CENTER FOR URBAN TRANSPORTATION RESEARCH

Autonomous Vehicle (AV) and Alternative Fuel Vehicle (AFV) Florida Market Penetration Rate and VMT Assessment Study

Final Report

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Center for Urban Transportation Research
University of South Florida
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Prepared for:

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Disclaimer

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the Florida Department of Transportation or the U.S. Department of Transportation.

Metric Conversion

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1000 L shall be shown in m^3				
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C

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16. Abstract

This report summarizes the results of a comprehensive market penetration analysis of autonomous vehicles (AV) and alternative fuel vehicles (AFV) and their impact on Florida's vehicle miles traveled (VMT). The analysis provided state-level AFV and AV market penetration rates and VMT forecasts for the state fiscal year (SFY) period 2017–18 to 2047–48. The projections consider high, medium, and low market penetration rates and VMT scenarios for autonomous and alternative fuel technologies and account for Florida-specific economic and sociodemographic conditions. The VMT projections were used to assess the impact on the state's transportation revenues. The estimates show that the increased adoption of AFVs and AVs will result in substantial tax revenue losses, particularly after 2030. Annual fuel tax revenue losses from federal, state and local taxes are projected to increase from $5.4 million in SFY 2017–18 to $85.4 million by SFY 2027–28. The period SFY 2027–28 through SFY 2047–48 will see increased AV acceptance and market penetration. The combined cumulative effect of increased AFV and AV market shares on total revenue over SFY 2018–48 is projected to be $18.3 billion, including $5.3 billion loss in federal taxes, $9.7 billion loss in state taxes and $3.3 billion loss in local taxes. By the end of SFY 2047–48, annual revenue losses from state fuel taxes are projected to be about to about 26 percent of federal, state and local fuel taxes. The report presents various policy options to address the funding shortfall.

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Executive Summary

Autonomous vehicles are expected to change how we travel. There is high uncertainty regarding how these technologies will develop and when their acceptance in the marketplace will occur. Projected shifts in mobility choices and travel behavior, advancements in vehicle propulsion and automation, and socioeconomic trends could drastically impact how passengers travel and freight goods move, introducing substantial uncertainty for federal, state, and local transportation tax revenue collection. To effectively plan for the influx of alternative fuel vehicles (AFVs) and autonomous vehicles (AVs), the Florida Department of Transportation (FDOT) must gauge the market penetration rate of these technologies and how they will contribute to the state's vehicle miles traveled (VMT).

This report summarizes the results of a comprehensive market penetration analysis of autonomous vehicles and alternative fuel vehicles and their impact on the state's vehicle miles of travel. The study's results will assist FDOT in (1) timely response to the implementation of autonomous and alternative fuel vehicles and (2) addressing FDOT future transportation funding needs and revenue requirements as the projected market penetration rates are achieved.

The initial stages of this research focused on reviewing the most recent literature providing national market penetration forecasts and analyzing factors affecting national trends. This information served to generate state-level AFV and AV market penetration rates and VMT forecasts for the state fiscal year (SFY) period 2017–18 to 2047–48. The projections consider high, medium, and low market penetration rates and VMT scenarios for autonomous and alternative fuel technologies and account for Florida-specific economic and sociodemographic conditions. The VMT projections were used to assess the impact on the state's transportation revenues.

This study estimates that over the 10-year Revenue Estimating Conference (REC) forecasting timeframe (ending in SFY 2027-28), the increased adoption of AFVs will negatively impact tax revenue generation. On an annual basis, tax revenue losses are projected to increase from $5.4 million in SFY 2017–18 (less than one percent of fuel-based annual state revenues) to $85.4 million by SFY 2027–28 (about 1.3 percent of fuel-based annual state revenues).

Over the entire period (SFY 2017-18 through SFY 2047-48) the cumulative impact of increased AFV and AV market penetration will result in $18.3 billion in revenue losses, or about 8 percent of of federal, state and local fuel taxes. The impact on tax revenues will increase rapidly starting at the end of the REC projection forecasting horizon. By then, AVs will start rapidly penetrating the market resulting in substantial annual revenue losses. In SFY 2047–48, annual revenue losses will be about to about 26 percent of federal, state and local fuel taxes.

The study also identifies potential AFV and AV investment needs and cost savings accruing to FDOT and the approximate time periods for each during their respective anticipated rollout periods. By 2048, Florida is projected to have 3.8 million BEVs, representing 14.6 percent of the state's vehicle market. The State of Florida will need additional charging infrastructure to accommodate the increased demand from battery electric vehicles. Improvements in fuel economy and wider use of alternative fuel vehicles may lead to a reduction in fuel consumption and translate into lower fuel tax revenue for the state.

One of the main benefits of AVs is the expected increase in roadway capacity due to the ability of vehicles to travel closer to each other and the reduction in collision-related congestion. As market penetration increases, capacity improvements remain minimal for non-cooperative AVs, but increase exponentially for connected AVs. Accommodating the increased adoption of AV technologies may require special infrastructure considerations such as road markings and signage, managed/dedicated AV lanes, the addition of drop-off lanes, intelligent transportation system roadside devices to enhance vehicle-to-infrastructure capabilities, and demand management strategies.

Future legislative bodies will encounter continuous pressure to increase tax and fee rates or transfer funds away from other programs and into transportation. Investments in transportation capacity improvements have been shown to be the most affected in a funding shortfall environment as ongoing operating and maintenance needs take priority. While federal, state, and local legislative bodies have demonstrated a propensity in recent years to partially accommodate transportation funding shortfalls, continued ad hoc adjustments and transfers may become increasingly difficult to achieve as fuel efficiency continues to improve and alternative fuel vehicles and autonomous vehicles gain market share.

The report discusses various policy options to address the STTF funding shortfall, including imposing AFV fees and taxes, adjusting motor fuel excise taxes to better reflect the energy content of fuels, mileage-based transportation funding options, and public-private partnership models to fund transportation infrastructure.

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List of Abbreviations and Acronyms

AFDC	Alternative Fuels Data Center
AFV	Alternative fuel vehicle
AV	Autonomous vehicle
BE	Battery electric
BEBR	Bureau of Economic and Business Research
BEV	Battery electric vehicle
CAFE	Corporate Average Fuel Economy standards
CARB	California Air Resources Board
CNG	Compressed natural gas
CO_2	Carbon dioxide
CPI	Consumer Price Index
CPU	Central processing unit
CT	Combination truck
CUTR	Center for Urban Transportation Research
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EIA	U.S. Energy Information Administration
EPA	U.S. Environmental Protection Agency
EV	Electric vehicle
EVI-Pro	Electric Vehicle Infrastructure Projection Tool
eVMT	Electric vehicle miles traveled
EVSE	Electric Vehicle Supply Equipment
FCV	Hydrogen fuel cell vehicle
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
GGE	Gasoline gallon equivalent
GHG	Greenhouse gas
GM	General Motors
GR	General Revenue
HD	Heavy-duty
ICE	Internal combustion engine
kWh	Kilowatt hour
LDV	Light-duty vehicle
LNG	Liquefied natural gas
MD	Medium-duty
MPG	Miles per gallon
MUTCD	Manual on Uniform Traffic Control Devices for Streets and Highways
MVL	Motor vehicle license
NHTS	U.S. National Highway Traffic Safety Administration
NGV	Natural gas vehicle
NREL	National Renewable Energy Laboratory
ODOT	Oregon Department of Transportation

P3	Public-private partnership
PAV	Pooled autonomous vehicle
PEV	Plug-in electric vehicle
PHEV	Plug-in hybrid-electric vehicle
REC	Revenue Estimating Conference
SAE	Society of Automotive Engineers
SAV	Shared autonomous vehicle
SCETS	State Comprehensive Enhanced Transportation Systems
SEED	State Economic Enhancement and Development Trust Fund
SFY	State fiscal year
STTF	State Transportation Trust Fund
SUT&B	Single-unit trucks and buses
SUV	Sport utility vehicle
TNC	Transportation network company
VMT	Vehicle miles traveled
V2I	Vehicle-to-infrastructure
V2V	Vehicle-to-vehicle
ZEV	Zero-emission vehicle

1 Introduction

1.1 Background Statement

Autonomous vehicles (AVs) and alternative fuel vehicles (AFVs) stand to have perhaps the most profound impact on transportation planning and investment since the invention of the automobile 131 years ago. Companies and research institutions, both nationally and globally, are investing substantial resources developing and refining these technologies. Profound changes can be expected in how we travel, what mode and vehicle type we use, how our goods are transported, and in our living, working, and travel patterns.

There is high uncertainty regarding how these technologies will develop, when their acceptance in the marketplace will occur, what additional investments may be needed to facilitate their adoption, what potential savings may ultimately be realized, and when investment costs and cost savings may be realized over the continuum from initial entry to potentially full market adoption. As such, a significant degree of risk exists with respect to what actions the Florida Department of Transportation (FDOT) should take to prepare for the ensuing implications on infrastructure needs and revenue funding flows. Such risks include the potential for directing revenue resources in areas that do not respond to these changes or underinvesting if autonomous and alternative fuel technologies penetrate the market at a higher-than-expected rate.

To effectively plan for the influx of automated and alternative fuel vehicles and create a transportation system for the future, it is recommended that FDOT gauge the market penetration rate of these technologies and predict how they will contribute to the state's overall vehicle miles traveled (VMT).

1.2 Project Objectives

The objective of this project was to conduct a comprehensive market penetration analysis of autonomous and alternative fuel vehicles and their impact on Florida's VMT. The study's results will assist FDOT in responding to the implementation of autonomous and alternative fuel vehicles in terms of future transportation funding needs and revenue requirements as market penetration rates are achieved.

The analysis conducted in the project produced high, medium, and low projections of market penetration rates for autonomous and alternative fuel technologies and will identify potential investment needs and cost savings accruing to FDOT and the approximate time periods for each during their respective anticipated rollout periods. The study estimated the impact to current motor fuel-based revenue sources. A set of revenue measures that addresses FDOT transportation funding needs was prepared. The effort identified policy considerations for further development by FDOT and policy makers for transportation infrastructure design, construction, maintenance, operations, and funding purposes as specific technologies are implemented in the marketplace and their consequences are better understood.

1.3 Project Activities

Previous work produced several deliverables that served to inform the analysis and findings of this report. The following activities and reports were delivered to FDOT:

- **Deliverable No. 1: Autonomous Vehicle Market Penetration Rate Analysis.** A technical report summarizing the review of the most recent (until 2018) literature providing market penetration forecasts, adoption rates, and factors affecting AV market penetration at the national level.
- **Deliverable No. 2: Florida-Specific Autonomous Vehicle Market Penetration Rate and VMT Projection Analysis.** A technical report detailing Florida-specific AV adoption and penetration rate, with VMT forecasts for the period 2017 through 2048.
- **Deliverable No. 3: Alternative Fuel Vehicle Market Penetration Rate Analysis**. A technical report summarizing factors affecting national AFV market adoption rates, recent and future AFV technology developments, and a review of the AFV subsidy environment and its influence on market penetration at the national level.
- **Deliverable No. 4: Florida-Specific Alternative Fuel Vehicle Market Penetration Rate and VMT Penetration Rate Analysis.** A technical report considering Florida-specific factors affecting AFV adoption and VMT determinants. The report produces AFV VMT 2018–48 forecasts under the scenarios of low, medium, and high AFV adoption rates.
- **Deliverable No. 5: Autonomous Vehicle and Alternative Fuel Vehicle Investment Analysis.** A report summarizing the potential impacts of AV adoption on capacity and total VMT, the potential requirements of dedicated lanes for AVs, and potential investment requirements for AFVs.
- **Deliverable No. 6: Autonomous Vehicle and Alternative Fuel Vehicle Cost Savings Analysis.** A technical report that identifies areas for potential costs savings from AV adoption, identifies benefits to stakeholders, and identifies AV implementation stages when savings might be realized.
- **Deliverable No. 7: Autonomous Vehicle and Alternative Fuel Vehicle Revenue Analysis.** A technical report that assesses the impact of alternative fuel vehicles and autonomous

vehicles on federal, state, and local transportation tax revenue collections in Florida, and their effects on generating additional future demand for transportation infrastructure investments.

- **Deliverable No. 8:** A technical report identifying key benchmarks for FDOT to monitor AFV and AV key trends and a summary of policy options for consideration.

1.4 Report Organization

This report is organized into seven chapters. Chapter 1 provides an overview of the project, including background, project objectives, and a list of all tasks completed earlier. Chapter 2 reviews the literature summarizing the state of the market for AFV and AV technologies, nationally and in the state of Florida. Chapter 3 discusses the revenue analysis estimation method, which includes an outline of the revenue forecasting timeframe and assumptions underlying the forecast generation. Chapter 4 presents the revenue forecasts, which break down the revenue impact from increased AFV and AV market penetration. Chapter 5 discusses the expected implications of AFV and AV technologies on future infrastructure investment needs. Chapter 6 outlines key technological, behavioral, and societal trends affecting the adoption of AV and AFV technologies, as well as discusses policy considerations to relieve pressures on the Florida transportation system. Chapter 7 summarizes the results of the analysis and conclusions.

2 Alternative Fuel and Automated Vehicle Market Penetration Analysis and Vehicle Miles of Travel Projections

2.1 Introduction

Alternative fuel vehicles are vehicles that run on fuels other than gasoline or diesel. They include all-electric vehicles (EVs), plug-in hybrid-electric vehicles (PHEVs), hydrogen fuel cell vehicles (FCVs), and vehicles running on compressed natural gas (CNG), liquefied natural gas (LNG), propane, biodiesel, ethanol, and other alternative fuels. Major vehicle manufacturers are either already offering or actively developing EV and PHEV models, as well as other AFVs. While EVs and PHEVs are more common as light-duty vehicles, natural gas vehicles (CNG and LNG) are often preferred for high-mileage, centrally fueled heavy-duty fleets.

While gasoline- and diesel-powered vehicles continue to dominate the motor vehicle market, AFVs have gained popularity in recent years as a means of reducing greenhouse gas (GHG) emissions, reducing dependence on imported energy sources, and lowering vehicle operating costs. Despite potential benefits, AFVs face challenges to their adoption, including higher up-front costs, insufficient fueling infrastructure, longer fueling time, shorter vehicle range, and lack of consumer awareness. Government action at all levels plays a vital role in encouraging the adoption of cleaner vehicles by offering incentives and enacting environmental standards.

Vehicle automation technologies, while still emerging, have the potential to improve safety and reduce congestion. As the automotive industry continues to push the technical boundaries, federal and state regulators are responding by implementing policy and regulations for testing autonomous vehicle technologies. As of 2016, Florida is one of a few states that allow the development, testing, and operation of autonomous-equipped vehicles on public roads without requiring a vehicle driver to be present.[1] For these reasons, it is becoming increasingly important to assess the impacts that AVs may have on the transportation system.

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[1] The Florida House of Representatives enacted HB 7027 in 2016, which “Permits operation of autonomous vehicles on public roads by individuals with a valid driver license. This bill eliminates the requirement that the vehicle operation is being done for testing purposes and removes a number of provisions related to vehicle operation for testing purposes. Eliminates the requirement that a driver is present in the vehicle. Requires autonomous vehicles meet applicable federal safety standards and regulations” (National Conference of State Legislatures).

While AV technologies can be implemented on multiple propulsion systems, it is anticipated that EVs will be most suited for automation due to readily available battery power that can satisfy the energy needs of automated systems, such as multiple sensors, vehicle-to-vehicle (V2V) communication devices, and more powerful central processing units (CPUs).

There is high uncertainty regarding how these technologies will develop and when they will be accepted in the marketplace. To effectively plan for the influx of AVs and create a transportation system for the future, FDOT must gauge the market penetration rate of these technologies to understand how they will contribute to the state's vehicle miles traveled. This chapter summarizes the results of Deliverable 1 through Deliverable 4 of this research effort. The next sections provide national and Florida-specific assessments of both current and predicted AFV and AV market penetration, and the repercussions on travel demand in the aggregate.

2.2 National-Level Market Penetration Analysis

2.2.1 Alternative Fuel Vehicles

In 2018, global electric vehicle (EV and PHEV) sales exceeded 2 million units, with the United States being the third largest EV market in the world, following Europe and China [1]. From 2011 through 2018, the global EV market averaged an annual growth rate of about 50 percent. Dramatic improvements in EV performance, safety, and reliability contributed to the increased adoption of these vehicles. In 2018, about 361,000 EVs were sold in the United States, representing 2 percent of national light-duty vehicle sales, with nearly half of EV sales taking place in California. In June 2019, U.S. EV sales reached approximately 2.5 percent of all light-duty vehicle sales [1]. While the electric vehicle market share remains low, its compound annual growth rate ranged between 20 and 30 percent over the past seven years. This growth may slow, at least temporarily, as federal purchase incentives (up to $7,500 per vehicle) are phased out for manufacturers who exceed 200,000 EV sales. In 2018, Tesla and General Motors (GM) reached this threshold.

The U.S. AFV stock continues to grow with vehicle sales but remains relatively low. Despite national sales growth, the current EV/PHEV stock is estimated at slightly over 1 million vehicles, or approximately 0.37 percent of the total light-duty vehicle stock [2]. Natural gas and hydrogen fuel cell vehicles maintain an even smaller market share than EV/PHEVs. As of 2018, there were approximately 160,000 natural gas vehicles operating in the United States—mainly in the heavy-duty sector—and about 15.2 million globally [3]. Global sales of fuel cell vehicles are estimated at 6,000 annually.

Recent declines in gasoline prices have reduced the economic advantage of natural gas vehicles (NGVs), which is needed to offset their higher infrastructure and operating costs. If future fuel price differentials favor NGVs, the impact for Florida transportation planning purposes should be minimal. This is because starting in January 2019, the various natural gas fuels used for transportation are taxed comparably to motor fuels on a per gallon of gasoline equivalent (GGE) basis.

The major factors influencing EV market penetration relate to government policy, vehicle costs, consumer attitude and awareness, availability of EV models, and fueling infrastructure. Major government policies that affect national EV sales include the California zero-emission vehicle (ZEV) program; the California Global Warming Solutions Act of 2006 that requires sharp reductions in GHG emissions; and a federal tax credit that provides up to $7,500 for purchasing EV/PHEVs, as well as CO_2 credits provided under the EPA/NHTS GHG/CAFE standards. Some states have also implemented various incentive and policy programs aimed at accelerating AFV adoption, including grants, tax incentives, loans and leases, rebates, and exemptions. Incentives play a vital role in developing the AFV market, particularly those that provide direct financial benefits to vehicle owners. Various AFV incentives available in different states are discussed in more detail in the Task 3 technical report.

From a technological standpoint, the primary driver of EV/PHEV costs and sales is the battery cost. Between 2010 and 2018, the cost of automotive batteries (measured by kilowatt hour) decreased by 80 percent, from over $1,000/kilowatt hour (kWh) to approximately $200/kWh, and is projected to continue declining, potentially falling below $100/kWh by 2030 [4]. Industry experts believe that electric vehicles will be able to reach true price parity with traditional gasoline/diesel-powered vehicles when battery costs fall below $100/kWh, which is conservatively projected to occur between 2025 and 2030. Battery management systems and technology improvements are extending battery durability. Lithium-ion technology is projected to remain the primary technology for automotive batteries in the near future and will see further improvements in energy density and efficiency, making batteries smaller and lighter.

2.2.1.1 Market Projections

AFV market penetration projections vary significantly from source to source. The Energy Information Administration (EIA) forecasts that sales of EV/PHEVs will exceed 1.1 million vehicles per year, accounting for 7 percent of all light-duty vehicle sales in 2025. EV/PHEV sales are also projected to reach 14 percent of annual vehicle sales in 2050 [5]. The National Renewable Energy Laboratory (NREL) forecasts that EVs will account for 20 percent of all light-duty vehicle sales in the United States in 2030. More aggressive forecasts place the share of EV sales at 35 percent of new light-duty vehicle sales in 2040, and up to 60 percent of all light-duty vehicle sales in 2050.

Overall, the reviewed EV sales forecasts imply short-to-medium-term (10–15 years) annual growth rates ranging from 20.6 to 25.1 percent, and long-term (20+ years) growth rates ranging from 7.5 to 16.0 percent. Nationally by 2040, natural gas vehicles are projected to account for 10 percent of new medium- and heavy-duty vehicle sales, while fuel cell vehicle sales are projected to represent approximately 0.6 percent of total vehicle sales in the same year. The projections regarding the stock of EVs range from 7 million vehicles in 2025 to 15 million in 2030, and 41 million vehicles in 2040. Even the most aggressive forecasts, however, indicate that the electric vehicle fleet is not expected to exceed 15 percent of the overall U.S. vehicle stock in 2040.

2.2.2 Autonomous Vehicles

The Task 1 technical report of this research provided a review of the most relevant studies published to date on the impact of AVs on travel demand and its effect on vehicle miles of travel. Although AV technology is still in the testing phase, there is a growing body of research focused on its impact on travel demand as measured by vehicle miles traveled. The Society of Automotive Engineers (SAE) International established functional definitions of AV capabilities. The full range of driving automation features spans from Level 0 to Level 5, where the level is determined by driving conditions in which the features are employed. Table 2-1 lists a summary of the taxonomy and definitions.

Table 2-1. SAE International Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles

<table>
<tr><th>SAE Level</th><th>Name</th><th colspan="2">Definition</th></tr>
<tr><td>0</td><td>No Automation</td><td colspan="2">The full-time performance by the human driver of all aspects of the dynamic driving task, even when “enhanced by warning or intervention systems”</td></tr>
<tr><td>1</td><td>Drive Assistance</td><td>The driving mode-specific execution by a driver assistance system of “either steering or acceleration/deceleration”</td><td rowspan="2">using information about the driving environment and with the expectation that the human driver performs all remaining aspects of the dynamic driving task</td></tr>
<tr><td>2</td><td>Partial Automation</td><td>The driving mode-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration</td></tr>
<tr><td>3</td><td>Conditional Automation</td><td rowspan="3">The driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task</td><td>with the expectation that the human driver will respond appropriately to a request to intervene</td></tr>
<tr><td>4</td><td>High Automation</td><td>even if a human driver does not respond appropriately to a request to intervene</td></tr>
<tr><td>5</td><td>Full Automation</td><td>under all roadway and environmental conditions that can be managed by a human driver</td></tr>
</table>

Source: Society of Automotive Engineers [6]

The literature review of Task 1 found that AVs are expected to have relevant impact on travel, possibly at Level 4 of the technology, to begin in the larger, more expensive, and luxury segments of the vehicle market in the early to mid-2020s. It is expected that the technology will diffuse into the medium, small, and lower priced vehicle categories in the mid-2020s to early 2030s. Around the same time, the Level 5 technology is anticipated to launch in a similar pattern, initially in the more expensive vehicle market segments and extending through the mid- to late-2030s or 2040s in the medium to compact vehicle segments.

2.2.2.1 Market Projections

The reviewed literature indicates that autonomous vehicles will likely enter the private vehicle market in a top-down pattern, first arriving in the larger and luxury car segments and then, shortly after, becoming available in the medium, small, and compact or pick-up vehicle categories. Level 4 functionality will initially become available in testing environments in 2020–25 and will diffuse through vehicles of different categories by the early to mid-2030s. In the early 2030s, the smaller and lower-priced vehicle categories will include Level 4 capabilities. In the early 2030s, the Level 5 technology will debut in the larger and luxury segments. By the 2030–40 timeframe, these features will be introduced into the medium to compact vehicle market segments. As time goes on, given the current technological developments and regulations, it can be expected that by 2035, Level 4-5 AV technology will encompass 35 percent of the private vehicle market share and anywhere from 11 to 14 percent of the private vehicle fleet.

One way AVs can affect vehicle travel demand is through supplying shared mobility services to the currently underserved, including youth, the elderly, and those with driving-prohibitive medical conditions. The shared mobility concept, which enables users to gain short-term access to transportation on an as-needed basis, is gaining popularity, especially with the younger generation of drivers. Recent developments in vehicle automation create additional opportunities for a wider adoption of the shared vehicle model. If fully autonomous vehicles become a reality, they can be used more efficiently to provide mobility to multiple users. The literature review indicated that the estimated impact of new travel demand from the underserved population can result in a 2 to 14 percent increase in VMT.

2.3 State-Level Market Penetration Analysis

2.3.1 Alternative Fuel Vehicles

The market acceptance of AFVs depends on many factors, including demographics and socioeconomics, geography and climate, gasoline and electricity pricing, charging infrastructure availability, government incentives, as well as consumer perception, personality, and social influences.

During the past 20 years, Florida's population grew almost twice as fast as the overall population of the United States and that trend is expected to continue. Additionally, Florida's population density is significantly higher than the national average and future growth in Florida is expected to concentrate mainly within urban areas. Population growth and density are expected to have a positive effect on the adoption of plug-in electric vehicles (PEVs) in the state.

In addition to demographic, socioeconomic, and population factors, geography and climate considerations could affect PEV growth, though to a lesser degree. Climate and regional temperature variation can affect the performance, efficiency, and range of PEVs, which depends on battery capacity and vehicle efficiency. With its subtropical climate, Florida experiences the highest average annual temperature compared to other states. Due to its climate and temperature patterns, Florida yields some of the most optimal energy efficiency and PEV range in the country, making it a favorable market for electric vehicle adoption.

Battery electric vehicles make up a greater share of PEV sales in Florida than in most other states. As of June 2018, Florida battery electric vehicle sales accounted for 61.3 percent of total PEV sales, which is higher than the national average share of 51.3 percent. During the period of 2013–18, Florida's PEV sales grew at an average annual rate of 20 percent per year, faster than other non-zero-emission vehicle states, which grew at a comparative annual rate of 16.5 percent. In 2018, approximately 42,962 plug-in electric vehicles were registered in the state, including 17,807 plug-in hybrid-electric and 25,155 battery electric vehicles [2].

AFV infrastructure availability is often cited as an important factor in accelerating PEV adoption. Florida's network of electric vehicle charging infrastructure continues to grow rapidly. As of August 2019, there are more than 3,300 charging outlets, including 1,139 Level 2 charging locations (with 2,640 ports) and 163 fast charging stations (with 630 ports) [7]. While Florida has roughly 3.6 percent of the national stock of electric vehicles, its Level 2 and fast chargers account for approximately 5.0 percent of the national EV charging infrastructure. The state is expected to add an additional 530 public EV charging stations through 2022 as a result of the Duke Energy Park and Plug Program.

At present, Florida lacks any rebate, grant, or tax incentive program to accelerate PEV adoption. However, in recent years state electric utilities began offering rebate and incentive programs incentivizing PEV ownership and lowering the installation cost of charging infrastructure.

Overall, there are a number of positive factors that contribute to Florida's increasing growth in PEV sales, including favorable climate, a greater preference for automobiles over light trucks than most other states, relatively low electricity costs, and a relatively high population density to support the developing vehicle charging infrastructure. Factors that may inhibit PEV growth, or delay growth until PEV costs decline, include lower than national average household incomes, a large sector of lower wage service jobs, and relatively few state and local incentives, including non-participation in the Zero-Emission Vehicle Program.

The stock of electric vehicles in Florida is projected to increase to more than 3.8 million by 2048. Light-duty vehicles are expected to account for the vast majority of all EVs in the state through the entire projection period and will account for 93.0 percent of the total Florida EV fleet in 2048. The current approach forecasts that by 2048, 18.0 percent of single-unit trucks and 10.0 percent of semitrucks in Florida will be battery electric.

