OFFICE OF POLICY PLANNING

# GUIDANCE FOR ASSESSING PLANNING IMPACTS AND OPPORTUNITIES OF AUTOMATED, CONNECTED, ELECTRIC AND SHARED-USE VEHICLES

FDOT

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# ACKNOWLEDGEMENTS AND THANKS

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One result of this ongoing consultation and investigation is the development of the ACES Planning Process shown in Figure ES 1. MPOs that intend to update their LRTPs and incorporate ACES guidance may choose to follow this planning process, which provides a workflow for MPO use.

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# EXECUTIVE SUMMARY

Florida metropolitan planning organizations (MPOs) are dealing with an unprecedented amount of potential change as they plan for their transportation needs between now and 2045. Within their next planning horizon, MPOs need to decide how best to address the increasing deployment of automated, connected, electric and shared-use vehicles (ACES) and complementary technologies.

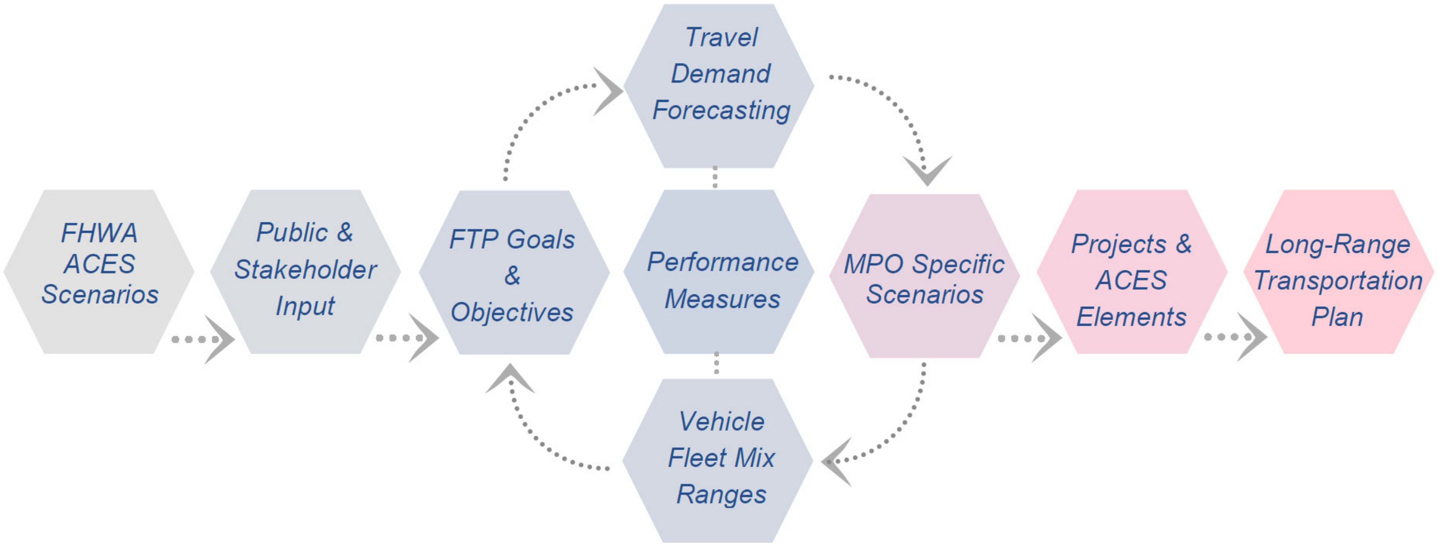
As with many technologies in their infancy, there is uncertainty about likely outcomes and how to plan for them. This guidance is intended to help each MPO consider how best to account for ACES within their individual planning process and long-range transportation plan. As such, the Florida Department of Transportation (FDOT) intends for it to be a catalyst that sparks consideration regarding how ACES uniquely will deploy and affect communities.

FDOT's overall approach to developing the guidance was to perform an extensive literature review, consider ACES-related practices of planning agencies around the country, electronically survey Florida MPOs followed by select individual interviews, develop an ACES-specific scenario planning approach and test ACES-related travel demand model concepts with two Florida MPO travel demand models. FDOT relied extensively on input from stakeholders and partners including the Florida Metropolitan Planning Organization Advisory Council (MPOAC) to help improve and refine contents of the guide.

> *"Transportation is in the midst of disruptive change from new technologies (automated and connected vehicles); new institutions (shared mobility firms); and changing attitudes (reduced car ownership). Across the nation, transportation planners are under pressure to develop performance-oriented policies, plans, and investment decisions that consider an increasingly complex transportation landscape. In the process, planners need to consider, but cannot yet reliably predict, the potential impact of disruptive and transformational ... technologies on safety, vehicle ownership, road capacity, VMT (vehicle miles travelled), land-use, roadway design, future investment demands, and economic development, among others."*
>
> *Federal Highway Administration (FHWA)*
>
> *Source:*
> *FDOT OPP Planning Emphasis Areas 2018*

One result of this ongoing consultation and investigation is the development of the ACES Planning Process shown in Figure ES 1. MPOs that intend to update their LRTPs and incorporate ACES guidance may choose to follow this planning process, which provides a workflow for MPO use.

*Figure ES 1: ACES Planning Process*



## Technology Adoption

ACES features have begun appearing in vehicles and are expected to increase significantly over the next few years. Initially, the introduction of ACES likely will be seen in the rapidly expanding number of electric and hybrid electric vehicles as well as those with driver-assist or basic connectivity functions. Later in the adoption curve, an increasing number of vehicles will operate autonomously in increasingly complex operating domains, under electric power and as parts of centrally managed fleets or under personal ownership.

A key planning implication revolves around the rate at which the vehicle fleet incorporates ACES technologies. There is considerable uncertainty surrounding the rate of deployment in the vehicle manufacturing industry. There's even more uncertainty around the actual usage rate, which is driven by a combination of consumer acceptance, the regulatory environment, business models and other factors.

In addition, adoption of different technologies and vehicle types can be expected to have different effects on planning issues, including:

- Automated Vehicles – When many vehicles can operate without a driver on board, potential increases in vehicle miles traveled (VMT) from empty vehicles, increased mobility for children, elderly or the disabled from lower costs, reduced parking demand and changes in urban form.
- Connected Vehicles – When most of the vehicle fleet can communicate with other vehicles and roadside devices, increases in road capacity, new safety features and improved congestion management could become more prevalent.
- Electric Vehicles – When a significant share of the vehicle fleet no longer pays motor fuel taxes, existing transportation funding sources may no longer be adequate, requiring MPOs to adjust their investment programs. On the other hand, widespread adoption of electric vehicles could result in substantially reduced air emissions. The magnitude of this effect depends on what energy sources are used to generate electricity and other factors.
- Shared-Use Vehicles – Ride sourcing, bike sharing and other shared mobility platforms are already creating new competition for limited curb space in urban areas, creating Complete Streets design challenges as well as opportunities for mobility hubs and new funding sources.

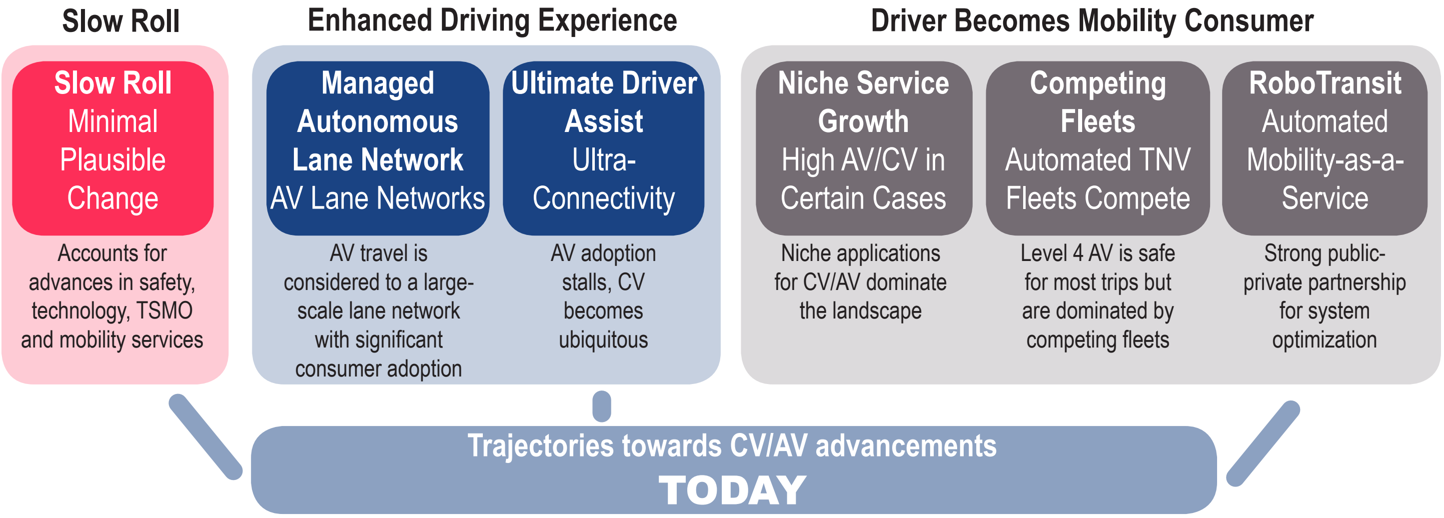
This guidance provides a range of potential fleet mix scenarios to help MPOs understand the likely contributions of different technologies and vehicle types on planning issues, including road design, VMT, parking, transit, urban form, transportation funding sources and safety (see Section 2). It's important to remember that technology is a tool for realizing community goals and not a solution itself.

This guidance also includes matrices that illustrate which vehicle types are associated with different impacts to help MPOs define the issues to consider in their planning processes based on the relative shares of different technologies and vehicle types in the future vehicle fleet (see Section 2.4).

## Scenario Planning

Given the uncertainties around ACES deployment and impacts, scenario planning provides a framework for developing a shared vision for the future that tests various alternatives regarding state, community or regional needs. As illustrated in Figure ES 2, this guidance builds on six scenarios developed by FHWA that represent a range of potential outcomes related to technology capabilities, the regulatory framework, consumer preferences and economic impacts following the introduction of ACES technologies. The FHWA scenarios describe impacts that could be common to many metropolitan areas across the United States.[a] MPOs may use these scenarios, or some variation of the scenarios, as a starting point for constructing their own range of scenarios that apply the national trends to their own local economy, geography, demographics and transportation network. In the process of defining locally specific scenarios, each community can decide how to reflect the national trends in the context of its own values, planning goals and objectives.

*Figure ES 2: FHWA 2035 CV/AV Scenarios*



*Source: FHWA, Scenario Planning for Connected and Automated Vehicles, DRAFT Scenario Descriptions, November 2017*

This guidance describes potential ACES-supportive considerations or project elements that MPOs may consider as elements of their scenarios. Scenario development creates opportunities for an MPO to strengthen its own planning and organizational sustainability by:

- Engaging a wide variety of stakeholders;
- Illustrating trade-offs among different land use and transportation choices;
- Creating a broader understanding of issues and stakeholders to be incorporated into planning;
- Helping develop performance measures and evaluation processes that provide policy guidance for local decision makers; and
- Producing more efficient, effective decision-making that results in significant benefits and improvements.[b]

This in-depth consideration enables planners to identify robust strategies and policy options that hold up across the spectrum of possible future conditions. It also is helpful in developing stable long-term “political will” to make and sustain necessary decisions, such as changes in land use policies or transportation funding sources. Finally, it helps create a context helpful to MPOs that employ performance-based planning to evaluate the tradeoffs between transportation policies and investments in relation to land use and other agency controlled or influenced policies.

## Transportation System Planning

To support definition of potential policy and scenario planning options, the existing transportation system planning process should be adapted to reflect ACES. The scenario planning process helps determine locally appropriate ranges of likely ACES impacts to employment, land use, facility design, capacity, auto ownership and consumer attitudes, among others. Two travel demand models were used to incorporate ACES scenarios and test impacts, including:

- The Gainesville Urban Area Transportation Study Model (GUATS), a traditional four-step travel demand model that includes a large university with a small urban area.
- The Central Florida Regional Planning Model (CFRPM), a large, multi-county regional four-step travel demand model.

## Revenue Planning

Electric vehicles and the move away from the combustion engine promise significant changes to Florida infrastructure, transportation and related revenue systems. Even with growth trends in VMT carried forward, an increase in the average fuel economy of vehicles may have a staggering effect on revenue from fuel sales. Revenue declines likely will be compounded by greater electrification of the vehicle fleet and shared mobility services using electric vehicles producing a larger share of local and state VMT. Financial scenarios evaluating the impact on MPO fiscally constrained capital programs are likely to become a more important part of the planning process.

## Education and Engagement

ACES-related impacts may significantly alter where people choose to live and bring changes to how they will travel and plan for land use. MPOs potentially can play a new or expanded role in communicating information about ACES and their impact on communities, policies and investments across a broad range of issues. Few organizations are as well positioned as MPOs to be the primary communicators about issues and opportunities stemming from ACES. These new demands on planning agencies, coupled with potential concerns about ACES impacts, will require added tools that empower the public to test planning assumptions and conclusions.

In this environment, MPOs may want to consider additional aspects during stakeholder engagement to better understand and evolve in reaction to new challenges to their planning processes and desired outcomes. This education and engagement will have the added benefit of building higher stakeholder tolerances for any extended period of unpredictable ACES evolution and impacts. Such uncertainty, driven by market- or technology-driven shifts in how, when and where ACES is deployed may trigger equally changing planning needs and decisions.

One way to mitigate against this uncertainty is to more extensively involve private-sector ACES stakeholders, including technology suppliers and emerging service providers, to:

- Identify location-specific ACES scenarios likely to occur;
- Resolve and integrate conflicting ACES priorities; and
- Explore public-private partnerships regarding emerging ACES opportunities.

Efforts like this may result in the creation of free-standing coalitions of stakeholders with similar interests. If proactively managed, such coalitions could become active, positive partners in helping MPOs appropriately prioritize their ACES efforts and invest their resources most effectively. Such coalitions, if supported through education and engagement, could help stimulate public- and private-sector policies and investments that support MPO policy changes and the performance measures they underpin.

MPOs likely will play a new or expanded role in communicating information about ACES and their impacts on communities, policies and investments across a broad range of issues. These new demands on planning agencies will require added tools that empower the public to test planning assumptions and conclusions. This guide provides “thought-starters” for MPOs in each of these areas as they consider where and how they can most appropriately invest their resources in shaping a region-specific vision of an ACES future.

## Considerations

As MPOs wrestle with these challenges, a greater tolerance for ambiguity and uncertainty may be required as they explore, test, evaluate and accept or reject different policy approaches to ACES. To succeed in this kind of environment will require MPOs to create an agile policy-making framework that sets in place a continual “look ahead” assessment.

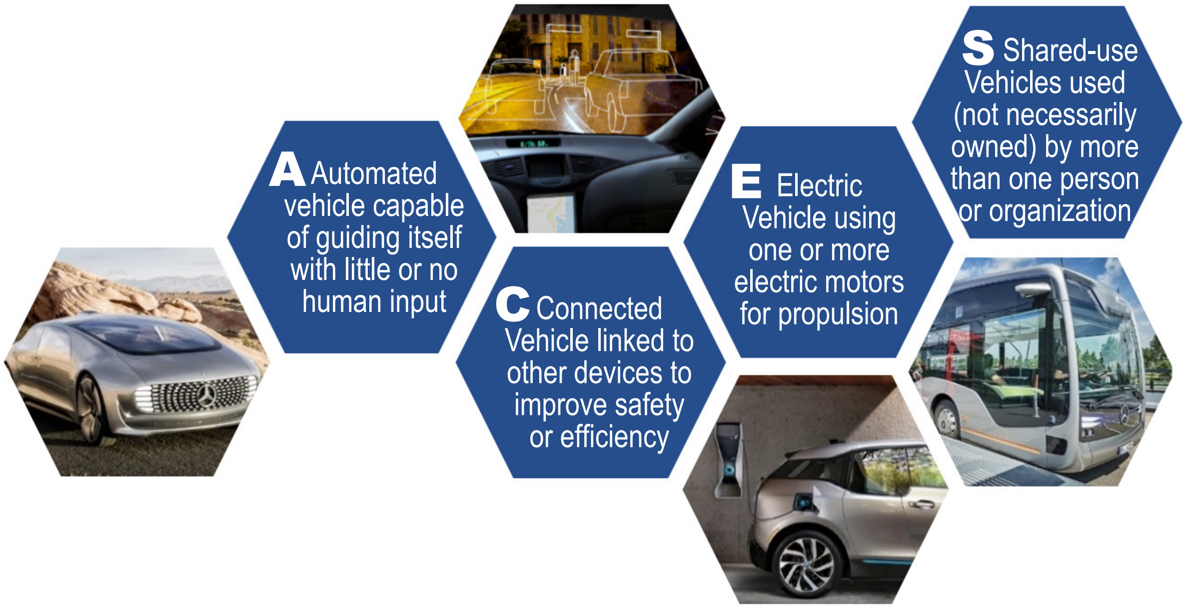
At the same time, MPOs should find some comfort in the expectation that the benefits of ACES align with traditional objectives of shared vehicle use, strong urban centers, efficient travel corridors and inclusive access. MPOs should pursue policies that are likely to yield benefits under a wide range of future ACES deployment scenarios.
ACES impacts can be focused on specific considerations in the areas of engagement, fiscally constrained financial planning, infrastructure programming, transportation planning and modeling, and policy.

# 1. INTRODUCTION & PURPOSE

## *CHAPTER 1 AT A GLANCE*

**Chapter 1 provides an introduction to the ACES guidance and describes the process used to develop the guide.**

Florida metropolitan planning organizations (MPOs) face an unprecedented amount of change as they plan for their transportation needs between now and 2045, the next planning horizon year for most Florida MPOs. MPOs need to decide how best to address opportunities presented to them by automated, connected, electric and shared-use vehicles (ACES). After all, ACES may improve personal productivity while traveling, increase road capacity and better utilize urban spaces. ACES may dramatically reduce negative outcomes associated with mobility systems on which our society currently relies by reducing injuries and fatalities due to human error while expanding mobility options for those who do not or cannot drive. At the same time, ACES may also introduce as-yet-unknown system costs, social inequities and new planning demands.



**A** Automated vehicle capable of guiding itself with little or no human input

**C** Connected Vehicle linked to other devices to improve safety or efficiency

**E** Electric Vehicle using one or more electric motors for propulsion

**S** Shared-use Vehicles used (not necessarily owned) by more than one person or organization

## 1.1 Legislative Reference

Florida statute requires MPOs to “assess capital investment and other measures necessary to … make the most efficient use of existing transportation facilities to relieve vehicular congestion, improve safety and maximize the mobility of people and goods. Such efforts must include, but are not limited to, consideration of infrastructure and technological improvements necessary to accommodate advances in vehicle technology, such as automated technology and other developments.”[c]

At the same time, the Federal Highway Administration (FHWA) and Federal Transit Administration (FTA) encourage Florida and other MPOs to begin addressing infrastructure needed to support emerging technologies and the transition time for implementation in their next round of Long-Range Transportation Plans (LRTP) updates.[d] Although not required at this time, the federal guidance clearly supports efforts by states, among which Florida is a leader, to incorporate ACES in long-range planning activities. In 2016, the State of Florida passed a bill mandating the MPOs address AV technology in their LRTPs. However, no uniform policy or design guidance previously existed to help MPOs anticipate, plan for, finance, or implement programs necessary to facilitate this transition.[e]

## 1.2 Study Goals and Objectives

Local, regional and statewide impacts of ACES on the Florida transportation system are still not fully understood. Nonetheless, the window for making planning decisions related to impacts has already opened. FDOT created this guidance to provide a common understanding and approach for Florida's 27 MPOs as they anticipate and respond to potential effects of ACES and complementary technology trends.

As with many technologies in their infancy, there is a great deal of uncertainty about likely outcomes and how to plan for them; some of the dimensions of uncertainty include:

- Consumer Acceptance
- Deployment Timeframe
- Economy
- Environment
- Land Use
- Mode Choice
- Parking
- Safety
- Transportation Funding
- Vehicles Miles Traveled

This guide takes a risk-management approach to identifying and examining planning strategies and approaches with the goal of positive benefits under a broad range of potential ACES futures. In this manner, MPOs can advance "sure wins" while waiting for the future impacts and opportunities to become clearer. It also serves as a starting point for each MPO to consider how best to account for ACES within their individual planning process and long-range transportation plan.

Too often the deployment of ACES is discussed as if it will happen in one fell swoop. The reality is that the rate and nature of market penetration will vary – from technology to technology, vehicle type to vehicle type and from region to region – based on a wide variety of factors such as: cost, benefit, cultural and demographic acceptance, legal environment, infrastructure improvement requirements and many others.

Rather than offering a prescriptive document, FDOT seeks to provide a catalyst that helps each MPO consider how ACES will uniquely deploy and affect its specific area, and as a starting point for consideration in its planning processes and long-range transportation plan. MPOs remain the front line in deciding how best to incorporate these emerging technologies through the planning process.

However, as technology evolves over time and the implications for planning issues become clearer, this guidance is intended to be updated by FDOT, which considers this guidance to be a "living document" that will be revisited regularly as new technology and impacts emerge.

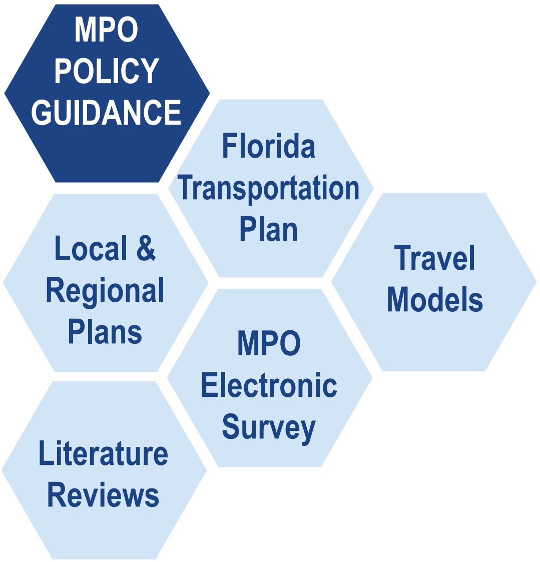
## 1.3 Methodology

The planning considerations presented in this document are drawn from a broad range of sources and influences. A review of many MPO practices nationally found few, if any, robustly reflecting the potential impacts of ACES on their TIPS or LRTPS at this time.

ACES have been more broadly addressed by scholars, academics and practitioners in the scholarly and popular press. As a result, an extensive literature review was conducted and the planning considerations presented in this document are drawn from that large and growing body of research that is relevant to planning for ACES. The bibliography at the end of this document provides links to many key resources.

These considerations were strengthened during development of this guidance by reaching out to Florida MPOs with an electronic survey and following up with select individual interviews to better understand their needs and testing travel demand model theories with selected MPO travel demand models.

Figure 1: Policy Guidance Resources



One result of this ongoing consultation and investigation is the development of the ACES Planning Process shown in Figure 2. MPOs that intend to update their LRTPs and incorporate ACES guidance may choose to follow this planning process, which provides a workflow for MPO use.

The process begins with FHWA scenarios, stakeholder input and FTP goals. Travel demand modeling, performance measures and vehicle fleet ranges become guidance inputs used to develop local MPO-specific scenarios to be considered.

Finally, local scenario planning will aid in the development of projects to be considered in existing and new long-range transportation plans. During this portion of the planning process, MPOs will begin to identify ACES-supportive elements that can be added to projects to prepare their local systems for successfully adapting to existing and emerging ACES technologies during the multi-year transition period ahead. An MPO, for example, may begin to increase its emphasis on its system state of good repair as an appropriate strategy to meet both short-term local transportation needs while also serving future navigational needs of an increasing number of ACES vehicles.

As illustrated in Figure 3, this guidance uses FHWA's six scenarios as an example of scenario building. FHWA's six scenarios are based on a future year of 2035. MPOs may use these scenarios as a starting point for constructing their own locally tailored scenarios.[f] The FHWA scenarios and the scenario planning process are described in more detail in Section 8.3.

*Figure 2: ACES Planning Process*

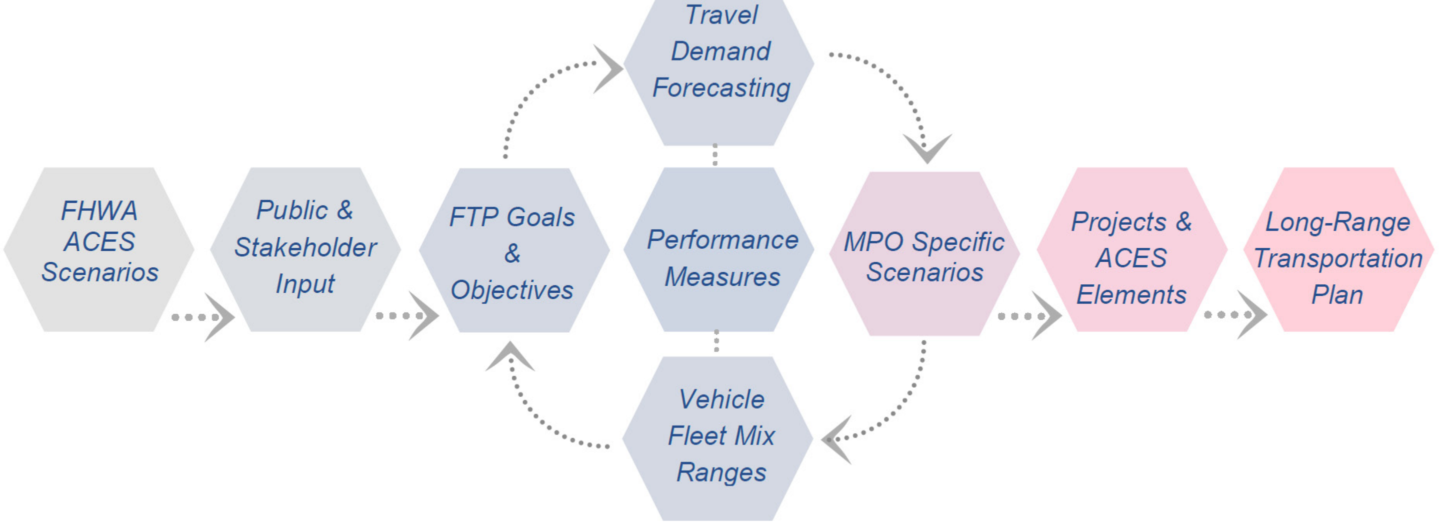
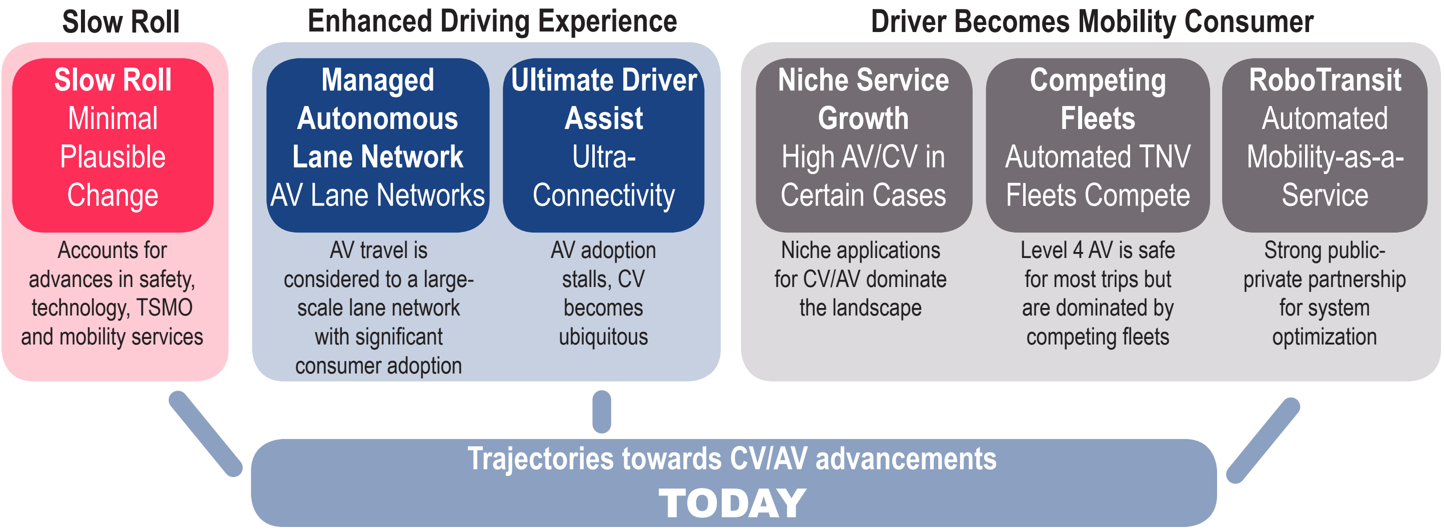


*Figure 3: FHWA 2035 CV/AV Scenarios*



# 2. AUTOMATED, CONNECTED, ELECTRIC AND SHARED-USE (ACES) TECHNOLOGY OVERVIEW

## CHAPTER 2 AT A GLANCE

- **Autonomous vehicles are likely to have profound impacts on society as a whole, not just on the transportation network.**
- **The move to electric vehicles potentially will significantly impact motor fuel tax revenues.**
- **Connected vehicles may profoundly change personal, freight and public transportation.**

Vehicles and how we use them are changing as a result of four independent, but complementary, technologies being introduced on different timeframes and with expected different impacts on our cities and transportation planning regions.

This section provides an overview of each technology, current predictions on implementation timing from the literature review, regulatory frameworks that may affect their implementation or impacts and key implications for MPO Long-Range Transportation Plans.

It is important to note that planning implications will vary among communities based on each community's vision and goals. However, a universal planning implication each community will encounter, is how to adequately fund achieving its individual vision and supporting goals.

Because automation is expected to take the longest to reach its full potential, the ACES technologies are presented here in reverse order, with Shared-Use Vehicles first.

## 2.1 Shared-Use Vehicles

Vehicle sharing involves multiple passengers (or shippers moving goods in the case of freight sharing) choosing to travel together in a single vehicle. Many different options, including fixed-route transit, paratransit, intercity buses, taxis, carpooling and vanpooling, are commonly used in Florida.

Shared-use vehicles are growing in numbers as the rapid adoption of location-aware smartphones over the previous decade has led to new business models and technology platforms for brokering trips between available transportation assets and people wanting to travel or ship more conveniently. Some of the more common forms of shared-use vehicles include:

- **Ride sourcing** – Also known as ride-hailing and ride-splitting, this industry is dominated by transportation network companies (TNCs) Uber and Lyft, which are disrupting the traditional taxi industry. Combining real-time ride reservations via a smartphone application (app), surge pricing to entice drivers to make their vehicles available as demand fluctuates, seamless electronic payment and mutual rating of drivers and passengers, ride sourcing has achieved new levels of efficiency, customer convenience and entrepreneurial ease of entry in the for-hire car business. TNCs are adding shared-trip capabilities in many markets that allow multiple trips to be served by the same vehicle at once, increasing vehicle occupancy and reducing fares to levels that are often competitive with fixed route transit.

- **Ride sharing** – Traditional carpools and vanpools have been supplemented with technology-enabled real-time ridesharing allowing a passenger to find an empty seat in a vehicle with someone traveling in the same direction toward a destination, frequently in exchange for taking on a portion of the driver's cost.

- **Car sharing** – Traditional car rental services, typically priced by the day or week, have been supplemented with platforms that allow renting a car for short trips, often on an hourly basis, by matching users with cars parked around an urban area. Variations include round-trip (the car is returned to the same location it was picked up), point-to-point (the drop-off location is different than the pick-up location) and peer-to-peer (individuals make their cars available to others via the platform when they are not in use). Car sharing in all its forms can reduce the need for car ownership and thus facilitate lifestyles with greater use of transit, biking, walking and other alternative modes.

- **Bike sharing** – Like point-to-point car sharing, bike sharing allows people to rent bikes for short trips around a community, frequently via a smartphone app that displays the location of nearby bicycles and facilitates payment. Public bike sharing systems have appeared in many communities in which publicly owned bikes are rented and returned at automated docking stations distributed around the service area. Dockless systems replace stations with location-tracking and unlocking devices on each bike.

- **Freight sharing** – Like ride-sharing, freight sharing involves companies sharing space on a vehicle and splitting "the fare" for their respective portions of the trip. Under the right circumstances, this distribution method can provide significant savings and reduce the overall carbon footprint of a manufacturer or distributor by reducing length of trips, empty backhauls or deadhead miles. This occurs by more directly moving goods from point to point whereas in traditional less-than-truckload (LTL) shipments, goods move through a spoke-and-hub network that may add distance and time.

