Report of the Tennessee Advisory Commission on Intergovernmental Relations

Electric Vehicles and Other Issues Affecting Road and Highway Funding in Tennessee

Bob Moreo, MArch
Research Manager

❖

David Lewis, MA
Research Director

❖

Teresa Gibson
Web Development & Publications Manager

December 2022

Recommended citation:

Tennessee Advisory Commission on Intergovernmental Relations. 2022. *Electric Vehicles and Other Issues Affecting Road and Highway Funding in Tennessee.*

Tennessee Advisory Commission on Intergovernmental Relations. This document was produced as an Internet publication.

Contents

Summary and Recommendations: Electric Vehicles and Other Issues Affecting Road and Highway Funding in Tennessee 1

How Tennessee Funds its Roads 2

Although the number of electric vehicles is expected to increase, increased fuel efficiency and inflation will have greater effects on the state's gas tax. 2

Additional or Alternative Sources of Revenue for Road Funding 6

Analysis: Electric Vehicles and Other Issues Affecting Road and Highway Funding in Tennessee 9

Tennessee's System of Highways, Roads, and Bridges 10

How Tennessee Funds its Roads 11

Electric vehicles will affect road funding as their numbers increase. 20

Several factors could affect future adoption of EVs. 24

Improvements in fuel efficiency and inflation will have a greater effect on road funding than EV adoption. 33

Other states' approaches to maintaining or enhancing road funding. 38

Evolving Issues for Other Battery-Electric Vehicles and Equipment 46

References 49

Persons Contacted 55

Summary and Recommendations: Electric Vehicles and Other Issues Affecting Road and Highway Funding in Tennessee

Since 1923, Tennessee has taxed sales of gasoline to help pay for highway construction and maintenance, and a portion of the revenue from this tax has been shared with local governments since 1929. Fuel taxes have become the primary source of road funding for the state and local governments. The principle behind a fuel tax is straightforward—the more a person drives, the more that person contributes towards the upkeep and construction of the roads they use, and until recently the amount of fuel consumed has been a way to approximate how much a person drove.

However, electric vehicles (EVs) have become a fast-growing segment of the automobile market, and fully electric vehicles don't use gas or diesel, and therefore, pay no gasoline tax. Representatives of the automobile industry say they are moving toward a predominantly electric future. While owners of these vehicles in Tennessee do pay additional fees to the state for registering their vehicles each year, revenue from these fees is not shared with local governments, unlike revenue from gas or diesel taxes. Given that the adoption of EVs is expected to increase in coming years, Commission members at their January 2021 meeting expressed concerns about the effect EVs might have on state and local road funding and directed staff to

1. study fuel taxes and the current intergovernmental funding structure for road construction and maintenance;
2. investigate road maintenance and construction costs, fuel efficiency, and electric vehicles in Tennessee and their effects on that funding; and
3. examine potential alternative means of financing transportation infrastructure to offset lost revenues without discouraging electric vehicle expansion.

Members also noted that increased adoption of EVs has brought with it demands from residents for more EV charging infrastructure. To that end, the Tennessee Department of Environment and Conservation (TDEC) and the Tennessee Valley Authority (TVA) are partnering to develop a statewide EV fast charging network to power the growth of EVs across Tennessee and reduce barriers to transportation electrification, agreeing to collaborate and fund a network of fast charging stations every 50 miles along Tennessee's interstates and major highways. Six major US utilities, including TVA, have also come together to form the Electric Highway Coalition, coordinating the expansion of charging stations throughout 16 states—including Tennessee—from the Atlantic Coast to the Gulf and

Central Plains regions. As the charging infrastructure evolves, the demand for EVs is projected to increase.

Additionally, members asked staff to investigate the effect increased EV adoption will have on total electricity consumption and on TVA payments in lieu of taxes (PILOTs). Staff found that vehicle charging will remain a small percentage of total electricity consumption, with only a small effect on TVA PILOTs.

How Tennessee Funds its Roads

To build and maintain the state's network of roughly 96,000 miles of public roads and 20,000 bridges, the Tennessee Department of Transportation (TDOT) and local governments rely on federal (approximately 34% of total road funding), state (approximately 54%), and local (approximately 12%) sources of revenue. Use of federal funding is restricted to the highways that are part of the federal-aid system, which account for approximately 20% of the road mileage in Tennessee, leaving much of the fiscal responsibility for road construction and maintenance to Tennessee's state and local governments. The 54% of total revenue for roads that comes from state sources includes

- the state's 27-cents-per-gallon tax on gasoline and 28-cents-per-gallon tax on motor fuels (36% of total road funding), some of which is distributed to counties and cities;
- vehicle registration and other fees (15% of total road funding), which are not shared with local governments—revenue from registration fees goes entirely into the state highway fund; and
- other sources (3% of total road funding).

Tennessee was one of just six states at the end of 2020 with zero debt obligations from bonds to finance new highway construction and hasn't typically allocated general funds for highway purposes—although the General Assembly did so in fiscal years 2021-22 and 2022-23, totaling $826.5 million. Most states do allocate general fund revenue for highway purposes; 37 did so in 2020.

Although the number of electric vehicles is expected to increase, increased fuel efficiency and inflation will have greater effects on the state's gas tax.

In Tennessee, less than 0.2% of light-duty vehicles registered in 2019 were electric—either fully electric or plug-in hybrid (PHEVs)—but the number of EVs registered in the state is growing. From September 2019 to September 2022, the number of EVs registered in Tennessee increased from approximately 8,800 to just under 25,000—a compound annual growth rate of 41%. Using vehicle registration data from September 2019

through September 2022, TACIR staff project approximately 186,000 EVs will be registered in Tennessee in 2030 and approximately 629,000 in 2040. However, these projections reflect that Tennessee has always had a below-average rate of EV ownership. To reach the goal set by the Drive Electric Tennessee coalition of 200,000 registered EVs in 2028, Tennesseans will need to increase their adoption of new EVs. If sales of EVs in Tennessee were to increase and match industry forecasts that project that 50% of new vehicles sold in the US in 2040 will be electric, there could be 1.2 million EVs registered in Tennessee in 2040.

Although the IMPROVE Act of 2017 imposed an additional $100 registration fee for electric vehicles—which is intended to offset the loss in fuel tax revenue—it is less than the $153 the average driver of a gas-powered vehicle pays annually in state fuel taxes. The fee does not apply to PHEVs. Unlike the gas tax, revenue from the additional EV registration fee is not shared with local governments, and no revenue is collected from owners of EVs registered in other states. When the General Assembly enacted Public Chapter 1143, Acts of 2022, it waived the state's regular vehicle registration fees for one year, although the additional registration fee for EVs was not waived.

In 2022, the net loss in state road funding attributable to EVs was approximately $1.7 million; this includes forgone gas tax revenue, offset by EV registration fees. Using historic trends, TACIR staff projects the net loss will continue and grow, reaching $10 million in 2030 and $27 million in 2040. Using forecasts for increased EV adoption, staff projects those losses increase to $16 million in 2030 and $52 million in 2040. See table 1, which also shows how forgone gas-tax revenue—and offsetting that revenue with registration fees—affects each level of government in Tennessee.

Table 1. Estimates of Forgone Revenue Attributed to EVs Replacing Gas-fueled Vehicles

Year	Number of EVs		Forgone gas tax revenue*	Revenue from EV registration fees	Net total forgone revenue^	Forgone revenue by level of government: State Highway Fund	County Aid Funds	Municipal Streets Funds
2022	16,774	BEV	($2,632,915)	$1,677,400	($955,515)			
	8,006	PHEV	(754,590)		(754,590)			
					($1,710,105)	($419,752)	($828,497)	($414,792)
			Share of forgone revenue if EV registration fee shared with local governments:			($1,059,073)	($402,469)	($201,499)
Projections based on vehicle registration data								
2030	129,960	BEV	($18,014,133)	$12,996,028	($5,018,105)			
	56,153	PHEV	(4,673,778)		(4,673,778)			
					($9,691,883)	($1,049,705)	($5,548,881)	($2,778,081)
			Share of forgone revenue if EV registration fee shared with local governments:			($6,002,988)	($2,248,136)	($1,125,543)
2040	439,897	BEV	($56,538,970)	$43,989,701	($12,549,269)			
	188,830	PHEV	(14,573,468)		(14,573,468)			
					($27,122,737)	($34,905)	($17,392,278)	($8,707,550)
			Share of forgone revenue if EV registration fee shared with local governments:			($16,801,061)	($6,219,727)	($3,113,945)
Projections based on increased EV adoption								
2030	214,110	BEV	($29,591,685)	$21,410,961	($8,180,724)			
	92,376	PHEV	(7,666,301)		(7,666,301)			
					($15,847,026)	($1,654,880)	($9,112,347)	($4,562,153)
			Share of forgone revenue if EV registration fee shared with local governments:			($9,815,415)	($3,674,369)	($1,839,595)
2040	845,868	BEV	($108,472,906)	$84,586,768	($23,886,138)			
	362,951	PHEV	(27,948,754)		(27,948,754)			
					($51,834,891)	$130,237	($33,365,238)	($16,704,511)
			Share of forgone revenue if EV registration fee shared with local governments:			($32,109,013)	($11,881,802)	($5,948,697)

Note: BEV are battery electric vehicles (fully electric). PHEV are plug-in hybrid electric vehicles.

* Includes 26¢/gallon gasoline taxes imposed by Tennessee Code Annotated, Section 67-3-201, and 1¢/gallon special privilege tax imposed by Tennessee Code Annotated, Section 67-3-203.

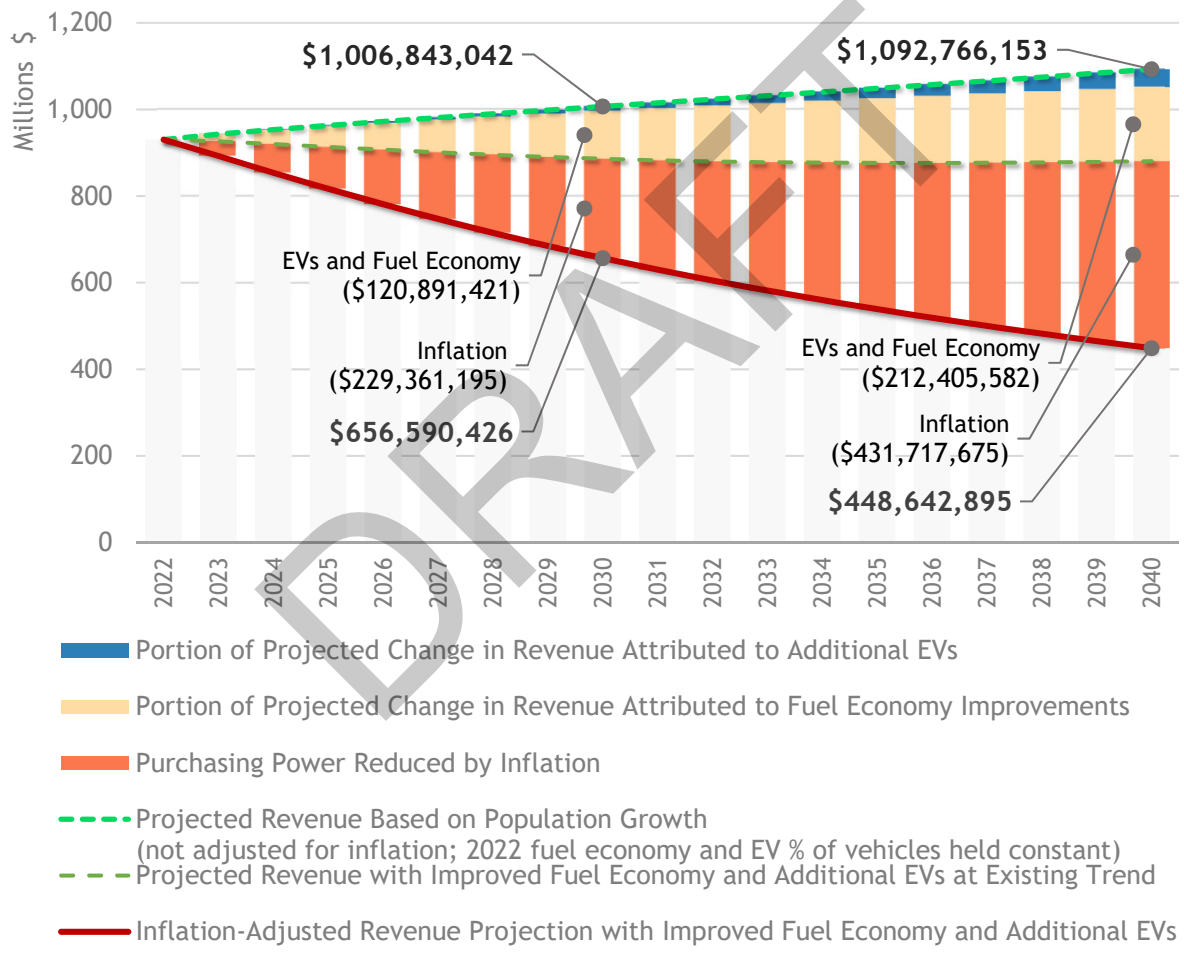
^ State, county, and municipal amounts do not add up to net total, which also includes some revenue (approximately 1.5%) that would be allocated for other, non-highway purposes.

Until EVs surpass gas- and diesel-fueled vehicles as the predominant type of vehicle on the roads, increases in fuel efficiency will have a greater effect on the state's road funding than EVs will. The average fuel economy for all light-duty vehicles in the US was 23.6 miles per gallon (mpg) in 2021. However, overall average efficiency is projected to increase to 27 mpg by 2030 and 29 mpg overall by 2040. With EV projections based on historic trends, 92% of Tennessee vehicles will still be fueled by gasoline in 2030,

and their increased fuel economy will be responsible for a $110 million decrease in revenue. In 2040, 85% of vehicles are projected to remain gas-powered, and the decrease in revenue from increased fuel efficiency would be $171 million.

Combined, the effects of increased fuel economy and the projected replacement of gas-powered vehicles with EVs could decrease revenue by $121 million in 2030 and by $212 million in 2040 (see figure 1). Using forecasts for increased EV adoption that exceed the state's historic trend would result in decreases of $130 million in 2030 and $240 million in 2040.

Figure 1. Select Factors Affecting Tennessee's State Gas Tax Revenue Projections through 2040 Based on Historic EV Registrations



Source: TACIR staff projections based on state population projections (Tennessee State Data Center), vehicle registration data (TN Department of Revenue), vehicle miles traveled (FHWA Highway Statistics), fuel economy projections (US Energy Information Administration), and inflation (National Highway Construction Cost Index).

Beyond this potential for reduced gas tax revenue, inflation significantly decreases the purchasing power of revenue collected. Tennessee's gasoline and motor fuel taxes are flat amounts based on volume sold, not price. This means that gasoline and motor fuel tax revenue will not necessarily keep up with inflation when prices increase. Furthermore, road construction costs (3.8% compound annual growth rate) have risen faster than overall inflation (2.5% compound annual growth rate) in the past decade. If construction costs continue to increase at that rate, they would increase 35% by 2030 and 96% by 2040. Based on current trends, inflation—rather than EV adoption or increases in fuel economy—is going to be the most significant factor affecting future funding for the state's roadways, as the buying power of the state's fuel taxes is diminished (see figure 1). It has the potential to reduce the purchasing power of revenue collected by an additional $229 million in 2030 and $432 million in 2040. Combining the projected effects of EV adoption, fuel economy, and inflation could lead to a net loss of $350 million in 2030, compared to projections that account only for population growth. In 2040 the gap would be $644 million. Factoring in the possibility of increased EV adoption raises those figures only slightly, to $357 million and $658 million.

Additional or Alternative Sources of Revenue for Road Funding

Other states have adopted or are in the process of testing other strategies for funding their roads. Examples include but are not necessarily limited to adopting fuel taxes that adjust automatically based on factors such as inflation, adopting higher registration fees, applying EV fees to plug-in hybrid vehicles, and testing vehicle-miles traveled taxes (VMT) as a replacement for fuel taxes. The Commission has identified considerations that would need to be taken into account before adopting any of these strategies.

Twenty-two states have variable fuel taxes that adjust automatically without a need for new legislation. In general, these states index their tax rate to inflation, average fuel economy, or both. If Tennessee were to do this, it could result in automatic tax increases in years when the General Assembly might otherwise choose to maintain existing rates. The General Assembly is already alerted to the effects of inflation on other important state programs—for example, each year the Tennessee Consolidated Retirement System informs the General Assembly of the effect of inflation on retirement benefits and cost of living adjustments.

Some states, including Tennessee, also rely on vehicle registration fees to fund their roads. Tennessee ranks near the bottom of all states in revenue per capita ($55.63) from "motor vehicle and carrier taxes" (i.e. fees). The national average is approximately $97. Tennessee charges the same flat registration fee for all light-duty, personal vehicles. Several states charge

higher registration fees for heavier vehicles, but there are tradeoffs to relying more on registration fees. While basic registration fees are indifferent to whether a vehicle is powered by gasoline or electricity, they are not exportable to drivers of vehicles registered in other states and not proportionate to road use like a fuel tax. Registration fees are usually paid in one annual payment instead of a few dollars each time a driver buys gas, which could make higher fees more difficult for some Tennesseans to pay. As discussed above, no registration fees in Tennessee are shared with local governments, so shifting more of the state's road funding framework to rely on registration fees would not benefit local road funding unless the revenue is shared in a manner like the gas tax.

Tennessee's additional EV registration fee applies only to fully electric vehicles (battery electric vehicles, or BEVs), but 17 states with EV fees also apply them to plug-in hybrid electric vehicles (PHEVs), usually at a reduced amount. On average, PHEVs have an estimated fuel economy of 60 mpg, meaning driving 13,574 miles uses 226 gallons of gas and generates approximately $61 in gas tax revenue.

Many researchers suggest taxing vehicles on a per-mile basis regardless of whether the vehicle is electric or gas-powered. Several states are testing pilot programs which use new technology and systems required to implement a vehicle-miles traveled tax, although none has fully replaced its fuel tax with a VMT tax. Some states are discussing forming regional consortia to administer interstate VMT agreements, and some officials have mentioned the possibility of a federal VMT framework. There are two basic methods of implementing a VMT system: a self-reporting approach in which the driver reports the number of miles traveled in a given year or a tracking approach in which tracking technology keeps track of how far a car is driven in a given year. Residents may have privacy concerns about their vehicles being tracked for the purposes of a VMT tax and such concerns may be a significant barrier to implementing such an approach.

Recently, TDOT and the Governor's Office have publicly stated that the state might also consider entering into public private partnerships, implementing toll express lanes—though not toll roads—and increasing the EV registration fee to $300.

While growing adoption of EVs might not become a major issue for road funding in Tennessee for decades, it along with changes in fuel economy, increases in inflation, and decisions about the distribution of new registration fees point to the need for modifications to Tennessee's road funding system. Moreover, automakers are investing heavily in EV manufacturing facilities across Tennessee. **Recognizing this, the Commission makes the following recommendations:**

1. **Because the practical effect of the state's EV registration fee is to serve as a substitute for the gas tax by collecting revenue**

for road funding from vehicle owners who don't purchase gasoline—and therefore don't contribute to road funding through the gas tax—the Commission recommends the state

a. increase the EV registration fee to better offset the revenue lost from state fuel taxes that those vehicle owners do not pay,

b. share revenue from EV registration fees with local governments in the same proportion as the gas tax, and

c. apply a reduced EV registration fee to plug-in-hybrid vehicles and share this revenue with local governments in the same proportion as the gas tax.

2. Given the effect of inflation on the purchasing power of gas tax revenue, and to assist lawmakers in evaluating whether to adjust the state's fuel tax rates, the Commission recommends the Department of Revenue or another entity such as the State Funding Board inform the General Assembly of the effect of inflation on the purchasing power of the state's fuel taxes at least once every two years.