2.3.2 Autonomous Vehicles

Various studies project that by 2030, AVs will make up around 18.5 percent of the U.S. vehicle fleet share. The share will gradually increase to 25.4 percent in 2035 and 30.0 percent by 2040. The reviewed literature suggests that by 2045, approximately 43.0 percent of the U.S. fleet will consist of AVs and that by 2050, AVs will make up almost half of the nation's vehicle fleet.

Several state-specific factors may impact Florida's AV adoption rates to diverge from these national trends, including population age, income level, education level, and urban density. Several studies find that AV acceptance is positively associated with a younger population [8-10], higher income levels [11-13], higher levels of education [8, 9], and urban environments [9, 14, 15]. According to the U.S. Census Bureau, the median household income measured in Florida in 2012–16 was $48,900 in 2016 dollars [16], relatively lower than the national median of $55,322. On the other hand, the distribution by income levels in Florida is similar to the rest of the country. Assuming some similar accessibility to AVs across different income groups, it will be difficult to discern a clear relationship between income levels and AV VMT.

Florida's population currently comprises a larger percentage of persons 65 and over compared to the rest of the United States. According to the Census, as of July 2017, 20.1 percent of Florida's population is 65 and over, compared to 15.6 percent nationally. The Bureau of Economic and Business Research (BEBR) projects that by 2040, this group will represent about a quarter of the state's population. Based on the existing demographic characteristics and BEBR projections, and assuming the association between AV acceptance and age remains constant, it is expected these population forecasts will result in a somewhat more moderate AV market acceptance in Florida compared to national trends.

The growing aging population in Florida also has implications for the way AVs will change VMT, as AVs may cater to underserved groups. Based on the literature review report of Task 1, it is assumed that additional VMT will be produced in response to projected increases in Florida's underserved population cohorts. According to the U.S. Census Bureau, the population of Florida is similarly, although slightly more, educated than the nation's total population. The percentage of the population over age 25 reported to be a high school graduate or higher is 87.0 nationally and 87.2 for Florida. The percentage of the population that has a bachelor's degree or higher is 27.9 nationally and 30.3 for Florida [16, 17].

New mobility options exist in population-dense, urban areas, which provide the opportunity for economies of scale. Nine of the large and population-dense metropolitan areas in the United States contain 70 percent of Uber and Lyft trips [18]. Florida is more densely populated than the rest of the country, with a population density of 350 persons per square mile compared to a national average of 87 persons per square mile. Florida is also the eighth most population-dense state. Combined with the population growth that is faster than the national average, this makes urban Florida among the fastest growing areas in the nation, increasing the likelihood of options such as shared mobility services provided by transportation network companies (TNCs), as detailed in the Task 1 and Task 2 technical reports of this research.

TNCs may lead individual adoption by providing mobility services in the form of shared autonomous vehicles (SAVs) or pooled autonomous vehicles (PAVs), which are SAVs that may pick up other passengers en route. TNC partnerships with auto manufacturers are in development and AV advancement, along with studies showing reduced individual willingness to own and pay for AVs, suggests that private AV ownership will lag TNC AV fleet development. However, the literature is not in full agreement. Some studies show that private vehicle ownership is preferred over shared vehicle use [13].

2.4 VMT Projections

The AFV and AV market penetration analysis served to inform the VMT projections, which are subsequently used in the revenue forecasts of Chapter 4 of this report. The baseline Florida VMT forecasts are based on the Federal Highway Administration's long-term (30-year) projections, adjusted using a weighted index of key sociodemographic and macroeconomic factors specific to the state that are expected to have significant effect on VMT generation. Task 2 and Task 4 technical reports detail the approach and method used to generate the VMT forecasts of Figure 2-1.

The forecast of electric vehicles miles traveled (eVMT) in Florida is driven by the projected number of EVs in the state and the average eVMT driven by electric vehicles, including battery electric vehicles and plug-in hybrids. The projection of the number of EVs in Florida, in comparison with the national EV market, employs a weighted index approach, similar to the one used to adapt the national Federal Highway Administration (FHWA) VMT projections. The eVMT forecasts are obtained by combining the forecasted number of EVs in each subcategory (passenger vehicles, single-unit trucks and buses, combination trucks) with projected VMT per electric vehicle. The per-vehicle eVMT estimates are based on the projected shares of BEVs and PHEVs in Florida's EV fleet, as well as the estimated electric range of these vehicles during the 30-year forecast period.

Under the baseline VMT growth forecast, total Florida VMT is projected to reach 336 billion by the year 2048. Under a high VMT growth scenario, VMT in Florida is forecasted to be as high as 380 billion total vehicle miles traveled. A low growth scenario results in a VMT projection of 295 billion total vehicle miles traveled in Florida in 2048. Over the period 2018–48, Florida VMT is projected to grow at an average annual rate of 1.41, which is higher than the national growth rate over the same period. From 2018 through 2038, total Florida VMT is projected to grow at an average annual rate of 1.6 percent, and a moderated 0.99 percent rate per year after 2038.

Autonomous vehicles are estimated to begin affecting VMT generation toward the end of the Revenue Estimating Conference (REC) forecasting timeframe (2027-28). AVs are not expected to account for a significant portion of VMT until at least 2035. By 2035, VMT from AVs is projected to account for 3.8 percent of total Florida VMT, increasing to 7.29 percent of total Florida VMT by 2040.

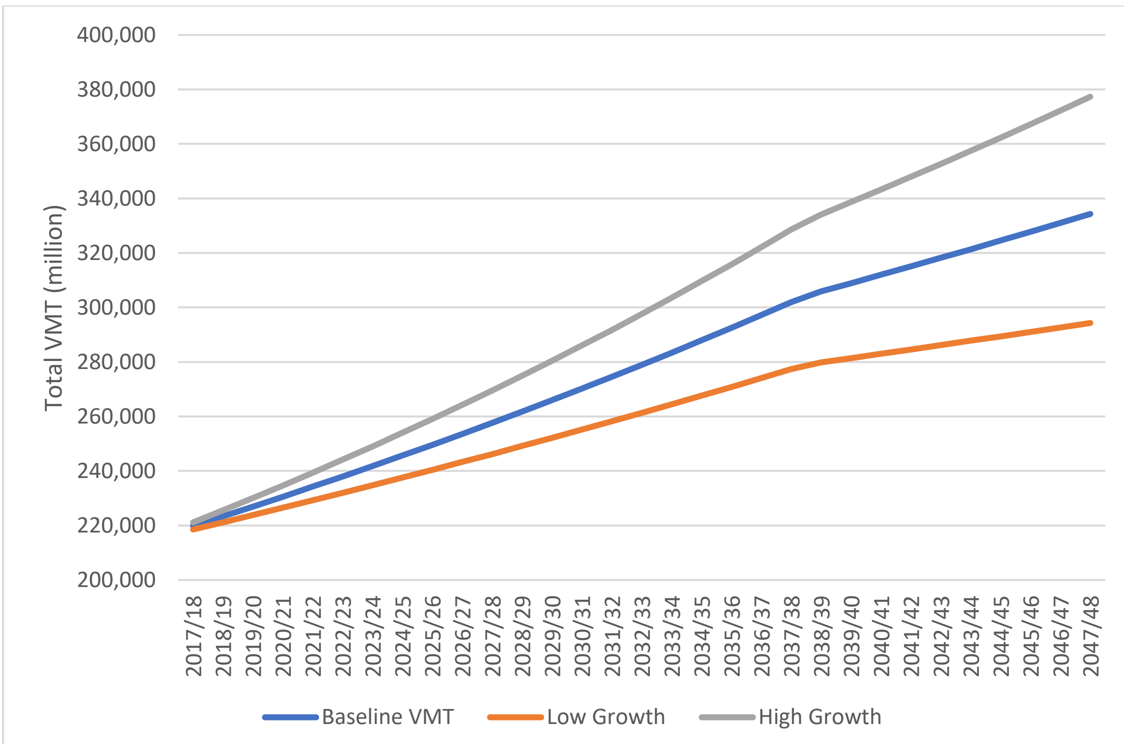

Figure 2-1. Projected VMT Scenarios

Source: Projections from Task 2 and Task 4 Technical Reports

The added impact of AVs on baseline Florida VMT forecasts is expected to be about 3.8 percent annually, or just over 11 billion miles in 2035. By 2048, AV market penetration is expected to result in approximately a 15 percent increase in VMT with respect to a baseline scenario with no AV penetration. This analysis assumes that by 2048, the increase in VMT due to the advent of AV market penetration will be fully absorbed by electric vehicles. As a result, eVMT is expected to grow by about 12 percent annually between 2035 and 2048. By 2048, eVMT is projected to account for 25.1 percent of total VMT.

3 Revenue Analysis Methodology

3.1 Introduction

This chapter presents the methodology and assumptions used to inform the revenue impact analysis of Chapter 4. To estimate revenue impact, the projected VMT of Chapter 2 is first converted into the forecasted number of gallons of gasoline and diesel motor fuel not consumed as a result of plug-in electric vehicles substituting for internal combustion engine (ICE) vehicles. The estimated gallons are then applied to the various federal, state, and local motor fuel tax rates to calculate lost revenues with adjustment assumptions for non-taxable fuel shares (public entities) and various administrative fees, refunds, and non-transportation diversions.

Current tax rates are assumed to stay in effect during the analysis periods for non-indexed fuel taxes. This was assumed because this revenue study intends to determine current and future projected transportation tax and fee revenue levels relative to funding needs in order to project future revenue adjustments needed to better align revenue growth with transportation infrastructure and service needs. To forecast future fuel tax rates in the instances where fuel taxes are indexed, this study utilizes projections consistent with historical Consumer Price Index (CPI) growth rates [19].

3.2 Assumptions

3.2.1 Revenue Estimating Conference Assumptions

The Florida Legislature's Office of Economic & Demographic Research Revenue Estimating Conference (REC) produces consensus forecasting for economic, demographic, and revenue impacts to inform the development of planning and budgeting for state resources [20]. REC assumptions for state fiscal year (SFY) 2018–19 through 2027–28 were incorporated into the analysis to retain consistency with state forecasts and demographic assumptions, with the exception of REC projections for current and future miles per gallon (MPG) levels. The REC reported MPG levels appear to reflect projections for the light-duty vehicle (LDV) segment of Florida's fleet and not total fleet MPGs, which also include single-unit trucks, buses, and combination trucks that have substantially lower MPG rates.

REC forecast tax rates for indexed motor fuel taxes were used through SFY 2027–28 and were then calculated based on an annual CPI growth of 2.2 percent, which reflects a continuation of the REC assumed inflation rate in the outer years of their 10-year forecast. This approach was also used to estimate future non-indexed transaction-based revenues beyond the REC forecasting period ending in 2047–48. All other tax rates were held constant. No assumptions were made regarding potential future local rate increases in those counties that have not assessed their maximum allowable local option tax rates. Documentary stamp tax revenues were held constant beginning in SFY 2028–29 when the statutory cap for the transportation revenue share is expected to be realized.

3.2.1.1 REC Revenue Forecasts

The March 5, 2019, REC revenue forecasts shown in Table 3-1 were applied for all state transportation tax revenues and fees for the SFY 2027–28 [20]. The indexed state motor fuel sales tax and State Comprehensive Enhanced Transportation Systems (SCETS) tax were assumed to increase at a 2.2 percent annual rate. All motor fuel tax revenues were calculated based on forecasted gallons of gasoline and diesel fuel consumed considering the electric vehicle miles traveled impact, using an eVMT-adjusted fleet average MPG rate. Non-fuel related fees were grown annually beyond SFY 2027–28 at the amount of increase each fee experienced in the last year of the REC forecast period. Documentary stamp tax revenue was frozen at $466.8 million annually beginning in 2028–29, based on the current legislative cap on State Transportation Trust Fund (STTF) transfers—$541.75 million less $75.0 million to the State Economic Enhancement and Development Trust Fund (SEED).

Table 3-1. Revenue Estimating Conference: Transportation Revenues

	2017–18	2018–19	2019–20	2020–21	2021–22	2022–23	2023–24	2024–25	2025–26	2026–27	2027–28
March 5, 2019											
Highway Fuel Sales Tax	1,426.3	1,486.5	1,539.0	1,578.9	1,624.1	1,670.6	1,723.0	1,775.2	1,820.8	1,862.5	1,912.1
SCETS Tax	811.5	849.3	877.7	900.6	930.1	958.0	985.1	1,012.0	1,037.3	1,062.6	1,088.2
Off-Highway Fuel Sales Tax	13.3	16.6	17.0	17.1	17.7	18.0	18.2	18.5	18.8	19.0	19.3
Aviation Fuel Tax	34.6	39.7	23.3	16.1	15.9	16.2	16.4	16.5	16.6	16.8	17.3
Fuel Use Tax and Fees	8.1	8.3	8.5	8.6	8.8	8.9	9.1	9.2	9.3	9.3	9.4
Natural Gas Fuel Tax	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.6	0.6	0.6
MVL-Related Amount (From HSMV Conference)											
Motor Vehicle Licenses	636.4	657.0	668.7	679.0	688.8	698.4	707.8	715.9	724.1	732.4	740.7
Initial Registration Fee	229.1	231.5	233.3	235.0	236.7	238.4	240.0	242.3	244.7	247.1	249.5
Title Fees	311.3	313.0	313.7	314.3	315.0	316.1	317.4	318.5	319.7	320.9	322.0
Motor Vehicle Compliance Penalties	13.2	14.5	14.5	14.5	14.5	14.5	14.5	14.7	14.8	15.0	15.1
Subtotal	1,190.0	1,216.0	1,230.2	1,242.8	1,255.0	1,267.4	1,279.7	1,291.4	1,303.3	1,315.4	1,327.3
Rental Car Surcharge	138.4	142.3	145.6	148.3	150.8	153.8	157.2	160.3	163.0	165.5	167.6
Local Option Distribution	45.7	47.3	47.8	48.3	48.6	48.9	49.1	49.2	49.3	49.4	49.5
Total	3,668.0	3,806.0	3,889.1	3,960.7	4,051.0	4,141.8	4,238.0	4,332.9	4,419.0	4,501.1	4,591.3

Source: Revenue Estimating Conference – March 5, 2019

3.2.2 Historical Fleet MPG Rates

The REC-reported MPG levels appear to reflect projections for the light-duty vehicle (LDV) segment of Florida's fleet and not fleet MPGs, which also include single-unit trucks, buses, and combination trucks that have lower MPG rates as shown in Figure 3-1.

In this analysis, historical fleet MPG rates were obtained by dividing the Florida Department of Revenue certified taxable gallons by the FHWA and FDOT reported annual VMT to derive fleet calculations of vehicle miles traveled by gallon of taxable motor fuel consumed [21, 22].

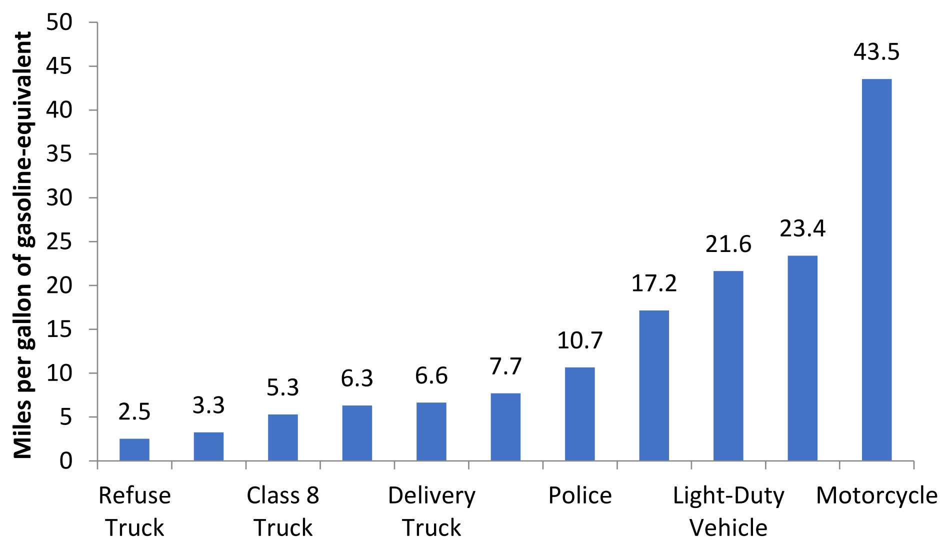

Figure 3-1. Average Fuel Economy by Fleet

Source: Adapted from Alternative Fuels Data Center (AFDC) [23]

3.2.3 Projected Plug-in Electric Vehicle Growth

Several factors suggest that Florida will experience increasing growth in PEV sales, which include both battery electric and plug-in hybrid electric vehicles, due to favorable climate, general preference for automobiles over light trucks compared to other states, relatively low electricity costs, and relatively high population density. Figure 3-2 shows projected PEV growth ending in 2048.

Electric vehicles are projected to increase in Florida from 42,900 units in 2018 to 278,275 units in 2025 and over 3.6 million by 2048, with eVMT accounting for 2.9 billion miles in 2025 and 47.5 billion miles of annual travel in 2048, and the majority of those vehicles concentrated in the higher density metropolitan areas.

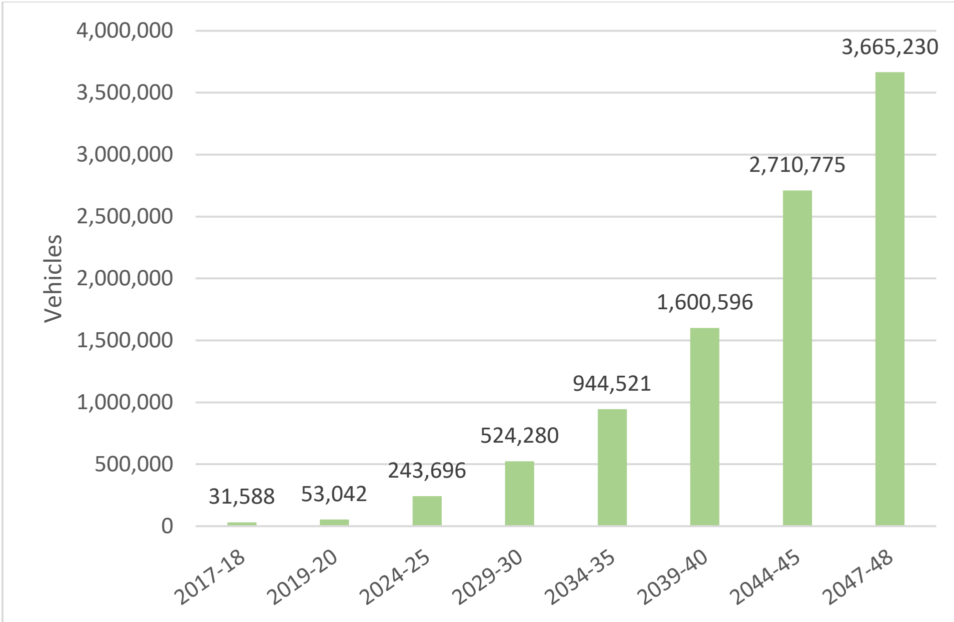

Figure 3-2. Projected Light-duty PEV Stock in Florida

Source: Projections from Task 4 Technical Report

Light-duty vehicles are expected to account for the vast majority of PEVs in Florida through the entire projection period and will account for 93.0 percent of the total Florida PEV fleet in 2048. The current approach forecasts that by 2048, 18.0 percent of single-unit trucks and 10.0 percent of semitrucks in Florida will be battery electric.

3.2.4 Projected Natural Gas Vehicle Growth

Natural gas vehicles represent a smaller share of the U.S. vehicle fleet than EVs and PHEVs. According to the U.S. Department of Energy (DOE), as of 2017 there were approximately 150,000 natural gas vehicles operating in the United States, which were mainly applied in the heavy-duty sector. The U.S. Energy Information Administration (EIA) reports that only 0.13 percent of natural gas consumed in the United States was used to fuel NGVs. The EIA 2018 Energy Outlook projects that while natural gas transportation fuel use is expected to increase, specifically in the commercial freight trucks and marine vessel market, it is expected to maintain a relatively minor share of the total transportation fuel demand. EIA forecasts suggest that by 2025, approximately 70,000 medium-duty (MD) and heavy-duty (HD) natural gas vehicles (CNG and LNG) will be operating in the United States, representing 0.6 percent of the overall MD and HD national fleet. The number of medium- and heavy-duty NGVs in the U.S. fleet is expected to reach 80,000 in 2030, 140,000 in 2040, and 290,000 in 2050, representing 0.6 percent, 0.9 percent, and 1.6 percent of the overall U.S. medium- and heavy-duty vehicle stock in the respective years.

Overall, natural gas vehicles are expected to represent a rather small share of the vehicle fleet even in the long term. Natural gas vehicles in Florida are expected to follow nationwide trends, growing modestly, mainly in the MD and HD vehicle sectors, but still maintaining a relatively small percentage of vehicle stock—less than 1.0 percent of MD and HD vehicle stock until 2040.

3.2.5 Calculation of Gallons of Motor Fuel Deficit

The first step in calculating gallons of motor fuel not consumed was to develop a fleet profile of light-duty PEVs by modeling annual vehicle sales, generally fitting sales to conform to eVMT projections, and then applying projected future MPG rates for each new model year to develop an annual fleet MPG rate to apply against eVMT projections in calculating gallons not consumed.

The National Center for Statistics and Analysis *Vehicle Survivability and Travel Mileage Schedules* were used to compute PEV lifespans and annual miles driven by vehicle age. ICE vehicles, in general, have demonstrated increased durability and lifespan since 2006, however the durability and life of PEVs currently is uncertain. Therefore, no adjustments were made to update these schedules. It was assumed the profile for PEVs would approximate 80 percent automobile and 20 percent truck vehicle life and annual miles driven [24]. While reflecting a lower percentage of truck/sport utility vehicle (SUV) share than may eventually materialize in the PEV market, this assumption was adopted due to the current uncertainty of average PEV lifespan.

Battery electric (BE) VMT per vehicle rates were reduced to 80 percent of ICE VMT based on studies performed by the California Air Resources Board (CARB) and as reported by Argonne National Laboratory [25]. Total eVMT miles as a share of PHEV total VMT miles were calculated assuming an initial utility factor (share of eVMT to total VMT) of 0.54 based on an analysis of PHEV utility factors for vehicles purchased in 2017. An assumption was made that PHEV utility factors would increase to 0.75 by 2048 as battery costs decline, allowing for larger batteries to capture a greater share of short- and medium-distance trips. The discounted BEV VMT rates and PHEV utility factor assumptions have an impact on projected levels of future vehicle sales, but neither should have a material effect on the calculation of motor fuel gallons lost, which is based on the eVMT forecast of this research (Task 3 and Task 4).

Fuel efficiency rates for new model year ICE vehicle purchases offset due to PEV sales were determined based on an analysis of 2017 PEV purchases and identification of comparable ICE vehicles in model size and performance. From this analysis, it was determined that PEV purchases in 2017 were made as a substitute for ICE vehicles that were approximately 5.5

percent more efficient than the new model year averages, using EPA real-world condition data. Accordingly, PEV substitution purchase MPG calculations for motor fuel gallons lost were based initially at a 5.5 percent MPG rate above the EPA new model year rate. Future year MPG rate increases were then based on the average annual EPA new model year MPG rate increase over the previous seven years. Once annual fleet MPG rates were established for each subcategory, these rates were divided into subcategory forecasts of annual eVMT in order to calculate resulting lost gallons of motor fuel.

Similar analyses were not performed for single-unit trucks and buses (SUT&Bs) and combination-truck (CT) vehicles due to a lack of availability of vehicle survivability (aging schedule) data. However, the potential effect of using more disaggregate new vehicle MPG calculations in lieu of annual forecast fleet MPGs on total eVMT gallons and revenue loss was estimated to be less than one percent and was therefore not material.

3.2.6 Projected Future Fuel Efficiency Rates

Annual fuel efficiency rates (MPG) for ICE vehicle subcategories were developed using 2016 highway statistics data from the Office of Highway Policy Information [26]. In 2016, the national fleet fuel efficiency was 6.65 percent less than the Florida combined fleet MPG based on certified gallons and VMT levels. Accordingly, each Florida category was increased to establish Florida baseline MPG rates for each vehicle subcategory and adjusted to fit the 2017–18 Florida fleet MPG levels and converted to an SFY basis for consistency with the state REC forecasts.

During the period from SFY 2018–19 through SFY 2027–78, fuel efficiency rates were driven by REC forecasts of annual gallons of motor fuel consumed divided into SFY-adjusted annual Florida forecasted VMT subcategory levels. This reconciliation assumed that the REC and Florida eVMT forecasts exhibit reasonably similar levels of eVMT growth through the REC forecast period. For the period beyond the REC forecast, annual increases in vehicle fuel efficiency were continued at the annual MPG increases that were applied in the last three years of the REC forecast period reconciliation process. This approach over time yields a reasonable projection of future vehicle efficiency increases that, while being less than forecasts prepared by the EIA's *Annual Energy Outlook 2018,* is consistent with recent fuel efficiency trends that have underperformed the EIA projections to date [5].

3.2.7 Fuel Shares

Gasoline and diesel fuel shares for each vehicle subcategory were determined by analyzing the composition of diesel and non-diesel fleet distributions produced by the EIA. From this analysis, it was determined that in 2014, diesel engines were applied in 0.62 percent of total cars and light trucks and 71.71 percent of total medium-duty trucks (Table 3-2). All heavy-duty trucks were indicated to use diesel fuel. Accordingly, these percentages were applied to the eVMT lost gallon forecasts in order to calculate gasoline and diesel fuel lost gallon shares [5, 27].

Table 3-2. Composition of Diesel and Non-diesel Fleet by Vehicle Subcategory

U.S. DOE Data			Calculated Breakout		
	Percent	Total Vehicles	Light Vehicles	Medium Truck	Heavy Truck
Gasoline Cars	56.0	122,009,819	122,009,819	n/a	n/a
Gasoline Light Trucks	39.4	85,844,093	85,844,093	n/a	n/a
Gasoline MD & HD Trucks	0.8	1,742,448	n/a	1,742,448	n/a
Diesel MD & HD Trucks	3.3	7,164,712	n/a	4,417,830	2,746,882
Diesel Cars	0.5	1,119,795	1,119,795	n/a	n/a
Diesel Light Trucks	0.1	186,725	186,725	4,417,830	2,746,882
TOTAL		218,067,592	209,160,432	6,160,278	2,746,882
Diesel			1,306,520	4,417,830	2,746,882
Percent Diesel			0.62	71.71	100.00
****Assumption that 100 percent of HD trucks are diesel***					

Source: U.S. Energy Information Administration [27]

In order to account for non-taxable gallons, the SUT&B lost gallons calculation was initially reduced by 24 percent. This represents one-half of the 48 percent public-sector share on similar natural gas vehicles [28]. The non-taxable share was reduced 10 percent annually beginning in 2020 to reflect greater private sector vehicle adoption. For LDVs and CTs, it was assumed that non-taxable public-sector shares were generally similar to those for ICEs and no further adjustments were made.