Start-up companies continue to introduce variations on these shared-use vehicle platforms, including applications for small electric vehicles, specialty vehicles and urban delivery vehicles in a vigorous and still-evolving marketplace.[g]

### 2.1.1 Implementation Timeframe

Shared-use platforms are rapidly building out their networks and gaining market share in many communities. By late 2015, 15 percent of Americans had used a ride sourcing app.[h] By 2017, 30 percent had used an app to hail, rent or share a ride in some form.[i] The introduction of Mobility as a Service (MaaS) platforms, which integrate trip planning, payment, transit use and shared-use mobility services via a single convenient smartphone app are expected to boost market share for Shared-Use Vehicles in the 2020s and beyond, particularly as shared automated taxi services become available (see Section 2.4). As an example, Goldman Sachs forecasts that ride hailing will grow from two percent of mobility spending on ride-hailing today to 16 percent in 2030.[j]

### 2.1.2 Regulatory Framework

As TNCs have increased market share in the taxi industry over the last five years, states and cities have imposed increasing regulations on the industry. Florida enacted a statute in 2017 that established uniform statewide requirements for driver employment rights, insurance, driver background checks and other issues, while precluding local governments from levying taxes, requiring business licenses or placing other requirements on TNCs, TNC drivers or TNC vehicles.[k]

Across the United States, few jurisdictions have been successful in requiring TNCs to disclose information on passenger travel patterns. A notable exception is New York City, where the Taxi and Limousine Commission has been collecting and publishing TNC trip logs, including date, time and origin location of each trip, since 2015.[l]

A key objective of the National Association of City Transportation Officials (NACTO) and others in the planning community is to gain access to travel data from TNCs and other shared mobility platforms to support transportation planning analyses with richer and more accurate data than has traditionally been available through Census products and household travel surveys.[m]

### 2.1.3 Planning Implications

Higher vehicle occupancy is expected to continue to provide benefits in the form of reduced congestion, energy use, and emissions. A key role of MPOs in supporting the transition to an ACES future will include developing policies and prioritizing projects that encourage shared use of vehicles. This may include carpooling, ride sourcing, curb allocation, parking fees, and transit as appropriate in the community.

Shared-use vehicles are creating increased competition for curb space in urban areas. Ride sourcing platforms are a primary contributor to rising demand for pick-up and drop-off areas. Bike sharing stations, mobility hubs, kiosks and other features of shared-use infrastructure add to the need to more effectively manage this limited resource.

Cities are beginning to turn to pricing of curb zones used by the taxi industry, TNCs and other transportation providers to both manage space and generate revenue.[n] While the role of planning and managing curb space generally falls to cities more than MPOs, new revenue from this resource may offset some or all the potential declines in other transportation funding sources.[o]

Likewise, MPOs may have a role in participating in or facilitating regional or subarea mobility studies that address the impacts of shared-use mobility curb space usage and pricing.

As of this writing, there are no true curb pricing programs fully implemented. However, two examples may serve to illustrate potential planning implications and approaches:

- To effectively manage and price curb space, communities must first inventory curb space and evaluate space allocation. Washington D.C. chose to focus on commercial loading zones. After digitally mapping all 600 commercial loading zones, DC implemented a cellphone payment system that charges commercial vehicles and collects usage data. The resulting database helped determine where additional zones were needed and how best to implement a demand-based pricing model that began in March 2015. By making available complementary driver information, this model has the potential to reduce the number of vehicles circling in search of space, therefore leading congestion relief, improved air quality and less noise pollution.[p]
- In San Francisco, for example, the city is partnering with Uber and Lyft on an experimental program to designate TNC pick-up and loading zones to mitigate their impacts on local congestion and accidents. Although TNCs account for only 20 percent of the city's traffic, they produce 65 percent of local traffic violations. In return for access to Uber and Lyft travel data the city desires for transportation planning purposes, San Francisco is specifying TNC curb space in selected areas. If the program proves successful, it is not difficult to imagine the city expanding its SFpark program of dynamic pricing of curbside parking to address TNCs impacts. Indeed, many believe that in 2014 the city effectively set the price of curbside parking at $1 per day as part of a deal with Google regarding private transit services.[q]

Additional discussion on land use planning implications can be found in Section 8.8 Land Use.

## 2.2 Electric Vehicles

Electrification of transportation vehicles is well underway. Advances with on-board energy storage, particularly lithium-ion batteries, over the previous decade have made electric drivetrains competitive with internal combustion engines in performance and range at increasingly affordable price points. Early movement in this transition was led by hybrid electric vehicles (HEVs) and plug-in hybrid electric vehicles (PHEVs). As technology has progressed, having a majority adoption of fully electric vehicles (EVs), dominated by battery electric vehicles (BEVs), now seems like less of a remote possibility. Based on the variety of vehicle types already using or soon to use batteries for energy storage (including passenger cars, large trucks, buses and streetcars), electrification appears to be scalable to a large share of the vehicle fleet.

EVs offer many advantages over combustion-engine vehicles, including reduced pollution, lower "well-to-wheel" carbon emissions, less maintenance and smoother travel. However, while there are clear benefits of EVs, the reuse and recycling of lithium-ion batteries used in the vehicles is a potential future industry challenge. Additionally, because the current electric power grid is incapable of accommodating a significant increase in EV charging, an important barrier to a full EV fleet is grid modernization. Concurrent with the transition in the transportation sector, the electric power sector may experience significant changes toward more resilient and efficient power generation and distribution. To meet potential demand for EVs, significant investment is necessary in infrastructure, data management and policy.

### *2.2.1 Implementation Timeframe*

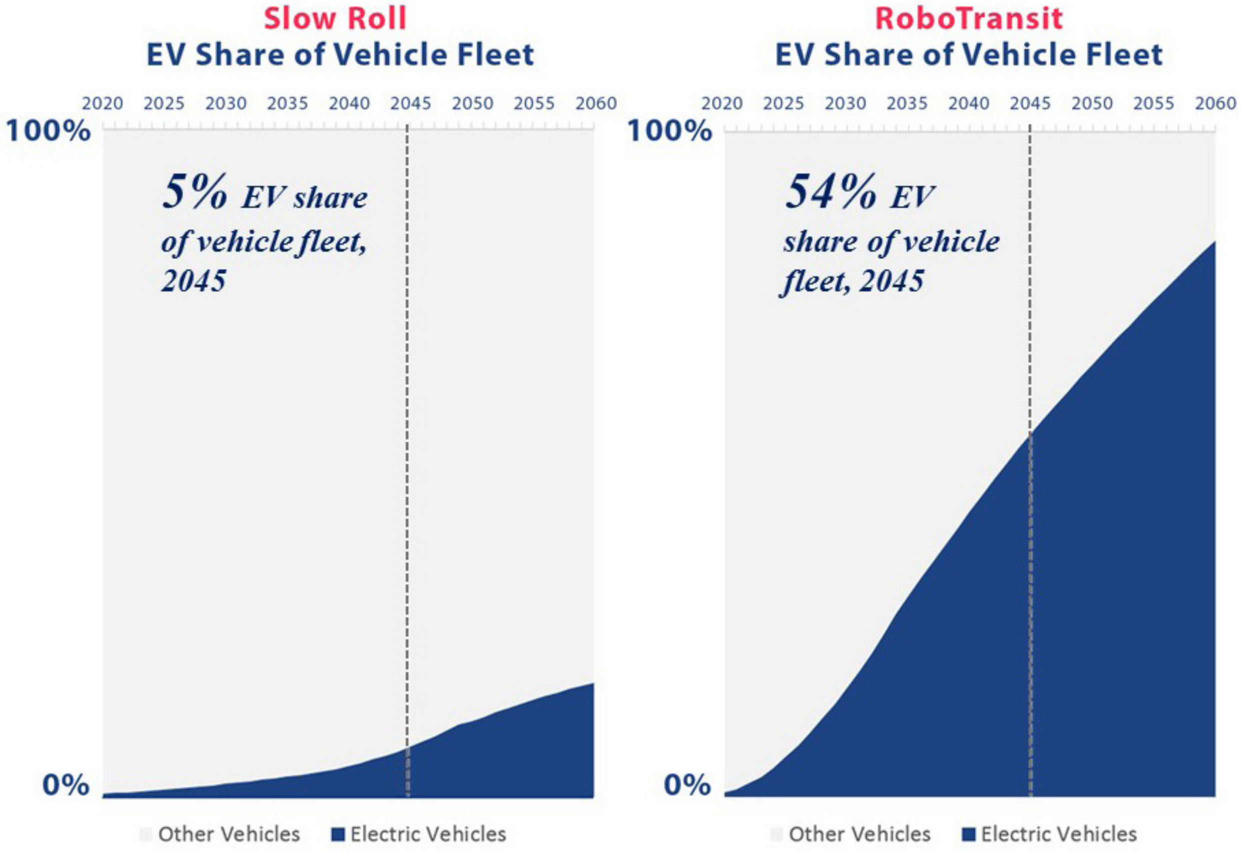
The Global EV Outlook 2017 published by the International Energy Agency (IEA) stated that the number of registered PHEVs and BEVs has grown 60 percent from the previous year.[r] While the total global and U.S. EV vehicle stock (number of EVs deployed on the road today) is small, EV sales and share of the vehicle fleet are expected to rise on an accelerating basis. Bloomberg predicts that EVs will become price competitive with internal combustion engine-powered vehicles without the need for subsidies by 2025, leading to EVs reaching seven percent of the global light vehicle fleet by 2030 and 33 percent by 2040.[s]

Figure 4 illustrates a range of potential electric vehicle adoption scenarios developed by the FHWA. The charts reflect the effect on the proportion of the overall fleet that operates electrically of lower and higher sales of EVs as a share of the total market for new vehicles. A key driver of the adoption timeframe is the turnover rate of existing vehicles in the fleet. With the average personal vehicle lasting nearly 20 years before it is replaced, even rapid changes in sales market share for a new technology have a gradual impact on the overall fleet composition.

By 2045 (the next expected LRTP planning horizon), the scenarios suggest that EVs could represent less than five percent to more than 50 percent of the fleet. Much of the difference depends on the degree to which shared automated mobility services (expected to use EVs in part for their automated "refueling" capability) replace personal vehicles. The Slow Roll assumes that "EVs gain market share only gradually, continuing at their current pace, comprising approximately 5 percent of new vehicle sales overall" [by 2035]. Conversely, the Robo Transit scenario assumes that "EV market share sharply increases [because all on-demand rides are electric]". A complete set of scenarios would also consider the appeal of personally owned automated vehicles, both electric and gas powered.

Another variable in the adoption rate is the degree to which jurisdictions encourage or mandate the shift away from internal combustion engines. These forecasts reflect an organic turnover of the vehicle fleet without abrupt shifts in public policy.

*Figure 4: Electric Vehicle Adoption Scenarios*



### *2.2.2 Regulatory Framework*

States and municipalities are playing a significant role in the sale and ownership of electric vehicles. Due to concerns about carbon emissions and the viability of EVs as an alternative, several countries have announced plans to ban sales of combustion-engine vehicles by 2040 or earlier including India, France, Britain, and China. Other countries have EV sales targets in place, including Austria, Denmark, Ireland, Japan, the Netherlands, Portugal, Korea, and Spain.[t] The California Air Resources Board, already working with seven other states to deploy 3.3 million zero-emission vehicles (ZEVs) by 2025, is considering a similar sales ban.[u]

Many states and other jurisdictions have taken measures to incentivize ownership of partial or fully electric vehicles through one or more of the following mechanisms. To date, more than 40 percent of states, including Florida, have promoted EVs through incentives or waivers.

### *2.2.3 Planning Implications*

Large-scale electrification would require an expansion of charging infrastructure, impacting power generation and distribution systems. While much of the implementation activity will be led by building owners, utilities and municipalities, MPOs may have a role in participating in or facilitating regional or subarea studies that address vehicle charging in the public right-of-way, renewable energy generation, supporting power systems and other features of the EV ecosystem.

Additionally, there are many uncertainties regarding the true environmental consequences of EVs when paired with automated vehicle deployment. Additionally, the implications on land use and public transit are unknown.

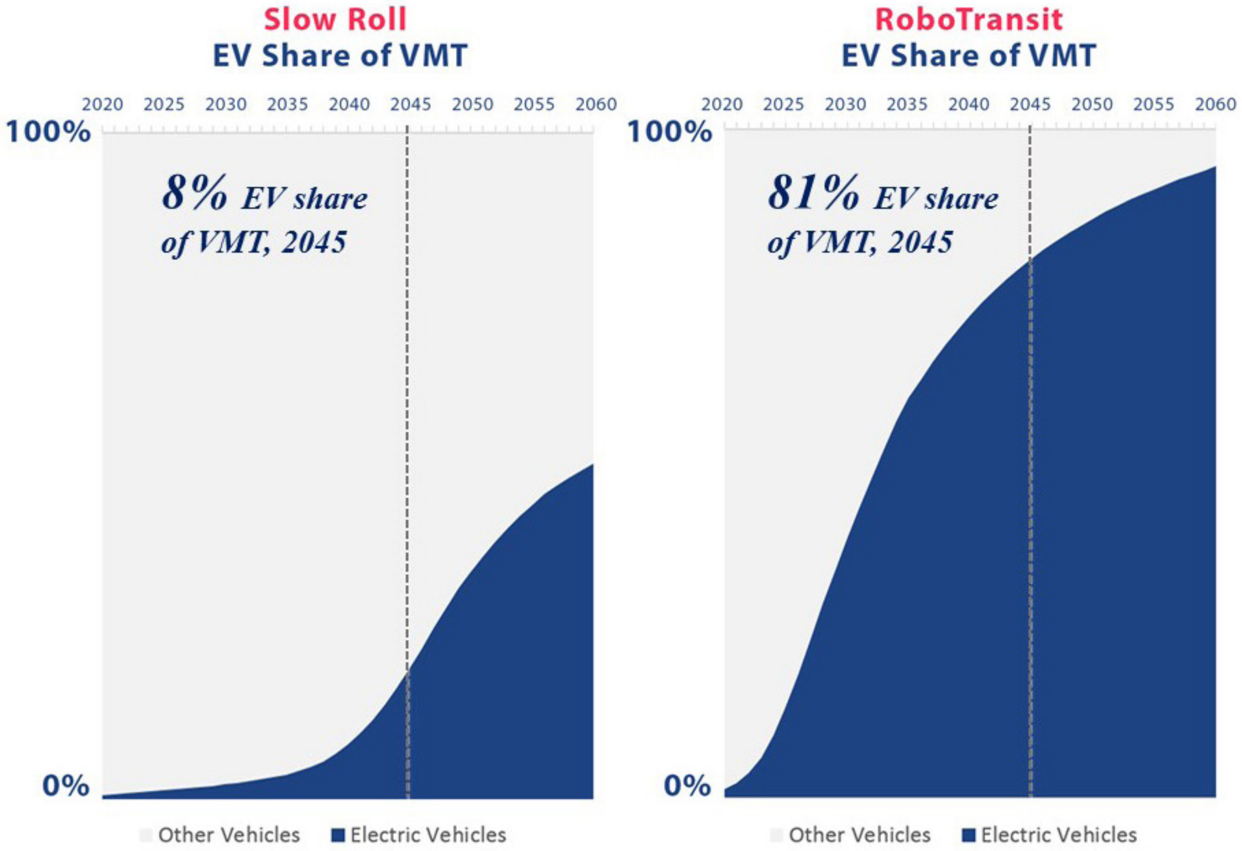
However, the move toward electrification would also significantly impact the motor fuel tax revenues that have traditionally been used to pay for transportation infrastructure. If fewer Florida drivers buy gas at the pump, revenue from the fuel tax will decline over time, affecting the ability to maintain transportation infrastructure and fund capital programs. The potential funding gap would be a primary hurdle for planners and administrators to overcome.

To offset a loss of fuel tax revenue, a growing number of states (including states that have incentivized EV purchase and ownership) are imposing EV-specific fees, typically in the form of higher annual registration fees. Other EV incentives that may also result in lost revenue include free charging, free parking, HOV lane access, vehicle inspection waivers, tax credits and vehicle rebates. Some states are considering more creative solutions, including mileage-based user fee programs, to address long-term revenue needs.

The Center for Urban Transportation Research (CUTR) completed a Transportation Revenue Study in 2012 and there is an existing effort to updated relevant section of the study to establish a baseline for analyzing AV and EV revenue impacts in the state.

Figure 5 represents the potential impact of electrification on the share of VMT made in EVs. More so than fleet mix, the shift of VMT from internal combustion to electric power is the main driver of potential impacts on motor fuel tax revenues. Because fleet vehicles, such as used by electric AV services, are expected to have higher utilization than personal vehicles, the FHWA scenarios suggest that EVs could represent less than 10 percent ("Slow Roll" scenario) to more than 80 percent ("Robo Transit" scenario) of VMT. Funding mechanisms to minimize the negative fiscal impact and expand the funding potential of ACES are further described in Section 6.0. More information on the vehicle fleet mix forecasting approach is provided in Appendix 2.

*Figure 5: Electric Vehicle Share of Vehicle Miles Traveled Scenarios*



## 2.3 Connected Vehicles

Connected vehicles (CVs) use over-the-air radio to communicate with each other, roadside devices and cloud-based internet platforms. Communications may occur via dedicated short-range communications (DSRC) reserved for transportation purposes, wireless broadband cellular data services, Wi-Fi and Bluetooth. A common feature of CVs is the broadcasting of a basic safety message that contains location, direction and speed information. The information in the basic safety message can be used by other connected vehicles and can be used to monitor the transportation network performance. The greatest concern for the development of CV is hacking by malicious entities, which poses an enormous threat to both the safety and security of future CVs. Secure communications technologies are critical to minimizing this potential problem. CV applications fall into the following major categories:

- **V2V – Vehicle to vehicle communications** enables equipped vehicles to alert drivers about an imminent forward collision or hard braking in the traffic stream ahead, assist drivers who are making unprotected left turns or passing maneuvers to proceed when it is safe or warn nearby drivers when one is changing lanes. V2V can also allow an adaptive cruise control system to harmonize speed with other nearby vehicles, which facilitates platooning on freeways as well as synchronized intersection approach and departure to reduce fuel consumption and emissions.

- **V2I – Vehicle to infrastructure communications** and the reverse (I2V) such as with traffic signals or other roadside devices, enables advanced signal timing or transit signal priority, in-vehicle warnings about road conditions in inclement weather, optimized intersection approach and departure coordinated with signal timing, real-time traffic data collection, work zone speed warnings and other applications.

- **V2X – Vehicle to everything communications** enable road users to connect with smart city infrastructure. For example, a connected vehicle equipped with V2X can pay tolls, pay for parking, or help you remember where you parked. Or a visually impaired person can use a smartphone app to request a “walk” signal at a signalized intersection and provide audio cues to safely navigate the crosswalk.

It is expected that V2V communications will primarily rely on DSRC technology. Most experts believe that 5G technology will provide sufficient wireless broadband technology to make V2I applications work on a large scale. Implementing V2I applications using DSRC technology would require publicly funded deployment of DSRC roadside units. With the expected bandwidth of 5G technology, the required V2I communications can be accomplished using a wireless network that is serving multiple uses.

Vehicles that are increasingly connected have the potential to profoundly change personal, freight and public transportation. Potential benefits to society include reductions in crashes, traffic congestion (and therefore air pollution) and other negative driving-associated externalities. Depending on the levels of automation and connectivity, future CVs may encourage greater prevalence of distracted driving through an over-reliance of non-fully automated driving features.

The Center for Transportation Research at the University of Texas, Austin, published a research report that lists a range of CAV technologies that are either in use today or expected in the future, as shown in Table 1.[v] Its matrix, while defining CAV types differently than the SAE classifications more frequently seen, is helpful in exploring potential technology deployments, their timeframes and implications.

*Table 1: Connected Vehicle Technologies*

| Technology | Automation Level | Maturity Timeframe | Major Safety Benefit | Safety Benefit Significance | Maturity | DOT Involvement |
|---|---|---|---|---|---|---|
| Forward collision warning | **Level 0: No Automation** | Short | Prevent rear-end collision | High | High | Infrastructure |
| Blind spot monitoring | | Short | Reduce crash risk at merging and weaving areas | High | High | Policy |
| Lane departure warning | | Short | Prevent lane departure crashes | High | Medium | Infrastructure |
| Traffic sign recognition | | Short | Assist driving | Intermediate | Medium | Infrastructure |
| Left turn assist | | Short | Prevent potential conflict | High | Medium | Policy |
| Pedestrian collision warning | | Short | Prevent backing collision | High | Medium | Policy |
| Rear cross traffic alert | | Short | Prevent pedestrian collision | High | Medium | Policy |
| Adaptive headlights | | Short | Improve light condition and visibility of environment | Intermediate | Medium | Policy |
| Adaptive cruise control | **Level 1: Funtion Specific Automation** | Short | Prevent rear end collision | High | High | Policy |
| Cooperative adaptive cruise control | | Short | Prevent rear end collision | High | High | Policy |
| Automatic emergency braking | | Short | Prevent rear end collision | High | Medium | Policy |
| Lane keeping | | Short | Prevent lane departure crashes | High | Medium | Infrastructure |
| Electronic stability control | | Short | Prevent rollover | High | High | Policy |
| Parental control | | Short | Prevent speeding | Intermediate | Medium | Policy |
| Traffic jam assist | **Level 2: Combined Function Automation** | Medium | Driving assist | Low | Medium | Policy |
| High speed automation | | Medium | Driving assist | High | Medium | Policy |
| Automated assistance in roadwork and congestion | | Medium | Driving assist | High | Medium | Policy |
| On highway platooning | **Level 3: Semi-Automation** | Medium | Driving assist, prevent rear-end crashes | Intermediate | Medium | Policy |
| Automated operation for military applications | | Medium | Prevent human fatalities | Unknown | Low | Policy |
| Self-driving vehicle | **Level 4: Full Automation** | Medium | Replace human drivers | High | Low | Both |
| Emergency stopping assistant | | Medium | Response when human drivers lose control | High | Low | Policy |
| Automated valet parking | | Medium | Convenience feature | Low | Low | Both |

*Source: University of Texas, Austin. Implications of Connected and Automated Vehicles on the Safety and Operations of Roadway Networks: A Final Report, 2016*

### *2.3.1 Implementation Timeframe*

Today's vehicles and drivers in the vehicles are already connected. The USDOT has continued to move forward with its CV plans. In early 2014, the National Highway Traffic Safety Administration (NHTSA) indicated its intention to move forward with the regulatory process regarding CV technology, specifically V2V communications capability. NHTSA issued a Notice of Proposed Rulemaking in 2017 that would require all new light vehicles to send and receive basic safety messages by 2023.[w] However, it is unclear whether the current administration will implement the policies in the rulemaking. Based on the average useful life of vehicles, it would take more than 20 years before at least 90 percent of the fleet is equipped with V2V capabilities unless the mandate were extended to require retrofits of older vehicles. This forecast could be accelerated though based on market-driven interest as is being seen today.

While this proposed rulemaking signals a positive step toward CV technology beginning to be present on public roads, it does not include any requirements on specific safety or mobility applications that must be running on the equipment. Additionally, CV infrastructure falls outside the scope of the proposed rulemaking, meaning CVs will only be able to take advantage of V2I safety and mobility applications if a state or local government or transportation organization has made the commitment to invest and deploy roadside equipment and applications.

### *2.3.2 Regulatory Framework*

The future of the NHTSA CV policy is uncertain. Without a mandate, it is unlikely that sufficient share of the fleet will be equipped with interoperable V2V capabilities to make many of the proposed safety features effective. With a mandate, the framework will be set by the federal government with MPOs addressing requirements assigned to them.

### *2.3.3 Planning Implications*

Even without a mandate for manufacturers to build V2V capabilities into new vehicles, some CV applications will be possible using smartphones and vehicles increasingly connected to the cloud via existing 4G wireless broadband technology. At the same time, advanced traffic signal control systems are increasingly relying on cloud-sourced vehicle location data and roadside smartphone detection equipment to manage congestion. With public agency access, these systems could support long-range planning by generating new streams of data on travel patterns while providing inputs to DOTs or other agencies for improved real-time management of roadway operations.

However, the most significant impact of CV technology on MPO programs is likely to be the introduction of dedicated AV/CV-only lanes that allow coordinated speed control and greater capacity on limited access highways and arterials. MPOs may have a role in prioritizing roads for platooning lanes, evaluating HOV/HOT lane conversions to AV/CV-only lanes, identifying intersections or districts where traffic signal systems will apply V2I for "eco-driving" and designating networks of arterial lanes reserved for high-occupancy AV/CVs, such as buses and microtransit vans.

The Florida Connected Vehicle Initiative, a program of projects being run out of the FDOT Traffic Systems Management and Operations Office, provides early examples of the kinds of projects that MPOs may consider for their transportation programs. The connected vehicle initiative uses leading edge technologies to quickly identify roadway hazards and alert drivers. These technologies include:

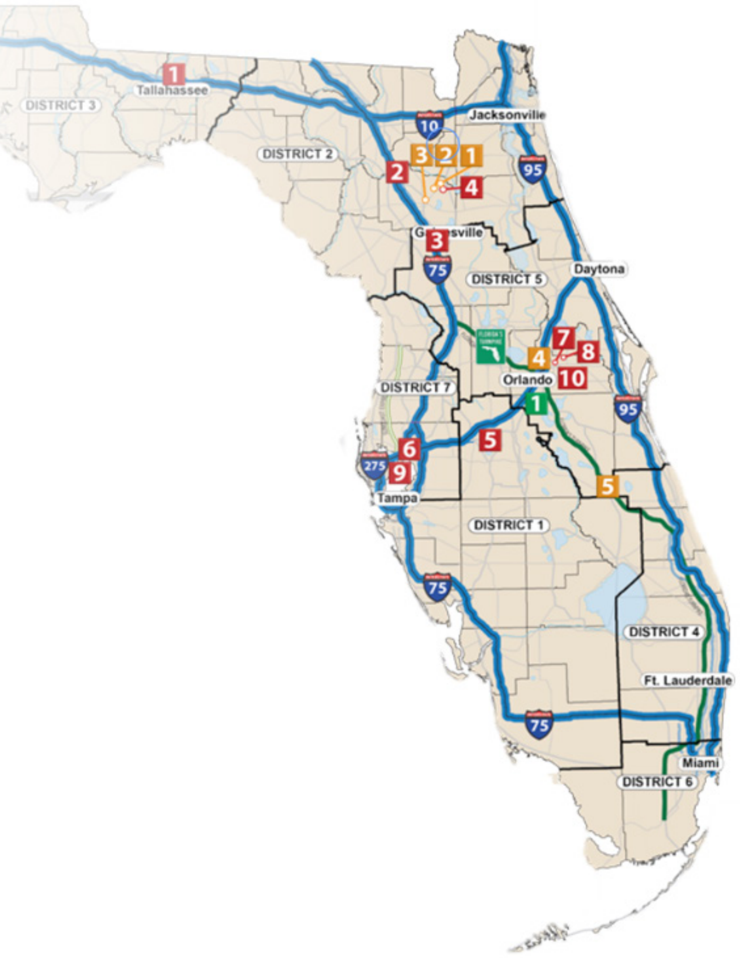
- Emergency Vehicle Preemption
- Freight Signal Priority
- Global Positioning System Navigation
- On-Board Units
- Roadside Units
- Signal Phase and Timing (SPaT)
- Transit Signal Priority
- Vehicle Sensors
- Wireless Communications

The Florida Connected Vehicle Initiative is shown in Figure 6.

*Figure 6: Florida Connected Vehicle Initiative*

**Projects / Initiatives**

| | | |
|---|---|---|
| **PLANNING** | | |
| 🟨 | 1 | University of Florida (UF) Accelerated Innovation Deployment (AID) Demonstration |
| 🟨 | 2 | Implementing Solutions from Transportation Research and Evaluation of Emerging Technologies (I-STREET) |
| 🟨 | 3 | Gainesville Signal Phase and Timing (SPaT) Trapezium |
| 🟨 | 4 | Central Florida Automated Vehicle (AV) Proving Ground |
| 🟨 | 5 | Driver Assistive Truck Platooning (DATP) Pilot |
| **DESIGN / IMPLEMENTATION** | | |
| 🟥 | 1 | US 90 SPaT Tallahassee |
| 🟥 | 2 | I-75 Florida's Regional Advanced Mobility Elements (FRAME) Gainesville |
| 🟥 | 3 | I-75 Florida's Regional Advanced Mobility Elements (FRAME) Ocala |
| 🟥 | 4 | Gainesville Automated Transit Shuttle (GAToRS) |
| 🟥 | 5 | Florida's Turnpike Enterprise (FTE) SunTrax |
| 🟥 | 6 | Tampa Hillsborough Expressway Authority (THEA) Connected Vehicle Pilot |
| 🟥 | 7 | City of Orlando Greenway/Pedestrian Safety |
| 🟥 | 8 | SR 434 Connected Vehicle Deployment |
| 🟥 | 9 | Downtown Tampa Automated Transit |
| 🟥 | 10 | Orlando Smart Community 2017 ATCMTD |
| **OPERATIONAL** | | |
| 🟩 | 1 | Osceola County Connected Vehicle Signals |



Source: FDOT$^{x}$

## 2.4 Automated Vehicles

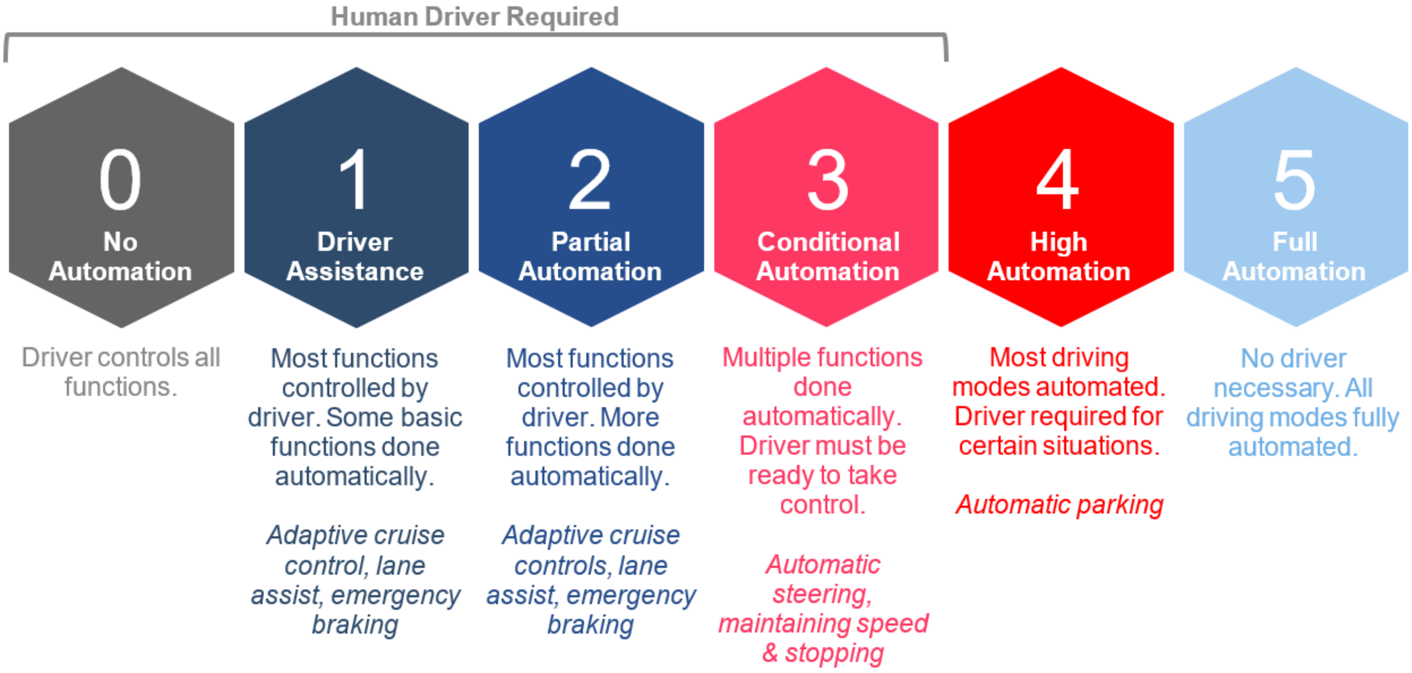
Of all the ACES technologies, automation is likely to have the most profound implications on our society, ranging from improved road safety to changes in the workforce. The Society of Automotive Engineers (SAE) framework for Levels of Automation is a helpful starting point for considering the planning implications of increasingly capable automated vehicles (see Figure 7). Complementary technologies of connected vehicle communications, electric propulsion and shared mobility platforms are expected to be introduced along with increasing levels of automation.

The share of vehicles with automated driving capabilities is expected to increase gradually from the small number of models available today that can operate with reduced human input in certain situations to a fleet that is largely automated and capable of operating in a wide variety of conditions.

How these capabilities grow over time will drive the use cases for which AVs are deployed and the resulting effects on our metropolitan regions. This guide breaks AVs into a range of nine different vehicle types, each with different potential rates of adoption, relevance in different operating contexts and impacts on metropolitan planning and infrastructure programs. Automated vehicle types include:

- *Level 2-3 Cars and Light Trucks* – Predominantly privately-owned vehicles with ADAS technology. Vehicles offer improved safety and potential for higher road capacity with V2V cooperative adaptive cruise control, but still require a human driver on board.

*Figure 7: SAE Levels of Automation*



Source: Society of Automotive Engineers

- *Level 2-3 Cars and Light Trucks* – Predominantly privately-owned vehicles with ADAS technology. Vehicles offer improved safety and potential for higher road capacity with V2V cooperative adaptive cruise control, but still require a human driver on board.

- *Level 2-3 Vans and Buses* – Mix of privately and publicly owned vehicles, including transit fleets. Vehicles offer improved safety with ADAS, but still require a human driver on board.

- *Level 2-3 Heavy Trucks* – Single unit and combination trucks with advanced driver assist technology. Vehicles offer improved safety and fuel savings from platooning, but because they still require a human driver on board, overall freight cost savings are limited.

- *Level 4-5 Cars and Light Trucks* – Predominantly personally owned vehicles that may operate without a human driver on board. New use cases could include ability to run errands while the owner is elsewhere, run home empty to transport other family members and earn money as a MaaS platform vehicle while not in use by the owner.