3. As the state confronts the tradeoffs associated with any potential alternatives to its current fuel-tax-based road funding framework, the Commission recommends the state

a. balance the ability to raise adequate revenue with equity for all drivers regardless of whether their vehicles are powered by gas, electricity, or some other method;

b. ensure that revenue from any adopted alternatives is shared with local governments in an equivalent manner to the current sharing of fuel taxes; and

c. ensure any alternatives intended to offset lost revenues are designed to do so without discouraging customers from purchasing electric vehicles.

Analysis: Electric Vehicles and Other Issues Affecting Road and Highway Funding in Tennessee

At the Commission's January 2021 meeting, several members raised concerns that the increased adoption of electric vehicles (EVs) as replacements for gas- or diesel-powered vehicles would reduce state-shared tax revenue—specifically from state fuel taxes—that the state and local governments use to build and maintain roads. Members also noted growing demand from residents for more EV charging infrastructure. Members directed staff to

1. study fuel taxes and the current intergovernmental funding structure for road construction and maintenance;
2. investigate road maintenance and construction costs, fuel efficiency, and electric vehicles in Tennessee and their effects on that funding; and
3. examine potential alternative means of financing transportation infrastructure to offset lost revenues without discouraging electric vehicle expansion.

Additionally, members asked staff to investigate the effect increased EV adoption will have on total electricity consumption and on the Tennessee Valley Authority's (TVA) payments in lieu of taxes (PILOTs). In 2021, electric vehicles in the US accounted for just 0.2% of all electricity used.[1] Vehicle charging will remain a small percentage of total electricity consumption, with only a small effect on TVA PILOTs.

In November 2020, TVA adopted new policies intended to remove barriers to the expansion of EV charging stations and set a target for 200,000 EVs in the region by 2028. This was a significant increase from approximately 14,000 EVs at the time.[2] TACIR staff estimate that, if there were currently 200,000 battery-powered EVs in the TVA region, the electricity needed to charge them would only represent 0.6% of TVA's total annual power sales. TVA's *2019 Integrated Resource Plan* forecasted average annual systemwide demand growth of just 0.1% while the number of EVs in the region grows to a projected 750,000 in 2038, and the agency plans to build the grid adequately to handle them.[3]

Because the amount of electricity used to charge EVs will remain a small portion of total consumption compared to other residential, commercial, and industrial uses, even as EVs become more common, their effect on TVA power sales and therefore TVA's PILOT will be minimal. Using TVA's goal

[1] International Energy Agency 2022.
[2] Flessner 2020.
[3] Tennessee Valley Authority 2019.

of 200,000 EVs in the region, TACIR staff estimates the electricity needed to power an additional 186,000 EVs could add approximately $2.8 million to TVA's total PILOT, assuming all other electricity use remains the same. Tennessee could see $1.9 million of that increase, with approximately $650,000 going to counties and $280,000 to cities.

Tennessee's System of Highways, Roads, and Bridges

Responsibility for construction and maintenance rests with both the state and local governments, and Tennessee's road system is generally considered to be in good condition. There are about 96,000 miles of public roads in Tennessee:

- The Tennessee Department of Transportation (TDOT) owns and maintains about 14,000 miles of roads (15% of the state's total), which includes 41% of the state's 20,377 bridges. Just a small portion—5,100 miles or 5% of the state's total—of these state-managed roads carry 55% of the state's annual traffic.
- There are about 58,000 miles of roads under county ownership (60%), mostly small with comparatively little traffic—although counties are responsible for 47% of all bridges.
- The remaining 23,000 miles (24%) of roads and 12% of bridges fall under city ownership.[4]

According to analysis of FHWA data by TRIP, a nonprofit organization that researches, evaluates, and distributes economic and technical data on surface transportation issues, "Nationwide, 40% of major roads are in poor or mediocre condition." Tennessee ranked best among all states with just 14%.[5] This ranking helped put the state at the top of WalletHub's 2022 list of best states for vehicle ownership and maintenance costs.[6] Tennessee's highway system ranks 10th in the nation in overall cost-effectiveness and condition, according to the Reason Foundation.[7]

Tennessee also ranks among the states with the smallest percentage of bridges rated as in poor condition and has a low share of bridges more than 50 years old. Sixty-three percent of the 880 bridges rated as poor-in Tennessee are owned by counties and cities. Using 2020 estimates, it could cost more than $200 million to replace these 554 local bridges.[8] As part of the federal Bipartisan Infrastructure Law passed in 2022, Tennessee is set to receive $302 million for bridge replacements, with incentives "to direct

[4] Federal Highway Administration (FHWA) "Highway Statistics 2020," Tables HM-10, HM-50, HM-60, and VM-2. Another 1,200 miles are owned by federal agencies. For bridge data, see FHWA "Bridge Condition by Owner 2022."
[5] TRIP 2022.
[6] Flessner 2022.
[7] Reason Foundation 2021.
[8] FHWA "Bridge Condition by Owner 2022."

the new Bridge Formula Program funds to off-system bridges owned by a county, city, town or other local agency."[9]

Governments in Tennessee report increasing needs for transportation projects. TACIR is charged with developing and maintaining an inventory of public infrastructure needs (PINI), and each year the category with the greatest estimated cost of needed improvements is transportation. The Commission's 2022 report noted that "of the $3.4 billion increase in infrastructure needs reported in this year's inventory, just over $2.0 billion (60.2%) is attributable to increases in the estimated cost for Transportation and Utilities." And as "infrastructure needs for Transportation and Utilities increased for the sixth year in a row," the report points to a $1.1 billion increase in the cost of new road projects and a $1.5 billion increase in the cost of road projects already in the inventory.[10] There were $34.1 billion in transportation project needs reported for the 2020-2025 inventory window—a 40.1% increase from the $24.4 billion reported for the 2016-2021 period.[11]

How Tennessee Funds its Roads

Road funding in Tennessee comes from federal, local, and state sources. Of these, federal revenue, which comes primarily from federal fuel taxes, accounted for approximately 34% of the state's overall road funding in 2019. But use of this federal funding is restricted to the highways that are part of the federal-aid system, which account for approximately 20% of the road mileage in the state, leaving much of the fiscal responsibility for road construction and maintenance up to local governments and the state. Local revenue sources contributed approximately 12% of Tennessee's overall road funding, including both local general fund revenue and, in some cases, bond issues. State revenue sources accounted for approximately 54% of overall road funding in Tennessee. Almost all the state's own-source revenue for roads comes from state fuel taxes, vehicle registration fees, and, in the two most recent fiscal years, the state's general fund. Approximately 3% of total road funding in 2019 came from other state sources.[12]

[9] Raucoules 2022.
[10] Tennessee Advisory Commission on Intergovernmental Relations 2022.
[11] Tennessee Advisory Commission on Intergovernmental Relations "Data Explorer."
[12] FHWA "Highway Statistics." Tables HM-15 (2020), LGF-1 (2020 with data for 2019), and SF-1 (2019).

Tennessee State Taxes on Fuel and Their Distribution[13]

Since 1923, Tennessee has taxed sales of gasoline to help pay for highway construction and maintenance, and a portion of the revenue from this tax has been shared with local governments since 1929. One of the strengths of Tennessee's existing road funding framework has been that fuel taxes have historically collected revenue from road users in rough proportion to their road use, including revenue generated from fuel purchased by out-of-state drivers who use Tennessee's roads. Approximately 40% of the revenue used by the state for roads comes from the state's own fuel taxes.[14] In 1989, Tennessee raised its gas tax by four cents to a total of 21 cents per gallon, and it was not increased again until July 1, 2017,[15] following passage of the Improving Manufacturing, Public Roads and Opportunities for a Vibrant Economy (IMPROVE) Act of 2017, which raised the gas tax to 27 cents over the course of three years.[16] Despite these recent increases, Tennessee's gas tax is below the average among all states (31.0 cents), and 27 states have higher tax rates on gasoline. See figure 2.

In fiscal year 2021-22, Tennessee collected $877.6 million from its gasoline tax and $325.2 million from the tax on motor fuel.[17] Although the state's per-gallon tax rates are below average, Tennessee's fuel tax receipts were above average on a per-capita basis in 2020, because the state has higher-than-average fuel sales on a gallons-per-capita basis. See maps 1, 2, and 3.

[13] Note: Tennessee Code Annotated, Section 67-3-401, exempts government agencies from paying fuel taxes if the agency holds an active exemption permit with the Department of Revenue. See permit form at https://www.tn.gov/content/dam/tn/revenue/documents/forms/motorfuels/f1403001.pdf.

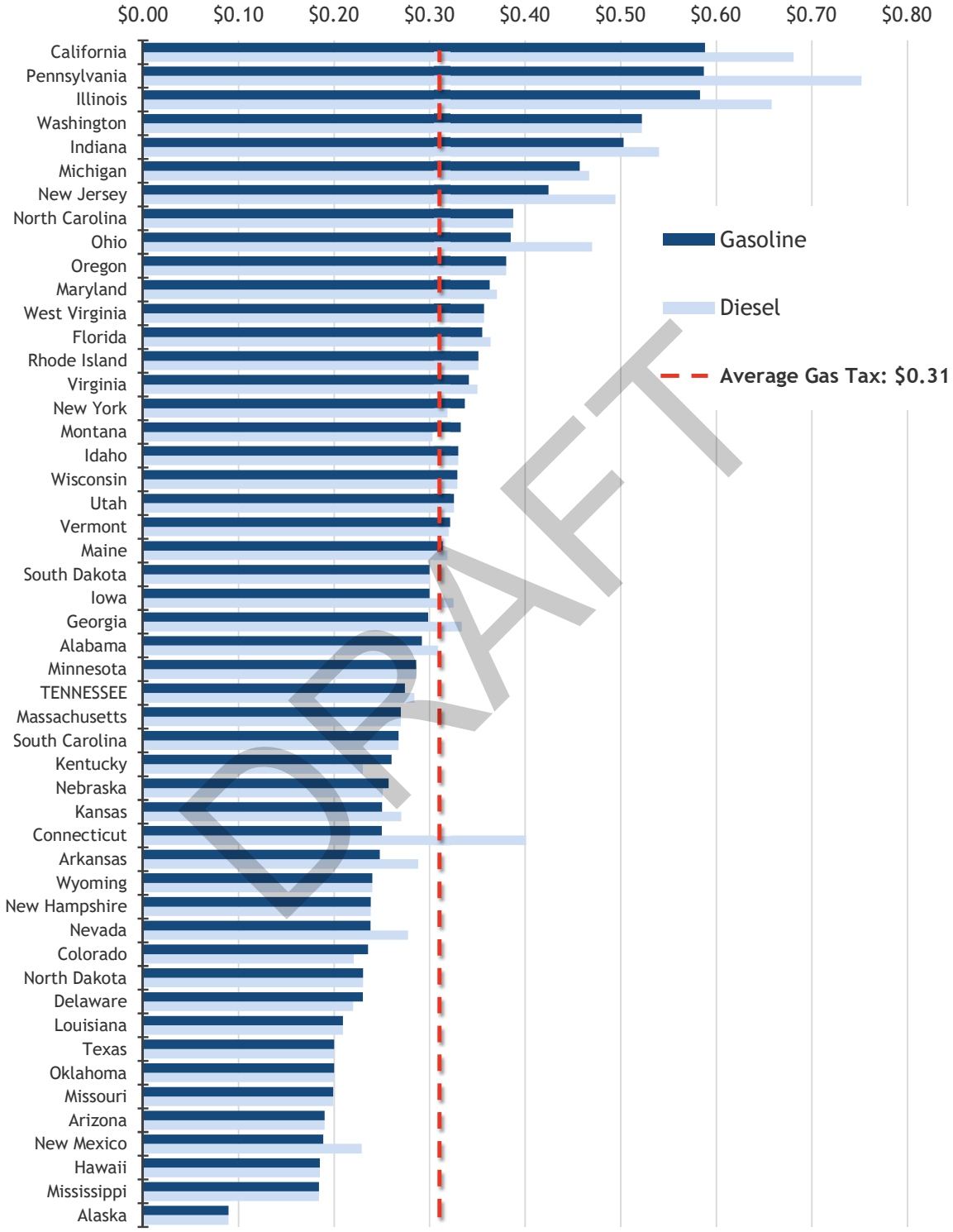
[14] FHWA "Highway Statistics" Table SF-1. Average of last three years (2018-2020).

[15] Public Chapters 46 and 241, Acts of 1989. See Tennessee Department of Transportation "Gas Tax History." Rates shown throughout this report include the one-cent Special Privilege Tax on all petroleum products imposed under Tennessee Code Annotated, Section 67-3-203.

[16] Public Chapter 181, Acts of 2017. See https://www.tn.gov/revenue/tax-resources/legal-resources/improve-act.html for a summary of the act's provisions.

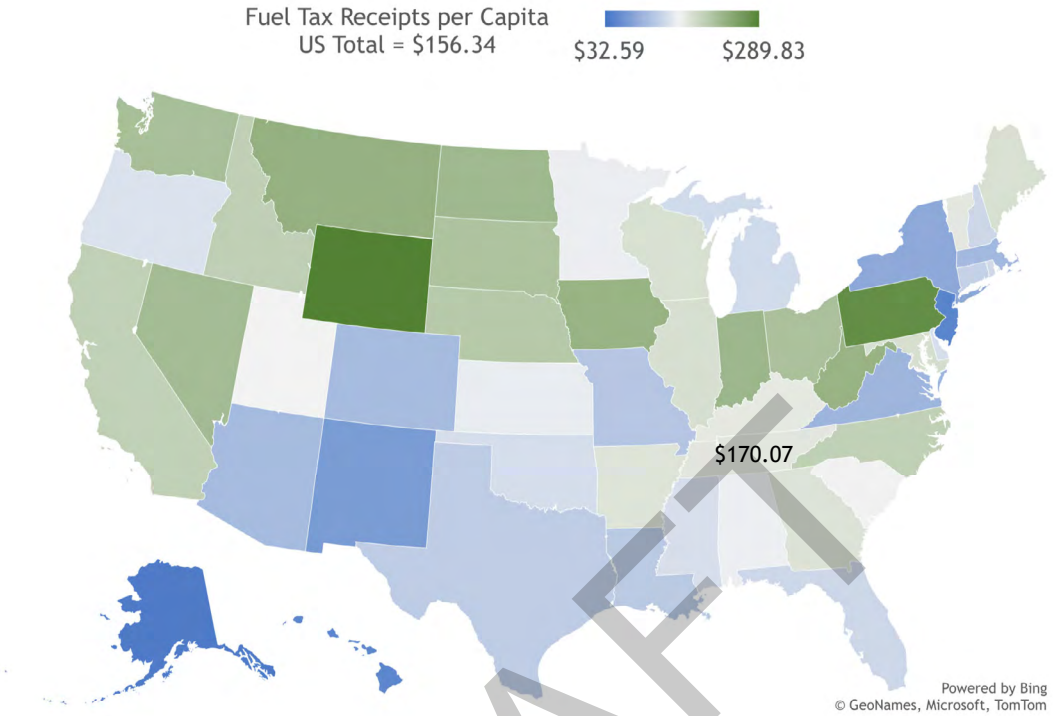
[17] Tennessee Department of Revenue.

Figure 2. State Fuel Tax Rates, January 2022



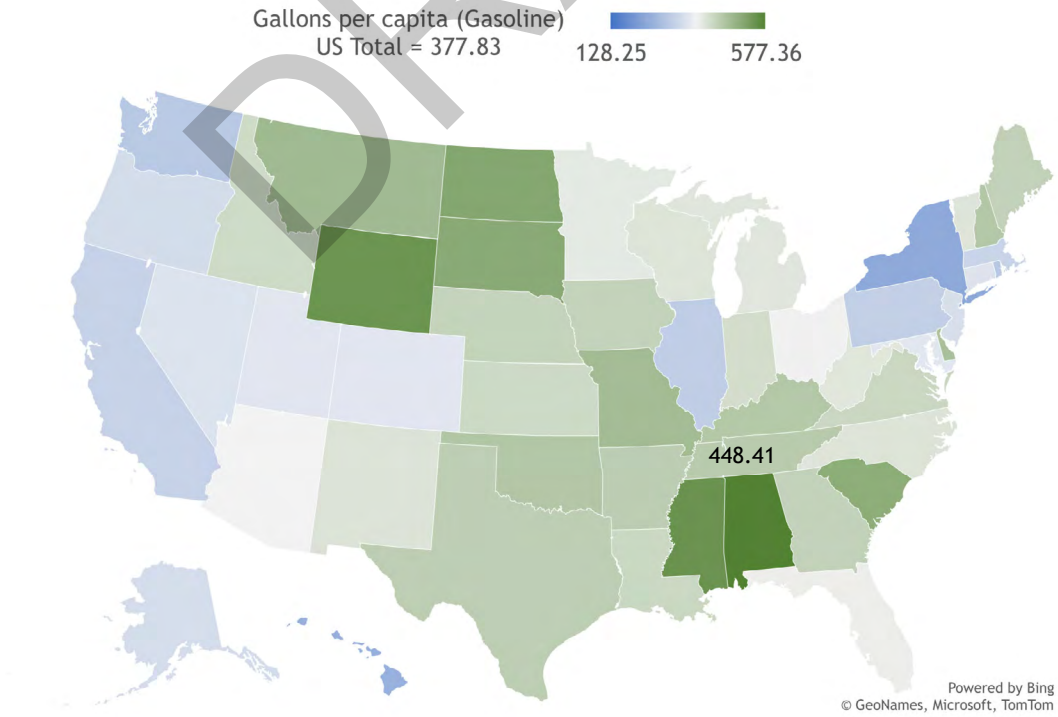
Source: US Energy Information Administration 2022b.

Map 1. State Fuel Tax Receipts per capita, 2020



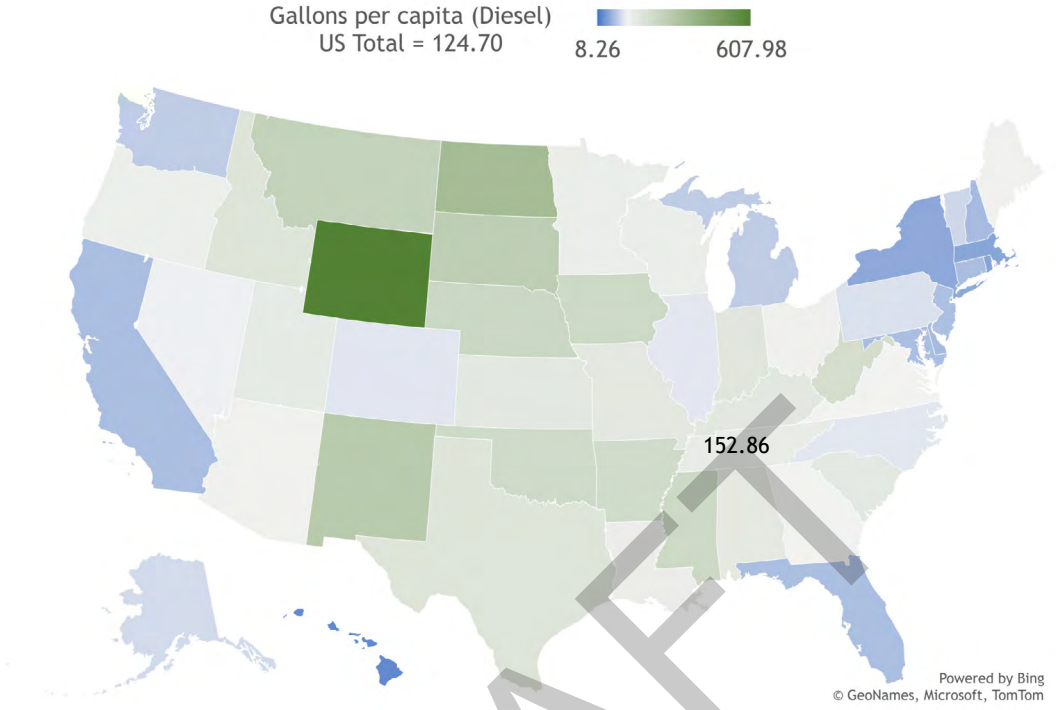
Source: FHWA. Table MF-1 (2020) Gross Tax Collections divided by Census 2020 state populations.