3.2.8 Calculation of Lost Motor Fuel Revenues

The calculated lost gallons of gasoline and diesel fuel due to projected eVMT by year were then applied against a schedule of the various federal, state, local-use, and local-option tax rates, with appropriate adjustments to each rate for non-transportation shares such as administrative fees and refunds, diversions to non-transportation uses, and non-taxable public use. The SCETS tax rates were adjusted annually at the REC projected rate increases through 2027–28, and then at an annual CPI assumed level of 2.2 percent thereafter, consistent with the REC CPI rate assumed in the outer years of their forecast. All other tax rates were held constant. No assumptions were made regarding potential future local rate increases in those counties that have not assessed their maximum allowable local option tax rates.

3.2.8.1 Non-fuel Related Revenue Impacts

No forecasts were made for AFV/AV impacts on non-fuel related revenue sources such as motor vehicle registrations, title fees, initial registration fees, rental car surcharges, or documentary stamp taxes as these impacts are currently too uncertain to quantify, and an examination of existing data from over the past 10 years did not indicate significant trend variances.

4 Revenue Analysis

4.1 Introduction

In July 2012, the Center for Urban Transportation Research prepared the *Florida MPOAC Transportation Revenue Study* for the Florida Metropolitan Planning Organization Advisory Council [29]. The purpose of the study was to examine the state of transportation revenues in order to assess the sufficiency of funding levels for transportation investments in Florida and to develop recommendations in the form of legislative actions.

For this study, the scope is limited to (1) updating relevant sections of the *Florida MPOAC Transportation Revenue Study* to establish a baseline for analyzing AV and AFV revenue impacts; (2) incorporating from AV and AFV analyses projections of impacts on VMT levels, both total VMT and the share of alternative fuel based VMT, on motor fuel consumption; and (3) determining and projecting these effects on current sources of federal, state, and local transportation revenues. Recommendations for specific legislative actions to offset revenue impacts as contained in the 2012 report were not developed.

This chapter presents the results of the revenue impact analysis from AFV and AV market penetration. The chapter includes an overview of Florida's transportation revenue sources to provide a detailed background of revenue sources likely to be affected by AFV and AV market penetration. The revenue losses resulting from AVFs and AVs are first presented separately. Then the chapter also presents a cumulative combined impact on revenue loss from AFV and AV penetration. Finally, the chapter also discusses assumptions and factors affecting the projections.

The forecasts cover the REC 10-year timeframe (SFY 2017–18 to 2027–28) and extend to 2047–48 to account for the timeframe when most of the AV market penetration is projected to occur. The loss revenue projections were based on the baseline Florida VMT, AFV, and AV VMT forecasts produced and reported in Task 2 and Task 4 technical reports. All dollar figures are in constant (2018) dollars.

4.2 Overview of Florida's Transportation Revenue Sources

In 2017, $7.8 billion in transportation taxes and fees were collected in Florida (see Figure 4-1). This consisted of $2.6 billion in federal fuel, heavy-duty truck, and aviation taxes; $1.4 billion in local option fuel taxes and state fuel taxes dedicated for local use; and $3.9 billion in state fuel taxes, vehicle-related fees, and impact fees. Roughly one-half of these revenues were collected for state purposes, one-third for federal, and one-sixth by and for local governments. Federal highway funds are appropriated to state highway departments and transit funds to state and local entities [21].

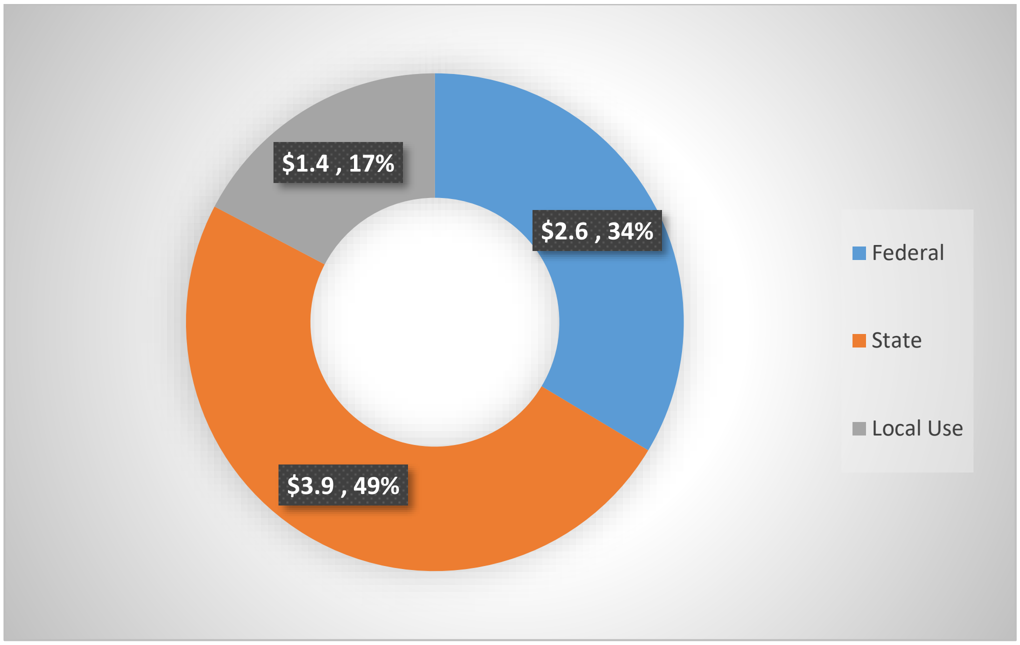

Figure 4-1. Florida's Transportation Revenues by Source ($, billion)

Source: Florida Department of Transportation [21]

Taxes based on motor fuel consumption accounted for 72 percent of total collections. As of January 1, 2019, the combined rate for federal, state, and local motor fuel taxes in Florida totaled 56.7 cents per gallon on diesel and ranged from 50.3 to 56.3 cents per gallon on gasoline based on the level of local option gasoline tax levies in individual counties. Statewide, gasoline taxes averaged 54.0 cents per gallon. These rates include the January 1, 2019, 0.6 cent per gallon state motor fuel tax increase as a result of annual CPI indexing provisions.

In 2017, federal, state, and local transportation taxes and fees generated approximately 3.6 cents per mile of vehicle travel in Florida: 1.2 cents per mile federal, 1.6 cents per mile state, and 0.6 cent per mile local. Of this total, the motor fuel tax collection share was approximately 2.6 cents per mile: one cent each federal and state and 0.6 cent local.

4.2.1 State Sources

Florida transportation revenues are generated from taxes, fees, and surcharges based on fuel consumption, vehicle use, and growth management impacts. Proceeds are deposited into FDOT’s State Transportation Trust Fund (STTF). The state’s motor fuel taxes generate 57 percent of all STTF revenues and are indexed to offset inflation impacts each January based on the CPI. Other sources are not automatically inflation adjusted, however, and their buying power diminishes over time unless specific legislative actions are taken to increase rates or provide new funding sources. One cent in Florida motor fuel taxes generates about $101 million per year (net of refunds and administrative charges). Florida's transportation revenue sources are listed below.

Highway Fuel Sales Tax – The highway fuel sales tax is levied on all highway fuels. Taxes on alternative fuels such as propane, butane, liquefied natural gas, and compressed natural gas are exempt until January 1, 2024, when an indexed tax will be assessed at a lower rate. The highway fuel sales tax as of January 1, 2019 is 18.1 cents per gallon and is indexed annually to the general rate of inflation (CPI, all items).

SCETS Tax – The SCETS tax is an additional highway fuel tax enacted in 1991. Proceeds of the SCETS tax proceeds must be spent in the respective FDOT district and, to the extent feasible, in the county in which they were collected. Like the fuel sales tax, the SCETS tax is indexed annually to the general CPI and alternative fuels are exempt until 2024. Currently, the SCETS tax rate is 7.8 cents per gallon.

Non-highway Fuel Sales Tax – This tax is levied on non-highway diesel fuel consumption—including intrastate railroads, commercial vessels, construction equipment, and others. Farming and commercial fishing are exempt. Off-highway fuel is taxed at a rate of 6 percent of the retail price.

Aviation Fuel Tax – Florida imposes a tax of 4.27 cents per gallon on fuels used for aviation. Revenues generated from this tax must be allocated to aviation projects.

Fuel Use Tax – The fuel use tax is imposed by every state by way of the International Fuel Tax Agreement on heavy vehicles engaged in interstate operations. The purpose of the tax is to ensure that heavy vehicles are taxed based on fuel consumed rather than fuel purchased. The tax comprises an annual decal fee of $4.00 plus a use tax based on the number of gallons consumed times the prevailing statewide fuel tax rate, with additional taxes (or refunds) when a vehicle consumes more (or less) fuel than purchased during a reporting period.

Motor Vehicle License Tax – The motor vehicle license tax is an annual tax for operating motor vehicles and other highway vehicles such as trailers. These taxes vary according to weight and type of vehicle. Pursuant to Article XII, Section 9 (d)(3) of the Florida Constitution, the first proceeds of the tax are deposited to the Public Education Capital Outlay Trust Fund and, as directed by s. 320.08, Florida Statutes, the remaining revenues are deposited into the STTF and the General Revenue (GR) fund. In addition, every vehicle—with the exception of mobile homes—is assessed a $1.20 surcharge of which $1.00 is deposited into the STTF and $0.20 into the Highway Safety Operating Trust Fund.

Initial Registration Fee – A one-time fee of $225 is charged for first-time registration of an automobile, light truck, or recreation vehicle that results in a net addition to the state's registered vehicle stock. In 2015, Florida's legislature redirected the $93 General Revenue Fund portion of the fee to the STTF, increasing the STTF share to $193, with the remaining $32 directed to the Highway Safety Operating Trust Fund.

Title Fee – A fee is charged for all motor vehicles when issuing titles for certificate of ownership. Of the $70 fee, $21 is distributed to the STTF and $49 to the state's GR Fund. The 2012 legislature directed that in addition to the STTF distribution, the first $200 million of the GR share of title fee shall be deposited each year into the STTF, with the first proceeds having taken effect in fiscal year 2013–14.

Rental Car Surcharge – A $2.00 per day surcharge is assessed on the first 30 days of leases or rentals of vehicles licensed for-hire and designed to carry less than nine passengers. Vehicles rented for less than 24 hours pay a $1.00 surcharge. Eighty percent of the proceeds—less administrative fees and an 8.00 percent GR service charge—are deposited into the STTF, 15.75 percent to the Tourism Promotional Trust Fund, and 4.25 percent to the International Trade and Promotion Trust Fund. STTF proceeds must be spent in the transportation district from which the surcharges were collected.

State Documentary Stamp Tax – Documentary stamp taxes are levied on deeds, stocks and bonds, notes and written obligations, mortgages, liens, and other evidences of indebtedness. The 2005 legislature enacted growth management legislation to address needed infrastructure in Florida and provided for $541.75 million annually to be used to fund transportation needs. The STTF share was reduced substantially in 2008 and then partially restored in 2015. Currently the STTF receives approximately 24.2 percent of documentary stamp tax revenues, not to exceed $541.75 million annually, from which $75 million per year is transferred to the State Economic Enhancement and Development Trust Fund. This results in net maximum proceeds of $466.75 million. According to the December 2018 Revenue Estimating Conference, the STTF received an estimated $297.1 million in net distributions from documentary stamp taxes in SFY 2017–18.

Figure 4-2 illustrates the shares of these revenues as a percentage of total state transportation tax and fee revenues for SFY 2017–18.

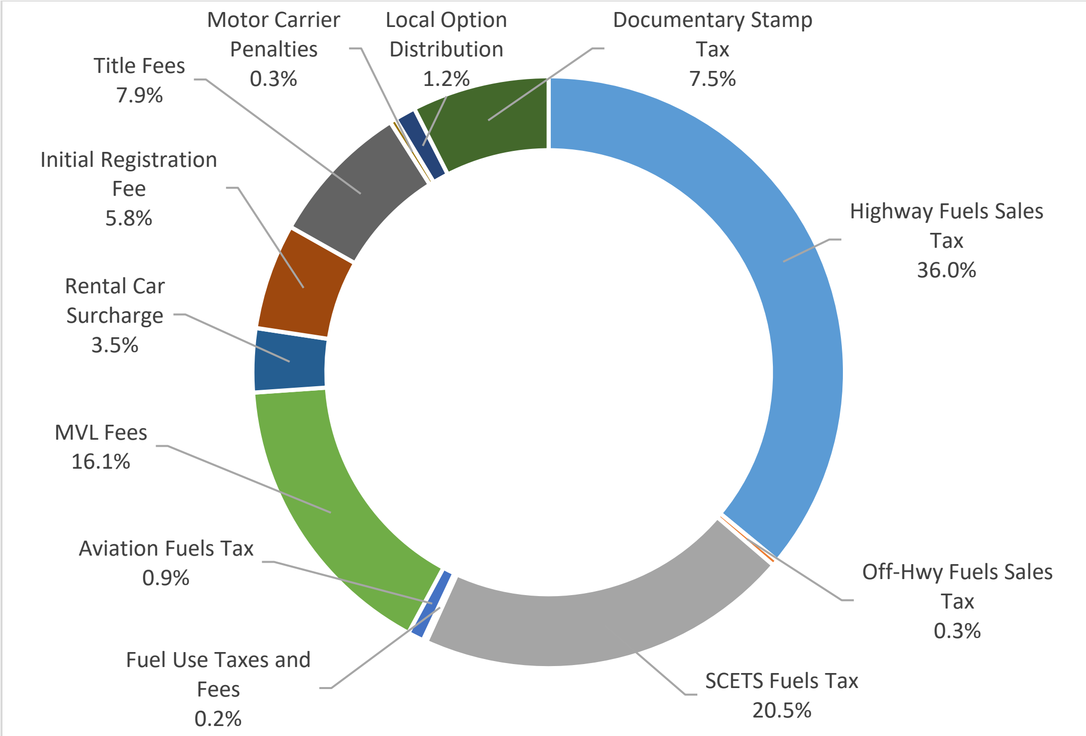

Figure 4-2. State Transportation Trust Fund Taxes and Fees

Source: Office of Economic & Demographic Research [30]

State transportation taxes and fees make up 52.4 percent of the FDOT work program funding with the remaining coming from federal funds, toll receipts, bond proceeds, and other sources. Of the state transportation taxes and fees share, 57.0 percent are indexed to the CPI and 43.0 percent are inflation sensitive.

The Florida Department of Transportation uses state transportation tax and fee revenue, federal aid, toll revenue, bond proceeds, and other revenue sources to pay for land acquisition, highway construction, air, sea, rail and transit projects, transportation operating, maintenance and safety programs, engineering, product support services, and general administration.

While state motor fuel taxes are indexed to inflation, state transportation vehicle fees and surcharges are not and require specific legislative action to be increased. Title and Initial Registration Fees were last increased in 2009, Rental Car Surcharges in 1990, and Motor Vehicle License Fees on private light-duty vehicles in 1983, with the exception of a $2 Motor Vehicle License (MVL) Surcharge first imposed in 1991. The STTF has received increased shares of Title and Initial Registration Fees in recent years.

4.2.2 Local Sources

Local governments utilize a variety of revenue sources to pay for transportation needs in addition to motor fuel taxes, such as valorem tax revenues, impact fees, and transportation and infrastructure sales taxes. Therefore, this section should not be considered all-inclusive as it is an evaluation of the motor fuel tax portion of total funding. Local governments receive revenues from six different motor fuel taxes, three of which are state imposed taxes dedicated to local use and three are local option taxes enacted by local governments. Certain counties are also authorized to impose a transportation-specific sales tax surcharge in addition to the infrastructure surcharges for which transportation is an eligible use.

4.2.2.1 State Sources for Local Use

The following motor fuel taxes are distributed to local governments.

Constitutional Fuel Tax – Set at 2 cents per gallon, this tax is distributed to counties based on a constitutional formula. The county distribution factor is calculated using population, area, and total tax collections. The priority for the proceeds of the constitutional gas tax is to meet the debt service requirements, if any, on local bond issues. Any remaining resources are credited to the counties' transportation trust funds.

County Fuel Tax – Set at 1 cent per gallon, this tax is distributed by the same formula as the constitutional gas tax. Counties may use the revenues from this tax for transportation-related expenses.

Municipal Fuel Tax – Revenues from this tax, set at 1 cent per gallon, are transferred into the Revenue Sharing Trust Fund for municipalities where they are joined with other non-transportation revenues. These revenues may be used for transportation-related expenditures within incorporated areas and are distributed to municipalities by statutory criteria.

4.2.2.2 Local Tax Sources

State law authorizes local governments to enact the following local option taxes for transportation purposes.

Ninth-Cent Fuel Tax – Originally called the ninth-cent tax when the state's fuel taxes totaled 8 cents, this tax may be levied in any county by an extraordinary vote (majority plus one) of its Board of County Commissioners. The tax proceeds can be shared with cities within the county by agreement. The tax is imposed on diesel fuel in every county; a total of 53 counties in Florida levy this tax on gasoline as of 2018.

1–6 Cents Local Option Fuel Tax – Counties are authorized to levy a fuel tax of up to 6 cents per gallon of motor fuel. The tax is imposed on diesel fuel in every county at 6 cents per gallon. The tax on motor fuel may be authorized by an ordinance adopted by a majority vote of the governing body or voter approval in a countywide referendum. As of 2018, all 67 counties levy the full 6 cents tax on gasoline.

1–5 Cents Local Option Fuel Tax – Counties are authorized to levy a fuel tax of up to 5 cents per gallon of motor fuel, however, diesel fuel is not subject to this tax. This tax is levied by an ordinance adopted by a majority plus one vote of the county's governing body or voter approval in a countywide referendum. The tax proceeds must be shared with municipalities.

Charter County and Regional Transportation System Surtax – This tax can be levied in any county that has adopted a home rule charter, any county government that has consolidated with one or more municipalities, and any county that is within or under an interlocal agreement with a regional transportation or transit authority. At present, 31 counties meet these eligibility requirements. The tax can be levied at a rate of up to one percent of taxable transactions up to $5,000—excluding fuel sales taxes—by countywide referendum. Permitted uses of the revenues include financing the development, construction, and operation of fixed guideway, rapid transit systems, bus systems, on-demand transportation services, roads and bridges, and pledges to bonds issued for these purposes. The surtax is currently levied in only Duval and Miami-Dade counties, generating an estimated $314 million in 2017–18.

Figure 4-3 illustrates the shares of local tax revenues as a percentage of total state transportation tax and fee revenues for SFY 2017–18.

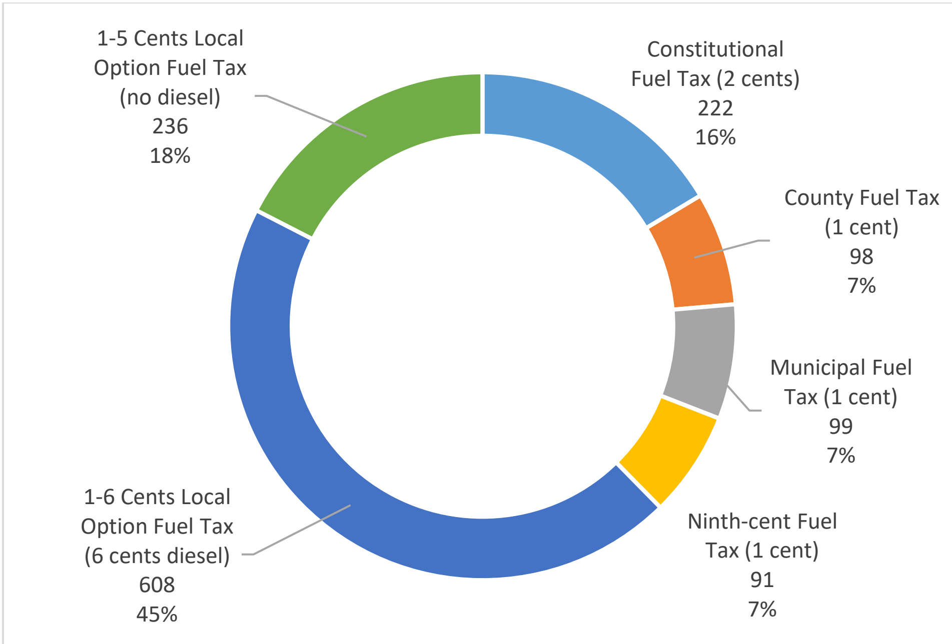

Figure 4-3. Local Government Transportation Fuel Taxes ($, million)

Source: FDOT Source Book [21]

In addition to the 4 cents in state taxes for local use, county governments have the option to impose an additional 12 cents on gasoline while a rate of 7 cents on diesel fuel is mandated in statute and collected for all counties, with the proceeds to be shared with municipalities. Of the 12 cents in local option gasoline taxes, 30 counties impose the full amount with other counties assessing taxes ranging from 6 to 11 cents per gallon. The statewide average of local option gas tax assessments has increased gradually from an equivalent of 9.13 cents per gallon in 2011 to 9.66 cents projected in 2019. Since the 1–6 cent local option tax is fully utilized, the increase is due primarily to certain counties imposing higher 1–5 cent gasoline tax rates and to a lesser extent the ninth-cent fuel tax.

Two additional sources of revenue that are playing an increasing role in funding transportation investment needs both at the state and local government levels are bond financing and tolling.

Bond Financing – Bond financing is increasingly used to finance transportation infrastructure needs by both the state and local governments, including local toll agencies. For example, right-of-way and state infrastructure bonds are being used to finance four percent of FDOT’s five-year work program.

Bond financing does not increase total available transportation funds. Principal and interest payments over time will exceed the amount of funds raised through the sale of bonds. However, it is an effective financing method to pay for large infrastructure projects that would otherwise take many years to complete if funds needed to be set aside on a pay-as-you-go basis. Thus, it enables motorists to take advantage of infrastructure improvements sooner.

Bond financing has also been used effectively to pay for costs that are expected to increase over time at rates that are greater than the interest rate cost of issuing bonds. Advance right-of-way purchases for future capacity expansion are examples. From a fairness and equity perspective, the payments for the cost of bond-financed transportation infrastructure projects are shifted from current motorists to future motorists who will benefit from the project.

While there are many benefits to bond financing, it can also be misused: when applied in excess, creating financial risks for the issuer; when used as a short-term substitute in lieu of prudent revenue generating policies; when pledging funds that should be reserved for future operating, maintenance, and renewal costs; or when issued under terms that exceed the useful life of the projects for which the proceeds are being used to finance. Higher rates of construction cost inflation may make debt financing of right-of-way acquisition and transportation capacity projects a more cost-effective consideration, particularly during periods of low interest rates when the economic benefits of earlier delivery of the infrastructure improvements, coupled with inflation cost avoidance, can more clearly be demonstrated to outweigh the interest costs associated with debt financing.

Tolls – Highway, bridge, and managed lanes tolling are examples of VMT-like user fees, where the motorist pays for the cost of the roadway, its maintenance, and future improvements based primarily on distance traveled and frequency of use. Higher toll rates are normally imposed on heavy vehicles, usually based on axle counts to capture the higher roadway maintenance and rehabilitation costs that are attributable to heavy vehicle use.

Florida has an established history of using tolls to pay for highways and bridges. It began in the 1950s when the state was sparsely populated but experiencing rapid growth in population and tourism. FDOT, FDOT's Florida Turnpike Enterprise, three local/regional transportation authorities, and four counties operate, maintain, and improve tolled highways and bridges throughout the state. Additionally, toll facilities have been built using public-private partnership arrangements. With some exceptions, most toll facilities are located in highly urbanized areas where the costs of adding capacity improvements were much higher. In 2017, gross toll collections by these entities totaled $1.965 billion. This amount was equal to the gross revenues generated from 18.1 cents in state motor fuel taxes.

4.3 Revenue Forecasts

The impact of increased eVMT and AV VMT on motor fuel tax revenues is modeled conforming to the March 2019 Office of Economic & Demographic Research Revenue Estimating Conference Transportation Revenue Forecasts. The REC forecasts cover SFY 2017–18 through 2027–28. To account for the impact of AVs, this study's forecasts extend the REC projection to SFY 2047–48 using the assumptions and approach detailed in Chapter 3 (see Figure 4-4).

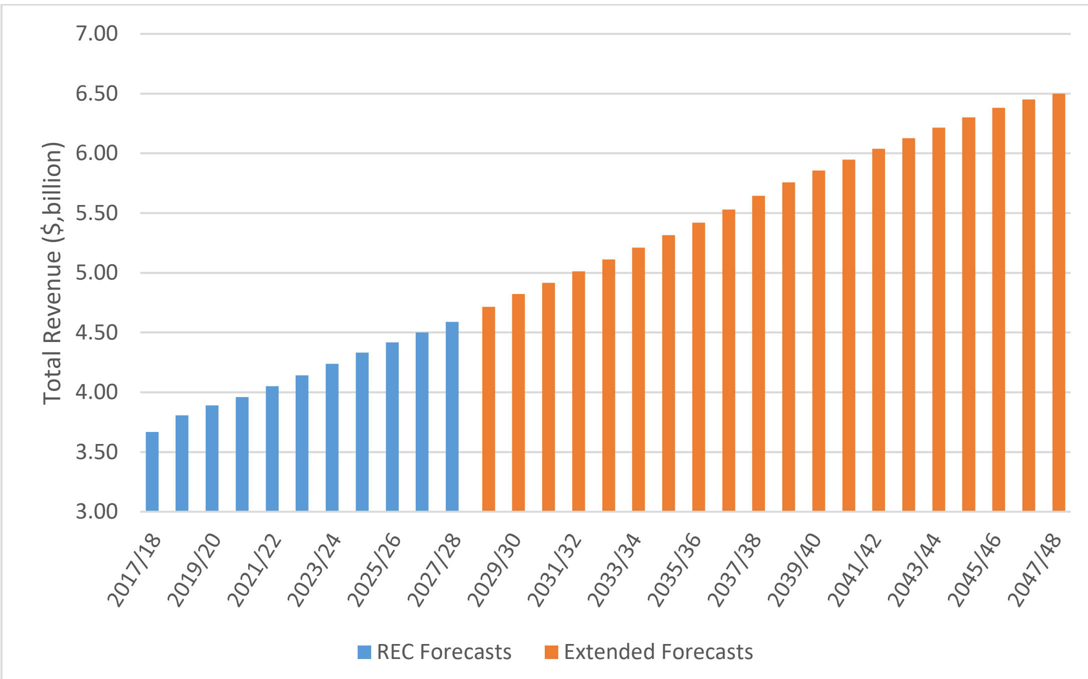

Figure 4-4. Transportation Revenue Forecasts: SFY 2017–18 through 2047–48
Source: Office of Economic & Demographic Research [20, 31] and Projections from Task 7 Report

The indexed state motor fuel sales tax and SCETS tax were assumed to increase at a 2.2 percent annual rate. All motor fuel tax revenues were calculated based on forecasted gallons of gasoline and diesel fuel consumed considering the eVMT impact, using an eVMT-adjusted fleet average MPG rate. Non-fuel related fees were increased annually beyond SFY 2027–28 at the amount of increase each fee experienced in the last year of the REC forecast period. Documentary stamp tax revenue was frozen at $466.8 million annually beginning in 2028–29, based on the current legislative cap on STTF transfers—$541.7 million less $75 million to the State Economic Enhancement and Development Trust Fund.

4.3.1 Revenue Losses from Alternative Fuel Vehicles

4.3.1.1 Losses in Highway Fuel Consumption from Plug-in Electric Vehicles

Several factors suggest that Florida will experience increasing growth in PEV sales, including a favorable climate, a greater preference for automobiles over light trucks compared to preferences in other states, relatively low electricity costs, and a relatively high population density to support the developing vehicle-recharging infrastructure. Task 4 of this research produced detailed VMT forecasts for SFY 2017–18 through 2047–48.