- *Level 4-5 Taxis* – Fleet owned automated vehicles used by Mobility as a Service (MaaS) platforms. Vehicles may take a variety of form factors from small single-occupant pods to large shared use vans that operate along a flexible route or fixed corridor.

- *Level 4-5 Low-Speed Shuttles* – Small automated shuttles used for campus, transit and first/last mile applications. Current vehicles are typically limited to less than 25 mph, particularly when operating in the presence of pedestrians. As technology advances, this category could merge with Level 4-5 Taxis and Level 4-5 Vans and Buses.

- *Level 4-5 Vans and Buses* – Larger or faster transit vehicles used for microtransit and trunk route applications, largely owned by public or private transit providers. Automation of transit vehicles could change the operating cost structure, potentially allowing for increased frequency in major urban corridors (see Section 7).

- *Level 4-5 Urban Delivery* – Fleet owned automated vehicles used for local freight delivery. Vehicles could take a variety of forms depending on the commodity shipped and the operating environment, ranging from small robots on city sidewalks to large delivery vans with a human on board primarily for loading and unloading.

- *Level 4-5 Heavy Trucks* – Single unit and combination trucks with advanced technology capable of operating without a human driver on board. Highly automated vehicles that require a human for some tasks could extend the hours of service that currently restrict the range and productivity of truck drivers. Fully automated trucks operating in dedicated lanes on intercity highways could radically transform the cost structure of long-distance freight.

### *2.4.1 Implementation Timeframe*

A key driver of planning implications is the rate at which automation will be adopted in the vehicle fleet. There is considerable uncertainty surrounding the rate of deployment and the rate of adoption, which is driven by a combination of consumer acceptance, the regulatory environment, business models and other outcomes. However, most estimates in the literature place widespread adoption of key features on some vehicle types by 2045, the planning horizon of MPO Long Range Transportation Plans.

Figure 3 illustrates a range of potential automated vehicle adoption scenarios developed by the FHWA (see Section 1.0). The charts reflect the effect on the proportion of the overall fleet that operates autonomously of lower and higher sales of each AV type as a share of the total market for new vehicles.

A key assumption in the vehicle fleet mix forecasts is that new personal vehicles continue to replace older vehicles as they wear out, typically after at least 20 years of service for passenger cars and light trucks. An abrupt transition caused by a policy change, such as a ban on human driving or, less drastically, zoning restrictions on downtown parking, could result in a more rapid adoption of ACES than is reflected in the charts. More information on the vehicle fleet mix forecasting approach is provided in Appendix 2.

By 2045, the FHWA scenarios suggest that Level 2 or higher AVs could represent less than 25% ("Slow Roll" Scenario) to nearly 35 percent of the fleet ("Robo Transit" scenario). Level 2-3 vehicles could range from a majority of the automated fleet (Slow Roll) to less than 40 percent of an automated fleet dominated by Level 4-5 taxis and delivery vehicles (RoboTransit). The Slow Roll scenario assumes that "Level 2 automated vehicles make up about 30-40 percent of the market [sales]" by 2035 while Level 3 vehicles remain rare. The RoboTransit scenario assumes that "Level 2 AVs make up 30-40 percent of the market overall market [sales]. Level 3 share is negligible. Level 4 AVs make up 30 percent of the overall market [sales]." by 2035.

Figure 9 illustrates the potential impact of automation on the share of VMT made in AVs. The shift of VMT is a key driver of the potential impacts of automation on overall road safety. The share of travel made in Level 4-5 shared taxis is a key driver of impacts on personal vehicle ownership, parking demand and urban form.

The scenarios suggest that travel in AVs could range from about 30 percent to more than 70 percent of total VMT by 2040. The share of total VMT in Level 2-3 AVs could range from about 10 percent in a fleet where half of travel is in Level 4-5 taxis and delivery vehicles to about 30 percent in a fleet where personal vehicles remain dominant and Level 4-5 vehicles are rare.

*Figure 8: Illustrative Automation Adoption Timeframes by Vehicle Type*

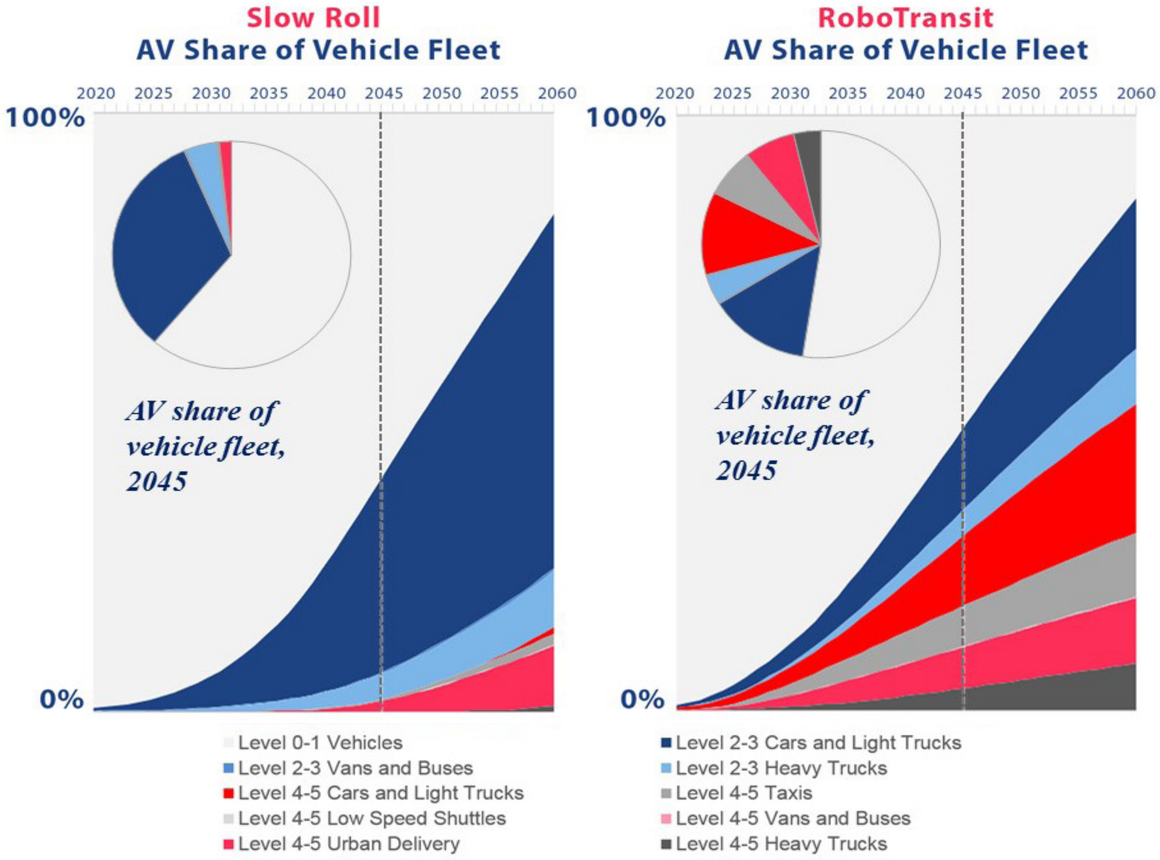
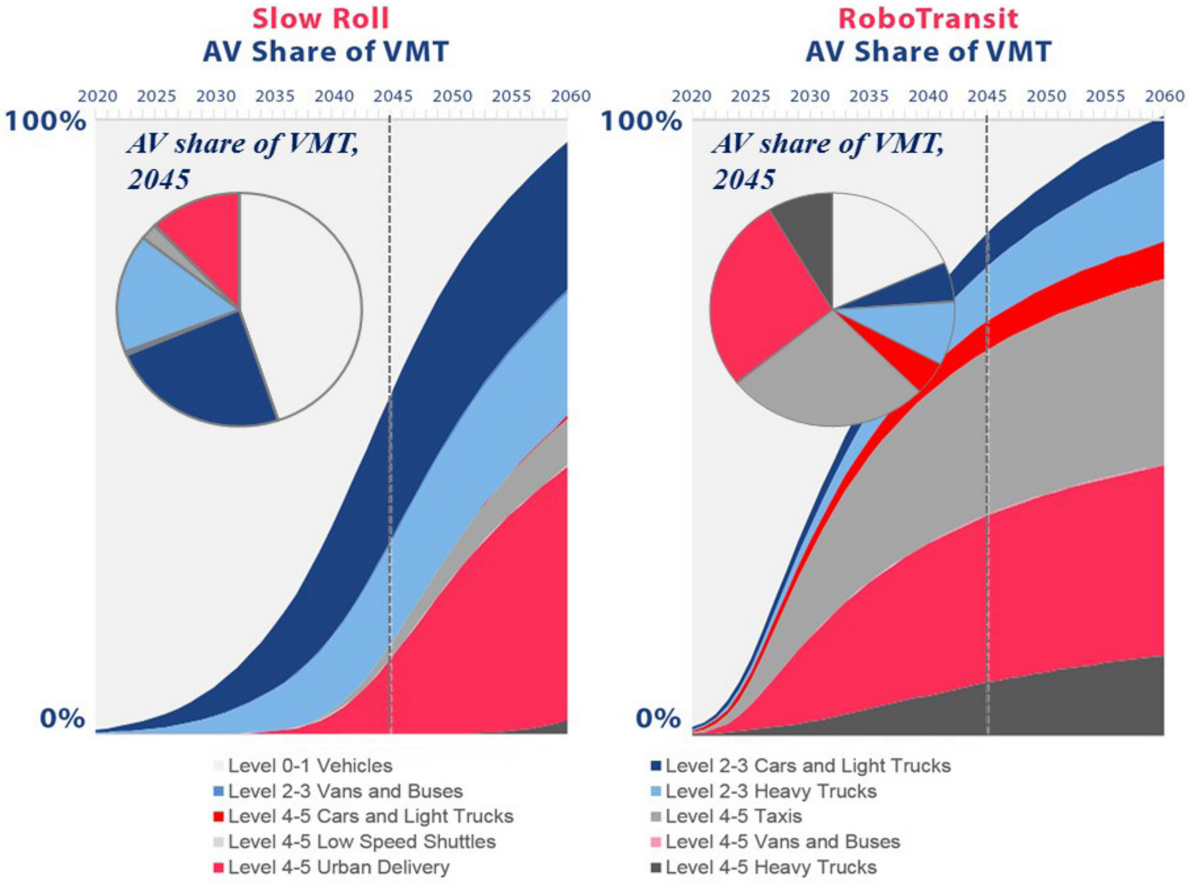


*Figure 9: Illustrative Automation Share of Vehicle Miles Traveled Scenarios*



The scenarios illustrate that even rapid changes in sales market share for a new technology have a gradual impact on the overall fleet composition. A more rapid transition could be possible if technology encourages car owners to sell their vehicles sooner or an abrupt shift in policy were to occur.

### *2.4.2 Regulatory Framework*

The regulatory environment is an additional source of uncertainty in forecasting the rate of adoption. For example, some in the automotive industry have suggested that human driving may come to be seen as irresponsible compared to the safer operation of AVs, leading governments to eventually ban Level 0 and Level 1 vehicles.[z] If this were to occur in the MPO planning horizon, forecasts assuming that AVs represent a gradually rising share of new vehicle sales would prove to be pessimistic.

Regulation may also influence the degree to which AVs contribute to the travel data available for long-range planning and the revenues needed to maintain the transportation system. Centrally managed fleets of AVs provide an attractive opportunity to collect detailed origin-destination travel pattern data by time of day as well as a mechanism to collect fees. An early example of legislation in this area is an automated vehicle use tax in Tennessee based on the number of axles.

### *2.4.3 Planning Implications*

Planning impacts may be comparatively minimal or non-existent from features that support Level 1 and Level 2 automated driving such as adaptive cruise control, lane keeping assist and automated emergency braking (already common on many new vehicles). The same may be true as automakers introduce more advanced Level 3 systems capable of steering, maintaining speed and stopping in certain situations, such as in freeway traffic, on more models every year. In these cases, a human driver is required to take over when the ADAS encounters a situation that it cannot safely manage.

A major shift in the implications of automated vehicles occurs when the human occupant is removed from the vehicle-driving process. When the vehicle can operate without anyone on board, many limitations of the current human-driven mobility system are removed, new business models are possible and potentially transformative and disruptive effects of technology emerge.

This guide recognizes the important distinction between the incremental effects on safety, mobility and convenience that we are experiencing with the Level 2-3 vehicles of today and the more profound effects that Level 4-5 vehicles may bring in the future.

Planning applications of AV technology to different vehicle types are likely to have different effects on road design, VMT, parking, urban form and other planning issues. The presumed ability of AV technology to help older individuals better age “in place” may have Complete Streets implications in terms of planning curbside loading zones, location of benches and other individual mobility comfort considerations. Of course, ultimately the effects that will be experienced will be distinguished by the degree of automation, the ownership of the vehicle, whether a vehicle can reposition itself without a driver on board and whether it is restricted for use by a single owner or available for shared use.

The matrices, in Appendix 3, illustrate which vehicle types are associated with different impacts to help MPOs define the issues to consider in their planning processes based on the relative shares of different technologies and vehicle types in the future vehicle fleet. For example, if a large share of fully automated taxis is expected in the planning horizon, MPOs should work with local agencies to place a greater emphasis on converting parking to other uses such as pick up/drop off zones and planning for major changes to transit systems. In contrast, if automation predominantly takes the form of partially automated personal vehicles, parking impacts may be limited to site design changes such as narrower parking spaces and more emphasis may be placed on developing dedicated lanes on freeways for platooning vehicles.

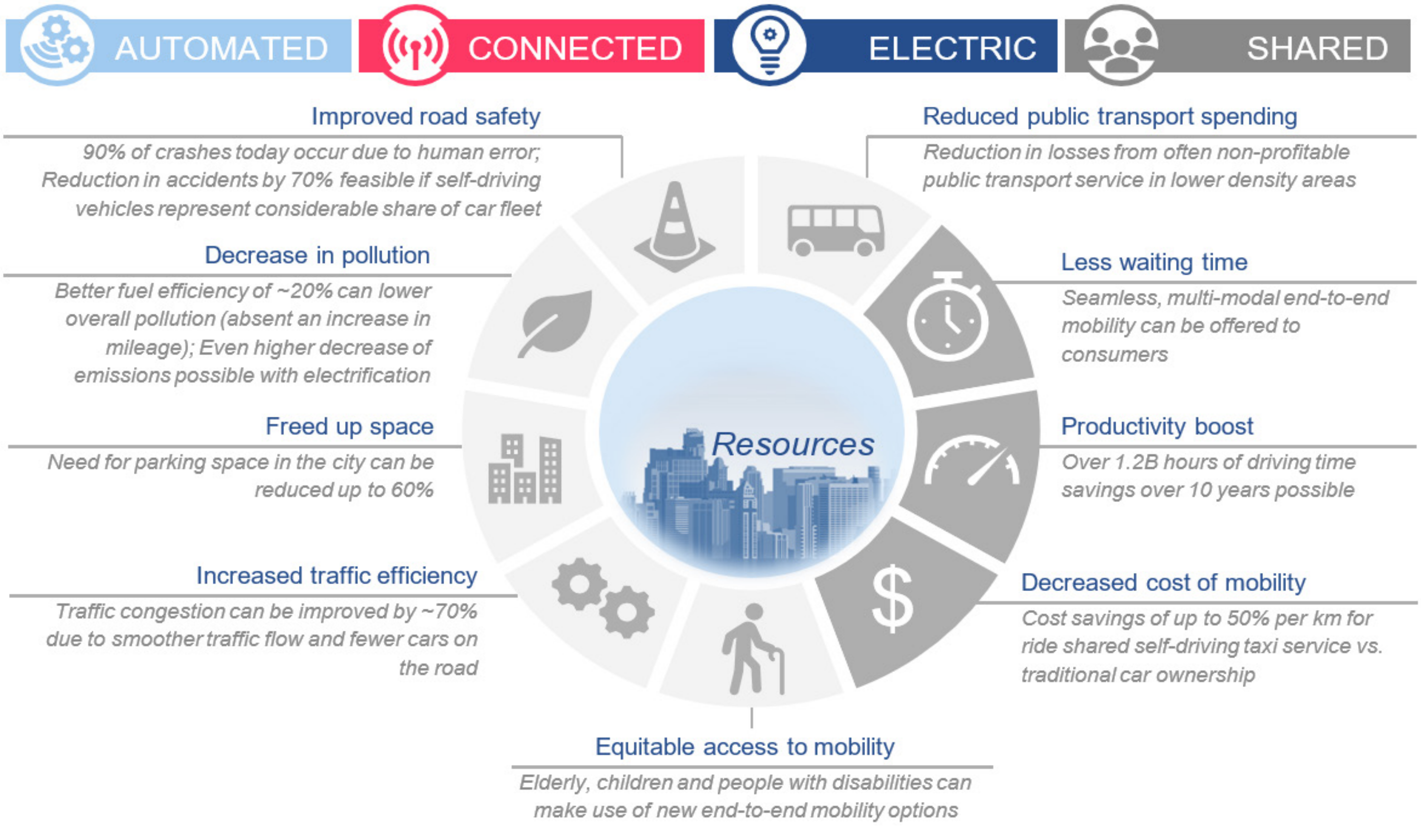
## 2.5 ACES Summary

The ACES technology overview section was presented in reverse order by individual technology to represent the order of anticipated deployment and penetration. However, these technologies will work within one transportation system for each individual user. As a result, when planning for the future, ACES should be thought of together as a set of tools within a common transportation toolbox.

Figure 10, adapted from the Florida DOT Suntrax project, demonstrates how ACES can work together to address common transportation problems. The Suntrax graphic is an excellent example of the comprehensive benefits that are achieved when ACES all work together.

Another viewpoint of ACES potential benefits by common MPO planning factors is a table developed by the Strategies to Advance Automated and Connected Vehicles briefing document (NCHRP 845).[aa] The briefing document outlines how ACES could lead to positive societal outcomes. The table summarizes the level of potential benefit for ACES by driving externality.

*Figure 10: Florida DOT Suntrax ACES Benefits*



Improved road safety

*90% of crashes today occur due to human error; Reduction in accidents by 70% feasible if self-driving vehicles represent considerable share of car fleet*

Decrease in pollution

*Better fuel efficiency of ~20% can lower overall pollution (absent an increase in mileage); Even higher decrease of emissions possible with electrification*

Freed up space

*Need for parking space in the city can be reduced up to 60%*

Increased traffic efficiency

*Traffic congestion can be improved by ~70% due to smoother traffic flow and fewer cars on the road*

Reduced public transport spending

*Reduction in losses from often non-profitable public transport service in lower density areas*

Less waiting time

*Seamless, multi-modal end-to-end mobility can be offered to consumers*

Productivity boost

*Over 1.2B hours of driving time savings over 10 years possible*

Decreased cost of mobility

*Cost savings of up to 50% per km for ride shared self-driving taxi service vs. traditional car ownership*

Equitable access to mobility

*Elderly, children and people with disabilities can make use of new end-to-end mobility options*

*Source: Adapted from FDOT Suntrax project*

*Table 2: Potential Benefits*

| Driving Externality | Connectivity (Full V2X) | Autonomy* (L4, L5) | Shared Autonomy (L4, L5) ** | Electrification *** |
|---|---|---|---|---|
| Safety | ● | ● | ● | ○ |
| Congestion | ● | ◎ | ◐ | ○ |
| Emissions | ◐ | ○ | ○ | ● |
| Land Use | ○ | ◎ | ◐ | ○ |
| Mobility | ○ | ● | ● | ○ |

- ○ *Weakest Benefits / No Impact*
- ◐ *Some Expected Benefits*
- ● *Strong Benefits*
- ◎ *Uncertain Impact*

*Autonomy is defined for this purpose as individually owned vehicle.
**Shared Autonomous Vehicles (SAV) are on-demand self-driving vehicles supporting shared rides as part of a privately or publicly managed fleet.
***While not a focus of this NCHRP research, the team provides assumptions of potential benefits of electrification based on known literature.

# 3. SAFETY IMPACTS

## CHAPTER 3 AT A GLANCE

- **Fatalities in Florida are on the rise.**
- **ACES may help reverse the fatalities trend.**
- **During transition, partial automation may increase risks associated with distracted driving.**

In the U.S. more than 90 people die in car accidents daily. As a result, motor vehicle crashes are among the top ten causes of death among people under 54 years of age.

In Florida, there were 395,785 total crashes in 2016 with 2,935 being fatality crashes representing 3,176 Floridians lives lost.[bb] Floridians saw reductions in fatalities between 2009 and 2014; however, fatalities are currently on the rise again as VMT has continued to increase due to several factors including low gasoline prices. Researchers believe this is a direct result of distracted driving due to increasing smart phone usage among drivers of all ages.[cc]

Automated and connected vehicles use advanced safety technologies to reduce crashes due to driver distraction or other human errors. Some reports project that as many as 90 percent of crashes will be avoided with fully automated vehicles. Until then, many safety experts see partial autonomy as a stop gap against the spike in distracted driving deaths. Studies suggest that universal adoption of existing features like blind spot monitoring, lane departure warning and forward collision warning could eliminate hundreds of thousands of crashes a year, largely on highways. However, other research suggests that partial automated vehicles will make distracted driving worse by lulling drivers into complacency.

It should be noted that automated vehicles may have less impact on the overall safety because they represent only part of the predicted vehicle fleet, even by the year 2045, and cannot mitigate for human-controlled vehicles. As stated in Section 2.4, Automated Vehicles, FHWA has estimated the travel share of automated vehicles could range from about 30 percent to more than 70 percent of total VMT by 2035. If automated vehicles deliver promised improvements in road safety in urban areas as well as highways, they could be a boost to Vision Zero campaigns to eliminate traffic fatalities. But complete automation of urban traffic is likely many decades away.

Automated and connected vehicles may have a positive impact on bicycle and pedestrian safety as well. While automated and connected vehicles have the potential to improve the functioning of the transportation network, one other view is that these vehicles have the potential to make bike and pedestrian travel within urban settings far more complicated and less easily achieved, as pedestrians and bicyclists maneuver within a more dense and complicated roadway system.

Alternatively, because automated and connected vehicles may require less urban space than traditional vehicles (due to efficiency, accuracy, and parking implications) the technology offers some promise for the development of quality, attrative separated bike/pedestrian infrastructure.

*Most safety benefits can be achieved with "Safe Cars" without full automation. Safe Cars use advanced driver assist systems to recognize and warn drivers about pedestrians and cyclists, increase awareness of threats that drivers may not be able to see before it is too late, and apply brakes to prevent a crash in an emergency. CV technology expands the range of situations that such systems can help to mitigate. (Adapted from Professor Alan Kornhauser, Princeton University)*

Other safety benefits such as vehicle platooning are also on the planning horizon. With connected platoon driving, braking is automatic with virtually zero reaction time compared to human braking.

## 3.1 Crash Rates

A significant benefit likely to arise from automated and connected vehicles is the potential reduction of crashes. The Insurance Institute for Highway Safety (IIHS) conducted a study which found that basic forward-collision warning systems attribute to a seven percent reduction in crashes and automatic braking results in a reduction of 14 to 15 percent.[dd] Table 3 provides a summary of the IIHS estimated reduction of various in-vehicle technologies.

More advanced fully self-driving cars are still being tested, which employ smart technology and reduce the likelihood to be involved in a crash. When fully developed, McKinsey and Company notes that advanced driver assistance systems automated vehicles could reduce up to 90 percent of accidents.[ee]

*Table 3: In-Vehicle Technologies and Benefits*

| Technology | Received Benefit |
|---|---|
| Forward collision warning | ▼ 27% Front-to-rear crashes<br>▼ 20% Front-to-rear crashes with injuries<br>▼ 7% Claim rates for damage to other vehicles<br>▼ 14% Claim rates for injuries to people in other vehicles |
| Forward collision warning plus autobrake | ▼ 50% Front-to-rear crashes<br>▼ 56% Front-to-rear crashes with injuries<br>▼ 13% Claim rates for damage to other vehicles<br>▼ 21% Claim rates for injuries to people in other vehicles |
| Lane departure warning | ▼ 11% Single-vehicle, sideswipe and head-on crashes<br>▼ 21% Injury crashes of same types |
| Blind spot detection | ▼ 14% Lane-change crashes<br>▼ 23% Lane-change crashes with injuries<br>▼ 9% Claim rates for damage to other vehicles<br>▼ 12% Claim rates for injuries to people in other vehicles |
| Rear automatic braking | ▼ 62% Backing crashes<br>▼ 13% Claim rates for damage to the insured vehicle<br>▼ 26% Claim rates for damage to other vehicles |
| Rearview cameras | ▼ 17% Backing crashes |
| Rear cross-traffic alert | ▼ 22% Backing crashes |

*Source: IIHS*

## 3.2 Crash Costs

The cost of motor-vehicle deaths, injuries and property damage in the US in 2016 was $432.5 billion crashes (a nine percent increase over the first six months of 2016 compared to 2015).[ff] In Florida, crash costs are significant to society.[gg] FDOT has calculated the cost of a crash as shown in Table 4.

*Table 4: 2014 FDOT Crash Costs*

| Crash Severity | Comprehensibe Crash Data |
|---|---|
| Fatal (K) | $10,100,000 |
| Severe Injury (A) | $818,636 |
| Moderate Injury (B) | $163,254 |
| Minor Injury (C) | $99,645 |
| Property Damage Only (O) | $6,500 |

*Source: FDOT Crash Analysis Reporting (G.A.R. System)*

As the table shows, fatality crashes cost approximately 10 times all other crashes combined. In Florida, in 2013, crash deaths resulted in $3.02 billion in medical and work loss costs.[hh] If 90 percent of the human cause crashes can be eliminated because of automated and connected technologies, more than $2.7 billion societal costs are estimated to be eliminated annually (based on latest available data from 2013).

## 3.3 Infrastructure Resilience Considerations

Transportation infrastructure increasingly faces potentially significant vulnerabilities stemming from age, budget constraints, population growth, growing reliance on existing and emerging technologies and other factors that may hamper local, state or national networks' abilities to withstand natural and human-made disruptions.

In Florida, for example, state and local transportation networks have to be robust enough to survive and operate adequately before, during and after severe meteorological events such as tornadoes and hurricanes. They must be able to provide adequate levels of service to pre-position disaster relief supplies and personnel; provide for safe, time-sensitive evacuations; and, as technology plays an increasingly large role in transportation now and in an ACES future, include sufficient systemwide redundancy and flexibility to be able to continue functioning even during a such an event (including maintaining the ability of ACES technologies to maintain power, radio and Wi-Fi access, among others). The widespread use of Shared Use vehicles instead of personally owned vehicles may introduce a new planning challenge for events such as a hurricane evacuation. Having a finger on the pulse of the the proliferation of shared use vehicle supply may influence evacuation decision notification timeframes and event staging needs.

Based on local conditions and scenario planning, individual MPOs will need to consider short and long-range policies and projects that can help produce a resilient local transportation system that, as the U.S. DOT's Volpe Center described in "Beyond Bouncing Back: Critical Transportation Infrastructure Resilience"[ii]

> *"...has design-level robustness so that it can withstand severe blows; it is adaptable so that it can respond appropriately to threats and it can mitigate the consequences of threats through response and recovery operations."*

This may require Florida MPOs to plan significant redundancies into their local networks, partner with ACES manufacturers to develop event "insensitive" technologies or workarounds and work with local officials and stakeholders to build support for adequately programming transportation investments in system robustness, adaptability and harm mitigation.

# 4. TRAVEL DEMAND IMPACTS

## CHAPTER 4 AT A GLANCE

- **Terminal Times, Friction Factors, and Modifying the Trip Table are Three Areas for Modifying the Travel Demand Models to Account for ACES technologies.**
- **Different model complexities produce a wide variety of results within travel demand models using the six integration scenarios.**
- **ACES technologies can lead to increased VMT and VHT, but also result in higher network speeds.**

The Gainesville Urbanized Area Transportation Model (GUATS) and Central Florida Regional Planning Model (CFRPM) four-step travel demand models were chosen for testing as they represent two different size MPO models and complexities as described below. The model years used for this analysis are 2040 as both models have 2040 data sets.

The GUATS model has a base year of 2010 and horizon year of 2040. The model covers the small urbanized area of Gainesville, Florida. The GUATS model area contains the University of Florida (UF) and Sante Fe College (SFC) as well as many medical facilities associated with the Shands UF teaching hospital. GUATS also includes local transit, bicycle and walking trips. This model was chosen for its smaller population as well as its mix of modes and colleges.

The CFRPM version 6.1 has a base year of 2010 and horizon year of 2045 with data sets for every five years from 2010 to 2045. The model covers several urban MPO areas including 11 counties. These include the nine counties of FDOT District 5 (Brevard, Flagler, Lake, Marion, Orange, Osceola, Seminole, Sumter, and Volusia) and all of Polk County and part of Indian River County. The CFRPM includes the tourist areas of Disney World, Universal Studios as well as a few smaller attractions. This model has several transit providers, special trip purposes, several toll facilities as well as complex trip distribution, mode choice and assignment models. This model was chosen for its complexity, size and mix of both travel modes and populations.

## 4.1 Travel Demand Modeling

The six FHWA Draft Scenarios shown in Figure 3: FHWA 2035 CV/AV Scenarios and explained in section 8.2.3 FHWA ACES Scenarios were tested in both the GUATS and CFRPM models. The modifications performed on both models by step in the model chain include changes to terminal times, friction factors, roadway capacities and trip tables. Table 5: ACES Potential Scenarios: Travel Demand Model Modifications describes the modifications. These are intended to help guide users on modifications and are not intended to be the only values or factors that can be modified to reflect ACES impacts.

Terminal times vary by area type and represent impedances at both ends of a trip, such as the amount of time required to walk to and from a transit mode, to park or access a parked car, or to pay parking cost. These durations are added to both the origin and the destination end of a trip. Terminal times are typically estimated as a function of population and employment density within a traffic zone or district. With an increase in automated vehicles, it is expected that terminal times will be reduced as the vehicle will pick up/drop off passengers as close to their origin/destination as possible and either leave for another fare or go park itself. Reductions to both the Central Business District (CBD) and CBD Fringe area types of 1 minute for the Slow Ride and Ultimate Traveler Assist scenarios and 2 minutes for all other scenarios were tested. It is anticipated that the initial highest penetration rates of automated vehicle usage will be in these areas since most CBDs have remote parking in either parking garages or surface lots and CBD Fringe areas also have some remote parking.

Friction Factors are parameters used in the gravity model portion of trip distribution to account for travel time separation between zones. They are impedance factors that enable the gravity model to distribute trips to the traffic analysis zones based on impedance between the traffic analysis zones. Friction factors are used to replicate observed trip length frequency distributions. With the increase in use of automated vehicles, it is assumed that passengers on certain types of trips will accept longer trip lengths since they can be doing things other than driving. To simulate this, Home Based Work (HBW) trip purpose friction factors of the two models were modified. Two sets of friction factors were created, one with HBW increased by 2.5 percent and the other by 5 percent. These percentages were chosen based on a slight increase (2.5 percent) in use of longer distance automated vehicles and a larger increase (5 percent) of AV use influencing housing locations away from employment.

An increase, decrease, or shift in trips is also possible depending on the manner in which automated and connected vehicles are used in an area. The modification of model produced trip tables is a method for taking this into account. The model produces trips tables that include all trips forecasted in the model area. It is anticipated that there could be increases in trips due to the use of automated vehicles by people who currently can't drive such as those younger than legal driving age, the elderly or the disabled. This could also be seen as a shift from transit based trips to automobile based trips. Modifying the trip table by factoring or shifting trips is a way to accommodate these types of trips. It is also possible that certain areas like downtown business districts or multiuse areas that contain housing and employment could have special automated vehicle areas. These areas would also exhibit increased trips as the vehicles would not only be picking up and dropping off passengers, but also be repositioning for the next fare if they are for hire.

Another method employed to consider the effects of automated and connected vehicles in the model is the modification of roadway capacities. It is assumed that as more automated and connected vehicles are on the roadway network that there could be less congestion through density balancing or more roadway capacity. This takes two forms with automated vehicles; the more automated vehicles that are on the road will lead to smaller gaps or distances between vehicles, thus allowing more vehicles on the road. With connected vehicles, the more vehicles that have travel information on congestion will result in more vehicles rerouting or choosing another time to travel, thus lessening or balancing congestion. One of the ways to simulate this in travel demand models is to adjust the capacities of the roads in the model. Freeways or limited access facilities will likely see an increase in capacity before other facilities due to fewer conflict points. The models use lookup functions to create their roadway link capacities. Modifications to those tables were performed to take into account an increase in capacity and are explained in more detail in Chapter 5.

## 4.2 Summary of Results

In order to compare the results of each model run, Vehicle Miles of Travel (VMT), Vehicle Hours of Travel (VHT) and both Network Original Speed and Network Congested Speed were reported by scenario. Tables 6 and 7 show the results of the model runs for each scenario. As expected, there are increases in VMT with more automated and connected vehicles except for the Ultimate Traveler Assist scenario where VMT decreases due to more efficient travel routes being used as a result of better real-time information. There is also a decrease in overall travel speed in the Competing Fleets scenario due to fleet vehicles repositioning and waiting on fares. There are also some variances in results from each model. For example, the Robo Transit scenario shows a decrease in VHT in the GUATS model but a significant increase in VHT in the CFRPM. This is due to more transit usage in the CFRPM being shifted to the Robo Transit as well as more induced trips overall in the model due to more trips being taken by those who can't drive.

