Executive Summary

Advancements in computing power and miniaturization, communications and networking, and the increased volume of and access to data have enabled the development of transportation technologies with the potential to transform the transportation system and the way that Oregonians travel. These technologies – termed emerging technologies – could provide benefits to Oregon’s transportation system, but there are also societal costs associated with technological advancements. The extent of possible impacts to the transportation system in the next three to four decades remains uncertain.

Examples of emerging technologies include connected vehicles and infrastructure that can sense the environment and driving conditions and communicate with each other in real time; on-demand mobility options (for example, carshare and bikeshare services); electric vehicles; and the collection and analysis of massive amounts of data.

These technological developments could improve the safety, reliability, accessibility, and environmental impacts of the transportation system. However, these same technologies have the potential to adversely impact travel demand and mobility, land use patterns, and the environment. While the extent of possible impacts to the transportation system in the coming decades remains uncertain, state and local agencies, including the Oregon Department of Transportation (ODOT), are beginning to consider and grapple with an uncertain future. ODOT is conducting strategic and scenario planning to consider the uncertainties associated with emerging technologies. ODOT’s Emerging Technology Impact Assessment (ETIA) identifies and describes the potential impacts of these advancements on Oregon’s transportation system. The ETIA outlines key trends in emerging transportation technology, assesses potential impacts to Oregon’s transportation system, and identifies a suite of tools Oregon could consider shaping future transportation outcomes.

Defining “Emerging Technologies”

The Emerging Technology Impact Assessment (ETIA) project team assessed three categories of technological advancements that have the potential to dramatically improve the safety, reliability, and accessibility of Oregon’s transportation system. However, industry experts disagree on the impacts these technologies may have on travel demand and behavior, land use patterns, and investment needs.

**Vehicle technology**, including connected vehicles (CVs), automated vehicles (AVs), and electric vehicles (EVs).

**Mobility options**, including active transportation options, shared mobility services, and ride-hailing services. made available to users using various models that operate within the concept of the integration of transportation services into a single trip-planning and payment platform is known as Mobility-as-a-Service (MaaS).

**Freight logistics and local delivery applications**, including freight vehicle platooning, efficiencies in distribution networks, and on-demand delivery services.
ODOT’s ETIA project team developed a framework – depicted on Figure ES-1 – that considered how modal and topic plans, regional and local planning, data, and funding would interact with emerging technology trends to identify impacts to Oregon’s transportation system. The project team conducted research, a literature review, interviews with industry experts, and engaged the Oregon Transportation Commission (OTC) to address how technological advancements in vehicle technology, mobility options, freight applications, and system management could impact statewide planning, policy-making, and investment decisions.

This report summarizes work conducted during Phase 1 of the ETIA project. The outcomes from Phase 1 will inform the analysis framework to be developed during Phase 2 of the project. Phase 2 will focus on the development of alternative future scenarios that explore a broader range of trends and considerations in preparation for updates to ODOT’s Oregon Transportation Plan (OTP) and Oregon Highway Plan (OHP).

Figure ES-1. ETIA Analysis Framework

Understanding Potential Impacts

The OTP and recent modal and topic plans provide a set of goals and desired outcomes for Oregon’s transportation system. The ETIA used these goals and desired outcomes to frame how emerging transportation technologies are likely to affect the transportation system. The project team identified eight foundational goal areas, as shown on the left-hand column of Table ES-1. The table summarizes the likely impacts of emerging technologies on each of the following goal areas:

- Safety
- Efficient freight movement
- Equity
- Mobility
- Transportation options
- Fuel efficiency/reducing carbon dioxide (CO2) emissions
- Transportation funding sufficiency
- Land use management

Table ES-1. Summary of Likely Impacts to ODOT Foundational Goals

<table>
<thead>
<tr>
<th>Goal Area</th>
<th>Likely Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>Safety is expected to improve significantly even with a limited adoption of CVs and AVs.</td>
</tr>
<tr>
<td>Efficient freight movement</td>
<td>Truck platooning, automated freight vehicles, and advanced logistics are likely to improve the safety and reliability of freight movement.</td>
</tr>
<tr>
<td>Equity</td>
<td>More transportation choices are likely to be available to many people who are unable to drive today. However, the benefits may not extend to all transportation-disadvantaged populations.</td>
</tr>
</tbody>
</table>
Table ES-1. Summary of Likely Impacts to ODOT Foundational Goals

<table>
<thead>
<tr>
<th>Goal Area</th>
<th>Likely Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Shared automated trips, including public transit vehicles and transportation network company (TNC) trips, are likely to cost less per mile than trips taken by private auto or public transit today.</td>
</tr>
<tr>
<td></td>
<td>Automated technology is likely to allow some people to commute farther and access new career and educational opportunities.</td>
</tr>
<tr>
<td>Mobility</td>
<td>Travel time reliability is likely to improve even with moderate adoption of CV and AV technologies.</td>
</tr>
<tr>
<td></td>
<td>Impacts to congestion are uncertain and depend on the uses of AVs. Non-recurrent congestion should decrease under any scenario.</td>
</tr>
<tr>
<td></td>
<td>It is difficult to predict impacts to vehicle miles traveled (VMT); the degree of impact will depend on whether AVs will be used predominantly as private or shared vehicles.</td>
</tr>
<tr>
<td>Transportation Options</td>
<td>Residents of urban communities are likely to experience increased access to more transportation options, potentially resulting in improved access to jobs, education, and services.</td>
</tr>
<tr>
<td></td>
<td>Access to transportation options could moderately improve in rural areas with limited public transit services, but this outcome is dependent on market support for expansion in rural areas.</td>
</tr>
<tr>
<td></td>
<td>Increased access to shared mobility options could enable greater use of active transportation options for short trips, addressing first-and-last mile issues. However, if motorized trips become more affordable, active transportation trips could decrease.</td>
</tr>
<tr>
<td>Fuel Efficiency / Reducing CO₂ Emissions</td>
<td>Some fleet electrification is likely and could generate environmental benefits. The prevailing usage of EVs could eliminate VMT as a factor in emissions.</td>
</tr>
<tr>
<td>Transportation Funding Sufficiency</td>
<td>Integrated vehicle technology enables some degree of expansion for a “user-pays” funding system, and some mechanisms are identified to ensure that all vehicles are paying some share for their use of the roadway. However, funding continues to be constrained, and increases in revenue are not fully sufficient to cover existing and future infrastructure needs.</td>
</tr>
<tr>
<td>Land Use Management</td>
<td>It is difficult to predict impacts to land use patterns. However, any impact will be somewhat tempered by Oregon’s Statewide Planning Goals.</td>
</tr>
</tbody>
</table>

Figure ES-2 depicts the range of potential impacts emerging technologies could have on the eight foundational goals summarized in Table ES-1. ODOT outlined the range of potential impacts emerging technologies could have on transportation system performance related to each foundational goal. The horizontal axis indicates whether impacts are anticipated to be positive or negative, while the vertical axis displays the certainty or uncertainty of the predicted outcome. A range of potential outcomes is depicted—including best case, worst case, and most likely scenarios—that Oregon could see by 2040 assuming the continuation of current policies without significant new policy interventions.
The State of Oregon plays an integral role in identifying, developing, and implementing policies to address the range of potential impacts from emerging transportation technologies. Impacts to Oregon’s transportation system are likely to affect many geographies, jurisdictions, and agencies. This assessment considers emerging technologies within a statewide, jurisdictionally neutral framework to more comprehensively identify the range of potential impacts to the transportation system.