Total electric VMT in Florida is projected to reach 45.1 billion by SFY 2047–48, accounting for slightly over 13.5 percent of the overall VMT in the state in the baseline case (Figure 4-5).

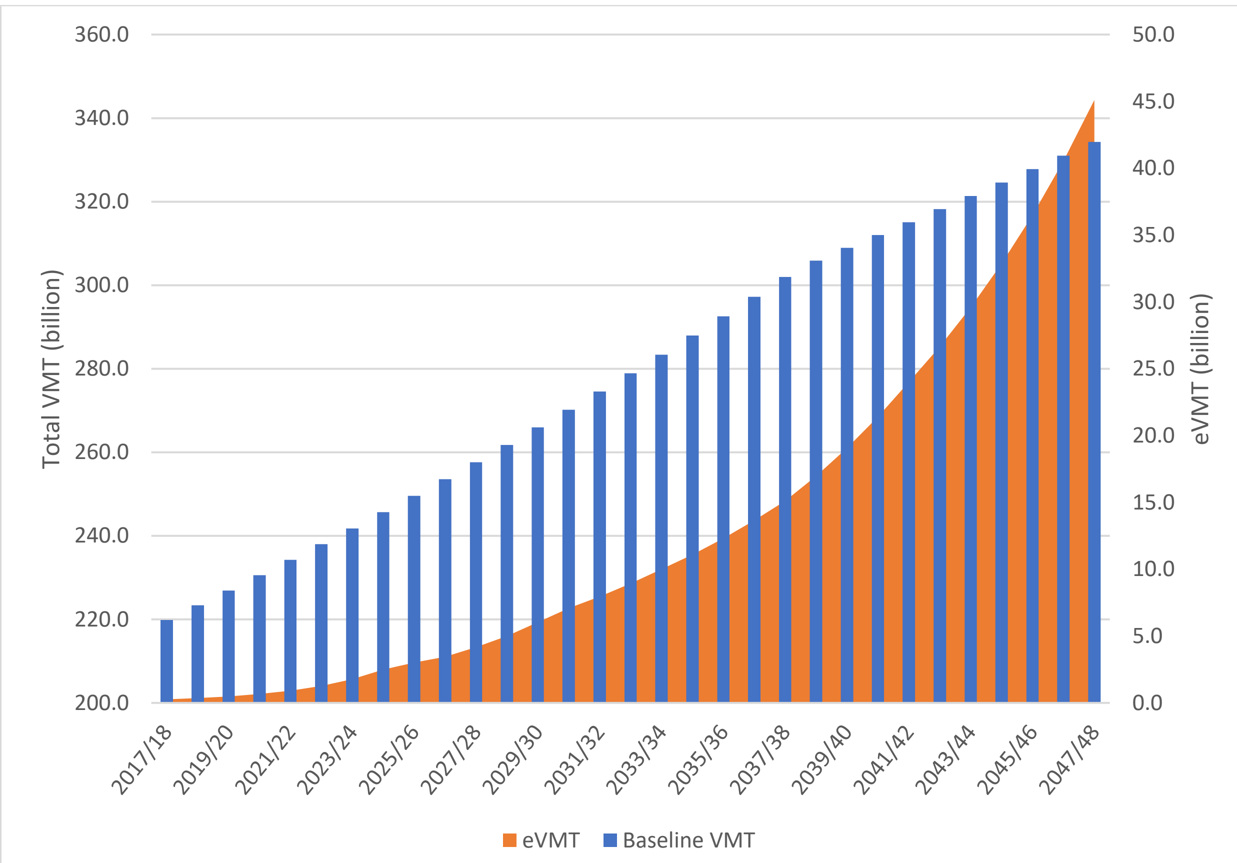

Figure 4-5. Baseline eVMT Projections

Source: Projections from Tasks 1-4 Technical Reports

The growth in eVMT is expected to reduce demand for gasoline and diesel fuel and in turn negatively affect revenue generation. The eVMT forecasts are applied to projected MPG rates to estimate the reduced demand for gasoline and diesel fuel. Appendix C details projected MPG rates and underlying assumptions. Figure 4-6 reports the estimated annual reduction in motor fuel demand from increased eVMT. While through the end of the REC forecasting period (2027–28) the annual loss in highway fuel will reach 1.2 percent of the total consumed, by 2047–48, total annual loss will reach 14.3 percent.

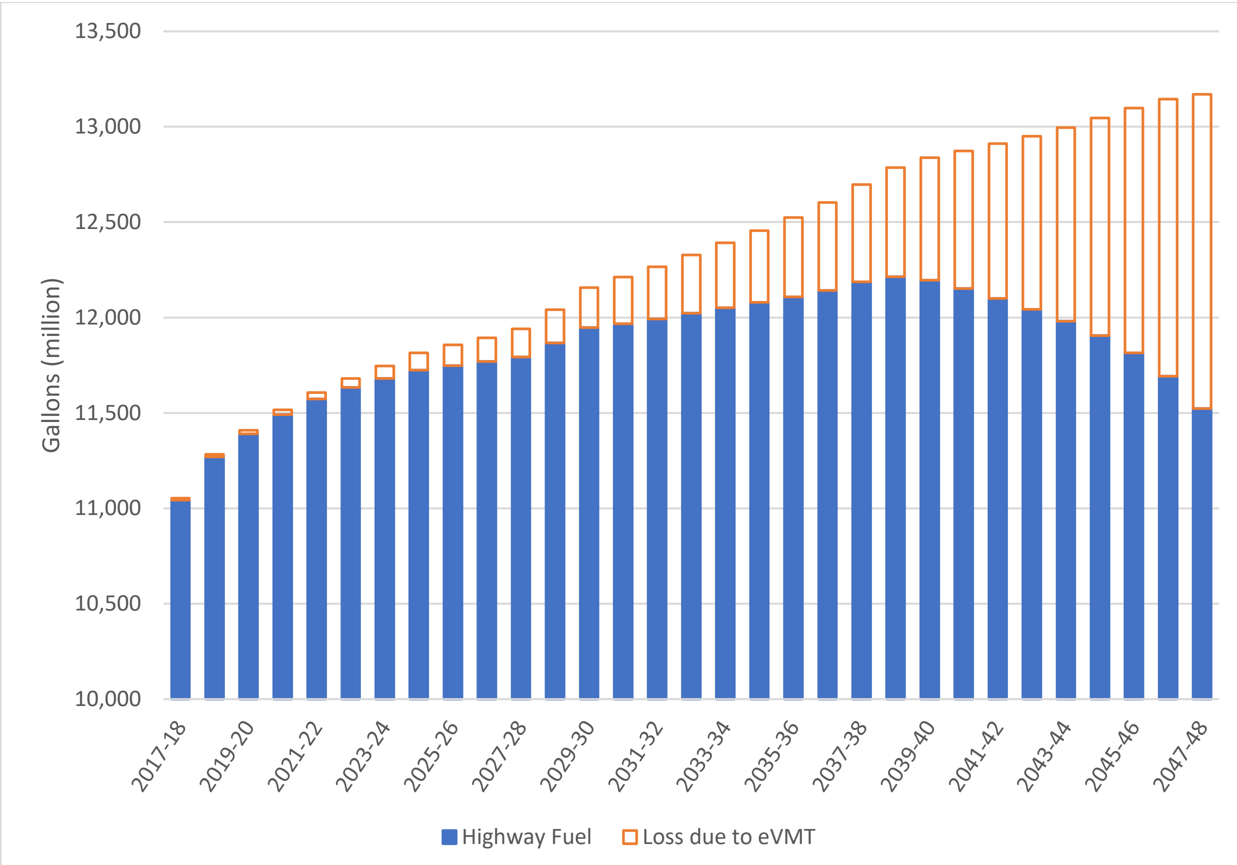

Figure 4-6. Total Highway Fuel Lost Due to Increased eVMT

Source: Projections from Task 7 Technical Report

4.3.1.2 Revenue Losses Due to Increased eVMT

The reduction in highway fuel consumption from increased eVMT negatively impacts the Transportation Revenue Fund. Figure 4-7 reports the estimated transportation revenue losses due to reduced motor fuel consumption from increased PEV adoption. In SFY 2018–19 the total impact is estimated at $5.4 million, including $2.0 million from federal taxes, $2.18 million from state taxes and $1.3 million from local taxes. While tax revenue losses have been small to date, the loss rate from PEV use is increasing, rising on a percentage loss basis from 0.1 percent of fuel tax revenues in SFY 2017–18 to 1.3 percent by the end of SFY 2027–28. Annual revenue losses are projected to increase to $83 million by SFY 2027–28. Cumulative tax revenue losses through SFY 2027–28 are projected to total $375.5 million: $126.5 million in Florida federal tax, $165.8 million in state tax, and $83.2 million in local use transportation tax collections. The State Fuel Tax share of total losses increases from 40 percent in SFY 2017–18 to 45 percent in

SFY 2027–28 and 56 percent in 2047-48 as indexed state tax rates increase while federal and local rates are assumed to remain constant.

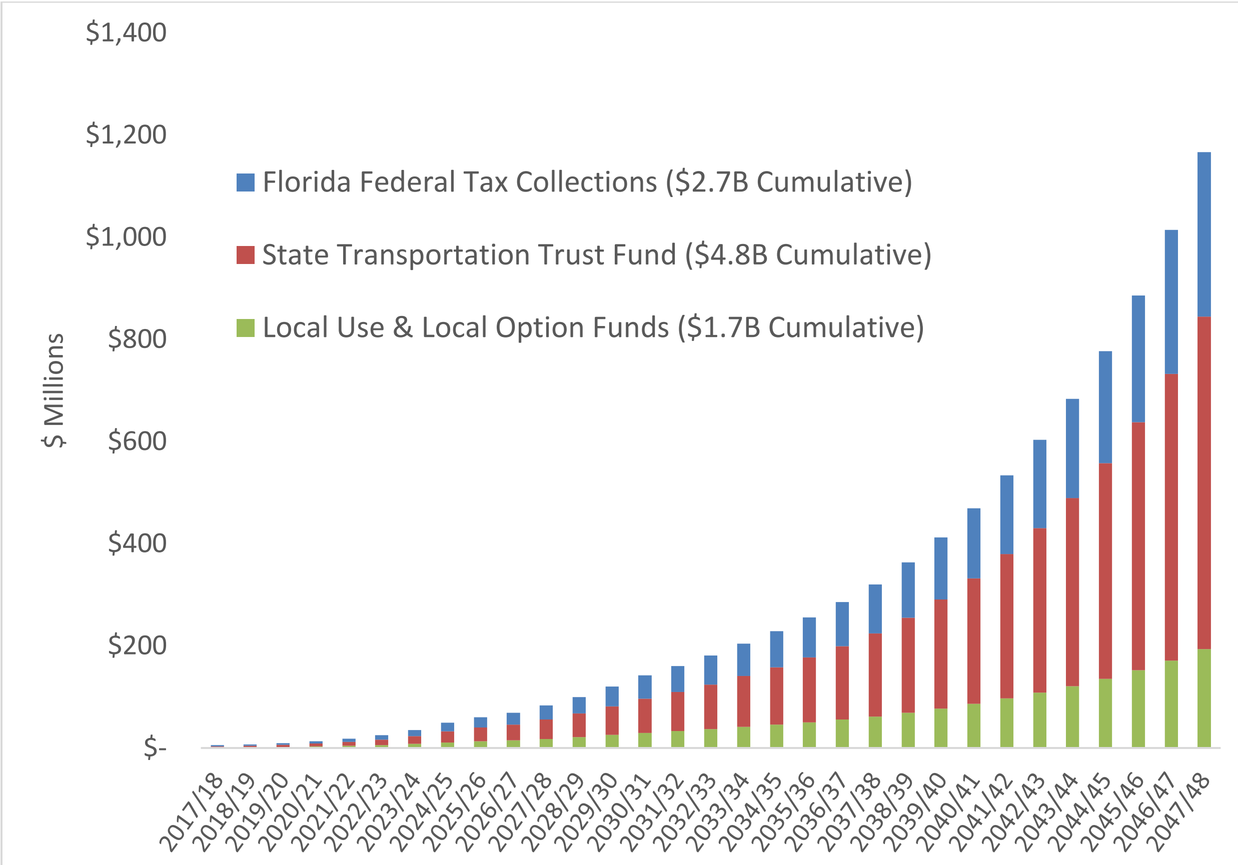

Figure 4-7. Lost Fuel Tax Revenue from PEV Use
Source: Projections from Task 7 Technical Report

An approximate ten-fold increase in the percentage share of motor fuel tax revenue lost from plug-in vehicle use is projected to occur from 2027–28 through 2047–48. The percentage share is estimated to increase to nearly a 13 percent loss in revenues, totaling $1.2 billion annually, including $651 million per year from state taxes, $322 million per year from federal taxes deposited to STTF, and $194 million per year from local taxes.

It should be noted that the PEV forecasts of vehicle sales, eVMT, motor fuel gallons not consumed, and corresponding transportation tax revenue losses produced in this report are based on national market–based forecasts of PEV vehicle penetration rates. These projections consider industry anticipated enhancements in battery storage technology, cost reduction, and battery recharging speeds, adjusted to Florida-specific demographic and socioeconomic factors. Furthermore, these projections assume annual real (inflation-adjusted) increases in the cost of motor fuels of approximately one percent per year. Should technology enhancements and cost reductions not materialize as expected or should the real cost of motor fuels remain constant or lower than the current forecasts, the actual rate of PEV adoption may be lower. Conversely, future breakthrough technology advancements, greater energy cost differentials, and public policy initiatives and mandates might accelerate the rate of PEV adoption and corresponding motor fuel–based transportation tax revenue losses.

4.3.1.3 Revenue Losses from Natural Gas Vehicles

Adoption rates of natural gas vehicles in Florida have lagged compared to average national rates. Historically, California has led the NGV market; in 2018, California consumed 46 percent of the total national CNG vehicle fuel consumption (Figure 4-8).

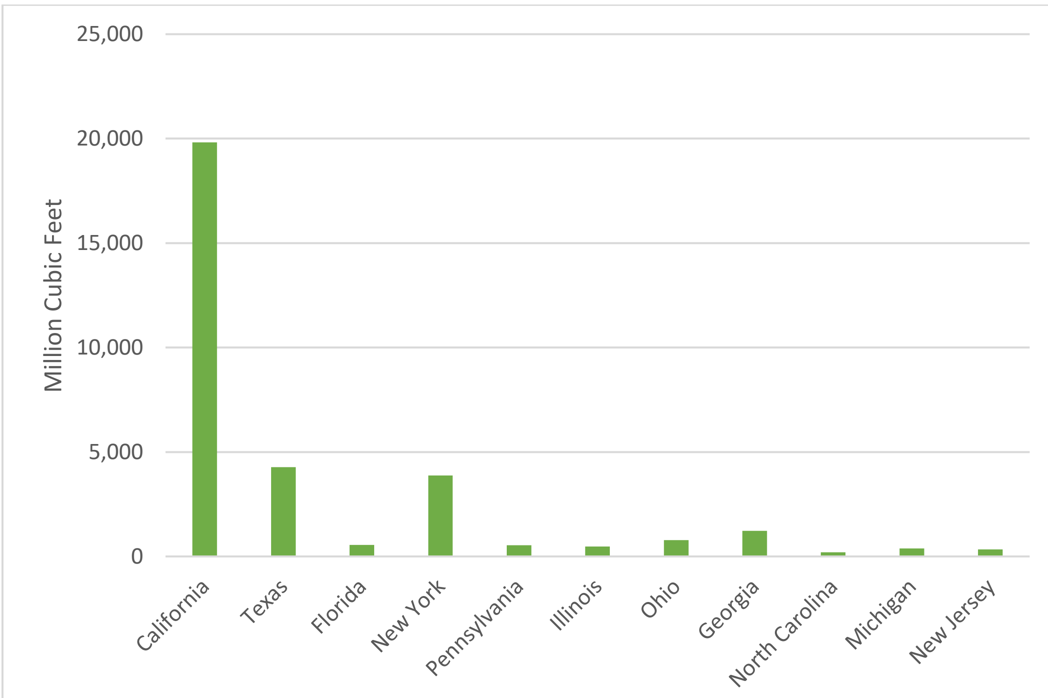

Figure 4-8. Natural Gas Vehicle Fuel Use in the 10 Most Populated States
Source: U.S. Energy Information Administration [5]

The REC forecasts natural gas consumption, as measured in “Natural Gas Fuel Taxable Units,” will grow at approximately 2 percent per year from SFY 2024–25 through 2027–28. The rate of natural gas for transportation use may decline if battery electric vehicle costs fall and ranges improve, as is currently projected. A 2014 report from NGVAmerica indicates that medium- and heavy-duty vehicles make up 43.0 percent of the entire NGV inventory, a significantly higher percentage in these categories than the 9.6 percent national share and 7.7 percent Florida share. These vehicle types operate at far lower fuel efficiencies (MPG) and normally incur much higher annual vehicle miles of travel than do light-duty vehicles. Their share of the total natural gas consumed for transportation purposes is a significantly higher percentage. Roughly 48 percent of the inventory of MD and HD NGVs were identified in the 2014 report to fall in market segments that are generally exempt from federal, state, and local fuel taxes, such as municipal vehicles, school buses, transit buses, and government vehicles. For purposes of determining taxable gallons, total NGV consumption as reported by EIA has been discounted accordingly.

Federal natural gas vehicle tax rates are comparable to those imposed on gasoline and diesel vehicles, and accordingly they do not impact federal transportation revenue collections. Presently, natural gas used for transportation purposes is not assessed state or local motor fuel taxes. However, the Florida legislature has enacted state, state for local use, and local option taxes that will take effect on January 1, 2024 and are based on equivalent gallons of motor fuel consumed. The state natural gas fuel sales tax and SCETS tax are indexed annually based on the consumer price index, although at an initial rate of approximately 6 cents per gallon below the tax rates applied to gasoline and diesel fuel. State for local use and local option natural gas tax rates will be set at 6 cents per gallon, which is 4 to 10 cents below the tax rates currently assessed at the local level for gasoline and 4 cents below for diesel.

Prior to January 2014, owners of vehicles titled in Florida paid fuel taxes through the purchase of an annual decal, the price of which varied according to the type of vehicle and the total amount of state and local diesel fuel taxes in effect in the county of residence. In order to encourage the use of alternative fuels, the 2013 Florida legislature passed legislation to exempt these fuels from taxation beginning January 1, 2014, and ending January 1, 2024 [32].

Figure 4-9 reports the estimated loss in fuel tax revenues from NGV use. The current market for non–tax exempt NGVs is not significant and accordingly the resulting tax revenue losses from their use are immaterial, totaling an estimated $2.2 million (state) and $1.3 million (local) during the eight-year period from SFY 2010–11 through 2017–18 (less AFV decal revenues collected prior to January 1, 2014). Peak NGV tax revenue losses in the years prior to the implementation of state and local NGV taxes in SFY 2024–25 will total approximately $1 million per year state and local combined, or roughly 0.03 percent of transportation motor fuel tax revenue collections. After the NGV tax implementation, the NGV tax revenue losses will fall to less than 0.01 percent of motor fuel tax revenues collected in that year.

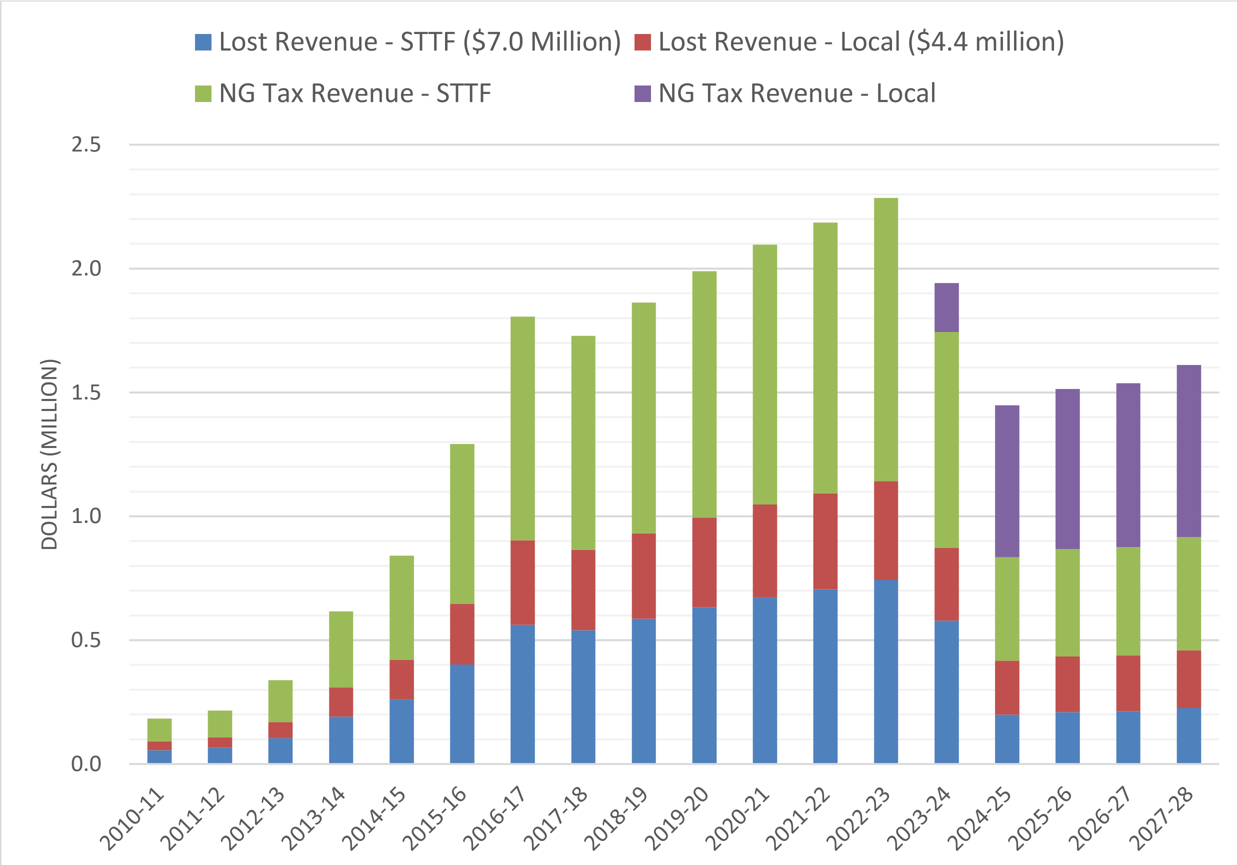

Figure 4-9. Lost Fuel Tax Revenue from NGV Use

Source: Florida Department of Transportation [32] and Projections from Task 7 Technical Report

4.3.2 Revenue Losses from Autonomous Vehicles

Vehicle automation is not expected to significantly affect VMT generation in Florida in the next decade. While many manufacturers are actively working on implementing AV technologies, there remain significant technological and regulatory challenges. The implementation of AV technologies will take an evolutionary path. Initially, AV technologies will likely be available on high-end vehicles or as paid options via TNCs. It is projected that until 2050, less than 45 percent of vehicles on the road will have full automation capabilities.

AV technologies are projected to reduce the cost of travel and to induce additional VMT when AVs reach a relatively high penetration rate. In the early 2030s, AVs are projected to generate noticeable impact to VMT generation in Florida. In 2035, AVs are projected to add 0.6 percentage points to the annual VMT growth rate. Toward 2047–48, AVs will be responsible for adding 0.8 percentage points to the projected annual VMT growth of 1.1 percent, accounting for 42.1 percent of the overall yearly VMT growth. Figure 4-10 summarizes the projected annual percentage growth rate in Florida VMT resulting from AV impact during the forecast period.

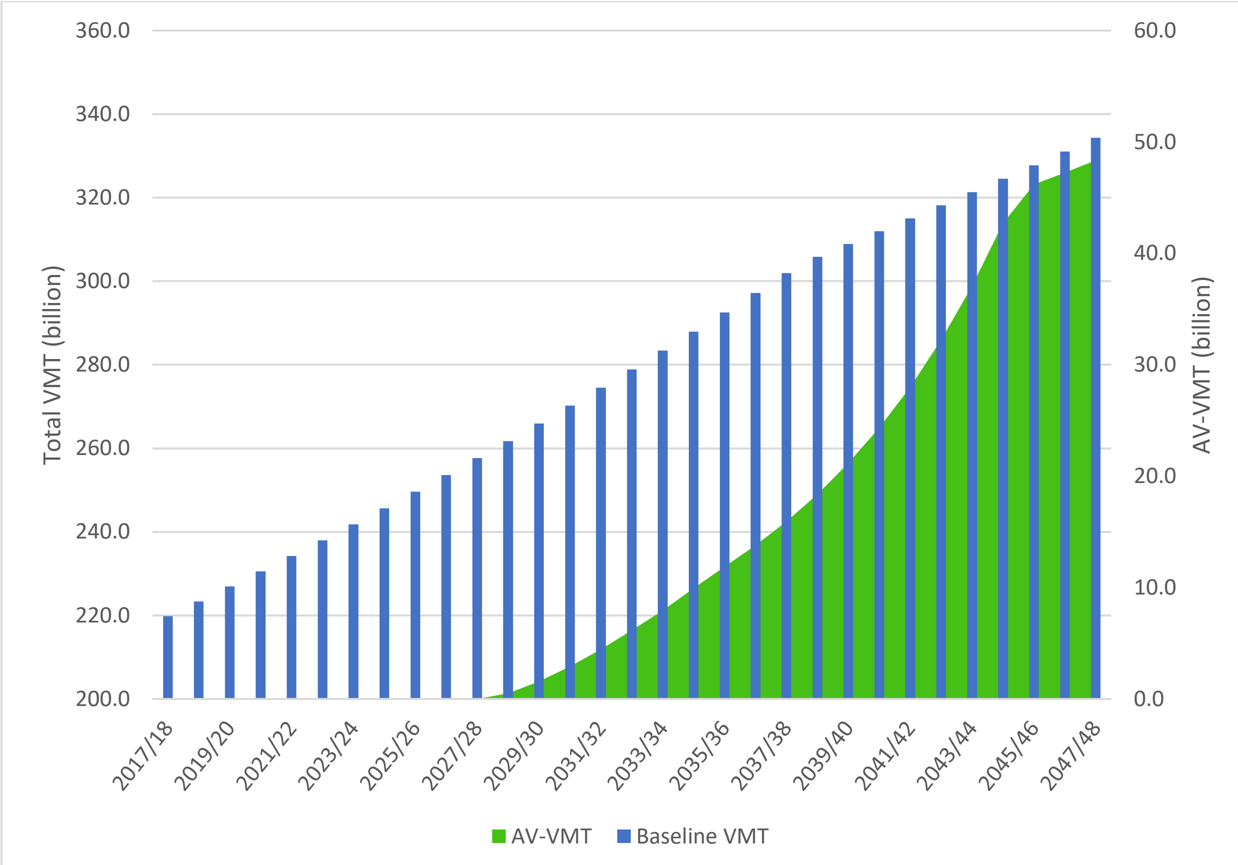

Figure 4-10. Impact of AVs on Projected Florida VMT Growth – Baseline Forecast

Source: Projections from Tasks 1-4 Technical Reports

4.3.2.1 Losses in Highway Fuel Consumption from Automated Vehicles

The growth in AV VMT is expected to reduce demand for gasoline and diesel fuel and in turn negatively affect revenue generation. The AV VMT forecasts are applied to projected MPG rates to estimate the reduced demand for gasoline and diesel fuel. Figure 4-11 reports the estimated annual reduction in motor fuel demand from increased AV VMT. While through the end of the REC forecasting period (2027–28) the annual loss in highway fuel will be less than 0.03 percent of the total consumed, by 2047–48 total annual loss will reach 13.3 percent.