## 4.3 Other Travel Demand Modeling Considerations

Evaluation of socioeconomic data relating to age, income, disability and other factors can also be performed to see if there are specific zones whose characteristics would lead to increased automated vehicle usage at an accelerated rate compared to other areas in the regional model. Additional research on the effects of capacities on arterials with the integration of smart connected signals can also produce more refined capacity results. Finally, additional regional travel characteristics surveys should include questions relating propensity to use to autonomous vehicles and if their use would affect value of time so it can be represented in the Toll or Value of Time (VOT) input of the travel demand model.

*Table 5: ACES Potential Scenarios: Travel Demand Model Modifications*

| | *Model Step* | | |
|---|---|---|---|
| | *Network* | *Trip Distribution* | *Mode Choice* |
| **Slow Roll**<br>*Minimum plausible change - Nothing beyond currently available technology and investments already in motion is adopted.*<br>*(Baseline for comparison)* | No changes | Decrease of 1 minute in Terminal Times in Central Business District and Fringe Areas. Increase of 2.5% in impedance Friction Factors for HBW to obtain longer trip lengths. | Auto Trip Table Factored by 2.5% to take into account non driving trips that are now using AV. Shift of 5% of transit trips to AV. |
| **Niche Service Growth**<br>*Innovation proliferates, but only in special purpose or "niche" AV zones, including retirement communities, campuses, transit corridors, urban cores, and ports.* | Increase in AV Zone roadway Capacities in Area Types 10-29 for Facility Types 10-19 of 33% and Area Types 10-39 for Facility Types 20-29 of 15%. | Decrease of 2 minutes in Terminal Times in Central Business District and Fringe Areas. Increase of 2.5% in impedance Friction Factors for HBW to obtain longer trip lengths. | Auto Trip Table Factored by 2.5% to take into account non driving trips that are now using AV and by 5% in AV Zones. |
| **Ultimate Traveler Assist**<br>*CV technology progresses rapidly, but AV stagnates – 85% of vehicles have V2X capability by 2035 due to NHTSA mandate allowing DOTs to manage congestion aggressively.* | Increase in Freeway & Arterial Capacities due to more efficient trip planning. Increased capacities in Area Types 10-59 for Facility Types 10-19 of 75% and Area Types 10-59 for Facility Types 20-39 of 35%. | Decrease of 1 minute in Terminal Times in Central Business District and Fringe Areas. | Auto Trip Table Factored by 2.5% to take into account non driving trips that are now using AV. |
| **Managed Automated Lane Network**<br>*Certain lanes become integrated with CV and AV – 50-60% of vehicles (75% of trucks) have automation capability for platooning in controlled settings.* | Special AV Lanes. Increase in Freeway & Arterial Capacities. Use of HOV lanes for AV only on Freeways in CFRPM (not in GUATS). Increased capacities in Area Types 10-59 for Facility Types 10-19 of 75% and Area Types 10-39 for Facility Types 20-39 of 35%. | Decrease of 2 minutes in Terminal Times in Central Business District and Fringe Areas. | Trip Table Factored by 2.5% to take into account non driving trips that are now using AV and by 5% to take into account increases on AV lanes. |
| **Competing Fleets**<br>*Automated TNC-like services proliferate rapidly, but do not operate cooperatively. VMT doubles due to induced demand and empty vehicle repositioning.* | Increase in Freeway Capacity in Area Types 10-59 for Facility Types 10-19 of 50%. | Decrease of 2 minutes in Terminal Times in Central Business District and Fringe Areas. Increase of 2.5% in impedance Friction Factors for HBW to obtain longer trip lengths. | Trip Table Factored by 2.5% to take into account non driving trips that are now using AV and by 7.5% in to take into account the AV Fleets. |
| **Robo Transit**<br>*On-demand shared services proliferate and integrate with other modes via cooperative data sharing, policies, and infrastructure.* | Increase in Freeway & Arterial Capacities due to more efficient trip planning. Increased capacities in Area Types 10-59 for Facility Types 10-19 of 75% and Area Types 10-59 for Facility Types 20-39 of 35%. | Decrease of 2 minutes in Terminal Times in Central Business District and Fringe Areas. Increase of 5% in impedance Friction Factors for HBW to obtain longer trip lengths. | Trip Table Factored by 2.5% to take into account non driving trips that are now using AV and by 12.5% to take into account Robo Transit. |

*Table 6: Scenario Results - GUATS Model*

| | *Measure* | | | |
|---|---|---|---|---|
| | *VMT (Millions)* | *VHT (Thousands)* | *Network Original Speed* | *Network Congested Speed* |
| **Cost Feasible** | 11.72 | 373.39 | 29.65 | 26.60 |
| **Slow Roll** | 11.96 | 391.77 | 29.65 | 26.42 |
| *Percent Change (%)* | *2.05* | *4.92* | *-* | *-0.68* |
| **Niche Service Growth** | 11.92 | 381.82 | 29.65 | 26.66 |
| *Percent Change (%)* | *1.71* | *2.26* | *-* | *0.23* |
| **Ultimate Traveler Assist** | 11.64 | 340.59 | 29.65 | 27.76 |
| *Percent Change (%)* | *-0.68* | *-8.78* | *-* | *4.36* |
| **Managed Automated Lane Network** | 11.76 | 340.40 | 29.65 | 27.69 |
| *Percent Change (%)* | *0.34* | *-8.84* | *-* | *4.10* |
| **Competing Fleets** | 12.14 | 396.98 | 29.65 | 26.30 |
| *Percent Change (%)* | *3.58* | *6.32* | *-* | *-1.13* |
| **Robo Transit** | 12.19 | 360.62 | 29.65 | 27.44 |
| *Percent Change (%)* | *4.01* | *-3.42* | *-* | *3.16* |

*Table 7: Scenario Results - CFRPM Model*

| | *Measure* | | | |
|---|---|---|---|---|
| | *VMT (Millions)* | *VHT (Thousands)* | *Network Original Speed* | *Network Congested Speed* |
| **Cost Feasible** | 177.72 | 5,513.11 | 41.44 | 36.14 |
| **Slow Roll** | 188.62 | 6,465.28 | 41.44 | 35.45 |
| *Percent Change (%)* | *6.12* | *17.27* | *-* | *-1.91* |
| **Niche Service Growth** | 187.87 | 6,203.48 | 41.44 | 35.47 |
| *Percent Change (%)* | *5.71* | *12.52* | *-* | *-1.85* |
| **Ultimate Traveler Assist** | 189.07 | 5,707.27 | 41.44 | 37.58 |
| *Percent Change (%)* | *6.39* | *3.52* | *-* | *3.98* |
| **Managed Automated Lane Network** | 194.43 | 6,021.60 | 41.44 | 37.29 |
| *Percent Change (%)* | *9.40* | *9.22* | *-* | *3.18* |
| **Competing Fleets** | 198.01 | 7,100.14 | 41.44 | 35.20 |
| *Percent Change (%)* | *11.42* | *28.79* | *-* | *-2.60* |
| **Robo Transit** | 203.29 | 6,901.49 | 41.44 | 36.72 |
| *Percent Change (%)* | *14.39* | *25.18* | *-* | *1.60* |

# 5. ROADWAY SYSTEM IMPACTS

## CHAPTER 5 AT A GLANCE

- **ACES technologies can lead to increases in VMT over 30 percent.**
- **ACES technology can also lessen VHT nearly 10 percent.**
- **Arterial and Freeway network speeds can vary between 5-10 percent for arterials and 6-14 percent for freeways.**

The impacts of ACES on the roadway system can be significant. This section looks at changes based on freeway and arterial lane capacities and the results of those changes measured by the changes in VMT, VHT and original and congested speeds on those facilities.

## 5.1 Freeway Lane Capacity

Freeway lane capacity is expected to increase faster and greater than other facilities due to the geometrics of freeway systems, their limited access, and the implications of changes in following distance based on connected and automated vehicles in the fleet. Mahmassani stated in 2016 it can be expected that there will be reductions from the standard 146 feet to 73 feet based on more connected and automated vehicles in the vehicle mix. As such, increases in capacity of 33 percent, 50 percent and 75 percent were applied. Since the adoption rates of automated and connected vehicles is something that individual areas will need to decide for themselves, 3 levels of increases based on slow (33 percent), moderate (50 percent) and fast (75 percent) adoption rates were analyzed. These capacities are shown in Table 5: ACES Potential Scenarios: Travel Demand Model Modifications.

## 5.2 Dedicated Freeway Lanes

The inclusion of dedicated freeway lanes in the models was accomplished by increasing capacity on the general freeway lanes as a proxy for the dedicated lanes. The results are shown in Tables 8 and 9.

## 5.3 Arterial Lane Capacity

Arterial lane capacity is expected to increase to a lesser degree than freeway facilities due to the increased number of conflict points and pedestrian crossings along a roadway segment. Variable increases in capacity of 15 percent, 35 percent and 50 percent as shown in Table 5: ACES Potential Scenarios: Travel Demand Model Modifications were applied. As with freeways, since the adoption rates of automated and connected vehicles is something that individual areas will need to decide for themselves, 3 levels of increases based on slow (15 percent), moderate (35 percent) and fast (50 percent) adoption rates were analyzed. These capacities were chosen as they lag behind the freeways with the exception of the Competing Fleets scenario which was tested at 50 percent, similar to freeways.

## 5.4 Dedicated Arterial Lanes

The inclusion of dedicated arterial lanes was accomplished by increasing the capacity of divided arterials in specific areas. The results are shown in Tables 10 and 11.

## 5.5 Summary of Results

Using the same statistics that were included in Chapter 4 (VMT, VHT, Network Original and Congested Speeds) for each scenario, the results of each scenario's model run were extracted for just Freeways and Divided Arterials and are shown in Tables 8 through 10. As expected, there are increases in VMT with more automated and connected vehicles and more significant increases seen in the CFRPM model as a result of the larger model. An increase in overall travel speeds are observed in four scenarios with the Slow Roll and Niche Service Growth scenarios showing decreases which are most like due to lack of market share in the Slow Roll scenario and lack of coordination in the Niche Service Growth scenario. It is important to note that there are some variances in results from each model. For example, several scenarios shows a decrease in Freeway VHT in the GUATS model but a significant increase in VHT in the CFRPM model. This is likely due to the lack of Freeway facilities in the GUATS model and a large number of freeway facilities in the CFRPM model.

For arterials, both models show a decrease in VHT and increases in speeds for the Ultimate Traveler Assist and Managed Automated Lane Network scenarios. The Robo Transit Scenario shows the largest increase in VMT and moderate increase in congested speeds.

MPOs should consider looking at ranges when taking into account automated, connected and shared vehicle usage. Although the six FHWA scenarios were tested with values that seemed reasonable based on available information and professional judgement, MPOs should consider their specific area demographics and economics when testing values.

*Table 8: Freeway Lanes - GUATS Model*

| | *Measure* | | | |
|---|---|---|---|---|
| | *VMT (Millions)* | *VHT (Thousands)* | *Network Original Speed* | *Network Congested Speed* |
| **Cost Feasible** | 2.590 | 0.434 | 68.52 | 60.84 |
| **Slow Roll** | 2.617 | 0.444 | 68.52 | 60.32 |
| *Percent Change (%)* | *1.04* | *2.3* | - | *-0.85* |
| **Niche Service Growth** | 2.597 | 0.436 | 68.52 | 60.7 |
| *Percent Change (%)* | *0.27* | *0.46* | - | *-0.23* |
| **Ultimate Traveler Assist** | 2.667 | 0.392 | 68.52 | 68.23 |
| *Percent Change (%)* | *2.97* | *-9.68* | - | *12.15* |
| **Managed Automated Lane Network** | 2.678 | 0.394 | 68.52 | 68.22 |
| *Percent Change (%)* | *3.4* | *-9.22* | - | *12.13* |
| **Competing Fleets** | 2.720 | 0.405 | 68.52 | 67.6 |
| *Percent Change (%)* | *5.02* | *-6.68* | - | *11.11* |
| **Robo Transit** | 2.712 | 0.400 | 68.52 | 68.19 |
| *Percent Change (%)* | *4.71* | *-7.83* | - | *12.08* |

*Table 9: Freeway Lanes - CFRPM Model*

| | *Measure* | | | |
|---|---|---|---|---|
| | *VMT (Millions)* | *VHT (Thousands)* | *Network Original Speed* | *Network Congested Speed* |
| **Cost Feasible** | 28.489 | 714.845 | 66.81 | 51.23 |
| **Slow Roll** | 30.100 | 783.478 | 66.81 | 48.78 |
| *Percent Change (%)* | *5.65* | *9.6* | - | *-4.78* |
| **Niche Service Growth** | 30.288 | 766.231 | 66.81 | 49.86 |
| *Percent Change (%)* | *6.31* | *7.19* | - | *-2.67* |
| **Ultimate Traveler Assist** | 38.228 | 729.226 | 66.81 | 58.55 |
| *Percent Change (%)* | *34.19* | *2.01* | - | *14.29* |
| **Managed Automated Lane Network** | 38.778 | 756.5 | 66.81 | 58.05 |
| *Percent Change (%)* | *36.12* | *5.83* | - | *13.31* |
| **Competing Fleets** | 37.671 | 811.433 | 66.81 | 54.63 |
| *Percent Change (%)* | *32.23* | *13.51* | - | *6.64* |
| **Robo Transit** | 39.554 | 792.584 | 66.81 | 57.34 |
| *Percent Change (%)* | *38.84* | *10.87* | - | *11.93* |

Table 10: Arterial Lanes - GUATS Model

| | Measure | | | |
|---|---|---|---|---|
| | VMT (Millions) | VHT (Thousands) | Network Original Speed | Network Congested Speed |
| **Cost Feasible** | 4.44 | 1.368 | 44.94 | 41.25 |
| **Slow Roll** | 4.57 | 1.5 | 44.94 | 40.75 |
| *Percent Change (%)* | *2.93* | *9.65* | *-* | *-1.21* |
| **Niche Service Growth** | 4.63 | 1.443 | 44.94 | 41.41 |
| *Percent Change (%)* | *4.28* | *5.48* | *-* | *0.39* |
| **Ultimate Traveler Assist** | 4.54 | 1.233 | 44.94 | 43.35 |
| *Percent Change (%)* | *2.25* | *-9.87* | *-* | *5.09* |
| **Managed Automated Lane Network** | 4.59 | 1.258 | 44.94 | 43.29 |
| *Percent Change (%)* | *3.38* | *-8.04* | *-* | *4.95* |
| **Competing Fleets** | 4.57 | 1.504 | 44.94 | 40.76 |
| *Percent Change (%)* | *2.93* | *9.94* | *-* | *-1.19* |
| **Robo Transit** | 4.83 | 1.357 | 44.94 | 42.95 |
| *Percent Change (%)* | *8.78* | *-0.8* | *-* | *4.12* |

Table 11: Arterial Lanes - CFRPM Model

| | Measure | | | |
|---|---|---|---|---|
| | VMT (Millions) | VHT (Thousands) | Network Original Speed | Network Congested Speed |
| **Cost Feasible** | 63.365 | 2,161.507 | 42.48 | 33.81 |
| **Slow Roll** | 66.949 | 2,320.139 | 42.48 | 33.36 |
| *Percent Change (%)* | *5.66* | *7.34* | *-* | *-1.33* |
| **Niche Service Growth** | 69.034 | 2,262.616 | 42.48 | 34.47 |
| *Percent Change (%)* | *8.95* | *4.68* | *-* | *1.95* |
| **Ultimate Traveler Assist** | 71.352 | 2,052.204 | 42.48 | 37.19 |
| *Percent Change (%)* | *12.6* | *-5.06* | *-* | *10* |
| **Managed Automated Lane Network** | 73.331 | 2,155.239 | 42.48 | 36.79 |
| *Percent Change (%)* | *15.73* | *-0.29* | *-* | *8.81* |
| **Competing Fleets** | 67.688 | 2,441.115 | 42.48 | 32.9 |
| *Percent Change (%)* | *6.82* | *12.94* | *-* | *-2.69* |
| **Robo Transit** | 76.63 | 2,352.04 | 42.48 | 36.72 |
| *Percent Change (%)* | *20.93* | *8.81* | *-* | *8.61* |

# 6. TRANSIT SYSTEM IMPACTS

## *CHAPTER 6 AT A GLANCE*

- **ACES has the potential to disrupt the transit industry by reducing demand for traditional services while simultaneously creating opportunities for more cost effective and customer friendly service.**
- **MPOs are in a unique position to help local transit agencies adapt by focusing on high quality services in major corridors and transforming into "mobility managers" that broker trips using multiple modes and providers across a metropolitan area.**

Between 2012 and 2016, ridership on fixed route bus services across the United States fell by more than seven percent.[jj] The American Public Transportation Association (APTA) attributes the decline to several factors, including erosion of time competitiveness, erosion of cost competitiveness and rising automobile ownership.[kk] Several factors may have led to the rising levels of automobile ownership including a strong economy allowing more people to afford personal automobiles, therefore transferring them off traditional fixed-route services.

All of these factors can be associated in part with the rise of shared use mobility services, particularly ride sourcing platforms such as Uber and Lyft. Apps have made it possible to avoid long wait times and circuitous bus routes, especially at off-peak times. As TNCs have introduced shared ride services, such as UberPool and Lyft Line, fares have approached those of urban bus services. TNCs are also aggregating pick-up and drop-off locations in major urban corridors to make shared ride services more time-competitive, increase vehicle utilization and reduce fare cost. At the same time, driving for a TNC has made it possible for some to own a car who previously relied on public transit to get around.

*Figure 11: uberPOOL Advertisement*

Ride sourcing can *complement* and *compete* with transit

During the same period, ridership on fixed guideway transit services, including heavy rail, light rail and commuter rail, grew by about two percent. Some of this rise has been attributed to the complementary nature of line-haul trunk route services and flexible "first-mile / last-mile" services made more effective by shared use mobility services. This pattern also suggests that urban dwellers continue to value premium transit services that offer high quality passenger amenities, travel time reliability and ease of use.

Although some have speculated that shared mobility services using automated vehicles could make public transportation obsolete, many suggest that a more nuanced impact is likely.[ll] [mm] [nn] [oo] In this scenario, the transit industry reacts to disruption by focusing on high quality services in major corridors, using flexible services and partnerships when and where demand is more diffuse, transforming into "mobility managers" that broker trips using multiple modes and providers across a metropolitan area, applying advances in automation to make its own fixed route services more effective, and facilitating the development of seamless transportation networks that make it possible for many households to live without reliance on a personal automobile. This section explores each of these strategies in more detail, focusing on actions that MPOs can take as they conduct their community-specific planning processes.

## 6.1 Fixed Route Service Competitiveness

If shared automated vehicle mobility services are successful in reducing travel costs to less than the cost of bus fare while offering door-to-door convenience and short wait times, the ridership decline since the widespread introduction of TNCs in 2012-2015 could be just the beginning of a long period of adjustment for traditional bus services. As ridership falls, public support for continued or increasing subsidies could deteriorate.

Every fixed route transit system offers a combination of relatively higher productivity routes (typically measured by passenger boardings per vehicle revenue hour) in major corridors and lower productivity routes that provide "coverage" in other parts of the service area and at off-peak times. The trade-off between allocating resources between the highest productivity routes and providing a minimum level of service to taxpayers across the service area creates the principal tension in transit service planning. Each community determines for itself, frequently through a public planning process, how to reconcile these competing interests.

The introduction of shared mobility platforms, whether operated by a TNC, by a transit provider or through a partnership, creates an opportunity to achieve a more cost-effective balance between areas and times where ridership demand is concentrated and where it is dispersed. Many partnerships between transit agencies and TNCs have focused on certain markets in which fixed route transit is less effective:

- ***First and Last Mile –*** In less walkable areas, TNCs can provide short trips within designated areas. This can extend the reach of existing fixed route services, eliminate the need for certain fixed route shuttles, and expand transit coverage throughout an area. Driverless shuttles provide a new option for short-distance services in campuses and other areas where small low-speed vehicles can operate.

  *Example: Altamonte Springs, Florida –* The City partnered with Uber to subsidize rides beginning and ending in the city.[pp] The partnership was developed as a lower-cost alternative to a proposed demand-responsive flex-route bus service. By providing an alternative to park-and-ride for "first and last mile" connections, the program also aims to encourage ridership on SunRail, the commuter rail line to Orlando.

- ***Nights and Weekends –*** At off-peak times, TNCs can provide door-to-door trips that may or may not include segments on fixed route transit. This could improve customer convenience and reduce transit agency operating costs where demand is not sufficient to support 24/7 transit service. TNCs may also be used to provide ADA services at lower cost per trip, however ADA compliance and accessibility should be a priority for vehicles and pick-up locations.

  *Example: Pinellas Suncoast Transit Authority (PSTA) –* In Pinellas County, the transit agency partnered with Uber and United Taxi to offer free overnight (9 p.m. to 6 a.m.) rides to eligible low-income customers.[qq] The program is aimed at helping workers travel to and from service-sector jobs, many of which end or begin when transit does not operate. PSTA is serving as the central coordinator and dispatcher of these on-call services. As an alternative to requesting a ride through a smartphone app, which is often cited as a barrier to TNC services for individuals who do not have access to a smartphone, riders may call a transit dispatch telephone number.

- ***Underserved Areas –*** In partnership with a transit agency via an integrated trip planning platform, TNCs can provide service in the parts of a metropolitan area that remain beyond the reach of fixed route service.

- ***ADA Paratransit –*** TNCs may also be used to provide ADA services at lower cost per trip due to the use of non-dedicated drivers and vehicles which allows for greater productivity and cost effectiveness. However, ADA compliance and accessibility should be a priority for vehicles and pick-up locations.

  *Example: Kansas City Area Transportation Authority (KCATA) –* KCATA is the primary fixed-route transit provider in the Kansas City area and contracts an on-demand paratransit program with a local transportation service company. The on-demand program supplements the agency's ADA-compliant complementary paratransit and non-ADA services under their "RideKC Freedom" program. In addition to the same day reservations, the service is available 24 hours a day, seven days a week, within a designated area and agency is looking to expand the service area.[rr]

To support decision-makers as they consider how much fixed route transit service is appropriate in their community, MPOs or transit agencies can evaluate the relative competitiveness of existing transit services at a trip level of detail (e.g. the 7:30 a.m. southbound departure of Route X) under a range of transit and shared-use AV fare cost scenarios using available data on ridership, timetables, operating costs and fare revenues. Because of the broad range of stakeholders with interests in urban mobility, there are a range of valid viewpoints from which the question of relative performance could be assessed. Some of the perspectives may include:

*Society*
Would society be better off if the bus route were replaced by shared AVs?
*(Transit user cost, emissions cost and crash cost vs. shared AV costs)*

*Agency*
Could the resources spent on the bus route be better used elsewhere in the system?
*(Route productivity in passengers per vehicle revenue hour vs. system average)*

*Taxpayer*
Would it be cheaper to pay every bus rider's shared AV fare?
*(Transit subsidy per passenger vs. SAV fare cost)*

*Customer*
Would I be better off taking a shared AV for my trip than the bus?
*(Transit value of travel time and out-of-pocket fare cost vs. SAV travel cost)*

This analysis can identify corridors where fixed route transit services may provide durable value into an automated mobility future. After these corridors have been identified, a strategic planning process for transit can then identify how to focus capital investment and operating resources in these corridors, ensure the availability of affordable mobility services elsewhere (whether provided by an existing transit agency, a private provider or TNC platform, or some partnership), manage impacts of automation on organized labor, and secure the appropriate level of public funding required to sustain the transit agency.

FDOT collaborated with Florida State University on an Autonomous Vehicle Policy Guide for Public Transportation in Florida MPOs which provides additional policy recommendations and considerations related to automation and transit system impacts including land use, infrastructure, coordination, safety, funding, liability, licensing and registration, and ADA compliance.[ss]

## 6.2 Paratransit

By incorporating accessible vehicles in their fleet of available vehicles through partnerships with special service providers, TNCs can relieve transit agencies of some of the burden of providing paratransit services. In some cases, partnerships can enhance existing public dial-a-ride services with the convenience of real-time reservations.

> *Example:*
> Massachusetts Bay Transportation Authority On-Demand Paratransit Pilot Program – In Boston, the transit agency conducted a one-year pilot program that allowed paratransit customers to reserve rides on Uber and Lyft in real-time, avoiding the agency's 24-hour reservation requirement and its 30-minute pickup window requirement. Reservations are made by smartphone app or phone call. Customers pay the first $2 of each ride, with the next $13 paid by the MBTA. After $15, riders are responsible for further charges.[tt] The pilot was reportedly successful in reducing customer costs by 80 percent, reducing trip times by an average of 34 minutes and increasing trips by 28 percent while reducing agency costs by more than 6 percent.

MPOs can facilitate or support efforts by transit agencies to introduce new reservation and dispatching technology to improve customer service, reduce costs and address mobility needs in their communities.

## 6.3 Integrated Payment

The location-aware smartphone apps that have made ride sourcing possible also allow regional transportation agencies, such as MPOs or transit providers, to emerge as "mobility managers" matching travelers with available transportation assets across modes and operators. In a CV future, such services could be the key to optimally spreading traffic across the transportation network using itinerary routing and pricing incentives to reduce congestion and delay.

Transit agencies are increasingly developing interfaces between TNC reservation and payment systems and agency-managed stored value accounts, commuter benefits programs and trip planning apps. Various funding models include free fares, sponsored fares and integrated smartphone-based payment of transit and TNC fares from a single customer account. Key functions that public agencies can bring to private platforms include call centers to support phone-based reservations for those without smartphones and cash-based payment for those without bank accounts.

MPOs can facilitate or support efforts by transit agencies to introduce new trip planning, reservation and payment platforms across a wide range of regional transit, parking, toll, ride sourcing, bike sharing and other shared mobility providers.

## 6.4 Transit Priority Corridors

Focusing fixed-route bus resources in the highest ridership corridors allows transit agencies to increase service frequency, which can make a stronger case for transit priority features, such as dedicated bus lanes and transit signal priority. Concentrating boardings at major stops allows transit agencies to reduce travel times, improve travel time reliability and provide stations with enhanced passenger amenities and upgraded crosswalks. Modernizing fare payment, such as with off-board payment, proof of payment and payment by smartphone app, can further reduce travel time. With more pedestrians, the case may also be strengthened for Complete Streets treatments, transit supportive land use policies and potentially real estate value capture districts to fund the transit improvements.

Higher-performing transit in such corridors is a hedge against ACES scenarios that suggest higher VMT and congestion that could result from lower travel costs, empty automated vehicles repositioning between assignments, land use changes and other potential effects. If congestion were to increase, transit in dedicated lanes could become the fastest and most reliable way to get across town. Dedicated lanes may also provide the less complex operating environment needed for early stages of transit automation.

The hierarchy of places that transit priority corridors define may also help to guide the development of activity centers where automation may allow parking to be converted to other uses, increasing density and supporting transit ridership and value capture strategies.

*Figure 12: Transit-Only Lanes*

Dedicated lanes for transit may be a hedge against rising VMT

## 6.5 Intercity Rail and Bus

As Florida introduces improved intercity passenger transportation services, such as BrightLine, higher-speed rail service between Miami and Orlando, the scale of travel that can be accommodated by the shared mobility network increases. MPOs have always been in a unique position to coordinate regional planning efforts for local transit and shared mobility networks with the larger networks of intercity air, rail, highway and bus services. With ACES potentially increasing the number of travelers using shared-use mobility services for parts of their trips, this coordination role becomes even more important.

# 7. FUNDING IMPACTS

## CHAPTER AT A GLANCE

- **Financial scenarios can help evaluate the impact on MPO fiscally constrained capital programs.**
- **Transportation funding relies heavily upon the motor fuel tax; the future of which is uncertain.**
- **Coordination with federal and state agencies is crucial to develop new funding mechanisms that will be successful in the face of ACES.**

The ACES transition may threaten existing funding sources as well as create opportunities for new, future transportation funding models. ACES technology may reduce revenues from traffic violations. EV technology may reduce revenue from motor fuel taxes. The shared-use economy may affect revenues from vehicle registration. However, smarter vehicles also allow for implementation of road usage fees and other funding sources that may be newly accessible via technology. This section outlines the high-level funding impact that ACES may have on traditional transportation funding sources including motor fuel tax, vehicle sales tax, vehicle registration fees, parking fees and traffic fines.

## 7.1 Motor Fuel Taxes

Currently, taxes and fees are imposed at local, state and national levels to fund Florida's transportation system. Two statewide fuel taxes contribute to the State Transportation Trust Fund: the state fuel sales tax and the State Comprehensive Enhanced Transportation System (SCETS) tax. State taxes distributed to FDOT are indexed annually in January to reflect inflation captured in the Consumer Price Index (CPI).

The assessment of historical trends in the state fuel tax is important as the fuel tax typically has been one of the largest contributing funding sources to the State Transportation Fund (greater than 30 percent).[uu] In 2016, the State of Florida received $1.9 billion from the fuel tax and $675 million from the SCETS tax.[vv]

FDOT, like other DOTs, will likely begin to feel the effects of EVs and other alternative fueled vehicles impact on revenue sooner rather than later as hybrid and fully electric vehicles become a larger portion of the Florida vehicle fleet and gasoline powered vehicle sales decline.

Additionally, the state receives federal assistance for transportation, funded largely by the federal fuel tax that will also be impacted. While the exact rate and timeframe is unknown, based on recent statewide VMT trends and an inventory of total gallons of motor fuel and diesel fuel sold, assumptions can be made to predict the effect that higher fuel efficiency will have on Florida DOT's revenue and therefore budget using the six FHWA scenarios and testing a variety of projections using assumptions of total gallons of fuel sold, anticipated average fuel economy and VMT projections.

CUTR is currently updating a Transportation Revenue Study conducted in 2012 to establish a baseline for analyzing AV and EV revenue impacts in the state. Financial scenarios evaluating the impact on MPO fiscally constrained capital programs of diminishing motor fuel tax revenues and potential replacements are likely to become a more important part of the planning process as ACES technology is adopted. MPOs should evaluate a range of financial implications through scenario planning.

## 7.2 Vehicle Registration Fees

While states have chosen to incentivize the ownership and use of electric vehicles, electric vehicles ultimately reduce revenues as they gain market share; automated and connected vehicles likely will add to this revenue decrease. To counter-balance this loss, some states impose vehicle registration fees on plug-in and fully electric vehicles. Statewide EV fees may be a separate annual fee or be an additional fee over normal registration renewal fees. States such as Wyoming and Colorado include a $50 fee on EVs and plug-in hybrid electric vehicles (PHEVs) whereas states such as West Virginia charge up to $200 and Georgia charges $300 for commercial EVs.[ww]

## 7.3 Traffic Fines

Local municipalities rely upon revenues from traffic violations for local transportation funding. ACES will transform traffic safety and, along the way, potentially reduce or eliminate traditional traffic violations, the revenue they produce and the programs they support. If faced with a shrinking revenue source, municipalities will need to prioritize programs and projects or turn to alternative revenue sources to fund transportation needs. MPOs can help municipalities prioritize projects and identify new revenue sources to replace traditional funding streams.

## 7.4 Parking Revenues

The ACES transition will influence driver behavior and will affect many existing revenue streams for state and local entities. Parking revenues are no exception. Level 5 AVs can function without a human driver present and therefore can drop a passenger off at a destination without needing to park adjacently. This may mean the vehicle goes on to serve another trip (shared-use) or parks elsewhere in free or reduced-cost parking. This scenario may be at or beyond the 2045 planning horizon.

A 2016 survey of the 25 largest U.S. cities found that, collectively, they generated nearly $5 billion in parking related activities, traffic citations, gas taxes, towing and vehicle registration and licensing fees. Parking collection fees and fines accounted for more than half the total revenues cities reported.[xx] Additionally, if vehicles are shared by many different people throughout the day, parking need and demand will be dramatically reduced along with their municipal parking revenues, which often fund transportation infrastructure. Municipalities most affected will be those with existing high demand for parking, typically dense urban environments. Based on previous shared-use modeling, this change in parking behavior could result in a 50- to 90-percent reduction in urban space dedicated to parking.[yy] [zz] Therefore, while parking revenues may decline, less parking may be required which will reduce maintenance costs of parking facilities for municipalities.