While ODOT considered impacts to Oregon’s transportation system, considering other local, regional, and state agencies, staff focused on identifying policy interventions that are exclusively within the authority of the OTC and the agency. Policy interventions include a variety of actions, including updating statewide modal and topic plans and guidance documents and standards, deploying infrastructure and initiating pilot projects, regulating how certain emerging technologies are used on Oregon’s roadways, and updating funding programs and strategic investment decision making processes.

ODOT could consider a variety of interventions to influence potential impacts of emerging technology on Oregon’s transportation system. Some policy interventions cross-cut multiple goal areas while others are specific to a single goal area. Potential policy interventions are organized according to each of ODOT’s eight foundational goals. The policy interventions with the greatest potential to influence impacts of emerging technology are summarized below. A complete list of potential ODOT policy interventions is provided in the final report.

**Safety**

- Deploy vehicle-to-infrastructure and vehicle-to-vehicle technology
- Regulate level 3 automated vehicles
- Update roadway design standards
- Update All Roads Transportation Safety program requirements

**Efficient Freight Movement**
EMERGING TECHNOLOGY IMPACT ASSESSMENT

- Deploy vehicle-to-infrastructure and vehicle-to-vehicle technology for freight
- Initiate automated, platooning, or other connected freight pilot projects
- Digitize freight route planning

**Equity**
- Ensure investments benefit transportation-disadvantaged and underserved groups
- Update equity criteria
- Update Statewide Transportation Improvement Fund program requirements

**Mobility**
- Deploy vehicle-to-vehicle and vehicle-to-infrastructure technology
- Update roadway standards
- Explore pricing strategies and priority for high-occupancy vehicles
- Update development review tools

**Transportation Options**
- Support investments in statewide Mobility-as-a-Service (MaaS) applications and payment systems, including integrated fare payment
- Support investments in mobility hubs
- Update funding program requirements to support public transit and active transportation

**Fuel Efficiency/Reducing CO₂ Emissions**
- Develop or adjust taxes and fees
- Participate in multistate initiatives
- Plan for alternative fuels infrastructure

**Transportation Funding Sufficiency**
- Implement statewide road usage charge
- Consider pricing of roadway infrastructure
- Develop Driver and Motor Vehicle Services fees and policies

**Land Use Management**
- Develop system planning and overlay standards and guidance
- Update mobility targets on state facilities
- Update development review requirements

**Conclusion**
Traditionally, planners have used past travel behavior to inform the development of transportation plans and policies to shape the transportation system. The rapid emergence and development of emerging transportation technologies is quickly changing travel patterns, making it difficult for planners to consider travel patterns developed prior to emerging technologies to inform decision making. Planners and transportation professionals are now using scenario planning to identify and define potential futures. These scenarios guide the development of plans and policies and inform investment decisions.
ODOT initiated the ETIA project to identify and define implications, including benefits and impacts, for Oregon’s transportation system from emerging transportation technology. The project will be conducted in two phases. Phase 1 outlines the key trends in emerging transportation technology, assesses potential impacts to Oregon’s transportation system, and identifies a suite of interventions ODOT could consider when addressing potential impacts to Oregon’s transportation system. ETIA Phase 1 will inform the analysis framework that will be developed during Phase 2 of the project.

Phase 2 will focus on development of three to five alternative future scenarios to explore a broader range of trends and considerations that will inform future updates to ODOT’s modal and topic plans, including the OTP and OHP. Phase 2 will develop a framework to conduct scenario planning, which will be incorporated during the OTP and OHP plan update process. The development of the scenarios and framework will be informed through internal and external engagement with ODOT staff and local, regional, and state stakeholders, including local agencies, Area Commissions on Transportation, and other state agencies.

Understanding how and when emerging technologies are likely to affect Oregon’s transportation system will help ODOT develop effective policies that can influence potential transportation outcomes. There are opportunities for further study in addition to the work conducted as part of the ETIA project. ODOT could conduct targeted studies of MaaS, Transportation System Management and Operations, and demographic trends to inform scenario development as part of ETIA Phase 2.
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### Acronyms and Abbreviations

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<th>Acronym</th>
<th>Definition</th>
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<tbody>
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<td>ARTS</td>
<td>All Roads Transportation Safety</td>
</tr>
<tr>
<td>AV</td>
<td>automated vehicle</td>
</tr>
<tr>
<td>CAV</td>
<td>connected and automated vehicle</td>
</tr>
<tr>
<td>CO₂</td>
<td>carbon dioxide</td>
</tr>
<tr>
<td>CV</td>
<td>connected vehicle</td>
</tr>
<tr>
<td>C-V2X</td>
<td>cellular vehicle-to-everything</td>
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<tr>
<td>DLCD</td>
<td>Department of Land Conservation and Development</td>
</tr>
<tr>
<td>DMV</td>
<td>Driver and Motor Vehicle Services</td>
</tr>
<tr>
<td>DSRC</td>
<td>Dedicated Short Range Communications</td>
</tr>
<tr>
<td>ETIA</td>
<td>Emerging Technology Impact Assessment</td>
</tr>
<tr>
<td>EV</td>
<td>electric vehicle</td>
</tr>
<tr>
<td>GHz</td>
<td>gigahertz</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>HOV</td>
<td>high-occupancy vehicle</td>
</tr>
<tr>
<td>MaaS</td>
<td>Mobility-as-a-Service</td>
</tr>
<tr>
<td>NHTSA</td>
<td>National Highway Traffic Safety Administration</td>
</tr>
<tr>
<td>ODOT</td>
<td>Oregon Department of Transportation</td>
</tr>
<tr>
<td>OHA</td>
<td>Oregon Health Authority</td>
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<tr>
<td>OHP</td>
<td>Oregon Highway Plan</td>
</tr>
<tr>
<td>OTC</td>
<td>Oregon Transportation Commission</td>
</tr>
<tr>
<td>OTP</td>
<td>Oregon Transportation Plan</td>
</tr>
<tr>
<td>PPP</td>
<td>public-private partnership</td>
</tr>
<tr>
<td>RUC</td>
<td>road usage charge</td>
</tr>
<tr>
<td>STIF</td>
<td>Statewide Transportation Improvement Fund</td>
</tr>
<tr>
<td>TNC</td>
<td>transportation network company</td>
</tr>
<tr>
<td>U.S. DOT</td>
<td>U.S. Department of Transportation</td>
</tr>
<tr>
<td>V2I</td>
<td>vehicle-to-infrastructure</td>
</tr>
<tr>
<td>V2V</td>
<td>vehicle-to-vehicle</td>
</tr>
<tr>
<td>V2X</td>
<td>vehicle-to-everything</td>
</tr>
<tr>
<td>VMT</td>
<td>vehicle miles traveled</td>
</tr>
<tr>
<td>ZEV</td>
<td>zero emission vehicle</td>
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</table>
Glossary of Terms

**Automated Vehicle (AV)**
An automated vehicle uses sensors and computer systems to drive itself. Often called "self-driving" cars, AVs partially or entirely remove the need for a driver to control the vehicle.