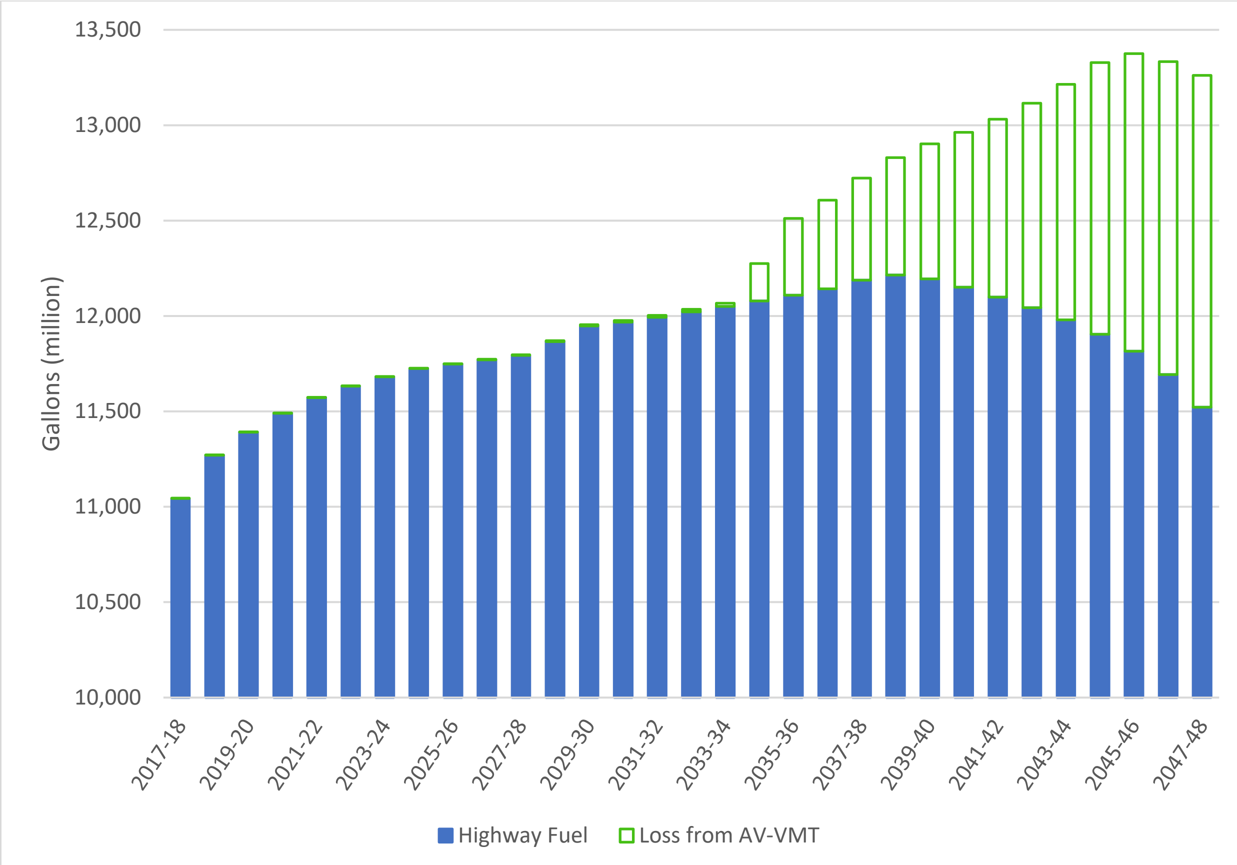

Figure 4-11. Total Highway Fuel Lost Due to Increased AV VMT

Source: Projections from Task 7 Technical Report

4.3.2.2 Revenue Losses Due to Increased Automated Vehicle VMT

Since battery electric vehicles do not consume any gasoline or diesel, they do not directly generate fuel taxes that accrue to the State Transportation Trust Fund. Since AV technologies are not projected to constitute a significant share of the state fleet at least until 2030–35, revenue loss from AV VMT is insignificant during the first half of the 30-year forecast period. Figure 4-12 summarizes forecasted annual fuel tax shortfall due to AV VMT.

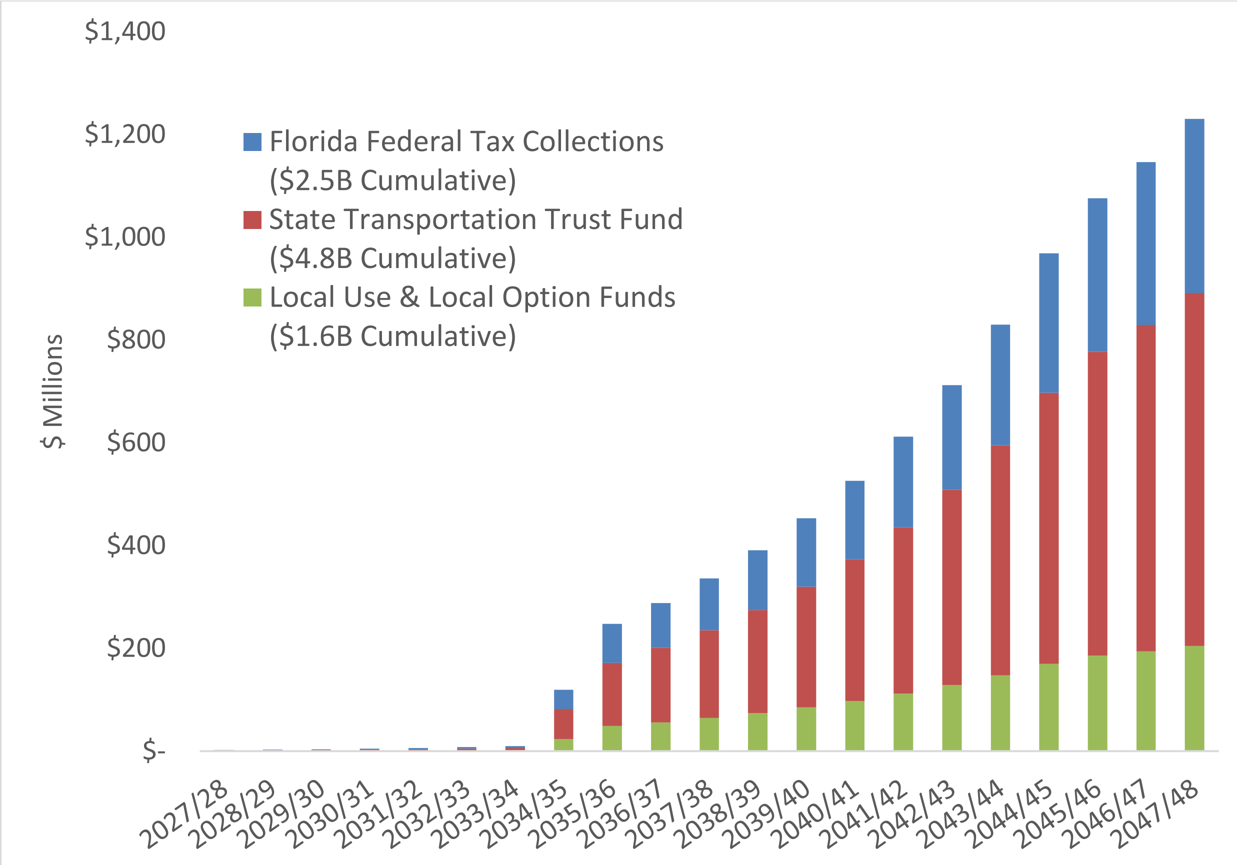

Figure 4-12. Lost Fuel Tax Revenue from AV Market Penetration

Source: Projections from Task 7 Technical Report

In SFY 2027–28, total annual funding shortfall from AV VMT is projected to be $2.3 million, including $0.9 million loss from federal taxes, $1.01 million loss from state taxes and $0.4 million loss from local taxes. This annual shortfall is projected to grow to $119.5 million in SFY 2034–35, $453.3 million in2039–40 and $1.23 billion in 2047–48. The cumulative impact of AV VMT on total fuel tax revenue shortfall is projected to reach $8.9 billion for the entire projection period of 2017–18 through 2047–48.

Annual tax revenue losses from AVs are projected to be insignificant during the REC projection timeframe. The period 2027–28 through 2047–48 will see increased AV adoption and market penetration, which will accelerate revenue losses, reaching 13.3 percent of total tax revenues.

4.4 Combined Impact of Alternative Fuel Vehicles and Automated Vehicles on Revenue Projections

As of 2017–18, PEVs have a relatively small impact on state revenue. However, annual fuel tax revenue losses are projected to increase over the next decade from $5.4 million in SFY 2017–18 to $85.4 million by SFY 2027–28. Over 20 years following the REC forecasting horizon, the increased adoption of AFVs and AVs will result in substantial tax revenue losses. By SFY 2047–

48, tax revenue losses are projected to reach $2.4 billion annually, including $1.3 billion from state fuel taxes, $660 million from federal fuel taxes deposited into STTF and $398 million from local tax revenues. NGVs will have a limited impact on revenue losses (about $1.5 million annually).

Figure 4-13 reports the combined effect of increased AFV and AV market penetration on the state portion of State Transportation Trust Fund. The cumulative impact of increased AFV and AV market penetration on state fuel tax revenue collection reaches $9.7 billion for the entire period of 2018–48.

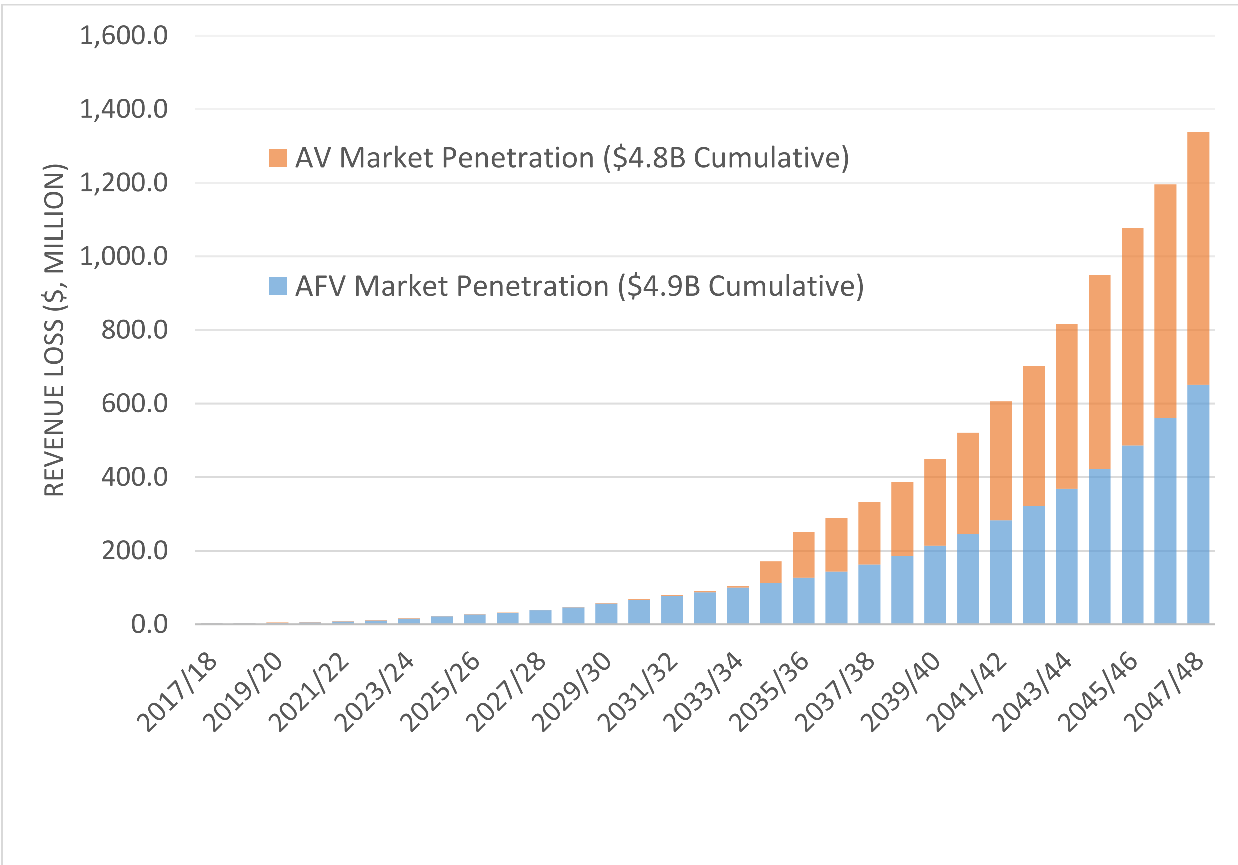

Figure 4-13. Combined State Fuel Tax Revenue Losses from AFV and AV Market Penetration

Source: Projections from Task 7 Technical Report

At the end of SFY 2027–28, lost fuel-based state revenues will reach 1.3 percent of the overall STTF collection. In the following 20-year period ending in SFY 2047–48, the projected increase in BEVs along with the rapid adoption of AVs will substantially increase revenue losses, reaching about 21 percent of total revenues or 26 percent of annual fuel-based state portion (Figure 4-14).[2]

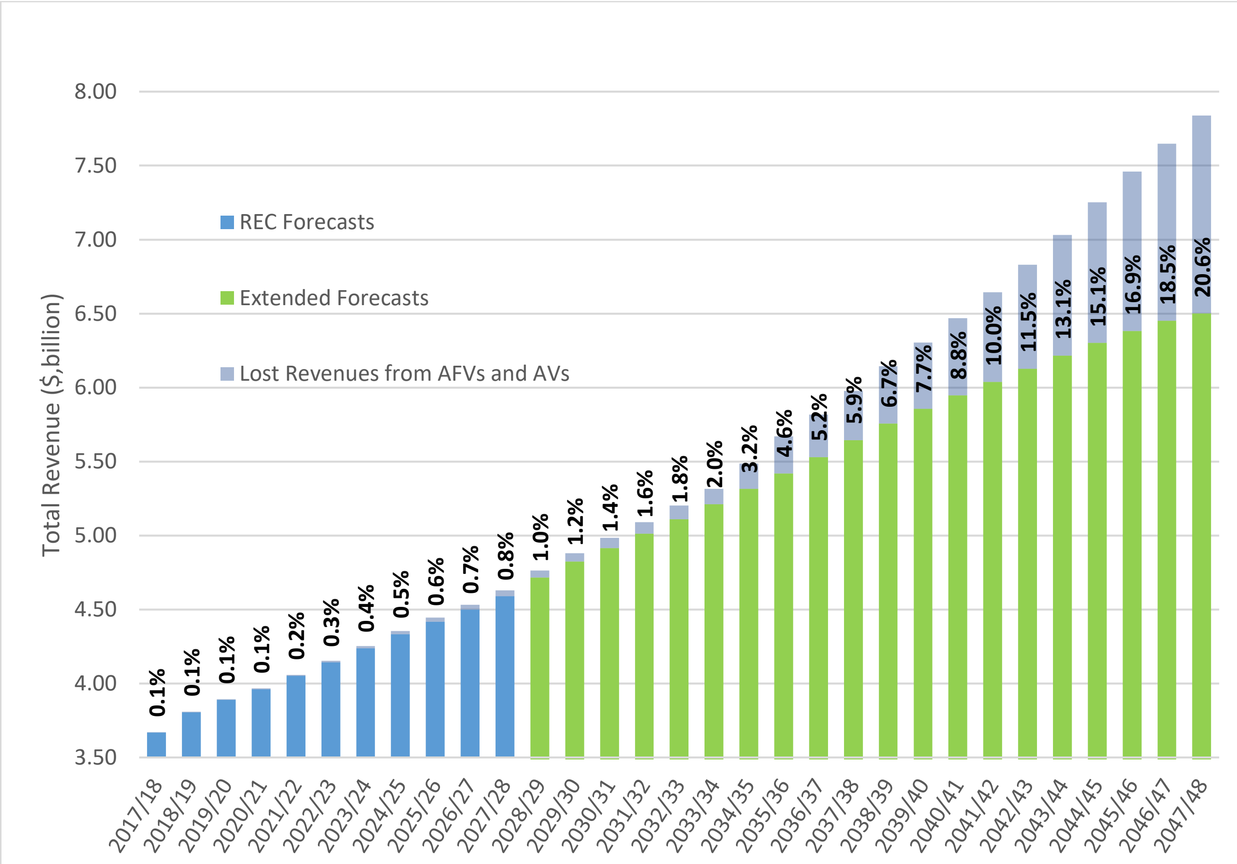

Figure 4-14. Total State Revenues and State Fuel Tax Revenue Losses SFY 2017–18 through SFY 2047–48

Source: Projections from Task 7 Technical Report

These losses do not include the potential reduction in capital and operating costs that AVs might generate by way of vehicle-flow capacity improvements from cooperative driving. Recent simulation-based studies (Task 5 and Task 6 reports) show capacity improvement ranging between 10 and 30 percent from high AV market penetration (60–100%). Therefore, the revenue loss estimates due to increased AV market penetration can be considered gross estimations.

The increased AFV and AV market adoption is projected to result in total cumulative fuel tax revenue losses of $18.3 billion over SFY 2017-18 through SFY 2047-48, including $5.3 billion loss

[2] The State portion includes States sales (14.1 cents/gallon), SCETS (7.8 cents/gallon), and 7 percent of the 1-6 cents local option contribution to STTF.

in federal fuel tax collection, $9.7 billion loss in state fuel taxes and $3.3 billion loss in local fuel tax revenue (Figure 4-15). Table 4-1 provides additional details on the relative impact by revenue source. Total losses over the 30-year forecast period are projected to account for 7.9 percent of total revenues or 8.6 percent of the STTF. However, by SFY 47/48 annual losses will total 26 percent of projected federal, state and local fuel taxes.

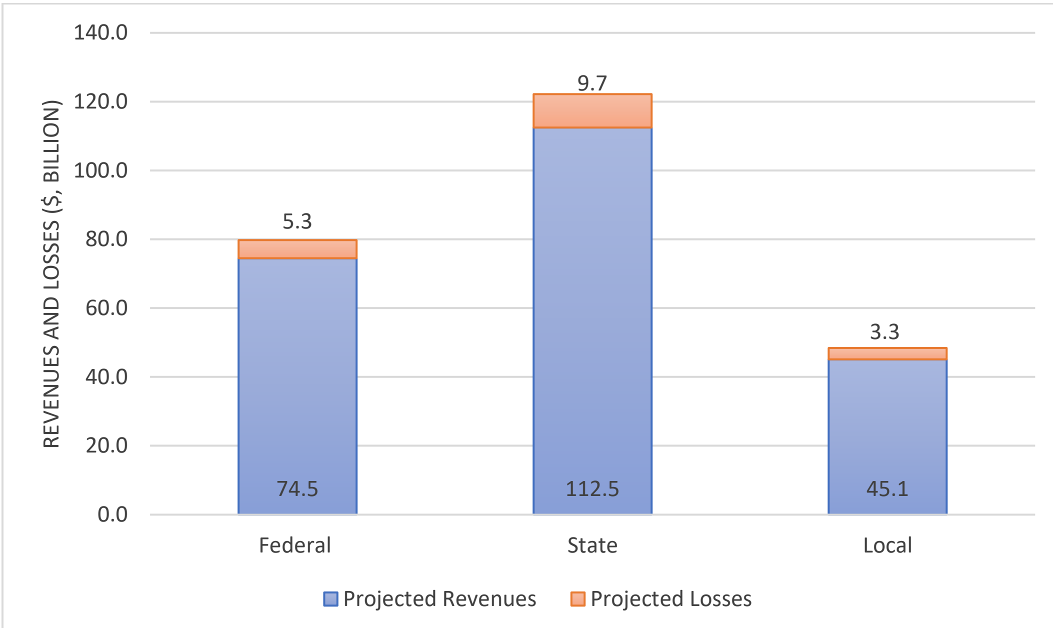

Figure 4-15. Cumulative Fuel Tax Revenues and Losses SFY 2017-18 through SFY 2047-48

Table 4-1. Projected Tax Revenue and Revenue Losses SFY 2017-18 through SFY 2047-48

Revenue Source	***Projected Revenues ($,B)***	***Projected Losses ($, B)***	***Share of Revenues***
Federal *	74.5	5.3	7.1%
State**	112.5	9.7	8.6%
Local***	45.1	3.3	7.3%
Total	**232.1**	**18.3**	**7.9%**

**Federal Gas (18.4 cents/gal); Federal Diesel Added 6 cents/gal*

***State Sales (14.1 cents/gal); SCETS (7.8 cents/gal); 7 percent of 1-6 cents local option*

****Local Option 1-6 cents/gal; Local Option 1-5 cents/gal; 9th cent/gal; constitutional; county; municipal*

4.5 Factors Affecting Projections

4.5.1 Average Miles Driven

A number of factors tend to lessen the initial impact of PEVs and eVMT on transportation revenue losses. To estimate PEV lifespans and annual miles driven by vehicle age, this study used the National Center for Statistics and Analysis *Vehicle Survivability and Travel Mileage Schedules*. ICE vehicles, in general, have demonstrated increased durability and lifespan since 2006; however, the durability and life of PEVs currently is uncertain. Therefore, no adjustments were made to update these schedules. It was assumed that the profile for PEVs would approximate 80 percent of automobile and 20 percent of truck vehicle life and annual miles driven [24]. While this assumption reflects a lower percentage of truck/SUV share than may eventually materialize in the PEV market, it was used due to the current uncertainty of the average PEV lifespan. BEV miles traveled per vehicle were reduced to 80 percent of ICE VMT, based on studies performed by CARB and as reported by Argonne National Laboratory [25].

4.5.2 Utility Factor

With respect to PHEVs, an analysis of vehicles purchased in 2016 indicated an average utility factor (the percentage of eVMT to total miles driven) of 0.52, meaning 48 percent of miles driven are powered by an internal combustion engine and consuming motor fuel (see Appendix C). With a utility factor of 0.52, the effect of PHEVs on lost consumption of motor fuel per vehicle is approximately one-half of the total motor fuel that would have been consumed by the ICE comparable vehicle. The eVMT miles as a share of total VMT were calculated using this utility factor. This study assumes that the PHEV utility factors would increase to 0.75 by 2048 as battery costs decline, allowing for larger batteries to capture a greater share of short- and medium-distance trips.

4.5.3 Vehicle Age

New cars and trucks are typically more fuel efficient than the average of the entire state fleet of registered vehicles, which contains a large percentage of older, less efficient vehicles—new cars and trucks sold in 2017 were on average 19 percent more fuel efficient than vehicles sold 10 years prior. While PEVs are more efficient than the average vehicle in the state's fleet, they tend to be purchased instead of ICE vehicles of comparable size, which are also more efficient that the average state fleet vehicle; thus, there is little overall gain in efficiency for the fleet. An analysis of 2017 vehicle sales indicated PEV vehicles replaced ICE vehicles that averaged 1.4 MPG, or 5.5 percent greater efficiency than the average MPG for all car and light truck sales in that year. This results in fewer gallons of motor fuel not consumed relative to VMT than is found for the statewide vehicle fleet on average, and the corresponding reduction in motor fuel taxes not levied are less than the state averages.

4.5.4 Plug-in Electric Vehicle Market Share in Florida

Battery electric vehicles have been increasing in the market share of new car sales relative to plug-in hybrid-electric vehicles. This became particularly evident with the introduction of the Tesla Model 3, which led PEV sales (70 percent market share) in 2018. The share of battery electric vehicles in PEV sales in Florida exceeded 71.0 percent in 2018. This represents a significant increase compared to previous years, given that the share of BEVs in Florida PEV sales averaged 53.14 percent over the past five years. It is expected that as battery range improves and the cost of the batteries decreases, the share of BEVs in Florida PEV sales will continue to rise. This trend has important implications for revenue assessment. Unlike PHEVs, that can consume both electricity and conventional petroleum fuel, BEVs do not use any gasoline/diesel, resulting in higher fuel tax revenue loss compared to PHEVs.

4.5.5 Plug-in Electric Vehicle Offset of Motor Fuel Consumption

Improvements in conventional vehicle technology and emission regulations result in continuing improvements in vehicle fuel economy. As the fleet becomes more efficient, it consumes less fuel, resulting in less fuel tax revenue for the state. The effect of fleet fuel efficiency improvements is moderated by the growth in the number of vehicles and increases in VMT. Depending on the magnitude of the effects of VMT, size of the fleet, and average vehicle efficiency, the resulting fuel consumption can either decrease or increase. An increase in the number of BEVs in the fleet can result in an increase in the average fuel economy of the entire fleet, and cause reductions in motor fuel consumption.

Figure 4-15 compares the projected annual change in Florida motor fuel consumption with and without PEVs. The graph demonstrates that without PEVs in the fleet, motor fuel consumption is projected to continue growing throughout the entire 30-year projection period (due to the effects of VMT and fleet size), but at a decreasing rate (due to the effects of fuel efficiency improvements). PEVs cause a faster decline in the fuel consumption growth rate. Starting from 2033–34, the use of PEVs is projected to result in a consistent reduction in the amount of motor fuel consumed annually in the state.

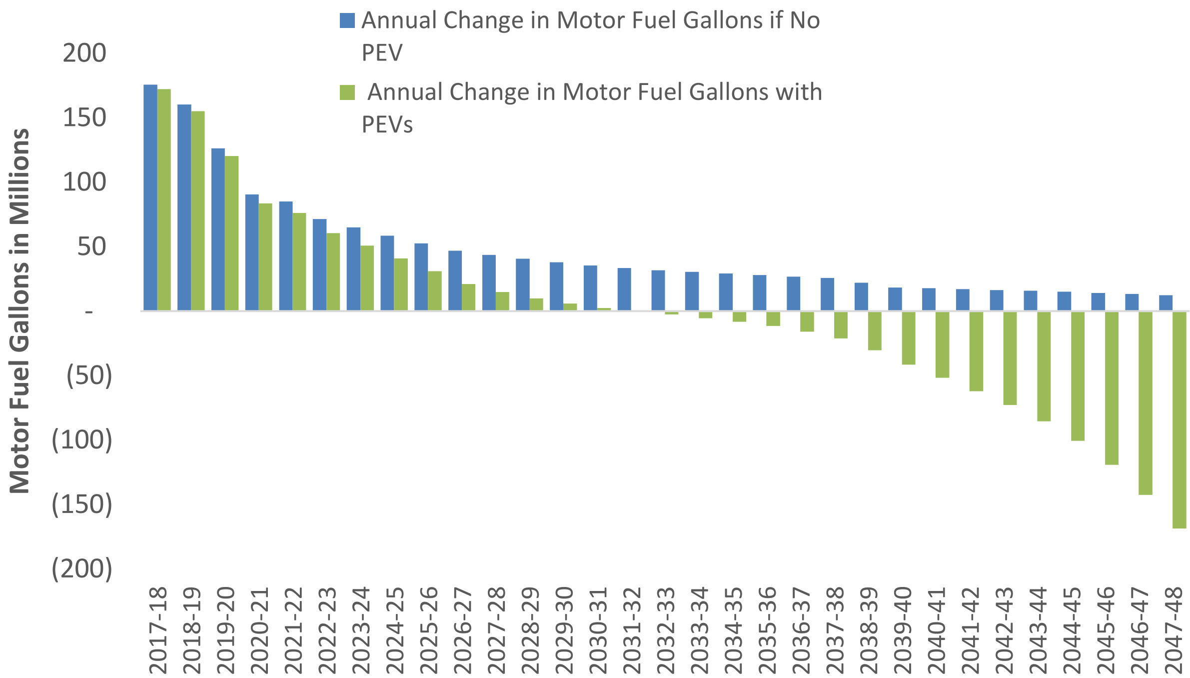

Figure 4-16. Projected PEV Effect on Annual Change in Gallons of Motor Fuel Consumed in Florida (2018–48)

Source: Projections from Task 4 Technical Report

4.5.6 Impact of Plug-in Electric Vehicles on Fleet Fuel Efficiency

The average fuel economy of the fleet can be affected by multiple factors, including Corporate Average Fuel Economy (CAFE) regulations, improvements in propulsion technology and vehicle materials, and AF use. Even accounting for zero PEV penetration, Florida fleet fuel efficiency is projected to increase by almost 36.0 percent during the 30-year forecast period, from 19.98 MPG in 2018 to 27.13 MPG in 2048. The use of BEVs projected to enter the fleet in large numbers after 2035 will accelerate average fleet fuel efficiency growth. Adoption of PEVs is forecasted to add 1.01 MPG (an increase of 4.1 percent over base fuel efficiency) to the average fuel efficiency of the Florida fleet by 2037, and 3.93 MPG (an increase of 14.5 percent over base fuel efficiency) to the average fuel efficiency of the fleet by 2048.