## 7.5 State of Florida Incentives

ACES may reduce revenue from existing, traditional transportation revenue streams, but that has not stopped states from advancing the ACES transition through purchase and ownership incentives. The majority of current incentive programs focus on EVs. However, as the sharing economy continues to grow, states may also incentivize shared ownership or use of vehicles. As shown in Table 12, there are several incentive programs within the state of Florida incentivizing purchase and ownership of Hybrid Electric Vehicles (HEVs) and EVs.[aaa]

*Table 12: Florida Hybrid and Electric Vehicle Incentives*

| Florida Hybrid and Electric Vehicle Incentives |
|---|
| **All-Electric Vehicle Rebate** |
| Duke Energy and Orlando Utilities Commission (OUC) customers and employees are eligible for a $10,000 rebate for the purchase of a new 2017 Nissan Leaf at participating dealerships. Rebates were available through June 30, 2017, or until funds are exhausted. |
| **Authorization for Alternative Fuel Infrastructure Incentives** |
| Local governments may use income from the infrastructure surtax to provide loans, grants, or rebates to residential or commercial property owners to install electric vehicle supply equipment (EVSE) as well as liquefied petroleum gas (propane), compressed natural gas and liquefied natural gas fueling infrastructure, if a local government ordinance authorizing this use is approved by referendum. |
| **Electric Vehicle Supply Equipment Financing** |
| Property owners may apply to their local government for funding to help finance EVSE installations on their property or enter into a financing agreement with the local government for the same purpose. |
| **HOV Lane Exemption** |
| Qualified alternative fuel vehicles (inherently low emission vehicle or HEV) may use designated HOV lanes regardless of the number of occupants in the vehicle. The vehicle must display a Florida Division of Motor Vehicles issued decal, which is renewed annually. Vehicles with decals may also use any HOV lane designated as a HOV toll lane without paying the toll. This exemption expires Sept. 30, 2019. |
| **PEV Rebate** |
| Jacksonville Electric Authority (JEA) offers rebates for PEVs with a battery less than 15 kilowatt-hours (kWh) in capacity to receive $500, and PEVs with larger battery capacity are eligible for $1,000. A copy of a valid Florida vehicle registration, proof of sale and a recent JEA Electric bill are required. |

*Source: National Conference of State Legislation*

In addition to state incentives, the federal government also offers incentives for EVs. The federal Internal Revenue Service (IRS) tax credit is \$2,500 - \$7,500 per new EV purchased for use in the U.S., depending on the size of vehicle and the battery capacity. The credit will be available until 200,000 qualified vehicles have been sold in the U.S. by each manufacturer. As of this writing, credits are still available for all manufacturers.[bbb]

## 7.6 Alternative Funding

In response to consumers buying less gasoline due to electric, hybrid or more efficient combustion vehicles, some states are exploring other funding mechanisms for transportation programs and investment. New funding models range from data monetization, increased vehicle registration fees, curb pricing, carbon taxes, and user fees.

One type of user fee that is gaining interest in many communities is a VMT-based user fee as a supplement to or replacement for fuel taxes. Many argue that simply raising fuel taxes will not serve as an equitable funding solution because drivers unable to afford fuel efficient vehicles will fund an increasing percentage of the transportation system. To supplement or eventually replace fuel taxes, VMT-based user fees charge drivers for use of the transportation system rather than the purchase of fuel. Potential obstacles to a VMT-based system include concerns about privacy, safeguarding against fee evasion and how to meter VMT on older vehicles.

Consequently, several states are further investigating how a VMT revenue model might be implemented. Table 13 summarizes some of these model state programs.

Several states, including Florida, have considered the effects ACES, and specifically EVs, will have on transportation and state-wide funding through qualitative studies and reports. While there is a large revenue potential from deploying a mileage-based user fee, there would also be great cost involved in implementing a program.

*Table 13: Alternative Road Usage Revenue Model Examples*

| | |
|---|---|
| **OReGO** | |
|  | The first large road-usage charge program in the United States, OReGO began in July 2015 and continues to operate. Volunteers enroll on-line based on their preferred metering devices, account managers and value-added program offerings. Metering devices are sent to the volunteers to be self-installed to track mileage and fuel consumption. Drivers are charged 1.5 cents per mile and credited for the state fuel tax in one account for a net calculation. Volunteers are either billed for their calculated fee or sent a refund. |
| **California Road Charge** | |
|  | The pilot program to explore road charging as a potential long-term replacement for the gas tax was initiated through the California State Transportation Agency (CalSTA), a component of the California Department of Transportation (Caltrans). The volunteer pilot included 5,000 Californians. |
| **Nevada Field Test** | |
|  | The Nevada Department of Transportation has conducted mileage-based fee studies and conducted a small field test that included 40 participants in 2012. The field test implemented a pay-at-the-pump system and did not rely on the collection of location data. |
| **Minnesota Road Fee Test** | |
|  | Minnesota Department of Transportation tested a road-usage revenue system that relied on smartphone GPS data for the collection and transmittal of mileage data. Participants were charged differently based on the geographic region the travel occurred within and whether the travel occurred during rush hour. |

# 8. STRATEGIES FOR ADDRESSING ACES - TRANSPORTATION SYSTEM PLANNING PROCESS

**CHAPTER 8 AT A GLANCE**

- **ACES will transform performance-based planning and, with it, the types of projects MPOs prioritize and plan.**
- **What do we do when every car produces 30 terabytes of data daily (equal to 13.2 billion single-spaced pages of text)?**
- **Finding locally meaningful data may require MPOs to conduct or participate in pilot ACES projects.**

Florida MPOs are responsible for influential planning documents such as the Unified Planning Work Program, which lists the planning studies and tasks the MPO will perform to support the regions planning process for a one- or two-year timeframe; the Transportation Improvement Program which the regions detail transportation investments and strategies every four years; the Public Participation Plan, a periodic review of the regions public engagement strategies and goals; and the Long-Range Transportation Plan, which every five years looks out 20 years to identify the region’s future goals, strategies and projects. LRTPs currently in preparation have a horizon year of 2045. Because of these responsibilities, and Florida Statute 339.175 (2016) Subsection (7) (c) which requires MPOS consider emerging technologies in Long Range Transportation Plans, this chapter identifies strategies for addressing ACES within this myriad of the region’s transportation system planning process.

## 8.1 Performance Measures

### *8.1.1 Performance management in an age of ACES*

The Federal Highway Administration defines Transportation Performance Management (TPM) as a strategic approach for gathering, analyzing and acting on data to make policy and investment decisions that create more efficient, effective transportation systems that support a community’s vision and goals.[ccc]

It’s an approach driven by a combination of factors in recent years. Legislatively, it’s been mandated by two federal transportation reauthorization bills - 2012’s Moving Ahead for Progress in the 21st Century (MAP-21) and 2015’s Fixing America’s Surface Transportation Act (FAST) – as well as National Performance Management Measures rule-making. [ddd] In 2014, the shift towards performance-based planning and programming was identified as one of three federal planning emphasis areas with related rule-making.[eee]

Performance-based planning accelerated movements by MPOs seeking to balance growing and changing transportation needs and technology in the face of changing and increasingly uncertain funding sources. As demonstrated by the Metropolitan Washington Council of Governments, there was a recognition that performance-based planning provides MPOs with an opportunity for advancing community goals, increasing accountability and transparency and better communicating the value and impact of transportation planning, policies and investments with elected officials and their constituents, local stakeholder groups and the public.[fff]

### *8.1.2 Opportunities and Challenges of ACES-Related Performance Measures*

“How are we going to get there?” is a key question in performance-based planning as described by the U.S. DOT in A Guide to Transportation Planning.[ggg] Answering that question involves identifying “trends and targets to help planners compare alternative strategies based on data and information from similar past projects.”

But that’s exactly the challenge for MPOs establishing ACES-related performance measures. There is limited real-world empirical data concerning ACES impact on transportation system performance; few vehicles operate “in mixed use traffic” and, when they do, they usually are monitored and accompanied by personnel familiar with the technology being used, potentially skewing initial findings. Additionally, each planning organization is looking at a different mix of projected deployment rates and set of automated technologies, ranging from relatively simple driver assistance systems to fully self-driving vehicles.

As a result, the planning environment presents more uncertainty than is typically the case as planning agencies address the coming proliferation of connected and automated vehicle technologies. Agencies are looking for ways to ensure accuracy and confidence in the performance measures they develop in relation to all aspects of their transportation networks, such as roadway, transit and parking capacity; system maintenance; data collection, security, privacy and analytics; and the viability of existing intelligent transportation system investments.

Perhaps that's why FDOT's 2016 Surveying Florida MPO Readiness to Incorporate Innovative Technologies into Long Range Transportation Plans found that only about one third of state MPOs include AV-related language in their current long-range plans, with much variability in what is discussed.[hhh] And while in 2016, the State of Florida passed a bill mandating the MPO's address AV technology in their LRTPs, no uniform policy or design guidance previously existed to help MPOs anticipate, plan for, finance, or implement programs necessary to facilitate this transit.

However, such uncertainty does not preclude transportation agencies from considering strategic planning and performance-setting activities undertaken at a high level. As outlined in Strategies to Advance Automated and Connected Vehicles, these might involve:

- Identifying transportation and societal goals and objectives that may be achieved through AV and CV technologies;
- Setting the general parameters under which CV and AV deployment can be facilitated to achieve agency and societal goals;
- Developing performance measures that support specific safety, congestion, mobility and environmental goals that may be supported by AV and CV systems and can be used to track the results of testing and investment in these systems over time; and
- Outlining potential communication toward building the business case for investing in ACES, generating support for adoption of safety and mobility applications, and promoting incentives for producers to improve applications and technology.[iii]

Additionally, nothing prevents an MPO from partnering in pilot projects to begin addressing the uncertainties ACES presents in order to understand the benefits to regional performance measures. As the U.S. Government Accounting Office noted in its "Automated Vehicles: Comprehensive Plan Could Help DOT Address Challenges," pilot programs like the Uber test conducted by the City of Pittsburgh are providing important information for a "better understanding emerging automated vehicle technologies, how the city should adapt its role in response, and when actions are needed to advance public-interest goals, such as equity and accessibility.[jjj] Strategies such as this provide decision-makers with a basis for decisions today about infrastructure needs decades in the future, but represent something of a departure from more traditional infrastructure planning approaches, according to some state, regional and local officials[.]"

Official results of the Pittsburgh Uber pilot project are not available yet.[kkk] But based on media coverage of the Pittsburgh test, transportation planners may need to factor into their planning automated vehicle attributes that include, for example, slower overall operation (AVs spend more time at stop signs than human drivers do). But the vehicles also may become transportation network "probes," providing important real-time data about potholes, obstructions, congestion points and traffic patterns.[lll]

How and when ACES evolve may present benefits for MPOs from a planning perspective. The ebb and flow of ACES policies and technologies over the next decades may align with good planning practices described by the Strategies authors: "Ultimately, public policy making for AVs and CVs will be informed through a cycle of learning and leveraging the activities of early adopter agencies that support testing, evaluation, research and continuous knowledge creation and that tie back to the MPOs performance measures. Agencies can create a nimble policy-making framework that espouses these principles and sets in place a continual 'look ahead' assessment."

The key, as noted in Advancement of Performance-Based Scenario Planning for Regional Planning and Decision-Making, is to make sure that performance measures are selected "that can be tracked across scenarios to compare the tradeoffs of each scenario and measure performance over time." [mmm]

### *8.1.2 Best Practices for Performance Measure Development*

In a 2015 white paper, former FDOT Secretary and current president of the Florida Transportation Builders Association Ananth Prasad outlined the results of a national survey of MPO best practices for performance measurement development (How to initiate MAP-21 performance-based planning: Lessons learned and best practices; Think Infrastructure Solutions white paper; HNTB Corp.; March 2015). Among the best practices the white paper identified were:

1. Derive performance measures from the link between the MPO vision and goals and how ACES may affect achieving them. Refine the measures based on input from MPO stakeholders and from an assessment of how easily and frequently the required data can be accessed, analyzed and acted upon.
2. Collaborate to maximize the alignment, where appropriate, between MPO vision and goals with those of the state DOT. This created opportunities to synergistically leverage the impact of data collection and analysis and resulting policy and investment development.
3. Correlate measurements to transportation investments. Be able to show how appropriate investments in infrastructure produces positive results or why, in times of constrained resources, one investment clearly is preferable to another. Programming decisions should reference scenario analysis used in order to correlate to performance measure inputs.
4. Use performance measures as future action triggers. For example, having set desired and acceptable travel time measures, a corridor beginning to intermittently fail this standard would trigger planning activities for future corridor improvements.
5. Update and communicate performance measurements regularly. Performance measures that can be publicly reported and understood can educate stakeholders on how local planning works, the value of it in their lives and whether individual metrics remain pertinent in terms of progress towards MPO vision and goals. It is a powerful tool for communicating how efficiently and effectively resources are being used. The good will this can produce becomes as asset that an MPO can manage and invest in maintaining its ability to tackle tough planning issues.

### *8.1.3 Other Considerations*

Implicit in the discussion of setting and monitoring performance measures are several other considerations, including:

- Data collection and analysis – Does an organization have the resources, training and easy access to the data required for the performance measures it has established? Data is expensive and time-consuming to acquire and maintain and must be constantly updated and improved. Poor quality data can make performance measures difficult to track and report, and it may lead to a loss of confidence in the necessity or effectiveness of system performance investments if it proves inaccurate. If not already in place, an MPO may want to explore establishing and maintaining shared datasets reflecting common standards regarding data collection, hygiene and maintenance.
- Staff capacity – ACES for the foreseeable future could require MPOs to maintain or access robust pertinent scenario-planning models requiring significant staff expertise and technical capacity to determine likely ACES-related outcomes. This also may be true in terms of monitoring actual system performance in terms of ACES impacts. This may be an area for further exploration in terms of collaboration with other MPOs or agencies.
- Technological support – Dashboards, visualizations and other technological systems and platforms can improve the ease of gathering analyzing and reporting system performance, particularly in ways that build stakeholder education and engagement. However, these tools come at a cost that will need to be identified and accounted for by MPOs, and they may grow in magnitude depending upon the degree to which an MPO wants to customize performance measurement and reporting.
- Collaboration and consensus – Differences may exist among MPOs and their clients and stakeholders regarding the need or wisdom of identifying and reporting on system performance issues or specific

policy/investment needs for addressing problems. This may diminish commitment to the need for – or value of - accurate and regularly updated performance measures and results. Reaching consensus about what will be measured and reported and to what end may demand considerable time in some jurisdictions and should be factored into the performance measure planning process. That being said, it is an important step that will enable MPOs to create and test new or refined performance measures that better reflect federal and state regulatory requirements while better meeting community needs, preferences and expectations.

### *8.1.4 Potential ACES-Related Performance Measures*

As Florida MPOs noted in Surveying Florida MPO Readiness to Incorporate Innovative Technologies into Long Range Transportation Plans, the challenge is in "dealing with the large amount of uncertainty associated with the AV technology, plausible set of AV/CV scenarios to plan for, insights into timelines for availability and adoption of these technologies and information on the potential impacts of these technologies." [nnn]

Performance measures for many aspects of ACES can be derived from normal MPO practice and data sources – if it can be determined when and to what degree particular technology elements are part of the regional vehicle fleet.

After all, there are certain givens in the LRTP process that can help MPOs begin developing ACES-specific performance measures. MAP-21/FAST Act provisions require MPOs to develop their LRTPs through a performance-driven, outcome-based approach to planning that addresses the following factors:

1. Support the economic vitality of the metropolitan area, especially by enabling global competitiveness, productivity and efficiency;
2. Increase the safety of the transportation system for motorized and non-motorized users;
3. Increase the security of the transportation system for motorized and non-motorized users;
4. Increase accessibility and mobility of people and freight;
5. Protect and enhance the environment, promote energy conservation, improve the quality of life and promote consistency between transportation improvements and State and local planned growth and economic development patterns;
6. Enhance the integration and connectivity of the transportation system, across and between modes, for people and freight;
7. Promote efficient system management and operation;
8. Emphasize the preservation of the existing transportation system;
9. Improve the resiliency and reliability of the transportation system and reduce or mitigate storm water impacts of surface transportation; and
10. Enhance travel and tourism.[ooo]

It still may not yet be possible to determine the impact of ACES in terms of setting and measuring specific performance measures with any degree of certainty for the foreseeable future. But all that means, as FHWA noted in Planning for Connected and Automated Vehicles, is that performance-based planning in an age of ACES requires implementing projects based on estimated outcomes coupled with repetitively and regularly evaluating results as new data and data sources come on line that are pertinent to ACES performance measures.

This implies a de-emphasis of precise predictions and suggests that ACES metrics might be best thought of, at least initially, as "action brackets." That is, planners set a range of desired outcomes then, as data comes in showing positive or negative trends that depart significantly from the estimated outcomes, revisit goals and associated performance measures to determine if either needs revision, refinement or more concrete policy or programmatic support. Such action brackets also would become an early warning system about opportunities that can be capitalized on or issues that can be resolved if action is taken early.

This uncertainty may make it more important for MPOs to align their planning with the Florida Transportation Plan, which envisions a state/local partnership in reaching common goals and objectives. Such an alignment may create opportunities for leveraging the positive impact of state plans and investments while generating a framework of performance measures and indicators that are consistent locally and regionally.

## 8.2 Scenario Planning

### *8.2.1 Overview*

The only thing certain about the future is uncertainty. Nevertheless, transportation planners engage the community in planning processes that describe and project future conditions to define long-range visions and outcomes, prioritize investments and craft performance measures to guide the way from here to there for their community.

Scenario planning provides a framework for developing a shared vision for the future that tests various future alternatives that meet state, community and/or regional needs. Scenario development transforms the planning process from strategic hindsight into strategic foresight. And at the same time, it creates opportunities for an MPO to strengthen its own organizational sustainability by:

- Engaging a wide variety of stakeholders;
- Illustrating trade-offs among different land use and transportation choices;
- Creating a broader understanding of issues and stakeholders to be incorporated into planning;
- Helping develop performance measures and evaluation processes that provide policy guidance for local decision makers; and
- Producing more efficient, effective decision-making that results in significant benefits and improvements.

The Federal Highway Administration considers scenario planning to be a critically important analytical tool that can help transportation professionals prepare for what lies ahead. It provides a context and framework for developing a shared vision of the future and analyzing how various forces (e.g., health, transportation, economic, environmental, land use) will shape, accelerate or derail that future.

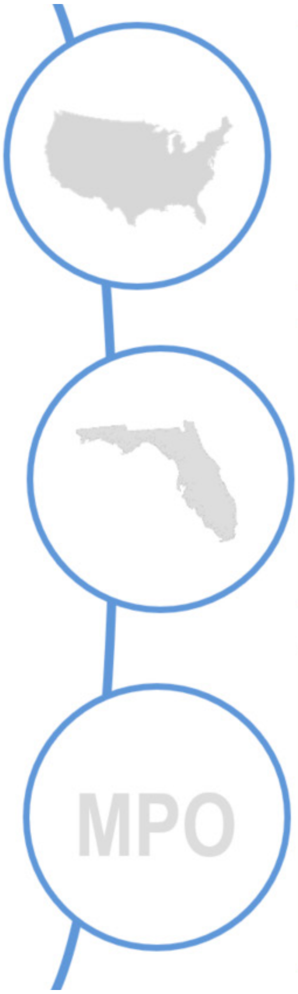
ACES technologies have the potential to change transportation on a global scale. These technologies could improve safety, significantly alter transportation costs and change traffic patterns and congestion. However, the future is very uncertain by even the most advanced professionals. Scenario planning is the best available tool to plan for this uncertain future. In 2008, the American Association of State Highway and Transportation Officials (AASHTO) established the forward-looking NCHRP Report 750 Strategic Issues Facing Transportation.[ppp] As the Foresight series explains, transportation's future will be determined by the interplay of impossible-to-predict changes in technology, the environment, global and local politics, the economy and society. Several of the Foresight reports used scenario planning as a tool for managing uncertainty. Scenario planning helps DOTs and MPOs consider the future, anticipate events and trends, understand risk and gather ideas for proactive organizational response.

Figure 13 provides one example framework for scenario planning that MPOs can use to plan the future impacts of ACES on your community. As each MPO works through their own individual scenario planning framework, Appendix 4 provides scenario planning thought starters related to the impact of ACES on common LRTP goals.

*Figure 13: Scenario Planning Framework Example*

### *8.2.2 A Common Transportation Vision*

While the country is diverse, there is a common transportation vision amongst us. That vision takes on different facets at different levels of government and geography but essentially the transportation vision is shared. This vision should be considered as each MPO develops their own ACES scenarios.



**NATIONAL**

*Beyond Traffic Trends and Choices 2045* is the US DOT's 30-Year Framework for the Future. Scenario 2045: Drifting Toward Gridlock is the baseline future scenario presented in Beyond Traffic. It is a scenario, not a forecast. US DOT used the trend analysis as a guide to construct a possible snapshot of a future, where the US failed to address the challenges the transportation system.[qqq]

**STATE**

The Florida Transportation Plan (FTP) Horizon 2060 is a plan for all of Florida. The plan defines Florida's future transportation vision and identifies goals, objectives and strategies to guide transportation decisions over the next 50 years. The FTP used scenario planning to help define Florida's future. Like any dynamic plan, the FTP will be revised and updated to respond to innovative ideas, as well as changes in social, economic, environmental and technological factors affecting our transportation system and travel needs.

**REGION**

There are 27 MPOs in Florida. Each is unique in its geographic area, demographic and socio-economic characacteristics yet similar in their definition of long-range transportation vision and goals. Researching Florida MPO LRTP goals indicated that most MPOs have a common set of goals consisting of:

1. Safety & Security
2. Quality Infrastructure
3. Efficient / Reliable Mobility
4. Economic Competitiveness
5. More Transportation Choices for People & Freight
6. Quality Community
7. Environment

### 8.2.3 FHWA ACES Scenarios

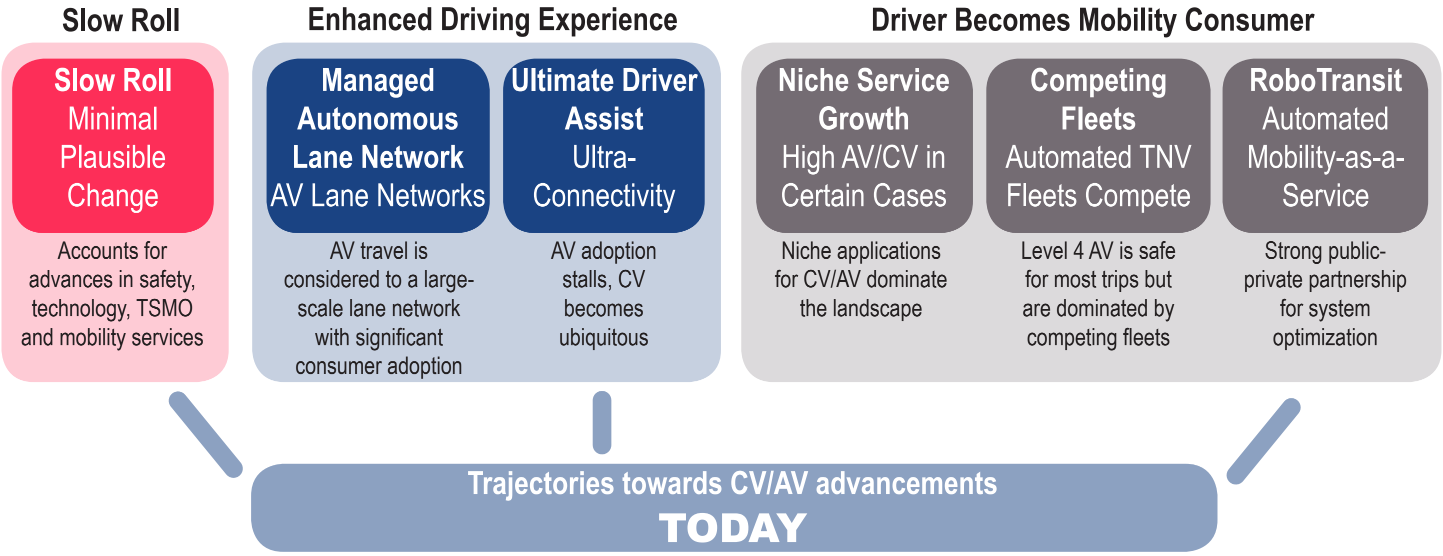
In November 2017, FHWA convened stakeholders and subject matter experts during a workshop to define potential future scenarios for connected and automated vehicles. The workshop participants understood that planners need to consider, but cannot yet accurately predict, the potential impact of disruptive and transformational connected vehicle and automated vehicle technologies on safety, vehicle ownership, road capacity, VMT, land-use, roadway design, future investment demands and economic development, among others. While some forms of CV and AV are already being deployed across the United States, significant unknowns exist regarding the rate of technology adoption, which types of technologies will prevail in the marketplace, the interaction between CV/AV vehicles and various forms of shared mobility services and the impacts of interim and widespread levels of CV/ AV usage.

The workshop's goal was to generate and pilot-test six scenarios of potential futures related to CV/AV deployment, adoption, use and likely impacts. Insights generated by the process will be compiled into a resource guide for transportation practitioners on the use of scenario planning to support informed decision-making in light of the changing realm of transportation technologies and business models.[rrr]

These scenarios are not predictions of the future. Rather, they are plausible futures designed to illustrate the causes and impacts of possible combinations of forces. One goal in creating these scenarios was to capture, as best as possible, the range of plausible futures regarding CV and AV technology, so that planners could be better prepared to discern the implications of events as they unfold.

The scenarios were developed to highlight uncertainties, with a focus on maintaining plausibility while also illustrating various cases within the spectrum of these scenarios. Figure 14 illustrates the scenarios in terms of their relation to one another, grouping those in which primary effects are in improved driving experience, versus those which result in shifting mobility models.

*Figure 14: FHWA 2035 CV/AV Scenarios*



*Source: FHWA, Scenario Planning for Connected and Automated Vehicles, DRAFT Scenario Descriptions, November 2017*

These six FHWA CV/AV Scenarios will have an impact on Florida MPO long-range transportation planning. Planners should consider aligning National, State and Regional transportation goals with the six FHWA scenarios when performing their own scenario analysis. One approach would be to pick two FHWA scenarios that may represent the range of possible scenarios. The FHWA scenarios that represent the full range include the Slow Roll – minimal plausible change to Robo Transit, Automated Mobility-as-Service – maximum plausible change.

It's important to note that Florida's 27 MPOs have individual transportation goals for their regions. However, for analytical purposes, it is possible to synthesize these into a broad, common set of goals as shown in Section 8.2.2. These have many similarities with the 2060 FTP goals and is why FTP goals were used in Table 14 and elsewhere to explore the linkages, impacts and opportunities that the six FHWA scenarios may uncover.

*Table 14: ACES Potential Scenarios: Impacts on Progress toward Planning Goals*

| | LRTP Goal | Slow Roll | Niche Service Growth | Ultimate Traveler Assist | Managed Automated Lane Network | Competing Fleets | Robo Transit |
|---|---|---|---|---|---|---|---|
| | | *Minimum plausible change - Nothing beyond currently available technology and investments already in motion is adopted.*<br>*(Baseline for comparison)* | *Innovation proliferates, but only in special purpose or "niche" AV zones, including retirement communities, campuses, transit corridors, urban cores, and ports.* | *CV technology progresses rapidly, but AV stagnates – 85% of vehicles have V2X capability by 2035 due to NHTSA mandate allowing DOTs to manage congestion aggressively.* | *Certain lanes become integrated with CV and AV – 50-60% of vehicles (75% of trucks) have automation capability for platooning in controlled settings.* | *Automated TNC-like services proliferate rapidly, but do not operate cooperatively. VMT doubles due to induced demand and empty vehicle repositioning.* | *On-demand shared services proliferate and integrate with other modes via cooperative data sharing, policies, and infrastructure.* |
| *ACES Shares - 2035* | *AVs – L2* | 50 – 60% | 50 – 60% | 50 – 60% | 30 – 40% | 30 – 40% | 30 – 40% |
| | *AVs – L3* | 0% | 0% | 0% | 20% | 1% | 0% |
| | *AVs – L4* | 0% / 0% | 1 – 5% / 1 – 5% | 0% | 1% | 30% | 30% |
| | *CVs in Fleet* | 40% | 40% | 85% | 75% | 75% | 75% |
| | *EV Sales (urban/all)* | 15% / 5 – 10% | 15% / 5 – 10% | 15% / 5 – 10% | 15% / 5 – 10% | 85% / 85% | 85% / 85% |
| | *Shared Trips (urban/all)* | 20% / 5 – 10% | 20% / 5 – 10% | 20% / 5 – 10% | 20% / 5 – 10% | 85% / 85% | 85% / 85% |
| | *1. Safety & Security* | Level 2 driver assist features (e.g. lane tracking, automatic braking) reduce fatalities and serious injuries. | Prevalence of AVs allows "Vision Zero" goals to be realized in AV zones. Level 2 features improve safety elsewhere. | V2V communications enable 80% reduction in crashes systemwide. | V2V communications enable significant (but less than 80%) reduction in crashes systemwide. | Automated fleets and V2V communications enable 80% reduction in crashes systemwide, including realization of "Vision Zero" in urban areas. | Automated fleets and V2V communications enable 80% reduction in crashes systemwide, including realization of "Vision Zero" in urban areas. |
| | *2. Maintenance and Operations* | Truck platooning is common on rural interstate highways. | Improvements to lane markings, pavement maintenance and new V2X infrastructure are concentrated in AV zones. | CV roadside units proliferate to cover all roads with V2I infrastructure. | AV-only lanes on rural interstates and urban expressways and separate freight corridors allow for safe, efficient and automated travel. Eco-signal corridors reduce congestion and emissions in urban cores. Cooperative use of CV data allows DOTs to improve network operations systemwide. | Suburban freight centers are interface between automated long-haul trucking and local delivery. Evenly distributed EV charging network serves fleets. Maintenance of lane markings and pavement improves for AVs. Restricted data sharing prevents optimization of road capacity, increasing congestion. | Suburban freight centers are interface between automated long-haul trucking and local delivery. Evenly distributed EV charging network serves fleets. Maintenance of lane markings and pavement improves for AVs. Cooperative use of CV data allows DOTs to improve network operations systemwide, nearly eliminating congestion. |
| | *3. Mobility and Connectivity* | Mobility services reduce car ownership near urban cores, while increasing travel by elderly and disabled populations everywhere. | Car ownership falls dramatically in AV zones as residents shift to local mobility services. | Public transit improves efficiency, competitiveness and customer service due to real-time pricing, universal trip planning and multimodal integration. | Mobility services reduce car ownership near urban cores, while increasing travel by elderly and disabled populations everywhere. Transit becomes less competitive with managed lanes. | Vigorous competition between mobility service providers drives many toward car-free lifestyles. Door-to-door, transportation as low as $0.20/mile is available in most contexts, outcompeting traditional transit. | Personal mobility becomes a commodity, integrating door-to-door and fixed guideway transit in urban corridors. Automated long-haul and local freight makes immediate consumption universal. Regions offer universal shared mobility services as low as $0.20/mile. |
| | *4. Economic Competitiveness* | Widespread use of real-time travel info reduces costs of congestion. | AV zones gain significant advantages from efficient transportation, leading to increased desirability and rising real estate values. | Near elimination of congestion through cooperative dynamic routing and pricing incentives improves economic productivity. | Reduced congestion and automated trucking improve economic productivity. | Costs of local travel and long-haul trucking plummet due to automation, increasing economic productivity. Induced demand offsets savings with congestion costs. | Near elimination of congestion through cooperative dynamic routing and pricing incentives, combined with driverless travel, dramatically improves economic productivity. |
| | *5. Community Livability* | | Quality of life improves in AV zones, leading to concerns about equitable access to technology benefits outside niche areas. | | Businesses locate outside of the urban core and people to move to the suburbs and exurbs near managed lanes. | Parking is converted to other uses in urban and suburban areas. | Parking is converted to other uses in urban and suburban areas. Walkable mixed-use development dominates in transit corridors. |
| | *6. Environmental Stewardship* | Electrification trend continues, decarbonizing the transportation sector and reducing emissions. | | | Automation of long-haul trucking reduces rail mode share and convenience of driving reduces transit mode share, increasing VMT and emissions. | Fleets use EVs exclusively, making 85% of urban VMT (plus 50% suburban and 5% rural) electric, greatly reducing emissions. Gains are offset by VMT increases. | Fleets use EVs exclusively, making 85% of urban VMT (plus 50% suburban and 5% rural) electric, greatly reducing emissions. Shared use reduces offsetting VMT gains. |

*Source: Adapted from FHWA, Scenario Planning for Connected and Automated Vehicles, November 6, 2017.*

## 8.3 Project Prioritization

ACES may change the types of existing projects that MPOs include in LRTPs and TIPs. In some cases, there will be new projects, such as platooning lanes on freeways, or elements of traditional projects that support ACES, such as EV charging in park-and-ride facilities. In other cases, priorities may change, such as greater emphasis on maintenance of pavement and lane markings to support ADAS.

Some of these projects may benefit from the wider latitude under the 2015 FAST Act to fund ITS projects with federal, state and or local funds. MPOs may be well served by brainstorming with state and local transportation agencies regarding how best to access those funds. Such outreach could also be used by MPOs as the first step in developing and implementing a region-specific process for winning consensus regarding how ACES should impact project development and prioritization.

One way to do this would be to create a dialog with stakeholders regarding the kind of ACES-supportive projects summarized in Figure 15 that ACES may engender, along with the kinds of projects that MPOs may consider in their community to support ACES across a range of potential scenarios.

The projects shown are examples, and actual projects and project components will be based on community and regional goals. Additionally, many of the projects chosen will require integration into communities' comprehensive plans and likely require additional analysis before moving forward.

