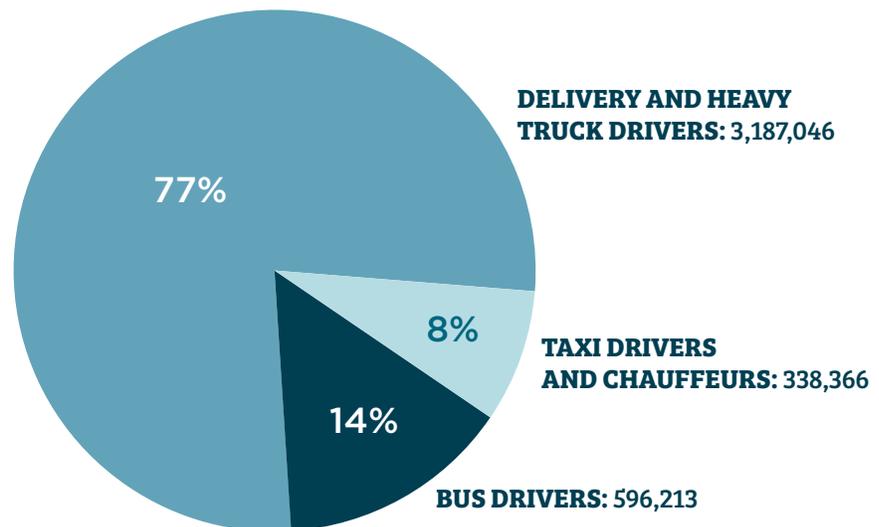
The potential for attacks can be disturbing, which is why automakers and federal policymakers are considering industry-wide cybersecurity standards for autonomous vehicle to reduce the risks to the transportation system. More discussion and research is warranted about the extent of securing public communication/ information networks needed to protect the transportation system.

WORKFORCE IMPLICATIONS OF AUTONOMOUS VEHICLES

With increasing numbers of connected autonomous vehicles, automation of a large number of jobs will become possible. For instance, the professional driving industry could become vulnerable within 10 years.[118]

Number and Percent of Workers in Driving Occupations by Occupation, 2010-2014

2.86 percent of all workers in the U.S. are in driving occupations. Texas has 353,000 drivers, or 2.97 percent of its workforce. Nearly 4 million jobs will be lost to autonomous vehicles.[119]

DELIVERY AND HEAVY TRUCK DRIVERS: 3,187,046

77%

8%

TAXI DRIVERS AND CHAUFFEURS: 338,366

14%

BUS DRIVERS: 596,213

Graphic recreated, with permission, from "Stick Shift: Autonomous Vehicles, Driving Jobs, and the Future of work," 2017, Center for Global Policy Solutions.

In order to promote equitable access to new jobs and services, policymakers must also ensure that those in legacy occupations have the opportunity to participate in newly created industries. For example, professional drivers may need new training and certifications to operate and maintain an AV. Driver responsibilities may also shift from driving to providing and selling services to riders or managing a large-scale fleet. In most cities, a driving position is relatively accessible and requires minimal training and qualifications. To ensure that these drivers can remain competitive in the new economy, policymakers should partner with automakers and transportation companies to provide drivers with access to the training they need to meet the trends and demands of the industry.[120]

Austin Community College (ACC) is helping prepare for this transition by offering training in electric and hybrid motor maintenance and repair.[121] But it will also be necessary to grow jobs in other industries to account for this loss. Jobs in the clean energy sector may provide a way forward.

To proactively manage this coming change, it is recommended a regional New Mobility Workforce Training task force be created to develop plans for new job training and educational opportunities. Collaboration with cities and national organizations across the U.S. should lead to a variety of best practices and ideas to prepare our community.
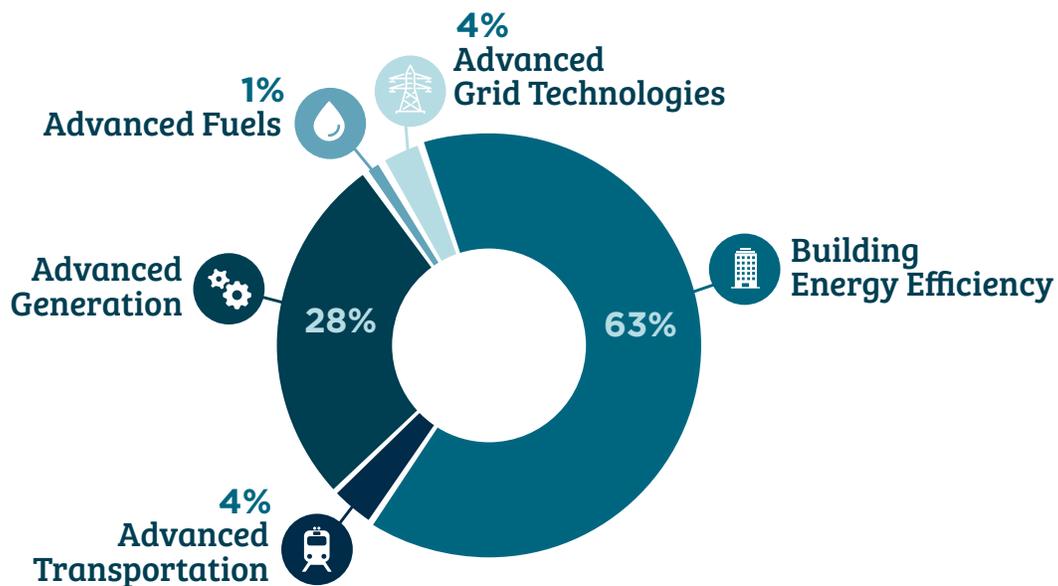
AN ECONOMIC SILVER LINING

A brief released in February 2017 by Environmental Entrepreneurs (E2) found that there are 3 million clean energy jobs in the U.S. This sector generates upwards of $200 billion in annual revenues.[122] The energy efficiency industry employs 2.2 million people alone and is continuing to grow, seeing a 7 percent uptick from 2015 through 2016.[123] Other clean energy sectors account for the remaining 700,000 jobs including solar and wind, clean vehicles, battery storage, ethanol and biodiesel smart grids, and others.[124]

Texas ranks second in terms of energy efficiency jobs, as 147,000 workers are employed in this field. These workers upgrade outdated heating, air and lighting systems as well as manufacture energy efficient appliances.[125] Texas' wind industry—which leads the nation in wind power production[126]—also supports more than 25,000 jobs and has provided $33 billion in capital investment.[127]

California has seen even greater growth in the clean energy sector. A recent report found that more than 500,000 Californians now work in clean energy as a result of public and private investments that have been injected into the state's economy.[128]

Advanced Energy Employment by Segment, 2015

4%
Advanced Grid Technologies

1%
Advanced Fuels

Advanced Generation

28%

63%

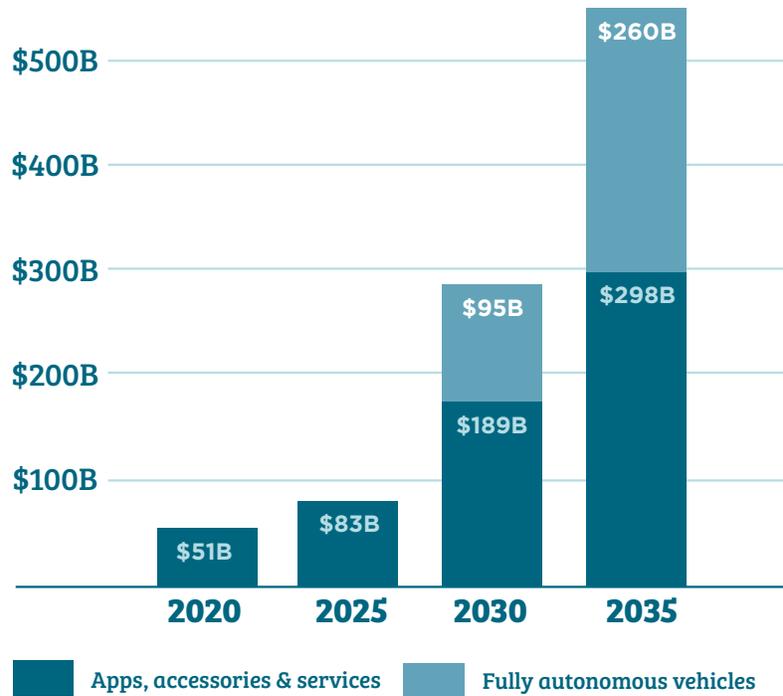**Building Energy Efficiency**

4%
Advanced Transportation

Recreated with permission from "Advanced Energy Jobs in California." 2016, AEE Institute

California's example highlights that new opportunities are on the horizon that can offer a silver lining to potential job loss.

Playing on Austin's core strengths as a national technology leader will aid in recruiting shared, electric and autonomous technology development and research technologies to our region. For instance, software will continue to be a big AV business.[129] One report shows that by 2035, autonomous driving will pull in nearly $560 billion in revenues, representing 17 percent of the global automotive market. The majority of these revenues will come from apps, accessories and services.[130]

Software Will Be a Big AV Business

	2020	2025	2030	2035
Fully autonomous vehicles			$95B	$260B
Apps, accessories & services	$51B	$83B	$189B	$298B

■ Apps, accessories & services   ■ Fully autonomous vehicles

Source: A.T. Kearney

Graphic recreated, with permission, from "Taming the Autonomous Vehicle: A Primer for Cities," March 2017, Bloomberg Philanthropies.

Major employers in the software and technology field operating in the Austin region include: Apple, Dell, IBM, Samsung, Amazon, Accenture, Applied Materials, AT&T, National Instruments, NXP, AMD, General Motors, Hewlett Packard, Intel, Google, Facebook, Cirrus Logic, Cisco Systems, eBay/PayPal, 3M, Bazaarvoice, Q2, Silicon Laboratories, Oracle, Cypress Semiconductor, NetSpend, Rackspace, Visa, VMWare and more.

A Commercialization Opportunities/ Economic Development Work Group composed of public and private sector members can capitalize on Austin's strengths to draw new business opportunities to the region. In fact, Daimler has already invested $1 million in Austin startup activity that focuses on transportation, creating MobilityX, through the partnership of Moovel and Capital Factory.[131] The University of Texas at Austin also launched a Transportation + Mobility incubator within Austin Technology Incubator in June 2017.[132] These developments indicate that Austin's transportation technology ecosystem is continuing to grow.

COMMUNITY ENGAGEMENT

Moving people out of their cars into shared vehicles, whether transit, carpools or other methods of transportation, will require a better service offering that speaks to cost, convenience and comfort.

SHARED MOBILITY

Austin residents themselves say they are ready to embrace change. In a 2016 Mobility Talks public survey, 76 percent of residents said they drive alone today and 4 percent use transit. But when asked which mode of transportation they would like to use more often, 42 percent of residents wanted to use more public transit while only 15 percent wanted to drive alone more often.[133]

Even with competitive end-to-end mobility service, the community will need to become aware of the different service options, test them, and believe in their reliability in order to make the behavioral changes necessary for shared mobility to succeed.

ELECTRIC VEHICLES

Advancing technologies, along with education and outreach, are critical to continuing to grow the electric vehicle market. Electric vehicle range is growing while the prices of EVs are decreasing.

AUTONOMOUS VEHICLES

Three-fourths of Americans say they are wary of riding in an autonomous vehicle.[134] Community engagement on the safety of the technologies and affordable options are a vital part of advancing autonomous vehicles in our region.

DATA

In addition, there are also very real concerns and perceptions attached to access to citizens' or their vehicles' data. How will the public sector use citizen or vehicle data? What policies and measures will be employed to ensure data is anonymized, kept private, minimized and the procedural rules for equity become publically accessible? The City and both public and private sector partners should initiate an on-going dialogue with the community on data standards and what to expect.

THE ROLE OF BUSINESSES, AGENCIES AND THE CITY

Citizens will need to know what to expect in a changing mobility environment, such as:

- New or improved ways to access jobs, school, basic needs and leisure,
- How to access mobility options,
- The trade-offs between different mobility options and offerings,

- The impacts on transportation costs and how that affects their household affordability,
- The health benefits of new active mobility offerings and connected transportation options,
- Impacts on safety for drivers, cyclists and pedestrians,
- Changes to the streetscape and traffic,
- Economic development opportunities that will arise in tandem with these new technologies, and
- Cyber security

To advance new mobility, companies will need to partner with the City to help educate the public on this new space and this new industry. Businesses will also need to be involved in championing shared mobility and transportation demand management.

An out-of-the box approach to communications and a combination of traditional media, social media, outreach events and especially hands-on customer experience must be utilized, given the newness of many of these mobility services. This approach needs to include the underserved and the unbanked. Following are some examples of successful communication programs that can be used as models for outreach.

The Los Angeles County Shared Mobility Action Plan calls for extensive communications, encouraging municipalities and transit agencies to prioritize adequate marketing resources to drive adoption of transit and new shared mobility services. It recommends allocating at least 15 percent of system expansion funds to outreach and marketing efforts in order to grow new services rapidly following their launch.[135]

The Denver Smart City website offers a user friendly interface to understand Denver's smart city goals. The website focuses on four priorities: Clean & Healthy City, Connected Multimodal, Internet of Things and Entrepreneurial City.[136] This wealth of information comes in an easy to digest format that allows residents and interested parties to understand and, by extension, engage more meaningfully in Denver's smart city initiatives.

Drive Cultural Change to Support Transit & Shared Mobility

Encouraging Angelenos to adopt car-free and car-light lifestyles will require a multi-pronged approach. While expanding shared modes such as transit, carsharing and bikesharing are crucial to this effort, Los Angeles County must also proactively work to change the prevailing perception of vehicle ownership and shift the region's cultural paradigm when it comes to transportation.

Public transit and shared mobility will likely find success if they can provide convenience and cost savings. However, building a culture that embraces active transportation is also vital. Some cities have a long history of transit use, and their residents accept it as part of daily living. In Los Angeles, this culture must be largely be built through a focused and creative effort. To succeed, such an effort must encompass a number of strategies, including:

- Investing in public-facing marketing campaigns across multiple systems, leveraging private resources to support outreach, and employing new technology to reach a wide array of communities.
- Supporting internal culture change at local government agencies that promotes innovation and new ideas. The creation of the new Office of Extraordinary Innovation, for instance, is a great start in this direction.
- Encouraging a shift in thinking around resource allocation and funding expansion of shared modes as a component of transportation infrastructure.
- Developing marketing campaigns that promote the positive benefits of using transit and shared mobility, such as reduced stress, increased physical activity and greater cost savings.

Capital Metro and the City of Austin have partnered to launch the Smart Trips program. This neighborhood focused commuter training program functions in the Zilker, Bouldin and Travis Heights neighborhoods, to help residents become more aware of the transit and commuting options available to them. Capital Metro's Transit Adventures also provides ongoing commuting opportunities.[137]

Austin Energy is a leader in providing information and education on electric vehicles, supportive infrastructure and customer rebates and can serve as a local model of public engagement. Austin Energy's Plug-In Austin program makes residents and businesses aware of the benefits of driving electric vehicles through information provided on their website and outreach materials. The agency also alerts the public to rebates available for installing EV chargers at work, home, or multifamily locations as well as encouraging residents to take part in the EV360 time-of-use rate pilot.
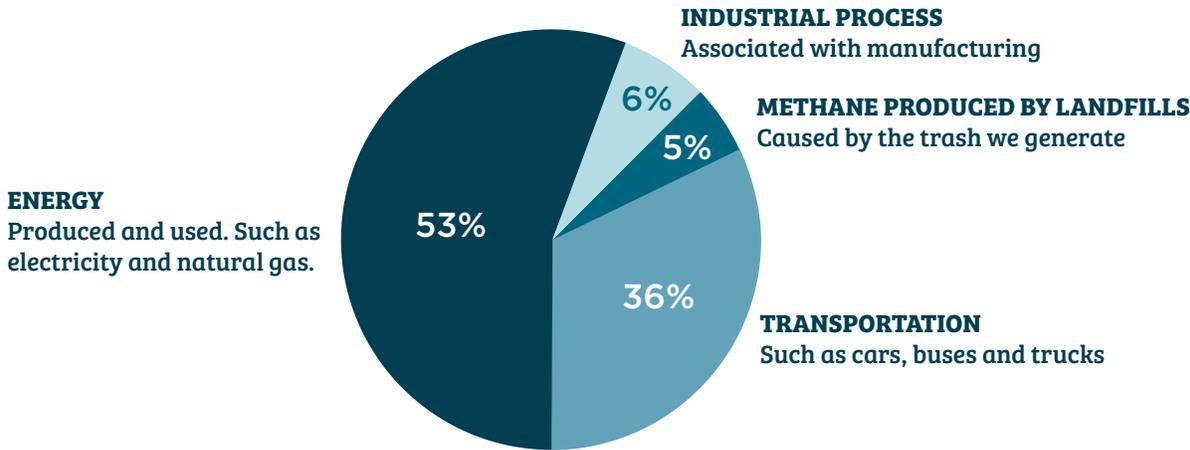
SECTION 3

NUTS AND BOLTS

RESOLUTION GOALS
AND COUNCIL INITIATIVES

A key component of the Council resolution focused on measurable interim greenhouse gas reductions toward meeting our community goal of NET-ZERO emissions by 2050, or sooner, and a 20 percent overall reduction goal by 2020.

The good news is that the City of Austin is well on its way to meeting the 2020 target. The Austin Community Climate Plan Update in September 2016 estimated that the anticipated reduction in the community-wide carbon footprint will surpass the 2020 interim reduction target of 11.3 million metric tons of carbon-dioxide equivalent.[138] The accomplishment is largely due to Austin Energy's efforts to increase solar and wind energy and retire its remaining part-ownership of a coal and generation facility.

36 percent of Austin-Travis County greenhouse gas emissions come primarily from cars and trucks.[139]

Currently, 13.7 Million Metric Tons of Greenhouse Gases Are Emitted Community-Wide From:

INDUSTRIAL PROCESS
Associated with manufacturing

METHANE PRODUCED BY LANDFILLS
Caused by the trash we generate

6%

5%

ENERGY
Produced and used. Such as electricity and natural gas.

53%

36%

TRANSPORTATION
Such as cars, buses and trucks

*In 2015, there were approximately 700,000 light-duty single occupancy cars and trucks on the road in Travis County**
City of Austin Office of Sustainability, Austin Community Climate Plan, June 10, 2015

Graphic recreated, with permission, from "Austin Community Climate Plan Summary," January 2017, City of Austin Office of Sustainability."

As energy generation reductions are being achieved, the transportation sector faces a comparably greater responsibility to reduce GHG emissions.

However, achieving these levels of emissions reductions from energy is not replicable as we approach 85 percent zero emission energy generation by 2027. The transportation sector, which accounts for nearly 36 percent of community-wide greenhouse gas emissions in Travis County,[139] will have a substantial role to play in order to meet 2030 reduction levels. Cars and trucks, predominantly, will need to reduce emissions through lower vehicle miles traveled, improved vehicle fuel efficiency standards and/or adoption of electric vehicles that plug into a cleaner grid. Public chargers should be linked to a 100 percent renewable energy source today.

The City of Austin and Capital Metro can demonstrate leadership in energy efficient vehicles and lower carbon footprints through purchases and agency policies, such as the City's Electric First policy.

IMPLEMENT ALIGNED PLANS AND POLICIES

The Austin City Council has adopted a number of policies and plans that intersect with this new mobility roadmap. The existing goals and metrics from those policies and plans will influence the metrics of this new roadmap. Key policies and plans that interrelate with the new mobility roadmap include the Council Strategic Plan, Imagine Austin, Vision Zero, Austin Community Climate Plan, Austin Energy Resource, Generation and Climate Protection Plan and the developing Austin Strategic Mobility Plan.
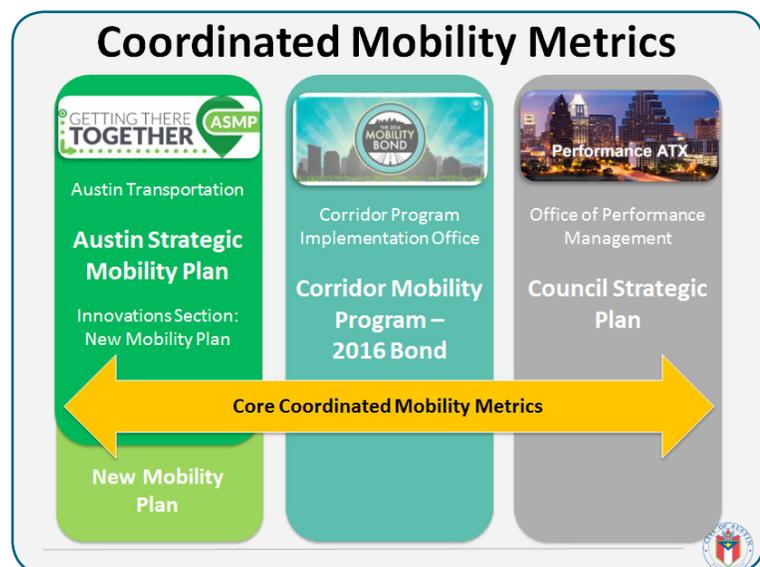
These local policies also intersect with the City's partnership with the Rocky Mountain Institute Mobility Transformation program, Capital Metro's Connections 2025 Plan and Project Connect, and the U.S. DOT Texas Autonomous Vehicle Proving Grounds program. More detail on these programs are included in the appendix.