The use of PEVs is expected to accelerate growth in the average fuel efficiency of the state fleet. While fuel economy of Florida's fleet is projected to grow by almost 36 percent during the period of 2018–48, incorporation of PEVs in the fleet is projected to increase the overall fuel efficiency growth to 55 percent during the 30-year forecast period.

4.5.7 Medium- and Heavy-duty Electric Vehicle Applications

On average, medium- and heavy-duty vehicles are less fuel efficient and consume more fuel per vehicle mile traveled. The uptake of battery electric MD and HD trucks is dependent upon further battery cost reductions and technology advances, and they are not expected to enter the market or impact fuel consumption and transportation revenues in a measurable way until the middle of the next decade. As was the case with natural gas vehicles, a significant percentage of initial adopters of BEV trucks and buses are anticipated to be public agencies and transit operations that generally are exempt from the payment of motor fuel taxes. This analysis assumes that these vehicles will not affect taxable gallons of fuel consumed based on these factors for the short-term forecast. Over time, the share of lost fuel revenue is expected to more closely match the share of eVMT as technology improvements encourage the substitution of PEVs beyond existing fuel-efficient models to include larger light-duty vehicles and MD and HD vehicle applications.

4.5.8 Automated Vehicle Adoption Rates

Autonomous vehicles are expected to change how we travel. There is high uncertainty regarding how these technologies will develop and when their acceptance in the marketplace will occur. Several studies support the introduction of the AVs into the market, possibly at Level 4 of the technology, to begin in the larger, more expensive, and luxury market segments in the early to mid-2020s. The AV impact on revenue losses depends on the market penetration projections developed in this study. While current studies support the introduction of AVs into the market by the late 2020s, adoption rates might be lower than projected. Institutional barriers might also push entrance into the market. As a result, realized revenue losses could be lower than projected in this study.

5 Effects of Autonomous and Alternative Fuel Vehicles on Future Investment Requirements

5.1 Introduction

Most of the studies reviewed during previous tasks of this project anticipate that the potential benefits of AV implementation may exceed the negative impacts of added VMT in terms of additional cost [33]. Generally, the research suggests that the existing road infrastructure will be adequate to handle additional miles of travel due to capacity improvements provided by AV technologies [34]. Yet, the research also concludes that the net effects of widespread adoption of AV technologies will not significantly reduce the need to expand infrastructure to keep pace with population growth [61]. While there may be multiple areas where future infrastructure investment may be necessary to accommodate a widespread adoption of AV technologies, the research in this subject is limited.

This chapter reviews a few potential areas of infrastructure investment identified in the literature, including need for additional lane capacity, pavement damage due to precise steering of AVs, pavement wear due to additional VMT from AVs, and additional signage and lane marking needs. These additional investments are estimated using present data and studies; however, additional infrastructure needs may be incurred with the higher penetration of AVs in the state fleet and will require further consideration. It is not envisioned that AFVs will require additional infrastructure investment from state departments of transportation. The required infrastructure investment for AFVs is expected to be provided by the private sector or through infrastructure grants (funded by federal, state, or local governments, or by utility companies).

5.2 Electric Vehicle Charging Infrastructure Investments

The Task 5 technical report provides an overview of infrastructure needs based on projected Florida battery electric vehicle growth. Light-duty electric vehicles are projected to increase from 42,900 vehicles in 2018 to 278,275 in 2025 and over 3.6 million vehicles by 2048. The existing electric vehicle infrastructure charging network in Florida includes 1,139 Level 2 chargers and 163 fast charging units throughout the state. The report found that an additional 250 Level 2 stations and 66 fast chargers will be needed by 2020 to accommodate the projected growth in PEV stock in the state. By 2040, Florida will need an additional 20,606 Level 2 public charging stations and 2,741 DC fast charging stations to accommodate the short-term demand from the projected PEV fleet. Addressing these public charging infrastructure needs may cost from $88.3 to $231.5 million, including the cost of equipment and installation but excluding the cost of right-of-way acquisition [35]. It is not envisioned that projected infrastructure needs will require significant investment from state departments of transportation, given that charging infrastructure investments are typically provided through the private sector and utilities, assisted by infrastructure grants from federal, state, and local entities as well as utilities. Utility investments are made primarily through three options: “make-ready” installations that do not include charging equipment, direct ownership and operation of charging equipment, or rebates for third-party purchases and installations [36].

5.3 Automated Vehicle Infrastructure Investment

5.3.1 Pavement Wear

The literature suggests that the implementation of AV technologies will lead to increased roadway capacity and reduction in the cost of travel, resulting in increased VMT. Higher VMT will likely require an additional investment in maintaining transportation infrastructure (Task 5 and Task 6 reports). AV efficiencies can help accommodate more VMT with the existing lane miles and eliminate the need for physical capacity expansion. However, more VMT will eventually translate into higher pavement wear and will result in higher roadway maintenance costs. The VMT impact of AV technologies, however, is expected to be rather minor until 2030–35.

The robust implementation of AV technologies may allow lane width reduction requirements by approximately 25 percent (from 12 to 9 feet). However, the higher traffic volume associated with wider adoption of AV technologies may necessitate thicker road pavement to withstand more intensive roadway use. The overall effect of AVs on road materials is not clear. No significant savings in terms of road materials use is expected during the 30-year projection period used in this study.

5.3.2 Annual Roadway Expenditures

Adapting modeled effects of AV adoption on miles traveled to Florida realities results in an estimated increase of 3.8 percent in Florida VMT that can be attributed to AV technologies by 2035. Increased AV market penetration is projected to lead to a 7.29 percent increase in Florida VMT by 2040, 14.00 percent increase in VMT by 2045, and 22.94 percent by 2050. The historic relationship between VMT and roadway infrastructure expenditures can be used to estimate the impact of the projected increase in Florida VMT on the state’s roadway expenditures. During 2016–17, FDOT’s work program provided approximately $7.77 billion of funding for roadway-related activities, including new road construction, resurfacing, bridge maintenance, right-of-way acquisition, environmental mitigation, and traffic engineering [37]. These expenditures translate to 3.6 cents per VMT in 2017 dollars, or 3.7 cents per VMT in 2018 dollars. Addressing additional VMT resulting from AVs would require an increase in Florida roadway expenditures by $403 million (2018 dollars) per year in 2035, $837 million per year in 2040, $1.7 billion per year in 2045, and $1.8 billion per year in 2048. Some researchers believe that at the early stages of technology implementation, AVs may be only allowed to operate in dedicated lanes to eliminate mixing with non-AV vehicles. If that approach is implemented, especially for over-the-road truck platooning, dedicated AV lanes may experience higher pavement wear due to higher heavy truck traffic and may cost more to maintain than regular traffic lanes. However, the magnitude of these extra costs is difficult to estimate given the uncertainties with AV adoption scenarios.

5.3.3 Markings and Signage

The emergence of vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication technologies may significantly reduce the need for markings and signs as automated vehicles will be able to obtain this information from other cars and roadway infrastructure in real time. At the early stages of adoption, AVs will likely require improvements in existing road markings and signage, such as clear line paintings and specialized traffic signals to enable automatic systems recognize them in all weather conditions [38]. The automatic systems currently used in vehicles are often unable to recognize lane markings and signs while driving in rain, snow, or fog. While the optical systems installed on AVs (e.g., cameras and sensors) are expected to improve over time, it is reasonable to expect that some additional investment in making road markings and signage more visible and recognizable may be necessary to enable AV operation at the early stages of adoption. This will likely be necessary during the period of 2025–35, when AVs reach a relatively significant share of the vehicle fleet but the full benefits of V2V and V2I communication are not realized. Some researchers argue that even a high penetration rate of AV technologies will not completely displace roadway markings and signage requirements. Even if higher AV penetration rates are realized, road markings and signs will still be necessary for redundancy purposes and for human drivers in mixed AV scenarios.

In 2018, the FHWA identified uniformity and quality of road markings and traffic control devices as essential factors in enabling vehicle automation. A 2018 U.S. Department of Transportation (DOT) report outlined strategies to address obstacles to vehicle automation. This report emphasized the adaptation of current road markings and signage to accommodate AVs as critical factors for increased AV adoption. As part of this effort, FHWA will pursue an update to the 2009 *Manual on Uniform Traffic Control Devices for Streets and Highways* (MUTCD), taking into consideration the needs of AV technologies [39].

While the exact suggestions that will be included in the new MUTCD is not known yet, it is anticipated that these criteria will be based on the requirements to help cameras detect pavement markings in challenging conditions, including rain or snow, glare, and worn markings. One suggestion provided by the National Committee on Uniform Traffic Control Devices includes standardizing the width of lane edge lines at six inches. If this suggestion is approved and included in the new MUTCD, Florida will not have to make any changes to the width of edge lines in the state. FDOT has been using six-inch-wide line markings to accommodate older drivers.

The exact cost implications of the markings and signs required to accommodate AV technologies in Florida are currently difficult to assess. It is expected that most of the benefits of AV adoption will be realized only after a large share of vehicles on the road are equipped with automation technologies. Similarly, the infrastructure investment requirements associated with AV technologies are expected to be minor in the short and medium terms. The need for a significant infrastructure investment to address AV technologies will likely arise toward the end of 2040.

6 Key Trends and Policy Considerations

6.1 Introduction

Over the last decade, a number of economic, technological, and demographic shifts have occurred that may impact future transportation trends. Perhaps the most important consideration for public policy planning and decision making is the need to maintain a heightened awareness of the variables and trends affecting transportation demand, service modes, and funding needs. The analysis of this research shows a high degree of variability and uncertainty in how AFVs and AVs will affect how people and goods move. There is a risk that during this transition phase, transportation investment decisions may be inconsistent with future needs if the implications of new developments in transportation demand and service utilization are not fully understood or are based on an incomplete understanding of their long-term effects on the state's transportation system. This calls for the development of an adaptive understanding of the underlying reasons for changes in transportation trends in order to address new trend patterns and long-term assumptions.

As the 2012 MPOAC study demonstrated, there is a growing disparity between investment requirements for transportation infrastructure needs on both the state and local levels and revenue estimates available for this purpose [29]. Public investment in transportation infrastructure is decreasing in real dollar terms, and existing revenue sources that traditionally financed the construction and maintenance of infrastructure—highways, bridges, and transit—are not meeting the cost burden for maintenance or replacement of facilities or addressing the demands for capacity expansion that AFV and AV may induce.

6.2 Key Trends

While the 2008 recession had a significant impact on transportation trends, some of which may be transitory as the state's economy normalizes over time, certain trends appear to be emerging that may affect future transportation investment decisions.

6.2.1 Vehicle Ownership and Changing Mobility Options

Since 2007, after a temporary decline during the Great Recession, vehicle ownership as measured by motor vehicle registrations has increased by 15.1 percent, consistent with the population growth of 14.1 percent (Figure 6-1) [40]. The cost of vehicle ownership has declined relative to general inflation and per capital incomes. This factor, coupled with extended lifespans for existing vehicles (Figure 6-2), may reflect shifts in transportation choices and travel preferences.

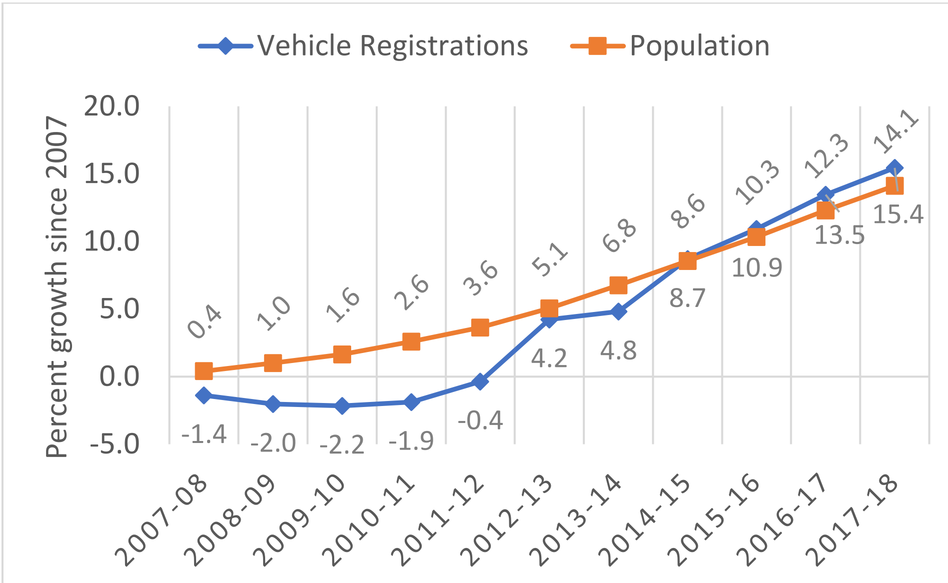

Figure 6-1. Florida Population and Vehicle Registration Growth
Source: [31], Florida Department of Highway Safety and Motor Vehicles [41]

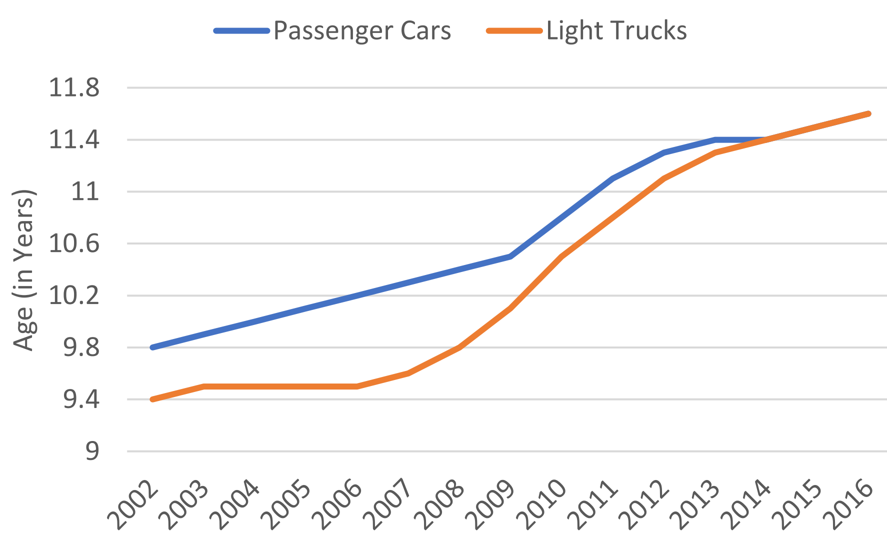

Figure 6-2. Average Age of Cars and Light Trucks
Source: U.S. Department of Energy [23]

Since 2011, the trend in the number of households where no vehicle is available has been declining, with significant declines occurring in many of the state's more densely populated urban counties [42]. Changing mobility and transportation options, including advancement of alternative and shared mobility services in both suburban and rural areas, the increase in telecommuting, and micro–transit options, are providing options that may change travel behavior and VMT. While ride-hailing and car-sharing services presently make up less than 5 percent of global passenger miles, they are anticipated to increase to 19 percent of total global passenger miles by 2040 [43]. This may indicate a future trend toward less private vehicle ownership and in turn fewer vehicle registrations and title fees. However, this trend may also be offset by economic factors contributing to the higher levels of private vehicle ownership among low-income individuals, including greater employment participation, improved access to financing, and the ongoing trend of improved vehicle durability and useful lifespans that is producing a greater used vehicle supply and lower costs. It is recommended that transportation planners and policy makers monitor private vehicle ownership trends to determine potential impacts related to revenue sources and over all transportation demand as vehicle ride-hailing technologies develop and gain market share.

A similar area for monitoring and analysis is the impact of vehicle ride-hailing and car-sharing services on vehicle rentals and future rental car surcharge revenues. The growth in ride-sharing services may result in material changes in the use of rental vehicles and may impact the revenues generated from this source.

6.2.2 Commercial Heavy-duty Vehicle Adoption

Given the change in retail supply chains and the growth of the e-commerce sector, the trucking industry has undergone changes in operations and distribution. In 2017, e-commerce totaled $449.9 billion or 9 percent of the total retail sales in the United States [44]. As a result, the trucking industry had to adapt to changes in logistics and distribution models as decentralized distribution and fulfillment centers increased and delivery time windows decreased, necessitating shorter regional and local trucking trips. While truck vehicle miles traveled has not yet returned to pre-recession levels, truck VMT is increasing, particularly in urban metropolitan areas, whereas rural truck VMT has seen some decline. Urban truck VMT grew by 177 percent between 2011 and 2016, whereas rural truck VMT declined by 2.2 percent during those same years [45]. This presents some potential for additional impact on urban interstates, which are experiencing more growth in total highway VMT compared to rural interstates. In addition to an increase in truck VMT, the trucking industry has also seen an increase in registrations for single-unit trucks, which are typically used for local deliveries. These registrations are outpacing the rate of registrations for traditional combination trucks (7.8 percent growth for single-unit trucks between 2008 and 2016 versus 4.4 percent growth for combination trucks) and the majority of these new single-unit truck registrations happened during the period of 2014–16 [45].

6.2.3 Fuel Efficiency

Fuel economy standards have continued to rise despite the current administration's proposed rollback of the standards, and it is projected that vehicle fuel efficiency will continue to increase. Fuel costs, economic prosperity, and the ensuing effects on driving habits appear to play a significant role in fuel efficiency. The shift in consumer preferences from automobiles to less fuel-efficient SUVs and crossover vehicles has depressed overall fuel efficiency and delayed the benefits of more efficient new model vehicles entering the state's fleet. Vehicle durability and lifespan have increased over the past 20 years, resulting in a larger share of older, less efficient vehicles negatively impacting increases in overall fleet fuel efficiency. However, constant improvements in the fuel efficiency of all types of new vehicles (including cars, SUVs, and light trucks) will eventually raise average fuel efficiency.

6.2.4 Impact of Automated Vehicles on eVMT

As detailed in the Task 1 and Task 2 technical reports, the VMT forecasts of this study are highly sensitive to the projected AV market penetration rates, which in turn depend upon the pace at which the technology evolves. While low-level automation can be implemented on all types of vehicles, it is expected that fully autonomous vehicles will most likely be battery electric powered. The electronic-intensive equipment required for fully autonomous vehicles will necessitate the use of large batteries that are only available on battery electric vehicles. Therefore, it is anticipated that BEVs will be a natural fit for high-level automation technologies.

AV technologies are projected to reduce travel costs due to improvements in safety and roadway capacity, which will improve average travel times. The reduced effort required to operate a vehicle combined with the capability of driverless vehicle operations, offered by AV technologies, can significantly change travel patterns and result in more miles driven. All the miles driven by AVs will be electric vehicle miles. Therefore, implementation of AV technologies is projected to directly increase electric VMT. It is anticipated that the implementation and adoption of AV technologies will result in almost 445,000 EVs added to the Florida vehicle fleet by 2035. By 2048, over 2.1 million EVs are projected to be added to Florida's fleet due to AV operations.

6.3 Key Benchmarks for Automated Vehicle and Alternative Fuel Vehicle Adoption

This section provides an overview of key benchmarks for the state to monitor and refine autonomous vehicle and alternative fuel vehicle market adoption projections, in conjunction with variables and trends that affect transportation demand, service modes, and funding, in order to develop an adaptive understanding of changes in transportation trends.

6.3.1 Passenger Electric Vehicle Market Considerations

The following decade is anticipated to be a critical junction for the passenger electric vehicle market. Falling battery prices and growth in shared mobility applications are anticipated to drive the passenger battery electric vehicle market.

6.3.1.1 Falling Battery Prices

As battery prices continue to decline, it is expected that BEVs will reach cost parity with ICEs by the middle of the next decade. At this point, electric passenger vehicles are expected to have a bigger market impact as battery pack prices fall. Based on the Bloomberg New Energy Finance (BNEF) projections, battery pack prices are expected to reach $94/kWh by 2024 and $62/kWh by 2030 [44]. These survey data show a declining trend in battery pack prices from 2012 to 2018 (see Figure 6-3). On average, battery prices have been declining 20.5 percent per year since 2010.

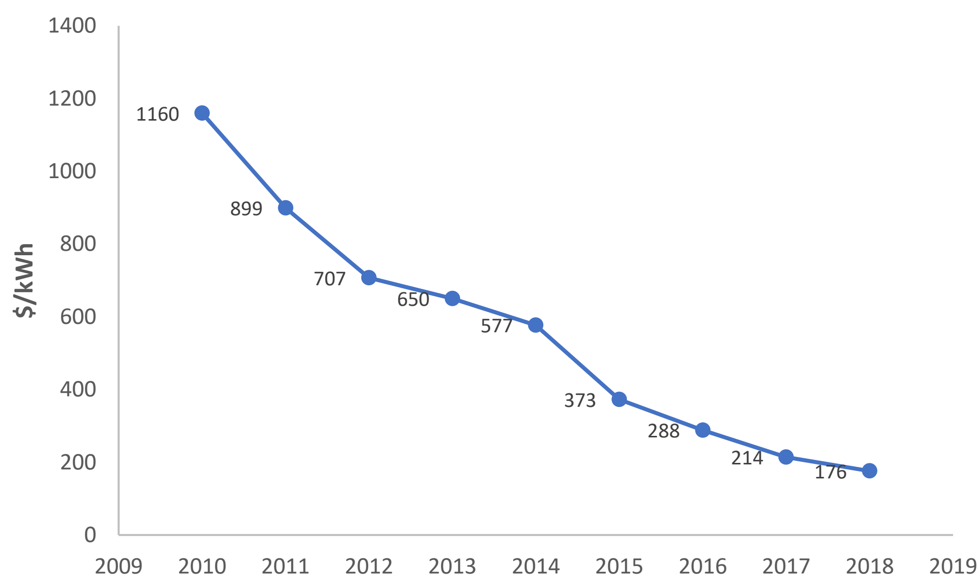

Figure 6-3. Lithium-ion Battery Price: BNEF Survey Results by Year[3]
Source: Goldie–Scot [44]

Battery price reduction, increased electric driving range, and improved vehicle performance are all key indicators of passenger EV market growth.

[3] Prices reflect volume-weighted averages and are shown in real 2018 $/kWh.

6.3.1.2 Electric Vehicle Charging Infrastructure Growth

Electric vehicle charging infrastructure plays an important role in the development of the EV market. While the majority of EV charging happens at home, public charging infrastructure is vital for enabling practical operation of EVs. Florida's public electric vehicle supply equipment (EVSE) network includes 2,640 Level 2 and 630 DC fast charge ports. By applying the Electric Vehicle Infrastructure Projection Tool (EVI-Pro) Lite from DOE's Office of Energy Efficiency and Renewable Energy, it is projected that Florida will need to add more than 20,500 Level 2 public charging stations and more than 2,700 DC fast chargers by 2040 to accommodate the forecasted EV growth [46]. It is expected that most of the required infrastructure will be provided (and funded) by the private sector and electric utilities. However, EVSE development can be significantly assisted by state financial incentives. Florida does not currently have a statewide incentive for EVSE. Implementing an EVSE rebate program or other incentives that reduce the cost of purchasing and installing public EV charging infrastructure could encourage EV market development in the state.

6.3.2 Automated Vehicle Market Considerations

The market penetration and potential impact of AVs on mobility, infrastructure, and freight is still highly indeterminate. AV deployment faces significant legal, security, political, economic, and technological challenges, and the development of AV technologies and their projected effects on travel behavior are speculative. In addition, AVs are in the infancy stage of real-world on-road testing, and there are a number of safety concerns about driving operation—such as how the vehicles interact with other vehicles and pedestrians, interpreting road signs and traffic signals, and operating in various weather conditions. Given these uncertainties and lack of real-world application data, literature projections of the effects of AV adoption on VMT ranges from -60 to 200 percent. Should the widespread implementation of AV technologies cause drastic changes in vehicle ownership, lifestyle, or travel habits of consumers, the effect on VMT may be considerably impacted. Thus, the current assumptions should be revisited and the forecasts refined.

6.3.2.1 Projected Light–duty Passenger AV Benchmarks

The advent of AVs requires consideration of a multitude of factors for future transportation planning. The American Planning Association reports that the top 11 major automakers plan to introduce fully autonomous models by 2021, but the first mass-market passenger AVs will likely be for the luxury vehicle sector or commercial fleets (such as taxi and on-demand mobility services) [47]. Ford has announced plans for a Level 4 AV in 2021 for ride-hailing service applications. General Motors is deploying an automated electric fleet in partnership with Lyft. Honda has invested to integrate Waymo automation technologies. The Daimler and Uber venture plans to introduce vehicles with Levels 4 and 5 automation capabilities early next decade [48]. However, the timing of when these vehicles will be fully automated (without driver assistance) is still highly indeterminate. As AV models are introduced to the market, refinements and adjustments should be made to the market penetration forecasts.

6.3.2.2 Medium- and Heavy-duty Commercial AV Applications

The VMT implications of AVs in the current analysis assume that all AVs during the projection period are light-duty vehicles. If AV technologies are implemented in significant numbers on MD and HD commercial vehicles during the forecast period, the impact on VMT generation will change—commercial fleets typically drive higher mileage, and automation of commercial vehicles can have a larger effect on VMT.

The growth of automated trucking is anticipated to occur in stages, with the implementation of lower level, semi-autonomous features and functions first. At this point, it is projected that full Level 5 automated trucking is unlikely until at least 2035 and beyond. Within a decade, there may be some limited application of semi-autonomous trucking. For example, self-driving trucks may operate on highway driving in good weather conditions and drivers handle the more complex functions, such as driving on urban roadways and loading [49]. This study recommends continued monitoring of commercial AV adoption trends to adjust VMT projections as the commercial autonomous trucking market develops.