### PROJECT PRIORITIZATION TOOLS

- **Update project prioritization process**
- **Employ scenario planning**
- **Tap into ACES steering committee insights**
- **Receive feedback from the public**
- **Integrate ACES compatible elements into programmed projects**
- **Incorporate required FAST Act performance measures**
- **Develop new ACES-focused performance measures**

*Figure 15: Potential Example ACES-Supportive Projects*

**ROAD MAINTENANCE (STATE OF GOOD REPAIR)**

- *Lane marking improvements/maintenance for machine vision*
- *Pavement Lane marking maintenance improvements for safe automated vehicle operation improvements*

**TRAVEL LANES (CAPACITY)**

- *Conversion of on-street parking to other uses*
- *Designation/planning of AV-only limited access arterial lanes or AV only transportation zones*

**CURB MANAGEMENT (SHARED MOBILITY)**

- *Designated pick-up/drop-off zones*
- *Curb space value capture policy plans*

**PARKING (LAND USE/ URBAN DESIGN)**

- *Activity center master plans to guide conversion of parking*
- *Conversion of public parking facilities*
- *ACES parking priority*
- *Electric vehicle charging stations and related support systems*

**TRANSIT (TRUNK & FEEDER)**

- *Transit plans to guide investments in urban corridors*
- *Dedicated high-occupancy AV expressway and arterial lanes*
- *Mobility hubs*
- *First/last mile or paratransit partnership opportunities*

**FREIGHT (LONG HAUL AND LOCAL)**

- *Dedicated AV truck corridors and platooning policies*
- *Suburban/weigh station truck terminals*
- *Intermodal terminal automation*
- *Lane management and restrictions planning*

**SMART CITIES (INTERNET OF THINGS)**

- *V2I roadside units*
- *Traffic signal prioritization and interconnections*
- *Transportation operations management centers/upgrades*
- *Transportation data processing centers*
- *Fleet management facilities*

Conversations on potential projects like these and others would help MPOs refine their project prioritization or selection criteria to rank specific investments or strategies that best advance their short-term Transportation Improvement Program and long-term Long-Range Transportation Plan.

They also would help refine the way projects included in the TIP/STIP are selected based on performance and show a clear link to meeting identified goals and performance objectives using a process unique to each MPO. Each MPO's LRTP identifies a number of policy goals and objectives for regional transportation investments. Within the eligible uses of these funds, priority is given to projects that advance the region's vision and transportation system policy goals and objectives.

As each MPO considers how ACES projects fit into its long-range transportation plans, it also is determining the importance of technology in solving their region's transportation needs. MPOs can use scenario planning as a tool not only to shape a vision and policy direction (through identification of goals, objectives and performance measures), but also to analyze the impacts of unpredictable forces on future conditions, to support long-range project prioritization and programming and to improve its performance-based framework for ongoing evaluation, reporting and system monitoring. The programming process typically identifies project prioritization and selection criteria, then evaluates proposed projects against the criteria to establish a priority list of projects for funding in the TIP/STIP.

Prioritization is something that should be discussed early by the MPO as ACES technologies are already present. Many MPOs around the country are incorporating ACES-related investments into their TIP/STIP and long-range plans.

## 8.4 Policies

Policies should help guide ACES technology towards safe, efficient and sustainable deployment. Based on the results of the scenario-planning exercise, MPO planners will want to develop policies that will positively impact people to achieve the region's desired long-range goals.

In response to increasing demands for federal guidance, National Highway Traffic Safety Administration (NHTSA) released its Federal Automated Vehicles Policy Statement (FAVP) in September 2016.[sss] The document provides national policy guidance for highly automated vehicles into the following four areas: Vehicle Performance Guidance for Automated Vehicles, Model State Policy, NHTSA's Current Regulatory Tools and New Tools and Authorities.

Local policy direction should consider relevant national and state policies. First start with local existing policies and consider how they may need to change to continue to achieve the desired goals. Next consider new policies. NCHRP 845, Advancing Automated and Connected Vehicles: Policy and Planning Strategies for State and Local Transportation Agencies is a new resource that can be used to identify potential policies around automated and connected vehicles. The report identifies assessments of 18 policy and planning strategies that states or localities can directly or indirectly impact as appropriate when they explore how to help influence private-sector ACES decisions in ways that maximize their benefits to communities. MPOs may want to consider which of the strategies make the most sense for them and for their communities as they examine potential future impacts. The 18 strategies are:

1. Enact legislation to legalize AV testing
2. Enact legislation to stimulate CV or AV testing
3. Modify driver training standards and curricula
4. Increase public awareness of benefits and risks
5. Subsidize SAV use
6. Implement transit benefits for SAVs
7. Implement a parking cash-out strategy
8. Implement location-efficient mortgages
9. Implement land use policies and parking requirements
10. Apply road use pricing
11. Implement a no-fault insurance approach
12. Require motorists to carry more insurance
13. Subsidize CVs
14. Invest in CV Infrastructure
15. Grant AVs and CVs priority access to dedicated lanes
16. Grant signal priority to CVs
17. Grant parking access to AVs and CVs
18. Implement new contractual mechanisms with private-sector providers

*Source: NCHRP 845, Advancing Automated and Connected Vehicles: Policy and Planning Strategies for State and Local Transportation Agencies*

## 8.5 Smart Cities

There is a lot of buzz around cities becoming “smart”. Smart cities tap into the power of the so-called “Internet of Things” to make sure that all aspects of services and infrastructure communicate and generate data that can be used to improve safety, economic vitality and quality of life. Investment in smart cities will continue to be significant over time, in fact Accenture predicts smart city infrastructure investments could bring as many as 90,000 jobs and $14 billion in economic growth to the City of Chicago.

One of the key activities that really sets a smart city apart is the strategic use of technology to improve the transportation system, particularly for populations that need transportation most.[ttt] As transportation technology continues to evolve, several benefits are expected to be seen, including vehicle-to-infrastructure communications for smoother traffic flow on city streets for commuters using rapid-transit buses or other connected vehicles. Additionally, applications may find parking spaces for drivers, and automated vehicles may eliminate the first-mile/last-mile problem for public transit riders. Transportation technology also is expected to provide significant safety benefits, such as pedestrian-detection and applications that provide alerts before potential collisions between vehicles or with transit systems, such as streetcars. Cities that implement these technologies may even see up to an 80 percent reduction in vehicle collisions, excluding those involving impaired drivers.[uuu]

However, cities should not implement this technology for its own sake – it must be implemented strategically to solve real issues. As cities become smarter and transportation technology more prevalent, cities and regions must first look to those populations with the greatest transportation needs, then bring together the resources of the public and private sectors to find the best solutions. When a city or region can find a way to use modern transportation infrastructure to connect jobs, schools, healthcare and other amenities, social equity is improved and quality of life bolstered.

Two examples from the USDOT Smart City grant winner Columbus, Ohio illustrate how this can work to benefit a community.[vvv]

- *Provide better access to transit, jobs and amenities*
  In one Columbus neighborhood, many businesses and retail centers were more than a mile walking distance from current bus routes and stops, a greater walking distance than is typically acceptable. Columbus will deploy automated multi-passenger electric vehicles to provide an accessible and easily expandable first mile/last mile transportation solution. The deployment will also reduce congestion by encouraging drivers to “park once” and more efficiently use transit resources by delaying or eliminating the need to add bus routes.

- *Improve local freight efficiency*
  America’s 10th most active logistics hub consists of the Rickenbacker International Airport, Rickenbacker Intermodal Terminal and Rickenbacker Logistics Park. But freight-induced congestion and queuing are significant challenges in and around the facilities. Columbus will deploy two-vehicle connected truck platoons and signal prioritization for logistics-related vehicles using intelligent transportation systems to reduce congestion and queuing.

As municipalities explore expanding these kinds of smart city elements and others, the role of MPOs likely will be one of technical advisor or service provider. It’s also likely that they will see growth in their role as a catalyst for helping local jurisdictions and their constituents better understand potential ACES impacts and opportunities along with current or future infrastructure-related needs and supplementary funding sources. This is often provided as municipalities consider public-private partnerships (P3) with entities bringing new funding and approaches to solving local infrastructure challenges. However, as these P3s grow in size or complexity, or new technologies come on line, new roles for MPOs may emerge.

## 8.6 Data

"Big Data" represents the idea that we are becoming a connected society through the Internet and that will produce a tremendous amount of data. The white paper, The Connected Vehicle: Big Data, Big Opportunities, illustrates this by stating that IHS Automotive forecasts that there will be 152 million actively connected cars on global roads by 2020.[www] The combination of new car features and aftermarket devices could mean nearly 2 billion connected cars on the world's roadways by 2025. Conservative estimates from IHS Automotive state the average car will produce up to 30 terabytes of data each day.

Hidden in the data are valuable clues regarding the performance and health of the local transportation network (e.g., how, when and where vehicles are driven and how those patterns are changing over time). Analyzing the data can reveal meaningful connections, trends and patterns that help provide better planning outcomes and improve decision-making reliability, potentially resulting in a more reliable, resilient transportation network.

As ACES deployment grows, AV and CV systems will require physical infrastructure assets, data management and ITS services – all of which may impact MPOs significantly based on how they assess their roles in collecting, analyzing and acting on ACES data related to technology, safety, workforce, operating policies, laws and regulations, economic vitality and quality of life.

Two important considerations particularly were identified in the Eno Center for Transportation report, Adopting and Adapting States and Automated Vehicle Policy, 2017:

- *Data sharing* - Creating initial guidelines for data sharing can set the stage for future data sharing agreements that can bring benefits to both public sector agencies and private companies.
- *Cybersecurity* - States should work with partners to proactively define AV developers' limited liability for crashes that result from a security breach and ensure that all AV developers are taking cybersecurity seriously.[xxx]

At the local level, this translates into MPOs playing key roles in facilitating discussions among local governments regarding how data, ACES-related and otherwise, will be collected, structured and transmitted so that there is efficient, effective sharing of data that informs transportation policies and investments. This role may extend to helping public entities entering into ACES-related P3 arrangements make sure that they have access to the invaluable, near-real-time data about their traffic systems, data generated by the vehicles themselves that will essentially act as traffic system probes. Helping a region come to agreement on common access and sharing requirements will position a region to leverage such data into improved state and local maintenance scheduling, current operations management and future infrastructure investment planning, maximizing the public interest.[yyy]

*Figure 16: Analytics Opportunities in CVs*

This also translates into MPOs considering local aspects of cybersecurity. Although many cybersecurity aspects likely will be addressed by federal regulation, product liability and OEM design, there will still need to be local discussions regarding the new partnerships, capacities and strategies that the public sector will need to securely manage and share AV/CV-related big data. Consider signal prioritization, for example. Localities may need to look at "hardening" traffic signal controllers beyond OEM standards to reduce the risk of hacking that may cause accidents and increase liability while still also maintain the data sharing capacity that maintains signal timing along corridors.

Potential cybersecurity issues and their local prioritization will depend upon several MPO considerations, among them the likelihood of occurrence, local concerns and preferences, budget and staff technical knowledge and resources. As part of its ongoing planning processes, an MPO may want to consider consulting with FDOT, local municipalities, Smart City grant recipients, industry experts, data aggregators, MaaS providers and others over time to help develop a locally appropriate cybersecurity workplan.

## 8.7 Freight

Automated and connected vehicle technologies are rapidly entering the freight environment and are expected to profoundly change all aspects of freight mobility. Because labor, crashes and fuel are the largest cost components of freight mobility, emerging technologies can have a profound impact on the freight industry. Starting with safety, collision mitigation systems are always-on radar sensors to detect stopped or slowed vehicles far down the road to alert the driver and apply brakes when needed.

From a fuel savings perspective, platooning trucks are connected using direct Vehicle to Vehicle (V2V) communications. This allows the rear truck to react immediately to the actions of the front truck. By electronically coupling the trucks in this way, they accelerate and brake together and can safely operate at closer distances to form a platoon.

One manufacturer, The Peloton System, has proven savings of more than 7 percent when platooning using industry standard tests: 4.5 percent for the lead truck and 10 percent for the following truck.[zzz] Platooning only occurs when it's safe, where it's safe and how it's safe. A cloud-based network operations center approves each platoon, and adjusts platooning parameters to be safe for conditions. Each driver is empowered with over-the-horizon alerts at all times.

For freight applications, Michigan companies can capitalize on AV/CV capabilities by operating platoons on streets or highways for entities, provided that they submit plans for general platoon operations with the state police department and state transportation department. If neither department rejects those plans within 30 days, the entity can initiate platooning tests and demonstrations.

FHWA is currently performing a freight pilot program in Wyoming. The pilot program focuses on applying CV technology along freight-intensive corridors that experience significant weather-related incidents and delays.

Florida has its own truck platoon pilot project along Florida's Turnpike. Based on the results of this pilot project, other state corridors would likely be candidate truck platooning corridors. Also, Florida ports may be ideal locations for automated and connected technology to move freight. MPOs should work with large freight operators and the military bases within their region to identify potential freight platooning routes and potentially partner with freight signal priority technology vendors for maximum efficiencies.

## 8.8 Land Use

Automobile use has influenced the form and extent of U.S. land development, influencing the density and land-use patterns of local communities. Additionally, the land and resources used for vehicle-supportive infrastructure has been considerable and represents one-time and ongoing local, state and federal investment decisions having impacts to the economy, environment, quality of life and other facets of how people live, work and play.

How these influences will change in the future due to ACES remains unclear. There are both potential benefits and costs of widespread deployment of ACES for cities and metropolitan regions. Automated and connected vehicles could increase safety and convenience of vehicle travel, lowering transportation costs and thus increasing people's willingness to live and travel farther. While there is some concern that ACES may encourage sprawl, if enhanced technology is incorporated into transit vehicles and shared vehicles, this shift could decrease vehicle ownership and use in favor of transit and shared mobility that may favor shorter trips and more compact development. The American Planning Association (APA) continually adds resources related to AV and CV planning and the interaction between land use and community implications to their on-line site.[aaaa]

Sensors will allow AVs to travel closer together, likely reducing the necessary pavement width and freeing up ROW for other uses. Local zoning codes may need to address requirements for passenger loading and unloading, and parking needs will potentially change drastically with increased shared use. Most existing ordinances require large amounts of land to be dedicated to parking and circulation, however, this may be unnecessary in the future and jurisdictions must determine how best to make use of newly available land through new approaches in land use and zoning.[bbbb]

The ACES transition is expected to change the physical layout of urban and suburban areas. Coupled with greater demand for e-commerce, retail space will shrink while there will be a higher demand for warehousing and e-commerce logistical square footage. There is even the potential for mobile workspace pods and tiny homes that may replace traditional office space, hotel uses, and traditional housing.[cccc]

The uncertainty of ACES' impacts on land use underscores the importance of MPOs and their local planning partners clearly defining the vision of their communities that they seek to realize – along with specific, actionable and measurable supportive goals and objectives.  Regularly measuring progress toward the vision will enable an MPO to better assess the real-time impacts of ACES and what response, if any, is required to keep progressing towards the community vision.

# 9. EDUCATION AND ENGAGEMENT

**CHAPTER 9 AT A GLANCE**

- **ACES introduce equity and other issues that may affect how MPOs define their community visions, goals and performance measures.**
- **MPOs will face new and perhaps unprecedented demands on engagement staff, resources and technical knowledge to address new needs and new stakeholders.**
- **ACES opens up new and more complex communication needs and opportunities across seven broad topic areas.**

MPOs are uniquely qualified to be the lead in educating the public on ACES. MAP-21 legislation and previous legislation require metropolitan planning organizations to provide a broad range of stakeholders with a reasonable opportunity to learn about and comment on their transportation plans.[dddd] This put in place the basic framework for understanding who affected stakeholders are and how to engage with them; indeed, many planning agencies have expanded this ethos to include many of their other activities.

Given the potential impacts of ACES, new strategies are needed to increase education and engagement in ways that help the public and specific stakeholders fully understand related needs and acceptable solutions. This is a critical step in developing and communicating a feasible, supportable vision of the community and the quality of life, economic vitality, and environmental quality it offers – based on stakeholders input about an ACES future. This may impose new costs, staff size, and skill requirements in areas other than transportation planning – communications most notably, but also data mining and data visualization.[eeee]

MPOs also are likely to play a new or expanded role in creating dialog about ACES and their impacts on communities, policies, and investments across a broad range of issues and concerns. Few organizations are as well positioned as MPOs to be informed, neutral communicators about issues and opportunities stemming from ACES. These new demands on MPOs, coupled with continually growing citizen engagement about public policy generally and concerns about ACES impacts specifically, will require added investments and tools that empower the public to test planning assumptions and conclusions.

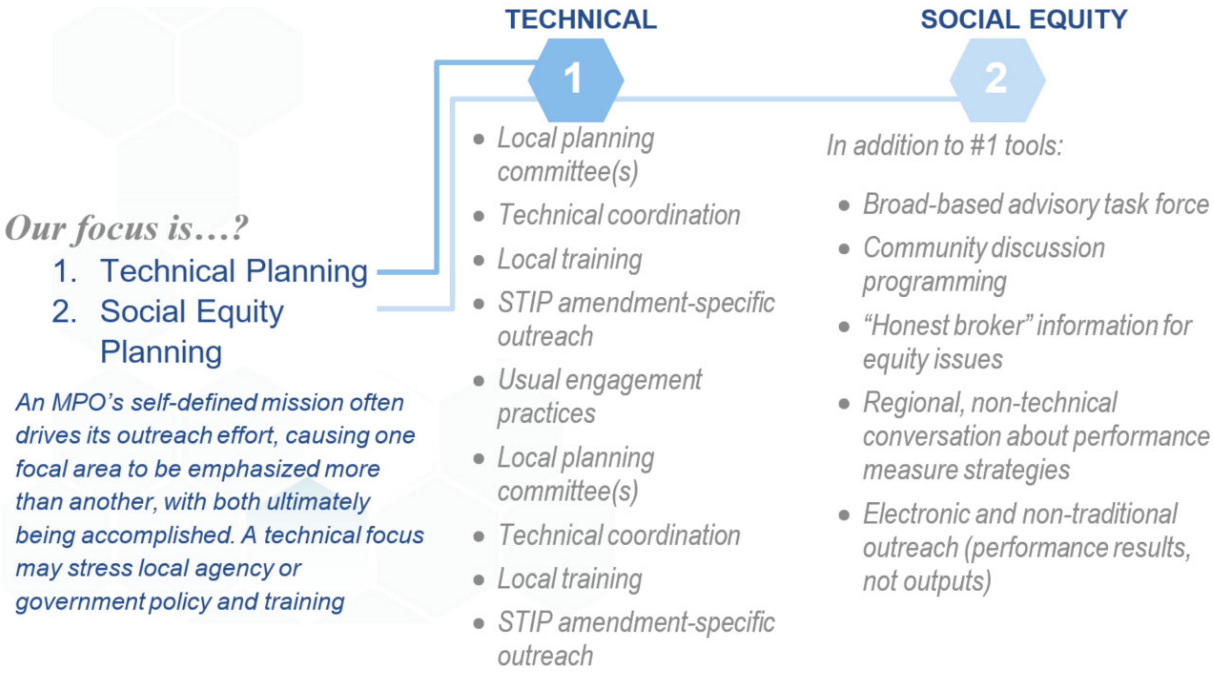
## 9.1 ACES - Impetus to Change?

The potential impacts of ACES are beginning to move metropolitan and regional planning agencies beyond the traditional approach of seeing stakeholder involvement as providing opportunities for input into the existing transportation planning process, along with the sharing policy, funding and technical services and expertise with local agencies and governments.

Many still feel, as one MPO leader put it, that "… transportation is all about getting from point A to point B, and that won't change; technology will just change attributes of that travel." This perspective, along with uncertainties surrounding ACES deployment, have caused many planning agencies nationally to delay addressing ACES in depth until their next LRTP updates. The hope is that they then can better assess how, when and to what impact ACES technology will deploy in their regions. This approach may be supplemented, as it is with the Mid-Ohio Regional Planning Commission, with the recognition that amendments to State Transportation Improvement Plans (STIP) can provide interim opportunities for adding ACES-related projects and strategies. Under this model, the LRTP planning process often remains the main entry point for engaging and educating stakeholders, using traditional outreach tools such as the MPO website, social media and newsletter/other publication, display advertisements, internal advisory groups and others.

On the other hand, an increasing number of planning agencies have embraced a more expansive engagement approach in recent years, reaching out to a much broader range of stakeholders directly affected by the infrastructure decisions in terms of access to jobs, amenities, quality of life and social equity. This

*Figure 17: ACES Engagement Alternatives*



*Our focus is…?*

1. Technical Planning
2. Social Equity Planning

*An MPO's self-defined mission often drives its outreach effort, causing one focal area to be emphasized more than another, with both ultimately being accomplished. A technical focus may stress local agency or government policy and training*

**TECHNICAL**

- *Local planning committee(s)*
- *Technical coordination*
- *Local training*
- *STIP amendment-specific outreach*
- *Usual engagement practices*
- *Local planning committee(s)*
- *Technical coordination*
- *Local training*
- *STIP amendment-specific outreach*

**SOCIAL EQUITY**

*In addition to #1 tools:*

- *Broad-based advisory task force*
- *Community discussion programming*
- *"Honest broker" information for equity issues*
- *Regional, non-technical conversation about performance measure strategies*
- *Electronic and non-traditional outreach (performance results, not outputs)*

movement began with the goal of doing a better job of involving low income and minority populations in voicing their ideas, values and opinions regarding transportation. It has been expanded by the realization of the potential sweeping impacts of ACES deployments, which for many organizations have been seen as adding educational opportunities regarding those impacts.

MPOs keyed into a social equity approach may use the same public involvement tools as those employed under a more traditional model. However, the need to reach new affected stakeholders in innovative ways, forums and manners, especially to address ACES-related issues - can create new demands on public involvement staff and resources in terms of time, resources, technology and approaches.

For example, the Mid-America Regional Council (MARC) – the MPO for Greater Kansas City - established an AV planning framework[fff] for developing regional goals and strategies for successfully deploying new transportation technologies. Its 12-month process will inform development of regional transportation plans, provide ACES policy resources for local governments and identify potential AV deployment strategies for cooperation among public and private sectors.

The MARC Regional Automated Vehicle Planning process is intended to provide ACES considerations for the region's metropolitan transportation plan, best practices for future infrastructure improvements and guidance for data management strategies and other policy and legislative priorities. In the context of its community vision, MARC identified seven broad and locally important topic areas in which a dialog needs to be held with stakeholders. They are:

1. Travel Demand Management and System Performance guidance focused on anticipating changes in travel demand and travel behavior that may result from widespread ACES adoption;
2. Infrastructure, Planning and Investment considerations regarding new infrastructure systems, standards, funding sources and planning tools and processes needed to prepare for successful regional integration of automated and connected vehicles;
3. Data Management and Cybersecurity partnerships, capacities and strategies that enable the public and private sectors to securely manage and share automated and connected vehicle-related data;
4. Environment and Land Use changes in travel behavior and measures for shaping or mitigating their impact on compact, efficient development

and environmental sustainability;

5. Equitable Access and Mobility Services deployment that equitably serves the needs of people and communities with transportation disadvantages;
6. Economic and Workforce Opportunity creation for regional industry clusters, workforce and related economic competitiveness; and
7. Certification, Liability and Insurance considerations and how they affect area local governments.

This work builds on MARC's recent scenario planning efforts and features a robust stakeholder engagement effort; key elements include:

1. Advisory Task Force - guides the process and provides feedback on outcomes and deliverables during the 12-month planning timeline. Proposed representation on this task force includes planning partners, industry experts and academic researchers in fields related to policy focus areas;
2. MARC Committee – provides ACES-related technical and planning capacity to a range of standing committees such as the Total Transportation Policy Committee, Sustainable Places Policy Committee, Highway Committee, Aviation Committee and others; and
3. Regional and National Experts – offer input and guidance acquired through staff-generated literature reviews, surveys and interviews with subject-matter experts.

## 9.2 New Directions

As the MARC example illustrates, ACES-induced engagement changes are potentially so great that new strategies will be needed to:

1. Re-examine and expand stakeholder groups to be involved by MPOs in discussions surrounding ACES and the opportunities they present;
2. Increase stakeholder engagement and public outreach to help these groups fully understand new and emerging ACES-driven needs and determine appropriate responses; and
3. Position stakeholders to flexibly adapt and prosper as ACES follows a typical technology adoption arc from "gold rush" to stable competitive and regulatory environment.

Such ACES-related impacts introduce a broad range of transportation planning challenges, most notably related to timing. The greatest impact may not come from the final shape of a definitive ACES future, but rather from the transitional planning and development period when related transportation needs, solutions and funding requirements and sources are in comparatively rapid flux – and are in competition with fully ACES-compliant projects that may cost less, be funded differently and pose new or alternative impacts.

Although challenging, long-term significant ACES deployment presents an opportunity to re-envision more equitable communities through policies and planning that reduce transportation costs, increase greenspace and build denser land uses. As Aurash Khawarzad with the Center for Social Inclusion noted At ConnectATL, the first automated vehicle summit convened by the Atlanta Regional Commission, the automated and connected future must include the entire community, with equity being addressed at the front end of the planning process for smart mobility projects.[gggg]

MPOs may want to consider whether more robust stakeholder engagement will help partners and stakeholders better understand and respond to ACES within planning processes. Such engagement also may build higher stakeholder tolerances for an extended period of shifting planning decisions made in response to - or in anticipation of – changing ACES impacts and needs. This would require involving private-sector stakeholders, including technology suppliers and emerging service providers, to:

- Identify location-specific ACES scenarios likely to occur;
- Resolve and integrate conflicting ACES priorities; and
- Explore ongoing relationships and initiatives required between the public and private sectors to mitigate potential harms and fully leverage emerging ACES opportunities.

One result of this kind of effort may be the creation of free-standing coalitions of stakeholders with similar interests. Such coalitions can become active, positive partners in helping MPOs prioritize their ACES efforts and invest their resources where they count most. If supported through education and engagement, these coalitions can help stimulate public- and private-sector policies and investments that support MPO policy changes and the performance measures they underpin. This creates collaborative opportunities for MPOs and these coalitions to report on ACES impacts on other community assets and goals, using communication channels MPO partners control.

The use of coalitions and other public advisory groups also can be particularly helpful in overcoming participatory barriers by populations who by income, training, mobility and other factors may have limited success in participating in traditional outreach activities like evening public meetings.

As MPOs consider the pace and attributes of ACES penetration of their regions for outreach and planning purposes, they will naturally engage with the multiplicity of policy makers, industries, and groups that have a stake in shaping local, state and national ACES futures, futures being the operative word as virtually every local community will see ACES play out differently from even nearby communities. The wide-ranging audiences interested in learning about automated vehicles and what is being done to promote the efficient and equitable incorporation of emerging and innovative transportation and technology into plans and projects includes, but is not limited to planners and engineers in the public and private sectors; freight operators; transit operators; automobile manufacturers; original equipment manufacturer (OEM) suppliers; aftermarket equipment manufacturers; academic professionals and students; elected officials and their constituents, as well as users of the transportation system.

With different agendas and needs, the sheer number of stakeholders – along with public need for greater understanding of the different technological paths forward – mean that MPOs are one of the few public institutions with the planning skills and credibility to identify and build support for various policy needs and initiatives that can help communities successfully adopt – and adapt to – ACES.[hhhh]

## POTENTIAL ENGAGEMENT TOPICS

- What is our community's vision for its future? How does that change, if at all, by location or demographics?
- What are the mobility priorities for achieving that vision? How do we resolve conflicting priorities?
- What will it cost to achieve our community vision? How will we pay that cost? At what price point do we revisit/revise our vision and priorities? How do we decide that?
- What are the likely impacts of working toward our vision? How do we decide which are acceptable and at what level? What are our strategies for mitigating or eliminating unacceptable impacts?
- Whose support or acquiescence do we need to create and achieve our community vision? What information and involvement do they need to give us that support? How will we provide it? How will we measure our progress in providing it in ways that measurably advance our vision?

## 9.3 Leading New Community Conversations

MPOs have a clear opportunity to lead in developing comprehensive communication programs that build recognition of and support for the role that emerging and innovative transportation and technology plays in the efficient movement of people and goods.

Given the potentially great – and as-yet unknowable – impacts of ACES, it may not be too early to begin a strategic and comprehensive education and outreach effort. Much information needs to be conveyed, public attitudes about ACES features understood and specific concerns addressed. As the May 2017 Pew Research survey on the rise of automation reported, the American "public generally expresses more worry than enthusiasm about emerging automation technologies" with 56 percent saying they would not want to ride in a driverless vehicle (and 87 percent favoring requirements that all driverless vehicles have a human in the driver's seat able to take control in an emergency).[iiii]

If an MPO sees a need to fully understand and respond to such concerns to ensure it captures the locally appropriate potential of ACES in community planning, beginning to do so now or soon may be beneficial organizationally. Promoting regional dialogs about ACES through MPO planning processes, community forums and topical briefings for area policy makers, for example, will spread the resource impact over a longer period. Interaction with a broader range of stakeholder groups will bring new information and perspectives into the planning process at regular intervals and may mean smaller, easier course corrections in planning over time.

An early start will help MPOs better coordinate ACES messaging between front-running agencies and other entities, thus minimizing potential stakeholder confusion or concern that may negatively affect public policy development. This also may help move stakeholder behaviors in desirable directions while infrastructure investment strategies are being developed, as noted in Advancing Automated and Connected Vehicles: Policy and Planning Strategies for State and Local Transportation Agencies.[iiii]

> *"Public involvement and education are used to inform the planning process. This step is also a planning activity that can have a direct influence on the behavior of consumers and producers in the market. Transportation agencies may, through any number of mediums and strategies, provide information to consumers as a means of encouraging desired behavior. For example, to encourage consumers to purchase CVs with safety, mobility, or environmental applications, transportation agencies can report and communicate the various benefits that have been identified through analysis and evaluation. Agencies may also coordinate with departments of transportation, metropolitan planning organizations, other rural and regional planning organizations, transit agencies and other stakeholders. For example, agencies can report information about AV/CV system performance and the effectiveness of plans and programs. They can also coordinate and form partnerships with the private sector to speed commercialization of CV technologies. In general, as AV and CV technology is developed and deployed, new information should be relayed to the public to expand its understanding of the technologies."*

Such MPO/private-sector partnerships can help the introduction of new ACES-related technology go more smoothly and predictably from a planning perspective by providing advance notice of new developments and potential impacts requiring mitigation. Such engagement frameworks provide continuity of focus over time while also offering flexibility to incorporate new insights and perspectives to meet changing needs using such strategies and tools as:

- Using scenario planning to identify groups to be included in advisory committees and other initiatives based on the probability and magnitude of likely outcomes;
- Tailoring advisory committees using specific geographic and demographic criteria that, together, reflect the weighted make-up of the community;
- Conducting regular polling (phone, in-person and online) to identify issues; develop a baseline of public attitudes to ACES and advocates to be included in planning and engagement activities;
- Participating in free-standing coalitions of stakeholder groups organized around pertinent focal areas - such as privacy, cybersecurity, safety, system performance, infrastructure, environment, land use, equitable access to mobility services and economic and workforce opportunity creation;
- Hosting workshops and community forums to educate the public and specific groups about a comprehensive array of ACES-related topics meaningful to particular audiences; and
- Measuring and publicly reporting on short- and long-term progress towards the community vision and supporting performance measures in ways, such as online dashboards, that help all stakeholders gain better understanding of how ACES affect their lives and their communities.

Approaches like these help create an environment in which MPOs can share insights, best practices and collaborative policy initiatives and advocacy across a broader range of public- and private-sector decision makers and influencers. These techniques can make the planning process more understandable and transparent for a wider spectrum of stakeholders. And perhaps more importantly, these strategies for seeking out and incorporating a broader range of perspectives increases the chances of real-time feedback and dialogue between planning agencies and stakeholders, thus decreasing the likelihood of a patchwork of contradictory strategies, policies and investments that could hinder ACES-related planning progress, potentially harming their communities.

## 9.4 Going Forward

MPOs fill a crucial role as essential ACES education and engagement leaders for policy committees, elected officials and their constituents, specific stakeholder groups and the public. They provide a balanced, informed framework for making important interim and long-term ACES-related decisions that will affect deployment rates, magnitude and timing of positive and negative impacts and the type, scope and effectiveness of community planning.

As MPOs consider how best to accomplish this, initial steps towards ACES engagement often can be incorporated in various existing aspects of an agency's planning process - Vision, LRTP, TIP – or into other planning documents and initiatives related to other MPO services that may be affected by ACES such as 9-1-1, senior services, air quality and other regional services.

Longer term, moving towards a more robust planning agency-led education and engagement model will require identifying and balancing the potentially competing resource demands of adequate engagement staffing, expertise and technology; data collection, analysis and reporting; political sensitivities and will; and speed of marketplace advances versus policy development. Implicit in this is the need for MPOs to assess how best to educate staff on advances in ACES on an ongoing basis so that they can help inform the public, local decision makers and other participants in the planning process, thus improving outcomes and helping regional actors make more sustainable planning decisions and investments.

Agencies and practitioners also cite an interest in having more readily available tools and guidance for addressing these and other challenges beyond transportation and land use-related topics. Examples of such tools include: incorporating emerging issues such as climate change adaptation, improving public health outcomes and social equity. Indeed, the National Association of Regional Councils in 2016 reiterated many of these same findings with a call to action for a broader consortium of public and private entities to organize, invest and share resources to provide technical assistance and more interoperability between appropriate tools and datasets.

