Impact of Electric Vehicle Adoption on State Tax Revenues and Transportation Infrastructure Funding: a Case Study of Alabama

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Abstract

In different states across the U.S., the growing number of electric vehicles (EVs) has been among the causes of the decline in fuel tax revenues that provide funding for transportation infrastructure projects. As the number of EVs on the road is expected to increase significantly in the coming years, the fuel tax revenue shortfall may grow and create a deficit in state transportation infrastructure funding, unless changes are made to the current EV taxation policies. Using the case of Alabama, this study examines the impact of EV adoption on state tax revenues that serve to fund transportation infrastructure projects in the state. The results include the impacts of EV adoption on Alabama's tax revenues on a per-vehicle basis for each year in the study period (2022-2041) as well as the total impact over the 20-year period of analysis. In the analysis, the predictions for future annual impacts of EV adoption on state tax revenues account for the consumer behavior in the EV market which allows estimating the tax revenue impacts for two different adoption scenarios: the conservative scenario and the "most likely" scenario. The study finds that on average, an internal combustion engine (ICE) vehicle driver in Alabama pays a larger amount in total annual taxes than an EV driver and the difference is expected to grow in the future, unless changes are made to the current EV taxation structure. Considering that the number of EVs is also expected to increase significantly over the coming years, the tax revenue shortfall associated with EV adoption in the state is expected to rise from year to year. The study also provides an overview of practices and strategies currently implemented in other states to supplement state transportation infrastructure funding through the taxation of EV drivers. The study explores the advantages and disadvantages of those policies and assesses the feasibility of those strategies for the state of Alabama. The study offers insights and recommendations that may be helpful to policymakers and stakeholders in Alabama and other states, in their decision-making regarding potential ways to offset tax revenue loss associated with EV adoption.

1. Introduction

Recently, electric vehicles (EVs) have seen a significant growth in adoption rates with some studies predicting that by 2032, 30% of all passenger cars worldwide will be EVs. (Rietmann et al., 2020). Historically, in many countries, the revenue from gasoline taxes has been used to fund transportation infrastructure construction and improvement projects. (Davis and Sallee, 2020). In the U.S., all states rely heavily on motor fuel tax revenues for transportation infrastructure projects: in different states, fuel taxes fund between 14%-82% of state and local transportation infrastructure spending (Boesen, 2021). Yet, it is estimated that revenue collected from gas taxes will diminish significantly over the coming years (Congressional Budget Office, 2024). The transition to EVs, that do not generate any fuel tax revenues, is expected to have a negative impact on the traditional methods for funding transportation infrastructure.

In recent years, in Alabama, 74% of state and local road spending relied on the revenues from motor fuel taxes. Therefore, the state's transition to EVs is expected to be associated with a negative effect on tax revenues utilized for transportation infrastructure funding. In 2022, EVs represented 0.15% (7,449 EV registrations) of all vehicle registrations in Alabama. However, that number is projected to swell in the coming years with EVs being projected to represent over 20% (1.2 million EV registrations) of all vehicle registrations statewide. In Alabama, EV drivers do not pay a gasoline tax, but they do pay an annual EV registration surcharge that, like the gas tax, helps fund state transportation infrastructure projects. (Code of Ala. § 40-12-242).

The objective of this analysis is to estimate the impact of EV adoption on Alabama's tax revenues that contribute to transportation infrastructure funding. The study is based on the 20-year period between 2022–2041. Alabama is a state that has already put in place strategies to mitigate the fuel tax revenue shortfall:

the state has indexed its gas tax to the National Highway Construction Cost Index (NHCCI) and has implemented annual EV registration surcharges with an automatic increase every three years to account for inflation. Most other studies measuring the tax revenue impact of growing EV adoption rates have not been conducted in a state where fuel tax revenue loss mitigation strategies are already in place. Additionally, this report offers an overview of practices and strategies currently implemented in other states to collect tax revenues from EV drivers. The study provides insights and recommendations that may be helpful to policymakers and stakeholders in Alabama and other states across the U.S. in their decision-making regarding potential ways to supplement state transportation infrastructure funding.

In the analysis, the predictions for future annual impacts of EV adoption on state tax revenues weigh heavily the information about consumer behavior in the EV market, when estimating the impacts. The predictions for future EV adoption rates are based on the projections generated by the EV Adoption Forecasting Tool EVOLVE developed by the Institute for Data Analytics (IDA) and the Alabama Mobility and Power Center (AMP) at The University of Alabama. Unlike many other existing EV adoption forecasting tools that are based primarily on governmental regulations in the EV market, EVOLVE generates projections for the number of EV and ICE vehicle registrations in Alabama, the Southeast, and the U.S., using consumer perceptions of – and opinions about – different trends in the EV industry. The forecasting model employs a set of indices to enter the information about consumer beliefs with regards to different trends in the EV industry into the prediction model. When estimating the impact of transportation electrification on tax revenues in the state, the study considers two adoption scenarios: the most conservative scenario generated by the model as well as "the most likely" scenario that is created using the model's user response data. Therefore, in the study, the estimates of tax revenue loss due to EV adoption are provided as a range between the tax revenue loss values obtained using the two scenarios.