NEW MOBILITY METRICS FOR SUCCESS

Imagine Austin, our comprehensive plan, included many mobility-related strategic outcomes and metrics. These will serve as a guide for the creation of a coordinated and comprehensive set of mobility metrics along with the Austin Strategic Mobility Plan (ASMP), the 2016 Corridor Mobility Bond Program, and the Council's Strategic Plan. Including:

- System efficiency and congestion,
- Transportation cost,
- Accessibility to & equity of transportation options,
- Safety, and
- Condition of infrastructure

Quantifying these metrics requires a greater understanding and response to individual and societal goals, such as protecting traveler safety; understanding traveler needs and preferences; ensuring comfortable and convenient transportation; advancing education, health and safety; ensuring environmental sustainability; and more broadly, getting people to where they want to go.

Coordinated Mobility Metrics

GETTING THERE TOGETHER — ASMP
Austin Transportation
Austin Strategic Mobility Plan
Innovations Section: New Mobility Plan

MOBILITY BOND
Corridor Program Implementation Office
Corridor Mobility Program — 2016 Bond

Performance ATX
Office of Performance Management
Council Strategic Plan

Core Coordinated Mobility Metrics

New Mobility Plan

IMPACTS ON CITY AND ORGANIZATIONS' BUDGETS

The Federal Highway Trust Fund and State gas taxes are diminishing in value because static price points, less driving and less overall vehicle miles traveled are reducing contributions to its coffers. E-AVs will further drain this traditional federal funding source.

While the price of technology may reduce costs for personal mobility, autonomous vehicles will have an impact on city budgets in significant ways. Speaking on a panel at the 2017 Consumer Electronics Show, Karen Francis, a strategic advisor for several automotive tech companies, predicted rapid adoption of autonomous vehicles with the help of government intervention.

> "Autonomous vehicle" is a misnomer, she said, because for self-driving cars to fully realize their safety and efficiency potential, a whole ecosystem of "smart" infrastructure must accompany them. Think street lights, roads, curbs, and parking spots equipped with sensors and special markings that "talk" to the cars. "These vehicles don't operate 'autonomously.' They have to operate within a larger connected world," she said.[141] Who's going to build that world? The public sector, of course—just as the government built out the autopia of the future that GM so thrillingly depicted back in 1939."[142]
>
> - Karen Francis, Strategic Advisor to Tech Companies

All cities today, including the City of Austin are struggling to figure out what types of technology and service levels are needed to promote a new transportation future that is safe and optimizes efficiency. How do you do investment planning for a disruptive future that is constantly changing?

Every automaker and technology company advancing autonomous vehicles uses different types of sensor technology, yet all autonomous vehicles today appear dependent on machines that read the roadway striping and signage for waypoints to operate. A key unanswered question is what level of striping and traffic signage visibility and reflectivity is sufficient for a safe autonomous vehicle world?

The City of Austin currently maintains striping for 370 arterials and 260 collector lane line miles and 5,410 pedestrian crosswalks. On average, the City budget allows for restriping at about a 50-60 percent renewal rate each year. In addition, the City maintains nearly 16,000 traffic signs in its jurisdiction, replacing nearly 2,000 each year.[143] The replacement cycle is based on a projected lifecycle of 8-10 years. That does not include repairs or graffiti removal. The Austin Transportation Department's combined budget for signs and markings is approximately $5 million per year.[144] Should AVs require a higher standard for signs and markings, the City's operating cost to maintain them could nearly double. There are new treatments and innovations in sign and marking materials and their application that make signs more machine readable while not affecting human readability. While this may not reduce costs, it would make for a more AV-friendly city.

In addition, new federal guidelines for connected vehicles are currently supportive of DSRC for interaction with other vehicles and the public infrastructure, including grabbing data from traffic signals.

New technologies like Vehicle to Infrastructure (V2I) for traffic signals requires roadway unit data sensors and transmitters, software, edge computing (so only relevant data gets transmitted) analytics, data warehousing and data scientists. These costs will be borne by the government and the rate of adoption of these

technologies will also signal the cities' readiness for the deployment of connected and autonomous vehicles. The technology investment that will help reach the promise of greater traffic safety will likely have a longer term pay-off. The data collection and analysis to inform traffic operations will have more immediate impacts. The level of funding needed for these new technologies or data analyses services is still uncertain. However, a bench contract for transportation data analyses is recommended while in-house staff capabilities are built over time.

With autonomous self-parking vehicles, parking will no longer need to exist right next to homes, offices and businesses. As such, cities will face a reduction in metered street parking and garage parking. A reduction in the City of Austin parking fund would blunt its ability to help pay for new traffic signals and roadway safety improvements. The fees collected at parking garages that help support operations at Austin-Bergstrom International Airport will also likely be impacted with increasing AV usage.

While the direct infrastructure costs associated with the operation of AVs adds a new revenue need, according to the ENO, Center for Transportation, there is a potential solution. "Conveniently, AV technology also opens up an opportunity to implement a fair and straightforward per-mile charge or vehicle mile travelled fee," the report suggests.[145]

FUNDING SUPPORT AND SOURCES

Various cities, agencies and state departments of transportation are supporting EV and AV plan development and pilots with dedicated funding and staff. A sampling is below with additional programs listed in the appendix.

Los Angeles County Shared Mobility Action Plan – a two-year community-driven process funded with $150,000 contract to a third party national experts, the Shared-Use Mobility Center. Additional funding is forthcoming to work on implementation and pilots.[146]

Minneapolis/ St. Paul - **Shared Mobility Action Plan**, a 15-month community driven process funded with a $150,000 contract to third party national experts, the Shared-Use Mobility Center.[147]

Seattle New Mobility Playbook – a two-year staff and consultant supported study for Autonomous Vehicles with $145,000 contract to national transportation experts.[148]

The Los Angeles County Transit Authority also established an Office of Extraordinary Innovation with five current staff members. They have a budget of nearly $10 million set aside for pilots and programs dedicated to Shared Mobility.[149]

The City of Los Angeles is focused on preparing for autonomous vehicles with a dedicated research fellow and an estimated $10 million budget for pilots and a $3 million budget for on-call technology services

North Central Texas Council of Governments recently awarded $2.4 million towards EV/AV pilot programs in the Dallas/Fort Worth region.[150]

The City of Austin will need to pursue similar finances from the Capital Area Metropolitan Planning Organization (CAMPO) in order to operate the variety of pilots mentioned above. A newly created grant writing position in Austin Transportation is already engaged to pursue all possible federal, foundation and private sector funding opportunities.

While the possibility exists for private sector investments to support project deployments, those funds and the projects they could support are not part of this report. Private investment strategies will be addressed in the partnership strategy developed as part of the key activities listed above.

Los Angeles EV Carsharing in Disadvantaged Communities

Basics: **Station-based one way carsharing model**
100 cars, 200 charging points
Central LA: Downtown, Pico-Union, Koreatown

Funding: $1.7 million from California Air Resources Board
$1.8 million from City of LA (including rebates)
$10 million plus from Bollore/ Blue Solutions

Goal: **7,000 members by 2019**

Excerpt from Shared-Use Mobility Center presentation to Minneapolis St. Paul - July 2017

SMART MOBILITY RESOURCES NEEDED

Just as the private-sector market is changing, so must the government sector to keep pace.

Predicting the 2020s will see the biggest transformation of the transportation sector since the Model T, international infrastructure and development firm Transurban CEO Scott Charlton said, "This involves a broadening of our focus from a traditional engineering business to a substantial technology business."[151]

The Council Resolution 20170302-39, to develop a nation-leading plan to shift the City's transportation system to one that enables "Shared, Electric and Autonomous Mobility Services" and provide a City ready and willing for it, called for:

- Consider creating an executive position for Chief Officer of EV/AV transportation Services, and
- Description of resources that may be needed and potential funding options

The Austin City Manager's Office approved the hiring of an executive level officer within the Transportation Department that would assume the duties of evaluating and bringing the necessary technology changes to the City of Austin to embrace a new mobility future.

Given the amount of technology offerings and changes, it is vital that a dedicated Autonomous, Electric and Shared Mobility Services technology-based team be established beyond the principal executive position. These types of dedicated teams are starting in leading cities across the U.S. An Austin team can be accomplished by accessing existing technology and policy staff and augmenting with additional new dedicated positions. This team will support the on-going regional, smart mobility efforts to:

- Develop a master plan roadmap for emerging electric – connected and autonomous vehicles, (E-CAV) technologies and services to pursue,
- Develop a master plan for shared mobility with the public and regional partners,
- Create a dialogue with the public on data standards and what to expect in the future,
- Invest in software, tools and storage to support E-CAV data analysis,
- Pilot DSRC and 5G technology in key corridors with emergency, transit and fleet vehicles,
- Pilot AV shuttles for first/last mile services, especially for underserved communities,
- Deploy multi-modal mobility hubs for electric shared auto uses, electric bikes and charging pilots,
- Pilot automated delivery bots to aid last mile delivery challenges,
- Develop a partnership strategy to leverage resources and investments from other providers,
- Establish a training environment for new technology with area universities, and the private sector, and
- Participate in national dialogue and data exchanges, contribute to national standards and benchmark other cities through leading partners such as NACTO, APA, ULI, Smart Cities, Bloomberg-Aspen, T4A, AASHTO, TRB, ITS America, Texas Innovation Alliance and National League of Cities

Key functions of a developed Smart Mobility team include:

- Communication Management,
- Public Policy and Governance,
- Financial and Resources Management,
- Risk Management,
- Technology Management,
- Grant Writing,
- Project Management, Design, Analysis & Simulation,
- Quality Control and Testing, and
- Report Writing

These key activities and functional areas will require advanced business and technical skills to build new information, data infrastructure and data analytics, in addition to engineering skills. In order to stay abreast of emerging technologies and applications, the principal executive and members of the team will need to attend national and international technology conferences and play a role to influence federal decision-making related to connected autonomous and electric vehicle policies.

Austin Energy will need to design, deploy, and maintain the fast growing and evolving technology of charging infrastructure required to support E-AVs and high-mileage EV adoption with a focus on reliability, maintenance, servicing, and network monitoring. Additionally, this E-AV support team will need to conduct advanced charging technology pilots for electric AVs, conduct EV electric grid integration pilots, integrate with Texas' energy market (ERCOT) programs to increase value and drive down cost, support electric bus infrastructure, and develop sustainable electric-fuel business models/rates.

The level of public outreach needed to encourage shared, electric and autonomous vehicles pilots and use should be coordinated among public sector agencies and private companies. The educational process will need to be broad in scope and sustained for many years. Reaching all citizens in our community, including those with special needs, languages or situations will require dedicated funding.

ACRONYMS AND TERMS DEFINED

5G technology
5th generation of mobile networks and wireless systems

AASHTO
American Association of State Highway and Transportation Officials

ABIA
Austin Bergstrom International Airport

ACC
Austin Community College

Access (transportation)
Able to be approached, entered or used by the public regardless of economic situation, geographic location, or physical ability

AE
Austin Energy

APA
American Planning Association

ASMP
Austin Strategic Mobility Plan

Autovot
AV taxi providing sequential private rides[152]

AV
Autonomous Vehicle

AVTA
Antelope Valley Transit Authority

Beta Version
Second stage of testing for an app or software. At this stage, the technology is generally released for public use[153]

Big Data
An accumulation of data that is too large and complex for processing by traditional database management tools[154]

CalEnviroScreen Index
Screening tool that evaluates the burden of pollution from multiple sources in communities while accounting for potential vulnerability to the adverse effects of pollution[155]

CAMPO
Capital Area Metropolitan Planning Organization

CAV
Connected and Autonomous Vehicle

CMTA
Capital Metropolitan Transportation Authority

Community Care Collaborative
Provides healthcare services to the uninsured and underinsured populations of Travis County in partnership with Seton[156]

CTRMA
Central Texas Regional Mobility Authority

Data Management Platform
Centralized computing system for collecting, integrating and managing large sets of structured and unstructured data from disparate sources[157]

Data Rodeo
City of Austin and the University of Texas Center for Transportation Research collaboration to make transportation data more accessible to professionals, the public, and private companies

DC Fast Charging
Fastest vehicle charging on the market typically at speeds of 50kW+

Delivery Bots
Autonomous bots that carry and delivery goods and food

Dial-a-Ride
Transportation service that can be summoned or scheduled by phone

DSRC
Dedicated Short Range Communications - two-way short-to- medium-range wireless communications capability that permits very high data transmission critical in communications-based active safety applications[158]

Dynamic Message Signs
Electronic signs that frequently change to alert drivers to certain situations or changing traffic conditions

E2
Environmental Entrepreneurs

E-Bike
Electric bike

E-CAV
Electric connected and autonomous vehicle

EV
Electric Vehicle

First/Last Mile
The distance between public transit and some origin or destination location creates a need for additional transportation options to fill the gap, whether it be walking, biking, carsharing or the like.

Fixed-Route Transit
Transit service in which vehicles run along an established path at preset times

GHG
Greenhouse Gases

HART
Hillsborough Area Regional Transit Authority

High-Capacity Transit
Light rails and bus rapid transit

HOV
High Occupancy Vehicle

ICE
Internal Combustion Engine

Interoperable
The extent to which systems and devices can exchange and interpret shared data

ITS America
Intelligent Transportation Society of America

Level 1 Charger
Includes an ordinary household outlet at 110v, typically draws power at 1kW

Level 2 Charger
Charger that supplies 240V[159] with a wide range of charging speeds[9] typically at 7kW

Low-Capacity Transit
Buses or paratransit

Micro-transit
Shared public/private sector transportation offerings that offer fixed or dynamically allocated routes and schedules in response to individual or aggregate consumer demand

Mobility Hub
Adjacent to transit stops to offer a variety of first and last mile options, from electric bikes to car-share to access to micro-shuttles to taxis and TNCs[160]

Mobility on Demand
MOD is an innovative, user-focused approach which leverages emerging mobility services, integrated transit networks and operations, real-time data, connected travelers, and cooperative Intelligent Transportation

Systems (ITS) to allow for a more traveler-centric, transportation system- of-systems approach, providing improved mobility options to all travelers and users of the system in an efficient and safe manner[161]

NACTO
National Association of City Transportation Officials

NHTSA
National Highway and Traffic Safety Administration

NLC
National League of Cities

Off-Peak Hours
Times of lower than maximum traffic levels, relating to non-commuting hours

Paratransit
Transportation service that supplements larger public transit systems by providing individualized rides without fixed routes or timetables[162] usually for people with disabilities

Parklet
Public seating platforms that convert curbside parking spaces into vibrant community spaces[163]

Peak Hours
Times when traffic volumes are highest

PEV
Plug-in Electric Vehicle

PSTA
Florida's Pinellas Suncoast Transit Authority

RFI
Request for Information

RFP
Request for Proposal

"Ride-Free" Zone
Area where transit riders can board the bus without paying to cut down on delays associated with people lining up to pay as they enter the bus as well as improving traffic flows[164]

Ride-Sharing
The travelling of two or more persons by any mode of private passenger vehicle, including, but not limited to, carpooling. vanpooling, buspooling, to any location incidental to another purpose of the driver, for which compensation is neither accepted, collected, encouraged, promoted, or requested.

Ride-Sourcing
Transportation provided by private companies like transportation networking companies

RMI
Rocky Mountain Institute

Shared-Use Mobility
Transportation services that are shared among users, including public transit; taxis and limos; bikesharing; carsharing (round-trip, one-way, and personal vehicle sharing); ridesharing (car-pooling, van-pooling); ridesourcing/ride-splitting; scooter sharing; shuttle services; neighborhood jitneys; and commercial delivery vehicles providing flexible goods movement[165]

Smart Corridors
Technology-based initiative that invests significantly in the physical infrastructure to support walking, biking, transit, and other multi-modal options

SOV
Single occupancy vehicle

SSTI
Smart State Transportation Initiative

SUMC
Shared-Use Mobility Center

SUV
Sport utility vehicle

T4A
Transportation for America

Taxibots
AV taxi shared simultaneously by several passengers[166]

TDM
Transportation Demand Management - strategies and policies to reduce transportation demand or to redistribute this demand in space or in time

TNC
An organization, whether a corporation, partnership, sole proprietor, or other form, which provides on-demand transportation services for compensation using an online-enabled application (app) or platform to connect passengers with drivers.

TRB
Transportation Research Board

Trip-Making Data
Data provided by mobile devices that show where people are traveling

TxDOT
Texas Department of Transportation

ULI
Urban Land Institute

Unbanked
Not having or having never had a savings, checking, or other account with a bank[167]

U.S. DOT
United States Department of Transportation

V2I Vehicle to Infrastructure
Capture vehicle-generated traffic data, wirelessly providing information such as advisories from the infrastructure to the vehicle that inform the driver of safety, mobility, or environment-related conditions[168]

V2V Vehicle to Vehicle
The ability to wirelessly exchange information about the speed and position of surrounding vehicles shows great promise in helping to avoid crashes, ease traffic congestion and improve the environment[169]

Vision Zero
An international movement that aspires to reduce the number of people who die or are seriously injured in traffic crashes to zero. Austin's Vision Zero Action Plan defines a community-wide approach to reach this goal by 2025[170]

VMT
Vehicle miles traveled

REFERENCES

[1]Resolution No. 20170302-039 The New Mobility Electric/Autonomous Vehicle Plan, March 2, 2017, http://www.austintexas.gov/edims/document.cfm?id=272885

[2]Imagine Austin, City of Austin, 2012, http://austintexas.gov/page/imagine-austin-vision

[3]What is Shared-Use Mobility, Shared-Use Mobility Center, http://sharedusemobilitycenter.org/what-is-shared-mobility/

[4]Electric Vehicle Drivers, Austin Energy, http://austinenergy.com/wps/portal/ae/green-power/plug-in-austin/electric-vehicle-drivers

[5]Electric Vehicle Outlook 2017, Bloomberg New Energy Finance, 2017, https://about.bnef.com/electric-vehicle-outlook/

[6]New Mobility: Today's Technology and Policy Landscape, ICCT, July 2017, http://www.theicct.org/new-mobility-tech-and-policy-landscape-2017

[7]Taming the Autonomous Vehicle, Bloomberg Philanthropies and the Aspen Institute, March 2017, https://www.bbhub.io/dotorg/sites/2/2017/05/TamingtheAutonomousVehicleSpreadsPDFreleaseMay3rev2.pdf

[8]Bringing Smart Transport to Texans : Ensuring the Benefits of a Connected and Autonomous Transport System in Texas, University of Texas Center for Transportation Research, August 2016, https://library.ctr.utexas.edu/ctr-publications/0-6838-2.pdf

[9]What is Shared-Use Mobility, Shared-Use Mobility Center, http://sharedusemobilitycenter.org/what-is-shared-mobility/

[10]Capital Metro's RideShare Program Breaks Record with 200 Vanpools, Capital Metro, March 24, 2016, https://capmetro.org/About-Capital-Metro/Media-Center/News-Stories/2016-News-Stories/10737420062/

[11]Taming the Autonomous Vehicle, Bloomberg Philanthropies and the Aspen Institute, March 2017, https://www.bbhub.io/dotorg/sites/2/2017/05/TamingtheAutonomousVehicleSpreadsPDFreleaseMay3rev2.pdf

[12]Taming the Autonomous Vehicle, Bloomberg Philanthropies and the Aspen Institute, March 2017, https://www.bbhub.io/dotorg/sites/2/2017/05/TamingtheAutonomousVehicleSpreadsPDFreleaseMay3rev2.pdf

[13]Effects of Next-Generation Vehicles on Travel Demand and Highway Capacity, FP Think, January 2014, http://orfe.princeton.edu/~alaink/Papers/FP_NextGenVehicleWhitePaper012414.pdf

[14]Unsustainable? The Growth of App-Based Ride Services and Traffic, Travel and the Future of New York City, Schaller Consulting, February 27, 2017, http://www.schallerconsult.com/rideservices/unsustainable.pdf

[15]Driverless Future: A Policy Roadmap for City Leaders, Arcadis, HR&A, and Sam Schwartz Consulting, 2017, https://drive.google.com/file/d/0B6YBhO59Nrj_ejJMU3N1OEpHUkU/view

[16]Driverless Future: A Policy Roadmap for City Leaders, Arcadis, HR&A, and Sam Schwartz Consulting, 2017, https://drive.google.com/file/d/0B6YBhO59Nrj_ejJMU3N1OEpHUkU/view

[17]They Can Just Take an Uber, Slate, December 14, 2016, http://www.slate.com/articles/business/metropolis/2016/12/cities_are_cutting_transportation_service_because_they_think_uber_will_fill.html

[18]Driverless Future: A Policy Roadmap for City Leaders, Arcadis, HR&A, and Sam Schwartz Consulting, 2017, https://drive.google.com/file/d/0B6YBhO59Nrj_ejJMU3N1OEpHUkU/view

[19]The Importance of Coding the Curb, Side Walk Talk, August 22, 2016, https://medium.com/sidewalk-talk/the-importance-of-coding-the-curb-bc5d2e106283

[20]Key Socioeconomic Indicators for Greater Austin and Travis County, CAN Community Dashboard 2017, Community Advancement Network, May 18, 2017, http://canatx.org/dashboard/wp-content/uploads/2017/05/2017-CAN-Dashboard-FOR-WEB.pdf

[21]Resolution No. 20160818-074: 2016 Mobility Bond, August 18, 2016, https://www.austintexas.gov/edims/document.cfm?id=262118

[22]Los Angeles County: Shared Mobility Action Plan, Shared-Use Mobility Center, September 2016, http://sharedusemobilitycenter.org/wp-content/uploads/2016/09/SUMC-Single-Page-Web-2.pdf

[23]Downtown Austin Parking Strategy, Downtown Austin Alliance, June 2017, http://www.downtownaustin.com/parkingstrategy

[24]Downtown Austin Parking Strategy: Summary of Key Findings, Downtown Austin Alliance, November 2016, http://www.downtownaustin.com/sites/default/files/DowntownParkingStrategy_SummaryofKeyFindings_20161109_0.pdf

[25]Parking Management: Strategies, Evaluation and Planning, Sept. 12, 2016, Victoria Policy Transport Institute, http://www.vtpi.org/park_man.pdf

[26]Smart Commute Rewards, City of Austin, 2017, http://www.austintexas.gov/smartcommute

[27]Energy Department Announces $13.4 Million Investment in Community-based Advanced Transportation Projects, U.S. Department of Energy, August 22, 2017, https://energy.gov/eere/articles/energy-department-announces-134-million-investment-community-based-advanced

[28]Driverless Future: A Policy Roadmap for City Leaders, Arcadis, HR&A, and Sam Schwartz Consulting, 2017, https://drive.google.com/file/d/0B6YBhO59Nrj_ejJMU3N1OEpHUkU/view

[29]This New "Mobility Service" App Will Help Helsinki Ditch Car Ownership, Fast Company, December 19, 2016, https://www.fastcompany.com/3066654/this-new-mobility-service-app-will-help-helsinki-ditch-car-ownership

[30]Electric Vehicle Drivers, Austin Energy, http://austinenergy.com/wps/portal/ae/green-power/plug-in-austin/electric-vehicle-drivers

[31]Electric Vehicle Outlook 2017, Bloomberg New Energy Finance, 2017, https://about.bnef.com/electric-vehicle-outlook/

[32]New Mobility: Today's Technology and Policy Landscape, ICCT, July 2017, http://www.theicct.org/new-mobility-tech-and-policy-landscape-2017

[33]Fleet Electrification Plan and Study, City of Austin, October 5, 2016, http://www.austintexas.gov/edims/document.cfm?id=264039

[34]The ABCs of EVs: A Guide for Policy Makers and Consumer Advocates, NASUCA, 2017, https://citizensutilityboard.org/wp-content/uploads/2017/04/2017_The-ABCs-of-EVs-Report.pdf

[35]The ABCs of EVs: A Guide for Policy Makers and Consumer Advocates, NASUCA, 2017, https://citizensutilityboard.org/wp-content/uploads/2017/04/2017_The-ABCs-of-EVs-Report.pdf

[36]Electric Vehicle Quarterly Report FY 2017 Q3 (April-June), Austin Energy, 2017.