**Connected Vehicle (CV)**
Connected vehicle sends and receives messages to other vehicles, wireless devices, and infrastructure such as traffic signals and roadside units.

**Connected and Automated Vehicle (CAV)**
Connected and automated vehicles enable both AV and CV technology to be used in a single vehicle simultaneously.

**Dedicated Short Range Communications (DSRC)**
Dedicated short range communications service involves vehicle-to-vehicle and vehicle-to-infrastructure communications, helping to protect the safety of the traveling public.

**Mobility-as-a-Service (MaaS)**
Mobility-as-a-Service is the integration of various forms of transportation services into a single, on-demand mobility service, such as public transportation, rideshare, carshare, bikeshare, and taxi.

**Electric Vehicle (EV)**
Electric vehicles, also known as plug-in electric vehicles, receive power from the electricity grid.

**High-Occupancy Vehicle (HOV)**
High-occupancy vehicles are motor vehicles that carry more than a specified number of occupants.

**Public-Private Partnership (PPP)**
Public-private partnerships, also known as P3s, are agreements between a public agency and a private entity that often implement public infrastructure projects.

**Transportation Network Company (TNC)**
Transportation network companies such as Uber and Lyft use mobile online platforms to enable people to secure individual and carpooling rides on demand, from drivers using their personal vehicles.

**Road Usage Charge (RUC)**
A road usage charge is a fee that is applied to every mile a driver drives.

**Vehicle-to-Vehicle (V2V)**
Vehicle-to-vehicle is technology that allows vehicles to communicate with other vehicles, often using a Global Positioning System (GPS) receiver, computer, and antenna.

**Vehicle-to-Infrastructure (V2I)**
Vehicle-to-infrastructure is technology that allows vehicles to communicate directly with their physical surroundings, such as traffic signals or other roadway infrastructure.

**Vehicle-to-Everything (V2X)**
Vehicle-to-everything is technology that allows communication from a vehicle to any entity that may affect the vehicle, and vice versa, such as a person, a traffic signal, or another vehicle.
Introduction

Technological advancements could provide safety, mobility, and environmental benefits to users of Oregon’s transportation system. These technological advancements – termed emerging transportation technologies – encompass a broad range of applications. Examples of emerging transportation technologies include automated vehicles (AVs) that can sense the environment and driving conditions, connected vehicles (CVs) that can communicate with each other and infrastructure in real-time, on-demand mobility options (such as carshare and bikeshare services), and electric vehicles (EVs). In addition, improved data collection and analysis could inform investment decisions, help agencies better manage the transportation system, and improve traveler experience. Benefits could include improve safety, reliability and accessibility, and reduced environmental impacts. Conversely, there are potentially adverse impacts associated with these technological advancements. Adverse impacts could include increased congestion and travel demand, increased travel costs for users, threats to cybersecurity and privacy, and the erosion of transportation funding sources, all of which present challenges for public agencies to address.

The ETIA Final Report is organized into the following sections:

- **Introduction** – describes the project purpose, background and development
- **Emerging Transportation Technology Trends** – provides an overview of the technological trends likely to impact Oregon’s transportation system
- **Policy Implications** – outlines potential interventions ODOT could consider to address impacts of emerging transportation technology to Oregon’s transportation system
- **Conclusion** – summarizes key takeaways from ETIA assessment

Purpose

While the extent of possible impacts to Oregon’s transportation system in the coming decades remains uncertain, state and local transportation agencies, including the Oregon Department of Transportation (ODOT), are beginning to consider and grapple with an uncertain future. ODOT initiated the Emerging Technology Impact Assessment (ETIA) project to identify and define implications, including benefits and impacts, for Oregon’s transportation system. This report outlines the key trends in emerging transportation technology, assesses potential impacts to Oregon’s transportation system, and identifies a suite of interventions ODOT could consider when addressing potential impacts to Oregon’s transportation system. The assessment will inform future ODOT planning, programming, and investment decisions.

Background and Development

ODOT is one of the many agencies leading studies and planning efforts to understand how emerging technology will impact the transportation system and identify strategies to address an uncertain future. ETIA builds on current and ongoing initiatives led by and supported by ODOT, including emerging technology research, planning efforts, and leveraging of staff expertise, such as the following:

- **Connected Vehicle and Automated Vehicle Steering Team**. Coordinates across the agency’s various functions and is responsible for tracking developments in CVs and AVs and briefing the agency on critical CV and AV investment decisions.
- **Task Force on Autonomous Vehicles**. Created by House Bill 4063, which directed ODOT to staff and convene a task force to make recommendations to the legislature for potential statutory changes.

- **The Drive Toward Change: Use Cases for Automated Vehicles.** Report produced by ODOT to help the State of Oregon and other stakeholders prepare for the deployment of AVs. For more information visit: [https://www.oregon.gov/ODOT/Programs/CAV%20documents/AV-ODOT-Use-Cases-for-Automated-Vehicles.pdf](https://www.oregon.gov/ODOT/Programs/CAV%20documents/AV-ODOT-Use-Cases-for-Automated-Vehicles.pdf)

Building on this foundation, ODOT developed the ETIA to assess how advancements in vehicle technology, mobility options, freight applications, and system management could affect statewide planning and investment decisions.

ODOT’s ETIA project team developed a framework – depicted on Figure 1 – that considered how modal and topic plans, regional and local planning, data, and funding would interact with emerging technology trends to identify impacts to Oregon’s transportation system.

The project team conducted research, a literature review, interviews with industry experts, and engaged the Oregon Transportation Commission (OTC) to address how technological advancements in vehicle technology, mobility options, freight applications, and system management could impact statewide planning, policy-making, and investment decisions.

ODOT formed an Expanded Project Management Team, comprising internal agency staff, to guide the project. The project team led a workshop with the OTC to identify and prioritize key questions to address. This report is the culmination of ETIA Phase 1. Figure 2 illustrates how ETIA Phase 1 will inform the second phase of the project. ETIA Phase 2 work will focus on the development of planning scenarios to explore a broader range of considerations in preparation of updates to the Oregon Transportation Plan (OTP) and Oregon Highway Plan (OHP).

**Figure 1. ETIA Analysis Framework**

**Figure 2. ETIA Project Phases**

**ETIA Phase 1**

- Identifies key trends in emerging technologies
- Assess implications to Oregon’s transportation system
- Identifies potential interventions

**ETIA Phase 2**

- Outcomes from Phase 1 inform development of scenarios
- Develop analysis framework to conduct scenario planning
- Develop three to five scenarios
Emerging Transportation Technology Trends

New transportation technologies are advancing rapidly and could revolutionize how people get around, how goods are delivered, and how vehicles are operated in the coming decades. Advancements can be grouped into three categories:

• **Vehicle technology**, including CVs, AVs, and EVs.

• **Mobility services**, including active transportation options, shared mobility services, and ride-hailing services. The integration of transportation services into a single trip-planning and payment platform is known as Mobility-as-a-Service (MaaS).

• **Freight logistics and local delivery applications**, including freight vehicle platooning, efficiencies in distribution networks, and on-demand delivery services.