Map 2. Gallons of Gasoline Taxed per capita, 2020



Source: FHWA. Table MF-2 (2020) Net Volume Taxed divided by Census 2020 state populations.

Map 3. Gallons of Diesel Taxed per capita, 2020



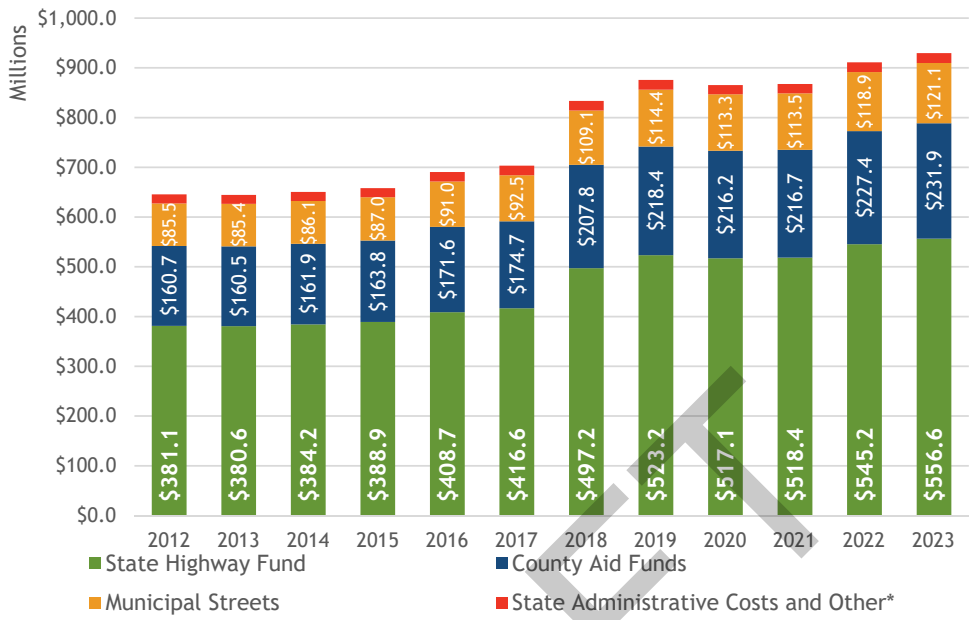
Source: FHWA. Table MF-2 (2020) Net Volume Taxed divided by Census 2020 state populations.

Some of the revenue from the gas tax is retained by the state, the rest is distributed to local governments. The state collects 27.4 cents in taxes for each gallon of gasoline sold, including a 0.4-cent portion allocated for the state's Petroleum Underground Storage Tank Fund.[18] The remaining 27 cents is the sum of decades of individual statutory taxes, and the revenue from each of these is allocated differently.[19] Overall, the combined receipts from Tennessee's gasoline tax (36% of total road funding) are distributed as shown in figure 3. Approximately 60% goes to the State Highway Fund, 25% to counties, and 13% to municipalities, with the remainder set aside for administrative costs and minor earmarks for mass transit, wildlife resources, and government training.[20]

State-shared fuel tax revenue accounts for just 55% of local governments' total road funds. Many of Tennessee's local governments supplement this revenue with their own funds—adding $322 million in 2019 (44% of total funding for local roads).[21] See figure 4.

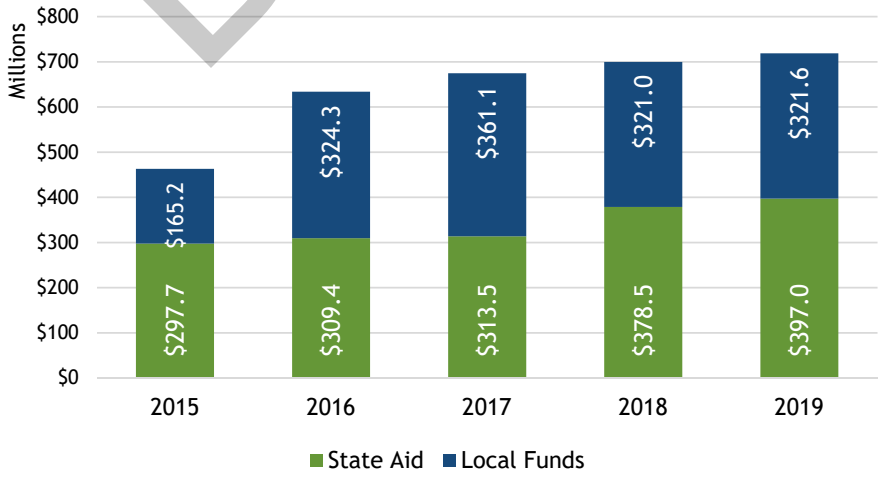
[18] Tennessee Code Annotated, Section 68-215-110.
[19] Tennessee Department of Transportation "Gas Tax History."
[20] TACIR calculations based on each subsection within Tennessee Code Annotated, Section 67-3-901, plus the Special Privilege Tax imposed under Section 67-3-203 as allocated under Section 67-3-906.
[21] FHWA "Highway Statistics." Table LGF-1.

Figure 3. Estimated Allocation of Revenue from Tennessee's Gasoline Tax
State Fiscal Years 2011-12 through 2022-23



Source: TACIR staff analysis of Tennessee Department of Revenue data. 2023 based on estimates.
* Includes statutory allocations for mass transit projects, wildlife resources, and the University of Tennessee Center for Government Training.

Figure 4. Revenue Sources Used by Local Governments for Roads
State Fiscal Years 2014-15 through 2018-19



Source: FHWA "Highway Statistics." Table LGF-1, 2015-2019.

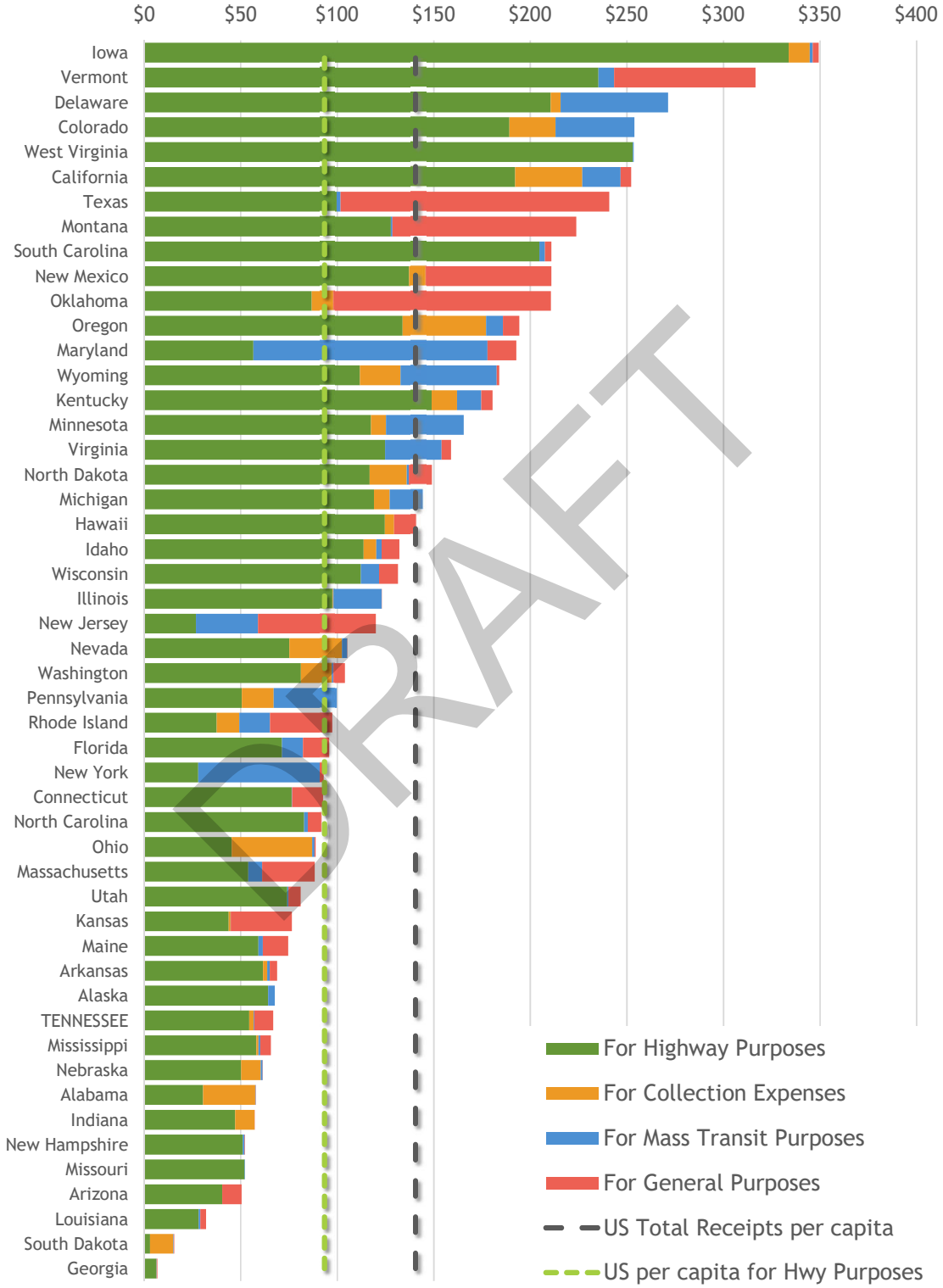
Unlike the state, local governments don't have any local revenue streams similar to the gas tax. Local governments can use general fund revenue to build and maintain their roads, including property taxes, sales taxes, and privilege taxes. Local governments sometimes issue bonds to finance road improvements.

Vehicle Registration Fees in Tennessee

Revenue from vehicle registration fees represents approximately 15% of Tennessee's total statewide highway funding.[22] The annual fee to register passenger vehicles in Tennessee is $23.75.[23] To help Tennessee's residents, Public Chapter 1143, Acts of 2022, waived the regular state registration fee for renewals occurring after July 1, 2022 and before June 30, 2023. However, the additional electric vehicle registration fee was not waived.[24] Fees for other types of vehicles, like those used for commercial transportation or to carry freight, can be as much as $1,352.50.[25] Unlike Tennessee's state fuel taxes, the revenue from registration fees is not shared with local governments. The majority of the money collected from these fees is designated for the state highway fund.[26] In state fiscal year 2021-22, the state collected $370.3 million from all types of vehicle registration fees, permits, and fines.[27] On a per-capita basis, however, this revenue places Tennessee near the bottom when compared to other states. Tennessee ranks near the bottom of all states in revenue per capita ($55.63) from "motor vehicle and carrier taxes" (i.e. fees). The national average is approximately $97. See figure 5.

[22] FHWA "Highway Statistics" Table SF-1 (2019).
[23] Tennessee Code Annotated, Section 55-4-111.
[24] Public Chapter 1143, Acts of 2022, waived fees to renew the registrations of Class A (motorcycles; $16.75 fee) and Class B motor vehicles from July 1, 2022, to June 30, 2023. The Fiscal Review Committee estimated this would reduce highway funding by $110.6 million, but the General Assembly appropriated the transfer of an equal amount from the general fund (see Public Chapter 1130, Acts of 2022, Section 60, Item 30).
[25] Tennessee Code Annotated, Sections 55-4-112 and 113.
[26] Tennessee Code Annotated, Section 55-6-107.
[27] Tennessee Department of Revenue "Summary of Collections," July 2021-June 2022.

Figure 5. Revenue per capita from Vehicle Fees and Taxes
2020 Federal Reporting Year



Source: FHWA "Highway Statistics 2020" Table SDF; US Census Bureau 2020 state populations.

Because drivers of fully electric vehicles don't buy gasoline to fuel them, they don't pay the fuel taxes that provide revenue for road construction and maintenance. Tennessee is one of several states where owners of fully electric vehicles pay a fee to make up for their lack of fuel taxes. "Thirty states have laws requiring a special registration fee for plug-in electric vehicles. Of those, 14 states also assess a fee on plug-in hybrid vehicles." According to the National Conference of State Legislatures (NCSL), "proponents support the fees to bring equity among drivers by ensuring all drivers pay for using roadways."[28] The IMPROVE Act set Tennessee's EV registration fee at $100, paid annually in addition to the regular fee for all passenger vehicles—there is no fee for plug-in hybrid vehicles.[29] This amount is less than what the driver of an average gas-powered vehicle might pay in fuel during a year:

13,574 miles driven at 24 mpg = 566 gallons = $152.71 gas tax[30]

EV fees in other states range from $50 to $225, and the revenue is allocated in a variety of ways. Data from the Tennessee Department of Revenue show that EV-fee collections increased from $584,000 in fiscal year 2019-20 to $893,000 in 2020-21 and $1.4 million in 2021-22 and have generated about $3.6 million—compared to $4.2 billion from gasoline taxes—for the state highway fund since the fee's inception in fiscal year 2017-18. Unlike the gas tax, however, in Tennessee revenue from the EV fee is not shared with local governments, and no revenue is collected from drivers of EVs registered out of state. Had that money been shared with local governments in the same proportion as the state's gas tax, about $2.2 million would have remained in the state highway fund, $900,000 would have been distributed to counties, and $470,000 would have gone to cities.

Tennessee's $100 fee also does not account for EVs reducing the amount of federal gas taxes collected in Tennessee, which over time could reduce the amount of federal aid the state receives. An average driver in Tennessee pays $106 in federal gas taxes each year.

Tennessee doesn't typically allocate revenue from its general fund for roads, though most states do.

Tennessee prides itself on being a pay-as-you-go state—state government does not issue bonds for new highway construction. According to data reported by states to the federal government for 2020, Tennessee was

[28] National Conference of State Legislatures (NCSL) "Special Fees on Plug-In Hybrid and Electric Vehicles."
[29] Tennessee Code Annotated, Section 55-4-116. Tennessee's fee applies only to a vehicle "with an electric motor as its sole means of propulsion," which excludes plug-in hybrids.
[30] TACIR staff estimate of average miles traveled per light-duty vehicle in Tennessee 2017-2020; US Energy Information Administration average miles per gallon of all gas-fueled vehicles in 2021 (EIA 2022a).

one of just six states with zero debt obligations from highway bonds.[31] Tennessee doesn't typically allocate general funds for highway purposes—although the General Assembly did so with funds for fiscal years 2021-22 and 2022-23. In fiscal year 2021-22, the state transferred $200 million from the general fund for a new interchange for Ford's Blue Oval City site,[32] and in fiscal year 2022-23, the General Assembly appropriated $626 million for highway improvement projects across the state.[33] Most other states allocate general fund revenue for highway purposes; 37 states reported doing so in 2020—sometimes more than $1 billion and constituting up to 18% of their state road revenue.[34]

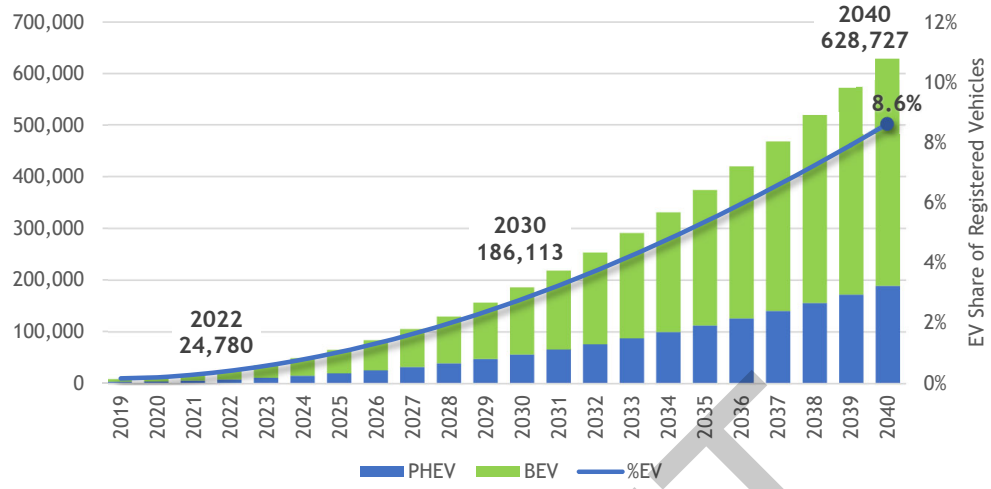
Electric vehicles will affect road funding as their numbers increase.

The way that cars and trucks are powered is changing—electric vehicles (EVs) have become a fast-growing segment of the market, and the automobile industry says it is moving towards a predominantly electric future. Fully electric vehicles, of course, don't use gas or diesel and, therefore, don't contribute to road funding through the state's fuel taxes. Plug-in hybrid electric vehicles (PHEVs), which combine an internal combustion engine with a rechargeable battery, average about 60 mpg and, as a result, use substantially less gasoline than a conventional vehicle.[35]

From September 2019 to September 2022, the number of EVs (both fully electric and PHEV) registered in Tennessee increased from 8,769 to 24,780—a compound annual growth rate of 41% as total registrations increased 1.4% annually—although EVs make up only 0.4% of the 6.1 million vehicles registered statewide.[36] Figure 6 shows how many EVs would be registered in Tennessee and the percentage of all vehicles registered in the state that will be electric if these three years of growth are projected through 2040.

[31] FHWA "Highway Statistics" Table SB-2 (2020). States may report on either a calendar or State fiscal year basis.
[32] Public Chapter 2, Second Extraordinary Session, 2021.
[33] Public Chapter 1130, Acts of 2022. "Proposed Highway Program for Fiscal Year 2022-2023."
[34] FHWA "Highway Statistics" Table SF-1 (2020). States may report on either a calendar or State fiscal year basis.
[35] TACIR staff estimate from sales-weighted average of PHEV tested by the US EPA for model years 2011-2019.
[36] TACIR staff analysis of vehicle registration data provided by the Tennessee Department of Revenue.

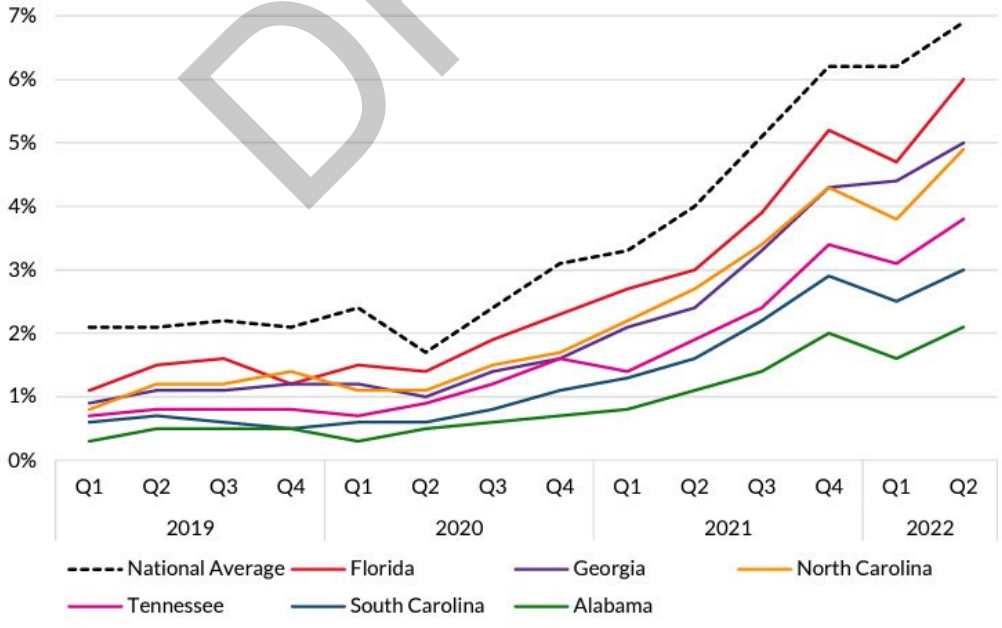
Figure 6. Projected Numbers of Electric Vehicles in Tennessee (based on historic registration data)



Source: TACIR staff projections of Tennessee Department of Revenue vehicle registration data.