[37]Electric Vehicle Drivers, Austin Energy, http://austinenergy.com/wps/portal/ae/green-power/plug-in-austin/electric-vehicle-drivers

[38]Power Up on Electric Drive, Austin Energy, http://austinenergy.com/wps/portal/ae/green-power/plug-in-austin/electric-drive

[39]2014 Comprehensive Housing Market Analysis, City of Austin, July 31, 2014, https://austintexas.gov/sites/default/files/files/NHCD/2014_Comprehensive_Housing_Market_Analysis_-_Document_reduced_for_web.pdf

[40]Master List Plug In Everywhere (PIE) Database 2017, Austin Energy Electric Vehicles and Emerging Technologies Multi-family Project Lead, 2017.

[41]External funding provided by the 11th Hour Project. Support staff resource. Employee start date: March 20, 2017.

[42]Electric Vehicle Drivers, Austin Energy, http://austinenergy.com/wps/portal/ae/green-power/plug-in-austin/electric-vehicle-drivers/electric-vehicle-drivers

[43]EV360 Residential Time-of-Use Rate Pilot Program, Austin Energy, http://austinenergy.com/wps/portal/ae/green-power/plug-in-austin/residential-time-of-use-rate

[44]Two-Wheel Electric Riders, Austin Energy, http://austinenergy.com/wps/portal/ae/green-power/plug-in-austin/two-wheel-electric-riders

[45]Bike Texas gets Austin Rebate for Fleet of New E-Bikes, KXAN, August 2, 2016, http://kxan.com/2016/08/02/biketexas-gets-austin-rebate-for-fleet-of-new-e-bikes/

[46]Taming the Autonomous Vehicle, Bloomberg Philanthropies and the Aspen Institute, March 2017, https://www.bbhub.io/dotorg/sites/2/2017/05/TamingtheAutonomousVehicleSpreadsPDFreleaseMay3rev2.pdf

[47]Austin SHINES: Innovations in Energy Storage, Austin Energy, https://austinenergy.com/wps/portal/ae/green-power/austin-shines/austin-shines-innovations-energy-storage

[48]Fleet Electrification Study and Plan, City of Austin, October 5, 2016, http://www.austintexas.gov/edims/document.cfm?id=264039

[49]Volkswagen Settlement Funding: What Cities Should Know, Center for Climate and Energy Solutions & The United States Council of Mayors, December 2016, https://www.c2es.org/docUploads/vw-settlement-final.pdf

[50]Volkswagen Settlement: Overview and Next Steps, Tennessee Department of Environment and Conservation, March 3, 2017, https://www.tn.gov/assets/entities/environment/attachments/energy_vw_settlement_presentation_tdec_3.3.17_final.pdf

[51]AVTA Seeks to be 100% Green in 2018, Antelope Valley Times, December 3, 2015, http://theavtimes.com/2015/12/03/avta-seeking-to-be-green-by-2018/

[52]King County Executive Announces Purchases of Battery Buses, King County, January 10, 2017, http://www.kingcounty.gov/elected/executive/constantine/news/release/2017/January/10-battery-buses.aspx

[53]Foothill Transit Battery Electric Bus Demonstration Results, National Renewable, Energy Laboratory, January 2016, https://www.nrel.gov/docs/fy16osti/65274.pdf

[54]Electric Bus Analysis for New York City Transit, New York City Transit & Columbia University, May 2016, http://www.columbia.edu/~ja3041/Electric%20Bus%20Analysis%20for%20NYC%20Transit%20by%20J%20Aber%20Columbia%20University%20-%20May%202016.pdf

[55]Electric Bus Analysis for New York City Transit, New York City Transit & Columbia University, May 2016, http://www.columbia.edu/~ja3041/Electric%20Bus%20Analysis%20for%20NYC%20Transit%20by%20J%20Aber%20Columbia%20University%20-%20May%202016.pdf

[56]Electric Bus Analysis for New York City Transit, New York City Transit & Columbia University, May 2016, http://www.columbia.edu/~ja3041/Electric%20Bus%20Analysis%20for%20NYC%20Transit%20by%20J%20Aber%20Columbia%20University%20-%20May%202016.pdf

[57]Taming the Autonomous Vehicle, Bloomberg Philanthropies and the Aspen Institute, March 2017, https://www.bbhub.io/dotorg/sites/2/2017/05/TamingtheAutonomousVehicleSpreadsPDFreleaseMay3rev2.pdf

[58]Future Autonomous Vehicle Driver Study, Kelley Blue Book, September 2016, https://mediaroom.kbb.com/future-autonomous-vehicle-driver-study

[59]Future Autonomous Vehicle Driver Study, Kelley Blue Book, September 2016, https://mediaroom.kbb.com/future-autonomous-vehicle-driver-study

[60]Ten Ways Autonomous Driving could Redefine the Automotive World. McKinsey and Company. June 2015. http://www.mckinsey.com/industries/automotive-and-assembly/our-insights/ten-ways-autonomous-driving-could-redefine-the-automotive-world

[61]Traffic in London is Still Out of Control, CityLab, October 28, 2016, https://www.citylab.com/solutions/2016/10/traffic-in-london-is-out-of-control-what-happened/505454/

[62]Technologies That Will Transform the Transportation System, U.S. Department of Energy, September 6, 2017, https://energy.gov/eere/articles/technologies-will-transform-transportation-system?utm_source=EERE+Weekly+Digest+of+Clean+Energy+News&utm_campaign=6734c97d50-EMAIL_CAMPAIGN_2017_09_13&utm_medium=email&utm_term=0_96dffafa2f-6734c97d50-34549969

[63]By 2030, 25% of Miles Driven in US Could Be in Shared Self-Driving Electric Cars, Boston Consulting Group, April 10, 2017, https://www.bcg.com/d/press/10april2017-future-autonomous-electric-vehicles-151076

[64]By 2030, 25% of Miles Driven in US Could Be in Shared Self-Driving Electric Cars, Boston Consulting Group, April 10, 2017, https://www.bcg.com/d/press/10april2017-future-autonomous-electric-vehicles-151076

[65]By 2030, 25% of Miles Driven in US Could Be in Shared Self-Driving Electric Cars, Boston Consulting Group, April 10, 2017, https://www.bcg.com/d/press/10april2017-future-autonomous-electric-vehicles-151076

[66]By 2030, 25% of Miles Driven in US Could Be in Shared Self-Driving Electric Cars, Boston Consulting Group, April 10, 2017, https://www.bcg.com/d/press/10april2017-future-autonomous-electric-vehicles-151076

[67]By 2030, 25% of Miles Driven in US Could Be in Shared Self-Driving Electric Cars, Boston Consulting Group, April 10, 2017, https://www.bcg.com/d/press/10april2017-future-autonomous-electric-vehicles-151076

[68]Cruising for Parking, University of California Los Angeles, 2007, http://shoup.bol.ucla.edu/CruisingForParkingAccess.pdf

[69]Today's Cars Are Parked 95% of the Time, Fortune, 2016, http://fortune.com/2016/03/13/cars-parked-95-percent-of-time/

[70]By 2030, 25% of Miles Driven in US Could Be in Shared Self-Driving Electric Cars, Boston Consulting Group, April 10, 2017, https://www.bcg.com/d/press/10april2017-future-autonomous-electric-vehicles-151076

[71]Expanding the Electric Vehicle Market in U.S. Cities, ICCT, July 2017, http://theicct.org/sites/default/files/publications/US-Cities-EVs_ICCT_White-Paper_25072017_vF.pdf

[72]Three Revolutions in Urban Transportation, UC Davis Institute of Transportation Studies & the Institute for Transportation & Development Policy, 2017, https://www.itdp.org/wp-content/uploads/2017/04/UCD-ITDP-3R-Report-FINAL.pdf

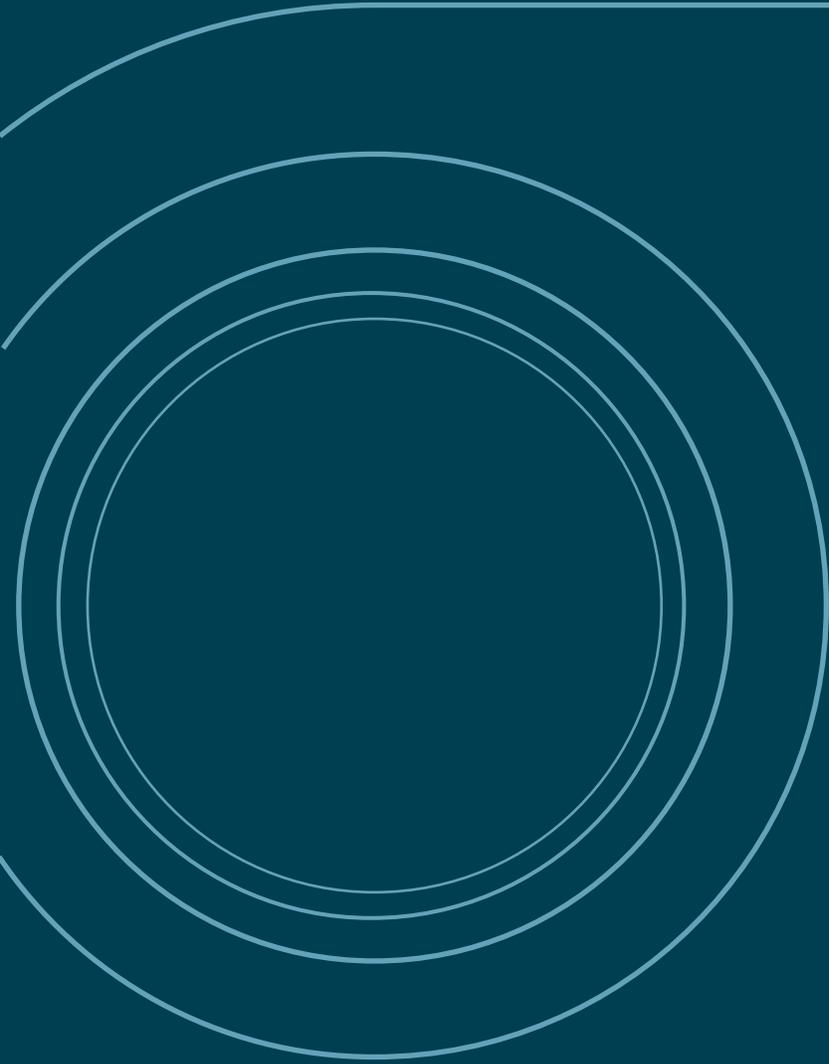[73]Smart City Challenge, U.S. Department of Transportation, https://www.transportation.gov/smartcity

[74]Taming the Autonomous Vehicle, Bloomberg Philanthropies and the Aspen Institute, March 2017, https://www.bbhub.io/dotorg/sites/2/2017/05/TamingtheAutonomousVehicleSpreadsPDFReleaseMay3rev2.pdf

[75]City Data Sharing Principles, NACTO, January 2017, https://nacto.org/wp-content/uploads/2017/01/NACTO-Policy-Data-Sharing-Principles.pdf

[76]Modernizing Government's Approach to Transportation and Land Use Data: Challenges and Opportunities, Brookings Institution, July 2017, https://www.brookings.edu/wp-content/uploads/2017/07/modernizingapproachtodata_report1.pdf

[77]Modernizing Government's Approach to Transportation and Land Use Data: Challenges and Opportunities, Brookings Institution, July 2017, https://www.brookings.edu/wp-content/uploads/2017/07/modernizingapproachtodata_report1.pdf

[78]Democracy by Design: Food for Thought, July 2016, https://www.democracybydesign.org/wp-content/uploads/2016/11/Democracy-by-Design-discussion-paper-07-2016.pdf

[79]Connecting Sacramento: A Trip-Making and Accessibility Study, State Smart Transportation Initiative, July 2017, http://www.ssti.us/wp/wp-content/uploads/2017/07/SSTI_Connecting_Sacramento_Highlights.pdf

[80]Why Aren't Urban Planners Ready for Driverless Cars, CityLab, December 8, 2015, http://www.citylab.com/cityfixer/2015/12/why-arent-urban-planners-ready-for-driverless-cars/419346/

[81]Downtown Austin Alliance, Downtown Austin Alliance Parking Strategy: Briefing Book 1, November 2017, http://www.downtownaustin.com/sites/default/files/DowntownParkingBriefingBook_Part1.pdf

[82]Downtown Austin Alliance, Downtown Austin Alliance Parking Strategy: Briefing Book 1, November 2017, http://www.downtownaustin.com/sites/default/files/DowntownParkingBriefingBook_Part1.pdf

[83]Downtown Austin Alliance, Downtown Austin Alliance Parking Strategy: Briefing Book 1, November 2017, http://www.downtownaustin.com/sites/default/files/DowntownParkingBriefingBook_Part1.pdf

[84]Parking Management: Strategies, Evaluation and Planning, Victoria Policy Transport Institute, September 12, 2016, http://www.vtpi.org/park_man.pdf

[85]Downtown Austin Alliance, Downtown Austin Alliance Parking Strategy: Briefing Book 1, November 2017, http://www.downtownaustin.com/sites/default/files/DowntownParkingBriefingBook_Part1.pdf

[86]Driverless Future: A Policy Roadmap for City Leaders, Arcadis, HR&A, and Sam Schwartz Consulting, 2017, https://drive.google.com/file/d/0B6YBhO59Nrj_ejJMU3N1OEpHUkU/view

[87]Smart City Challenge, U.S. Department of Transportation, https://www.transportation.gov/smartcity

[88]Los Angeles County Shared Mobility Action Plan, Shared-Use Mobility Center, 2017, http://sharedusemobilitycenter.org/wp-content/uploads/2016/09/SUMC-Single-Page-Web-2.pdf

[89]PSTA Expands Transit Partnership with Uber, Lyft Across Pinellas County, PSTA, https://www.psta.net/about-psta/press-releases/2016/psta-expands-transit-partnership-with-uber-lyft-across-pinellas-county/

[90]EV Car Sharing Pilot for Disadvantaged Communities, City of Los Angeles, http://sd24.senate.ca.gov/sites/sd24.senate.ca.gov/files/EV%20Carsharing%20Pilot.pdf

[91]Peer to Peer Electric Car Sharing Pilot Launches in Portland, Efficientgov, March 31, 2017, https://efficientgov.com/blog/2017/03/31/peer-to-peer-electric-car-sharing-pilot-portland/

[92]Self-Driving Bus with No Back-Up Drivers nears California Street, Reuters, March 6, 2017, http://www.reuters.com/article/us-california-autonomous-bus-idUSKBN16E08I

[93]Autonomous Shuttle just Around the Corner for Downtown Tampa, Crain's Tampa Bay, January 29, 2017, http://tampabay.crains.com/article/news/autonomous-shuttle-just-around-corner-downtown-tampa

[94]Taming the Autonomous Vehicle, Bloomberg Philanthropies and the Aspen Institute, March 2017, https://www.bbhub.io/dotorg/sites/2/2017/05/TamingtheAutonomousVehicleSpreadsPDFreleaseMay3rev2.pdf

[95]Uber's Carpool Service Sacrifices Convenience for Efficiency in NYC, Engadget, May 22, 2017, https://www.engadget.com/2017/05/22/uber-pool-manhattan-smart-routes/

[96]Driverless Future: A Policy Roadmap for City Leaders, Arcadis, HR&A, and Sam Schwartz Consulting, 2017, https://drive.google.com/file/d/0B6YBhO59Nrj_ejJMU3N1OEpHUkU/view

[97]Community Care Collaborative, Dell Medical School and RideAustin Partner to Provide Rideshare Services to Low Income Patients, Central Health, July 10, 2017, http://www.centralhealth.net/community-care-collaborative-dell-medical-school-rideaustin-partner-provide-rideshare-services-low-income-patients/

[98]Housing Tenure: Occupied Housing Units, American Fact Finder, U.S. Census Bureau, 2015, https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_15_SPL_K202502&prodType=table

[99]Data Shows Big Differences Between Austin Renters and Homeowners, KUT, August 15, 2016, http://kut.org/post/data-shows-big-differences-between-austin-renters-and-homeowners

[100]Affordable Housing, U.S. Department of Housing and Urban Development, https://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/affordablehousing

[101]Austin Seeks Fix to Traffic Issues, Community Impact Newspaper, May 31, 2017, https://communityimpact.com/austin/city-county/2017/05/31/austin-seeks-fix-traffic-issues/

[102]Something's Gotta Give: Working Families and the Cost of Housing, Center for Housing Policy, April 2005, http://www2.nhc.org/media/documents/somethings_gotta_give.pdf

[103]FAQ: How was the 45% Affordability Benchmark Developed?, Housing + Transportation Affordability Index, 2017, https://htaindex.cnt.org/faq/

[104]Key Socioeconomic Indicators for Greater Austin and Travis County, CAN Community Dashboard 2017, Community Advancement Network, May 18, 2017, http://canatx.org/dashboard/wp-content/uploads/2017/05/2017-CAN-Dashboard-FOR-WEB.pdf

[105]National Summit on Design and Mobility, American Architectural Foundation, May 2017, http://www.archfoundation.org/2017/01/2017-national-summit-on-design-and-urban-mobility/

[106]8 Bright Ideas for Driverless Cities, Laura Bliss, City Lab, May 12, 2017, https://www.citylab.com/transportation/2017/05/8-bright-ideas-for-driverless-cities/526446/

[107]Can GM's Ridesharing Service Make It Big in New York City?, Yahoo Tech, May 15, 2017, https://www.yahoo.com/tech/gm-maven-ridesharing-big-york-162137339.html

[108]Citywide Relevancy & Advocacy Report, Digital Inclusion, City of Austin, 2014, http://austintexas.gov/sites/default/files/files/Telecommunications/Relevancy___Advocacy_Report_Citywide.pdf

[109]District 3 Relevancy & Advocacy Report, Digital Inclusion, City of Austin, 2014, http://www.austintexas.gov/sites/default/files/files/Telecommunications/Relevancy___Advocacy_Report_District_3.pdf

[110]District 2 Relevancy & Advocacy Report, Digital Inclusion, City of Austin, 2014, http://austintexas.gov/sites/default/files/files/Telecommunications/Relevancy___Advocacy_Report_District_2.pdf

[111]Seattle New Mobility Playbook, Seattle Department of Transportation, September 2017, http://www.seattle.gov/transportation/docs/NewMobility_Playbook_9.2017.pdf

[112]Taming the Autonomous Vehicle, Bloomberg Philanthropies and the Aspen Institute, March 2017, https://www.bbhub.io/dotorg/sites/2/2017/05/TamingtheAutonomousVehicleSpreadsPDFreleaseMay3rev2.pdf

[113]Taming the Autonomous Vehicle, Bloomberg Philanthropies and the Aspen Institute, March 2017, https://www.bbhub.io/dotorg/sites/2/2017/05/TamingtheAutonomousVehicleSpreadsPDFreleaseMay3rev2.pdf

[114]NACTO Policy Statement on Automated Vehicles, National Association of City Transportation Officials, June 22, 2016, https://nacto.org/wp-content/uploads/2016/06/NACTO-Policy-Automated-Vehicles-201606.pdf