### Vehicle Technology

**Connected vehicles (CVs).** CV technology enables vehicles to communicate with each other, roadside infrastructure, smartphones and other devices. CV applications are organized into three general categories that describe different types of connectivity: vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and vehicle-to-everything (V2X). Vehicle-to-everything is technology that allows communication from a vehicle to any entity that may affect the vehicle, and vice versa, such as a person, a traffic signal, or another vehicle.

Connected vehicles principally rely on two communication technologies: cellular technology and Dedicated Short Range Communications (DSRC). The Federal Communications Commission allocated a range of wireless spectrum, referred to as the 5.9-gigahertz (GHz) band, for Intelligent Transportation System services. DSRC utilizes the 5.9-GHz band and is a WiFi-derivative technology developed to support secure, low-latency communications.

Cellular and DSRC technology have enabled navigation systems to alert drivers of real-time traffic, roadway incidents, and weather conditions. However, cellular technology is now the most widely used form of communication technology inside vehicles. The newest generation of cellular technology, 5G or cellular vehicle-to-everything (C-V2X), could potentially compete with DSRC as a communication
platform for CVs because it transmits low latency communication and enables peer-to-peer communication.¹

The National Highway Traffic Safety Administration (NHTSA) and U.S. Department of Transportation (U.S. DOT) initiated the federal rulemaking process to mandate use of V2V radios in all-new light vehicles by 2023, but the current administration has delayed this process and has taken a technology-neutral approach to regulation. Furthermore, some automotive manufactures have committed to DSRC while others focus on 5G cellular technology.

Regardless of which communication platform succeeds in the long term, CV deployments have had documented safety, mobility, and operational benefits. Results from CV pilots conducted by the U.S. DOT indicate that short-range communication technology could prevent 80 to 90 percent of incidents in which the driver is not impaired. However, the ongoing debate between 5G and DSRC advocates and the lack of federal rulemaking complicates investment decisions for state, regional, and local agencies.

**Automated vehicles (AVs).** Technologies enabling AVs, including those that improve sensing, mapping, and control, have advanced rapidly over the past 5 years. The Society of Automotive Engineers established six levels of automation to describe different levels of vehicle autonomy and driver responsibility (see Figure 3). The six levels are organized along a spectrum from no automation (level 0) to full automation (level 5). The AV system can monitor the driving environment at levels 3 and above.

![Source: NHTSA, 2019](https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety)

**Figure 3. Society of Automotive Engineers Levels of Automation**

AVs will affect the transportation system; however, experts are not certain exactly how, in large part because the deployment model for AVs remains uncertain. While AVs have the potential to create public benefits, such as reducing the occurrence and severity of collisions and improving mobility, AVs could also have societal and environmental costs. The advantages and disadvantages of three potential operating models are outlined as follows:

---

¹ A detailed discussion of the differences between cellular and DSRC communication platforms can be found in the Key Trends Memorandum conducted as part of Phase 1 of the ETIA project.

• Personal automated vehicles: Includes motorists who own or lease their own self-driving vehicles. This operational model is highly convenient and allows for immediate and on-demand usage. Disadvantages include high costs and inflexibility to choose different modes for different trips.

• Shared automated vehicles: Includes self-driving taxis to transport individuals or groups to destinations. This operational model allows users to choose the vehicles and services that best meet their needs, including door-to-door service. However, users must wait for vehicles and service could be limited at times.

• Shared automated rides: Includes self-driving vans that take passengers to or near destinations. This operational model is associated with lower costs and is typically operated on a fixed route and schedule. This model is least comfortable, convenient, and expedient.

AV and CV technology could be combined to maximize the safety and efficiency benefits of AVs. However, in the near term, it is likely that connected vehicle technology will not be a precondition to the deployment of automated vehicles.

AVs will likely be adopted incrementally over the next several decades and may look substantially different in Oregon’s large- and medium-sized cities than in the rest of the state. AVs could have major impacts on transportation demand by making travel more convenient and accessible and providing transportation options for people who previously could not drive, including the elderly, disabled, and those without a driver’s license. However, the introduction of AVs will likely affect urban, suburban, and rural communities differently because of differing demographics, population density, and travel patterns.

Electric vehicles (EVs). EVs have the potential to significantly reduce transportation-related emissions. EVs have become more prevalent because improvements in battery technology have increased the operating ranges, shortened recharging periods, and lowered costs. These advancements make EVs more practical for more households, supporting broader adoption of EVs.

Many experts believe that CVs and AVs will be electric due to the advancements in battery technology. However, adequate charging infrastructure for these vehicles continues to limit widespread adoption, both nationally and at the state and regional level. Oregon supports the West Coast Electric Highway, a network of EV direct current fast-charging stations located along Interstate 5, Highway 99, and other major roads that span British Columbia, Washington, Oregon, and California. Oregon is also a member of the Multi-State Zero Emission Vehicle (ZEV) Task Force, a group of nine states that have committed to putting a combined 3.3 million ZEVs on their roads by 2025.

Mobility Services

Mobility services are advancing rapidly as the number of transportation modes in the last decade have expanded beyond the realm of personal vehicles, carpools, vanpools, taxis, public transportation, bicycling, and walking. Advancements in mobility services include ride-hailing services (for example Uber or Lyft and are sometimes referred to as transportation network companies or TNCs), carshare, bikeshare, microtransit, and Maas. In addition to these services, companies also offer dockless or electric shared mobility options such as scootershare and electric bikeshare services and programs.

Figure 4 displays the five different types of shared mobility service models: (1) membership-based self-service, (2) peer-to-peer self-service, (3) non-membership self-service, (4) for-hire service, and (5) mass transit systems. Several mobility services are represented in more than one category of shared mobility service models. For example, bikesharing and carsharing can be organized according to three of the shared mobility service models, including membership-based self-service, peer-to-peer self-service, and non-membership self-service models. Maas platforms could allow customers to plan and pay for trips across multiple mobility options through a single application.
Without public sector intervention, benefits from mobility options are likely to be disproportionately concentrated in wealthier urban communities. Because most shared mobility providers are private, for-profit entities, they do not have an incentive to provide services in less profitable rural markets without specific subsidies or mandates. Access to shared mobility services can also be more difficult in unbanked communities, or for people who lack a smartphone with a data plan.

**Freight Logistics and Local Delivery Applications**

The freight industry is undergoing significant changes and advancements in logistics management enabled by automated technologies affecting both long-distance freight movements as well as distribution networks. In addition, consumer expectations and new e-commerce services have influenced the local delivery providers to develop more demand-responsive delivery services. This includes individual delivery services (for example, UberEATS), an increased emphasis on car and bike deliveries, and fleets of smaller trucks.

The trucking industry could gain safety, environmental, and operational benefits from CVs, AVs, and EVs. For example, CAV technology is being used in pilot studies that enable trucks to engage in cooperative adaptive cruise control, or “platooning” and advancements in propulsion technologies have enabled battery-electric and fuel-cell options for long-haul freight vehicles. The current shortage of truck drivers across the country has increased interest in these technologies.

**Overarching Implications**

Adoption timelines for emerging transportation technologies, including vehicle technology, mobility options, and freight logistics, will vary. The most significant impacts are likely to occur in the long term (30 to 40 years) and will require the convergence of multiple technological advancements. In the near to medium term (20 years), Oregon likely will have a mixed fleet of connected vehicles, automated vehicles, and vehicles that are not connected and have low levels of automation operating on the

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transportation system. While safety benefits can be realized, the combination of vehicle types will present challenges to realizing these benefits.