While a perfect set of predictive tools may not yet exist, fortunately for MPOs they don't have to be final at this point. "Envisioning Florida's Future: Transportation and Land Use in an Automated Vehicle Automated Vehicle World," issued by FDOT in collaboration with the Florida State University Department of Urban & Regional Planning stated:

> *Automated vehicles will be the catalyst for the next great transformation in our transportation systems and the built environment. By providing public and private stakeholders with a starting point for envisioning the impact of AVs on the built environment, MPOs can offer guidance for public and private stakeholders to prepare for these impacts and ensure that this remarkable opportunity is grasped.*

Such engagement increases the likelihood of a planning agency identifying and implementing actionable, quantifiable strategies that can be monitored and measured against vision-based goals for the community – and helping deliver the policy, institutional and investment changes required to achieve the vision. Additional opportunities for gaining insight on new tools, trends, and techniques for incorporating ACES technologies into transportation plans can also be garnered from conferences such as the annual Florida Automated Vehicle Summit, where many of these planning issues are discussed. Finally, as recommended in the FHWA guidance Federal Strategies for Implementing Requirements for LRTP Updates for the Florida MPOs, a key part of this also involves making sure that MPOs systematically test and validate their outreach strategies to ensure that stakeholders are effectively engaged in ways that ensure full, open participation as outlined in the Code of Federal Regulations.[kkkk]

# 10. CONSIDERATIONS

## CHAPTER 10 AT A GLANCE

- **Florida requires state MPOs to address emerging technologies in long-range plans.**
- **39 considerations focused on engagement, fiscal planning, modeling, planning policy and projects can be a starting point to for LRTP updates.**
- **ACES should support existing state and local goals already established.**

Increasingly automated, connected, electric and shared-use vehicles will profoundly change the personal, public and freight transportation needs and expectations. The multi-faceted challenge MPOs face going forward involves identifying and assessing policy processes and tools that can help them align ACES technologies and public policy outcomes in ways that meet those needs while ensuring safe and efficient mobility that promotes equity and minimizes negative impacts.

ACES are the foundation of mobility in a Smart City or region. Many MPOs are in the middle of Smart City initiatives. It is important for MPOs to think about ACES in the context of other areas of infrastructure (power, water, etc.), data and regional partnerships. In each area, MPOs can help to frame discussions of technology as a tool to realize community goals, not a solution in itself.

Creating a smart city – let alone a "smart state" – will require decision-makers and planners to find ever-more efficient and effective ways to define community goals. They should prompt and measure progress towards those goals while anticipating and helping overcome public and private sector barriers to ACES implementation and the mitigation of any impacts that implementation triggers.

The collection and analysis of the massive amounts of data that will become available in an ACES future data will be challenging. FDOT has already begun to collect some of the data and is formulating strategies and methods to manage this data and analyze it in a secure environment, an extension of previous and ongoing initiatives such as its Reliable, Organized and Accurate Data Sharing Project. ROADS is an example of the focus FDOT puts on improving data reliability and simplifying data sharing.

In addition to collaborating with FDOT in such initiatives, these efforts may also provide models from which MPOs can look to for lessons learned and best practices regarding how to deal with large influxes of data. Additionally, working groups and industry panels are good ways to stay informed and identify new strategies for partnering on data collection, analysis and security and should be considered by MPOs during their long-range planning.

## 10.1 Evaluation

The considerations presented here should be considered "thought-starters" for MPOs as they consider where and how they can most appropriately invest their resources in shaping a region-specific vision of an ACES future. It is not an all-inclusive list.

Local conditions may lead to the creation of new or modified considerations. New research and technology will present new considerations as well. Considerations will not be universally applicable to every MPO. Rather their utility will depend on local conditions, preferences and trends.

When reviewing these considerations, an MPO should determine first whether it has effective formal and informal processes and assessment tools in place to evaluate each consideration in terms of locally defined standards.

## 10.2 Challenges

The Florida Legislature has required the state's MPOs to address emerging technologies in their long-range plans, including assessing the capital investment and other measures necessary to:

> *"...make the most efficient use of existing transportation facilities to relieve vehicular congestion, improve safety, and maximize the mobility of people and goods. Such efforts must include, but are not limited to, consideration of infrastructure and technological improvements necessary to accommodate advances in vehicle technology, such as autonomous technology and other developments."*

Assessing those technologies, however, present multiple levels level of uncertainty for local planning organizations. America is still sorting out which public- and private-sector entities will lead and enforce the development and implementation of policies affecting ACES institutional, informational, technological, operational, political and other impacts. Some combination of these known and unknown future responsibilities may be sought out by MPOs - or imposed upon them by commission or omission – with potentially disruptive institutional impacts affecting organizational focus, priorities and organizational structure, staffing and operations.

The speed of first-mover technology companies may outrun slower-paced efforts to create a positive, impact-neutral policy framework – or create situations in which pressure is brought to bear to shape policies that favor one approach over another. The proliferation of automated models could cause start-and-stop investments in new policies and technologies; make existing intelligent transportation system investments less effective; and negatively affect transportation funding sources and/or their impact on improving transportation infrastructure and related services.

As MPOs wrestle with these challenges, a greater tolerance for ambiguity and uncertainty may be required as they explore, test, evaluate and accept or reject different policy approaches to the opportunities and challenges of ACES. However, tolerance for ambiguity should not be confused with failing to address the issue. To succeed in this kind of environment will require MPOs to create what NCHRP Research Report 845: Advancing Automated and Connected Vehicles: Policy and Planning Strategies for State and Local Transportation Agencies described as "an agile policy-making framework that espouses these principles and sets in place a continual "look ahead" assessment." [llll]

One way to do this would be for MPOs to consider consulting regularly with industry experts to better understand the future and how it might impact localities and regions. Doing this informally or through an "industry council" may help an MPO develop a roadmap of appropriate interactions with industry, legislatures, federal government and others to facilitate ACES deployment and accelerate accompanying societal benefits they have identified.

At the same time, MPOs should find some comfort in the expectation that the benefits of ACES increase with traditional objectives of shared vehicle use, strong urban centers, efficient travel corridors and inclusive access. MPOs should pursue policies like those reflected in the following considerations, in Table 9, that are likely to yield benefits under a wide range of future ACES deployment scenarios. Finally, the following considerations should support MPO and FDOT goals related to transportation mobility and safety. ACES will help with both goals.

*Table 15: Considerations*

| | Considerations | Implementation Time Frame | Report Location |
|---|---|---|---|
| **A** | **ENGAGEMENT** | | |
| 1 | Coordinate with other organizations regarding ACES communication roles and responsibilities. | Short-term | Chapter 9 |
| 2 | Report ACES impact on transportation system performance and other community vision, goals, objectives and assets. | Short-term | Chapter 9 |
| 3 | Collaborate with the private sector to deploy ACES technologies in more uniform, predictable ways. | Short-term | Chapter 9 |
| 4 | Identify and develop staff skills and knowledge on advances in ACES to help them better inform and serve the public, local decision-makers and other participants in the planning process. | Short-term | Chapter 9 |
| 5 | Help the public understand ACES technology so that community decisions about related investments and impacts are made in a timely, factual and sustainable fashion. | SShort-term | Chapter 9 |
| 6 | Develop a roadmap of appropriate interactions between MPOs and industry, legislatures, federal government and others to facilitate ACES deployment and accelerate the accompanying societal benefits. | Short-term | Chapter 9 |
| 7 | Consider developing an ACES committee to inform other policy committees on the trade-offs of ACES. | Short-term | Chapter 9 |
| 8 | Develop an industry council to identify opportunities for private-sector ACES interactions and collaboration. | Short-term | Chapter 10 |
| **B** | **FISCAL PLANNING** | | |
| 1 | Determine potential effects of ACES on infrastructure funding, revenue sources and stakeholder support. | Medium-term | Chapter 7 |
| 2 | Explore funding scenarios to evaluate effects of revenue shortfalls and alternative revenue sources on capital programs. | Medium-term | Chapter 7 |
| 3 | Investigate road pricing and other non-traditional funding sources that better support desired community outcomes. | Medium-term | Chapter 7 |
| 4 | Coordinate with ACES committee and the public to weigh the benefits and drawbacks of non-traditional funding sources to determine whether there is the political will to adopt and sustain those sources in support of a community vision. | Medium-term | Chapter 7 |
| 5 | Coordinate with federal and state agencies to ensure that new funding mechanisms create opportunities to replace local revenue sources disrupted by ACES. | Medium-term | Chapter 7 |
| 6 | Capitalize on the funding opportunities at federal, state and/or local funds. | Short-term | Chapter 7 |
| **C** | **MODELING** | | |
| 1 | Terminal Times, Friction Factors, and modifying the Trip Table are three areas to account for ACES technologies in travel demand models | Short-term | Chapter 4 |
| 2 | Socioeconomic data may be a factor in market penetration rates of ACES technologies in certain zones | Short-term | Chapter 4 |
| 3 | Travel Characteristic surveys may also be used to refine inputs within the Value of Time parameter for additional demand model refinements | Short-term | Chapter 4 |
| 4 | ACES impacts on the relationships between VHT, VMT and network speeds within the model vary between FHWA scenarios and may influence goals and objectives | Short-term | Chapter 4 |
| 5 | Freeway lanes may realize higher capacity improvements due to fewer friction factors and the lack of pedestrian crossings | Medium-term | Chapter 5 |
| 6 | The complexity of models impact the results of capacity, speeds, and VMT depending on scenario used. Therefore, no two model results may be alike. | Long-term | Chapter 5 |

Table 15: Considerations Continued

| | Considerations | Implementation Time Frame | Report Location |
|---|---|---|---|
| **D** | **PLANNING** | | |
| 1 | Refine or revise MPO goals in light of ACES opportunities, impacts and uncertainties. | Medium-term | Chapter 8 |
| 2 | Link local ACES-related long-term goals with state and federal goals to take advantage of benefits and future opportunities. | Medium-term | Chapter 8 |
| 3 | Use regular planning processes such as development of unified work program and scenario planning to capture new data and trends that can be used to achieve regional vision and goals. | Short-term | Chapter 9 |
| 4 | Transit Planning | | |
| | A. Reconsider current transit development plan in light of ACES-related opportunities and threats. | Short-term | Chapter 6 |
| | B. Identify and prioritize major corridors where fixed route transit can be most effective in an ACES future and plan for supporting transit features and land use. | Medium-term | Chapter 6 |
| | C. Support integration of transportation payment and trip planning systems across public and private mobility service providers | Short-term | Chapter 6 |
| | D. Identify locations for mobility hubs where flexible taxi services can interface with fixed route transit. | Short-term | Chapter 6 |
| 5 | Performance Measures | | |
| | A. Develop and continually refine a flexible approach to determining ACES-driven system performance needs and measures. | Short-term | Chapter 9 |
| | B. Create and test new or refined performance measures that better reflect federal and state regulatory requirements while better meeting community needs, preferences and expectations. | Short-term | Chapter 8 |
| 6 | Smart Cities | | |
| | A. Work with municipalities and the private sector to define, collect and share “smart cities” data relevant to long-range planning | Short-term | Chapter 8 |
| | B. Facilitate regional or subarea studies and pilot projects that address vehicle charging in the public right-of-way, renewable energy generation, supporting power systems and other features of the EV ecosystem. | Short-term | Chapter 2 |
| | C. Partner in pilot ACES projects to begin addressing the uncertainties ACES presents. | Short-term | Chapter 8 |
| **E** | **POLICY DEVELOPMENT** | | |
| 1 | Identify ACES solutions to mitigate potentially increased VMT and vehicle emissions. | Medium-term | Chapter 2 |
| 2 | Coordinate with local governments on land-use and parking policies to achieve local and regional goals. | Short-term | Chapter 8 |
| 3 | Work with the local transit agency to develop policies that integrate ride hailing and TNCs with traditional transit, including integrated payment. | Short-term | Chapter 6 |
| 4 | Develop a comprehensive freight strategy that addresses private sector and military freight needs and trends. | Short-term | Chapter 8 |

Table 15: Considerations Continued

| | Considerations | Implementation Time Frame | Report Location |
|---|---|---|---|
| **D** | **PLANNING** | | |
| 1 | Build consensus with MPO members regarding how to account for ACES in project development and prioritization. | Long-term | Chapter 8 |
| 2 | Explore how best to implement new ACES-related infrastructure needs and standards into project planning, including such considerations as the need for: | Long-term | Chapter 8 |
| | A. Increased road marking implementation and maintenance for machine vision (e.g. electronic lane markings that allow use of V2I to provide more accurate lane markings and to provide changing road lanes for work zones.) | Long-term | Chapter 8 |
| | B. Increased pavement maintenance for safe automated vehicle operation. | Long-term | Chapter 8 |
| | C. Electric vehicle charging and related power generation and distribution systems. | Long-term | Chapter 8 |
| | D. Supplementary or supportive ITS investments. | Long-term | Chapter 8 |
| | E. Dedicated or priority lanes for exclusive use by ACES vehicles (intermittently or uniformly). | Long-term | Chapter 8 |
| | F. Signal priority for ACES vehicles. | Long-term | Chapter 8 |
| | G. Parking access and priority for ACES vehicles. | Long-term | Chapter 8 |
| | H. Evaluation of future operations related to lane management and restrictions (truck platoons operating in the left lanes rather than the right lanes, for example), pick up zones for transportation network companies, etc. | Long-term | Chapter 8 |
| | I. Other ACES-related needs as identified. | Long-term | Chapter 8 |
| | J. ACES-related impacts on non-transportation related programs (911, Meals on Wheels, Air Quality, etc.). | Long-term | Chapter 8 |
| | K. Incorporate into existing or planned Complete Streets projects. | Long-term | Chapter 8 |
| 3 | Incorporate ACES-related investments into already programed TIP/STIP and fiscally constrained LRTP infrastructure plans and individual projects. | Long-term | Chapter 8 |

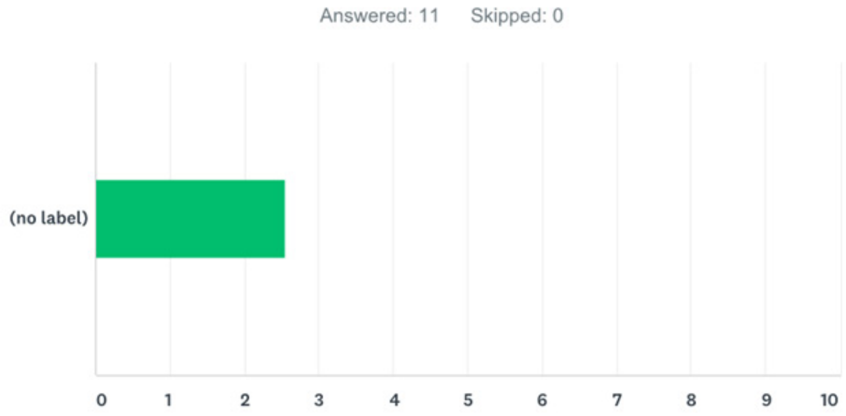
# APPENDIX 1: SURVEY ON THE POTENTIAL IMPACTS OF AN ACES FUTURE ON LRTP GOALS

An electronic survey was developed and emailed to all 27 Florida MPOs and TPOs as a means identifying their understanding questions and concerns related to addressing ACES – Automated, Connected, Electric and Shared vehicles - in their long-rang planning. The questions were designed to better understand how planning organizations were currently thinking about ACES in terms of locally relevant priorities, impacts and organizational challenges and opportunities.

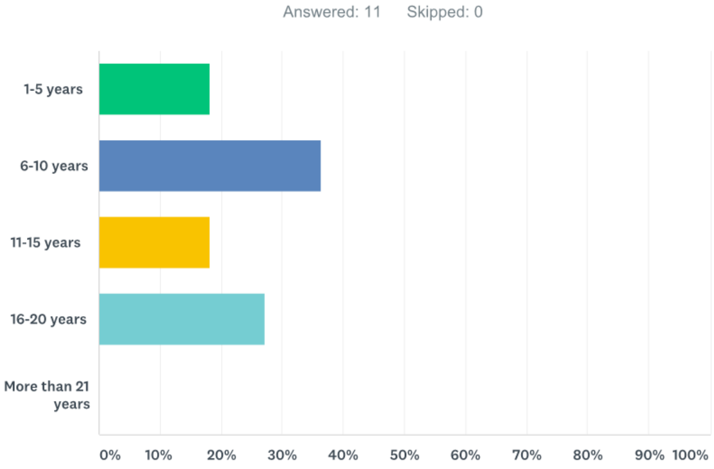
The survey was distributed in early October 2017, to the executive directors of all Florida MPOs, who also were told about the survey and given an opportunity to ask questions about it and its uses at the October MPOAC meeting. Initially, eleven MPOs responded to the electronic survey. A follow up survey was directly sent to MPO planners and three additional MPOs responded for a total of 14 MPO responses (52 percent response rate). Responses to the survey were used to help develop and refine ACES guidance.

## Survey A: FDOT MPO ACES Guidebook Survey (E-mail Survey)

*Q1 How informed do you feel on the subject of ACES – Automated, Connected, Electric and Shared vehicles? (1 = very well informed; 5 = not very informed at all)*

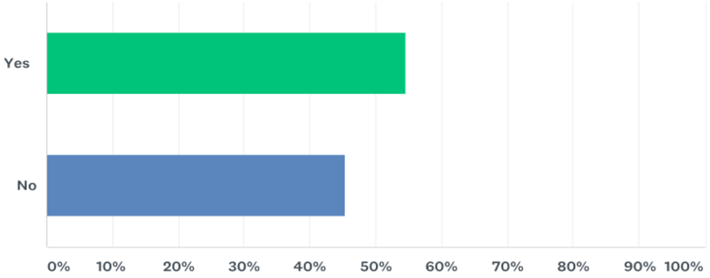


*Q2 Based on your knowledge of ACES, when do you think they will have a significant impact on your region? (select the answer that best applies)*



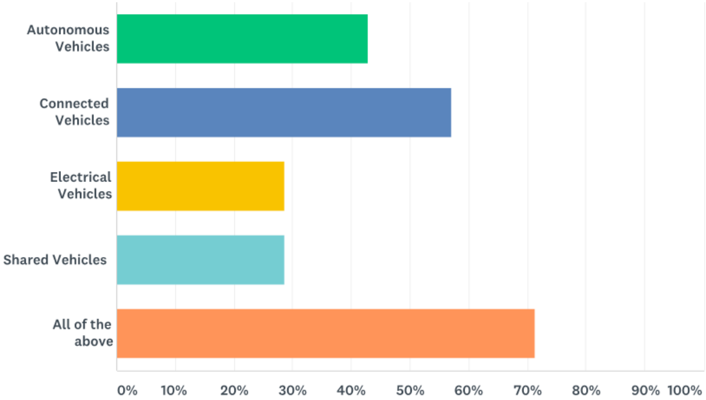
*Q4 If it is, which elements of ACES are being actively addressed? (select all that apply)*

Answered: 11 Skipped: 0



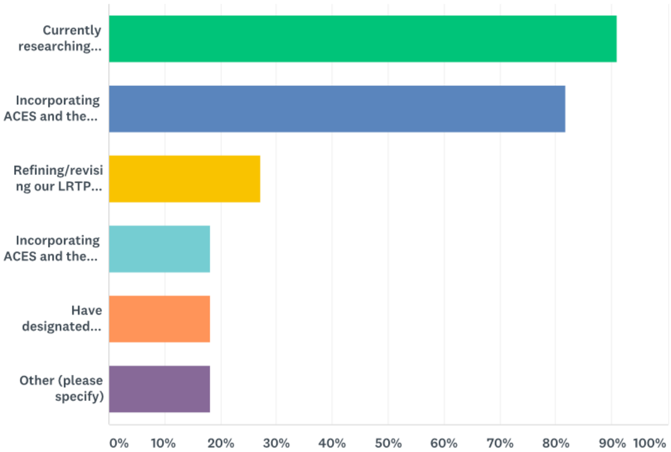
*Q4 If it is, which elements of ACES are being actively addressed? (select all that apply)*

Answered: 7 Skipped: 4



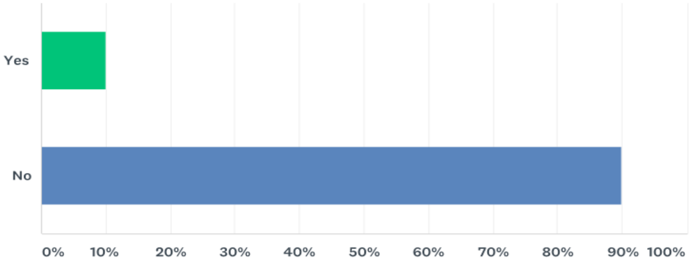
*Q5 How are you addressing ACES at your agency? (select all that apply, even if only to some elements of ACES)*

Answered: 11 Skipped: 0



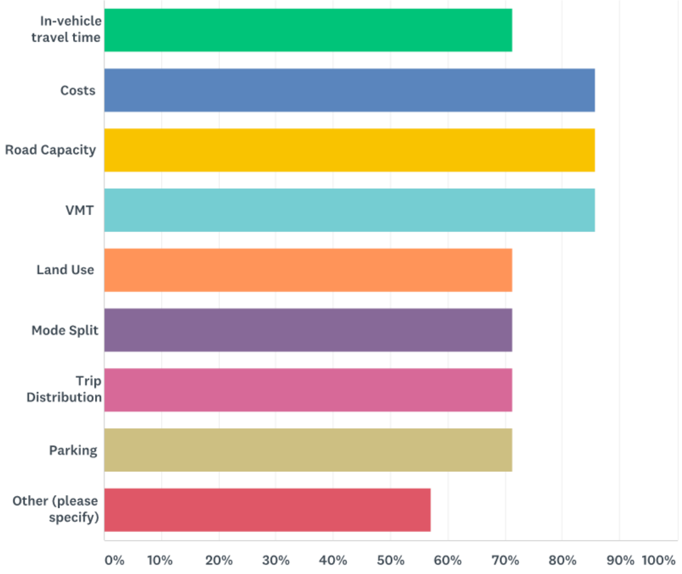
*Q6 Are you reflecting ACES in your travel demand modeling? (select the answer that best applies)*

Answered: 10 Skipped: 1



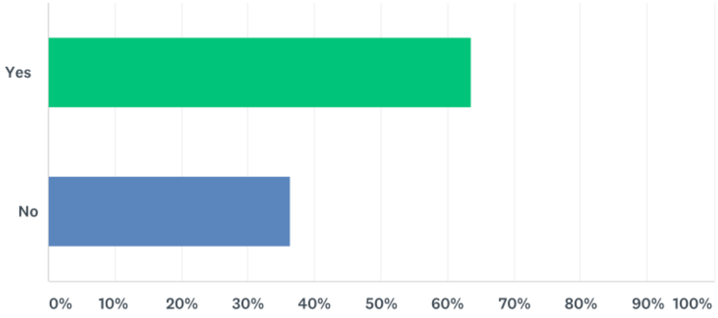
### *Q7 What kinds of changes are you exploring? (select al that apply)*

Answered: 7 Skipped: 4



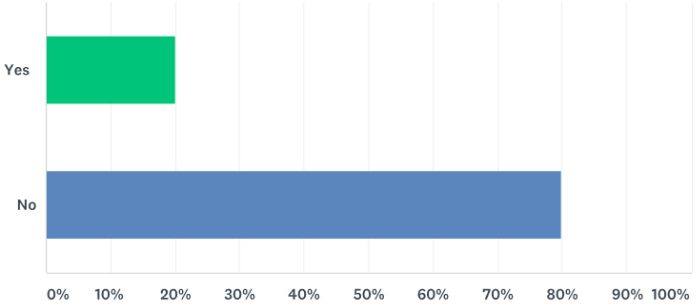
### *Q8 Have you engaged your existing policy and advisory groups to think about future ACES implementation? (select the answer that best applies)*

Answered: 11 Skipped: 0

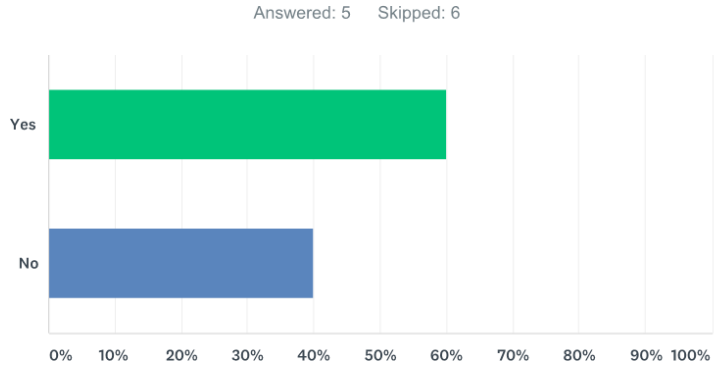


### *Q9 Has your agency been involved in Smart City Challenge activities? (select the answer that best applies)*

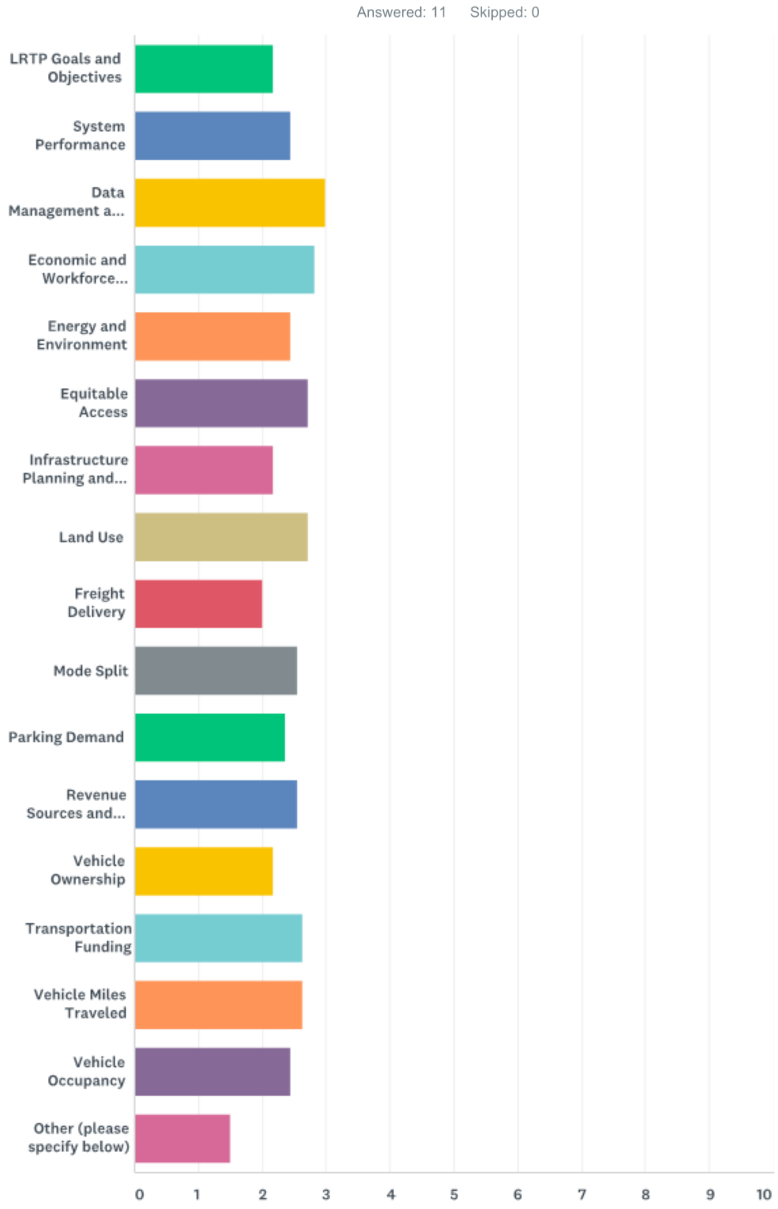
Answered: 10 Skipped: 1



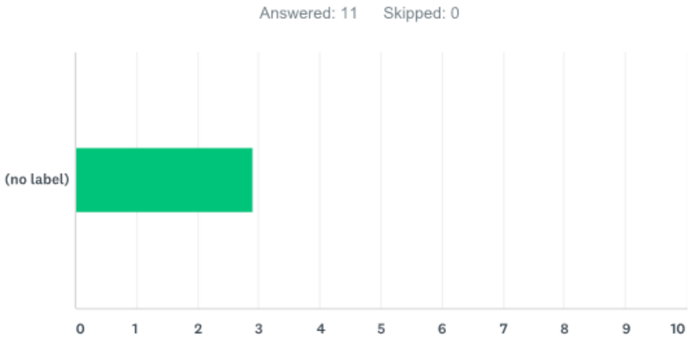
*Q10 If yes, have you continued to engage in Smart City Challenge activities since Columbus, Ohio was awarded the grant? (select the answer that best applies)*



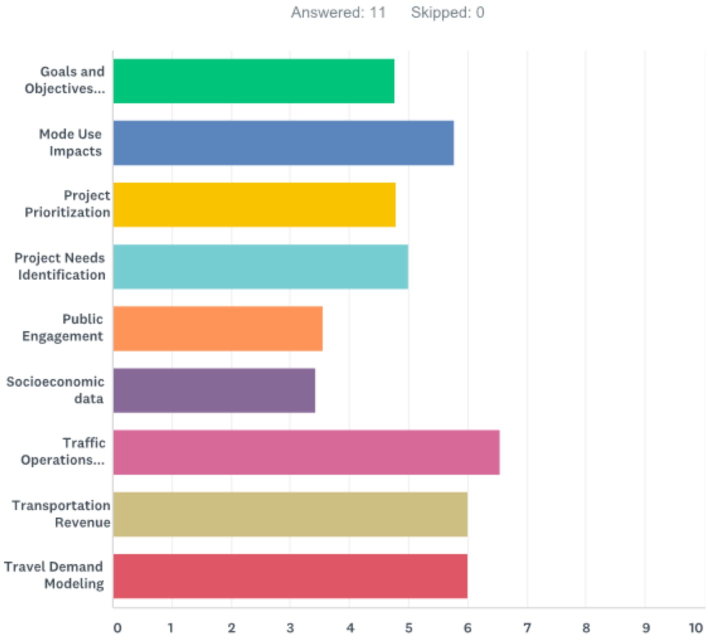
*Q11 From your agency's perspective and within your LRTP horizon year, how much impact will ACES have in the following areas: (1 = high impact; 5 = low impact)*



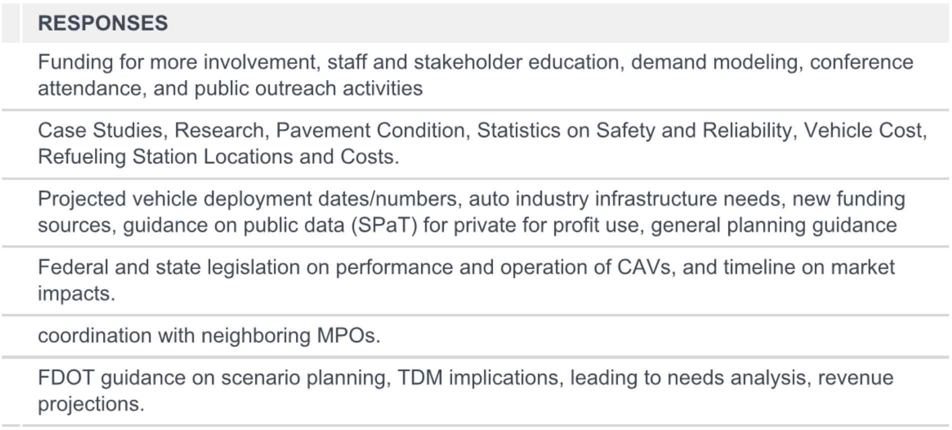
*Q15 Thinking about ACES and potential impacts on how your agency functions, how big a priority does it represent to your organization? (1 = high priority; 5 = low priority)*



*Q16 Please rank the following in terms of information or guidance you may need to better assess future transportation technology impacts? (1 = most important 9 least important)*



*Q17 What tools, information or resources do you need as you look into a future with more ACES?*



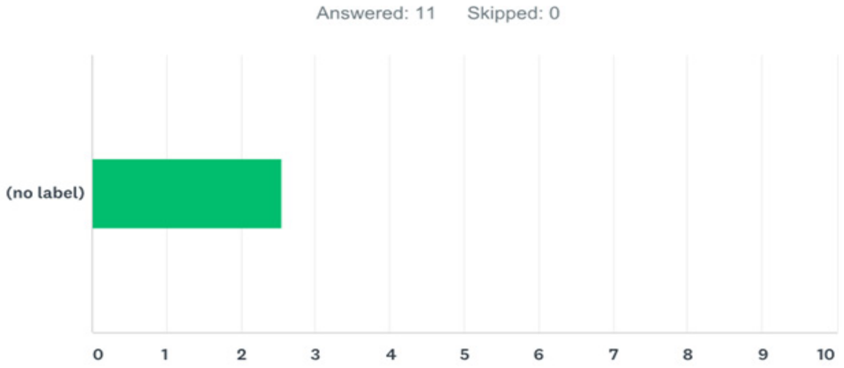
| RESPONSES |
|---|
| Funding for more involvement, staff and stakeholder education, demand modeling, conference attendance, and public outreach activities |
| Case Studies, Research, Pavement Condition, Statistics on Safety and Reliability, Vehicle Cost, Refueling Station Locations and Costs. |
| Projected vehicle deployment dates/numbers, auto industry infrastructure needs, new funding sources, guidance on public data (SPaT) for private for profit use, general planning guidance |
| Federal and state legislation on performance and operation of CAVs, and timeline on market impacts. |
| coordination with neighboring MPOs. |
| FDOT guidance on scenario planning, TDM implications, leading to needs analysis, revenue projections. |