[115]National Highway and Traffic Safety Administration, Federal Automated Vehicles Policy: Accelerating the Next Revolution in Roadway Safety, September 2016, https://www.transportation.gov/sites/dot.gov/files/docs/AV%20policy%20guidance%20PDF.pdf

[116]University Embraces Proposed Ruling for New Vehicle Technology Standards, The Michigan Daily, March 29, 2016, https://www.michigandaily.com/section/news/university-embraces-proposed-rule-new-vehicle-technology-standards

[117]The Biggest Threat Facing Connected Autonomous Vehicles is Cybersecurity, TechCrunch, August 26, 2016, https://techcrunch.com/2016/08/25/the-biggest-threat-facing-connected-autonomous-vehicles-is-cybersecurity/

[118]The Employment Impact of Autonomous Vehicles, Office of the Chief Economist: U.S. Department of Commerce, August 11, 2017, http://www.esa.doc.gov/sites/default/files/Employment%20Impact%20Autonomous%20Vehicles_0.pdf

[119]Stick Shift: Autonomous Vehicles, Driving Jobs, and the Future of Work, Center for Global Policy Solutions, 2017, http://globalpolicysolutions.org/wp-content/uploads/2017/03/Stick-Shift-Autonomous-Vehicles.pdf

[120]Advanced Energy Jobs in California: Results of the 2016 California Advanced Energy Employment Survey, Advanced Energy Economy Institute, 2016, http://info.aee.net/hubfs/PDF/california-jobs-report-2016.pdf?t=1462473190835

[121]Automotive Technology and Outdoor Powered Equipment, Austin Community College, http://www.austincc.edu/degrees-and-certificates/areas-of-study/design-manufacturing-construction-and-applied-technologies/automotive-technology-and-outdoor-powered-technology

[122]Clean Energy is Seeing Monumental Job Growth, U.S. News and World Report, March 15, 2017, https://www.usnews.com/news/at-the-edge/articles/2017-03-15/clean-energy-is-seeing-explosive-job-growth-dont-let-budget-kill-it

[123]3 Million Clean Energy Jobs in America, E2, February 2017, https://www.e2.org/wp-content/uploads/2017/02/E2_CleanEnergyJobs_National.pdf

[124]3 Million Clean Energy Jobs in America, E2, February 2017, https://www.e2.org/wp-content/uploads/2017/02/E2_CleanEnergyJobs_National.pdf

[125]3 Million Clean Energy Jobs in America, E2, February 2017, https://www.e2.org/wp-content/uploads/2017/02/E2_CleanEnergyJobs_National.pdf

[126]Texas Leads the Nation in Wind Energy, Houston Public Media, February 10, 2017, https://www.houstonpublicmedia.org/articles/news/2017/02/10/187375/texas-leads-nation-in-wind-energy/

[127]Texas' Clean Energy Economy: Prioritizing Jobs, Investments, and Economic Growth, Environmental Defense Fund, February 2017, https://www.edf.org/sites/default/files/texas-report-to-legislators.pdf

[128]Clean Energy is Powering California's Economy, Creating Jobs, Environmental Entrepreneurs, April 2017, https://www.e2.org/cleanjobscalifornia/

[129]Taming the Autonomous Vehicle, Bloomberg Philanthropies and the Aspen Institute, March 2017, https://www.bbhub.io/dotorg/sites/2/2017/05/TamingtheAutonomousVehicleSpreadsPDFreleaseMay3rev2.pdf

[130] How Automakers Can Survive the Self-Driving Era, AT Kearney, 2017, https://www.atkearney.com/automotive/article?/a/how-automakers-can-survive-the-self-driving-e-1

[131] Capital Factory and Moovel North America Create MobilityX Accelerator, moovel Group, March 9, 2017, https://moovel-group.com/en/press/capital-factory-and-moovel-north-america-create-mobilityx-accelerator

[132] Transportation + Mobility, Austin Technology Incubator, June 2017 https://ati.utexas.edu/current-portfolio/transportation/

[133] Mobility Talks, City of Austin, 2016, http://austintexas.gov/mobilitytalks

[134] Americans Feel Unsafe Sharing the Road with Fully Self-Driving Cars, AAA, March 7, 2017, http://newsroom.aaa.com/2017/03/americans-feel-unsafe-sharing-road-fully-self-driving-cars/

[135] Los Angeles County Shared Mobility Action Plan, Shared-Use Mobility Center, 2017, http://sharedusemobilitycenter.org/wp-content/uploads/2016/09/SUMC-Single-Page-Web-2.pdf

[136] Denver Smart City, City of Denver, https://www.denvergov.org/content/denvergov/en/denver-smart-city.html

[137] Smart Trips Austin, Capital Metro and the City of Austin, http://smarttripsaustin.org/about/

[138] Resolution 20150604-048 Austin Community Climate Plan Update, City of Austin, September 16, 2016, http://austintexas.gov/sites/default/files/files/2016-09 16_Memo_to_MC_Community_Climate_Plan_Implementation_and_Progress....pdf

[139] Austin Community Climate Plan Summary, City of Austin, January 2017, http://www.austintexas.gov/sites/default/files/files/Sustainability/Climate/ACCP_summary_final_012717.pdf

[140] Austin Community Climate Plan Summary, City of Austin Office of Sustainability, January 2017, http://austintexas.gov/sites/default/files/files/Sustainability/Climate/ACCP_summary_final_012717.pdf

[141] The Future of Autonomous Vehicles Is Shared, CityLab, January 6, 2017, https://www.citylab.com/life/2017/01/the-future-of-autonomous-vehicles-is-shared/512417/

[142] The Future of Autonomous Vehicles Is Shared, CityLab, January 6, 2017, https://www.citylab.com/life/2017/01/the-future-of-autonomous-vehicles-is-shared/512417/

[143] Austin Transportation Department, Source: Anthony Forcier – Signs and Markings, 2017

[144] 2016/2017 Austin, TX Approved Budget: Volume One, City of Austin, https://assets.austintexas.gov/budget/16-17/downloads/Approved_Volume_1_FINAL.pdf

[145] Beyond Speculation Automated Vehicles and Public Policy, Eno Center for Transportation, May 2017, https://www.enotrans.org/wp-content/uploads/2017/04/AV_FINAL-1.pdf

[146] Los Angeles County Shared Mobility Action Plan, Shared-Use Mobility Center, September 2016, http://sharedusemobilitycenter.org/wp-content/uploads/2016/09/SUMC-Single-Page-Web-2.pdf

[147] July 11, 2017 Transportation & Public Works Recording, YouTube: City of Minneapolis, July 11, 2017, https://www.youtube.com/watch?v=1Jvy3lNeXLg&index=3&list=PLcNuebgSUruD_OjmsfA6WPCC5paz6KcbN

[148] New Mobility Playbook, Seattle Department of Transportation, June 2017, http://www.seattle.gov/Documents/Departments/TransitAdvisoryBoard/Presentations/NewMobility_PlaybookFINAL.PDF

[149] Proposed Budget Fiscal Year 2018, Los Angeles County Transportation Authority, 2017, https://media.metro.net/about_us/finance/images/fy18_proposed_budget_2017-05.pdf

[150]NTCOG Regional Transportation Council 4-13-17 meeting minutes, Item 8

[151]Transurban: CEO Scott Charlton Sees 2020s Transport 'Revolution,' Australian Financial Review, March 8, 2017, http://www.afr.com/brand/business-summit/transurban-ceo-scott-charlton-sees-2020s-transport-revolution-20170306-gursb5

[152]Taming the Autonomous Vehicle, Bloomberg Philanthropies and the Aspen Institute, March 2017, https://www.bbhub.io/dotorg/sites/2/2017/05/TamingtheAutonomousVehicleSpreadsPDFreleaseMay3rev2.pdf

[153]Beta Version, The Free Dictionary, http://www.thefreedictionary.com/beta+version

[154]Big Data, Merriam-Webster, https://www.merriam-webster.com/dictionary/big%20data

[155]CalEnviroScreen FAQs, OEHHA, February 26, 2016, https://oehha.ca.gov/calenviroscreen/calenviroscreen-faqs

[156]Health is Central, Central Health, http://www.centralhealth.net/initiatives/community-care-collaborative/

[157]Data Management Platform, TechTarget, http://searchcio.techtarget.com/definition/data-management-platform-DMP

[158]DSRC: The Future of Safer Driving, U.S. Department of Transportation, https://www.its.dot.gov/factsheets/dsrc_factsheet.htm

[159]Understanding Electric Vehicle Charging, Plug-In America, January 31, 2011, https://pluginamerica.org/understanding-electric-vehicle-charging/

[160]Microtransit: An Assessment of Potential to Drive Greenhouse Gas Reductions, MaRS Discovery District, 2016, http://taf.ca/wp-content/uploads/2016/12/Microtransit-report-2016.pdf

[161]Mobility on Demand, U.S. Department of Transportation, https://www.its.dot.gov/factsheets/pdf/MobilityonDemand.pdf

[162]Paratransit, Merriam-Webster, https://www.merriam-webster.com/dictionary/paratransit

[163]Parklets: Urban Street Design Guide, NACTO, https://nacto.org/publication/urban-street-design-guide/interim-design-strategies/parklets/

[164]Ride Free Area Update, King County Metro, March 2012, http://metro.kingcounty.gov/tops/bus/ride-free-area/pdf/RFA_Brochure_3-2012.pdf

[165]What is Shared-Use Mobility, Shared-Use Mobility Center, http://sharedusemobilitycenter.org/what-is-shared-mobility/

[166]Taming the Autonomous Vehicle, Bloomberg Philanthropies and the Aspen, March 2017, https://www.bbhub.io/dotorg/sites/2/2017/05/TamingtheAutonomousVehicleSpreadsPDFreleaseMay3rev2.pdf

[167]Unbanked, The Free Dictionary, http://www.thefreedictionary.com/Unbanked

[168]Vehicle-to-Infrastructure (V2I) Resources, U.S. Department of Transportation, https://www.its.dot.gov/v2i/

[169]Vehicle-to-Vehicle Communications, NHTSA, https://www.nhtsa.gov/technology-innovation/vehicle-vehicle-communications

[170]Vision Zero, austintexas.gov, http://www.austintexas.gov/visionzero

APPENDIX

RESOLUTION NO. <u>20170302-039</u>

WHEREAS, the City of Austin Texas is recognized as an innovative, pioneering, and technologically savvy Smart City, that is creative, compassionate, and economically vibrant; and

WHEREAS, the City of Austin is a founding member of the Texas Coalition of Smart Cities and together with our research partners and coalition cities were collectively selected as an Automated Vehicle Proving Ground by the USDOT; and

WHEREAS, the City has been and continues to be recognized with significant grant monies by United States Department of Energy supporting our New Mobility initiatives and further participates as an initial member of the Bloomberg Aspen Initiative on Cities and Autonomous Vehicles, which will galvanize experts and data to accelerate cities' planning efforts for Autonomous Vehicles and produce a set of principles and tools that participating cities can use to chart their own paths forward; and

WHEREAS, the City is challenged with increasing congestion associated with its growing population, leading to increasing vehicle miles traveled, longer commutes, and difficulties for some in our community to access reliable, affordable, and accessible transportation options; and

WHEREAS, the City of Austin was called the "Kitty Hawk" of driverless vehicles for hosting the first passenger-only vehicle on a public City Street; and

WHEREAS, the City seeks to be a leader in the deployment of "Shared, Electric and Automated Vehicles" and to build upon its "Kitty Hawk" designation for this emerging technology industry, bringing jobs and new skilled training opportunities to Central Texas; and

WHEREAS, "Shared, Electric, Autonomous Mobility Services" in a City Designed for It, would offer the opportunity to provide mobility, accessibility,

affordability, and better designed communities and cities that will provide the underpinnings for improved health and livability, and reduced transportation costs, as compared to owning a single occupancy vehicle, specifically to seniors, persons with disabilities, millennials, and others without a driver's license or means to access a car; and offers further opportunities to the broader population to transition to shared, electric, autonomous mobility services for their transportation needs as a strategy to reduce transportation costs and improve health and well-being outcomes via improved air quality, stress reduction, physical fitness, and affordability; and

WHEREAS, the City of Austin remains dedicated to seeking out and employing strategies and solutions that make our City more sustainable, support clean renewable energy and our municipal utility, and enhance overall quality of life and equity in our community; and

WHEREAS, the City of Austin recognizes the power and potential of creating a groundbreaking P4 Public/Private/People Partnership as a means to leverage and create communally beneficial solutions to the challenges and opportunities we face as a City in the 21st century; and

WHEREAS, autonomous driving technology is being heavily invested in by many large companies, with 13 of the world's 14 largest automakers announcing plans to bring autonomous vehicles to market, and 12 of the world's 14 largest technology companies announcing plans to build technologies to support and operate autonomous vehicles; and

WHEREAS, there is opportunity and logic in leveraging the synergy between autonomous and plug-in electric vehicles technologies as a way to address not just mobility but also clean air and climate change goals; and

WHEREAS, the City Council passed Resolution No. 20140410-024 that established a goal of reaching NET-ZERO community-wide greenhouse gas

emissions by 2050, recognizing that it is important and valuable to accomplish emissions reductions as soon as it is feasible; and

WHEREAS, as of 2010, greenhouse gas emissions in Travis County were created approximately 52% by energy use, 36% from transportation, and 12% from local landfills and manufacturing processes; and

WHEREAS, the City Council passed Resolution No. 20140828-157 that set the vision for reducing carbon dioxide (CO_2) emissions from all city-controlled generation resources to zero by 2030, subject to the previously-adopted and reaffirmed affordability goals; and

WHEREAS, the City Council passed Resolution No. 20141211-112 recognizing "Automated and Connected Vehicle (AC-V) technology" as an emerging field of transportation innovation and established a goal of becoming a leader in the public infrastructure adaptation of AC-V technology; and

WHEREAS, expanding electrification options for more vehicle classes and within vehicle classes will be available going forward leveraging advancements in automotive and utility technology; and

WHEREAS, leading cities and nations have recently completed adoption of electric vehicle sales targets up to 100% electric vehicles by as soon as 2030; and

WHEREAS, a high degree of electrification will have significant impact on fiscal opportunities for Austin Energy; and

WHEREAS, Austin Energy is a national leader in utility electric vehicle ("EV") programs; and

WHEREAS, Austin Energy's public charging network, Plug-in EVerywhere, has over 500 level 2 charging ports and 3 DC Fast Ports backed by the utility's 100% renewable energy program, GreenChoice, to maximize the carbon emission reduction benefits of electric vehicles over fossil fuel vehicles; and

WHEREAS, "New Mobility Electric/Autonomous Vehicles and Services" have the potential to make travel more affordable, accessible, and efficient, as well as helping our City reach environmental and community health goals by reducing emissions and improving air quality, as well as reducing stress and anxiety, and improving access to jobs/food/healthcare; and

WHEREAS, to successfully make the transition to "New Electric/Autonomous Mobility Vehicles and Services" will take sustained effort, with all individuals, businesses, and organizations in the community playing a role; **NOW, THEREFORE,**

BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF AUSTIN:

The City Manager is directed to develop a plan (The New Mobility EV/AV Plan" or "Plan") and prepare the City to take a state/national/global leadership role in the ensuing **"New Mobility Electric/Autonomous Vehicle (EV/AV)"** solution. The New Mobility EV/AV solution will shift the City's transportation system to one that enables **"Shared, Electric, and Autonomous Mobility Services" and provide a City ready and willing for it.**

BE IT FURTHER RESOLVED:

"The New Mobility EV/AV Plan" should include measurable interim greenhouse gas reduction targets to support the goal set by City Council Resolution No. 20140410-024 of reaching NET-ZERO community-wide greenhouse gas emissions by 2050, or sooner if feasible, that includes a 20% overall reduction goal by 2020 and, procedures for when and how annual progress reports will occur.

BE IT FURTHER RESOLVED:

The New Mobility EV/AV Plan will address on-demand mobility, accessibility and reduced transportation costs, reduced congestion, improved air quality, and mobility for seniors, persons with disabilities, and others without a driver's license

or means to access a car. The Plan will include opportunities to the broader population, making it easier to shed private vehicle ownership and migrate to shared, electric, autonomous mobility services for their transportation needs. Wide spread adoption of Shared, Electric, and Autonomous transportation services has potential to transform our transportation system and provide benefits such as reduced transportation costs and congestion as well as improved air quality and increased affordability. The plan will also include and provide opportunity to evolve with future technological advancements, as well as:

- Consider creating an executive position to act as Chief Officer of EV/AV transportation services;
- Measure of savings and increased access to transportation options to individuals and our community;
- List of next steps and targets needed to achieve goals;
- Description of resources that may be needed and potential funding options; and
- Safety considerations.

BE IT FURTHER RESOLVED:

The City Manager shall develop and present a New Mobility EV/AV Plan to City Council by June 15, 2017.

ADOPTED: ___March 2___, 2017   **ATTEST:**
Jannette S. Goodall
City Clerk
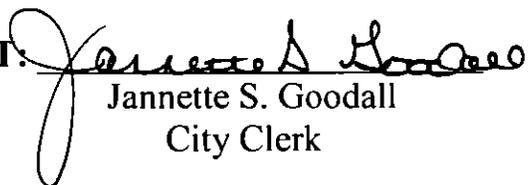
SUBJECT:
Approval of a resolution authorizing the President/CEO, or her designee, to develop a plan in coordination with the City of Austin to futher the goal of environmentally sustainable tranportation solutions and demonstrate support for shared and autonomous mobility strategies.

FISCAL IMPACT:

Plan development has no immediate fiscal impact.

STRATEGIC PLAN:
Strategic Goal Alignment:
2. Demonstrate regional leadership
3. Demonstrate the value of public transportation in a dynamic community

Strategic Objectives:
2.1 Lead public transportation and development
2.2 Pursue service expansion opportunities
3.1 Develop new ridership markets
3.2 Develop and deliver key agency messages
4.4 Implement sustainability and environmental stewardship best practices

EXPLANATION OF STRATEGIC ALIGNMENT:
This plan demonstrates Capital Metro's role as a key partner in efforts to develop sustainable and integrated mobility solutions.

BUSINESS CASE:
Development of this plan coordinates with the City of Austin's New Mobility Electric/Autonomous/Shared Mobility Services Plan which seeks to leverage the 2016 Mobility Bond in improving key corridors and leveraging these improvements to create more sustainable and walkable communities.

COMMITTEE RECOMMENDATION:
This agenda item will be presented to the full board on May 22, 2017.

EXECUTIVE SUMMARY:
This resolution directs Capital Metro staff to develop a plan in coordination with the City of Austin to futher the goal of environmentally sustainable tranportation solutions and demonstrate support for shared and autonomous mobility strategies.

DBE/SBE PARTICIPATION: Does not apply

PROCUREMENT: Does not apply.

RESPONSIBLE DEPARTMENT: Planning and Development

RESOLUTION

OF THE

CAPITAL METROPOLITAN TRANSPORTATION AUTHORITY

BOARD OF DIRECTORS

STATE OF TEXAS

COUNTY OF TRAVIS   **RESOLUTION (ID # AI-2017-463)**

New Mobility Electric/Autonomous/Shared Vehicle Plan

WHEREAS, the Capital Metropolitan Transportation Authority (Capital Metro) serves Central Texas as its primary public transit provider, connecting people, jobs and communities by providing quality transportation choices; and

WHEREAS, Capital Metro offers a variety of transit services through its MetroBus, MetroExpress, MetroRapid, Night Owl, E-Bus, University of Texas Shuttles, MetroAccess, MetroRideShare, and Freight rail demonstrating a wide range of modality and public service being performed in our community; and

WHEREAS, despite having achieved major reductions in pollutant emissions by using the latest technologies as new fleet has been acquired, almost all Capital Metro vehicles continue to be powered by fossil fuels; and

WHEREAS, advancing technologies provide an opportunity to transform the fleet to a clean green fleet through electrification, thereby reducing maintenance and operation costs, as well as providing improvements to air quality and the environment; and

WHEREAS, Capital Metro is a significant partner with the City of Austin in delivering Smart Mobility solutions for its residents and visitors, and both entities are working together to contribute to Austin being a technologically savvy Smart City, that is creative, compassionate, and economically vibrant; and

WHEREAS, Capital Metro and the City of Austin are challenged with increasing congestion associated with its growing population, leading to increasing vehicle miles traveled, longer commutes, and difficulties for some in our community to access reliable, affordable, and accessible transportation options; and

WHEREAS, Capital Metro and the City of Austin seek New Mobility initiatives, along with data, to accelerate our city's mobility, equity and economic future, along with our partner Texas cities and institutions in the Texas Coalition of Smart Cities; and
WHEREAS, the City of Austin is developing a plan to be a leader in the deployment of

"Electric/Automated/Shared Vehicles" and recognizes the importance and value in its partnership with Capital Metro in growing electric and autonomous fleets; and

WHEREAS, the City of Austin's "New Mobility Electric/Autonomous/ Shared Mobility Services Plan", would offer the opportunity to provide mobility, accessibility, affordability, and further provide the underpinnings for improved health, livability, and reduced transportation costs, as compared to owning a single occupancy vehicle, specifically to seniors, persons with disabilities, millennials, and others without a driver's license or means to access a car; and

WHEREAS, "The New Mobility Electric/Autonomous/Shared Mobility Services Plan" would extend the reach of Capital Metro bus and rail lines, as a first and last mile solution, enabling accelerated adoption by the broader population to use public transit as a way to get to work, access healthcare and education, or meet other personal needs, and would subsequently increase transit use and overall efficiency throughout the transportation system; and

WHEREAS, the City of Austin recently passed a $720 million Mobility Bond providing $482 million in funds to improve key corridors, making them more walkable and to better enable delivery of improved transit services; and

WHEREAS, there is opportunity in leveraging corridor improvements to create and enhance charging opportunities for electrified vehicles and transit fleets; and

WHEREAS, Capital Metro, as the operator of the region's public transit system, is uniquely qualified to connect transit operations and schedules to shared, first and last mile and mobility on demand solutions by developing partnerships with private sector providers; and

WHEREAS, Capital Metro, the City of Austin, and regional interests seek to pilot Electric/Automated/Shared Vehicle technology in Austin along the Riverside Corridor, which is a designated Automated Vehicle Proving Ground by the United States Department of Transportation, and elsewhere; and

WHEREAS, the City of Austin's "New Mobility Electric/Autonomous/Shared Vehicles Plan" will have the potential to make travel more affordable, accessible, and efficient, as well as helping the City of Austin and regional partners reach environmental and community health goals by reducing emissions and improving air quality, as well as reducing stress and anxiety, and improving access to jobs/food/healthcare; and

WHEREAS, to successfully make the transition to "New Mobility Electric/Autonomous/Shared Mobility Vehicles and Services" will take sustained effort, with all individuals, businesses, and organizations, in the community playing a role including Capital Metro as the key transit mobility partner for the City of Austin.