However, these projections reflect the fact that Tennessee has always had a below-average rate of EV ownership, and it will take even faster growth to reach the Drive Electric Tennessee coalition's goal of 200,000 EVs in 2028. EVs' share of new light-duty vehicle sales in Tennessee in the second quarter of 2022 was roughly double what it was the year prior, though it still accounted for less than 4% of light-duty vehicle sales. See figure 7.

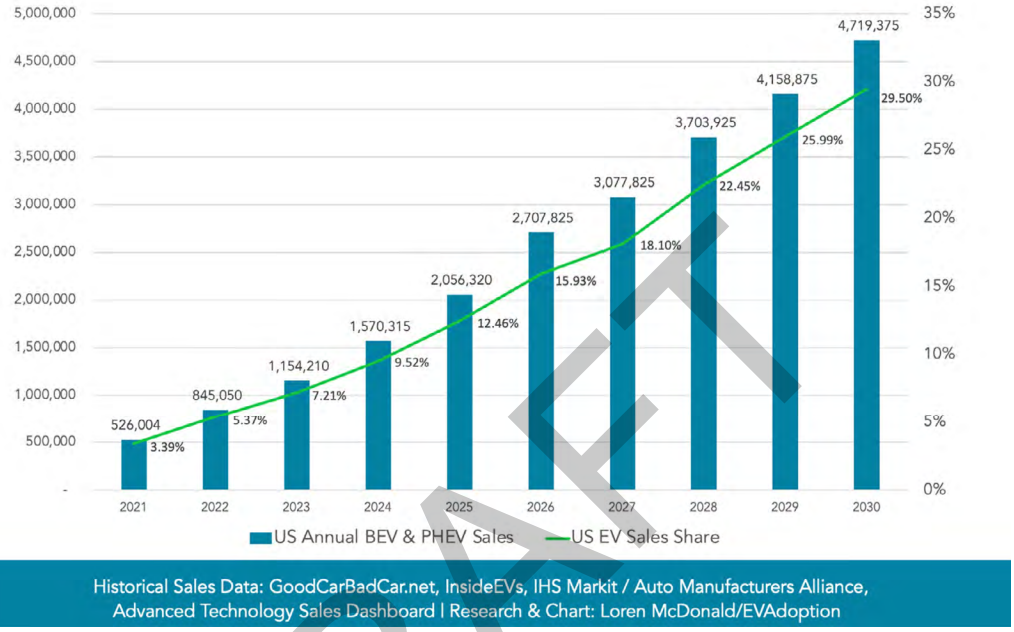
Figure 7. Southeast States' EV Sales as a Percentage of Light-duty Vehicle Sales



Source: Atlas EV Hub. EV sales (includes fully-electric and PHEVs) as a percentage of light-duty vehicle sales from January 1, 2019, through June 30, 2022.

If sales of EVs in Tennessee were to increase and match industry forecasts that say 30% of new vehicles sold in the US in 2030 will be electric (see figure 8), and continue increasing to 50% in 2040, there could be 1.2 million EVs registered in Tennessee in 2040, one in six vehicles.

Figure 8. US Electric Vehicle Sales and Sales Share Forecast 2021 through 2030



Historical Sales Data: GoodCarBadCar.net, InsideEVs, IHS Markit / Auto Manufacturers Alliance, Advanced Technology Sales Dashboard | Research & Chart: Loren McDonald/EVAdoption

Compared to the gas-powered vehicles they replace, the approximately 25,000 EVs in Tennessee on September 30, 2022, represent about a $3.4 million loss of yearly fuel tax revenue, some of which is offset by the $1.7 million in EV registration fees collected from owners of the nearly 17,000 fully electric vehicles; as discussed above the fee doesn't apply to PHEVs. Driving 13,574 miles in a PHEV with a fuel economy of 60 mpg uses 226 gallons of gas and generates about $61 in gas tax revenue—just 40% of the $153 generated by an average driver.

Using historic trends, TACIR staff projects the net loss will continue and grow, reaching $10 million in 2030 and $27 million in 2040. Using forecasts for increased EV adoption, staff projects those losses increase to $16 million in 2030 and $52 million in 2040. See table 1 (reposted), which also shows how forgone gas-tax revenue—and offsetting that revenue with registration fees—affects each level of government in Tennessee.

Table 1 (reposted). Estimates of Forgone Revenue Attributed to EVs Replacing Gas-fueled Vehicles

Year	Number of EVs		Forgone gas tax revenue*	Revenue from EV registration fees	Net total forgone revenue^	Forgone revenue by level of government: State Highway Fund	County Aid Funds	Municipal Streets Funds
2022	16,774	BEV	($2,632,915)	$1,677,400	($955,515)			
	8,006	PHEV	(754,590)		(754,590)			
					($1,710,105)	($419,752)	($828,497)	($414,792)
			Share of forgone revenue if EV registration fee shared with local governments:			($1,059,073)	($402,469)	($201,499)
Projections based on vehicle registration data								
2030	129,960	BEV	($18,014,133)	$12,996,028	($5,018,105)			
	56,153	PHEV	(4,673,778)		(4,673,778)			
					($9,691,883)	($1,049,705)	($5,548,881)	($2,778,081)
			Share of forgone revenue if EV registration fee shared with local governments:			($6,002,988)	($2,248,136)	($1,125,543)
2040	439,897	BEV	($56,538,970)	$43,989,701	($12,549,269)			
	188,830	PHEV	(14,573,468)		(14,573,468)			
					($27,122,737)	($34,905)	($17,392,278)	($8,707,550)
			Share of forgone revenue if EV registration fee shared with local governments:			($16,801,061)	($6,219,727)	($3,113,945)
Projections based on increased EV adoption								
2030	214,110	BEV	($29,591,685)	$21,410,961	($8,180,724)			
	92,376	PHEV	(7,666,301)		(7,666,301)			
					($15,847,026)	($1,654,880)	($9,112,347)	($4,562,153)
			Share of forgone revenue if EV registration fee shared with local governments:			($9,815,415)	($3,674,369)	($1,839,595)
2040	845,868	BEV	($108,472,906)	$84,586,768	($23,886,138)			
	362,951	PHEV	(27,948,754)		(27,948,754)			
					($51,834,891)	$130,237	($33,365,238)	($16,704,511)
			Share of forgone revenue if EV registration fee shared with local governments:			($32,109,013)	($11,881,802)	($5,948,697)

Note: BEV are battery electric vehicles (fully electric). PHEV are plug-in hybrid electric vehicles.

* Includes 26¢/gallon gasoline taxes imposed by Tennessee Code Annotated, Section 67-3-201, and 1¢/gallon special privilege tax imposed by Tennessee Code Annotated, Section 67-3-203.

^ State, county, and municipal amounts do not add up to net total, which also includes some revenue (approximately 1.5%) that would be allocated for other, non-highway purposes.

Comparing the transition to electric vehicles with other technological shifts.

Mainstream EV adoption has been slower than some other historic technology transitions. For example, the percentage of US adults with a broadband internet connection at home increased from just 1% in 2000 to 54% by the end of 2007 and to 77% in 2021.[37] Major manufacturers in the United States have sold EVs for 12 years now; the Nissan Leaf and Chevrolet Volt both became available in December 2010.[38] As a startup, Tesla began producing its electric Roadster in limited quantities in 2008.[39] Until 2018, sales of EVs were less than 2% of new vehicle sales in the US,[40] the share increasing to more than 4% in 2021 and more than 6% in 2022.

Drivers have already had to change the type of fuel they use once before. Prior to 1975, when the EPA mandated the use of catalytic converters in new passenger vehicles, less than 10% of gasoline produced in the US was unleaded. By 1985 it was approximately 65%, and lead additives in gasoline were completely prohibited in 1996.[41] This rapid transition was the result of a government mandate imposed on auto manufacturers to comply with environmental standards. While the federal government has since used its regulatory power to establish higher emissions and fuel economy standards, these standards have been technology neutral, and have not mandated the end of combustion engines.

Several factors could affect future adoption of EVs.

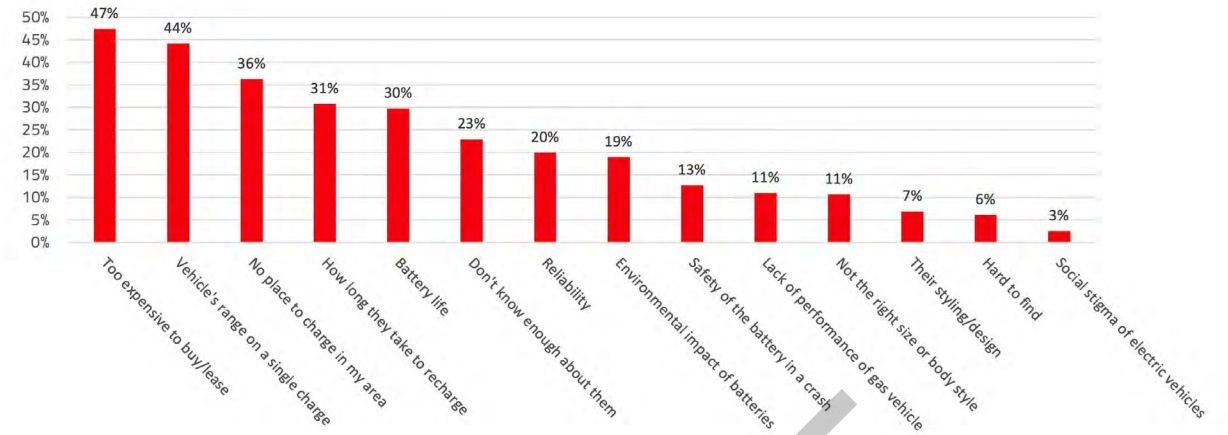
Many factors could affect the numbers of EVs on the road. Three of the most important ones are the availability of charging infrastructure; automakers' plans to shift away from internal combustion engines; and government actions at the federal, state, and local levels. Other factors affecting adoption include the prices of gasoline and electricity, the availability of federal and state tax incentives, the availability of raw materials needed to build EVs and batteries, and global supply chain disruptions.

Availability of charging infrastructure will affect EV adoption.

In a 2022 survey of active car shoppers, 44% said they were worried about EVs' range on a single charge, and 36% said that there wasn't enough local charging infrastructure to support them using an EV. After price, these were the two most common reasons shoppers wouldn't buy an EV. See figure 9.

[37] Pew 2021.
[38] Edelstein 2016.
[39] Drori 2008.
[40] EPA 2021.
[41] Newell and Rogers 2003.

Figure 9. Reasons Car Shoppers Chose Not to Buy an EV



Source: Autolist.com 2022

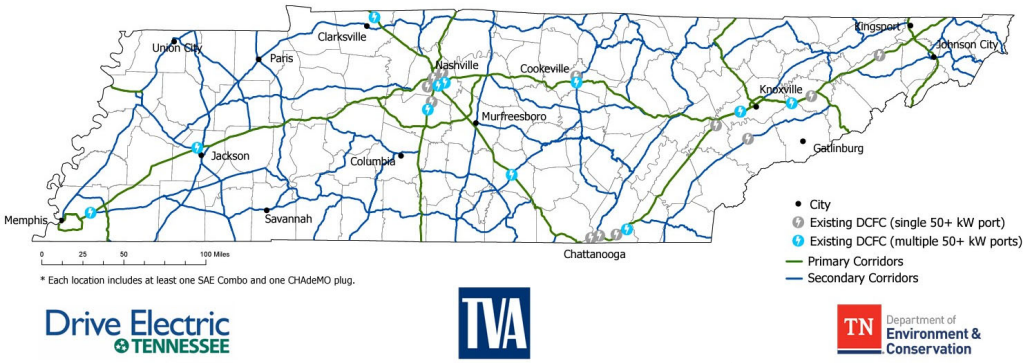
The federal government has created new programs to encourage the expansion of the nation's charging infrastructure. The 2022 Bipartisan Infrastructure Law (Infrastructure Investment and Jobs Act) established a $5 billion National Electric Vehicle Infrastructure Formula Program (NEVI) to build out a national network of 500,000 EV chargers by 2030. The law also created a Joint Office of Energy and Transportation to facilitate collaboration between the departments of Energy and Transportation.[42]

Efforts to Expand Charging Infrastructure in Tennessee

Tennessee has been developing plans to expand charging availability since 2018 when several stakeholders came together to form Drive Electric Tennessee (DET). In January 2019, DET published *A Roadmap for Electric Vehicles in Tennessee*, setting the goal of having 200,000 EVs on the road by 2028. One aspect of the group's plan to reach that goal was to improve charging infrastructure across the state—at the time, there were just 23 publicly accessible fast-charging stations in Tennessee. To help facilitate these improvements, TDEC and TVA formed a partnership to construct 50 new fast-charging locations at a cost of $20 million towards their construction, including $5 million from the state's Volkswagen Diesel Settlement Environmental Mitigation Trust allocation and $7 million in federal funds provided through TDOT. The program will provide up to 80% funding for local power companies and utilities to develop charging stations along designated corridors.[43] See map 4.

[42] Public Law 117-58 (Nov. 15, 2021). See FHWA "Bipartisan Infrastructure Law" and Joint Office of Energy and Transportation at driveelectric.gov.
[43] TDEC "Fast Charge TN Network."

Map 4. Designated Charging Corridors in Tennessee
July 2021



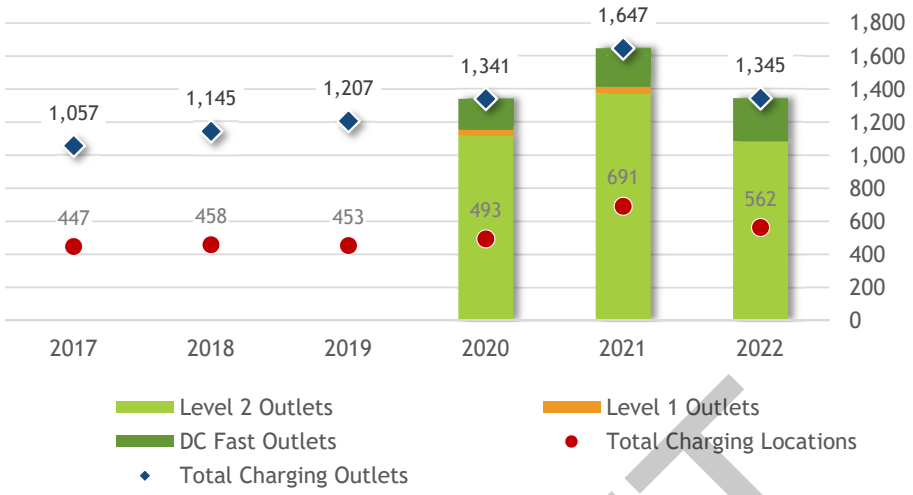
Source: Drive Electric Tennessee.

In July 2022, TDEC awarded $5.2 million to 12 entities for the installation of 32 charging units at 13 sites. TVA says it anticipates funding an additional 21 projects in Tennessee that will include 56 total charging units in 27 locations.[44] TDEC says the state will need at least 20 additional charging sites to meet the federal government's requirements to locate chargers at 50-mile intervals along these designated corridors. To help reach this goal, the state will use some of the $88 million in NEVI funds it expects to receive over the next five years.[45]

Some of Tennessee's local power companies offer incentives to residential and commercial customers who install charging equipment. The Knoxville Utilities Board offers residential customers a rebate up to $400 for the purchase and installation of a Level 2 EV charging station.[46] In Chattanooga, EPB offers incentives of $500 or $2,000 for commercial customers to install publicly available charging stations.[47] Figure 10 shows how the number of charging stations in Tennessee has increased since 2017. Some stakeholders have expressed concerns that the current electric grid may not be able to support the projected number of charging stations in certain locations.[48]

[44] TDEC 2022.
[45] TDOT 2022.
[46] KUB "Electric Vehicle Charger Rebate."
[47] EPB "EV Charging Incentive."
[48] Giordano 2022 and Vock 2022.

Figure 10. Electric Vehicle Charging Stations in Tennessee 2017 through 2022



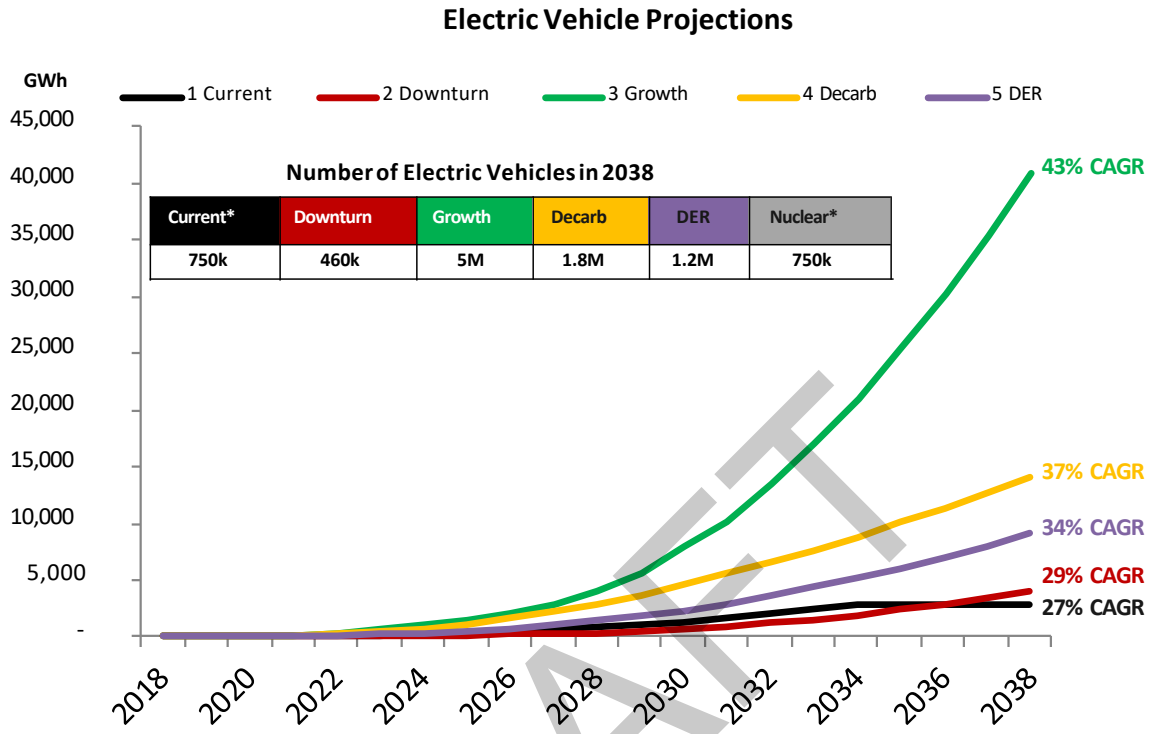
Source: Alternative Fuels Data Center (last updated 9/13/2022). In 2021, increases resulted from a change in counting methods; in many cases, one station was split into several new stations to represent different physical locations of equipment at one address. Data for outlet types was not collected prior to 2020.

Improving the Power Grid to Accommodate Vehicle Charging

Although there may be localized barriers to charging electric vehicles, especially in rural areas, TVA is planning for the electric grid to be able to handle the increase in electric-vehicle charging. Adopted in 2019, TVA's Integrated Resource Plan sees near-term action to stimulate the local electric vehicle market as a positive development for the region.[49] The plan's 2038 projection for EVs in the Valley under current assumptions is 750,000; TACIR staff projects 519,000 EVs in Tennessee if current trends continue to 2038. TVA has considered higher EV-adoption scenarios. The plan's Valley Load Growth scenario assumed every new vehicle sold by 2038—light, medium and heavy duty along with transportation (buses)—will be electric, translating into almost five million EVs on the road in the Valley. See figure 11.

[49] Tennessee Valley Authority 2019.