As emerging technologies are deployed on Oregon’s transportation system, ODOT and other local, regional, and state agencies will have access to significantly more data. Increased access to data can improve agency decision making as it could allow for ODOT to better understand traveler patterns, behavior, and demand. However, much of the data are likely to be proprietary and will require agencies to purchase access to traveler data or the development of public-private and public-public partnerships to leverage data use. In addition, increasing volumes of data will require agencies to dedicate more resources to the analysis and interpretation of data in support of informed decision making. These trends will impact ODOT planning, policy, and investment decisions.

**Policy Implications**

The State of Oregon has an integral role in identifying, developing, and implementing policies to address the range of potential impacts from emerging transportation technologies. This report considers emerging technologies within a statewide, jurisdictionally neutral framework to more comprehensively identify the range of potential impacts to the transportation system. While ODOT considered impacts to Oregon’s transportation system as a whole, taking into account other local, regional, and state agencies, staff focused on identifying policy interventions that are exclusively within the authority of the agency and the OTC.

The OTP and recent modal and topic plans provide a set of overarching goals and desired outcomes for Oregon’s transportation system. The ETIA used these goals and desired outcomes to frame how emerging transportation technologies are likely to affect the transportation system. The project team identified the following eight foundational goals:

- Safety
- Efficient freight movement
- Equity
- Mobility
- Transportation options
- Fuel efficiency and reducing carbon dioxide (CO2) emissions
- Transportation funding sufficiency
- Land use management

These goals provide a framework to examine how emerging technology could affect important transportation outcomes.

ODOT outlined the range of potential impacts emerging technologies could have on transportation system performance related to each foundational goal. Figure 5 illustrates the potential transportation system impacts based on degree of impact and certainty. The horizontal axis shows whether impacts are anticipated to be positive or negative, while the vertical axis displays the certainty or uncertainty of the predicted outcome. Figure 5 depicts a range of potential outcomes—including best case, worst case, and most likely scenarios—that Oregon could see by 2040 assuming the continuation of current policies without significant new policy intervention.
Figure 5. Impacts of Emerging Technology on ODOT’s Foundational Goals

The range of impacts without new policy intervention identifies where influences or changes may need to be applied to create a more positive or certain outcome. Observing the range of impacts shown on Figure 5, ODOT identified areas where potential policy interventions may influence how impacts to the transportation system could unfold. The analysis of policy implications for each foundational goal covers the following elements:

- Summary of potential impacts from emerging technologies to Oregon’s transportation system
- Level of influence for partner government agencies (including federal, state, regional, and local) and private industry on each outcome area
- Suite of tools that ODOT could employ to address potential impacts to the transportation system given the uncertainty of future impacts

The following sections describe the relative level of influence ODOT, partner government agencies (including the federal government, other state agencies, local and regional agencies), and private industry could have to effect how emerging technologies impact Oregon. The level of public acceptance regarding emerging transportation technologies will influence both private sector technological developments and how public agencies implement policies.

Each entity’s influence is indicated by either a partially or fully filled-in circle in the graphic accompanying the description. Entities with the greatest influence are indicated by a fully filled-in circle, while those with least influence are indicated by an empty circle. Specific interventions identified to address impacts to the transportation system are specific to the OTC and ODOT.

Safety

Safety is one of the most positive and certain outcomes of changing technology. Even with as little as 15 to 30 percent market penetration, CV and AV technology could improve safety outcomes on Oregon’s
roadways for all users, including drivers of legacy vehicles and people walking and biking. CV and AV technology could reduce human error and driver distraction, which contributes to crashes. CVs could communicate with each other, infrastructure, and other devices in real-time about vehicle position, traffic and infrastructure condition, inclement weather, work zones, and other safety-related elements. CVs and AVs could also improve information available to drivers and road operators about conditions, enabling more active system management.

Although CVs and AVs are expected to provide significant transportation safety benefits, technology could develop more slowly than predicted or fail to provide anticipated reductions in crashes. Additionally, different communication platforms that enable V2X communications are competing for market dominance, potentially resulting in incompatible communication systems and lengthening the time to achieve critical mass to support safety benefits.

Particular risk exists with level 3 AVs, those that have many automated features but still require driver input, because drivers may be distracted and unready to assume control of the vehicle when needed. Furthermore, all CVs and AVs have varying levels of security that protect them from rogue control or system corruption. These cybersecurity systems may have vulnerabilities that could result in vehicle safety systems failures or in-operation. This is of greatest concern when individuals or companies fail to update software to adequately protect against unauthorized access to automated driving technology.

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Figure 6. Agency and Private Sector Level of Influence for Safety

Influence. Private industry and the federal government have the most influence over safety outcomes from new technology because they will dictate how fast technology comes to the market and because the federal government is responsible for setting safety standards for vehicles. However, ODOT can have significant influence on how, where, and when safety benefits accrue. Oregon State Police can also influence safety outcomes through enforcement. Figure 6 illustrates the level of influence that the federal government, ODOT, other state agencies, local and regional agencies, and the private sector possess to shape safety-related outcomes.

Potential Areas of ODOT Policy Intervention:

- **V2I and V2V** – V2V communication is a private industry endeavor. A pending federal rule would mandate use of V2V communications and define system requirements. To best capitalize on V2I, ODOT can include policies designed to encourage local and regional agencies to deploy V2I that use the same communications and system framework as V2V in modal and topic plans.

- **Traveler information and incident response** – Policies designed to improve traveler information and incident response could be included or updated in topic and modal plans. Policies could encourage the deployment of technology that provides real-time data on roadway and weather conditions, evacuation routes, and road closures. Implementing roadside infrastructure to enable V2I communications would provide access to useful data from equipped CVs. To garner these data, ODOT may want to consider developing operational strategies to support the deployment of CV technologies on facilities and corridors.

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• **Regulation of level 3 automation** – ODOT’s Driver and Motor Vehicle Services division (DMV) could implement policies for special driver license endorsements or certifications enabling the operation of vehicles with Level 3 automation.

• **Cybersecurity protections** – As the transportation system becomes increasingly connected, its exposure to cybersecurity threats increases, which could pose serious risks to safety and privacy. The federal government has a significant role in leading the regulation of cybersecurity for vehicles. ODOT has a role in developing operational plans, policies, and guidelines for the deployment of V2I technology that could protect ODOT facilities from potential cybersecurity attacks.

• **Public-private partnerships (PPPs) to leverage data** – There is the potential for CVs and AVs to produce a lot of data that can support greater understanding of the use and status of the transportation system. CVs provide an opportunity to make use of anonymized data. There is also an opportunity for both ODOT and private industry to benefit through partnerships that support sharing of proprietary anonymized data between them. Agencies possess, real-time data that can help make automated driving safer, such as detailed information about work zones, crashes, closures, and other system disruptions. Other types of data that are normally not publicly available such as road weather information from fleet vehicles or signal, phase, and timing from traffic signals could form the basis of PPPs. Safety and traveler behavior data can be used to inform investment and operational decision making and exchanging real-time agency data to support safer operation of AVs on Oregon’s roadways. Policies that reduce barriers to establishing partnerships could further support development of partnerships.