2. Background

Several previous studies have examined the impact the shift to EVs will have on revenues for transportation infrastructure. Konstantinou et al. (2023) explored the impact of the transition to EVs on fuel tax revenue by vehicle class. The case study was based in Indiana, U.S. and estimated the optimal EV fee based on vehicle class to recuperate the revenue lost from the shift to EVs. The authors also discussed a vehicle-miles-traveled fee (VMT) and pay-as-you-charge fee as potential mitigation measures for the decrease in revenues. Short and Crownover (2021) investigated the impact of EVs on the Highway Trust Fund (HTF) and considered other options for collecting revenue from EV users including charging station taxes, state-level registration fees, and VMT fees. Another case study in Alabama (Xu et al., 2020) evaluated the EV fee needed to mitigate the revenues lost from gas tax collections in the state.

Ricciuti (2020) evaluated the impact of tax revenue loss due to the EV transition in all 50 states from 2019-2028. The study estimated the annual EV registration fee necessary in each state to make up for the lost revenue. Jia et al. (2019) investigated the impact to revenues in Virginia from the growth of EVs. The model looked at county-level EV registrations, with the study evaluating nine impact scenarios. Their results projected a 5-19% decrease in tax revenue by 2025. The Iowa Department of Transportation (2018) addressed the revenue loss from three different EV adoption scenarios in Iowa and proposed alternative options to recover lost revenue. Their recommendations included adding a charging station tax at non-residential EV charging stations and adding a supplemental EV registration fee. Jenn et al. (2015) investigated how the transition to different models of EVs would impact revenues at the state and national levels. The study looked at potential solutions to mitigate the loss of revenue including a fee at 0.6% of the vehicle's manufacturer's suggested retail price, a $0.02 per mile charge, and a $0.045 per kilowatt-hour charging station fee.

These previous studies have not dealt with a scenario, like Alabama's, where the gasoline tax rate is indexed to one source, resulting in a potential automatic increase or decrease in funds; while the annual EV registration surcharge consistently increases at different rate, pre-defined by the EV registration surcharge policy.

In Alabama, the current annual tax amount paid by an internal combustion engine (ICE) vehicle driver consists of the annual registration tax and the annual fuel tax amount. The annual vehicle registration tax includes: (1) the standard license plate fee ($23-$105, depending on vehicle weight and license plate type), (2) the issuance fee ($1.25), and (3) the ad valorem tax. The average license plate fee amount paid by Alabama ICE vehicle drivers in 2022 was estimated to be $51.75. This is the portion of the vehicle registration tax that contributes to the state's transportation infrastructure funding. The ad valorem tax portion of the annual vehicle registration payment and additional fees, paid when a distinctive license plate is purchased, do not directly contribute to transportation infrastructure-related revenue funds and therefore are not considered in this analysis.

Alabama state fuel taxes are currently paid at the rate of $0.29 per gallon for gas vehicles and $0.30 per gallon for diesel vehicles. Under the Rebuild Alabama Act, effective October 1st, 2023, and on July 1st of every other year thereafter, the gasoline and diesel tax rates will be adjusted by the percentage change in the yearly average of the National Highway Construction Cost Index (NHCCI) and rounded to the nearest whole cent with the increase or decrease of the excise tax rate not exceeding $0.01 per gallon.

The current annual tax amount paid by an EV driver in Alabama consists of the annual EV registration tax which includes: (1) the standard license plate fee of $23, (2) the issuance fee of $1.25, (3) the EV registration surcharge of $203 for battery electric vehicles (BEVs) and $103 for plug-in hybrid electric vehicles (PHEVs), and (4) the ad valorem tax. EV registration fees will increase by $3 every 4 years until the total number of (BEV+PHEV) registrations in the state exceeds 4% of all vehicle registrations. After that, the EV registration fees will be reduced to the annual rate of $150 for BEVs and $75 for PHEVs while the $3 increase will continue to occur once every four years.

3. Analysis and Methodology

The study includes two parts. First, the impact of EV adoption on state tax revenues is estimated following the steps outlined below:

Step 1: Estimating the impact of EV adoption on fuel tax revenues in Alabama.

Step 2: Estimating the impact of EV adoption on vehicle registration tax revenues in Alabama.

Step 3: Estimating the total annual and per-vehicle tax revenue loss due to EV adoption in Alabama.

Once the impact of EV adoption on state tax revenues in Alabama is estimated, potential strategies to offset the tax revenue loss are identified. These strategies are formulated based on the research about existing approaches to compensate for tax revenues losses due to EV adoption implemented in other states nationwide.