Figure 11. Range of TVA Projected Numbers of Electric Vehicles in 2038



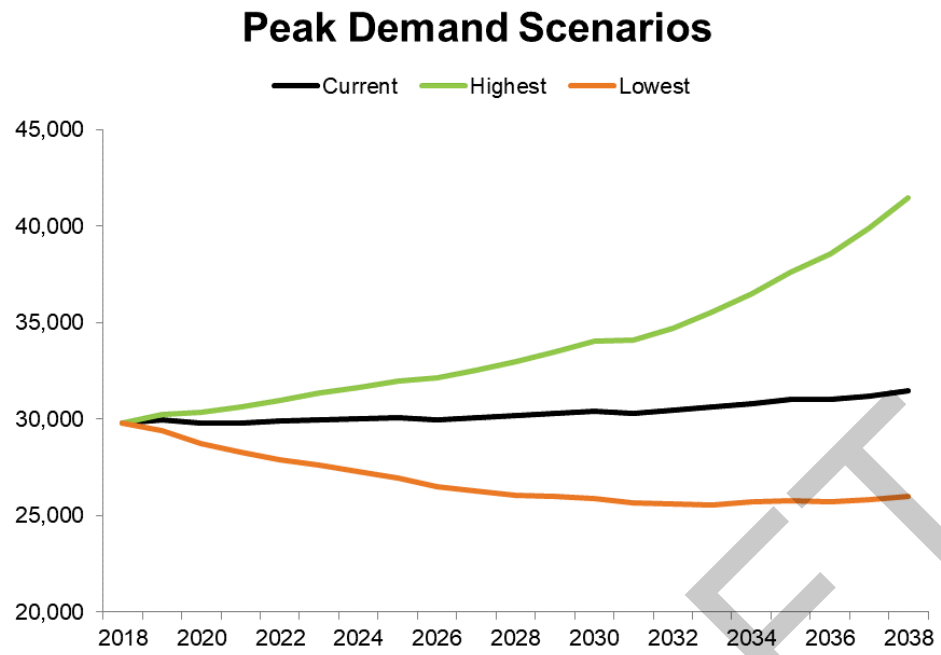
*Light duty only

Source: TVA 2019.

TVA says it has planning reserve margins of 17% above peak load requirements in the summer and 25% above peak load requirements in the winter. Under current outlook assumptions, TVA forecasts peak demand to grow 0.3% annually through 2038, and for total annual energy demand to average 0.1% growth. Peak demand would increase 1.7% and total demand 2% each year under the most extreme growth scenario. See Figures 12 and 13.

TVA is already working to add the additional capacity it will require to meet the region's needs in the next two decades. TVA's 2022-2026 Strategic Plan says that "TVA is investing more than $2 billion in transmission system improvements over five years" and that its $300 million "System Operations Center and energy management system" will employ "smart technologies to manage power grid operations more reliably, efficiently, and securely . . . [to] support a diverse portfolio of clean energy sources, advanced technologies, and broad electrification in the transportation sector and elsewhere." This includes adding a solar energy expansion of 10,000 megawatts by fiscal year 2034-35, as well as the adoption of new natural gas technologies to enable solar expansion and support additional

Figure 12. TVA Peak Demand Forecast Scenarios

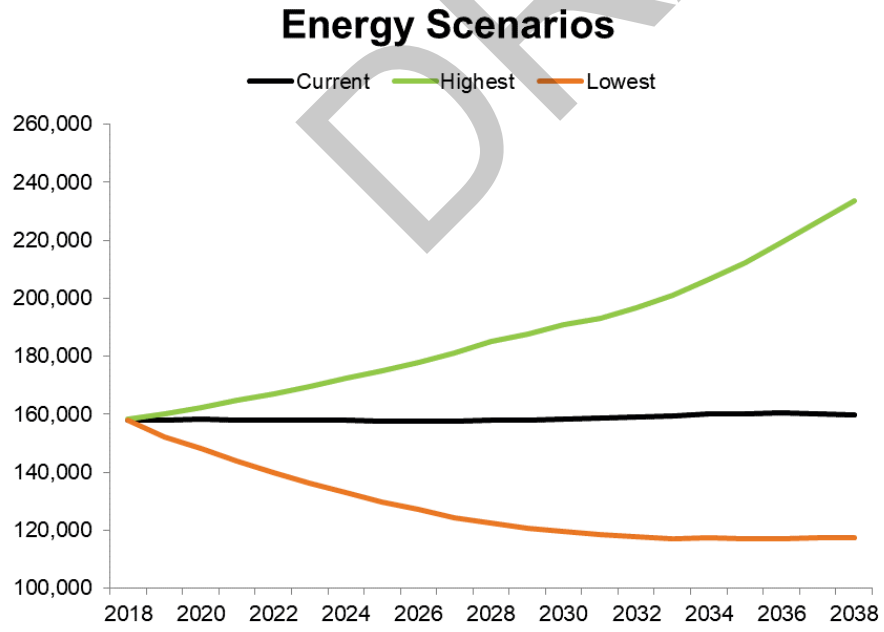


2018 - 2038
Annual Growth Rates

Highest Scenario:	1.7%
Current Outlook:	0.3%
Lowest Scenario:	-0.7%

Source: TVA 2019.

Figure 13. TVA Annual Energy Forecast Scenarios



2018 - 2038
Annual Growth Rates

Highest Scenario:	2.0%
Current Outlook:	0.1%
Lowest Scenario:	-1.5%

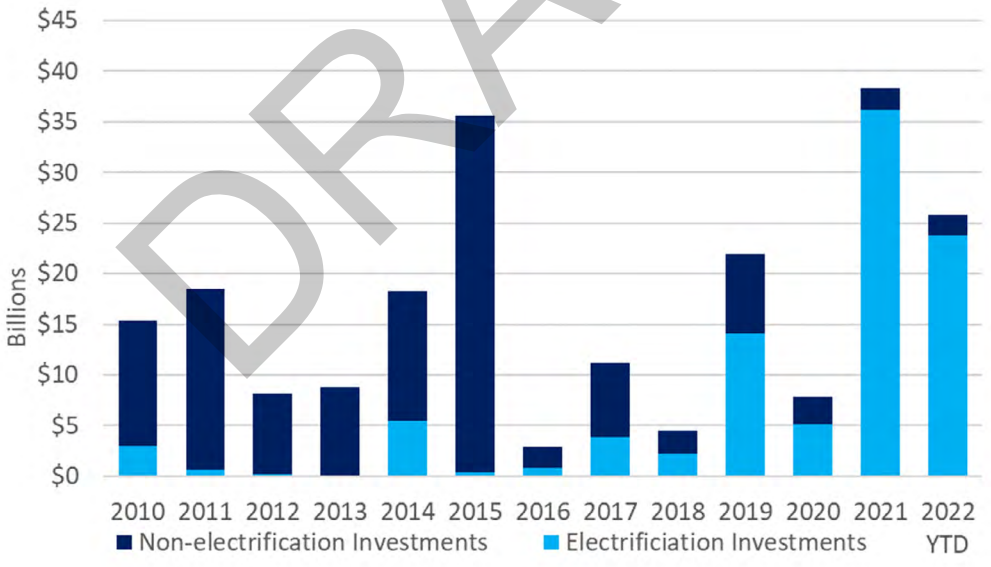
Source: TVA 2019.

coal retirements while helping to maintain both system reliability and resiliency.[50]

Automakers are decreasing production of internal combustion engines and investing heavily in EV and battery manufacturing.

Nearly every major vehicle manufacturer has made a public statement or commitment to mostly end their production of internal combustion engines by 2040, and automakers are making substantial investments in EV and battery manufacturing. In October 2020, General Motors (GM) announced it will invest $2 billion in its Spring Hill assembly plant to transition the facility for electric vehicle manufacturing. Shortly thereafter, Ultium Cells, GM's joint venture with LG Energy, said it will invest more than $2.3 billion to build its second US battery cell manufacturing plant in Spring Hill.[51] According to the Center for Automotive Research, automakers have announced $60 billion of investments in 2021 and 2022 to build North American facilities dedicated to manufacturing EVs and batteries—including Ford's plan to invest $11.4 billion to build Blue Oval City and Blue Oval SK Battery Park in Tennessee and Kentucky.[52] See figure 14.

Figure 14. Automotive Investment Announcements in North America 2010 through 2022



Source: Center for Automotive Research 2022.

[50] Tennessee Valley Authority 2022.
[51] Area Development 2021.
[52] Center for Automotive Research 2022.

The federal government is encouraging automakers to rapidly increase EV production as well. In 2021, President Biden issued an executive order with the goal "that 50 percent of all new passenger cars and light trucks sold in 2030 be zero-emission vehicles, including battery electric, plug-in hybrid electric, or fuel-cell electric vehicles."[53] California's governor signed a similar order in 2020;[54] in 2022, the California Air Resources Board approved the regulations necessary to phase out the sale of new gasoline-powered cars completely by 2035.[55]

Other Government Actions Affecting EV Adoption

Federal and state tax incentives that lower the cost of buying an EV could affect the rate of EV adoption. The federal government has offered tax credits of up to $7,500 since 2008.[56] The Inflation Reduction Act of 2022 continued this credit for purchases of some new EVs and expanded it for the first time with a $4,000 credit for some used EVs. Should future administrations choose to end these incentives, it could have a negative effect on the EV market. Eighteen states also offer additional incentives, but Tennessee is not currently among them.

With an executive order issued December 2021, President Biden directed the federal government to use its scale and procurement power to achieve goals of 100% light-duty zero-emission vehicle (ZEV) acquisitions by 2027 and 100% of all vehicle acquisitions being ZEV by 2035.[57] Towards those goals, the US Postal Service (USPS) is replacing tens of thousands of its gas-powered delivery vehicles with EVs in the coming years. Between a contract for 50,000 newly designed next-generation vehicles and "plans to buy more than 34,500 commercial off-the-shelf delivery vehicles over two years . . . USPS says at least 40% of the 84,500 vehicles it will buy will be EVs."[58] The Inflation Reduction Act of 2022 "allocated $3 billion in additional funding to the US Postal Service for electrification of the nation's delivery fleet."[59]

Several state governors have issued executive orders directing their agencies to buy electric for their vehicle fleets. State agencies in Connecticut, Illinois, and Maine are adopting electric vehicles and installing EV charging stations on state property. The state of Washington intends to reach a 100% light-duty battery electric vehicle fleet by 2035 and make medium- and heavy-duty fleets fully electric by 2040. Finally, in Massachusetts, the

[53] Executive Order 14037 of August 5, 2021. 86 FR 43583.
[54] Office of Governor Gavin Newsom "Governor Newsom Announces California Will Phase Out Gasoline-Powered Cars & Drastically Reduce Demand for Fossil Fuel in California's Fight Against Climate Change." (Press release.)
[55] Rott 2022.
[56] Public Law 110-343 (Energy Improvement and Extension Act of 2008) October 3, 2008.
[57] Executive Order 14057 of December 8, 2021. 86 FR 70935.
[58] Shepardson 2022.
[59] Dow 2022.

governor ordered all state agencies to buy ZEVs starting in 2022, to double electric charging stations installed at state facilities by 2030, and to make its entire fleet 100% ZEV by 2050.[60] As of June 30, 2020, the State of Tennessee owned five electric vehicles and two hybrids.[61] State law "encourage[s] the acquisition of energy-efficient and alternative fuel motor vehicles in the fleet of state vehicles." By definition, "energy-efficient motor vehicles" are not necessarily EVs and include gas-powered vehicles with highway fuel economy of at least 25 mpg (essentially average for all gas-powered vehicles).[62]

According to Drive Electric Tennessee, the cities of Knoxville, Nashville, and Kingsport have added EVs to their government fleets—Kingsport has the first Nissan Leaf police car in the country. Electric utilities in Chattanooga and Knoxville also have EVs in their fleets.[63] In August 2022, Shelby County Mayor Lee Harris signed an executive order to replace county government gas vehicles with hybrid and zero-emission electric ones.[64] The Tennessee Valley Authority (TVA) "intends to add nearly 1,200 light- and medium-duty EVs and more than 300 additional charging stations at key TVA locations" to replace half of its vehicle fleet with EVs by 2030.[65]

Other factors will affect the adoption of EVs.

Gasoline prices will affect the EV rate of adoption. If gasoline prices are low for an extended period, consumers may not see purchasing an EV as beneficial. Conversely, if gas prices increase, more consumers could consider EVs to replace their gas-powered vehicles. Currently, the relatively low cost of electricity makes charging an EV at home cheaper than the equivalent cost of gasoline. If electricity prices were to increase dramatically, that too could have a negative effect on EV purchases.

Supply chain and material costs could make EVs too expensive for mainstream adoption. Although the gap is narrowing, EVs are often priced higher than gas-powered vehicles in the same class. Supply shortages and disruptions have the potential to drive up EV prices and slow the rate of adoption. Materials like lithium, titanium, and metals used to make rare-earth magnets come from countries all over the globe. The scarcity of these materials is a concern, as is the reliance on countries other than the United States to supply them.[66] To begin to address these concerns, and "ensure that the United States has a viable battery materials processing industry to supply the North American battery supply chain," the federal Infrastructure

[60] Mullaley 2022.
[61] TN Department of General Services 2020.
[62] Tennessee Code Annotated, Section 4-3-1109. For fuel economy, see EIA 2022a.
[63] Drive Electric Tennessee "EV Fleets & Projects in TN."
[64] Chaney 2022.
[65] Tennessee Valley Authority "TVA Announces Fleet EV Plan."
[66] US Department of Energy 2022a.

Investment and Jobs Act of 2022 established a Battery Material Processing Grant Program.[67] In October 2022, the US Department of Energy awarded $2.8 billion to 20 companies—including three in Tennessee—"to build and expand commercial-scale facilities in 12 states to extract and process lithium, graphite and other battery materials, manufacture components, and demonstrate new approaches, including manufacturing components from recycled materials."[68]

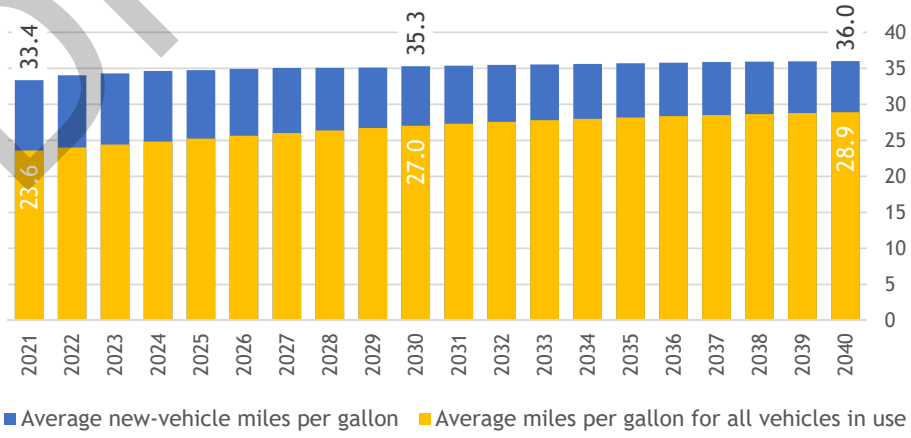
Improvements in fuel efficiency and inflation will have a greater effect on road funding than EV adoption.

Although EVs will affect road funding in Tennessee, they won't have the greatest effect in the coming decades. Instead, improvements in fuel efficiency will reduce fuel tax revenue to a greater extent. But inflation will have the greatest overall effect because it erodes the purchasing power of the state's road funding.

Improved fuel efficiency reduces fuel tax revenue.

Passenger vehicle fuel economy is increasing due to federal mandates. "The U.S. Department of Transportation's National Highway Traffic Safety Administration (NHTSA) published the Final Rule on Corporate Average Fuel Economy (CAFE) Standards for Model Year (MY) 2024 – 2026 passenger cars and light-duty trucks in March 2022. The standards require an industry-wide average fleet fuel economy of approximately 49 mpg in MY 2026, increasing fuel efficiency by 8% in MY 2024 and 2025 and 10% in MY 2026."[69] As fuel economy increases, less tax revenue is generated per mile driven. The national average fuel economy for all light-duty vehicles in use was 23.6 mpg in 2021. The new-vehicle average in 2021 was 33.4 mpg, and overall average fuel economy is projected to increase to 27.1 mpg in 2030 (a 15% improvement from 2021) and 29.0 mpg in 2040 (+23%).[70] See figure 15.

Figure 15. Projected Average Fuel Economy of US Light-Duty Vehicles 2021 through 2040

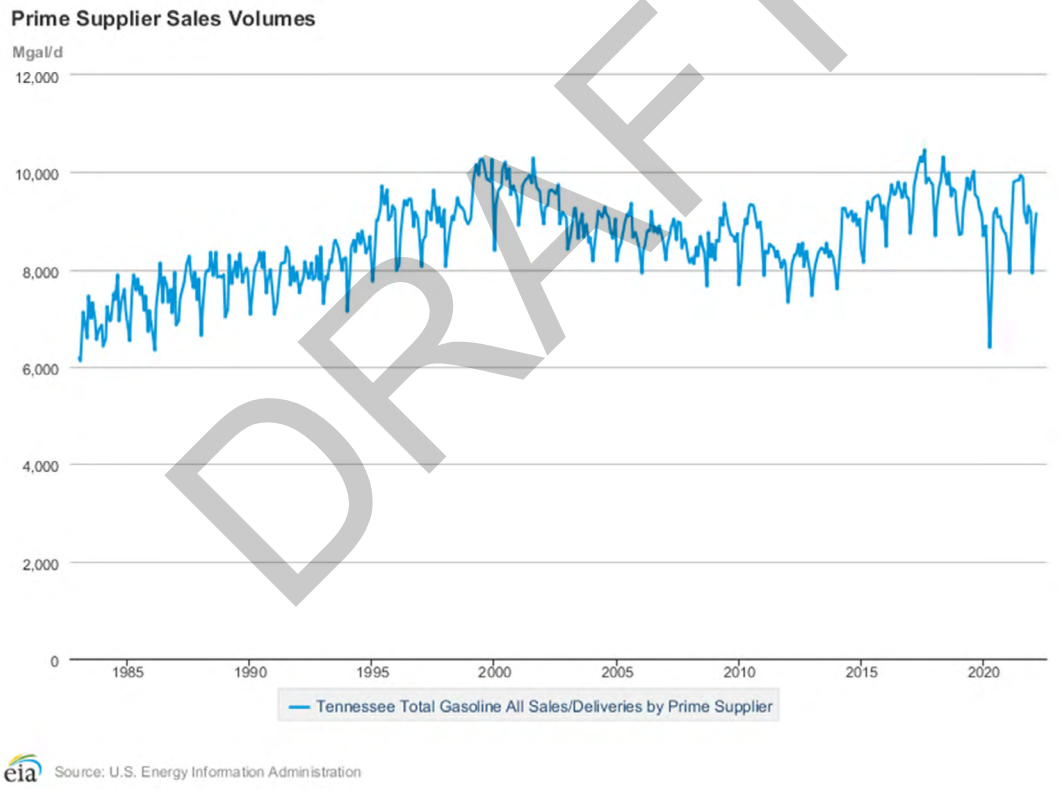


Source: US Energy Information Administration 2022a.

[67] Public Law 117-58, Section 40207(b).
[68] US Department of Energy 2022b and Mazza 2022.
[69] Alternative Fuels Data Center "Recent Federal Actions."
[70] US Energy Information Administration 2022a.

For a person driving an average of 13,574 miles in a year, increased fuel economy means buying 90 fewer gallons of gas in 2030 (paying $24 less in gas tax at the state's current rate) and 123 fewer gallons in 2040 (paying $33 less in gas tax). Using EV projections based on historic trends, 92% of Tennessee vehicles will still be fueled by gasoline in 2030, and their increased fuel economy will be responsible for a $110 million decrease in revenue (-11%). In 2040, 85% of vehicles are projected to remain gas-powered, and the decrease in revenue from increased fuel efficiency could be $171 million (-16%). Gasoline sales in Tennessee peaked around the year 2000, then fell steadily until 2014 before peaking again in 2017. Sales in 2021 and 2022 have rebounded from 2020 lows during the COVID-19 pandemic but remain below these previous peaks. This despite there being 700,000 more registered vehicles in 2020 than 2010. See figure 16.