• **Update roadway design standards** – ODOT could monitor and update roadway design standards in the Highway Design Manual to improve the operation of AVs on roadways (for example, striping and signing standards and lane widths).

• **All Roads Transportation Safety (ARTS) program** – ODOT manages and facilitates disbursement of ARTS program funding through a jurisdictionally blind process. Both local and regional agencies and ODOT are eligible for program funding. ODOT could consider updating evaluation criteria to encourage V2I deployment on state and local facilities.

• **Coordination with Oregon State Police** – ODOT could coordinate with and develop partnerships or initiatives to support Oregon State Police efforts to enforce current and future laws that may be affected by emerging transportation technologies.

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5 Data anonymization seeks to protect private or sensitive data by deleting or encrypting personally identifiable information from a database. Its purpose is to protect an individual’s or company’s private activities while maintaining the integrity of the data gathered and shared.
Efficient Freight Movement

Advances in vehicle technology, logistics, and other technologies will likely enable more efficient freight movement. Connected freight vehicles will provide information on travel time and road and weather conditions, contributing to the safety and efficiency of freight movement. Platooning, automated freight vehicles, and advanced logistics could result in reduced shipping costs and more reliable delivery times. Data sharing between system operators and freight vehicles can improve information about the system and guide investment and operational decisions. Even if CV or AV technologies mature more slowly than predicted, limited deployments could still improve the safety, reliability, and efficiency of freight movement.

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Figure 7. Agency and Private Sector Level of Influence for Freight

Influence. Private industry has been a key driver of advances in freight movement and logistics and will continue to influence which emerging transportation technologies are widely deployed (that is, whether connected, automated, or connected and automated freight vehicles prevail). The federal government has the authority to establish standards for commercial vehicles and regulate interstate commerce. Local and regional governments hold some degree of influence over the deployment of short-haul freight and local delivery vehicles. Figure 7 illustrates the level of influence that the federal government, ODOT, other state agencies, local and regional agencies, and the private sector possess to shape freight-related outcomes.

Potential Areas of ODOT Policy Intervention:

- **V2I and V2V for freight** – ODOT could develop operational policies to support the deployment of V2I targeted at freight vehicles on state facilities. Policies included in modal and topic plans would encourage deployment on local and regional facilities.

- **Automated, platooning, or other connected freight pilot projects** – ODOT could develop pilot projects involving automated or connected freight projects on select facilities. Pilot projects would likely require ODOT to establish PPPs with freight vehicle manufacturers, among others in the private sector.

- **Update roadway design standards** – Any updates will be informed by research conducted by the U.S. DOT, National Cooperative Highway Research Program, and Federal Motor Carrier Safety Administration to understand safety considerations and identify which design changes may be necessary as AV and CV technology is more fully deployed on the transportation system. ODOT could update roadway design standards to address identified safety considerations related to the

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6 Truck platooning is the linking of two or more trucks in convoy, using connected vehicle or automated vehicle technology. These vehicles automatically maintain a set, close distance between each other when they are connected while traveling on roadways. Platoonning has the potential to improve safety, mobility, and fuel efficiency.
operation of connected and automated freight vehicles on state-owned and -operated facilities, paving the way for pilot projects.

- **Leverage new data** – ODOT could develop operational policies, plans, and programs to gather data about the freight system in support of investment and operational decision making. To fully maximize available data, ODOT may consider developing PPPs with application developers and others in the private sector.

- **Digitize freight route planning** – ODOT could digitize freight routes and characteristics to support development of an integrated, real-time freight route planning system or an application or system by the private sector. Digitization of freight routes and characteristics would require significant staff time and resources.

### Equity

Emerging technologies are likely to provide benefits for many populations. However, the benefits are not likely to extend to all populations or be evenly distributed. For example, new mobility services could be concentrated in more affluent and urban areas. Additional observations include the following:

- **Mobility for the transportation-disadvantaged** is likely to improve with increased access to affordable and efficient transportation options for those who are unable to drive. Expanded public and private transportation services could increase access to jobs, education, social activities, and essential services. However, new mobility services may not be available to some people who need some assistance or an attendant during travel. In addition, public transit services may decrease in some areas due to competition between private automated transportation services and public transit. These two trends could result in diminished transit services and travel options for those that need the most assistance during travel.

- **Mobility for the transportation-underserved** could be negatively impacted for groups that are traditionally underserved. A recent study, *Predictive Inequity in Object Identification*, suggests that the equity implications of AVs are not limited to class, disability, and geography. People of color could bear a disproportionate burden of pedestrian crash injuries and fatalities because the systems designed to help automated cares recognize pedestrians may have trouble recognizing people with darker skin tones.7

- **Transportation costs per mile** are likely to decrease for ride-hailing services (for example, example app-based, on-demand ride services such as Uber and Lyft) and public transit trips as AV technology matures. This is due to decreased overhead from removing drivers. Reductions in travel costs could allow people to make more trips, including those at lower income levels. However, if public

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transportation services decrease and travel costs increase, people at lower income levels could experience constraints on the number of trips they can make.

- **Access to jobs and educational opportunities** is likely to increase as AVs are deployed. Commute times could be dedicated to other activities, resulting in a willingness to commute longer distances. How AVs are used – shared versus personal/private – will impact how benefits are distributed. For example, personally owned AVs would primarily benefit those who are more affluent.

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**Influence.** The private sector significantly affects issues related to equity. Access to affordable and efficient transportation options, jobs, and educational opportunities for the transportation-disadvantaged could be limited if driven primarily by the private sector. The federal government can influence equity-related outcomes through policy and regulations such as through Title VI and Environmental Justice requirements\(^8\). ODOT, other state agencies, and local and regional agencies can impact the equitable implementation of emerging transportation technologies through policies that support increased access to new transportation and mobility options for all Oregonians, especially transportation-disadvantaged groups. Figure 8 illustrates the level of influence that the federal government, ODOT, other state agencies, local and regional agencies, and the private sector possess to shape equity-related outcomes.

**Potential Areas of ODOT Policy Intervention:**

- **Statewide Transportation Improvement Fund (STIF) requirements** – ODOT could evaluate and revise STIF program funding requirements to ensure public transportation will be available for transportation-disadvantaged groups.

- **Ensure investments benefit transportation-disadvantaged groups** – Policies that evaluate equity impacts of CV and AV infrastructure investments and projects could ensure that rural areas and areas with concentrations of traditionally underserved populations experience benefits from emerging transportation technologies.

- **Consider equity criteria** – ODOT could include equity criteria to ensure that transportation-disadvantaged and underserved populations have access to affordable and efficient transportation options through funding, pilot, and grant programs.

- **Leverage increased access to data** – ODOT could use data about travel patterns and behavior to better understand the travel needs of underserved groups and inform investment decisions.

- **Oregon Health Authority (OHA) partnership** – ODOT and OHA have established a Memorandum of Understanding to guide collaboration between the two agencies and identify, develop, and promote connections between public health and transportation, including climate change. Building from this Memorandum of Understanding, ODOT could identify strategies that leverage emerging transportation technology to increase access to health services and to mitigate health-related impacts from climate change for transportation-disadvantaged and underrepresented groups.