6.3.2.3 Effect of AV on Car-share and Ride-hailing

If fully automated vehicle technologies materialize, it can be expected that AVs will be employed mostly by TNCs offering ride-hailing and car-sharing services. It is projected that as soon as high-level vehicle automation becomes operational, TNCs will be among the early adopters of the technology with the expectation of lowering operating costs and increasing service frequency and availability. TNCs are anticipated to purchase battery electric vehicles at a faster rate than individuals, primarily due to cost saving benefits [50]. Urban areas are seeing higher PEV adoption rates in the same areas that are experiencing growth in shared mobility services. Given the high annual mileage of shared fleet vehicles, fuel savings from PEVs present cost-attractive options [51]. A 2019 report from the International Council on Clean Transportation (ICCT) found that taxis and full-time ride-hailing drivers demonstrate the lowest total cost of ownership (TCO)[4] on a per-mile basis. ICCT estimated a $0.20 per mile cost for full-time ride-hailing drivers, compared to $0.44–$0.93 for individual owners, part-time ride-hailing drivers, and car-sharing fleets [51]. The authors estimate that BEVs become most economically viable for ride-hailing operators in the early part of the next decade (2023–25).

6.3.2.4 Automated Vehicle Infrastructure Requirements

Depending on the adoption rate of AFVs and AVs, additional infrastructure investments may need to be evaluated and considered. The projected automated vehicle penetration is expected to impact roadway structure, design, and function. Improvements will be needed for signage and markings to indicate lane awareness and speed regulation, and this will be particularly important to accommodate a mixed (fully autonomous, semi-autonomous, and human driver-operated) fleet. Thicker pavement may be needed to handle additional VMT from AVs, along with pavement extension, wider shoulders, and continuous fiber optic and power lines along major corridors [52]. Additional investments may be required to provide adequate roadside equipment (such as 5G cellular or dedicated short-range communications) and upgrades to communication infrastructure to provide for detection (such as camera or video processing) and dynamic messaging signs to transmit real-time information [52].

It is uncertain how AV technologies will be implemented during the transition period: whether fully automated technologies will be allowed to operate together with non-AVs or required to operate in dedicated lanes. Segregated lanes, similar to the function of high-occupancy vehicle lanes, are better suited for automated lane assistance features, and may be important for safety and efficiency considerations and to allow for platooning [53]. If a dedicated lanes approach is used, FDOT may need to invest in construction of dedicated AV lanes. However, the need for such lanes will likely not arise until the late 2030s, when the fleet share of high-level AVs will require significant use of those lanes.

6.4 Policy Considerations

Revenue for transportation infrastructure investments has declined over the past two decades. A 2012 study from the Center of Urban Transportation Research (CUTR) identified several contributing factors, including a decline in traditional funding sources, increases in construction and fuel costs, and a lack of adjustment of traditional fuel taxes and fees [29]. As federal funding allocation for transportation investment continues to fall, planners need to address this gap with traditional and nontraditional, flexible, and efficient funding methods to allocate

[4] TCO accounts for purchase cost, fuel costs, maintenance, taxes, and incentives.

toward state transportation infrastructure investment. This section discusses traditional and nontraditional policy options for further consideration by FDOT for transportation infrastructure investment, design, construction, maintenance, operations, and revenue purposes.

6.4.1 Alternative Fuel Vehicle Fees and Taxes

States have begun to diversify revenue sources to address declining revenues from motor fuel taxes as improvements in fuel efficiency and increased adoption of AFVs have led to a decrease in conventional fuel use. Twenty-one states have implemented AFV fees and taxes for vehicles that do not consume petroleum-based fuels (primarily battery electric and fuel cell and adjusted for hybrid vehicles). Table 6-1 summarizes these fees, which are applied in addition to motor vehicle registration fees [54]. These fees apply to both battery electric vehicles and plug-in hybrid-electric vehicles.

Table 6-1. State Alternative Fuel Vehicle Fees

State	Statute	Description
California	Cal. Vehicle Code §9250.6/SB 1	$100 annual fee for zero-emission vehicles model year 2020 or later; in January 2021 and following years, the annual fee will increase in conjunction with the CPI.
Colorado	Colo. Rev. Stat. §42-3-304(25)(a)/HB 1110	$50 annual fee for PEVs (includes battery electric and plug-in hybrid vehicles).
Georgia	Ga. Code Ann. §40-2-151(19)(A)(i)/HB 170	$200/$300 annual license fee for non-commercial/commercial AFVs, including battery electric vehicles. Does not apply to PHEVs. Fees are adjusted on an annual basis.
Idaho	Idaho Code §49-457/HB 312	$140 annual fee for BEVs and $75 annual fee for PHEVs.
Indiana	Ind. Code Ann. §9-18.1-5-12/HB 1002	$150 annual fee for BEVs and $50 annual fee for PHEVs and hybrid-electric vehicles (HEVs). The fee is indexed to same inflation rate as existing motor fuel tax.
Michigan	Mich. Comp. Laws Ann. §257.801(7)/HB 4736	$135 for BEVs up to 8,000 pounds, $235 annual fee for BEVs over 8,000 pounds, $47.50 annual fee for HEVs up to 8,000 pounds, $117.50 annual fee for HEVs over 8,000 pounds. The annual fees are indexed to motor fuel tax.
Minnesota	Minn. Stat. Ann. §168.013/HF 3	$75 fee for BEVs.
Mississippi	Miss. Code Ann. §§27-19-1 et seq./HB 1	$150 fee for BEVs and $75 fee for PHEVs. On July 1, 2021, fees will be indexed to account for inflation, which will be applied to following years.

State	Statute	Description
Missouri	Mo. Ann. Stat. §142.869/SB 619	$75.00 for passenger AFVs and $37.50 annual fee for PHEVs.
Nebraska	Neb. Rev. Stat. §60-3,191/LB 289	$75 for AFVs, which include vehicles powered by electricity, solar, and any other energy source that is not taxed under motor fuel laws.
North Carolina	N.C. Gen. Stat. §20-87(13)/SB 402 and HB 97	$130 annual fee for PEVs.
Oklahoma	HB 1449	$100 annual fee for BEVs and $20 annual fee for PHEVs and HEVs.
Oregon	HB 2017	$110 annual fee for PHEVs.
South Carolina	S.C. Code Ann. §56-3-645/HB 3516	$120 biennial fee for battery electric or hydrogen fuel cell vehicles and $60 biennial fee for PHEVs.
Tennessee	Tenn. Code Ann. §55-4-116/HB 534	$100 annual fee for electric vehicles
Utah	Utah Code §41-1a-1206/SB 136	$60 annual fee for BEVs in 2019, which is increased to $90 in 2020 and to $120 in 2021 and thereafter. $10 annual fee for HEVs in 2019, which is increased to $15 in 2020 and to $20 in 2021 and thereafter. $26 annual fee for PHEVs in 2019, which is increased to $39 in 2020 and to $52 in 2021 and thereafter. $60 annual fee for AFVs fueled by a source other than motor fuel, diesel, natural gas, or propane in 2019, which is increased to $90 in 2020 and to $120 in 2021 and thereafter. Starting on January 1, 2022, fees will be indexed to the CPI.
Virginia	Va. Code §58.1-2249(b)/SB 127	$64 annual license tax for AFVs or BEVs. HEVs and PHEVs are excluded from this license tax.
Washington	Wash. Rev. Code §46.17.323/HB 5897	$150 annual fee for PEVs.
West Virginia	W. Va. Code §17A-10-3c/SB 1006	$100 annual fee for PHEVs, $200 annual fee for electric, hydrogen fuel cell, or natural gas vehicles, and $100 annual fee for HEVs.
Wisconsin	Wis. Stat. Ann. §341.25/Act 59 §1895	$75 annual fee for PHEVs and $100 annual fee for BEVs.
Wyoming	Wyo. Stat. §31-3-102(a)(xxiii)/HB 9	$50 annual decal fee for PEVs.

Source: Hartman and Pula [54]

6.4.1.1 Adjustments to Motor Fuel Excise Tax

A number of states have chosen to address projected motor fuel tax revenue losses by changing the tax structure to better reflect the disparity in the energy content of alternative fuels compared to gasoline or diesel. Motor fuel taxes use volumetric measures for fuel tax calculations, which do not necessarily reflect the energy content of the fuel and subsequently the miles traveled as a way to quantify the vehicle's impact on road infrastructure [55]. To address that issue, some states tax alternative fuels based on their energy content (e.g., gasoline gallon equivalent or diesel gallon equivalent) rather than volumetric measure of the fuel).

6.4.2 Public-Private Partnerships for Transportation Infrastructure

Public-private partnerships (P3s) provide an alternative method for private sector funding for the development and operation of transportation infrastructure projects [56]. While transportation P3s presently make up a relatively minor share, P3s present an opportunity to access private investment for infrastructure projects either in the form of design-build-finance-operate-maintain (DBFOM) projects or long-term leasing arrangements. DBFOM expands on a more traditional method of P3s where the public entity manages the building, financing, operating, and maintenance of infrastructure, but contracts out construction to a private partner. DBFOM involves the private sector in the construction, operation, and maintenance of new facility investments, which is then subsequently repaid by uses of those facilities in the form of fares, tolls, or state or local government payments [56]. P3s present certain risks, but some of those risks may be shifted from the public to the private sector in a DBFOM arrangement. Long-term leasing also presents an opportunity in which the private sector entity pays a concession fee to maintain and operate the service, and also collects tolls or other user-based fees [56].

As automated vehicles may necessitate more advanced roadway communication technology infrastructure—including fiber optic lines, sensors, cameras, transmission towers, and rights-of-way—this may present an additional opportunity for public-private partnerships. However, there are inherent security and privacy issues that may also present challenges with these alternative policy options.

6.4.3 Tolling and Congestion Pricing

Congestion pricing has been viewed as an option both to address congestion and as a potential additional source of transportation revenue. Congestion pricing has been applied in some states to charge roadway users that are operating in certain areas, with the option to adjust the fee based on timeframes (such as peak congestion times). The Federal Highway Administration identifies five different types of pricing options [57]:

1. **Variably priced lanes –** Variable tolls on divided lanes on a highway (for example, express toll lanes or high-occupancy toll lanes).
2. **Variable tolls on entire roadways –** Implemented on toll roads, bridges, and toll-free facilities during peak congestion times.
3. **Zone-based charges –** Involves applying variable or fixed charges to access congested zones within an area.
4. **Area-wide charges –** Allocated a per-mile charge on roads in an area with varying degrees of congestion.
5. **Non-toll pricing strategies –** Implementing parking-pricing strategies and parking cash-out policies.

6.4.4 Emission Fees

Emission fees are calculated based on the degree and amount of pollution emitted by a vehicle source, which presents challenges for calculation as is it difficult to accurately quantify emissions; in some instances, an alternative is to employ a fee that is determined by vehicle fuel efficiency or type [58].

6.4.5 Road Use Fee/VMT Fee

A VMT fee is an example of a user fee, which is essentially a pricing scheme based on mileage and use of roadway infrastructure. VMT fees involve charging drivers a fee based on mileage traveled with several variations (some VMT fees account for vehicle weight, location, and time, in addition to total miles traveled) [58]. VMT fee implementation requires states to develop and employ specific policy guidelines to address various aspects, including fee collection and methods for calculating mileage and data collection, and if this fee should be voluntary or mandatory, particularly as this option presents significant challenges with privacy considerations.

The Oregon Department of Transportation (ODOT) instituted the ORe*GO* road usage charge program in 2015, which is a voluntary option that drivers can use to pay fees by mileage instead of fuel consumed. ORe*GO* and is the first state in the nation to adopt such a program [59]. ODOT has established a 1.7 cents per mile fee, and participants of the program receive credits for paid fuel tax. ODOT also contracted with a private sector partner to provide mileage reporting [59]. Mileage is collected through a reporting device that uses wireless communication networks.

7 Conclusions

The objective of this research was to conduct a market penetration analysis of autonomous and alternative fuel vehicles and their impact on Florida's vehicle miles of travel. The study's results will assist FDOT in (1) timely responding to the implementation of autonomous and alternative fuel vehicles, and (2) addressing FDOT future transportation funding needs and revenue requirements as the projected market penetration rates are achieved.

This study generated a series of technical reports summarizing the latest AFV and AV developments. The initial stages of research (Task 1 and Task 3 technical reports) focused on reviewing the most recent (end of 2018) literature providing national market penetration forecasts and analyzing factors affecting national trends. This information served to generate state-level AFV and AV market penetration rates and VMT forecasts for the SFY period of 2017–18 to 2047–48 (Task 2 and Task 4 technical reports). The projections consider high, medium, and low market penetration rates and VMT scenarios for autonomous and alternative fuel technologies, and account for Florida-specific economic and sociodemographic conditions.

Tasks 5 and 6 identified potential AFV and AV investment needs and cost savings accruing to FDOT and the approximate rollout periods. One of the main benefits of AVs is the expected increase in roadway capacity due to the ability of vehicles to travel closer to each other and the reduction in collision-related congestion. It is expected that most of the AV-induced capacity improvements will be achieved through vehicle cooperation. Low levels of market penetration are associated with minimal capacity improvements since the mix of conventional and automated vehicles limits the extent to which vehicles can travel closer to each other and the level of coordination. As market penetration increases, capacity improvements remain minimal for non-cooperative AVs but increase exponentially for connected AVs. Accommodating the increased adoption of AV technologies may require special infrastructure considerations, such as road markings and signage, managed/dedicated lanes to AVs, the addition of drop-off lanes, intelligent transportation system roadside devices to enhance V2I capabilities, and demand management strategies.

By SFY 2047-48, Florida is projected to have 3.8 million BEVs, representing 14.6 percent of the state's vehicle market. Florida will need an additional 20,600 Level 2 public charging stations and about 2,700 additional DC fast charging stations to accommodate short-term demand from the projected PEV fleet. Addressing these public charging infrastructure needs may cost from \$88.3 million to \$231.5 million, including the cost of equipment and installation but excluding the cost of right-of-way acquisition [35]. It is not envisioned that projected infrastructure needs will require significant investment from state departments of transportation, given that charging infrastructure investments are typically provided through the private sector and utilities, assisted with infrastructure grants from federal, state, and local entities.

The VMT projections through SFY 2047–48 were used to assess the impact on the state's transportation revenues (Task 7 technical report). Annual fuel tax revenue losses are projected to increase over the next decade from $5.4 million in SFY 2017–18 to $85.4 million by SFY 2027–28. Over the 20-years following Revenue Estimating Conference forecasting timeframe, the increased adoption of AFVs will result in substantial tax revenue losses. By SFY 2047–48, tax revenue losses are projected to reach $2.4 billion annually, including $1.3 billion from state fuel taxes, $660 million from federal fuel taxes deposited into STTF and $398 million from local tax revenues. NGVs will have a limited impact on revenue losses (about $1.5 million annually).

The increased adoption of AVs can be expected in the form of AFVs and the projected increases in VMT will have a negative impact on the state motor fuel tax collection. Annual tax revenue losses from AVs are projected to be insignificant during the REC timeframe. The period 2027–28 through 2047–48 will see increased AV adoption and market penetration, which will accelerate revenue losses..

The combined effect of increased AFV and AV market penetration on total revenue collection is projected to reach $18.3 billion over the SFY 2017-18 through SFY2047-48. By the end of SFY 2047–48, the projected increase in BEVs, along with the rapid adoption of AVs, will substantially increase annual revenue losses to about 26 percent of Federal, State and local fuel taxes.

Projected shifts in mobility choices and travel behavior, advancements in vehicle propulsion, and automation will increase uncertainty in projecting impact on federal, state, and local transportation tax revenue collection.

There are several trends that need to be monitored closely to assess their effect on VMT generation and fuel usage (Task 8 technical report). Private vehicles are becoming more affordable and lasting longer. At the same time, advancement in shared mobility services, telecommuting, and micro-transit options offer alternative transportation options and may change travel behavior and VMT. Improvements in fuel economy and wider use of AFVs may lead to a reduction in fuel consumption and translate into lower fuel tax revenue for the state.

Cost increases, both general inflation and those higher costs specific to the provision of transportation infrastructure in an increasing complex and urbanizing state environment, lessen the purchasing power of existing revenue sources and reduce their ability to meet ongoing needs.

The effects AFV and AV technologies on state transportation revenue is projected to be small in the short and medium terms. However, when combined with vehicle fuel efficiency growth, construction cost increases, and other factors, AFV and AV impacts add to the erosion of the STTF.

Motor fuel-based taxes, which historically have served as an effective and administratively efficient surrogate for a user-fee based collection system, are becoming increasingly less effective in this role as vehicle fuel efficiencies continuously increase and as non-motor-fuel powered vehicles, such as battery electric vehicles, are adopted in greater numbers.

The state can consider various policy options to address the STTF funding shortfall, including imposing AFV fees and taxes, adjusting motor fuel excise taxes to better reflect the energy content of fuels, mileage-based transportation funding options, and public-private partnership models to fund transportation infrastructure. Mileage-based fees provide an example of an alternative user-fee based transportation tax collection process. This approach has many public policy and privacy implications that extend beyond the issue of revenue collection to encompass allocative efficiency and equity. Recent developments in the ubiquitous nature of private data collection by both public and private entities are changing public perceptions on the merits of using this approach. As an example, toll agencies have implemented electronic toll collection with general public acceptance of data collection as an acceptable trade-off for greater convenience and time savings. Additionally, the technology advances will likely enable various mileage-based strategies to be developed and implemented in ways that are administratively efficient and that may be able to mitigate privacy concerns.

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Appendix A 2018 Florida VMT and eVMT Forecasts – Summary

Florida VMT Forecast Summary

In “Task 4 – Technical Report: A Review of Alternative Fuel Vehicle Market Penetration and Projected VMT Penetration Rate Analysis for Florida,” Kolpakov et al. developed a set of Florida-specific VMT forecasts to account for three scenarios reflecting an average (baseline), a low growth in VMT, and a high growth in VMT. These forecasts used a weighted index approach, which were based on the 2017 FHWA national VMT forecasts for light-duty vehicles, single-unit trucks, buses, and combination trucks. FHWA developed both 20-year (2018–38) and 30-year (2018–48) baseline, low, and high economic growth outlook forecasts for projected VMT growth rates. These national forecasts were adjusted to account for Florida-specific factors that are expected to have significant effect on VMT generation, including population growth, fleet profile, real gross domestic product growth, growth in disposable income per capita, and fuel prices. The forecasting approach assumed that Florida VMT growth will follow the general pattern of the national VMT, growing faster during the first 20-year period and slowing down during the last 10 years of the 30-year projection period.

Tables A-1 through A-3 summarize forecasted VMT annual growth rates in Florida for different types of vehicles under baseline, low-growth, and high-growth VMT scenarios.

Table A-1. Florida Baseline VMT Growth Forecast

Projection Period	Average annual growth rate in VMT (in percent)			
	Light-duty	Single-unit trucks/buses	Combination trucks	Total
2018 – 2038	1.53	2.33	2.11	1.60
2018 – 2048	1.32	2.34	2.07	1.41
2038 – 2048	0.84	2.37	1.97	0.99

Source: Projections from Tasks 2 and 4 Technical Reports

Table A-2. Florida Low VMT Growth Rate Forecast

Projection Period	Average annual growth rate in VMT (in percent)			
	Light-duty	Single-unit trucks/buses	Combination trucks	Total
2018 – 2038	1.13	1.92	1.71	1.20
2018 – 2048	0.91	1.93	1.66	1.00
2038 – 2048	0.41	1.93	1.53	0.56

Source: Projections from Tasks 2 and 4 Technical Reports

Table A-3. Florida High VMT Growth Forecast

Projection Period	Average annual growth rate in VMT (in percent)			
	Light-duty	Single-unit trucks/buses	Combination trucks	Total
2018 – 2038	1.93	2.73	2.52	2.00
2018 – 2048	1.71	2.73	2.46	1.80
2038 – 2048	1.21	2.74	2.34	1.36

Source: Projections from Tasks 2 and 4 Technical Reports

Under the baseline VMT growth forecast, total Florida VMT is projected to reach 335.9 billion annually by the year 2048. Under the high VMT growth scenario, VMT is forecasted to be as high as 379.9 billion. The low growth scenario results in VMT projection of 295.1 billion per year in 2048. Figure A-1 summarizes the comparison of projected Florida VMT between baseline, high, and low growth scenarios during the 30-year forecast period. Figures A-2 and A-3 demonstrate FHWA national projections compared to Florida-specific VMT forecasts.

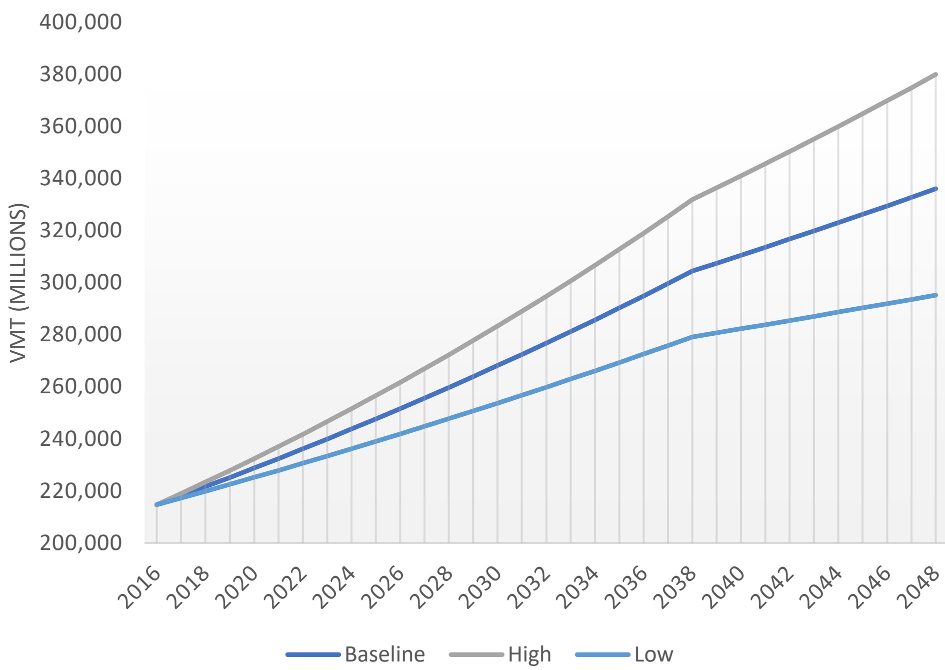


Figure A-1. Comparison of Total Florida VMT Forecast Scenarios

Source: Projections from Tasks 2 and 4 Technical Reports

FHWA Forecasts of Vehicle Miles Traveled (VMT): Spring 2018

Table 1. Projected Growth in Vehicle Miles Traveled (VMT): Spring 2018

Vehicle Class	Compound Annual Growth Rates					
	Low Economic Growth Outlook		Baseline Economic Growth Outlook		High Economic Growth Outlook	
	2016 - 2036 (20 Year)	2016 - 2046 (30 Year)	2016 - 2036 (20 Year)	2016 - 2046 (30 Year)	2016 - 2036 (20 Year)	2016 - 2046 (30 Year)
Light-Duty Vehicles	0.9%	0.7%	**1.1%**	**0.8%**	1.3%	1.0%
Single-Unit Trucks	1.4%	1.5%	**1.8%**	**1.9%**	2.3%	2.4%
Combination Trucks	1.2%	1.2%	**1.6%**	**1.6%**	1.9%	1.9%
Total	0.9%	0.8%	**1.2%**	**0.9%**	1.3%	1.1%

Table 2. IHS Baseline Long-Term Economic Forecasts: Spring 2018

Demographic and Economic Indicators	Historical Growth Rate	Forecast Growth Rate: 2016-46
U.S. Population	1.00%	**0.60%**
GDP (Real 2009$)	2.60%	**2.00%**
Real Goods Component of GDP (Real 2009$)	3.20%	**2.70%**
Disp. Personal Income per Capita (Real 2009$)	1.70%	**1.60%**
Gasoline Price per Gallon (Real 2009$)	0.70%	**1.00%**

CUTR Forecasts of Florida Vehicle Miles Traveled (VMT)

Projected Growth in Vehicle Miles Traveled (VMT): 2018

Vehicle Class	Compound Annual Growth Rates					
	Low Economic Growth Outlook		Baseline Economic Growth Outlook		High Economic Growth Outlook	
	2018 - 2038 (20 Year)	2018 - 2048 (30 Year)	2018 - 2038 (20 Year)	2018 - 2048 (30 Year)	2018 - 2038 (20 Year)	2018 - 2048 (30 Year)
Light-Duty Vehicles	1.1%	0.9%	**1.5%**	**1.3%**	1.9%	1.7%
Single-Unit Trucks	2.1%	1.9%	**2.5%**	**2.4%**	2.9%	2.7%
Combination Trucks	1.8%	1.7%	**2.2%**	**2.1%**	2.6%	2.5%
Total	1.2%	1.0%	**1.6%**	**1.4%**	2.0%	1.8%

Baseline Florida Long-Term Economic Forecasts: 2018

Demographic and Economic Indicators	Historical Growth Rate	Forecast Growth Rate: 2018-48
Florida Population	1.90%	**0.97%**
Real GDP	2.40%	**1.85%**
Disposable Income per Capita	0.98%	**1.08%**
Gasoline Prices	0.65%	**0.93%**

Figure A-2. Comparison of FHWA National & CUTR VMT Forecasts

Source: U.S. Department of Transportation [60] and Projections from Tasks 2 and 4 Technical Reports

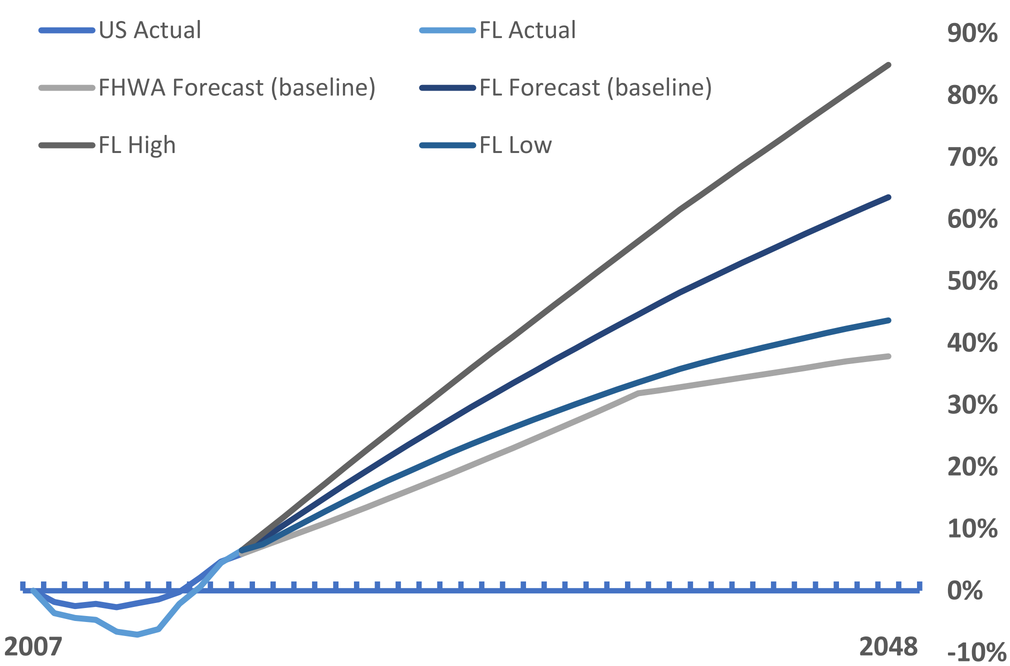


Figure A-3. Comparison of Florida and National Forecast

Source: Analysis from Task 4 Technical Report

Florida eVMT Forecast Summary

The projection of the number of EVs in Florida, in comparison with the national EV market, employs a weighted index approach, similar to the one that has been used for baseline VMT projections in the state. Key macroeconomic parameters that are used as predictors of EV market development in Florida include growth in disposable income per capita, gasoline prices, availability of government EV rebates/incentives, residential electricity rates, and prices of photovoltaic panels in Florida in comparison to national averages.