NOW, THEREFORE, BE IT RESOLVED that the President/CEO, or her designee, is directed to develop a plan in coordination with the City of Austin's New Mobility Electric/Autonomous/Shared Vehicle (EV/AV/Shared) Plan that demonstrates the organizations critical role as partner with the City of Austin as a state/national/global leader in the ensuing "New Mobility Electric/Autonomous/Shared Vehicle" solution; and

BE IT FURTHER RESOLVED that the President/CEO, or her designee is also directed to:

- Establish goals, targets, and a timetable for fleet electrification that supports the organizations financial health as well as the health of the community it serves;

- Enhance and coordinate opportunities to electrify Capital Metro's fleet;

- Consider participation in pilot test strategies related to transit services and communicating transit needs;

- Work with private sector providers with technology tools that dynamically route services and provide payment platforms for multi-modal transportation options, including for the unbanked, and for pilot programs such as along the Riverside Corridor in concert with the City of Austin Autonomous and Connected Vehicle technology pilots;

- Consider sharing in testing, funding, operations, data collection and marketing support of autonomous and electric shuttle and vehicle pilots along and near the Riverside corridor with the city of Austin and other future potential partnering projects;

- Realize the full potential of the integrated mobility system by advancing the approved Connections 2025 schedule changes for the Riverside Corridor so they begin with initial implementation in early 2018 and can be coordinated with the Riverside Corridor new mobility pilots;

- Develop a plan to pilot electric buses on Riverside Corridor and other corridors to compare performance, emissions and Operations and Maintenance costs with existing gas-powered buses, and work with Austin Energy and the City's partner, Rocky Mountain Institute, to develop a plan to convert the Capital Metro fleet to an electric one;

- Measure customer savings and increased access to transportation options to individuals and our community;

- List next steps and targets needed to achieve goals;

- Provide a description of resources that may be needed and potential funding options; and

BE IT FURTHER RESOLVED that the President/CEO, or her designee, shall present the New Mobility EV/AV/Shared Plan to the Board of Directors for consideration by July 31, 2017.

_____   **Date: _____**
Secretary of the Board
Juli Word

RESOLUTION NO. <u>20160818-074</u>

WHEREAS, City staff estimates that $500 million in bond capacity for an eight year bond program is available under Austin's current debt tax rate; and

WHEREAS, City Council desires to preserve $250 million of bond capacity for a future bond referendum in 2017 or 2018; and

WHEREAS, City Council is ordering a Special Election to be held on November 8, 2016 for the purpose of asking the voters to authorize $720 million in general obligation bonds comprised of $250 million of the City's $500 million of bond capacity under its existing debt tax rate, and an additional $470 million associated with an estimated debt tax rate increase of approximately 2.25 cents per $100 worth of property valuation; and

WHEREAS, City Council desires to allocate the $720 million as follows:

(i) $101,000,000 for the following Regional Mobility projects to address congestion and enhance safety: (a) $46,000,000 for improvements to the Loop 360 corridor intersections at Westlake Drive, Courtyard Drive, RM 2222, Lakewood Drive and Spicewood Springs Road/Bluff Stone Lane, (b) $17,000,000 for improvements to Spicewood Springs Road east of Loop 360, (c) $30,000,000 for improvements to Anderson Mill Road, intersection

of RM 620 and RM 2222, and Parmer Lane between SH45 and Brushy Creek, and (d) $8,000,000 for improvements to Old Bee Caves Road Bridge;

(ii) $482,000,000 for the following Corridor Improvement Projects: (a) implementation of corridor plans for North Lamar Boulevard, Burnet Road, Airport Boulevard, East Martin Luther King Jr. Boulevard/FM 969, South Lamar Boulevard, East Riverside Drive and Guadalupe Street (b) implementation of corridor plans for Slaughter Lane and/or William Cannon Drive, and (c) preliminary engineering and design of improvements for the following additional critical arterials and corridors: William Cannon Drive, Slaughter Lane, North Lamar/Guadalupe Street, Rundberg West, Rundberg East, East Colony Park Loop Road, East Martin Luther King Jr. Boulevard/FM 969, South Congress Avenue, Manchaca, and South Pleasant Valley; and

(iii) $137,000,000 for the following Local Mobility Projects: (a) $37,500,000 for sidewalks, (b) $27,500,000 for implementation of Safe Routes to School, to be divided evenly among each Council District, (c) $26,000,000 for urban trails for transportation and mobility purposes, (d) $20,000,000 for bikeways for transportation and mobility purposes, (e) $15,000,000 for implementation of fatality reduction strategies including

. projects listed on the Top Crash Location Intersection Priorities Improvements List, and (f) $11,000,000 for the following sub-standard streets/capital renewal: Falwell Lane, William Cannon Overpass Bridge, FM 1626, Cooper Lane, Ross Road, Circle S. Road, Rutledge Spur, Davis Lane, Latta Drive/Brush Country, Johnny Morris Road, and Brodie Lane; and

WHEREAS, City Council desires that the $720 million bond program be completed within eight years from voter approval and in accordance with the guidance and procedures set forth in this resolution; **NOW, THEREFORE,**

BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF AUSTIN:

The Council, by this official action, reaffirms its commitment to the voters regarding the conditions contained in the ordinance calling the November 2016 Mobility Bond election. Further, Council, by this official action, clarifies and declares its intent and commitment to the voters to create a contract with the voters that specifies that the proceeds from the $720,000,000 in bonds and notes shall only be used for the projects identified in the ordinance calling the November 2016 Mobility Bond election.

BE IT FURTHER RESOLVED:

Council, by this official action declares its intent to contract with the voters as to the following permissible purposes for which bond proceeds must be

expended and the processes that must be followed in determining and prioritizing those expenditures:

(A) Upon voter approval of the November 2016 Mobility Bond Program, the City Manager shall begin coordination, design, and engineering activities as soon as possible for all projects listed under subsection (ii), parts (a) and (b) above associated with the $482,000,000 allocated for Corridor Improvement Projects in order to develop recommendations for a construction program for City Council consideration. When City staff has gathered sufficient data to develop potential construction elements for the Corridor Improvement Projects, and before any construction funding is appropriated or construction initiated for these projects, the City Manager is directed to bring forth recommendations supported by identifiable metrics for implementation of a "Corridor Construction Program" in ways that prioritize: a) reduction in congestion; b) improved level of service and reduced delay at intersections for all modes of travel; c) connectivity, and improved effectiveness of transit operations within these corridors and throughout the system; and subject to the foregoing, also makes allowances for: i) preservation of existing affordable housing and local businesses on the corridors, and opportunities for development of new affordable housing along the corridors, including, but not limited to, the use of community land trusts, tax increment finance zones along corridors, homestead preservation zone tools, revisions to the S.M.A.R.T. Housing

Program, and targeted investments on the corridors utilizing affordable housing bonds and the Housing Trust Fund; ii) geographic dispersion of funding; and iii) opportunities to facilitate increased supply of mixed-income housing;

(B) Subject to subsection (A) above, the "Corridor Construction Program" developed by the City Manager for City Council consideration shall recommend implementation timelines in accordance with need, as established by the Imagine Austin Comprehensive Plan, the Critical Arterials List, Top Crash Location Intersection Priorities List, and other policy plans as identified in this resolution;

(C) Subject to subsection (A) above, in implementing the "Corridor Construction Program," the City Manager shall further emphasize making corridors livable, walkable, safe, and transit-supportive, and aligned with the principles and metrics in the Imagine Austin Comprehensive Plan, with goals of reducing vehicle miles traveled, increasing transit ridership and non-vehicular trips, and promoting healthy, equitable, and complete communities as growth occurs on these corridors;

(D) In reviewing and approving the Corridor Construction Program, the City Council shall be guided by the same priorities and consideration 'as apply to the City Manager as set out in Sub Sections (A), (B), and (C) above;

(E) The City Manager shall revisit and update existing corridor plans as needed to ensure that final design and implementation conforms to the region's

most recently adopted transportation plans and recently adopted policies and standards for transportation infrastructure design, including, but not limited to:

- Capital Metro Connections 2025;

- Capital Metro Service Guidelines and Standards;

- Project Connect Regional High Capacity Transit Plan;

- City of Austin Strategic Housing Plan;

- City of Austin Transit Priority Policy;

- City of Austin Strategic Mobility Plan;

- City of Austin Complete Streets Policy;

- City of Austin Sidewalk Master Plan;

- City of Austin Urban Trails Master Plan;

- City of Austin Bicycle Master Plan;

- Vision Zero Plan;

- applicable National Association of City Transportation Officials standards; and

- Imagine Austin Comprehensive Plan;

(F) The City Manager is directed to coordinate with other local taxing entities and identify and pursue potential opportunities for grants and other collaborative funding from federal, state, local, as well as private sources. If additional funding is required to complete specified improvements, the City

Manager is directed to identify available funding within existing capital budgets and other sources described above (provided that neither the identification, commitment nor receipt of such additional funding shall limit Council's authority to proceed with the issuance of bonds or notes authorized by the November 2016 Mobility Bond Election). If the cost of improvements associated with an identified Regional Mobility project is less than the amount designated for that specific project, the excess funds shall be used on additional improvements in the corridors on which identified Regional Mobility projects are being implemented; and

(G) The City Manager is directed to analyze existing capital project delivery systems and processes in order to recommend potential changes and resource requirements to complete the proposed bond program within eight years from initiation (provided that bonds and notes authorized by the November 2016 Mobility Bond Election shall be issued to provide funding for the bond program at the appropriate time, as determined by Council, which may be more than eight years after initiation of the bond program). Further, the City Manager shall bring forth recommendations to City Council within 90 days of voter approval, outlining a process for City Council oversight, including a report to the Mobility Committee, a report to the full Council, and a timeline and process for reporting to the Citizen Bond Oversight Committee.

(H) City Manager is directed to include in bond informational materials that educate the voters about the bond election, in addition to the typical voter information about projects and programs that are included in the bond program as described above, as well as the typical tax rate and tax bill impact information that has been included in previous bond information, tax impact information for a median-valued house and houses of various appraised values in a Bond Voter Information Brochure and a tax bill impact calculator to be included on a Bond Program Informational Website.

ADOPTED: ___August 18___, 2016   **ATTEST:** _Jannette S. Goodall_
Jannette S. Goodall
City Clerk
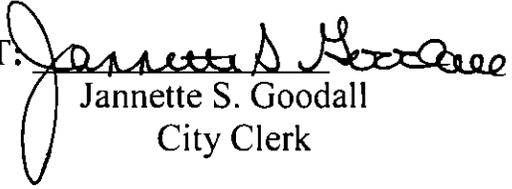
RESOLUTION NO. <u>20160505-025</u>

WHEREAS, the City of Austin's original 2007 Climate Protection Resolution 20070215-023 included a goal to achieve a carbon neutral fleet by 2020 "through the use of electric power, non-petroleum fuels, new technologies, mitigation, and other measures necessary, prioritizing the earliest possible conversion to such fuels and technologies and establishing timelines and benchmarks for such conversions"; and

WHEREAS, in 2011, City facilities went to 100% GreenChoice power, resulting in greenhouse gas emissions related to vehicles and equipment constituting the vast majority of the carbon footprint from the City's operations; and

WHEREAS, in that same year, City Fleet Services and the Office of Sustainability worked together to develop a practical plan to reach the goal of carbon neutrality in a cost effective manner; and

WHEREAS, the committed goal of 95% of new vehicles and equipment being alternatively fueled/hybrid units has been met these past two years, but dual fuel capable vehicles have not met the goals set for alternative fuel use due to fuel quality and accessibility challenges, as well as driver behaviors, such as excessive idling, inefficient driving, and failure to refuel with alternative fuels; and

WHEREAS, the Office of Sustainability and Fleet Services 2020 Carbon Neutral Fleet plan suggested in 2011 that current automotive technology available presented challenges to meeting the goals of the plan and that the City may be forced to look at mitigation through other measures, namely the purchase of carbon offsets; and

WHEREAS, on April 10, 2014, Austin City Council passed Resolution 20140410-024, which establishes a new long-term goal of reaching net zero community-wide greenhouse gas emission by 2050, or earlier if feasible, to include efforts to develop transportation action plans to meet this goal; and

WHEREAS, electric automotive, transportation, and utility technology have all experienced technological advancements in subsequent years; and

WHEREAS, in September of 2015, the City was selected to serve as the lead implementation partner with Rocky Mountain Institute in the Mobility Transformation Program with one of its five projects being "Fleet Electrification"; and

WHEREAS, the "Fleet Electrification Project" has identified opportunities for companies and cities to drastically reduce the cost and increase the efficiency of fleets by electrifying high-mileage vehicles and will work with Austin Energy, the City's municipally owned utility, to enable electric vehicles to improve the electric grid with smart charging to accelerate electrification in years 2 and 3 of our partnership; and

WHEREAS, Austin Energy is a national leader in utility electric vehicle ("EV") programs; and

WHEREAS, Austin Energy's public charging network, Plug-in EVerywhere, is backed by the utility's 100% renewable energy program, GreenChoice, to maximize the carbon emission reduction benefits of electric vehicles over fossil fuel vehicles; and

WHEREAS, Austin Energy, with support from two U.S. Department of Energy federal grants, has led a 10 county regional collaboration effort to reduce

barriers to transportation electrification through its Texas River Cites EV Plan and the Central Texas Fuel Independence Project; and

WHEREAS, Austin Energy, in collaboration with area businesses, community groups, multifamily property owners, developers, and city departments, has deployed over 250 public and commercial electric vehicle charging stations; and

WHEREAS, Austin Energy has launched a pilot to understand the needs of EV charging at more than twenty multifamily properties, including low-income residences; and

WHEREAS, on December 17, 2015, Austin City Council passed a resolution to give the honorary name Electric Drive to a portion of West 2nd Street, to showcase a sustainable transportation future, including DC fast charging station infrastructure; and

WHEREAS, the City of Austin is committed to its goal of making the entire City fleet of vehicles carbon neutral by 2020 and to currently having more opportunities to electrify the fleet; **NOW, THEREFORE,**

BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF AUSTIN:

The City Manager is directed to work with Rocky Mountain Institute, Vulcan, Inc., and Electrification Coalition on an assessment to determine the benefits, timeline, and feasibility of increasing electric vehicle adoption into the City's Fleet Services vehicles, in anticipation of the Smart Cities application.

BE IT FURTHER RESOLVED:

The assessment should, without limitation, consider:

1.   the benefits, timeline, feasibility, and short and long term cost savings to the City of a plan to increase its vehicle fleet electrification;

2.   return on investment comparisons between current considered options and electric vehicle options, as well as cost of ownership comparisons that include purchase, repair, maintenance, and cost of fuel(s);

3.   potential impacts and benefits to Austin Energy with municipal and private fleet services electrification; and

4.   fleet electrification targets in consideration of the City's goal to have a carbon neutral fleet by 2020; and

5.   leverage potential synergies with other governmental organization and commercial large fleet owners.

BE IT FURTHER RESOLVED:

The City Manager is directed to engage the Joint Sustainability Committee, Urban Transportation Commission, Electric Utility Commission, and Environmental Commission in the development of recommendations for opportunities to increase electrification of the City's Fleet Services vehicles, along with financial considerations, and provide a final report on such recommendations to the Council Mobility Committee by October 5, 2016.

ADOPTED: ____May 5____, 2016   ATTEST: _____
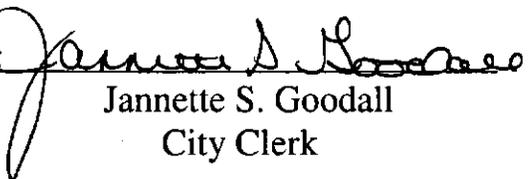
Jannette S. Goodall
City Clerk

RESOLUTION NO. <u>20150604-048</u>

WHEREAS, the City of Austin is committed to protecting the long-term health and viability of our community through strategies designed to reduce greenhouse gas emissions and mitigate the effects of climate change; and

WHEREAS, the City Council passed Resolution No. 20070215-023 that established the framework for the Austin Climate Protection Plan (ACPP), which includes five major goals and related supporting objectives to: (1) Make all City of Austin facilities, fleets, and operations carbon-neutral by 2020; (2) Make Austin Energy (AE) the leading utility for greenhouse gas reductions; (3) Implement the most energy efficient building codes and aggressively pursue energy efficiency retrofits; (4) Create a community-wide inventory of greenhouse gases, establish short- and long-term emission reduction targets, and a comprehensive plan for meeting those targets; and (5) Develop and implement a program to assist all citizens, businesses, organizations, and visitors in achieving carbon neutrality; and

WHEREAS, City Council recognizes that investments in reducing greenhouse gas emissions also have positive outcomes that extend beyond environmental benefits, which include enhancing social equity, maintaining an innovative and strong economy, and providing affordable options for Austin residents related to energy, transportation and waste; and

WHEREAS, the C40 Cities Climate Leadership Group (C40) is a network of the world's megacities committed to addressing climate change, and the City of Austin is an "Innovator City" within C40; and

WHEREAS, City Council passed Resolution No. 20131121-60 that directed the City Manager to develop climate adaptation strategies as an important missing piece to the existing ACPP; and

WHEREAS, the City Council passed Resolution 20140828-157 that set the vision for reducing CO_2 emissions from all city-controlled generation resources to zero by 2030, subject to the previously-adopted and reaffirmed affordability goals; and

WHEREAS, the City Council passed Resolution No. 20140410-024 that established a goal of reaching net zero community-wide greenhouse gas emissions by 2050, recognizing that it is important and valuable for our city's climate protection effort to accomplish emissions reductions as soon as it is feasible; and

WHEREAS, Resolution No. 20140410-024 directed the City Manager to review the goals and objectives of the 2007 ACPP and work with stakeholders to create an action plan, here referred to as the Austin Community Climate Plan (ACCP), for the following major sectors responsible for the community-wide greenhouse gas emissions in Austin, energy, transportation, and waste/industrial, in order to meet the new long-term goal established by Resolution No. 20140410-024; and

WHEREAS, Resolution No. 20140410-024 directed the ACCP to include the following components:

- Measurable interim greenhouse gas reduction targets, starting with 2020 and periodic targets until 2050;

- When and how annual progress reports will occur; and

- How often to conduct comprehensive updates to the climate protection plan; and

WHEREAS, the Office of Sustainability and multiple City departments produced the draft 2015 ACCP, attached here as Exhibit A, the result of the work of fifty community volunteers meeting regularly over a seven-month period and Austin residents providing public input and feedback on the draft strategies and actions throughout the plan development process; and

WHEREAS, reaching the goal of NET-ZERO emissions by 2050 will take sustained effort, with all individuals, businesses, and organizations in the community playing a role; NOW, THEREFORE,

BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF AUSTIN:

The City Council adopts the 2015 Austin Community Climate Plan (ACCP) to achieve the citywide NET-ZERO greenhouse gas emissions by the 2050 goal and a target path to get to NET-ZERO by 2050 including interim targets for 2020, 2030, and 2040 allowing for up to 10% of carbon offsets for all targets.

BE IT FURTHER RESOLVED:

The City Council directs the City Manager to:

- Implement the recommendations from the executive summary of the ACCP within one year of the passage of this resolution;

- Identify and prioritize any resources needed to implement these recommendations and incorporate this information into the FY 2015-2016 budget allocations;

- Develop appropriate performance metrics for the relevant City departments to report progress to achieving the ACCP goals; and

- Provide semi-annual progress updates to City Council, with the first one occurring by September 1, 2015.

BE IT FURTHER RESOLVED:

The City Council directs the City Manager to create a Joint Sustainability Committee as recommended by the City of Austin Board and Commission Transition Task Force, consisting of members of the:

1) Environmental Board;

2) Electric Utility Commission;

3) Zero Waste Advisory Commission;

4) Urban Transportation Commission;

5) Water and Waste Water Commission;

6) Planning Commission;

7) Economic Prosperity Commission;

8) Community Development Commission,

9) Sustainable Food Policy Board;

10) Resource Management Commission, and

11) Parks and Recreation Board.

Each of the above identified boards and commissions shall select one member to serve on the Joint Sustainability Committee.