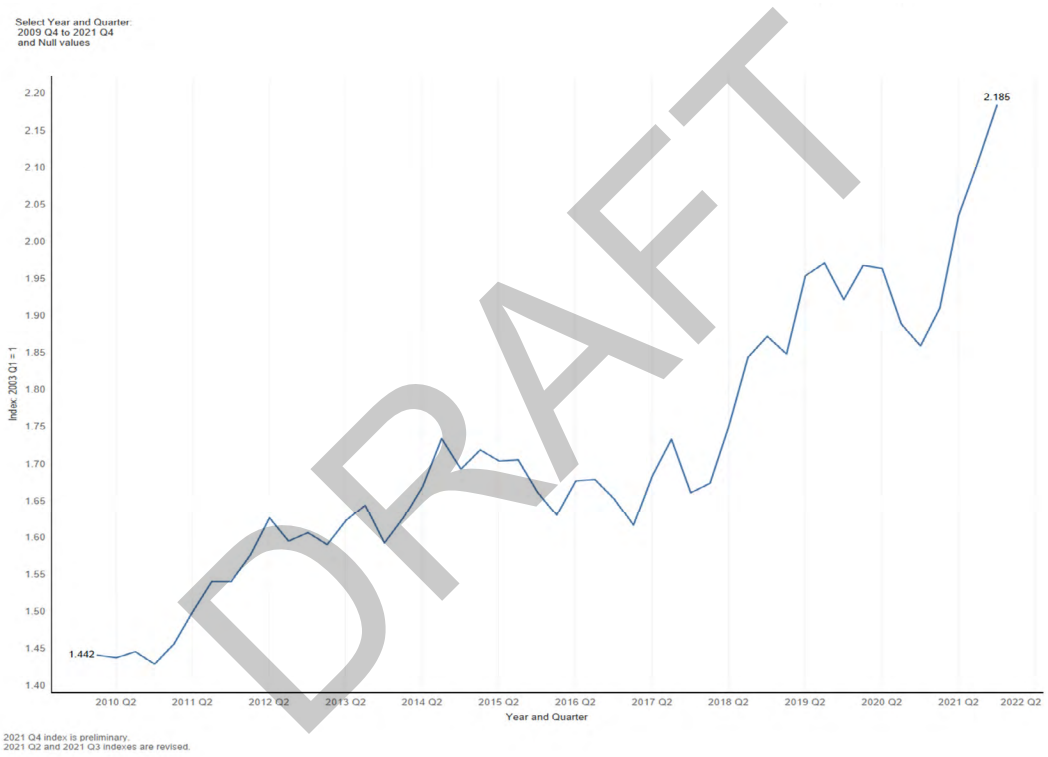
Figure 16. Monthly Gasoline Sales to Suppliers in Tennessee



Inflation is going to continue to decrease the purchasing power of transportation revenue.

Road construction costs are increasing, reducing the purchasing power of Tennessee's fuel tax revenue. The national Highway Construction Cost Index (NHCCI) is a quarterly price index developed by the FHWA "to measure the national average changes in highway construction costs over time."[71] The NHCCI rose sharply between 2010 and 2014, held somewhat level until 2018, and has been trending upward since—with the exception of 2020 during the COVID-19 pandemic. See figure 17.

Figure 17. National Highway Construction Cost Index (NHCCI)

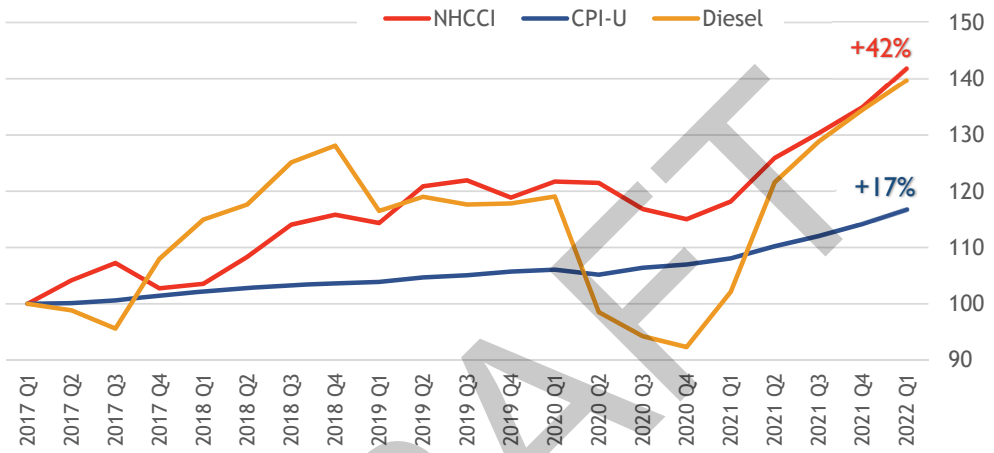


Source: Federal Highway Administration.

[71] FHWA "Description of NHCCI Methodology." "It uses data from winning bids on highway construction contracts to "represent state- and project-level details on prices, and quantities of pay items for those winning contracts."

Prices for most goods and services increase each year, but over the past four years highway costs have grown much faster than prices overall. One reason could be higher fuel prices, particularly for the diesel fuel needed to power trucks and equipment. The US average price for diesel increased 40% from the first quarter of 2017 to the first quarter of 2022, while highway construction costs increased by 42%. Meanwhile, the government's broad measure of inflation, the Consumer Price Index (CPI-U), increased 17% over the same four years. See figure 18.

Figure 18. Highway Construction Costs and Consumer Price Inflation



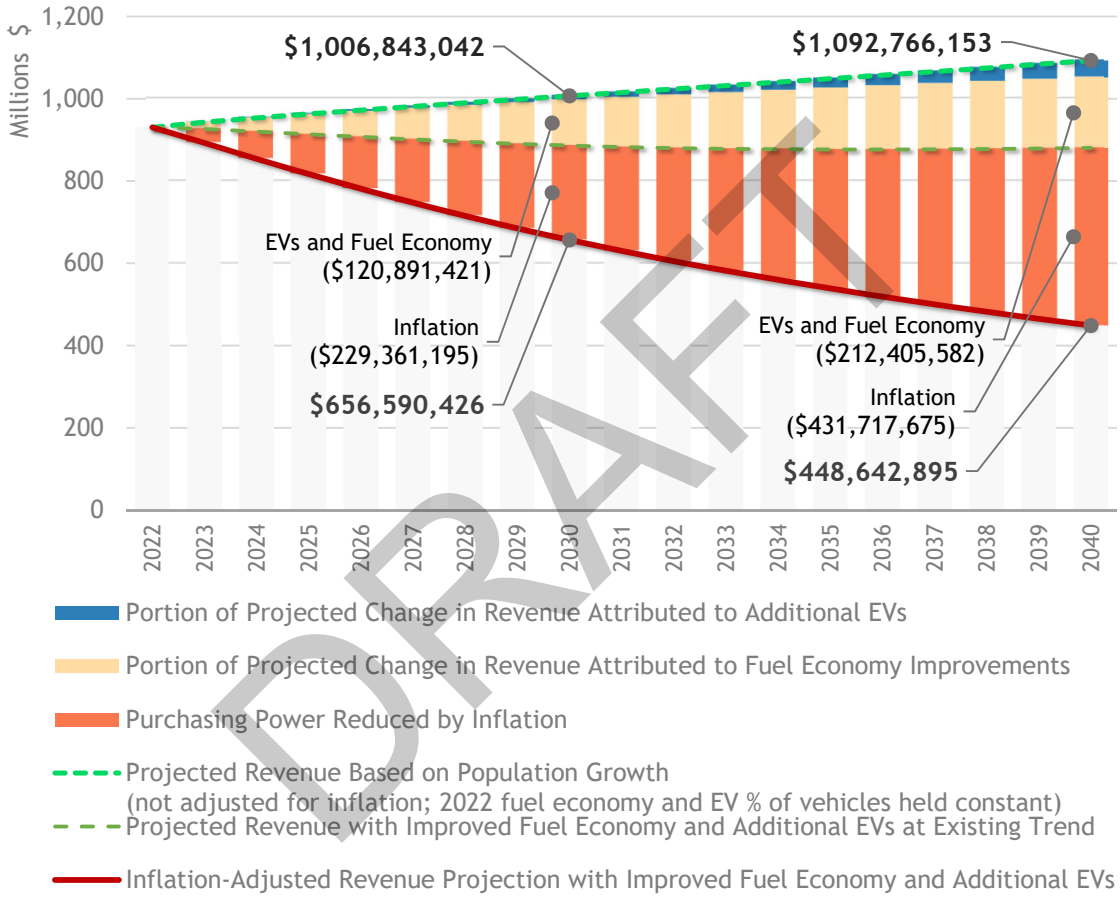
Source: Bureau of Labor Statistics CPI for All Urban Consumers (CPI-U); FHWA National Highway Construction Cost Index (NHCCI); US Energy Information Administration Weekly Retail Diesel Prices.

When inflation occurs, and prices increase, sales tax revenue increases because it is calculated according to the price of the item sold. But for gasoline and motor fuel taxes, the tax is based on the volume sold, not on the price. This means that gasoline and motor fuel tax revenue will not necessarily increase when prices increase. Highway costs have risen faster than the overall inflation rate in the past decade (3.8% on average vs. 2.5%) and at that rate would increase by 35% by 2030 and by 96% by 2040.

Based on current trends, construction cost inflation—rather than EV adoption or increases in fuel economy—is going to be the most significant factor affecting future funding for the state's roadways, as the buying power of the state's fuel taxes is diminished. Combined, the effects of increased fuel economy and the projected replacement of gas-powered vehicles with EVs could decrease revenue by $121 million in 2030 and by $212 million in 2040. Using forecasts for increased EV adoption that exceed the state's historic trend would result in decreases of $130 million in 2030 and $240 million in 2040. Inflation has the potential to reduce the purchasing power of revenue collected by an additional $229 million in 2030 and $432 million in 2040. Combining the projected effects of EV adoption, fuel economy,

and inflation could lead to a net loss of $350 million in 2030, compared to projections that account only for population growth. In 2040 the gap would be $644 million—leaving the state with less than half the buying power it has in 2022. Factoring in the possibility of increased EV adoption raises those figures only slightly, to $357 million and $658 million. See figure 1 reposted.

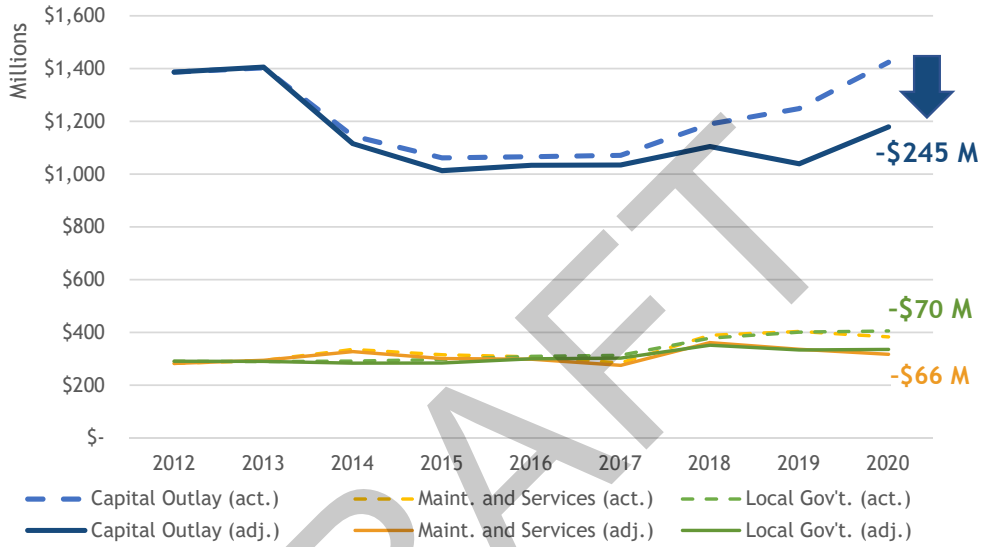
Figure 1 (reposted). Select Factors Affecting Tennessee's State Gas Tax Revenue Projections through 2040 Based on Historic EV Registrations



Source: TACIR staff projections based on state population projections (Tennessee State Data Center), vehicle registration data (TN Department of Revenue), vehicle miles traveled (FHWA Highway Statistics), fuel economy projections (US Energy Information Administration), and inflation (National Highway Construction Cost Index).

Figure 19 shows the effects of inflation on actual state highway spending in recent years. In nominal dollars, capital outlay spending on state roads appears to have returned to 2012-13 levels. However, because of inflation, adjusted spending was $245 million less. Compared to 2012, inflation has also reduced the actual spending power of funding for maintenance and services by $66 million and aid to local governments by $70 million.

Figure 19. Inflation-adjusted State Highway Spending by Category State Fiscal Years 2011-12 through 2019-20



Source: FHWA "Highway Statistics," Table SF-2 (2012-2020).

Other states' approaches to maintaining or enhancing road funding.

Tennessee is not the only state facing the adoption of electric vehicles, increasing fuel efficiency, and inflation. According to the National Association of State Budget Officers, "States are concerned that in the long term, the current structure of state and federal fuel tax revenue will not be able to meet transportation needs, as most gas taxes are set at fixed rates and do not rise with inflation, new vehicle fuel economy continues to increase, and growth in vehicle miles traveled has leveled off."[72] In Tennessee, TDOT and the Governor's Office have recently stated that the state might also consider entering into public private partnerships, implementing toll express lanes—though not toll roads—and increasing the EV registration fee to $300.[73]

[72] NASBO 2021.
[73] Mattise 2022.

Some of the approaches adopted by other states to maintain or enhance their road funding include sharing EV registration fees with local governments, using EV fees to support the expansion of EV-charging infrastructure, varying all registration fees by vehicle weight, indexing fuel taxes to inflation or fuel efficiency, authorizing local option fuel taxes, taxing electricity at commercial charging stations, and adopting vehicle miles traveled (VMT) taxes.

Allocating EV Registration Fees

Tennessee's additional registration fee for electric vehicles is not shared with local governments unlike revenue from the gas tax. This is despite it being adopted in part to make up for EVs' lack of fuel consumption.[74] Nine states with EV fees distribute some of that revenue to their local governments.[75] Mississippi, Missouri, and North Dakota distribute revenue from EV fees in the same proportion as those states' fuel taxes.[76] The others share a portion of the revenue with local governments, but not necessarily the same as with fuel taxes.

A few states also allocate some EV-fee revenue to support electric vehicle infrastructure. For example, Alabama allocates $50 of its $200 fee for new electric vehicle infrastructure and Washington added an additional $75 fee in 2019 to support charging stations. Colorado dedicates $20 of its $50 EV fee to the Electric Vehicle Grant Fund to support charging stations.[77]

Varying Registration Fees by Vehicle Weight

Research has shown that heavier vehicles "impose a vastly disproportionate share of wear and tear on highway infrastructure compared with the lightest vehicles."[78] Like in other states, heavy freight vehicles pay higher registration fees in Tennessee, but the state does not vary the fee for personal vehicles based on weight. Table 2 shows the percentage of Tennessee's registered light-duty vehicles by weight class.

In Tennessee, the owner of a 7,000-pound, long-bed, crew-cab pickup truck pays the same $23.75 registration fee as the owner of a 3,000-pound compact car. Arkansas, for comparison, has three weight classes

Table 2. Tennessee Vehicles by Weight Class, 3rd Quarter, 2022

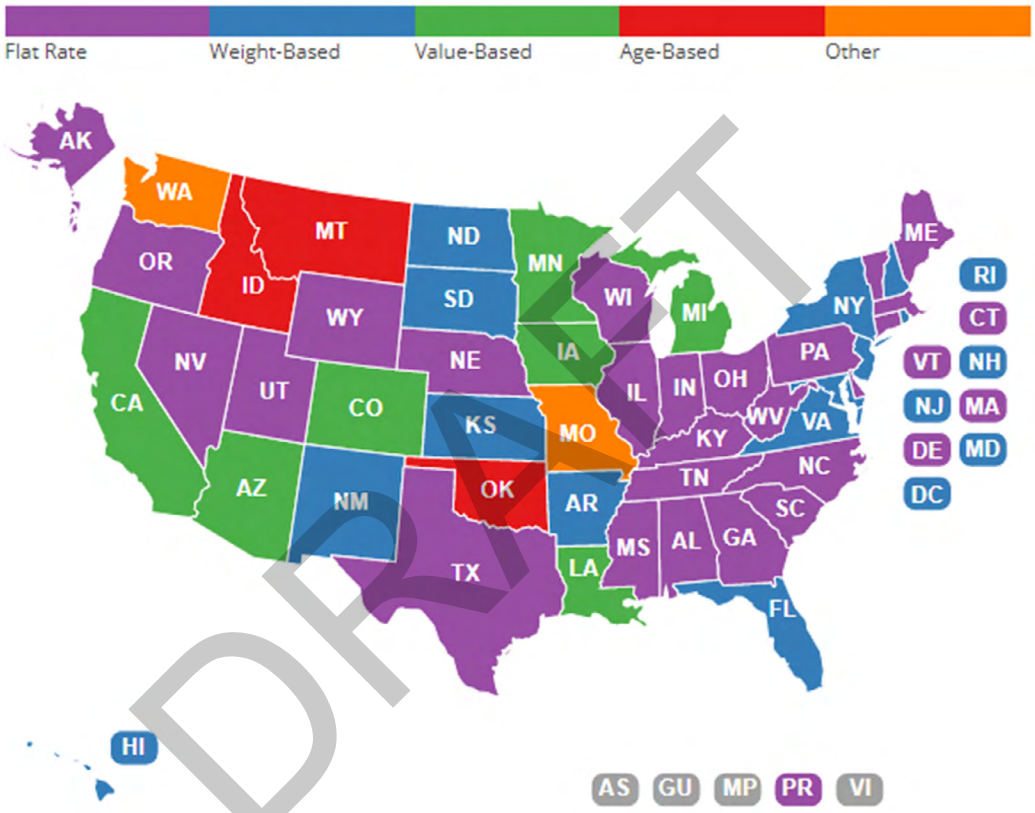
Class A: 0-3,000 lb	29.50%
Class B: 3,001-4,000 lb	4.00%
Class C: 4,001-5,000 lb	19.10%
Class D: 5,001-6,000 lb	18.60%
Class E: 6,001-7,000 lb	17.30%
Class F: 7,001-8,000 lb	6.50%
Class G: 8,001-9,000 lb	2.10%
Class H: 9,001-10,000 lb	2.90%

Source: Tennessee Department of Revenue.

[74] Interview with Stephen Smith, Deputy Commissioner and Director, TennCare, April 1, 2021.
[75] NCSL "Special Fees on Plug-In Hybrid and Electric Vehicles." The states are: Alabama, Idaho, Indiana, Michigan, Minnesota, Mississippi, Missouri, North Dakota, and Ohio.
[76] Mississippi Code Annotated, Section 27-19-21; Missouri Annotated Statutes, Sections 142.345 and 142.869; Missouri Constitution, Article IV, Section 30a; North Dakota Century Code, Section 39-04-19.2 and Section 54-27-19.
[77] NCSL "Special Fees on Plug-In Hybrid and Electric Vehicles."
[78] National Academies of Sciences, Engineering, and Medicine 2019.

for automobiles, with fees that range from $17.00 to $30.00, and trucks over 6,000 pounds are charged $6.50 per 1,000 pounds.[79] Florida is similar, with fees for three classes of vehicles under 5,000 pounds ($14.50-$32.50). The fee for trucks between 5,000 and 5,999 pounds is $60.75 and $87.75 from 6,000 to 7,999 pounds.[80] Thirteen states and the District of Columbia have weight-based registration fees for all passenger vehicles, ranging from $14.50 to $274.00. See map 5.

Map 5. Methods Used to Determine Registration and Title Fees by State



Source: National Council of State Legislatures 2020.