### *Q18 Describe your MPO region. (geography, demographics, economic outlook, etc.)*

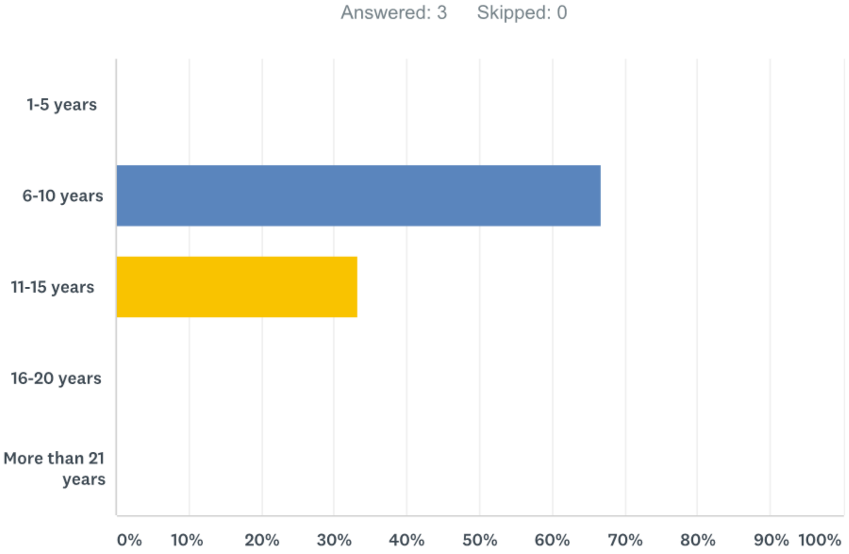
| RESPONSES |
|---|
| MPO covers Palm Beach County, with approximately 2,300 square miles with 1.4 million people; relatively fast growing area |
| Coastal, fast-growing, continued growth projected, tied to Tampa Bay and Orlando regional economies. |
| The three TPOs in our region are located in the extreme northwest Florida or the Panhandle. The population of the metropolitan planning areas for the three TPOs based on the 2010 Census are 434,896 (Florida-Alabama), 214,967 (Okaloosa-Walton), and 168,852 (Bay). Most of the population is between the ages of 18-44. The male and female population is almost identical and is predominately white followed by African-American, multiracial, and Hispanic or Latino. The majority of the population speaks English The Economic Outlook for the region is good. Airbus locating to Mobile in 2015, the expansion of the Navy Federal Credit Union, Military presence, tourism, proximity to the Gulf of Mexico and Interstate 10, a 4-year University and three state colleges, and agricultural presence in the northern parts of the region are reasons for the good economic outlook. |
| http://www.planhillsborough.org/2040-lrtp/ |
| Population of 561,714 in 2015, 72 miles long, constrained by water on east and west, lots of urban sprawl, Auto oriented, for more see our State of the System Report http://spacecoasttpo.com/wp-content/uploads/2016/12/2015-SOS-Final-Report-2016_11_16.pdf |
| www.metroplanorlando.com for Annual Report or Tracking the Trends. |
| Polk County - Lakeland/Winter Haven MSA Prominent logistics and freight distribution hub |
| flat. old. growing. |
| Collier MPO. End of the line from transportation perspective. High/low income and retirees/families split west/east axis; economic outlook - high growth residential and service industries |

## Survey B: FDOT MPO ACES Guidebook Survey (Phone Survey)

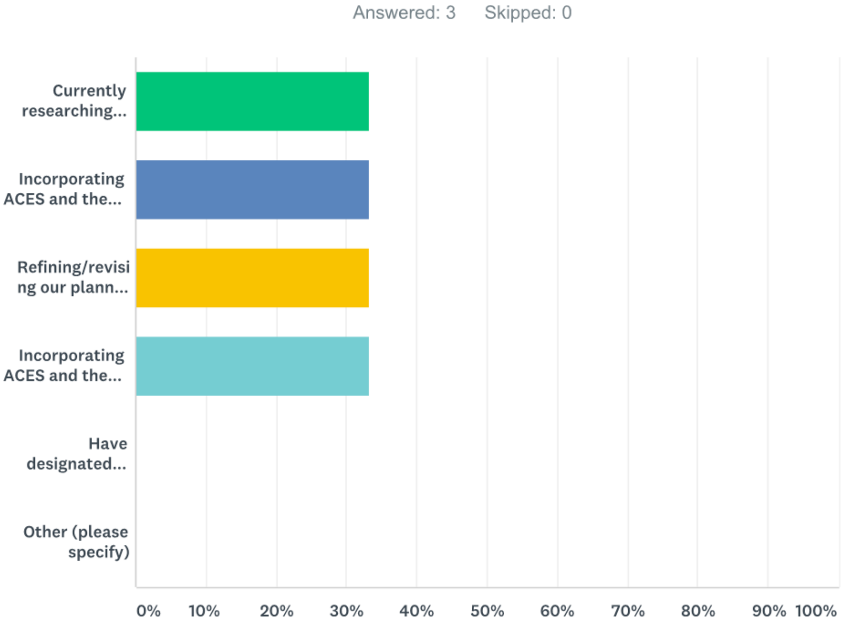
*Q1 How informed do you feel on the subject of ACES – Automated, Connected, Electric and Shared vehicles? (1 = very well informed; 5 = not very informed at all)*



*Q2 Based on your knowledge of ACES, when do you think they will have a significant impact? (select the answer that best applies)*

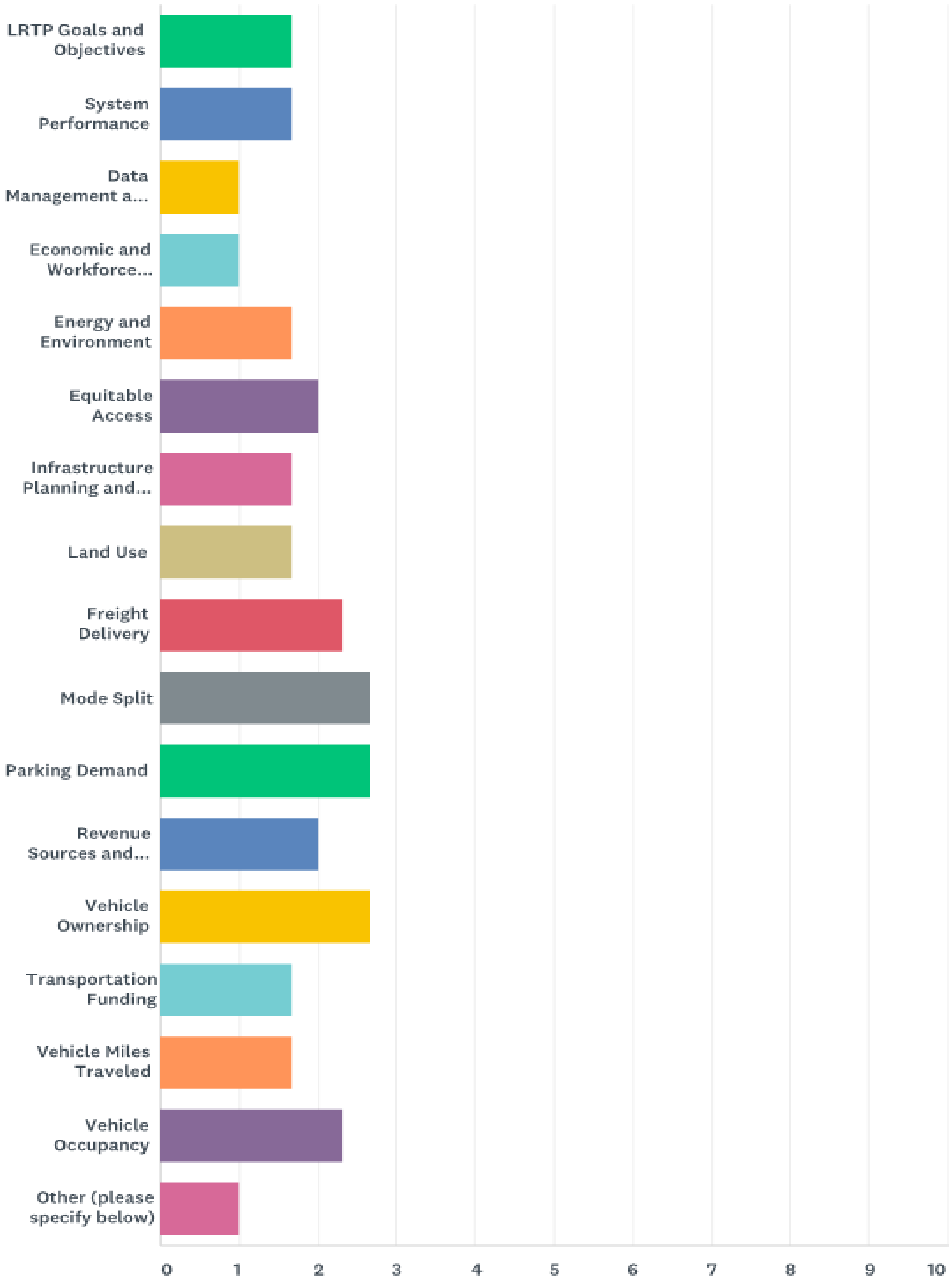


*Q3 How are you addressing ACES at your agency/business? (select all that apply, even if only to some elements of ACES)*



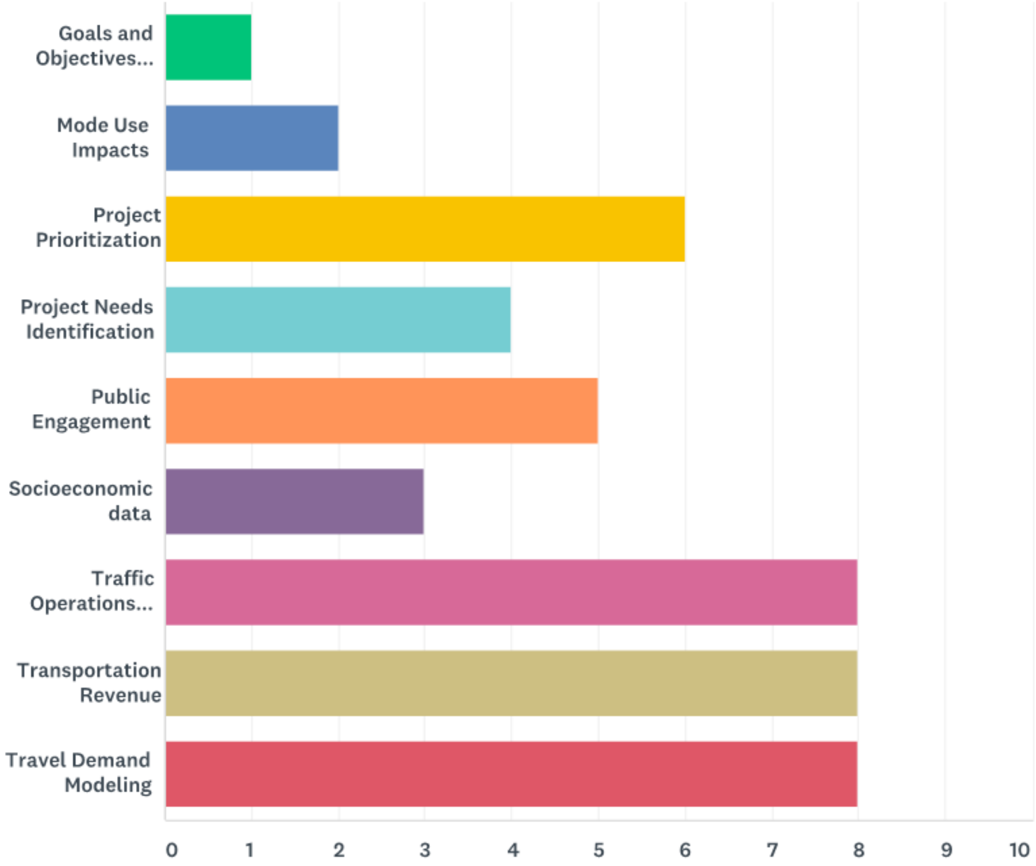
*Q4 From your agency's/businesses perspective, how much impact will ACES have on the following transportation planning or network attributes: (1 = high impact; 5 = low impact)*

Answered: 3 Skipped: 0



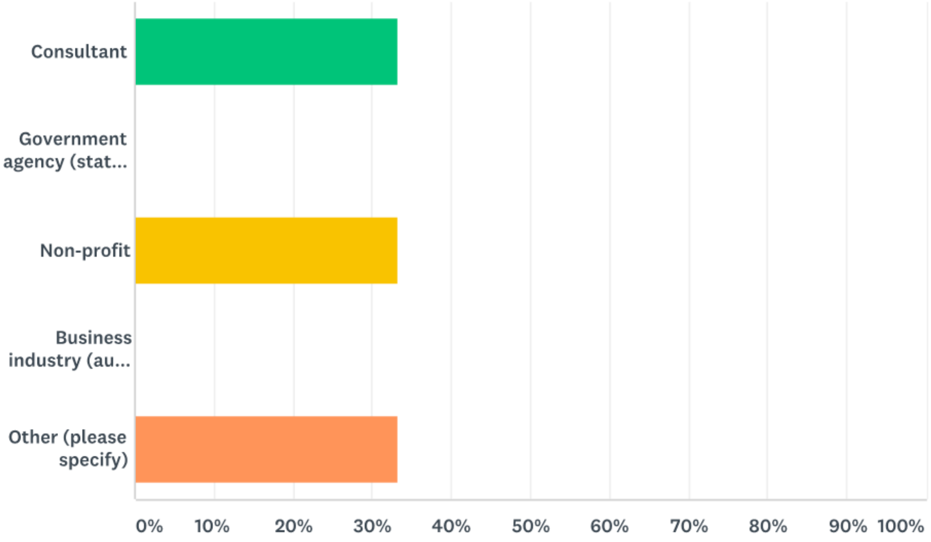
*Q5 Please rank the following in terms of information or guidance you may need to better assess future transportation technology impacts? (1 = most important 9 least important)*

Answered: 2 Skipped: 1



*Q6 What industry do you represent?*

Answered: 3 Skipped: 0



# APPENDIX 2: ACES ADOPTION METHODOLOGY

As organizations grapple with the potential opportunities and implications of ACES, they quickly encounter a broad and rapidly changing range of estimates and projections regarding the speed and depth of impacts to be experienced by local, state and national transportation networks.

For example, consider just three estimates from credible, mainstream sources:

- *IHS Automotive* – "Autonomous vehicle sales to surpass 33 million annually in 2040, enabling new autonomous mobility in more than 26 percent of new car sales."
- *RethinkX* – "By 2030, within 10 years of regulatory approval of autonomous vehicles (AVs), 95 percent of U.S. passenger miles traveled will be served by on-demand autonomous electric vehicles owned by fleets, not individuals, in a new business model we call "transportation-as-a-service".
- *Victoria Transportation Policy Institute* – "In the 2040s, autonomous vehicles will represent approximately 50 percent of vehicle sales, 30 percent of vehicles and 40 percent of all vehicle travel. Only in the 2050s would most vehicles be capable of automated driving."

Such a variety of estimates arise from a number of factors that, depending upon even small fluctuations between projected and actual experience may produce dramatically different outcomes:

- Because new vehicles sold today remain in service for at least 20 years on average, the fleet is expected to contain a significant share of traditional Level 0-1 vehicles for several decades. Whether that fleet turnover rate remains the same or is accelerated by broad public acceptance of automation benefits is unknown. However, it illustrates one example of the considerable uncertainty surrounding the rate of adoption, prompted in part by the wide range of factors that could affect acceptance and dispersal of automation technology.
- There is widespread interest among investors, ride-sourcing companies (e.g. Uber and Lyft), trucking companies and vehicle manufacturers in introducing Level 4-5 vehicles, with testing occurring around the world. Transit agencies are also implementing low-speed automated shuttles in urban centers, campus environments and as a first-mile/last mile connection near rail stations in many cities. Both trends could influence overall market demand by accelerating consumer familiarity and comfort with automated vehicles that translates into faster rates of private ownership.

Because the rate of adoption of AV technology is so uncertain and has important effects on planning implications, it was necessary to develop a fleet transition model to evaluate the relationships between sales forecasts, vehicle types as a share of the total fleet and VMT share. As represented in the S-curves and use cases illustrated elsewhere in this guidance, the informal modeling was designed to simulate the organic growth and replacement of the vehicle fleet as new technologies are introduced. It covers not just various types of automated vehicles, but simulates connected and electric vehicle adoption as well.

Key steps in the simulation included estimating or computing the:

1. Growth of existing fleet of cars, light trucks, motorcycles, buses and heavy trucks based on USDOT vehicle inventory data, Census population forecasts and Congressional Budget Office economic projections. This estimate reflects what demand for vehicles of each type would be without the introduction of ACES technologies.

2. Reductions in demand for human-driven vehicles caused by the introduction of Automated fleet services for personal mobility and local freight delivery. This is modeled using an S-curve approach in which a midpoint year and a duration for moving from 1 percent to 99 percent of the ultimate impact is derived from the FHWA scenarios (see Section 9.3).

3. Resulting "adjusted" vehicle demand after the effects of fleet platforms are considered. This becomes the base fleet forecast that is then allocated among vehicle types with various ACES characteristics. The forecast is broken out by annual sales of vehicle replacements (estimated using the average age at which vehicles are replaced) and additional vehicles needed to accommodate growth.

4. Annual sales of each of 10 types of AVs, including shares of each that are CVs and EVs based on a similar S-curve approach. Fleet AV sales are reduced to reflect the higher levels of utilization expected from automation.

5. Resulting fleet size of each of the vehicle types, including the shares of each that are CVs and EVs.

6. VMT contributed by each vehicle type based on current USDOT average annual mileage traveled data and estimates of vehicle utilization for AVs from the literature.

7. Impacts in terms of AV, CV and EV share of fleet from 2020 to 2060; AV, CV and EV share of VMT; and same for a snapshot in 2040.

A more detailed look at the assumptions used in producing S-curves related to the six FHWA scenarios can be seen as part of the S-curves projection workbook that follows. The workbook provides a look at the sources and assumptions used to produce the S-curves. It also enables users to adjust assumptions and variables to more closely mirror known or projected conditions in a region in order to estimate what an ACES future might local like in a specific jurisdiction.

# APPENDIX 3: ACES USE CASES

A major shift in the implications of automated vehicles occurs when the human occupant is removed from the vehicle driving process. When the vehicle can operate without anyone on board, many limitations of the current human-driven mobility system are removed, new business models are possible and potentially transformative and disruptive effects of technology emerge.

This planning guide recognizes the important distinction between the incremental effects on safety, convenience and mobility that we are experiencing with the Level 2-3 vehicles of today and the more profound effects that Level 4-5 vehicles may bring.

A "use case" is made up of a set of possible sequences of interactions between systems and users in a particular environment and related to a particular goal. Use cases that are likely to have different effects on road design, Vehicle Miles Traveled (VMT), parking, urban form and other planning issues are distinguished by the degree of automation, the ownership of the vehicle. Whether a vehicle can reposition itself without a human on board and whether it is restricted for use by a single owner or available for shared use results in different effects. Likely use cases to consider in the planning process are described in the following tables. Each icon illustrates a potential impact and is associated with a descriptive note.

| Use Case | Shared Use | Road Design Impacts | VMT Impacts | Parking Impacts | Urban Form Impacts | Other Impacts |
|---|---|---|---|---|---|---|
| **Level 2-3 Cars and Light Trucks** | Largely household ownership; shared use limited to rental fleets, ride sourcing and car sharing | 1<br>2 | 3<br>4 | 5<br>6 | 7 | 8 |

1 Driving systems increase need for lane marking maintenance.
2 Connected vehicle lanes on highways facilitate platooning, increasing capacity.
3 Easier driving on freeways and in traffic increases tolerance for longer commutes.
4 Electrification reduces cost of vehicle operation, promoting more and/or longer trips.
5 Level 4-5 remote parking capability expected to allow for smaller parking spaces.
6 Electrification likely to increase need for chargers at homes and destinations.
7 Level 4-5 remote parking expected to reduce need for physical proximity of parking and uses. Reduced emphasis on parking availability near main entrance contributes to more walkable site design.
8 Broad adoption may reduce crash rates.

| Use Case | Shared Use | Road Design Impacts | VMT Impacts | Parking Impacts | Urban Form Impacts | Other Impacts |
|---|---|---|---|---|---|---|
| **Level 2-3 Vans and Buses** | Mix of privately and publicly owned vehicles, including transit fleets | 1<br>2 | 3<br>4 | 5<br>6 |  | 7 |

1 Driving systems increase need for lane marking maintenance.
2 Connected vehicle lanes on highways facilitate platooning, increasing capacity.
3 Improved working conditions could enable longer hours of service, potentially reducing operating costs.
4 Electrification reduces cost of vehicle operation, potentially increasing mode share.
5 Level 4-5 remote parking capability expected to allow for smaller fleet storage facilities.
6 Electrification likely to increase need for chargers at bus route terminals or en-route stations.
7 Broad adoption may reduce crash rates.

| Use Case | Shared Use | Road Design Impacts | VMT Impacts | Parking Impacts | Urban Form Impacts | Other Impacts |
|---|---|---|---|---|---|---|
| **Level 2-3 Heavy Trucks** | Largely fleet ownership | 1<br>2 | 3<br>4 | | | 5 |

1 Driving systems increase need for lane marking maintenance.
2 Connected vehicle lanes on highways facilitate platooning, increasing capacity.
3 Improved working conditions may reduce truck driver shortage, leading to diversion of some shipments from rail to truck.
4 Platooning and electrification expected to reduce fuel consumption, reducing costs and potentially leading to diversion of some traffic from rail to truck.
5 Broad adoption may reduce crash rates.

| Use Case | Shared Use | Road Design Impacts | VMT Impacts | Parking Impacts | Urban Form Impacts | Other Impacts |
|---|---|---|---|---|---|---|
| **Level 4-5 Cars and Light Trucks** | Largely household ownership; shared use limited to rental fleets and car sharing | 1<br>2<br>3<br>4 | 5<br>6<br>7<br>8 | 9<br>10 | 11<br>12 | 13 |

1 Driving systems increase need for lane marking maintenance.
2 Connected vehicle lanes on highways facilitate platooning, increasing capacity.
3 Connected vehicle lanes at arterial intersections may increase capacity.
4 Road construction, emergencies and other temporary conditions require fleet operators or subscription services to divert vehicles to other routes.
5 Electrification reduces cost of vehicle operation, promoting more and/or longer trips.
6 Fully automated driving may reduce disutility of travel, promoting more and longer trips.
7 Greater mobility for non-driving populations increases demand for travel.
8 Reduced parking cost in remote lots may divert trips in dense urban centers from transit to auto.
9 Remote parking capability expected to allow for smaller parking spaces.
10 Electrification likely to increase need for chargers at homes and destinations.
11 Remote parking expected to reduce need for physical proximity of parking and uses, potentially contributing to more walkable site design.
12 Remote parking allows for conversion of parking lots and structures in urban centers, as well as some residential garages, to other uses.
13 Broad adoption may reduce crash rates.

| Use Case | Shared Use | Road Design Impacts | VMT Impacts | Parking Impacts | Urban Form Impacts | Other Impacts |
|---|---|---|---|---|---|---|
| **Level 4-5 Taxis** | Almost exclusively public or private ride sourcing fleets | 1<br>2<br>3<br>4<br>5 | 6<br>7<br>8<br>9 | 10 | 11<br>12<br>13<br>14 | 15<br>16<br>17 |

1 Driving systems increase need for lane marking maintenance.
2 Connected vehicle lanes on highways facilitate platooning, increasing capacity.
3 Connected vehicle lanes at arterial intersections may increase capacity.
4 Road construction, emergencies and other temporary conditions require fleet operators or subscription services to divert vehicles
5 to other routes.
6 Increased need for curbside drop-off areas.
7 Greater mobility for non-driving populations increases demand for travel.
8 Automation likely to reduce cost of taxi services, shifting demand from buses to smaller vehicles.
9 Reduced cost of mobility expected to increase number of trips.
10 More efficient smartphone-based dispatching likely to offset some VMT growth with less deadhead compared to human-driven taxis.
11 On-demand mobility services likely to reduce car ownership and demand for both residential and destination parking.
12 Reduced parking demand expected to lead to conversion of parking lots and structures in urban centers, as well as some residential garages, to other uses.
13 Parking areas near main entrances likely to transition to pick-up/drop-off areas.
First-mile/last-mile services support consolidation of transit stops into high-amenity stations in major urban corridors.
14 Fleet service centers likely to emerge on fringes of urban centers.
15 Broad adoption may reduce crash rates.
16 Reduced car ownership likely to have transformative impacts on automobile-dependent industries, including manufacturing, repair, driving and insurance.
17 New jobs created in mobility service control centers, vehicle fleet maintenance facilities and support services

| Use Case | Shared Use | Road Design Impacts | VMT Impacts | Parking Impacts | Urban Form Impacts | Other Impacts |
|---|---|---|---|---|---|---|
| **Level 4-5 Low Speed Shuttles** | Almost exclusively transit fleets | 1<br>2 | FM LM 3 | 4<br>5 | 6 | |

1 Additional signals or other traffic control may be needed where low-speed shuttle routes cross mixed traffic streets.
2 Mixed use trails that accommodate low-speed shuttles may be wider than pedestrian/bike only trails.
3 Improved options for first-mile/last-mile may increase transit mode share.
4 Increased transit mode share may reduce parking demand in campuses and urban centers.
5 Remote parking shuttles may reduce parking demand near destinations.
6 Level 4-5 remote parking expected to reduce need for physical proximity of parking and uses. Reduced emphasis on parking availability near main entrance contributes to more walkable site design.

| Use Case | Shared Use | Road Design Impacts | VMT Impacts | Parking Impacts | Urban Form Impacts | Other Impacts |
|---|---|---|---|---|---|---|
| **Level 4-5 Vans and Buses** | Almost exclusively public or private transit fleets | 1<br>2 | 3<br>4 | 5 | 6 | 7<br>8 |

1 Driving systems increase need for lane marking maintenance.
2 Dedicated road space in major urban corridors provides priority to high occupancy vehicles and may facilitate high degree of automation sooner.
3 Reduced transit operating costs allow more frequent service in major urban corridors.
4 Reduced transit operating costs may support fixed route services in lower density settings, such as connections between suburban campuses and transit corridors.
5 On-demand mobility services likely to reduce car ownership and demand for both residential and destination parking.
6 Dedicated transit priority corridors encourage transit-supportive development patterns around stations.
7 Mix of public and private transit operators likely as taxi companies aggregate trips into larger vehicles in major urban corridors.
8 Transit automation may reduce demand for bus drivers, potentially offset by increased service frequency in major corridors and new control center jobs.

| Use Case | Shared Use | Road Design Impacts | VMT Impacts | Parking Impacts | Urban Form Impacts | Other Impacts |
|---|---|---|---|---|---|---|
| **Level 4-5 Urban Delivery** | Almost exclusively fleet ownership | 1<br>2<br>3<br>4<br>5 | 6<br>7 | | 8<br>9 | 10<br>11<br>12 |

1 Driving systems increase need for lane marking maintenance.
2 Connected vehicle lanes on highways facilitate platooning, increasing capacity.
3 Connected vehicle lanes at arterial intersections may increase capacity.
4 Increased need for curbside and off-street loading zones.
5 Low-speed delivery vehicles share space with pedestrians, requiring new intersection control systems in urban centers and potentially wider sidewalks.
6 Electrification reduces cost of vehicle operation, promoting more and/or longer trips.
7 New business models built on low-cost driverless delivery likely to generate demand for more trips.
8 Fleet service centers likely to emerge on fringes of urban centers.
9 Transition to on-demand delivery likely to further reduce demand for traditional brick-and-mortar retail uses, especially outside urban centers.
10 Broad adoption may reduce crash rates.
11 Retail industry continues transition from selling physical goods to providing individualized services and experiences in urban shopping centers.
12 Food service industry may transition to more delivery-based business models.

| Use Case | Shared Use | Road Design Impacts | VMT Impacts | Parking Impacts | Urban Form Impacts | Other Impacts |
|---|---|---|---|---|---|---|
| **Level 4-5 Heavy Trucks** | Almost exclusively fleet ownership | 1<br>2<br>3 | 4<br>5 | 6 | 7 | 8<br>9 |

1 Driving systems increase need for lane marking maintenance.
2 Connected vehicle lanes on highways facilitate platooning, increasing capacity.
3 Connected vehicle lanes at arterial intersections may increase capacity.
4 Electrification reduces cost of vehicle operation, promoting more and/or longer trips.
5 Automation reduces operating costs, leading to diversion of some traffic from rail to truck.
6 Less use of human drivers for long-haul trucking reduces demand for truck plazas near highway interchanges.
7 Truck terminals needed near highway interchanges to transfer loads between large trucks and urban delivery vehicles.
8 Trucking industry jobs may shift from driving to fleet control centers, vehicle maintenance and logistics hubs.

# APPENDIX 4: POTENTIAL IMPACTS OF AN ACES FUTURE ON LRTP GOALS

The impact of ACES on LRTP Goals is unknown. This table provides some thought starters for your scenario planning exercise.

| | | Possible LRTP Goals | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **Safety & Security** | **Quality Infrastructure** | **Efficient & Reliable Mobility** | **Transportation Choice** | **Economic** | **Quality Community** | **Environment** |
| **Potential Impacts** | **Safety** | Increase in ACES increases safety for all modes<br>Technology security is a concern | Safety can be incorporated into the rebuilding of infrastructure to meet ACES needs | ACES are expected to increase the efficiency of the transportation system and improve mobility for everyone | ACES will provide people with greater choices in transportation | ACES will provide more choice to the marketplace lowering transportation costs<br>Anticipated “winners” and “losers” in the transportation industry | ACES will improve the safety of the most vulnerable road users (pedestrians & cyclists) | Crash reduction will have a positive impact on the environment |
| | **Infrastructure** | ACES provide opportunity to improve the safety of outdated infrastructure | May need high quality dedicated infrastructure only accessible with ACES technology | Investments in infrastructure to meet ACES needs provides the opportunity to improve efficiency and reliability | Infrastructure investment allows investment in a range of transportation infrastructure providing more choice | Reduction in congestion and improved travel time reliability<br>Infrastructure will support the economic growth potential of an area by allowing efficient and reliable mobility | Reductions in infrastructure creates opportunity to enhance quality of life | Reduced infrastructure needs would reduce the physical impact on the environment |
| | **Land Use** | Changes in land use patterns will require safety and security to be rethought | Decreased parking requirements will make land available for high-density residential or mixed-use development | Land use changes effect on travel efficiency and reliability is unknow<br>Travel models aim to project the potential range of impacts | More transportation choices offered that could impact land use | May increase commuter willingness to travel longer distances<br>Households and businesses may situate farther away from urban cores in search for affordability<br>May incentive sprawl, low-density urban development and increase in travel | Reduction in parking requirements<br>May allow for road diets<br>Increase in available land for redevelopment<br>Opportunity to invest in walkable communities and encourage compact urban growth patterns | Land use changes could provide either a positive or negative impact on the environment |
| | **Capacity** | Enables safe travel at higher speeds with fewer accidents<br>Less congestion and bottlenecks | Expected higher capacity and ability to serve more people and goods | A higher capacity transportation system will be more efficient and reliable | Reduced need to invest in increased capacity will allow investment in increased modes | ACES technology will vastly increase highway capacity increasing economic growth and opportunity | Increased capacity may allow communities to focus transportation dollars on more Complete Street concepts | By reducing traffic congestion and the need for fossil fuels, environmental factors will improve |
| | **Mode Choice** | Increased mode choices with safety features | Light EVs and shared use vehicles would have less impact on infrastructure | AVs are expected to increase headways and provide more efficient and reliable trips | Increased car-sharing and driverless taxis with potentially reduced individual vehicle ownership | Influence the relative competitiveness of other modes of transportation maximizing economic competitiveness | Enable new opportunity for those who cannot currently drive (elderly, disabled, children) | Technology will reduce carbon emissions |
| | **Freight** | Improved technology with freight movement will provide safety and security to goods movement | Electric freight vehicles will have less wear and tear on infrastructure | Advanced freight technology will have a role to play in optimizing and streamlining logistic movements | Technology will provide alternative freight mobility choices to consumers | Increased fuel economy through vehicle weight reductions will also reduce battery and storage tank requirements (and costs) alternative-fuel vehicles | Technology improvements to freight will provide opportunities for quality community infrastructure | Technology improvements to freight will reduce environmental impacts |
| | **Revenue** | EVs will reduce existing revenue sources impacting safety and security goals | EVs will reduce existing revenue sources impacting ability to maintain infrastructure | EVs will reduce existing revenue sources impacting efficient and reliable mobility | EVs will reduce existing revenue sources impacting transportation choice | Reduced driver costs (gas, ownership, property damage/insurance)<br>Impact on revenue | Potential for niche occupations to become obsolete (bus drivers, taxi drivers, chauffeurs, etc.) | Reduced transportation revenue due to EVs may reduce environmental mitigation opportunities |
| | **Parking** | Shared vehicles will reduce parking needs<br>AVs will eliminate human error and reduce parking lot collisions | Reduction in parking demand will reduce public and private costs | Point to point travel efficiency and reliability is improved without the need to park | In cities where parking is expensive/limited, ACES vehicles act as a viable option for mobility | ACES vehicles will reduce parking requirements<br>Increase in available land for development | Reduced parking allows for more walkable spaces, trees and less heat absorbent asphalt | Reduction in parking lots and negative externalities including toxic runoff |

# CONTACT INFORMATION

Mark E. Reichert

Administrator for Metropolitan Planning

Office of Policy Planning, Florida Department of Transportation

605 Suwannee Street, MS 28

Tallahassee, Florida 32399-0450

Direct: 850-414-4901

Mark.Reichert@dot.state.fl.us

# ENDNOTES

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[c] 339.175 Fla. Stat. (2016) Subsection (7) (c) 2.

[d] *Federal Strategies for Implementing Requirements for LRTP Updates for the Florida MPOs* (draft). U.S. Federal Highway Administration, October 2017. Accessed at http://www.fdot.gov/planning/revenueforecast.com

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