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Impacts to mobility are difficult to predict with a high level of certainty. The predominant operational model and resultant changes in vehicle miles traveled (VMT), and the timeline under which CVs and AVs are deployed, will significantly influence mobility. For example:

- **Travel time reliability** is likely to improve even with moderate deployment of CV and AV technology. Safety benefits related to CVs and AVs will contribute to traffic “smoothing” through reductions in crashes and incidents. Travel time may increase but would become more reliable as access to real-time traveler information improves.

- **VMT** impacts are difficult to predict with a high degree of certainty and depend on the AV operational model that is adopted. A shared-ownership model could decrease reliance on single-occupancy trips and potentially limit or slightly decrease VMT. If a private ownership model prevails, or if reduced travel costs induce additional demand, VMT per capita could increase.

- **Congestion** is difficult to predict. It is likely that the conveniences of AVs, such as being able to work while driving, will lead to additional vehicle travel and increase congestion. Consequently, either AV operational model, shared or personal/private, could contribute to increased congestion. If ridesharing and other forms of shared mobility are common, congestion could worsen as AVs make zero-occupancy trips. If personal/private AVs are common, congestion could increase as people make more trips. However, non-recurrent congestion should decrease under any scenario as safety benefits are realized.

Influence. ODOT and the private sector wield the greatest influence over mobility. The private sector will drive operational model for AVs, though state and local agencies can put policies in place to influence private sector choices. Local and regional governments can influence mobility through land use policies and policies that regulate TNCs and other transportation options such as bikeshare services. Figure 9 illustrates the level of influence that the federal government, ODOT, other state agencies, local and regional agencies, and the private sector possess to shape mobility-related outcomes.

**Potential Areas of ODOT Policy Intervention:**

- **Real-time traveler information** – Development of operational and long-range planning policies to increase access to real-time traveler information could address impacts to mobility. This will likely necessitate the development of PPPs to access available data because private application developers own much of the data that could provide ODOT with real-time traveler information in the near term. There is still an opportunity for mutually beneficial partnerships that facilitate data sharing between ODOT and
the private sector in the medium to long term because ODOT will continue to be an authoritative source of data about closures, chain and tire requirements, and construction activity.

- **Pricing strategies** – Implementation of pricing strategies could address mobility issues on state facilities related to potential increases in VMT and congestion. Strategies that address equity concerns should be considered.

- **V2X infrastructure** – Development of ODOT operational strategies to deploy V2X infrastructure could increase access to real-time traveler information and support the integration of transportation information, mobility hubs, and MaaS.

- **Roadway design standards** – ODOT could evaluate the Highway Design Manual and consider updates to roadway design standards that improve operations of AVs. Standards could address striping, roadway widths, and signage, among other elements.

- **Incident response** – ODOT could develop operational policies that encourage the deployment of CV applications to optimize incident response, minimizing clearance times and providing travelers with real-time information to support route planning.

- **Priority for high-occupancy vehicles (HOVs)** – Policies designed to prioritize HOVs on ODOT facilities could mitigate congestion and increased VMT related to the deployment of AVs.

- **Development review tools** – Policies that address the development review process could improve system capacity in urbanized areas by rethinking trip generation. Curb space access needs will likely change; with the deployment of AVs, and other emerging transportation technologies, it is expected that there will be a significant increase in demand for curb space to pick up and drop off passengers and delivery goods. This will warrant important discussions regarding any changes to development review policies.

- **PPPs** – ODOT could consider policies that reduce barriers to PPPs and leverage data to inform investment and operational decision making.

**Transportation Options**

Impacts to transportation options are uncertain and the distribution of benefits is likely to vary according to geography and income. Public transit services could erode as the public opts to take more trips using shared mobility options or private vehicles. However, it is possible that an increased use of first-and-last-mile AV transit could increase the use of public transit. For example:

- **Urban transportation options** are likely to improve as people experience increasing travel options, including TNCs, microtransit, carshare, bikeshare, and e-scooters. These emerging options improve access to jobs, education, and essential services. However, these increased options are likely to be concentrated in affluent communities and could contribute to the erosion of fixed route transit service in some areas.

- **Rural transportation options** could expand due to AV technology and provide increased access for people in areas with limited public transit services. However, new transportation choices in rural areas may not be economically viable for the private sector.

- **Active transportation choices** are expanding, with many new active transportation services coming online today. Increased access to shared mobility options, including bike and e-scooter share, enables people to use active transportation options for short trips, increasing access to public transit.
and addressing first-and-last mile issues. However, as motorized shared mobility options become accessible and affordable, active transportation trips could decrease.

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Figure 10. Agency and Private Sector Level of Influence for Transportation Options

**Influence.** Private industry, local agencies, and ODOT have the greatest influence on access to transportation options in Oregon. The private sector is likely to deliver mobility services to affluent, urban, and suburban communities first. Local and regional agencies can guide public transit investments and regulate how TNCs, microtransit, bikeshare, and e-scooters operate within their jurisdictions. Figure 10 illustrates the level of influence that the federal government, ODOT, other state agencies, local and regional agencies, and the private sector possess to shape outcomes related to transportation options.

**Potential Areas of ODOT Policy Intervention:**
- **Public transit support** – ODOT could consider policies to ensure public transit is provided in urban and rural areas. STIF program requirements and evaluation criteria could be updated to ensure and maintain access to public transit, especially for transportation-disadvantaged populations.
- **Active transportation support** – ODOT could have a role in coordinating various providers and jurisdictions to encourage development of active transportation options, including bikeshare and scootershare.
- **Integrated fare payment** – ODOT could consider including policies in modal and topic plans to encourage coordination between different public transportation providers and jurisdictions to integrate fare payment systems for customers. PPPs may be necessary to facilitate integrated fare payment systems. ODOT could update STIF program requirements and evaluation criteria to further support deployment of integrated fare payment systems.
- **Statewide MaaS applications and payment systems** – Policies that facilitate and support implementation of universal payment systems and MaaS applications, including integrated trip planning and first-mile/last-mile connections to transit, could be considered for inclusion in ODOT modal and topic plans. PPPs may be necessary to facilitate early applications and payment systems. ODOT could consider updating STIF program requirements to encourage statewide MaaS applications.
- **Support for mobility hubs** – STIF funding program requirements that encourage implementation of mobility hubs, support the integration of traveler information, and encourage connections to other transportation options, including transit, carshare, bikeshare, and other services, could increase access to transportation options. In addition, ODOT could coordinate with transportation providers and jurisdictions to encourage the development of mobility hubs across the state.
Fuel Efficiency and Reducing CO₂ Emissions

The impacts of emerging technologies on emissions are uncertain and depend on the public’s adoption of EVs and deployment of the supporting charging infrastructure. Fleet electrification could range from moderate penetration to widespread adoption of EVs, generating some reductions in CO₂ emissions. The prevailing operational model of EVs, whether it is shared or private, could also influence emissions. It is likely that shared AVs, which are expected to be mostly electric, will emerge as a transportation option in some urban environments. Connected vehicles and automated vehicles are likely to improve system reliability and reduce non-recurrent congestion, which may provide fuel efficiency benefits regardless of VMT. However, if AVs are not electric and if people use AVs for more frequent and longer trips, CO₂ emissions could increase.