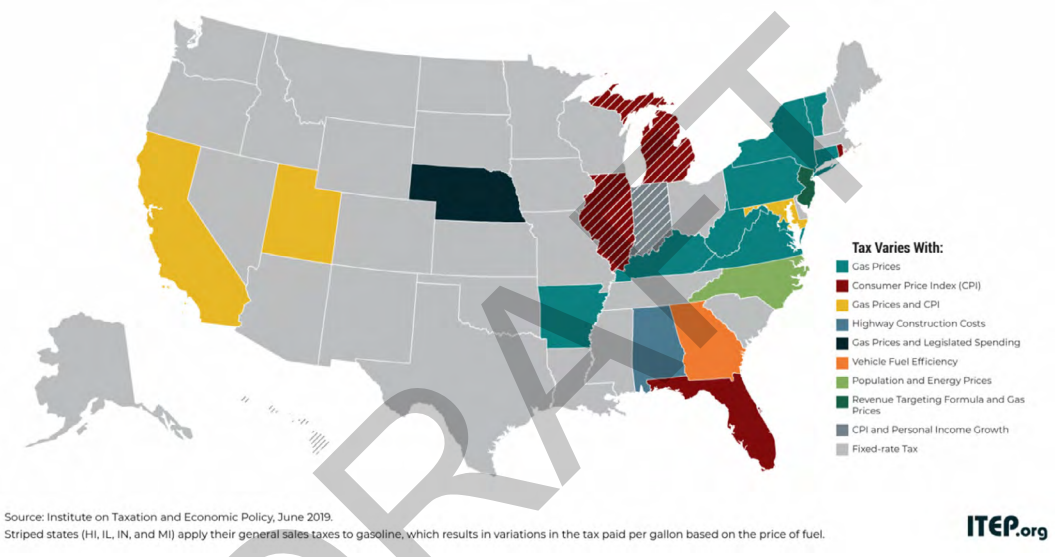
Indexing Fuel Taxes to Inflation or Fuel Efficiency

Because they are set at fixed, per-gallon amounts that require legislative action to amend, Tennessee's fuel taxes are similar to federal fuel taxes and those in most states. This means that fuel consumption (the volume of gallons sold and taxed) needs to increase over time for revenue to simply keep up with inflation. "Since 2013, eight states (Alabama, Arkansas, Maryland, New Jersey, Pennsylvania, Rhode Island, Utah, and Virginia) as well as the District of Columbia have abandoned their old gas tax

[79] Arkansas Code Annotated, Section 27-14-601.
[80] Florida Annotated Statutes, Section 320.08.

structures in favor of more sustainable, variable-rate designs where the tax rate is allowed to rise alongside gas prices, the general inflation rate in the economy, vehicle fuel efficiency, or other relevant factors."[81] In 2017, when the General Assembly was considering the legislation that ultimately became the IMPROVE Act, Senate Bill 1107 by Senator Kyle and House Bill 1243 by Representative Clemmons proposed indexing Tennessee's fuel tax rates to a combination of inflation and population growth, but the proposal did not pass. Map 6 shows the 22 states that have mechanisms to automatically adjust gas tax rates and the criteria for adjustment used in each.

Map 6. States that have mechanisms to automatically adjust gas tax rates (2019)

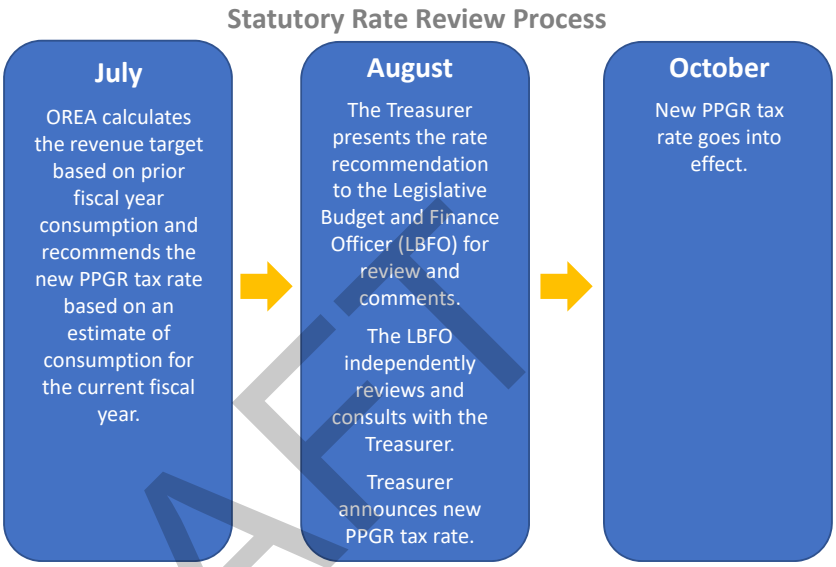


Some of these states combine fixed rates with automatically adjusting portions and legislative adjustments to regularly set total rates that meet their states' current transportation needs. "Nebraska's gas tax is calculated twice a year based on three factors: a fixed rate which is set by the Legislature, a wholesale tax rate that varies based on the price of fuel, and a variable tax rate, which is adjusted to pay for transportation spending budgeted by the Legislature."[82] If fuel prices decline, the portion based on wholesale costs declines. However, if the resulting rate becomes insufficient to meet the state's transportation budget, the legislature can adjust the variable portion to make up the difference. In 2016, New Jersey enacted legislation to provide its Transportation Trust Fund (TTF) program with "$16 billion over eight years to support critical infrastructure improvements to the state's roadways and bridges."[83] The state has a fixed

[81] Institute on Taxation and Economic Policy 2019.
[82] Weinberg 2020. See Revised Statutes of Nebraska Annotated, Sections 66-489, 66-489.02, and 66-4140 through 4145.
[83] New Jersey Department of the Treasury 2021a.

"motor fuels tax" of 10.5 cents per gallon.[84] To generate the revenue needed for the TTF program, it adds to that a variable Petroleum Products Gross Receipts (PPGR) tax. The state's Office of Revenue and Economic Analysis provides an explainer (see figure 20).[85]

Figure 20. New Jersey's Petroleum Products Gross Receipts Tax



Source: New Jersey Office of Revenue and Economic Analysis.

The PPGR rate can increase or decrease as needed. In August 2021, the PPGR rate decreased by 8.3 cents after state officials determined that fuel sales had recovered faster than expected following the 2020 pandemic and collections exceeded the state's target.[86]

Local-Option Fuel Taxes

Fourteen states give local governments the option to levy a local fuel tax.[87] In 2017, Senate Bill 1107 by Senator Kyle and House Bill 1243 by Representative Clemmons would have authorized counties in Tennessee to levy a local tax of up to 3 cents per gallon on gasoline, subject to voter approval. The bill did not pass.

[84] New Jersey Department of the Treasury "Excise Rates."
[85] New Jersey Department of the Treasury 2021b.
[86] New Jersey Department of the Treasury 2021a.
[87] EIA "Federal and State Motor Fuels Taxes." The states are: Alabama, California, Florida, Georgia, Hawaii, Illinois, Mississippi, Missouri, Montana, Nevada, New York, Oregon, South Carolina, and Washington.

Taxing Electricity at Commercial Charging Stations

Three states have enacted legislation to tax the electricity used to charge EVs at public charging stations. Starting July 1, 2023, drivers in Iowa will pay a $0.026/kWh excise tax for electric fuel; charging station owners must register as licensed electric fuel dealers.[88] Revenue from the tax will go into the state's road use tax fund in the same manner as the state's gas tax. Similar laws go into effect in Kentucky and Oklahoma on January 1, 2024, when both states will begin collecting taxes of $0.03/kWh. Oklahoma's law exempts stations that provide free charging, but Kentucky will require charging station owners who provide free charging to pay the tax. Kentucky will adjust its rate annually for inflation.[89] Similar legislation has been introduced in Minnesota to replace the state's $75 EV registration fee with a $0.051/kWh tax on electricity used to charge vehicles. That proposal would tax electricity used by all charging locations, public and private.[90]

How much revenue could a tax on electric charging generate in Tennessee compared to the state's gas tax? A 2022 Hyundai Kona with a gas engine gets an EPA-estimated 32 mpg and would therefore consume 424 gallons of gas in a typical year (13,573 miles) and generate $114.52 in gas tax revenue. The fully electric Kona has 64.0 kWh useable battery capacity and a 258-mile estimated range, giving it an estimated efficiency of 0.248 kWh/mile.[91] The electric Kona would therefore use 3,367 kWh of electricity to travel the same distance as its gas-powered counterpart. If all the electricity used by the Kona were taxed at $0.03/kWh, it would generate $101.01. However, if 80% of charging is done at home and exempt from a charging tax, a three-cent tax on commercial charging would only generate about $20.

The state already generates some revenue from the sale and distribution of electric power, although not specifically to fund roads. Electric utilities pay a 3% gross receipts tax[92] and are subject to franchise and excise tax laws. Sales of electricity are generally subject to Tennessee's 7% sales tax.[93] However, energy "sold directly to the consumer for residential use" is exempt.[94] Cities and counties cannot apply local-option sales taxes to electricity.[95]

[88] Iowa Annotated Statutes, Sections 452A.40 through 44.
[89] Kentucky Revised Statutes, Section 138.477; Oklahoma Statutes Annotated, Title 68, Sections 6501 et seq.
[90] Senate File 1602 and House File 1878. https://www.revisor.mn.gov/bills/bill.php?f=SF1602&b=senate&y=2022&ssn=0.
[91] HyundaiUSA.com and EV-Database.org.
[92] Tennessee Code Annotated, Section 67-4-405.
[93] Tennessee Code Annotated, Section 67-6-102 (97)(A).
[94] Tennessee Code Annotated, Section 67-6-334(a).
[95] Tennessee Code Annotated, Section 67-6-704.

Vehicle Miles Traveled Taxes

Historically, a vehicle's fuel consumption was a reasonable approximation of its miles driven, and fixed-rate fuel taxes generated revenue in close proportion to road use. As fuel efficiency has increased, the connection between fuel consumption and road use has weakened, and with the introduction of EVs, some drivers pay no fuel tax at all.

Because of the many factors reducing the effectiveness of fuel taxes as the primary source of road funding, researchers and transportation experts in several states are exploring the viability of a vehicle-miles-traveled (VMT) tax instead. "A VMT tax is philosophically and literally a direct pay-per-mile-of-use system, similar to a toll road."[96] This type of system allows governments to charge drivers of all types of vehicles, regardless of their fuel source, for each mile driven. Transitioning to a VMT system, however, would require governments to overcome several challenges.

Data Collection and System Design Challenges

"The hurdles to launching a new system are significant, starting with how to collect the tax," writes *Washington Post* transportation reporter Ian Duncan. "The gas tax is cheap to collect, levied on a small number of wholesalers rather than customers, while taxing mileage would require tracking millions of drivers." Possible methods of collection include: odometer reporting, smartphone apps, road sensors or cameras similar to tolling, and onboard GPS devices. Each of these methods would come with tradeoffs as to their cost, level of compliance, ease of administration, interoperability, and concerns about privacy and data security, among others.

Studies show that a VMT tax in the US could be much more efficient and could collect many more dollars for the Highway Trust Fund than the current federal taxing regimen does. One report, commissioned by the American Transportation Research Institute (ATRI), showed that a VMT tax assessed on 272 million private vehicles could result in the collection of more than $20 billion annually—or 300 times more than the federal fuel-tax system. According to that same March 2021 ATRI study, implementing a VMT collection system would be costly—as much as $20 billion—in hardware and administration.

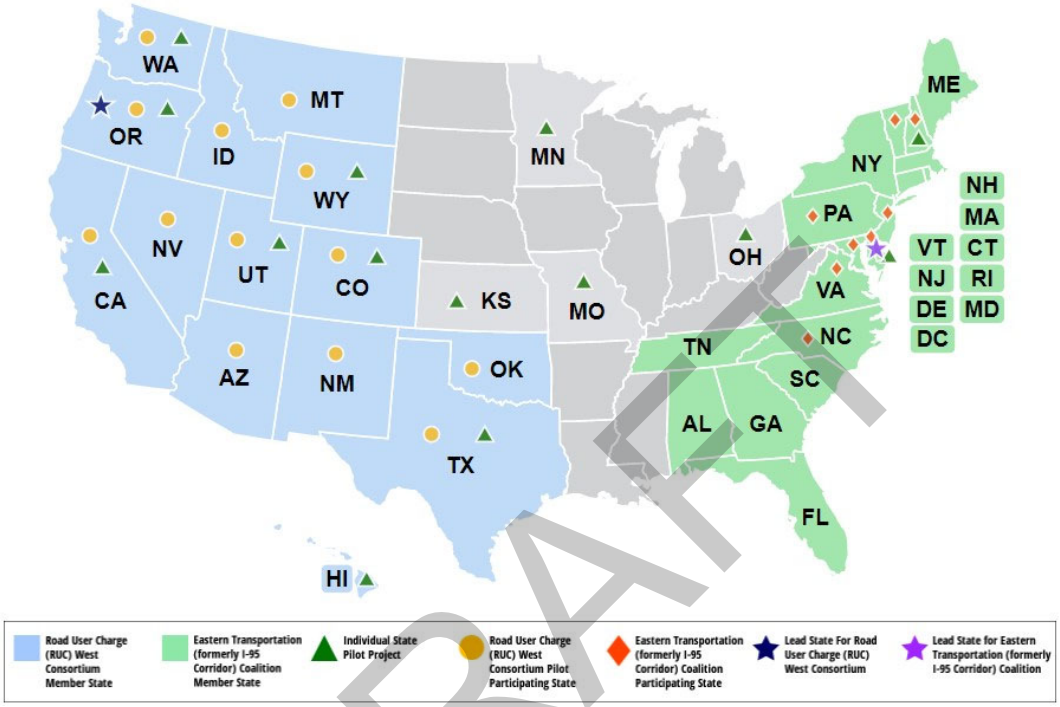
Case studies and pilot programs underway

The FAST Act established the Surface Transportation System Funding Alternatives (STSFA) Program to provide grants to states or groups of states "to demonstrate user-based alternative revenue mechanisms." Fourteen states (California, Colorado*, Delaware, Hawaii, Kansas, Minnesota,

[96] Short and Murray 2021.

Missouri, New Hampshire, Ohio, Oregon, Texas, Utah, Washington, and Wyoming) and regional pilots have received federal grants to explore alternative funding mechanisms.[97] See map 7.

Map 7. Surface Transportation System Funding Alternatives Pilot Project States



Source: FHWA "Surface Transportation System Funding Alternatives Program."

Six states have ongoing pilot programs funded by STSFA. Oregon and Utah have the most advanced pilot projects, where drivers can avoid paying registration fees by opting instead to pay mileage-based user fees, with revenue still directed to transportation infrastructure projects. California tested various fee technologies. Washington conducted a 12-month pilot. Grants in the remaining states were used primarily for planning and research. The United States Government Accountability Office (GAO) published a report in January 2022 that highlighted some challenges and lessons learned from these programs:

- Many of the states reported that public acceptance of mileage fee systems remains limited by concerns about protecting privacy and achieving equity.

[97] NCSL "State Road Usage Charge Toolkit." *Colorado was awarded funds that they subsequently returned.

- Some state DOT officials stated that the public perceived that rural drivers may pay more under a mileage fee system than under the current fuel tax structure.
- In the two states that currently operate active mileage fee systems, Oregon and Utah, costs to date have exceeded revenues.[98]

Pilot Programs in the Infrastructure Investment and Jobs Act

The Infrastructure Investment and Jobs Act (IIJA) directs the U.S. Department of Transportation to establish a national per-mile road usage fee pilot program while continuing to support existing STSFA pilots. The extension of STSFA expands eligibility to include local governments and metropolitan planning organizations and increases the federal cost share.

Fifty million dollars over five years is allocated for a new "National Motor Vehicle Per-Mile User Fee Pilot." USDOT is directed to carry out a nationwide pilot with volunteer participants from all 50 states, including commercial and passenger vehicles. The legislation requires the pilot program to offer different methods for participants to track their mileage and directs USDOT to set annual per-mile fees for different types of vehicles.[99]

Evolving Issues for Other Battery-Electric Vehicles and Equipment

At the Commission's September 2022 meeting, members expressed concerns about other battery-electric vehicles and equipment and wanted to know more about them. The speed of adoption of other types of battery-powered equipment and vehicles will vary. Manufacturers continue to add battery-powered versions of equipment and vehicles, which are gaining market share. On the smaller end these include motorcycles,[100] outboard motors,[101] and forklifts.[102] On the larger end, manufacturers are developing battery-powered fleet vehicles, both private and public—such as buses,[103] ambulances,[104] and fire trucks[105]—as well as battery-powered construction equipment—such as excavators, wheel loaders, and mining trucks.[106] Most larger construction vehicles are diesel powered; replacing diesel-powered versions with battery-powered versions is said to lower carbon emissions, decrease noise pollution, and lower project costs.[107]

---

[98] US Government Accountability Office 2022.
[99] Bipartisan Policy Center "Mileage-Based User Fee Pilot Programs and the IIJA."
[100] Purvis 2022.
[101] Market Growth Reports 2022.
[102] BigRentz.com 2021.
[103] Lewis 2022; Wilson 2022.
[104] Lightning eMotors "Ambulances."
[105] Lambert 2022.
[106] BigRentz.com 2021.
[107] Ibid.

Manufacturers are also developing battery-powered agricultural equipment. However, it may take a long time to perfect battery-powered equipment to replace larger diesel-powered farm equipment. According to John Deere,

> the duty cycles of passenger cars and farm machinery are very different. Passenger cars sit in garages, or parking lots most of the time, providing ample charging opportunities. A tractor operating 24 hours a day, seven days a week during the planting season, often in remote locations, requires battery technology that can power equipment for a full working day and be charged in a timely fashion.[108]

Agricultural and construction equipment is often expensive, and adoption will be affected by projected up-front costs and maintenance costs, as well as reliable charging availability. "As the costs of renewable energy and battery storage come down," however, farmers "could be drawn to the idea of replacing diesel with on-site renewable power."[109] "At new construction sites, it's possible there isn't an electrical hookup at all—much less high voltage options," notes one writer. Workforce training for operators and mechanics is also a challenge.[110] One fruit farm in California replaced four small diesel tractors with electric ones, along with an "all-electric Class 6 vehicle-to-vehicle charging truck," that can drive to where the tractors are working, "eliminating time-consuming round-trips back to the charging station."[111]

[108] McClinton 2022.
[109] Kowalski 2021.
[110] Golden 2022.
[111] MotorWeek 2021.

References

Area Development. 2021. "Ultium Cells Joint Venture Plans Spring Hills, Tennessee, Battery Cell Manufacturing Plant." April 19. https://www.areadevelopment.com/newsitems/4-19-2021/ultium-cells-spring-hills-tennessee.shtml.

Atlas Public Policy. "State EV Registration Data." Data for Tennessee last updated June 30, 2022. https://www.atlasevhub.com/materials/state-ev-registration-data/.

Autolist.com. 2022. "Survey: Price and Range, Not Gas Prices, Dominate Worries About EVs." July 20. https://www.autolist.com/news-and-analysis/2022-survey-electric-vehicles.

BigRentz.com. 2021. "Electric Construction Equipment: The Future of Heavy Machinery." Blog post, September 6. https://www.bigrentz.com/blog/electric-construction-equipment.

Center for Automotive Research. 2022. "Automakers Invest Billions in North American EV and Battery Manufacturing Facilities." July 21. https://www.cargroup.org/automakers-invest-billions-in-north-american-ev-and-battery-manufacturing-facilities/.

Chaney, Kim. 2022. "Going green in Shelby County: Mayor signs order to replace gas-powered county vehicles with hybrid & electric ones." *ABC24/LocalMemphis.com*, August 17. https://www.localmemphis.com/article/news/local/shelby-county-mayor-lee-harris-signs-executive-order-green-fleet-memphis-climate-change/522-bdc8fc4e-6c19-4dde-a7a6-9ef6c713002e.