It is encouraged that these Committee members should also represent a broad diversity of community stakeholders including the following:

1) Large companies and employers;

2) Small businesses owners and non-profit leaders;

3) Renters;

4) Central city individuals and families; and

5) Suburban individuals and families.

If the Open Space, Environment and Sustainability Committee, or a comparable Council committee assigned the authority to review climate protection, determines that greater diversity of Joint Sustainability Committee members is needed to ensure adequate community stakeholder representation, the applicable Council committee may appoint three community stakeholders members.

BE IT FURTHER RESOLVED:

The Joint Sustainability Committee shall:

- Review all city policies and procedures relevant to the ACCP, including the planning, implementation, community engagement, goal setting and progress monitoring;

- Promote close cooperation between the City Council, City departments, City boards, commissions, committees, and taskforces, and individuals, institutions, and agencies concerned with the

politics, procedures, and implementation of the ACCP with the goal of coordinating all similar activities within the City and the community in order to secure the greatest public benefits; and

- Forward to the City Manager all advisory material that the committee provides to the City Council, the Office of Sustainability, City departments or City boards, commissions, committees and taskforces.

The Joint Sustainability Committee may:

- Advise the City Council, the City Manager, the Office of Sustainability, City departments and City boards, commissions, committees and taskforces on policy matters related to the ACCP;

- Ask the City Manager for any information it deems to pertain to the ACCP;

- Make recommendations to the Open Space, Environment and Sustainability Committee before final council action on relevant policies or procedures; and

- Establish advisory groups or working groups as it deems necessary to pertain to the ACCP.

The Council directs the City Manager to provide staff support to the Joint Sustainability Committee. Council recommends that such support be provided by the Office of Sustainability.

BE IT FURTHER RESOLVED:

On behalf of the City Council, the City Manager is authorized to complete the Memorandum of Understanding with C40 Cities Climate Leadership Group to continue the City of Austin's official participation with C40.

ADOPTED: June 4, ~~2~~ , 2015 **ATTEST:** _Jannette S. Goodall_
Jannette S. Goodall
City Clerk

RESOLUTION NO. <u>20140410-024</u>

WHEREAS, the City of Austin is committed to protecting the long-term health and viability of our community through strategies designed to reduce greenhouse gas emissions and mitigate the effects of climate change; and

WHEREAS, according to the United Nations Intergovernmental Panel on Climate Change (IPCC), which is comprised of the world's leading scientific experts in the field of climate change, to avoid the worst impacts of climate change greenhouse gas emissions need to be cut by at least 80% from 1990 levels by 2050; and

WHEREAS, the City Council passed Resolution No. 20070215-023 that established the framework for the Austin Climate Protection Plan (ACPP), which includes five major goals with supporting objectives: (1) Make all City of Austin facilities, fleets, and operations carbon-neutral by 2020; (2) Make Austin Energy (AE) the leading utility for greenhouse gas reductions; (3) Implement the most energy efficient building codes and aggressively pursue energy efficiency retrofits; (4) Create a community-wide inventory of greenhouse gases, establish short- and long-term emission reduction targets, and a comprehensive plan for meeting those targets; and (5) Develop and implement a program to assist all citizens, businesses, organizations, and visitors in achieving carbon neutrality; and

WHEREAS, as of 2010, greenhouse gas emissions in Travis County were estimated to be 15.2 million metric tons of carbon dioxide-equivalent (CO_2e) per year, and approximately 52% of those emissions were created by energy use, 36% from transportation, and 12% from local landfills and manufacturing processes; and

WHERAS, reducing community-wide greenhouse gas emissions, especially from the transportation sector, can have a positive impact on local air quality and result in a healthier community; and

WHEREAS, in April 2010, City Council adopted the AE Resource, Generation, and Climate Protection Plan to 2020, which included specific utility strategies to meet the goals set out in the 2007 ACPP and included an affordability goal; and

WHEREAS, in December 2011, City Council adopted the Austin Resource Recovery Master Plan which includes zero waste goals, carbon footprint reduction efforts, and goals for expanding public/private partnerships; and

WHEREAS, in June 2012, City Council adopted the Imagine Austin Comprehensive Plan, which established goals related to land use and transportation policies; and

WHEREAS, City Council passed Resolution No. 20131121-60 that directed the City Manager to develop climate adaptation strategies as an important missing piece to the existing ACPP, and that report will come back with recommendations for next steps by September 2014; and

WHEREAS, Council has appointed a new Generation Plan Task Force to review the AE Resource, Generation, and Climate Protection Plan to 2020 and make recommendations on the utility's generation mix for the near future; and

WHEREAS, peer cities, including Seattle and Portland, have recently completed updates to their original Climate Action Plans, and the updates incorporate new data and information that led to establishing new long-term goals in line with the IPCC calculations; and

WHEREAS, the City of Austin has made significant progress on the goals set out in the 2007 ACPP, either meeting its goals ahead of time or being on schedule to meet its goals by 2020; and

WHEREAS, the 2007 ACPP and the current AE Resource, Generation, and Climate Protection Plan to 2020 are now reaching a point where an update is needed to ensure the City of Austin and Austin Energy continue as leaders in climate protection efforts; NOW, THEREFORE,

BE IT RESOLVED BY THE CITY COUNCIL OF THE CITY OF AUSTIN:

The City Council establishes a goal of reaching net zero community-wide greenhouse gas emissions by 2050 and prefers to achieve this goal as soon as it is feasible. The City Council also recognizes that emissions reductions accomplished sooner are more important and valuable for our city's climate protection efforts.

BE IT FURTHER RESOLVED:

The City Manager is directed to review the goals and objectives within the 2007 Austin Climate Protection Plan and work with stakeholders to create an action plan for each major sector (energy, transportation, and waste/industrial) responsible for the community-wide greenhouse gas emissions in Austin in order to meet the new long-term goal. The action plans should include secondary goals and measures for sector-specific factors such as renewable energy, building energy use reductions, vehicle miles traveled, waste diversion rates, and more. The plans should determine what is achievable for each sector and how the other sectors could make up for any shortfalls in reaching the interim community-wide goals.

BE IT FURTHER RESOLVED:

The sector action plans should include greenhouse gas reductions that will be achieved by implementing existing City plans and also include new actions

that could reduce emissions in the short- and long-term. The action plans should take into consideration regional factors that may present challenges or opportunities, including:

- population and business growth,
- available and emerging technology,
- potential costs and benefits,
- climate preparedness and resilience, and
- barriers where the City does not exert direct control over community emissions.

BE IT FURTHER RESOLVED:

The stakeholder input process should include a mix of public input sessions, discussions with relevant Boards and Commissions, consideration of the results from the 2014 Generation Plan Task Force, and the formation of technical advisory groups to work with city staff to develop the action plans.

BE IT FURTHER RESOLVED:

The recommendations from stakeholders and city staff should also include:

- measurable interim greenhouse gas reduction targets, starting with 2020 and periodic targets until 2050,
- when and how annual progress reports will occur, and
- how often to conduct comprehensive updates to the climate protection plan.

BE IT FURTHER RESOLVED:

The City Manager shall provide a progress update to City Council by September 1, 2014, including a framework for meeting short- and long-term community-wide greenhouse gas emissions reduction goals. The City Manager should combine all applicable greenhouse gas emission reduction

strategies and climate change resiliency plans into one comprehensive Climate Protection Plan document to be presented for community review and Council adoption by March 1, 2015.

ADOPTED: ___April 10___, 2014 **ATTEST:** _____
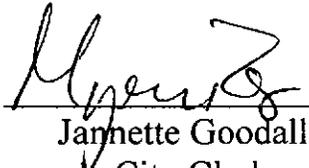
Jannette Goodall

City Clerk

Memorandum of Understanding

This Memorandum of Understanding (MOU) is effective _____ and is made, by and between Rocky Mountain Institute (RMI), a Colorado nonprofit 501(c)(3) corporation and **the City Government of Austin, TX,** a city government, (collectively, the "Parties").

I. Background

Today's mobility system is built around personal vehicles available for any combination of potential needs—just in case. These privately-owned, individually-driven, gas-powered vehicles sit unused 95% of the time, cost their owners over $1 trillion annually, and account for 15% of all emissions in the U.S. The fully-burdened cost is approximately $3 trillion per year, when road construction and maintenance, public land lost to parking, pollution, and other factors are included. As city populations increase, so does pressure on infrastructure, pollution, and traffic congestion.

Emerging technologies and societal trends are creating an opportunity for a new mobility future in which self-driving, electrified vehicles operate within transit-friendly, walkable, and bikeable cities. In contrast to the current, just-in-case transportation system, mobility becomes a service, available when and where it is needed—just in time—allowing fewer vehicles to do the same job at lower cost.

The cost of mobility could be 80% less than today, unlocking $1 trillion in value for consumers, businesses, and municipalities. Access to transportation will improve across all levels of society, congestion will decrease, and 1 gigaton of emissions per year can be prevented nationally.

While technological and societal progress are laying the groundwork to make this vision possible, pioneering cities are required to drive this transformation. After a detailed and exhaustive search, RMI selected the City of Austin to be the Lead Implementation City (LIC) for our mobility transformation project. Additionally, RMI selected the City of Denver as the lead Global Engagement Platform (GEP) partner to prove out RMI's collaborative solutions development and scaling model. RMI and the cities of Austin and Denver will collaborate on a program to develop and implement Mobility Transformation and create mechanisms to scale the enabling solutions to other GEP partner cities.

II. Purpose

RMI has a goal to raise sufficient funds through its philanthropic and other sources to cover its costs associated with this MOU. The City commits to providing in-kind resources directly and to engage with the broader stakeholder group to solicit in-kind resources from the community. The City and Community combined will match RMI's resources dedicated to the City resulting in an overall 50/50 cost share. These resources may include, but are not limited to, office space for RMI staff as needed, telecommunications, meeting space, convening space and time spent by public sector employees to support The Program. The City cost-share contributions do not include activities that support The Program but would have occurred in any case.

VI. Term/Termination

The term of this MOU shall commence on September 14th, 2015 and shall continue until such time that the Parties mutually agree that the goals of The Program have been fulfilled or the MOU has been terminated . Subsequent Co-Development Agreements, addenda to this MOU, will serve to document specific details of The Program.

Either Party may, with 60 days advanced written notice, choose to terminate this MOU.

VII. Press/Media

Any public announcements through press releases, media advisories, media alerts or other similar, press-related means regarding this Agreement or the joint work of the Parties hereunder shall require the prior written approval of the Parties hereto prior to such announcements. Generally the Parties acknowledge and agree that their mutual goal is to credit each other for participation and leadership in The Program.

VIII. Modification

This MOU may be modified only in writing by mutual agreement of the Parties.

IX. Relationship

It is acknowledged that nothing in this agreement or in any other documents drafted by the Parties shall be construed to make the Parties agents or representatives of each other. Furthermore, the Parties are not joint venture partners and this agreement is a contract for a collaborative project only. All rights and liabilities hereunder are and shall be several and not joint or collective.

X. Assignment

This MOU may not be assigned by either Party.

This MOU will become effective upon approval by the Austin City Council.

The City of Austin

By:

Name: Marc Ott
Title: City Manager
Date: September 14th, 2015
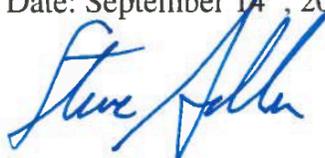
Rocky Mountain Institute

By:
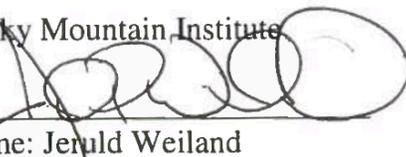
Name: Jeruld Weiland
Title: Managing Director
Date: September 14th, 2015

3

AGENDA

Recommendation for Council Action

Austin City Council		**Item ID**	52478	**Agenda Number**		76.

Meeting Date:	11/19/2015		**Department:**		Transportation	

Subject

Approve a co-development agreement with the Rocky Mountain Institute to conduct a multi-year "Mobility Transformation" program, which focuses on approaches for transforming personal mobility.

Amount and Source of Funding

Program costs will be absorbed into existing City programs and operations.

Fiscal Note

A fiscal note is not required.

Purchasing Language:	
Prior Council Action:	
For More Information:	Donna Tiemann, (512) 978-2166
Council Committee, Boards and Commission Action:	To be reviewed by the Mobility Committee on November 16, 2015.
MBE / WBE:	
Related Items:	

Additional Backup Information

Rocky Mountain Institute (RMI) selected the City to be the Lead Implementation City (LIC) for a mobility transformation project. The purpose of the program is to catalyze and demonstrate a holistic, scalable approach for transforming personal mobility. Its goal is to create an opportunity for a new mobility future in which self-driving, electric vehicles operate within transit-friendly, walkable, and bikeable cities. In contrast to the current, just-in-case transportation system, mobility becomes a service, available when and where it is needed—just in time—allowing fewer vehicles to do the same job at a lower cost.

The Co-Development Agreement (attached) is a full suite of documents that includes: a) the Memorandum of Understanding (MOU), b) Proposed Governance Structure, c) five Workstream Scopes of Work, d) Budget, and e) a Communications Plan.

This agreement is a contract for a collaborative project only. Beginning with the execution of this MOU, the Parties will begin actionable initiatives based on RMI's MTX Strategy and theory of change, along with high level deliverables

to be performed by RMI, the cities, and community stakeholders.

The five key program areas to be developed into Integrated Project Teams include:

Interoperable Transit Data
Mobility as a Service
Fleet Electrification
Mobility Oriented Development, and
Self-Driving Vehicles

In the Memorandum of Understanding, the Parties agree that strategically, the Program will include the following:
- A 3-5 year commitment of resources by the Parties, each city targeting a matching contribution to the respective RMI resources dedicated to that city engagement.
- Measurable reduction of single-occupancy and gas-powered vehicle miles traveled.
- Collaboration with the Global Engagement Platform (GEP) cities of which Denver is the lead GEP partner city.
- Stakeholder engagement throughout the greater metro-city area and, where applicable for collaboration opportunities, nationally and/or globally.
- Promotion of the program, locally and nationally, to accelerate scaling to additional cities.
- External communication plan to create maximum impact for the program.
- City support to RMI in substantive efforts to secure philanthropic funding for The Program.

National Electric Vehicle Examples

	Austin	Denver	Los Angeles	New York	Portland	San Francisco	Seattle
Current State	• 547 EV publically accessible chargers[1]	• 140 publically accessible EV chargers	• 1,390 publicly accessible EV chargers[4]	Approximately 800 publicly accessible EV chargers in NYC area[5]	• Approximately 375 publicly accessible EV chargers in Portland area[7]	Approximately 1,000 publicly accessible EV chargers in San Francisco area[9]	Approximately 400-500 publicly accessible EV chargers in Seattle area[11]
	• 34 EVs in city fleet[2]	• 18 EVs in city fleet[3]		• Over 1,000 EVs in city fleet[6]	• 80 EVs in city fleet[8]	• 52 EVs in city fleet[10]	• 125 on-road EVs[12]
Goals	• 330 electric PEVs in city fleet by 2020[13]	• Add 200 EVs to city fleet by 2020[16] • Join effort to bulk order EVs from automakers[17]	• 50% of city fleet procurements to be EVs.[20] • Lead effort to bulk order EVs from automakers[21]	• 2,000 EVs in the city fleet by 2025 • Join effort to bulk order EVs from automakers[25]	• Add 60 EVs to the City's sedan fleet by 2020[29] • Join effort to bulk order EVs from automakers[30]	• Join effort to bulk order EVs from automakers[34]	• Join effort to bulk order EVs from automakers[38]
	• 330 city fleet charging stations by 2020	• Install 387 EV chargers citywide[18]	• At least 100 publically available chargers on city property[22]	• 450 charging stations to be installed across the state[26]	• Double publically available chargers by 2020[31]	• EV-ready parking in 10% of spaces[35]	• Install 200 new charging stations for fleet vehicles in 2017/18[39]
			• Increase ZEVs in the City to 10%[23]	• 20% vehicles sold in NYC to be EVs by 2025[27]	• Increase electric vehicles from 20% to 30%[32]	• Region EV deployment targets 110,000 EVs by 2020; 247,000 EVs by 2025[36]	• Increase electric light duty vehicle ownership to 30% by 2030 [40]
	• Carbon neutrality for city operations by 2020[14] • Net zero GHG emissions by 2050[15]	• Reduce CO$_2$ emissions to below 1990 levels[19]	• 80% GHG reduction by 2050[24]	• 80% GHG reduction by 2050[28]	• Decrease transportation-related carbon emissions 80% below 1990 levels by 2050[33]	• Reduce GHG emissions 80% by 2050[37]	• Carbon neutral city by 2050[41] • Reduce carbon emissions from city vehicle fleet by 50%[42]
Programs	*EV Car Share Program*[43] • Austin Energy exploring EV car share program in low-income areas • Will be offered with tiered pricing		*EV Car Sharing for Low-Income Neighborhoods*[44] • 100-vehicle fleet • 200 Level-2 charging units		*Peer-to-Peer Car Sharing Pilot*[45] • 3 used Honda Fit EVs at affordable housing complex *Tri-Met Electric Buses*[46] • TriMet will add 4 all-electric	*Electric Hybrid Buses* • 200 standard buses and up to 163 articulated low-floor biodiesel-electric hybrid buses[47]	

	based on income *EV Multifamily Expansion* • AE to provide chargers for EVs or EV car share programs *EVs for Teachers* • Austin Energy offers rebate incentive for charging infrastructure at school campuses *Capital Metro E-Bus* • Austin energy supports Capital Metro's E-Bus infrastructure and will evaluate a special electrical fuel tariff			buses to its fleet in 2018		
Funding	*Charge Ahead Colorado[48]* • Funding for charging stations	*EV Car Sharing for Low-Income Neighborhoods[49]* • $1.6 million CARB grant • $8 million in in-kind city resources and private investment • $880,000 in rebates from LA Department of Water and Power[50]		*Peer-to-Peer Car Sharing Pilot[51]* • $220,000 from foundations *Tri-Met Electric Buses[52]* • Funded by a $3.4 million from the Federal Transit Administration	*Electric Hybrid Buses[53]* • Funded by FTA grants, AB644 bridge tolls, Proposition K and Proposition B funds	
Incentives	• BEVs and PHEVs eligible for HOV lanes[54]	*2017 Charge! Program[55]* • Grant funding to help offset the cost of charging stations • Funded through the Transportation Fund for Clean Air Regional Fund	• PEVs and hybrid EVs may use HOV lanes • New York Clean Pass Program gives certain vehicles discounts on ferry crossings[56]		*2017 Charge! Program[57]* • Grant funding to help offset the cost of charging stations • Funded through the Transportation Fund for Clean Air Regional Fund	

National Shared Vehicle Examples

	Austin	Denver	Los Angeles	New York	Portland	San Francisco	Seattle
Current State	• Carpool and vanpool services like MetroRideShare[58] • Carsharing services like Car2Go[59] and Zipcar	• Vanpool and carpool services like Way to Go[61] • Carsharing services like Zipcar[62], Maven[63] and eGo Carshare[64] • Peer-to-peer services like Turo[65]	• Carpooling services like LA County Rideshare[67] • Carsharing services like Zipcar[68] and BlueLA[69] • Peer-to-peer services like Turo[70]	• Carpool services like 511NY[71] • Carsharing services like Car2Go, ReachNow, and Maven[72] • Peer-to-peer services like Getaround[73] and Turo[74]	• Carpool services like Drive Less Connect[76] and vanpool services[77] • Carsharing services like Zipcar[78], Car2Go, and ReachNow[79] • Peer-to-peer services like Getaround[80] and Turo[81]	• Carpool and vanpool services like 511 Rideshare and SF Casual Carpool[84] • Peer-to-peer services like RelayRides[85] • Carsharing services like Zipcar[86]	• King County Metro Rideshare[88] • Peer-to-peer services like Turo and Getaround[89] • Carsharing services like Car2Go, Zipcar, ReachNow[90]
	• Free floating parking for some carsharing ventures[60]	• Carshare permit program offering dedicated spaces or permit areas[66]		• Reserved parking spaces for carshares[75]	• Carpool parking program[82] • Reserved parking spaces[83]	• Vanpool permits[87]	• Free floating and designated space permits[91]
Goals & Policies	• *Shared, Electric and Autonomous Vehicle Roadmap*	• *[93]Denver's Mobility Action Plan*	• *Sustainability pLAn* • *Urban Mobility in a Digital Age*	• *OneNYC 2017[100]*		• *2013-2018 Strategic Plan* • *SFMTA Car Sharing Policy*	• *Drive Clean Seattle*
			• Build Integrated Mobility Hubs[96]		• Integrate public transit and shared EV mobility options[103]		Advance electric shared mobility at Shared Mobility Hubs[107]
		• Partner with car share, taxi and TNCs to deploy EVs for ridesharing[94]	• Facilitate the transition to low and zero-emissions transportation[97]	• Expansion of carshare fleet to additional agencies, using low-emissions technology[101]	• Prioritize the electrification of shared vehicles, bikes and buses[104]		• Improve air quality by encouraging shared electric transportation[108]
	• Mode shift to 15% commuter bicycling by 2020 while reducing SOV trips by 10%[92]	• Mode shift to 50% SOV commuters trips, 15% bike and pedestrian commuters, and 15%	• Mode shift to 35% non-SOV trips by 2025.[98] • Increase shared services trips to 2% by 2025[99]	• Mode shift to 80% trips made by sustainable modes by 2050[102]	• Mode shift to 10% carpool and 25% public transit in 2030[105]	• Mode shift to 50% non-auto (transit, bicycling, walking and taxi)	• Mode shift to 70% of non-SOV commuting into downtown[109]

		transit commuters[95]				for all trips by 2018[106]	
Programs	*EV Car Share Program[110]* • Austin Energy exploring EV car share program in low-income neighborhoods • Will be offered with tiered pricing based on income	*eGo Carshare* • Multi-year car share pilot with eGo CarShare[111]	*EV Car Sharing for Low-Income Neighborhoods[112]* • 100-vehicle fleet • 200 Level-2 charging units	*New York DOT Pilot (2010)[113]* • Provided 350 employees with access to ZipCars *Lower Manhattan Car Sharing Permit Pilot[114]* • 2-year parking pilot offering 600 spots to car shares	*Peer-to-Peer Car Sharing Pilot[115]* • 3 used Honda Fit EVs installed at affordable housing complex	*On-Street Car Share Space* • 202 on-street car share parking spaces for use by multiple car share operators[116] *One-Way Car Sharing[117]* • Car Share pilot offers free-floating, one-way car sharing	*Scoop Commuter Ridesharing[118]* • Discounts for commuters arriving or departing from certain areas
Funding		• $5.8 million in investments and revenue[119]	• $1.6 million CARB grant • $8 million in in-kind city resources and private investment		• $220,000 from foundations		*Scoop Commuter Ridesharing[120]* • $49,000 from Seattle's Commuter Trip Reduction program