Influence. State departments of transportation, the federal government, and the private sector have the greatest role in driving fuel efficiency and reductions in CO₂ emissions. The federal government is a strong driver of fuel economy increases through the Corporate Average Fuel Economy standards, which mandate fuel economy standards for vehicle manufacturers. However, the private sector also tends to be a leader in technological innovations that could support improved fuel efficiency and reductions in CO₂ emissions if there is adequate consumer demand to drive these innovations.

ODOT and other state agencies, including the Oregon Department of Energy, Oregon Department of Environmental Quality, Oregon Public Utility Commission, and Oregon Department of Administrative Services, are collaborating to support the expansion of EV adoption and infrastructure in Oregon. Figure 11 illustrates the level of influence that the federal government, ODOT, other state agencies, local and regional agencies, and the private sector possess to shape outcomes related to fuel efficiency and reducing CO₂ emissions.

### Potential Areas of ODOT Policy Intervention:

- **Taxes and fees** – To support expansion of EV adoption and infrastructure, ODOT could consider developing incentive programs for the electrification of transit, freight, or personal vehicles. Taxes or fees, including a user-pays system, could be used to support any future incentive programs.

- **Planning for alternative fuels infrastructure** – ODOT could convene stakeholders to determine fueling infrastructure needs, identify gaps in coverage, and develop investment plans to support expansion of alternative fuels infrastructure in the region.

- **Participation in multistate initiatives** – Continued participation in multistate initiatives, such as the Multi-State ZEV Task Force, Pacific Coast Collaborative, and International ZEV Alliance, could support EV adoption and expansion of charging infrastructure.
• **Coordination with other state agency efforts** – ODOT’s continued participation in the ZEV Interagency Working Group could support planning for charging infrastructure and EV adoption in Oregon.

### Transportation Funding Sufficiency

Increased fuel economy and fleet electrification will continue to reduce gas tax revenue, but the rate of decrease is uncertain. One option for addressing the future funding shortfall is to implement a user-pays system. The state legislature will determine whether a mandatory road usage charge (RUC) program or another system is implemented.

#### Potential Areas of ODOT Policy Intervention:

- **Road usage charge (RUC)** – ODOT is a leader in operating a RUC system based on miles driven, and the implementation of an expanded statewide, mandatory RUC could supplement or replace decreasing revenues from the gas tax.

- **Pricing of roadway infrastructure** – Pricing strategies to capture costs associated with increased VMT or delay on the state highway system could supplement transportation revenue.

- **DMV fees and policies** – ODOT could consider DMV policies that require issuance of a special driver’s license, and an associated fee, for people operating vehicles with Level 3 automation. This registration process could also be used to monitor not only the penetration of these types of vehicles into the population, but to generate analyses of crashes or changes in driver behavior.

- **Western State RUC Consortium** – ODOT’s ongoing participation in RUC West could continue to build broad support and technical capacity to implement a statewide or multistate RUC.

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**Figure 12. Agency and Private Sector Level of Influence for Transportation Funding Sufficiency**

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**Influence.** The federal government and ODOT have the most influence over policies that will support sufficient transportation funding. The federal government allocates significant transportation funding to state departments of transportation, but typically agencies must supplement this funding with other sources.

ODOT can impact funding levels through various policy levers, including pricing, fees, and taxes, among others. However, the Oregon State Legislature would have to direct ODOT to implement pricing, fees, and taxes, because ODOT does not have authority to initiate new taxes. Figure 12 illustrates the level of influence that the federal government, ODOT, other state agencies, local and regional agencies, and the private sector possess to shape transportation funding sufficiency outcomes.

Emerging technologies can help ensure that all vehicles are paying some share for their use of Oregon’s roadways. However, transportation funding is likely to continue to be constrained.

**Integrated vehicle technology will enable an expansion of a user-pays funding system.**

Integrated vehicle technology will enable an expansion of a user-pays funding system.
Land Use Management

It is difficult to predict the impacts of emerging technologies on land use patterns. The operational model that emerges for AVs will influence land use patterns, and what model is most likely to emerge is uncertain. It is possible that a combination of operational models (i.e. personal automated vehicles, shared automated vehicles, and shared automated rides) could be deployed, with shared mobility options prevalent in urban areas and private ownership models prevalent in rural areas. Shared mobility operational models are anticipated to support denser development patterns, while private ownership models are expected to contribute to longer commute distances and more diffuse land use patterns. However, any impact will be somewhat tempered by Oregon’s Statewide Planning Goals.

Influence. Local and regional agencies, state agencies, and private sector actors and market economies drive local development patterns. The Department of Land Conservation and Development (DLCD) manages the statewide land use program, which lays out goals and policies that influence land use and development patterns in Oregon. Local jurisdictions implement land use goals and policies, guiding development patterns through zoning and regulations. ODOT supports and complements the implementation of DLCD goals and policies through mobility policies and the development review process. Figure 13 illustrates the level of influence that the federal government, ODOT, other state agencies, local and regional agencies, and the private sector possess to shape land use outcomes.

Potential Areas of ODOT Policy Intervention:

- **System planning and overlay standards and guidance** – ODOT could update standards, guidance documents, and processes for Interchange Area Management Plans, policies, and land use overlay standards, to consider impacts to capacity resulting from increased deployment of AVs and CVs.

- **Mobility policies and targets on state facilities** – Mobility policies and targets may need to be updated to address potential capacity issues stemming from a mixed fleet of AVs, CVs, and legacy vehicles. These policies would be included in any future updates to the OTP or OHP. The OTC would play an integral role in supporting and adopting any updates to mobility policies.

- **Development review** – ODOT could update guidance to support consideration of AVs, CVs, and emerging active transportation modes (for example, bikeshare, scootershare, and paratransit) in the development review process. Development review requirements may need to consider changes in trip generation associated with new transportation technologies. Both DLCD and local agencies may need to consider changes to development review processes and requirements within their respective purviews.
Conclusion

Emerging technologies are rapidly changing the ways Oregonians move around the state, how goods are transported, and how Oregon’s roadways are used. ODOT has traditionally used past behavior to help anticipate and model future travel needs. As technology changes occur more rapidly, it becomes harder to rely on the trends of the past to forecast future outcomes.

As ODOT considers the investment needs and policies to guide its decisions over the next 20 years, understanding and accepting uncertainty by preparing for a range of futures is the most reliable course of action. ODOT’s next generation of statewide plans – particularly the OTP and OHP – must be flexible.

Over the next 20 years, the transportation system will increasingly incorporate new transportation technologies, which will exist alongside legacy vehicles and systems. Knowing exactly how fast different technological changes may occur, how those technological changes will interact, and what the outcomes of technology changes will be may be impossible. However, understanding the likelihood of possible outcomes can help ODOT both adopt policy now to support desired outcomes and be prepared to react as the future unfolds.

This first phase of the ETIA was designed to introduce the emerging technology trends that are impacting transportation, to begin to examine how these trends may affect how ODOT delivers transportation services in the state, and to identify policy implications and interventions to maximize positive outcomes and minimize negative outcomes.

The second phase will be an opportunity for ODOT to develop several possible futures that include different combinations of technological change and adoption, demographics, and other variables. Assessing key outcomes under each of these futures will lay the groundwork for updating ODOT policy documents in a way that allows the agency to anticipate and proactively address future challenges in a changing world.