Chervin, Stan, and Cliff Lippard. 2002. *Highway Finance in Tennessee.* Tennessee Advisory Commission on Intergovernmental Relations. https://www.tn.gov/content/dam/tn/tacir/documents/HIGHWAYFINANCEFinal.pdf.

CTAS (County Technical Assistance Service). "County Motor Vehicle Privilege Tax." Accessed September 2, 2022. https://www.ctas.tennessee.edu/eli/county-motor-vehicle-privilege-tax-wheel-tax.

———. "Tennessee County Tax Statistics." Accessed September 2, 2022. https://www.ctas.tennessee.edu/tennessee-county-tax-statistics.

Dow, Jameson. 2022. "Senate calls USPS bluff with $3 billion for electric trucks – will it go 100% BEV?" *electrek.co*, August 8. https://electrek.co/2022/08/08/senate-calls-usps-bluff-3-billion-for-electric-trucks/.

Drive Electric Tennessee. 2019. *A Roadmap for Electric Vehicles in Tennessee.* https://driveelectrictn.org/wp-content/uploads/2019/08/Roadmap_for_Electric_Vehicles_in_Tennessee_Report.pdf.

———. "EV Fleets & Projects in TN." Accessed September 23, 2022. https://www.driveelectrictn.org/fleetsandprojects/.

Drori, Ze'ev. 2008. "We have begun regular production of the Tesla Roadster." Blog post, March 17. https://www.tesla.com/blog/we-have-begun-regular-production-tesla-roadster.

Edelstein, Stephen. 2016. "Automobile Driving Museum show offers electric-car history retrospective." *Green Car Reports*, May 16. Accessed November 23, 2022. https://www.greencarreports.com/news/1104173_automobile-driving-museum-show-offers-electric-car-history-retrospective.

EPB. "EV Charging Incentive." Accessed September 13, 2022. https://business.epb.com/energy/incentives/ev-incentive-commercial-customers/.

FHWA (Federal Highway Administration). 2012. "Funding Basics and Eligibility." Federal-aid Essentials for Local Public Agencies. https://www.fhwa.dot.gov/federal-aidessentials/companionresources/44funding.pdf.

———. 2013. "Highway Functional Classification: Concepts, Criteria and Procedures." https://www.fhwa.dot.gov/planning/processes/statewide/related/highway_functional_classifications/fcauab.pdf.

———. 2017a. "Highway Trust Fund and Taxes." FAST Act Fact Sheets. Last modified on February 8, 2017. https://www.fhwa.dot.gov/fastact/factsheets/htffs.cfm.

———. 2017b. "National Highway System." Last modified June 29, 2017. https://www.fhwa.dot.gov/planning/national_highway_system/.

———. 2021. "Description of NHCCI Methodology." Last modified on March 25, 2021. https://www.fhwa.dot.gov/policy/otps/nhcci/methodology.cfm.

———. 2022a. "Bridge Condition by Owner 2022." National Bridge Inventory. Last modified July 19, 2022. https://www.fhwa.dot.gov/bridge/nbi/no10/owner22d.cfm#tn.

———. 2022b. "Bipartisan Infrastructure Law." Last modified August 31, 2022. https://www.fhwa.dot.gov/bipartisan-infrastructure-law/.

———. (Multiple years.) "Highway Statistics Series." Office of Highway Policy Information. https://www.fhwa.dot.gov/policyinformation/statistics.cfm.

Flessner, Dave. 2022. "Study ranks Tennessee best in road quality among all states." *Chattanooga Times Free Press*, updated January 27. https://www.timesfreepress.com/news/2022/jan/26/study-ranks-tennessee-best-road-quality-states/.

———. 2020. "TVA sets goal for 200,000 electric vehicles in the Tennessee Valley by 2028." *Chattanooga Times Free Press*, November 13. https://www.timesfreepress.com/news/2020/nov/13/tva-electric-vehicles/.

Giordano, Lizz. 2022. "Expansion of electric vehicle grid hits roadblocks in rural WA." *Crosscut.com,* August 8. https://crosscut.com/news/2022/08/expansion-electric-vehicle-grid-hits-roadblocks-rural-wa.

Golden, Sarah. 2022. "What it will take to electrify construction equipment." *GreenBiz.com*, November 17. https://www.greenbiz.com/article/what-it-will-take-electrify-construction-equipment.

Institute on Taxation and Economic Policy. 2019. "Most Americans Live in States with Variable-Rate Gas Taxes." Brief, June 27. https://itep.org/most-americans-live-in-states-with-variable-rate-gas-taxes-0419/.

International Energy Agency. 2022. *Global Electric Vehicle Outlook 2022.* https://iea.blob.core.windows.net/assets/ad8fb04c-4f75-42fc-973a-6e54c8a4449a/GlobalElectricVehicleOutlook2022.pdf.

IperionX Limited. 2022. "Titan Project Scoping Study." Press release, June 30. https://app.sharelinktechnologies.com/announcement/asx/fbe3a5ce7eb9c24833e9c0f2a0d7df8b.

Knoxville Utilities Board. "Electric Vehicle Charger Rebate." Accessed September 23, 2022. https://www.kub.org/about/kub-environmental-stewardship/ev-charger-rebate-program.

Kowalski, Kathiann M. 2021. "Weight, dawn-to-dusk demands pose challenges to electrifying farm vehicles." *Energy News Network*, August 18. https://energynews.us/2021/08/18/weight-dawn-to-dusk-demands-pose-challenges-to-electrifying-farm-vehicles/.

Lambert, Fred. 2022. "The first electric fire truck is deployed in the US by LAFD." Electrek.co, May 17. https://electrek.co/2022/05/17/electric-fire-truck-deployed-us-lafd/.

Lewis, Michelle. 2022. "The largest electric school bus fleet in the US just launched in Maryland." Electrek.co, October 25. https://electrek.co/2022/10/25/largest-electric-school-bus-fleet-us/.

Lightning eMotors. "Ambulances." Web page accessed November 22, 2022 at https://lightningemotors.com/ambulances/.

McClinton, Lorne. 2022. "Rural Electrification." *The Furrow* (John Deere), March 1. https://www.deere.com/en/publications/the-furrow/2022/march-2022/rural-electrification/.

Market Growth Reports. 2022. "Outboard Electric Motors Market Value in 2025 with Competition Analysis Data of Top Key Players." Press release, October 17. https://www.theexpresswire.com/pressrelease/What-is-a-CAGR-of-Outboard-Electric-Motors-Market-Outboard-Electric-Motors-Market-Value-in-2025-with-Competition-Analysis-Data-of-Top-Key-Players_17966159.

Mattise, Jonathan. 2022. "Tennessee roads plan mulls toll lanes, electric car fee hike." *Associated Press*, December 3. https://apnews.com/article/technology-tennessee-nashville-transportation-traffic-ada9353ebcec0e984e708e1d9d7508e7.

Mazza, Sandy. 2022. "Tennessee to add 1,900 electric-battery jobs with aid of $490M in federal grants." *The Tennessean*, October 23. https://www.tennessean.com/story/money/industries/2022/10/24/three-new-electric-battery-plants-coming-to-tennessee-federal-backing/69575517007/.

Minott, Owen. 2022. "Mileage-Based User Fee Pilot Programs and the IIJA." Bipartisan Policy Center, February 11. https://bipartisanpolicy.org/blog/mileage-based-user-fee-pilot-programs-and-the-iija/.

MotorWeek. 2021. "How Farming is Looking to the Future with Electrification." *Auto World*, March 24. https://www.motorweek.org/features/auto_world/green-orchards.

Mullaley, Mike. 2022. "By Electrifying Government Vehicles, States are Leading by Example." *Advanced Energy Economy*, April 25. https://blog.aee.net/by-electrifying-government-vehicles-states-are-leading-by-example.

NASBO (National Association of State Budget Officers). 2021. *State Expenditure Report.* https://www.nasbo.org/reports-data/state-expenditure-report.

National Academies of Sciences, Engineering, and Medicine. 2019. *Renewing the National Commitment to the Interstate Highway System: A Foundation for the Future.* Washington, DC: The National Academies Press. https://doi.org/10.17226/25334.

NCSL (National Conference of State Legislatures). 2020. "Vehicle Registration Fees By State." Last modified on February 4, 2020. https://www.ncsl.org/research/transportation/registration-and-title-fees-by-state.aspx.

———. "Special Fees on Plug-In Hybrid and Electric Vehicles." Last modified on July 26, 2022. https://www.ncsl.org/research/energy/new-fees-on-hybrid-and-electric-vehicles.aspx.

New Jersey Department of the Treasury. 2021a. "Treasury Announces Gas Tax Rate Will Decrease by 8.3 Cents Effective October 1." News release, August 24. https://www.nj.gov/treasury/news/2021/08242021.shtml.

———. 2021b. *OREA Explains: The "Gas Tax."* https://www.nj.gov/treasury/pdf/symposium/OREA-Explains-Issue-3-Gas-Tax.pdf.

———. 2022. "Excise Rates." Last modified on June 9, 2022. https://www.state.nj.us/treasury/taxation/excisetaxrate.shtml.

Office of Governor Gavin Newsom. 2020. "Governor Newsom Announces California Will Phase Out Gasoline-Powered Cars & Drastically Reduce Demand for Fossil Fuel in California's Fight Against Climate Change." News release, September 23. https://www.gov.ca.gov/2020/09/23/governor-newsom-announces-california-will-phase-out-gasoline-powered-cars-drastically-reduce-demand-for-fossil-fuel-in-californias-fight-against-climate-change/.

Purvis, Ben. 2022. "Battery-Swapping Tech Gives Electric Motorcycles an Edge." *Wired.com,* October 27. https://www.wired.com/story/battery-swapping-tech-gives-electric-motorcycles-an-edge/.

Raucoles, Gregory. 2022. "Tennessee receives $300 million to improve bridges." *WATE.com*, January 14 (updated August 2). https://www.wate.com/news/tennessee/tennessee-receives-300-million-to-improve-bridges/.

Reason Foundation. 2021. *Annual Highway Report.* "Tennessee Ranks 10th in the Nation in Highway Performance and Cost-Effectiveness." https://reason.org/policy-study/26th-annual-highway-report/tennessee/.

Rott, Nathan. 2022. "California will ban sales of new gasoline-powered cars by 2035." *NPR.org*, August 25. https://www.npr.org/2022/08/25/1119456396/california-is-set-to-ban-sales-of-new-gasoline-powered-cars-by-2035.

Shepardson, David. 2022. "U.S. Postal Service to boost electric delivery vehicle purchases." *Reuters*, July 20. https://www.reuters.com/world/us/us-postal-service-plans-up-electric-delivery-vehicle-purchases-2022-07-20/.

Short, Jeffrey and Dan Murray. 2021. *A Practical Analysis of a National VMT Tax System.* American Transportation Research Institute. https://truckingresearch.org/2021/03/16/a-practical-analysis-of-a-national-vmt-tax-system/.

Sulek, Marissa. 2022. "TN landowners lease land to titanium company for profit." *WSMV.com*, August 3. https://www.wsmv.com/2022/08/03/tn-landowners-lease-land-titanium-company-profit/.

Tennessee Advisory Commission on Intergovernmental Relations. 2022. *Building Tennessee's Tomorrow: Anticipating the State's Infrastructure Needs, July 2020 through June 2025.* https://www.tn.gov/content/dam/tn/tacir/infrastructure/2022infra2020-2025/2022_Infrastructure.pdf.

———. "Data Explorer." Accessed August 30, 2022. https://www.tn.gov/tacir/infrastructure/data-explorer.html.

Tennessee Department of Environment and Conservation. 2022. "TDEC Announces Grants for Fast Charge TN Network Under Volkswagen Settlement Environmental Mitigation Trust." News release, July 28. https://www.tn.gov/environment/news/2022/7/28/tdec-announces-grants-for-fast-charge-tn-network-under-volkswagen-settlement-environmental-mitigation-trust.html.

———. "Fast Charge TN Network." Accessed September 20, 2022. https://www.tn.gov/environment/program-areas/energy/state-energy-office--seo-/programs-projects/programs-and-projects/sustainable-transportation-and-alternative-fuels/sustainable-transportation-and-alternative-fuels/transportation-electrification-in-tennessee/tdec-and-tva-moa.html.

Tennessee Department of General Services. 2020. *Annual Report on Energy-Efficient Purchasing, Fiscal Year 2019-2020.* December 2020, Vehicle and Asset Management Division. https://www.tn.gov/content/

dam/tn/generalservices/documents/reports/2020%20VAM%20Energy%20Efficiency%20Report%20FINAL.pdf.

Tennessee Department of Revenue. "IMPROVE Act." Accessed September 23, 2022. https://www.tn.gov/revenue/tax-resources/legal-resources/improve-act.html.

———. Summary of Collections, July 2021-June 2022. https://www.tn.gov/content/dam/tn/revenue/documents/pubs/2022/Coll202206.pdf.

Tennessee Department of Transportation. 2019. *State Transportation Improvement Program, Fiscal Years 2020-2023.* https://www.tn.gov/content/dam/tn/tdot/programdevelopment/stip-amendments/1.5.21_Tennessee%20STIP%202020-2023%20Final_R.pdf.

———. 2022. *Tennessee Electric Vehicle Infrastructure Deployment Plan.* https://www.tn.gov/content/dam/tn/tdot/long-range-planning/air-quality-folder/TEVI%20Proposed%20Plan%20072822.pdf.

———. "Electric Vehicle Infrastructure Deployment Plan." (Web page). Accessed September 13, 2022. https://www.tn.gov/tdot/long-range-planning-home/air-quality-planning/tevi.html.

———. "Gas Tax History." Accessed September 13, 2022. https://www.tn.gov/tdot/finance/gas-tax/gas-tax-history.html.

———. "Proposed Highway Program for Fiscal Year 2022-2023." https://www.tn.gov/content/dam/tn/tdot/community-relations/FY23%20Transportation%20Projects%20with%20Counties.pdf.

Tennessee Valley Authority. 2022. *Strategic Plan FY 2022-FY 2026.* https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/about-tva/guidelines-reports/fy-2022---2026-strategic-plan5be28920-60e0-4839-b86b-608794f85519.pdf?sfvrsn=ee73bc84_3.

———. 2019. *2019 Integrated Resource Plan.* https://www.tva.com/environment/environmental-stewardship/integrated-resource-plan.

———. "TVA Announces Fleet EV Plan." Accessed September 23, 2022. https://www.tva.com/newsroom/articles/tva-announces-fleet-ev-plan.

Tennessee Valley Authority and Tennessee Department of Environment and Conservation. 2022. *Fast Charge TN Network Program Guidelines.* https://prod.tva-ers.media.energyright.com/wp-content/uploads/2022/08/Fast-Charge-TN-Network-Program-Guidelines_v2_FINAL_August-2022.pdf. (Accessed September 13, 2022 at https://energyright.com/ev/fast-charger-program/tn/.)

TRIP. 2022. *Funding America's Transportation System.* https://tripnet.org/wp-content/uploads/2022/03/Funding_Americas_Transportation_System_Report_March_2022.pdf.

US Census Bureau. 2020 Census Redistricting Data (P.L. 94-171) Summary Files. Released September 16, 2021. https://www.census.gov/programs-surveys/decennial-census/about/rdo/summary-files.html#P1.

"QuickFacts Tennessee." Accessed August 23, 2022. https://www.census.gov/quickfacts/TN.

US Department of Energy. 2022a. *America's Strategy to Secure the Supply Chain for a Robust Clean Energy Transition.* February 24. https://www.energy.gov/sites/default/files/2022-02/America%E2%80%99s%20Strategy%20to%20Secure%20the%20Supply%20Chain%20for%20a%20Robust%20Clean%20Energy%20Transition%20FINAL.docx_0.pdf.

———. 2022b. "Biden-Harris Administration Awards $2.8 Billion to Supercharge U.S. Manufacturing of Batteries for Electric Vehicles and Electric Grid." News release, October 19. https://www.energy.gov/articles/biden-harris-administration-awards-28-billion-supercharge-us-manufacturing-batteries.

———. "Recent Federal Actions." Alternative Fuels Data Center. Accessed September 23, 2022. https://afdc.energy.gov/laws/recent?key=federal

US Energy Information Administration. 2022a. *Annual Energy Outlook 2022.* https://www.eia.gov/outlooks/aeo/.

———. 2022b. "Federal and State Motor Fuels Taxes." (Excel workbook) https://www.eia.gov/petroleum/marketing/monthly/xls/fueltaxes.xls. Accessed September 1, 2022 at https://www.eia.gov/tools/faqs/faq.php?id=10&t=10.

US Environmental Protection Agency. 2021. *Automotive Trends Report.* (EPA-420-R-21-023, November 2021). https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1013L1O.pdf.

US Government Accountability Office. 2022. *Federal Highway Administration Should Develop and Apply Criteria to Assess How Pilot Projects Could Inform Expanded Use of Mileage Fee Systems.* https://www.gao.gov/products/GAO-22-104299

Vock, Daniel C. 2022. "The Growing Debate Over Where to Put EV Chargers in Rural America." RouteFifty.com, September 12. https://www.route-fifty.com/infrastructure/2022/09/growing-debate-over-where-put-ev-chargers-rural-america/377046/.

Weinberg, Adam. 2020. "Nebraska Gas Tax to Decline 4.5 Cents a Gallon in 2021." Platte Institute, December 22. https://platteinstitute.org/nebraska-gas-tax-to-decline-4-cents-in-2021/.

Wilson, Kea. 2022. "US DOT Will Double the Nation's Electric Bus Fleet (But It Will Still Be Tiny)." StreetsBlogUSA, August 16. https://usa.streetsblog.org/2022/08/16/us-dot-seeks-to-double-the-nations-electric-bus-fleet-which-is-currently-tiny-and-will-still-be/.

Persons Contacted

Nicole Barranco
Senior Director of State Government Relations
Volkswagen Group of America, Inc.

Shauna Basques
Communications Coordinator / Energy Analyst
Tennessee Department of Environment and Conservation

Jonathon Bates
Transportation Policy Associate
National Conference of State Legislatures

Terra Beach
Driver Services- A-list & Idemia Liaison Lead
Tennessee Department of Safety & Homeland Security

Jeff Bjarke
Research Director
Tennessee Department of Revenue

Kevin Brooks
Mayor,
City of Cleveland, Tennessee

Jeremy Elrod
Director of Government Relations
Tennessee Municipal Electric Power Association

Dr. Bill Fox
Special Advisor to the Chancellor
University of Tennessee, Knoxville

Eric Henning
Southeast Regional Director State Government Relations
General Motors

Joe Hoagland
Vice President of Enterprise Relations and Innovation
Tennessee Valley Authority

Michael Hogan
Director, Driver Services Division
Tennessee Department of Safety & Homeland Security

Jeff Huffman
County Executive
Tipton County, Tennessee

Holly Salmons Kirby
Principal
JohnsonPossKirby Government Relations

Nicole Lepre
Policy Analyst
Atlas Public Policy

Michael Maten
Director of EV Policy and Regulatory Affairs
General Motors

A. Keith McDonald
Mayor
City of Bartlett, Tennessee

Matt Meservy
Long Range Planning Director
Tennessee Department of Transportation

Wendell Moore
Partner
MNA Government Relations

Adam Muncy
Assistant VTRS Team Lead
Business Information Systems, Inc.

Jeremy Nagoshiner
Partner
MNA Government Relations

Adam Nickas
Lobbyist/Consultant
Capitol Resources, LLC

Nick Nigro
Founder
Atlas Public Policy

Lia Prince
Planning Manager
Tennessee Department of Transportation

Mark W. Smith
Attorney
Miller & Martin PLLC

Stephen Smith
Deputy Commissioner and Director
TennCare

Brian Solsbee
Executive Director
Tennessee Municipal Electric Power Association

Jim Spears
Owner
Spears Public Strategies

Alexa Voytek
Grants Program Manager
Tennessee Department of Environment and Conservation

Joseph Wegenka
Chief Economist
Tennessee General Assembly

Leighton Yates
Director of State Affairs
Alliance for Automotive Innovation