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National Autonomous Vehicle Examples

	Austin	Boston	Los Angeles	Portland	San Francisco	Tampa
Current State	• Google/Waymo	• nuTonomy • Optimus Ride • Delphi On-Street[121]	• Delphi • BMW • Ford[122]	• No companies currently testing[123] • Open to proposals to test[124]	• Delphi • BMW • GM Cruise • Google/Waymo[125]	• No testing currently in Tampa. Shuttle pilot to launch November 2017
Goals & Policies	• *Shared, Electric, and Autonomous Vehicle Roadmap*	• *Boston AV Plan[127]* • *GoBoston 2030[128]*	• *Urban Mobility in a Digital Age[132]*	• *Smart Autonomous Vehicle Initiative (SAVI)[136]*		• *Florida Automated Vehicles Initiative[141]*
	• State permissive legislation for AVs[126] with no municipal authority	• Executive order to promote the testing of AV technologies and created a working group[129]	• Requires adoption of safety standards and allows AV testing pending compliance with the standards[133] • Allows AV testing without steering or pedals[134]		• Requires adoption of safety standards and allows AV testing pending compliance with the standards[139] • Allows AV testing without steering or pedals[140]	• No permitting or licensed drivers required for AVs[142]
		• Develop policies to support on-street testing of AVs[130]	• Test and develop AV road network[135]	• PBOT solicit proposals from companies to test AVs by end of 2017[137]		• Test EV/AV technology and connected vehicles
		• Goal of zero deaths, injuries, disparities, emissions, stress[131]		• Develop AV policy that promotes vision zero, equity, and environment goals[138]		• AVs to help improve safety and reduce congestion[143]
Program	*Texas Automated Vehicle Proving Ground* • Designated as USDOT AV testing ground[144]	*Boston AV Plan* • Testing in Flynn Marine Park and Seaport District[145]	*Urban Mobility in a Digital Age* • Dedicated staff position focused on AVs and connected vehicles[146]	• No pilots currently	*San Ramon Pilot* • Two 12-passenger AV buses from EasyMile testing in office complex[147]	*Downtown Tampa* • DSRC to connect vehicles, people, and roadside units on city streets[148] *HyperLink Pilot* • 4 AVs and 1 paratransit vehicle to move passengers to

						and from transit stops[149] *AV Shuttles* • 2 low-speed AV shuttles between downtown and a transit center[150]
Funding	• No funding included in designation[151]				• Backed by private companies, transit and air quality authority	*Downtown Tampa[152]* • $17 million from US DOT *Hyperlink Pilot[153]* • $25,000 from Innovation Place • $200,000 private donations from businesses • $450,000 FDOT • $450,000 HART *AV Shuttles* • $1 million grant from FDOT and HART[154]
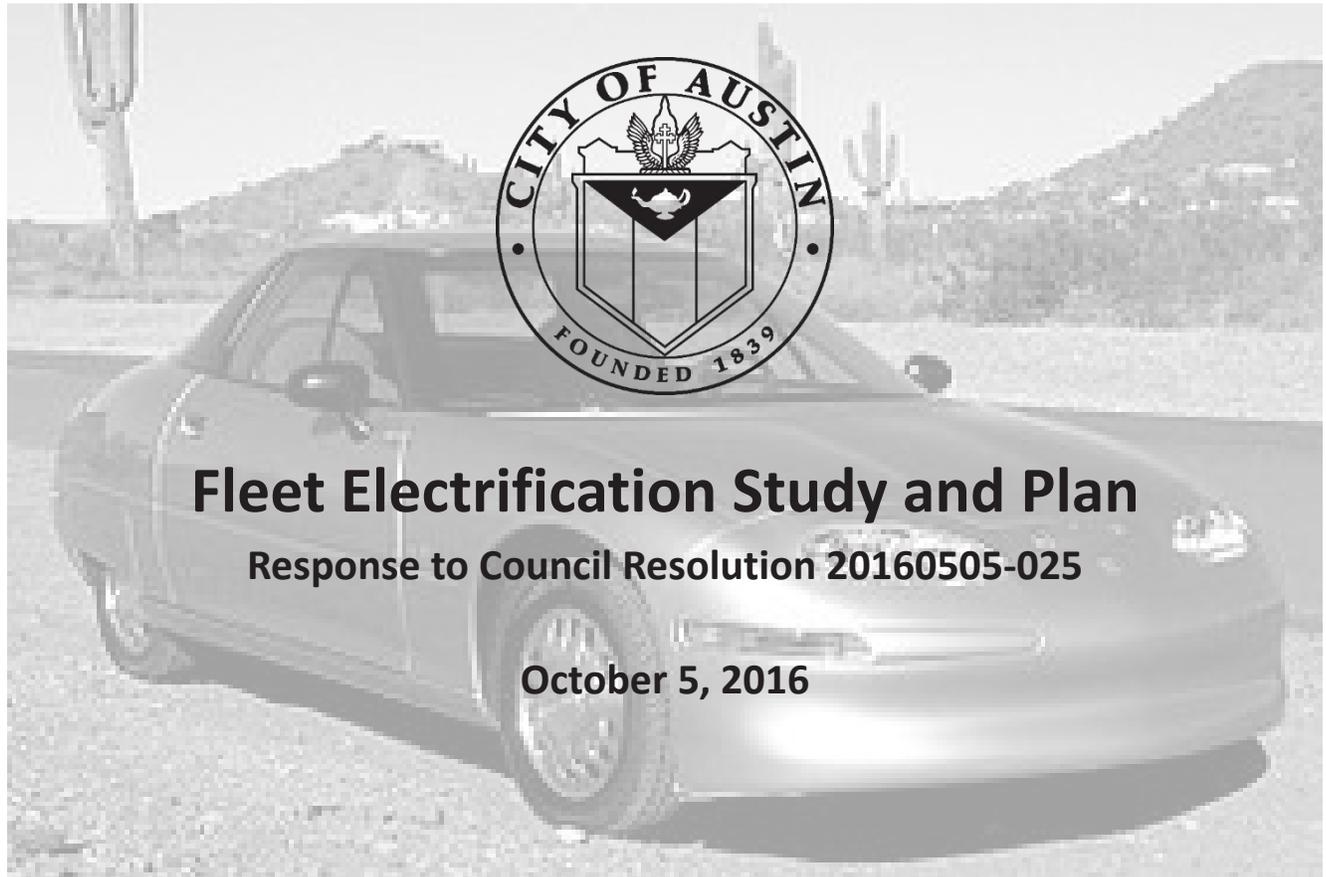
Fleet Electrification Study and Plan

Response to Council Resolution 20160505-025
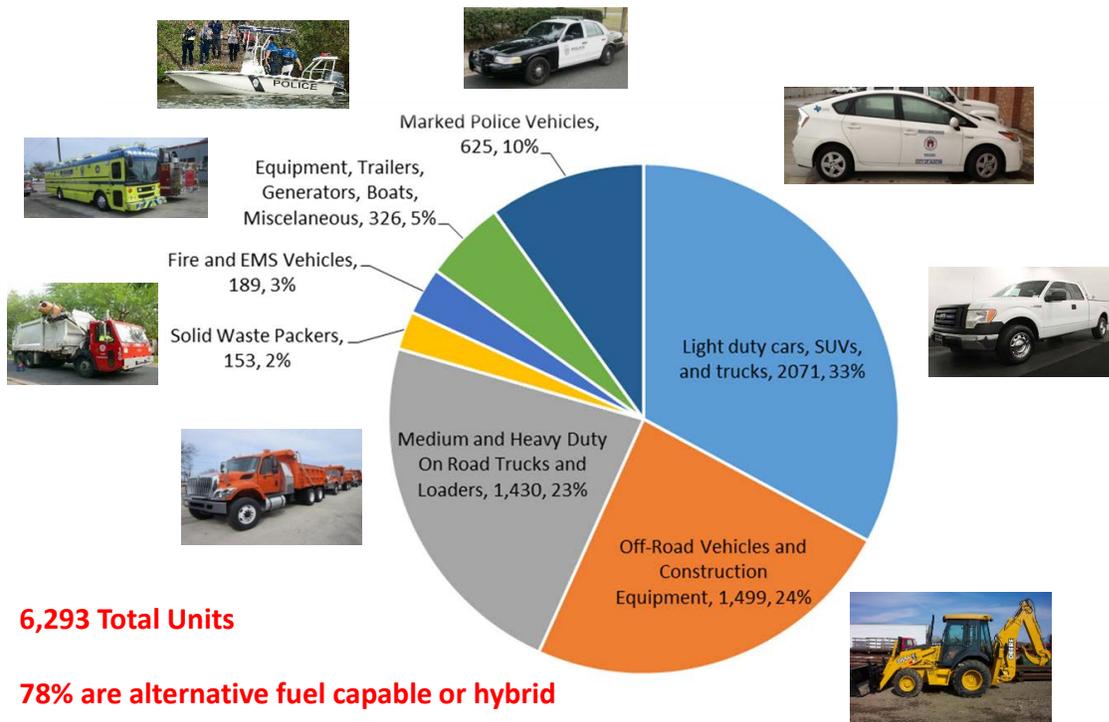
October 5, 2016

Council Resolution 20160505-025

"…work with Rocky Mountain Institute, Vulcan, Inc., and Electrification Coalition on an assessment to determine the benefits, timeline, and feasibility of increasing electric vehicle adoption into the City's Fleet Services vehicles."

- Evaluate short and long-term cost savings.

- Analyze return on investment options.

- Determine impacts and benefits to Austin Energy.

- Identify electrification targets to achieve carbon neutral fleet by 2020.

Current Fleet Composition

Marked Police Vehicles, 625, 10%

Equipment, Trailers, Generators, Boats, Miscelaneous, 326, 5%

Fire and EMS Vehicles, 189, 3%

Solid Waste Packers, 153, 2%

Light duty cars, SUVs, and trucks, 2071, 33%

Medium and Heavy Duty On Road Trucks and Loaders, 1,430, 23%

Off-Road Vehicles and Construction Equipment, 1,499, 24%

6,293 Total Units

**78% are alternative fuel capable or hybrid**

3

Recommendations

1. Add 330 plug-in electric vehicles by 2020.

2. Expand City Fleet charging stations from 33 to 330 by 2020.

3. Fund electric vehicle acquisitions by the execution of municipal leases (lease-to- own).

4. Fund charging infrastructure through an interdepartmental fuel surcharge.

4

Electric Vehicle Economic Benefits

- Lower life-cycle costs than gasoline vehicles.

- Supports the local economy by purchasing kWh from Austin Energy.

- Reduces fuel price volatility risk.
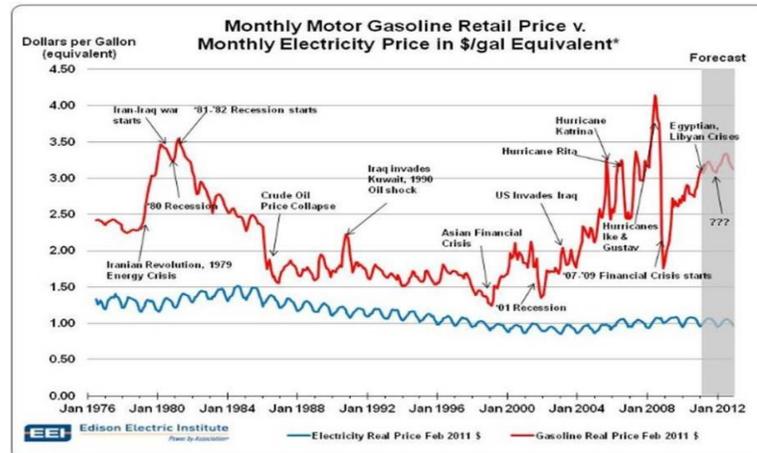
Electric Vehicle Additional Benefits

- Supports Council adopted goal of Net Zero Community Wide GHG emissions by 2050.

- Demonstrates innovation and leadership to employees and the community.

- Diversifies the City fleet.

- Fuel independence.
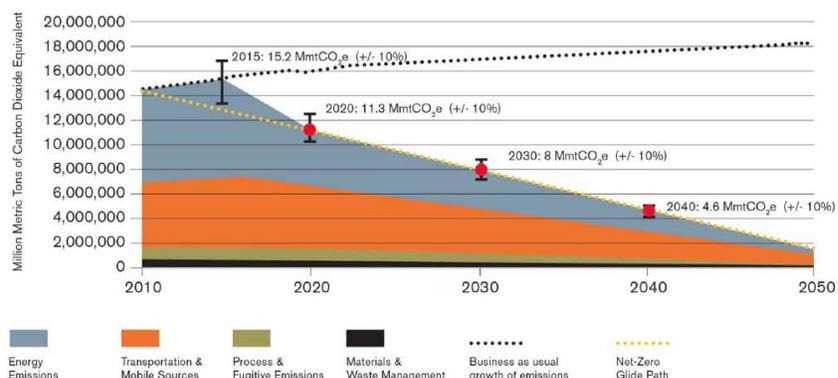
Charging Technology

Level 1:

    1kW adds 4 miles per hour

Level 2:

    6.6kW adds 25 miles per hour

DC Fast Charge:

    50kW+ = full charge in 15 minutes

8

Fleet Analysis

Fleet Electrification Coalition:

- Analyzed over 1,000 City-owned sedans, minivans, and SUVs
  - Excluded marked police vehicles and pickup trucks

- Identified best electric vehicle candidates:
  - Older vehicles
  - Low daily mileage vehicles
  - High lifetime mileage vehicles
  - Expensive-to-operate SUVs and minivans

- 326 vehicles targeted for electrification

- **Fleet Services re-analyzed and recommends 330 by 2020**
  - 72 Plug-in Hybrids, 258 Battery Electric Vehicles

9

Vehicle Purchases

GOAL:

330 Plug In Hybrid and Battery Electric vehicles that are charged at City facilities by the end of CY 2020.

- **35** vehicles by the end of CY 2017
- **134** total vehicles by the end of CY 2018 (add 99)
- **229** total vehicles by the end of CY 2019 (add 95)
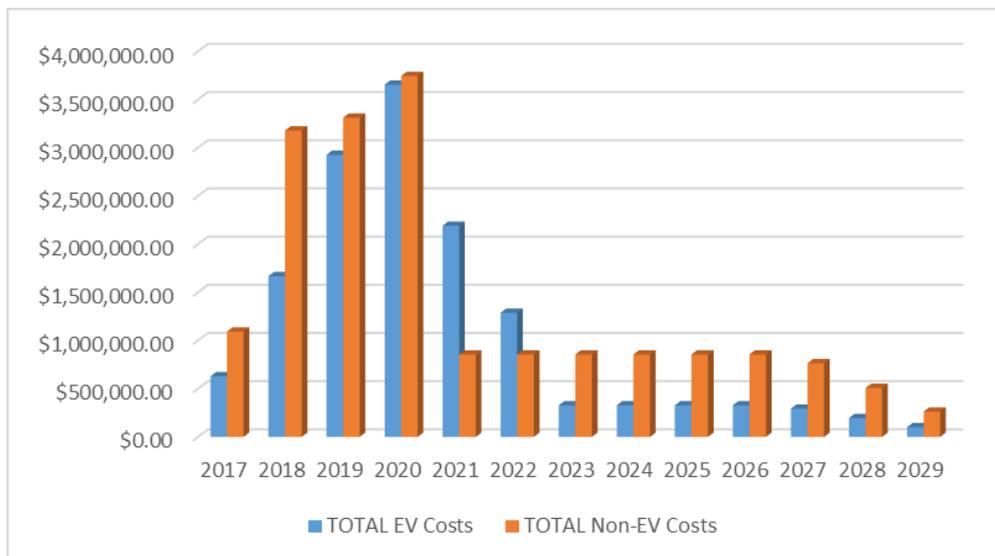- **330** total vehicles by the end of CY 2020 (add 101)

Municipal Lease to own:
- Spreads initial costs over 3 years
- Takes advantage of $7,500 federal tax credit per vehicle

Over their 10 year lifetime, these 330 vehicles will avoid:
- 12,000 metric tons of Carbon Dioxide
- 22 metric tons of Nitrogen Oxides
- 34 metric tons of Volatile Organic Compounds

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13 year Cash Flow

Total Non-EV Cost:	$16,500,000
Total EV Cost:	$13,000,000
10 Year EV Savings:	$3,500,000

12

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Charging Infrastructure Implementation

Currently 33 charging stations deployed

Add 100 stations by the end of CY 2018:

- 10 Departments

- 15 Building locations

- All Level 2 Charging

13

Commission Feedback

- 9/13 – Urban Transportation Commission
  - Positive feedback and supportive

- 9/19 – Electric Utility Commission
  - Questions related to GreenChoice and impact to AE operations, positive feedback on the initiative

- 9/21 – Environmental Commission
  - Questions related to quantifying air quality benefits, positive feedback on the initiative

- 9/28 – Joint Sustainability Committee
  - Positive feedback. Passed a resolution recommending City Council direct staff to research the costs and benefits of increasing the number of electric vehicles to at least 25% of the total City vehicle fleet. Includes looking more in depth at Austin Energy and storage as well as partnering with other local fleet owners.

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2017 Rollout Process

- Install charging stations

- Buy first batch of electric vehicles

- Train City staff on Electric vehicle operation

- Place electric vehicles into service

- Evaluate performance and adjust as necessary

Commission Feedback

- 9/13 – Urban Transportation Commission
    - Positive feedback and supportive

- 9/19 – Electric Utility Commission
    - Questions related to GreenChoice and impact to AE operations, positive feedback on the initiative

- 9/21 – Environmental Commission
    - Questions related to quantifying air quality benefits, positive feedback on the initiative

- 9/28 – Joint Sustainability Committee
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Questions?

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References

[1] Austin Energy Launches Electric Drive, Austin Energy, March 27, 2017, http://austinenergy.com/wps/portal/ae/about/news/press-releases/2017/ae-launches-electric-drive/

[2] Spoke with Jennifer Walls from Austin's fleet services. 28 of the 34 EVs are to be approved by Council at the end of August.

[3] Spoke with Tyler Svitak from Denver's Department of Environmental Health.

[4] Sustainable City pLAn: 2nd Annual Report 2016-2017, 2017, http://plan.lamayor.org/wp-content/uploads/2017/03/sustainability_pLAn_year_two.pdf

[5] Portland Electric Vehicle Chargers, Plugshare, https://www.plugshare.com/?latitude=45.525308&longitude=-122.677628&spanLat=0.075406&spanLng=0.165482#

[6] ONENYC: Mayor Announces City Electric Vehicle Fleet Ahead of Schedule, Office of the Mayor, April 20, 2017, http://www1.nyc.gov/office-of-the-mayor/news/245-17/onenyc-mayor-city-electric-vehicle-fleet-ahead-schedule-half-way-toward-goal

[7] Portland Electric Vehicle Chargers, Plugshare, https://www.plugshare.com/?latitude=45.525308&longitude=-122.677628&spanLat=0.075406&spanLng=0.165482#

[8] Spoke with Colleen, who oversees city owned chargers for the City of Portland

[9] San Francisco Electric Vehicle Chargers, Plugshare, https://www.plugshare.com/?latitude=45.525308&longitude=122.677628&spanLat=0.075406&spanLng=0.165482#

[10] Supervisor Tang Holds Hearing to Require City of San Francisco to Procure Only Electric Sedans and Light-Duty Trucks by 2020, November 17, 2016, http://sfbos.org/sites/default/files/Supervisor_Tang_Press_Release_Holds_Hearing_To_Require_City_Of_Sf_To_Procure_Only_Electric_Sedands_And_Light-Duty_Trucks_2020_111716.pdf

[11] Seattle Electric Vehicle Chargers, Plugshare, https://www.plugshare.com/?latitude=45.525308&longitude=-122.677628&spanLat=0.075406&spanLng=0.165482#

[12] 2017 Drive Clean Seattle Implementation Strategy, Seattle Office of Sustainability & Environment, June 2017, http://www.seattle.gov/Documents/Departments/OSE/Reports/Drive%20Clean%20Seattle%202017%20Report.pdf

[13] City on Course to Add 330 Electric Vehicles by 2020, Austin Monitor, September 22, 2016, https://www.austinmonitor.com/stories/2016/09/city-course-add-330-electric-vehicles-2020/

[14] Climate Change, Office of Sustainability, http://www.austintexas.gov/climate

[15] Ibid.