Total electric VMT in Florida was estimated by combining the projections of the number of EVs in Florida with the forecasted average annual eVMT per electric vehicle. Separate eVMT projections were developed for each subcategory (LDV, SUT&B, CT) and for each scenario (baseline, low, high).

Total eVMT in Florida is projected to reach 47.5 billion by 2048, accounting for about 14.0 percent of the overall VMT in the state (baseline scenario). Under a scenario of high growth in total Florida VMT, eVMT is projected to reach 12.5 percent of the overall state VMT in 2048. In the low-growth scenario, eVMT is forecasted to account for 16.1 percent of the total annual VMT. Table A-4 presents the summary of the forecasted eVMT in Florida during the period from 2020 through 2048.

Table A-4. Projected eVMT Forecast for Florida (2020-48)

eVMT Forecast (Millions)				
Year	**Total**	**Light-duty**	**SUT/B**	**Combination Trucks**
2020	**559.6**	559	0.5	0.0
2025	**2,893**	2,873	19.2	0.5
2030	**6,629**	6,564	48.9	16.7
2035	**11,669**	11,451	160.0	57.6
2040	**20,039**	19,358	482.2	198.7
2045	**34,573**	32,372	1,515.2	686.0
2048	**47,502**	43,010	3,049.7	1,442.7

Source: Projections from Tasks 2 and 4 Technical Reports

For this analysis, VMT annual growth rates were further adjusted to reflect Florida population growth projections indicating more rapid initial year growth and slower outer year growth, using the Florida Office of Economic & Demographic Research population estimates for medium county projections [20]. Additionally, Florida's vehicle mix was adjusted to reflect the smaller share of combination trucks in Florida—approximately one-third less compared to the national share. The Florida subcategory shares were developed by combining data from FHWA 2017 VMT3 and VMT4 reports. While the percentage change in CT VMT share is small (1.8 percent), the effect of revenue forecasts is considered to be a material factor since combination trucks consume four times more fuel per VMT than do LDVs and CTs, which generally use diesel fuel, which has differing federal and local motor fuel tax rates.

Florida AV VMT Summary

This analysis projects a modest penetration rate of AV technologies. AVs are not expected to account for a significant portion of VMT until at least 2035. By 2035, VMT from AVs is projected to account for 3.80 percent of total Florida VMT, increasing to 7.29 percent of total Florida VMT by 2040 and 14.56 percent by 2048. The analysis assumes that all AV VMT in Florida will be eVMT from light-duty vehicles.

Automated vehicles are expected to drive more VMT per vehicle compared to other vehicles due to the reduced cost of travel offered by AV technologies and likely use of AVs for ride-sharing applications. Autonomous driving is projected to increase the average eVMT per electric vehicle by 35 percent beginning in 2035. Total VMT from AVs in Florida are projected to reach 11.0 billion VMT by 2035, 22.6 billion VMT by 2040, 45.7 billion VMT by 2045, and almost 49.0 billion VMT by 2048. Figure A-4 presents forecasted Florida VMT under different growth scenarios, accounting for the impact of AV technologies.

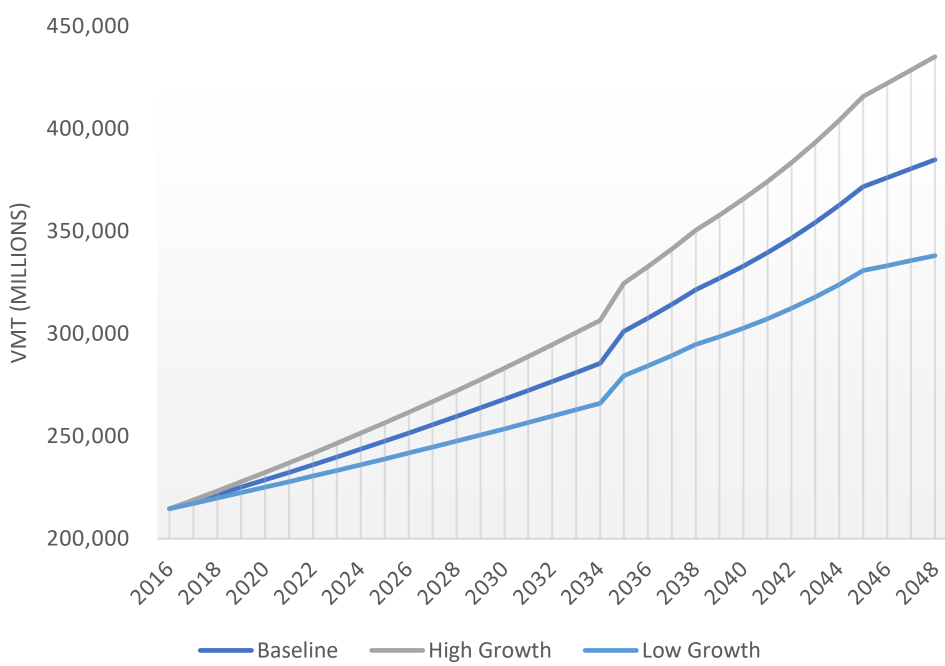


Figure A-4. Projected Florida VMT with AV Impact
Source: Projections from Tasks 2 and 4 Technical Reports

Appendix B Florida Alternative Fuel Vehicle Market Analysis

Kolpakov et al. provide an overview of Florida alternative fuel vehicle market projections in Task 4. This section summarizes those findings and provides updated sales and registration data through the end of 2018.

Historical – PEV Sales and Fleet

During the period of 2013–18, Florida's PEV sales grew at an average annual rate of 20.0 percent per year, faster than other non-zero-emission vehicle states, which grew at a comparative rate of 16.5 percent per year.

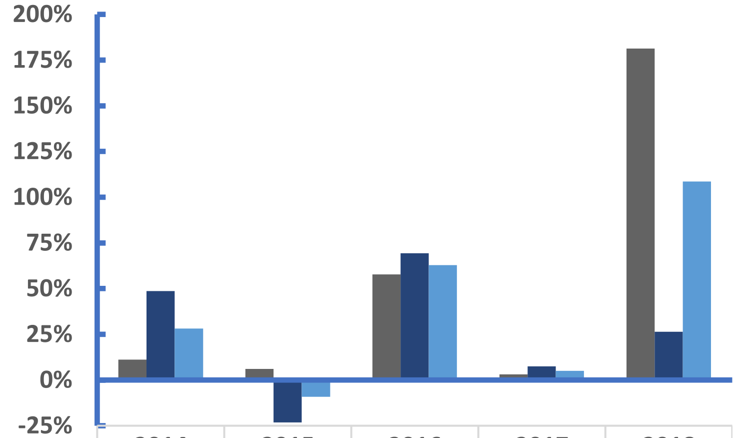
Florida PEV sales as a share to total light vehicle sales has grown from 0.31 percent in 2013 to 0.53 percent in 2017. Both BEVs and PHEVs have grown in market share at similar rates, with BEVs increasing from 0.17 percent of total share in 2013 to 0.28 percent in 2017, and PHEVs from 0.14 to 0.25 percent.

As of the end of 2018, over 42,900 plug-in electric vehicles were registered in Florida, including approximately 17,800 plug-in hybrid-electric and 25,100 battery electric vehicles. Ninety-two percent of those vehicles are registered to individuals compared to 8 percent registered to fleets.

Auto Alliance reported an annual growth rate of 109.0 percent in 2018, however, PEV sales currently represent 1.0 percent of total vehicles sales in Florida and make up 0.2 percent of the state's vehicle fleet.

The existing light-duty vehicle lifespan trends continue to rise with the average vehicle age presently exceeding 10 years. Annual new model year light vehicle sales comprise on average 7.5 percent of the total vehicle fleet. Considering PEVs were introduced to the market in 2011, the average age of a PEV is 2.5 years. The inventory of plug-in vehicles has yet to build to appreciable levels.

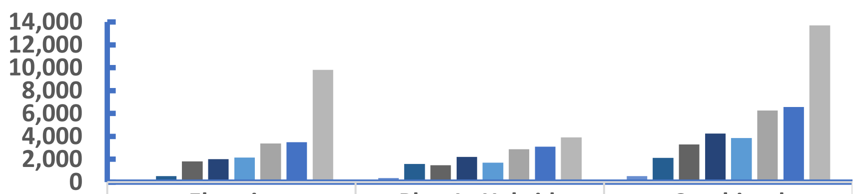
Figures B-1 and B-2 illustrate Florida's PEV sales and annual growth rates.



	2014	2015	2016	2017	2018
Electric	11%	6%	58%	3%	181%
Plug-In Hybrid	49%	-23%	69%	7%	26%
Combined	28%	-9%	63%	5%	109%

Figure B-1. Florida PEV Sales Annual Growth Rates

Source: Alliance of Automobile Manufacturers [2][5]



	Electric	Plug-In Hybrid	Combined
2011	181	343	524
2012	527	1,587	2,114
2013	1,817	1,487	3,304
2014	2,021	2,211	4,232
2015	2,144	1,697	3,841
2016	3,382	2,873	6,255
2017	3,485	3,088	6,573
2018	9,804	3,901	13,705

Figure B-2. Florida PEV Sales

Source: Alliance of Automobile Manufacturers [2]

[5] The Alliance of Automobile Manufacturers produces the *Advanced Technology Vehicle Sales Dashboard*, which provides publicly available sales data for U.S. light-duty advanced technology vehicles and is updated quarterly. Sales data from this database, in conjunction with registration data from the Florida Department of Highway Safety and Motor Vehicles, were used to develop the AFV market analysis and vehicle uptake projections referenced in this report.

Projected PEV Growth

Favorable factors suggest that Florida will experience increasing growth in PEV sales due to favorable climate, general preference for automobiles over light trucks compared to preferences in other states, relatively low electricity costs, and relatively high population density.

Electric vehicles are projected to increase in Florida from 42,962 units in 2018 to 278,275 units in 2025 and more than 3.6 million by 2048, with eVMT accounting for 2.9 billion miles in 2025 and 47.5 billion miles of annual travel in 2048, with the majority of those vehicles concentrated in the higher density metropolitan areas.

Light-duty vehicles are expected to account for the vast majority of PEVs in Florida through the entire projection period and will account for 93.0 percent of the total Florida PEV fleet in 2048. The current approach forecasts that by 2048, 18.0 percent of single-unit trucks and 10.0 percent of semitrucks in Florida will be battery electric.

Figure B-3 illustrates the state's projected increases in light-duty vehicles for the period 2018–48.

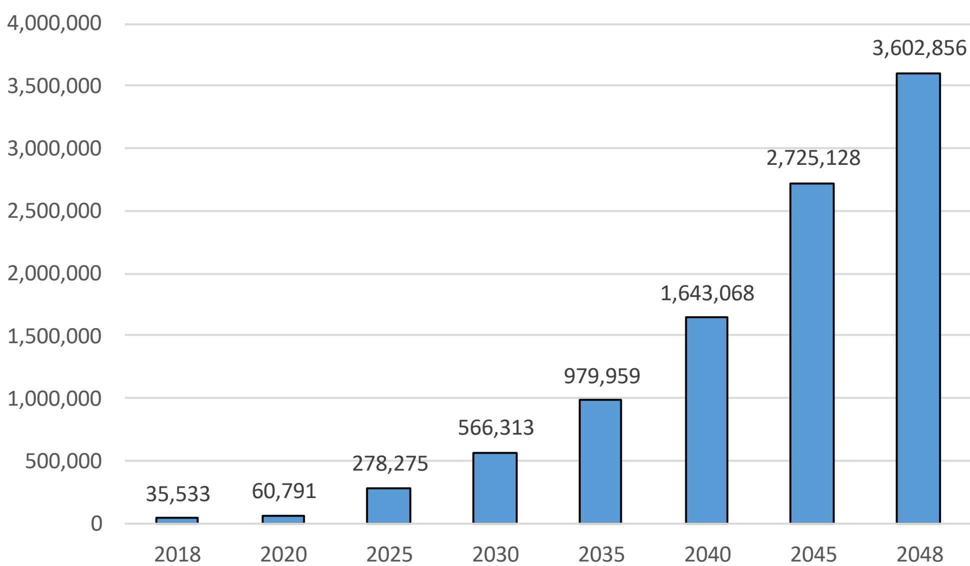


Figure B-3. Projected Light-Duty EV Stock for Florida (2018–48)

Source: Projections from Task 4 Technical Report

Natural Gas Vehicles

Natural gas vehicles represent a smaller share of the U.S. vehicle fleet than EVs and PHEVs.

According to DOE, as of 2017, there were approximately 150,000 natural gas vehicles operating in the United States, which were mainly applied in the heavy-duty sector. The U.S. Energy Information Administration reports that only 0.13 percent of natural gas consumed nationally was used to fuel NGVs. The EIA 2018 Energy Outlook projects that while natural gas transportation fuel use is expected to increase, specifically in the commercial freight trucks and marine vessel market, it is expected to maintain a relatively minor share of the total transportation fuel demand. EIA forecasts suggest that by 2025, approximately 70,000 MD and HD natural gas vehicles (CNG and LNG) will be operating in the United States, representing 0.6 percent of the overall MD and HD national fleet. The number of medium- and heavy-duty NGVs in the U.S. fleet is expected to reach 80,000 in 2030, 140,000 in 2040, and 290,000 in 2050, representing 0.6 percent, 0.9 percent, and 1.6 percent of the overall U.S. MD and HD vehicle stock in the respective years.

Overall, natural gas vehicles are expected to represent a rather small share of the vehicle fleet even in the long term. Natural gas vehicles in Florida are expected to follow nationwide trends, growing modestly mainly in the MD and HD vehicle sectors while maintaining a relatively small percentage of vehicle stock (less than 1.0 percent of MD and HD stock until 2040).

Appendix C Vehicle Fuel Efficiency Rates

Table C-1. EPA Adjusted, EPA Unadjusted, and CAFE Values by Model Year

	Car				Truck				Both Car and Truck			
Model Year	Adj. (MPG)	Unadj. (MPG)	NHTSA CAFE (MPG)	Diff.	Adj. (MPG)	Unadj. (MPG)	NHTSA CAFE (MPG)	Diff.	Adj. (MPG)	Unadj. (MPG)	NHTSA CAFE (MPG)	Diff.
1975	13.5	15.8	N/A	-	11.6	13.7	N/A	-	13.1	15.3	N/A	-
1976	14.9	17.5	N/A	-	12.2	14.4	N/A	-	14.2	16.7	N/A	-
1977	15.6	18.3	N/A	-	13.3	15.6	N/A	-	15.1	17.7	N/A	-
1978	16.9	19.9	19.9	0	12.9	15.2	N/A	-	15.8	18.6	19.9	1.3
1979	17.2	20.3	20.3	0	12.5	14.7	18.2	3.5	15.9	18.7	20.1	1.4
1980	20	23.5	24.3	0.8	15.8	18.6	18.5	-0.1	19.2	22.5	23.1	0.6
1981	21.4	25.1	25.9	0.8	17.1	20.1	20.1	-	20.5	24.1	24.6	0.5
1982	22.2	26	26.6	0.6	17.4	20.5	20.5	-	21.1	24.7	25.1	0.4
1983	22.1	25.9	26.4	0.5	17.8	20.9	20.7	-0.2	21	24.6	24.8	0.2
1984	22.4	26.3	26.9	0.6	17.4	20.5	20.6	0.1	21	24.6	25	0.4
1985	23	27	27.6	0.6	17.5	20.6	20.7	0.1	21.3	25	25.4	0.4
1986	23.7	27.9	28.2	0.3	18.2	21.4	21.5	0.1	21.8	25.7	25.9	0.2
1987	23.8	28.1	28.5	0.4	18.3	21.6	21.7	0.1	22	25.9	26.2	0.3
1988	24.1	28.6	28.8	0.2	17.9	21.2	21.3	0.1	21.9	25.9	26	0.1
1989	23.7	28.1	28.4	0.3	17.6	20.9	21	0.1	21.4	25.4	25.6	0.2
1990	23.3	27.8	28	0.2	17.4	20.7	20.8	0.1	21.2	25.2	25.4	0.2
1991	23.4	28	28.4	0.4	17.8	21.3	21.3	-	21.3	25.4	25.6	0.2
1992	23.1	27.6	27.9	0.3	17.4	20.8	20.8	-	20.8	24.9	25.1	0.2
1993	23.5	28.2	28.4	0.2	17.5	21	21	-	20.9	25.1	25.2	0.1
1994	23.3	28	28.3	0.3	17.2	20.8	20.8	-	20.4	24.6	24.7	0.1
1995	23.4	28.3	28.6	0.3	17	20.5	20.5	-	20.5	24.7	24.9	0.2
1996	23.3	28.3	28.5	0.2	17.2	20.8	20.8	-	20.4	24.8	24.9	0.1
1997	23.4	28.4	28.7	0.3	17	20.6	20.6	-	20.1	24.5	24.6	0.1
1998	23.4	28.5	28.8	0.3	17.1	20.9	21	0.1	20.1	24.5	24.7	0.2
1999	23	28.2	28.3	0.1	16.7	20.5	20.9	0.4	19.7	24.1	24.5	0.4
2000	22.9	28.2	28.5	0.3	16.9	20.8	21.3	0.5	19.8	24.3	24.8	0.5
2001	23	28.4	28.8	0.4	16.7	20.6	20.9	0.3	19.6	24.2	24.5	0.3
2002	23.1	28.6	29	0.4	16.7	20.6	21.4	0.8	19.5	24.1	24.7	0.6
2003	23.2	28.9	29.5	0.6	16.9	20.9	21.8	0.9	19.6	24.3	25.1	0.8
2004	23.1	28.9	29.5	0.6	16.7	20.8	21.5	0.7	19.3	24	24.6	0.6
2005	23.5	29.5	30.3	0.8	17.2	21.4	22.1	0.7	19.9	24.8	25.4	0.6
2006	23.3	29.2	30.1	0.9	17.5	21.8	22.5	0.7	20.1	25.2	25.8	0.6
2007	24.1	30.3	31.2	0.9	17.7	22.1	23.1	1	20.6	25.8	26.6	0.8
2008	24.3	30.5	31.5	1	18.2	22.7	23.6	0.9	21	26.3	27.1	0.8
2009	25.4	32.1	32.9	0.8	19	23.8	24.8	1	22.4	28.2	29	0.8
2010	25.8	32.7	33.9	1.2	19.1	23.8	25.2	1.4	22.6	28.4	29.3	0.9
2011	25.4	32.3	33.1	0.8	19.1	23.9	24.7	0.8	22.3	28.1	29	0.9
2012	26.9	34.4	35.3	0.9	19.3	24.1	25	0.9	23.6	29.9	30.8	0.9
2013	27.7	35.5	36.4	0.9	19.8	24.8	25.7	0.9	24.2	30.7	31.6	0.9
2014	27.6	35.6	36.5	0.9	20.3	25.5	26.5	1	24.1	30.7	31.7	0.8
2015	28.2	36.5	37.2	0.7	21.1	26.5	27.3	0.8	24.6	31.4	32.2	0.8
2016	28.5	36.9			21.2	26.8			24.7	31.6		
2017	29.1	37.9			21.2	26.8			24.9			

Source: U.S. Environmental Protection Agency [61] and Calculations from Task 7 Technical Report

Table C-2. Vehicle Survivability and Travel Mileage Schedules

Age	Passenger Cars	Light Trucks			
		All Light Trucks	Pickups	SUVs	Vans
1	14,231	16,085	16,869	16,270	16,321
2	13,961	15,782	16,270	15,786	15,951
3	13,669	15,442	15,681	15,316	15,555
4	13,357	15,069	15,105	14,859	15,135
5	13,028	14,667	14,541	14,417	14,693
6	12,683	14,239	13,990	13,988	14,234
7	12,325	13,790	13,453	13,571	13,759
8	11,956	13,323	12,931	13,167	13,271
9	11,578	12,844	12,424	12,775	12,774
10	11,193	12,356	11,932	12,395	12,270
11	10,804	11,863	11,457	12,025	11,763
12	10,413	11,369	10,999	11,667	11,255
13	10,022	10,879	10,559	11,320	10,750
14	9,633	10,396	10,138	10,983	10,249
15	9,249	9,924	9,736	10,656	9,757
16	8,871	9,468	9,353	10,338	9,275
17	8,502	9,032	8,991	10,031	8,808
18	8,144	8,619	8,650	9,732	8,358
19	7,799	8,234	8,331	9,442	7,927
20	7,469	7,881	8,034	9,161	7,519
21	7,157	7,565	7,761	8,888	7,137
22	6,866	7,288	7,511	8,623	6,783
23	6,596	7,055	7,285	8,367	6,461
24	6,350	6,871	7,085	8,118	6,174
25	6,131	6,739	6,911	7,876	5,923
26		6,663	6,762	7,641	5,714
27		6,648	6,641	7,414	5,547
28		6,648	6,548	7,193	5,427
29		6,648	6,483	6,979	5,355
30+		6,648	6,448	6,771	5,336

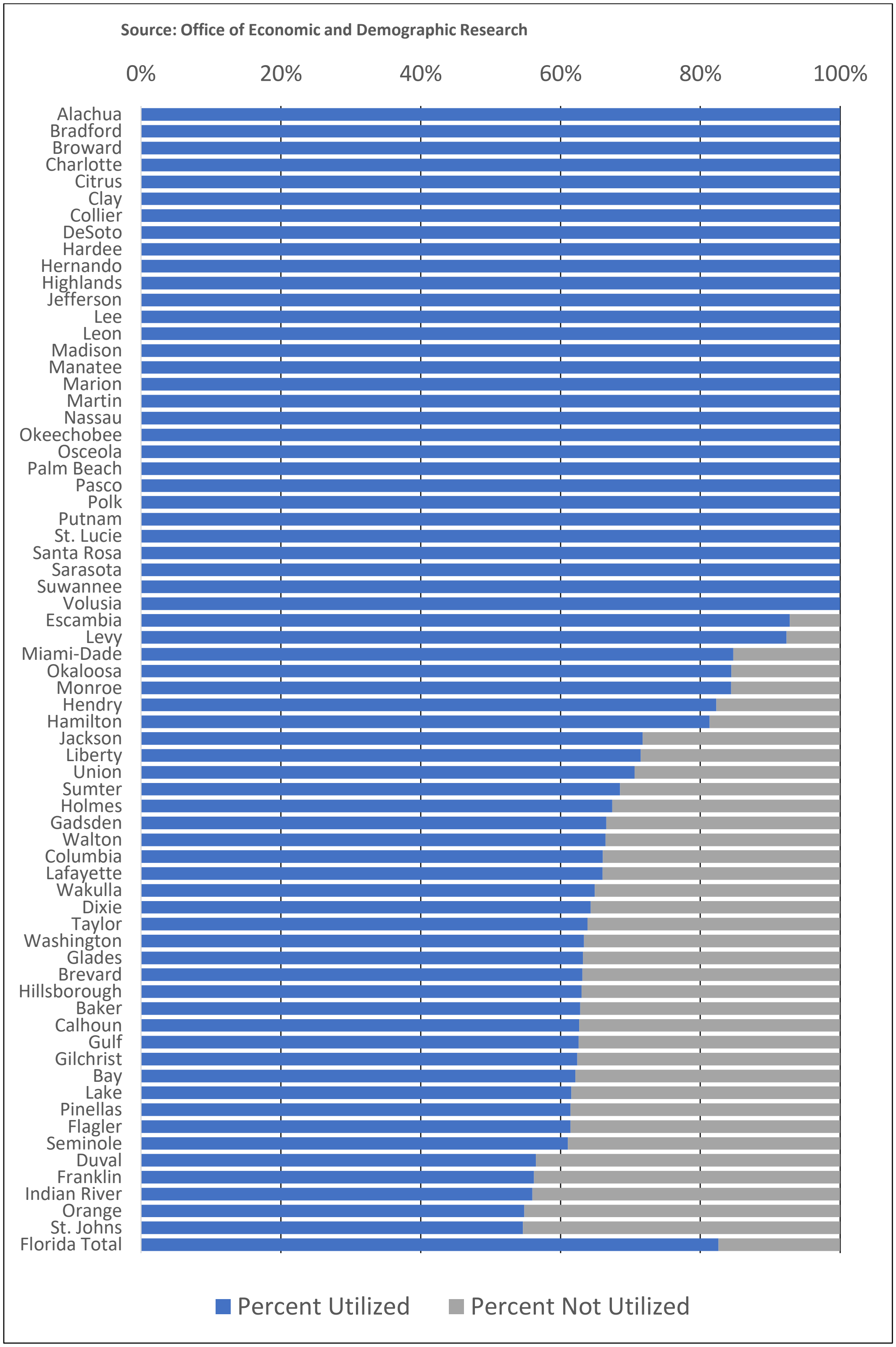
Source: U.S. Department of Transportation [24]

Table C-3. Utility Factors by Model Year

PHEV Sales and Utility Factor 2014				
	2014 Volume	**Utility Factor**		**Weighted Factor**
Toyota Prius	13,264	0.29		*3,847*
Chevrolet Volt	18,805	0.66		*12,411*
Cadillac ELR	1,310	0.65		*852*
Ford C-Max	8,433	0.45		*3,795*
Ford Fusion	11,550	0.45		*5,198*
Honda Accord	449	0.33		*148*
Subtotal	**53,811**	**0.49**	**Average**	***26,250***
Other	2,308			
Total	56,119			
PHEV Sales and Utility Factor 2017				
	2017 Volume	**Utility Factor**		**Weighted Factor**
BMW 330e	4,141	0.36		*1,491*
BMW 740e	707	0.36		*255*
BMW I8	488	0.37		*181*
BMW X5	5,349	0.35		*1,872*
Chrysler Pacifica	4,597	0.62		*2,850*
Ford C-Max	8,140	0.46		*3,744*
Ford Fusion	9,632	0.48		*4,623*
Cadillac CT6	207	0.59		*122*
Chevrolet Volt	20,349	0.76		*15,465*
Hyundai Sonata	2,535	0.56		*1,420*
Kia Optima	1,512	0.57		*862*
Mercedes C350e	817	0.30		*245*
Mercedes GLE 550	463	0.31		*144*
Mercedes S 550e	666	0.35		*233*
Toyota Prius Prime	20,936	0.53		*11,096*
Volvo XC90	2,196	0.35		*769*
Audi A3e	2,877	0.39		*1,122*
Porsche Cayenne S	1,574	0.37		*582*
Subtotal	**87,186**	**0.54**	**Average**	***47,076***
All Other (9 models)	6,676			
Total	**93,862**			

Source: Calculations from Task 7 Technical Report

Appendix D Local Motor Fuel Taxes by County



Source: The Florida Legislature [20] and CUTR Estimated Percent Utilized at September 30, 2019