[16] City of Denver Commits to Adding 200 Electric Cars by 2020, The Denver Post, November 10, 2016, http://www.denverpost.com/2016/11/10/denver-electric-cars/

[17] U.S. Cities' Massive Electric Vehicle Order Increases to 114,000 Vehicles, Electrek, March 15, 2017, https://electrek.co/2017/03/15/electric-vehicle-order-114000-vehicles-40-companies-competing/

[18] Enterprise Data Management (EDM) Ecosystem, City of Denver, https://www.denvergov.org/content/denvergov/en/transportation-mobility/smart-city.html

[19] 2020 Sustainability Goals, Denver Office of Sustainability, https://www.denvergov.org/content/denvergov/en/office-of-sustainability/2020-sustainability-goals.html

[20] Mayor Garcetti Leads 'Climate Mayors' to Oppose U.S. Withdrawal from Paris Agreement, Office of the Mayor, June 1, 2017, https://www.lamayor.org/mayor-garcetti-leads-%E2%80%98climate-mayors%E2%80%99-oppose-us-withdrawal-paris-agreement

[21] U.S. Cities' Massive Electric Vehicle Order Increases to 114,000 Vehicles, Electrek, March 15, 2017, https://electrek.co/2017/03/15/electric-vehicle-order-114000-vehicles-40-companies-competing/

[22] Sustainable City pLAn: 2nd Annual Report 2016-2017, 2017, http://plan.lamayor.org/wp-content/uploads/2017/03/sustainability_pLAn_year_two.pdf

[23] Ibid.

[24] Carbon & Climate Leadership, Los Angeles Sustainability pLAn, 2017, http://plan.lamayor.org/portfolio/carbon-climate-leadership/

[25] U.S. Cities' Massive Electric Vehicle Order Increases to 114,000 Vehicles, Electrek, March 15, 2017, https://electrek.co/2017/03/15/electric-vehicle-order-114000-vehicles-40-companies-competing/

[26] Governor Cuomo Announces New Campaign to Install Charging Stations and Promote Electric Vehicle Use Across New York State, NYSERDA, March 6, 2017, https://www.nyserda.ny.gov/About/Newsroom/2017-Announcements/2017-03-06-Governor-Cuomo-Announces-Campaign-to-Install-Charging-Stations-and-Promote-EV

[27] ONENYC: Mayor Announces City Electric Vehicle Fleet Ahead of Schedule, Office of the Mayor, April 20, 2017, http://www1.nyc.gov/office-of-the-mayor/news/245-17/onenyc-mayor-city-electric-vehicle-fleet-ahead-schedule-half-way-toward-goal

[28] Progress Report OneNYC 2017, Office of the Mayor, 2017, http://onenyc.cityofnewyork.us/wp-content/uploads/2017/05/OneNYC_Progress_Report_2017.pdf

[29] 2017 City of Portland Electric Vehicle Strategy, City of Portland, 2017, https://www.portlandoregon.gov/bps/article/619275

[30] U.S. Cities' Massive Electric Vehicle Order Increases to 114,000 Vehicles, Electrek, March 15, 2017, https://electrek.co/2017/03/15/electric-vehicle-order-114000-vehicles-40-companies-competing/

[31] 2017 City of Portland Electric Vehicle Strategy, City of Portland, 2017, https://www.portlandoregon.gov/bps/article/619275

[32] Ibid.

[33] Ibid.

[34] Ibid.

[35] Mayor Lee and Supervisor Katy Tang Introduce Legislation Requiring All New Buildings to be 100% "Electric Vehicle Ready," Office of the Mayor, February 28, 2017, http://sfmayor.org/article/mayor-lee-and-supervisor-katy-tang-introduce-legislation-requiring-all-new-buildings-be-100

[36] Charge Program, Bay Area Air Quality Management District, http://www.baaqmd.gov/grant-funding/businesses-and-fleets/charge

[37] Supervisor Tang Holds Hearing to Require City of San Francisco to Procure Only Electric Sedans and Light-Duty Trucks by 2020, November 17, 2016, http://sfbos.org/sites/default/files/Supervisor_Tang_Press_Release_Holds_Hearing_To_Require_City_Of_Sf_To_Procure_Only_Electric_Sedands_And_Light-Duty_Trucks_2020_111716.pdf

[38] U.S. Cities' Massive Electric Vehicle Order Increases to 114,000 Vehicles, Electrek, March 15, 2017, https://electrek.co/2017/03/15/electric-vehicle-order-114000-vehicles-40-companies-competing/

[39] 2017 Drive Clean Seattle Implementation Strategy, Seattle Office of Sustainability & Environment, June 2017, http://www.seattle.gov/Documents/Departments/OSE/Reports/Drive%20Clean%20Seattle%202017%20Report.pdf

[40] Ibid.

[41] Drive Clean Seattle, Office of Sustainability & Environment, 2017, http://www.seattle.gov/environment/transportation-and-land-use/drive-clean-seattle

[42] Drive Clean Seattle FAQs, Seattle Office of Sustainability & Environment, http://www.seattle.gov/documents/departments/ose/dcs_faq_final.pdf

[43] "EVs are for Everyone: Pilot Programs in Discovery Phase." Austin Energy.

[44] EV Car Sharing Pilot for Disadvantaged Communities, City of Los Angeles, http://sd24.senate.ca.gov/sites/sd24.senate.ca.gov/files/EV%20Carsharing%20Pilot.pdf

[45] Peer to Peer Electric Car Sharing Pilot Launches in Portland, Efficientgov, March 31, 2017, https://efficientgov.com/blog/2017/03/31/peer-to-peer-electric-car-sharing-pilot-portland/

[46] TriMet gets Grant to Buy Its First All-Electric Buses, The Oregonian, July 22, 2016, http://www.oregonlive.com/commuting/index.ssf/2016/07/trimet_gets_grant_to_buy_first.html

[47] Muni Hybrid Buses, SFMTA, https://www.sfmta.com/about-sfmta/our-history-and-fleet/sfmta-fleet/muni-hybrid-buses

[48] Charge Ahead Colorado, Colorado Energy Office, 2017, https://www.colorado.gov/pacific/energyoffice/charge-ahead-colorado

[49] EV Car Sharing Pilot for Disadvantaged Communities, City of Los Angeles, http://sd24.senate.ca.gov/sites/sd24.senate.ca.gov/files/EV%20Carsharing%20Pilot.pdf

50 Ibid.

51 Peer to Peer Electric Car Sharing Pilot Launches in Portland, Efficientgov, March 31, 2017, https://efficientgov.com/blog/2017/03/31/peer-to-peer-electric-car-sharing-pilot-portland/

52 TriMet Awarded $3.4 Million Federal Grant to Buy Its First Electric Buses, TriMet, July 22, 2016, http://news.trimet.org/2016/07/trimet-awarded-3-4-million-federal-grant-to-buy-its-first-electric-buses/

53 Muni Hybrid Buses, SFMTA, https://www.sfmta.com/about-sfmta/our-history-and-fleet/sfmta-fleet/muni-hybrid-buses

54 Colorado Laws and Incentives, Alternative Fuels and Data Center with the Department of Energy, June 2017, https://www.afdc.energy.gov/laws/state_summary?state=CO

55 Charge Program, Bay Area Air Quality Management District, http://www.baaqmd.gov/grant-funding/businesses-and-fleets/charge

56 New York Laws and Incentives, Alternative Fuels and Data Center with the Department of Energy, November 2016, https://www.afdc.energy.gov/laws/state_summary?state=NY

57 Charge Program, Bay Area Air Quality Management District, http://www.baaqmd.gov/grant-funding/businesses-and-fleets/charge

58 MetroRideShare, Capital Metro, https://www.capmetro.org/rideshare/

59 Car2Go Austin, Car2Go, https://www.car2go.com/US/en/austin/

60 Parking in Austin, Car2Go, https://www.car2go.com/US/en/austin/parking/

61 Vanpool, Colorado Department of Transportation, https://www.codot.gov/programs/commuterchoices/vanpool-program.html

62 Zipcar Denver, Zipcar, http://www.zipcar.com/denver

63 Another Car-Sharing Service Debuts in Denver, Denver Business Journal, November 16, 2016, https://www.bizjournals.com/denver/news/2016/11/16/another-car-sharing-service-debuts-in-denver.html

64 eGo CarShare, http://carshare.org/

65 TURO, https://turo.com/

66 Car Share Permit Program, City of Denver, 2016, http://www.denvergov.org/content/denvergov/en/home-page/permits/car-share.html

67 Carpool, Rideshare L.A. County, http://rideshare.lacounty.gov/carpool/

68 Los Angeles Rates & Plans, Zipcar, http://www.zipcar.com/check-rates/losangeles

69 BlueLA, https://www.bluela.com/

70 TURO, https://turo.com/

71 Carpooling and Ridematching, City of New York, http://www1.nyc.gov/nyc-resources/service/1340/carpooling-and-ridematching

72 Maven, the General Motors Car-Sharing Service, Expands to Increasingly Competitive New York Market, Daily News, May 15, 2017, http://www.nydailynews.com/autos/news/maven-car-sharing-new-york-city-general-motors-article-1.3167582

73 Getaround, https://www.getaround.com/

74 TURO, https://turo.com/

75 New York City Carshare Pilot, New York City Department of Transportation, June 2017, http://www.nyc.gov/html/dot//downloads/pdf/carshare-qn3-june2017.pdf

76 Carpooling, Portland Department of Transportation, https://www.portlandoregon.gov/transportation/39987

77 Vanpool, Portland Metro, http://www.oregonmetro.gov/tools-living/getting-around/share-ride/vanpool

78 Zipcar, https://www.zipcar.com/

79 ReachNow Portland, ReachNow, https://reachnow.com/en/portland-or/

80 Getaround Portland, Getaround, https://www.getaround.com/portland

81 Car-and-Ride-Sharing: Get Around Portland with a Variety of Car-and-Ride-Share Services, Travel Portland, August 1, 2013, https://www.travelportland.com/article/car-sharing/

82 Policy and Procedures, Portland Bureau of Transportation, https://www.portlandoregon.gov/transportation/article/98116

83 Carsharing Parking Administrative Rules, City of Portland, https://www.portlandoregon.gov/citycode/article/135620

84 Carpool: Overview, 511 SF Bay, http://511.org/carpool-vanpool/carpool/overview

[85] Peer-to-Peer Car Sharing Gaining Popularity in SF, ABC News 7, March 31, 2011,
http://abc7news.com/archive/8046628/

[86] Find Cars Near You, Zipcar, https://www.zipcar.com/find-cars

[87] Vanpool Permits, SFMTA, https://www.sfmta.com/services/permits-citations/parking-permits/carpool-vanpool

[88] Rideshare, King County Metro, http://metro.kingcounty.gov/tops/van-car/van-car.html

[89] Affordable Car Sharing is Moving in on Auto-Rental Market, The Seattle Times, December 30, 2016,
http://www.seattletimes.com/life/travel/affordable-car-sharing-is-moving-in-on-auto-rental-market/

[90] The 4 Best Car Sharing Companies in Seattle, Reviews.com, November 11, 2015, http://www.reviews.com/car-sharing/seattle/

[91] Car Share, Seattle Department of Transportation, http://www.seattle.gov/transportation/carshare.htm

[92] Mode Shift, American Council for Energy-Efficient Economy, http://database.aceee.org/city/mode-shift

[93] Denver Car Share Permit Program, City of Denver, March 13, 2014,
http://www.law.du.edu/documents/rmlui/conference/powerpoints/2014/FerrinRGettingAroundWithoutTheChevy.pdf

[94] Denver's Mobility Action Plan, City of Denver, 2017,
https://www.denvergov.org/content/dam/denvergov/Portals/728/documents/Denver's%20Mobility%20Action%20Plan_7.7.pdf

[95] Ibid.

[96] Los Angeles Sustainability pLAn, City of Los Angeles, 2015, http://plan.lamayor.org/wp-content/uploads/2017/03/the-plan.pdf

[97] Ibid.

[98] Ibid.

[99] Sustainable City pLAn: 2nd Annual Report 2016-2017, 2017, http://plan.lamayor.org/wp-content/uploads/2017/03/sustainability_pLAn_year_two.pdf

[100] Progress Report OneNYC 2017, Office of the Mayor, 2017, http://onenyc.cityofnewyork.us/wp-content/uploads/2017/05/OneNYC_Progress_Report_2017.pdf

[101] Ibid.

[102] Mode Shift, American Council for Energy-Efficient Economy, http://database.aceee.org/city/mode-shift

[103] 2017 City of Portland Electric Vehicle Strategy, City of Portland, 2017,
https://www.portlandoregon.gov/bps/article/619275

[104] Ibid.

[105] Ibid.

[106] SFMTA Strategic Plan, SFMTA, https://www.sfmta.com/about-sfmta/reports/sfmta-strategic-plan

[107] [107] 2017 Drive Clean Seattle Implementation Strategy, Seattle Office of Sustainability & Environment, June 2017,
http://www.seattle.gov/Documents/Departments/OSE/Reports/Drive%20Clean%20Seattle%202017%20Report.pdf

[108] Mayor Murray Launches Drive Clean Seattle, Office of the Mayor, March 10, 2016,
http://murray.seattle.gov/mayor-murray-launches-drive-clean-seattle/#sthash.PO397lFl.dpbs

[109] Keep Seattle Moving, Seattle City Council, February 2013, http://metro.kingcounty.gov/tops/get-you-there/alaskan-way-viaduct/pdf/Metro-Seattle-City-Council-AWV-presentation-02-13.pdf

[110] "EVs are for Everyone: Pilot Programs in Discovery Phase." Austin Energy.

[111] Car Sharing at a Mile High, International Parking Institute, November 2013,
http://www.parking.org/2016/01/19/tpp-2013-11-car-sharing-at-a-mile-high/

[112] EV Car Sharing Pilot for Disadvantaged Communities, City of Los Angeles,
http://sd24.senate.ca.gov/sites/sd24.senate.ca.gov/files/EV%20Carsharing%20Pilot.pdf

[113] Car Sharing, New York City Department of Transportation, 2011,
http://www.nyc.gov/html/dot/downloads/pdf/ssi11-car-sharing.pdf

[114] Establishment of a Carshare Parking Pilot Program, New York City Council, March 1, 2017,
https://council.nyc.gov/press/2017/03/01/1372/

[115] Peer to Peer Electric Car Sharing Pilot Launches in Portland, Efficientgov, March 31, 2017,
https://efficientgov.com/blog/2017/03/31/peer-to-peer-electric-car-sharing-pilot-portland/

[116] On-Street Car Sharing Pilot Program, SFMTA, January 2017,
https://www.sfmta.com/sites/default/files/projects/2017/Carshare_eval_final.pdf

[117] Bay Area's First One-Way Car Share Debuts in Berkeley and Oakland, Berkeleyside, April 19, 2017, http://www.berkeleyside.com/2017/04/19/bay-areas-first-one-way-car-share-debuts-berkeley-oakland/

[118] City of Seattle Partners with Scoop for Flexible Commuter Ride Sharing Pilot Program, City of Seattle, April 13, 2017, http://sdotblog.seattle.gov/2017/04/13/city-of-seattle-partners-with-scoop-for-flexible-commuter-ride-sharing-pilot-program/

[119] Denver Car Share Permit Program, City of Denver, March 13, 2014, http://www.law.du.edu/documents/rmlui/conference/powerpoints/2014/FerrinRGettingAroundWithoutTheChevy.pdf

[120] City of Seattle Partners with Scoop for Flexible Commuter Ride Sharing Pilot Program, City of Seattle, April 13, 2017, http://sdotblog.seattle.gov/2017/04/13/city-of-seattle-partners-with-scoop-for-flexible-commuter-ride-sharing-pilot-program/

[121] Autonomous Vehicles: Boston's Approach, City of Boston, June 2017, https://www.boston.gov/innovation-and-technology/autonomous-vehicles-bostons-approach

[122] Testing of Autonomous Vehicles, California DMV, June 2017, https://www.dmv.ca.gov/portal/dmv/detail/vr/autonomous/testing/

[123] Portland Opens Its Streets to Driverless Car Testing, Next City, June 19, 2017, https://nextcity.org/daily/entry/portland-driverless-car-testing

[124] Ibid.

[125] Testing of Autonomous Vehicles, California DMV, June 2017, https://www.dmv.ca.gov/portal/dmv/detail/vr/autonomous/testing/

[126] Texas Senate Bill 2205, LegiScan, 2017, https://legiscan.com/TX/text/SB2205/id/1620770

[127] Autonomous Vehicles: Boston's Approach, City of Boston, June 2017, https://www.boston.gov/innovation-and-technology/autonomous-vehicles-bostons-approach

[128] GoBoston 2030: Vision and Action Plan, Boston Transportation Department, March 7, 2017, https://www.boston.gov/sites/default/files/go_boston_2030_-_full_report_to_download.pdf

[129] Autonomous Vehicles, National Conference of State Legislatures, June 25, 2017, http://www.ncsl.org/research/transportation/autonomous-vehicles-self-driving-vehicles-enacted-legislation.aspx

[130] GoBoston 2030: Vision and Action Plan, Boston Transportation Department, March 7, 2017, https://www.boston.gov/sites/default/files/go_boston_2030_-_full_report_to_download.pdf

[131] Autonomous Vehicles: Boston's Approach, City of Boston, June 2017, https://www.boston.gov/innovation-and-technology/autonomous-vehicles-bostons-approach

[132] Urban Mobility in a Digital Age, Office of the Mayor, August 2016, http://www.urbanmobilityla.com/strategy/

[133] Autonomous Vehicles, National Conference of State Legislatures, June 25, 2017, http://www.ncsl.org/research/transportation/autonomous-vehicles-self-driving-vehicles-enacted-legislation.aspx

[134] Ibid.

[135] Urban Mobility in a Digital Age, Office of the Mayor, August 2016, http://www.urbanmobilityla.com/strategy/

[136] Portland Launches Smart Autonomous Vehicles Initiative (SAVI), Portland Bureau of Transportation, 2017, https://www.portlandoregon.gov/transportation/73493

[137] Launching Portland's Smart Autonomous Vehicles Initiative, City of Portland, April 19, 2017, https://www.portlandoregon.gov/transportation/article/636498

[138] Connected and Autonomous Vehicles Policy: Discussion Draft Recommendations, City of Portland, May 4, 2017, https://www.portlandoregon.gov/transportation/article/643814

[139] Autonomous Vehicles, National Conference of State Legislatures, June 25, 2017, http://www.ncsl.org/research/transportation/autonomous-vehicles-self-driving-vehicles-enacted-legislation.aspx

[140] Ibid.

[141] Florida Automated Vehicles, Florida Department of Transportation, 2016, http://www.automatedfl.com/

[142] In Florida, No Permit Needed for Driverless Cars, PolitiFact Florida, December 28, 2016, http://www.politifact.com/florida/statements/2016/dec/28/jeff-brandes/florida-no-permit-needed-driverless-cars-florida-s/

[143] Florida Automated Vehicles, Florida Department of Transportation, 2016, http://www.automatedfl.com/

[144] Texas Automated Vehicle Proving Ground Partnership, Texas Transportation Institute, https://tti.tamu.edu/group/connected-vehicles/files/2014/02/Texas-AV-Proving-Ground-Partnership-Proposal-12192016-Final-updated.pdf

[145] Autonomous Vehicles: Boston's Approach, City of Boston, June 2017, https://www.boston.gov/innovation-and-technology/autonomous-vehicles-bostons-approach

[146] Beverly Hills to Develop Autonomous Vehicle Program, Government Fleet, April 8, 2016, http://www.government-fleet.com/news/story/2016/04/beverly-hills-to-develop-autonomous-vehicle-program.aspx

[147] Self-Driving Bus with No Back-Up Driver Nears California Street, Reuters, March 6, 2017, http://www.reuters.com/article/us-california-autonomous-bus-idUSKBN16E08I

[148] Tampa THEA Pilot, United States Department of Transportation, https://www.its.dot.gov/pilots/pilots_thea.htm

[149] Tampa Area Transit Agency is Deploying Tesla Vehicles for Pilot Program, Tampa Bay Business Journal, April 18, 2017, https://www.bizjournals.com/tampabay/news/2017/04/18/tampa-area-transit-agency-is-deploying-tesla.html

[150] HART Moves Forward with Driverless Shuttles for Tampa, 10 News Tampa Bay Sarasota, April 12, 2017, http://www.wtsp.com/news/local/hart-moves-forward-with-driverless-shuttles-for-tampa/430644215

[151] Why was Arlington Picked to be a Testing Ground for Self-Driving Cars?, Dallas News, February 3, 2017, https://www.dallasnews.com/business/technology/2017/02/03/future-self-driving-cars-may-get-tested-arlington

[152] U.S. Department of Transportation Announces up to $42 Million in Next Generation Connected Vehicle Technologies, U.S. Department of Transportation, September 14, 2015, https://www.transportation.gov/briefing-room/us-department-transportation-announces-42-million-next-generation-connected-vehicle

[153] Tampa Area Transit Agency is Deploying Tesla Vehicles for Pilot Program, Tampa Bay Business Journal, April 18, 2017, https://www.bizjournals.com/tampabay/news/2017/04/18/tampa-area-transit-agency-is-deploying-tesla.html

[154] Autonomous Shuttle just Around the Corner for Downtown Tampa, Crain's Tampa Bay, January 29, 2017, http://tampabay.crains.com/article/news/autonomous-shuttle-just-around-corner-downtown-tampa