3.1. Impact on Fuel tax Revenues

To estimate the impact of EV adoption on fuel tax revenues in Alabama, the average annual fuel tax amount paid by an ICE vehicle driver is calculated using Alabama's average annual per-car mileage of 17,523 miles (Federal Highway Administration Highway Statistics, 2022), and the assumption of average

fuel economy of 24 miles per gallon. The resulting average number of gallons used by an Alabama ICE vehicle driver in 2022 is 730 gallons. The analysis assumes that this annual fuel tax amount is lost when an EV is driven instead of an ICE vehicle for the period of one year.

Then, the average number of gallons value is multiplied by the 2022 tax rate values for gas ($0.28 per gallon) and diesel ($0.29 per gallon), to estimate the total annual per-car fuel tax payment of $204.40 for gas vehicles and $211.70 for diesel vehicles. Assuming that 97% of Alabama's registered ICE vehicles are gas vehicles and 3% are diesel vehicles (according to the state vehicle registration statistics data), the weighted average annual per-car fuel tax amount ($204.62) is obtained. Therefore, the analysis assumes that the average fuel tax payment amount of $204.62 was lost in 2022, each time an ICE vehicle was replaced by an EV and used for the duration of one year.

The approach described above is used to calculate the annual per-car and state total fuel tax amounts paid by ICE vehicle drivers for each year over the 20-year period between 2022-2041. The calculations are based on the state vehicle registration data, and the EV adoption projections (Figure 1-2) generated by the EV Adoption Forecasting Tool *EVOLVE* developed by the Institute for Data Analytics (IDA) and the Alabama Mobility and Power Center (AMP) at The University of Alabama. *EVOLVE* generates projections for the number of EV and ICE vehicle registrations in Alabama, the Southeast, and the U.S., using a set of indices to enter the information about consumer beliefs with regards to different trends in the EV industry into the prediction model. The analysis estimated the impact for two scenarios: (1) the most conservative scenario generated by the *EVOLVE* forecasting model (Figure 1) and (2) "the most likely" scenario that is obtained using the data about EV adoption projections based on our data from polling of the general public and automotive industry experts (Figure 2). In the scenarios with higher rates of EV market growth, the fuel tax revenue losses due to EV adoption will be larger.

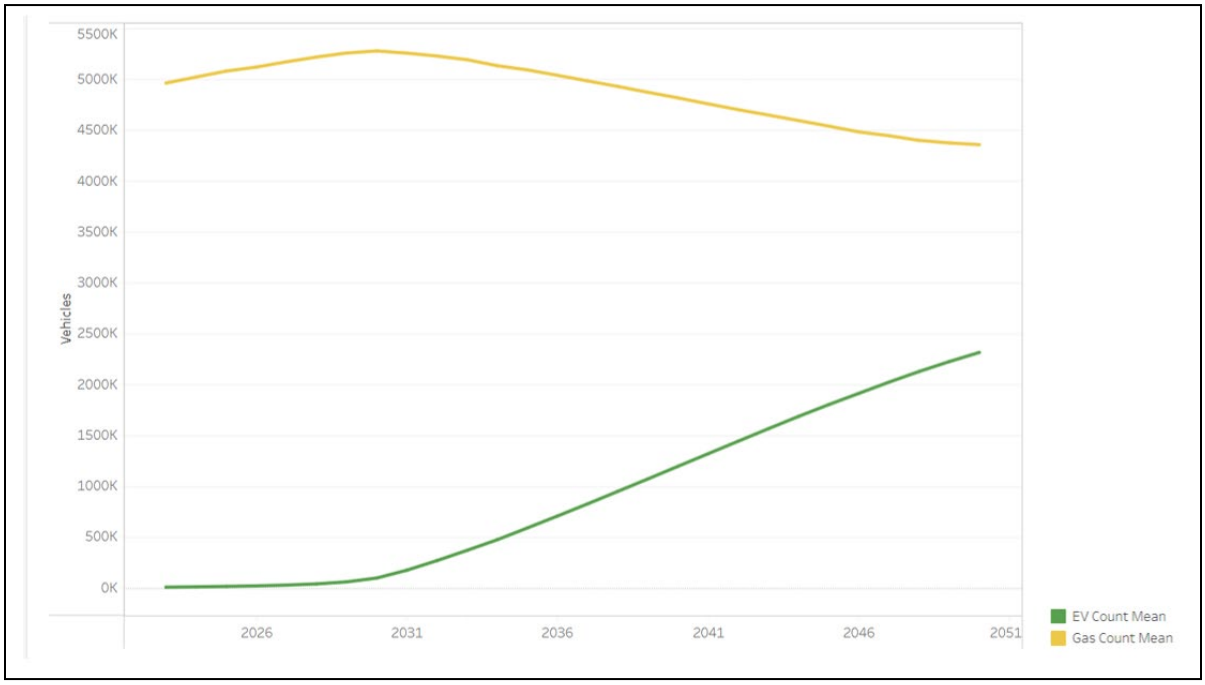


Figure 1: EVOLVE Forecasting Model: Alabama EV Adoption Forecast, Conservative Scenario

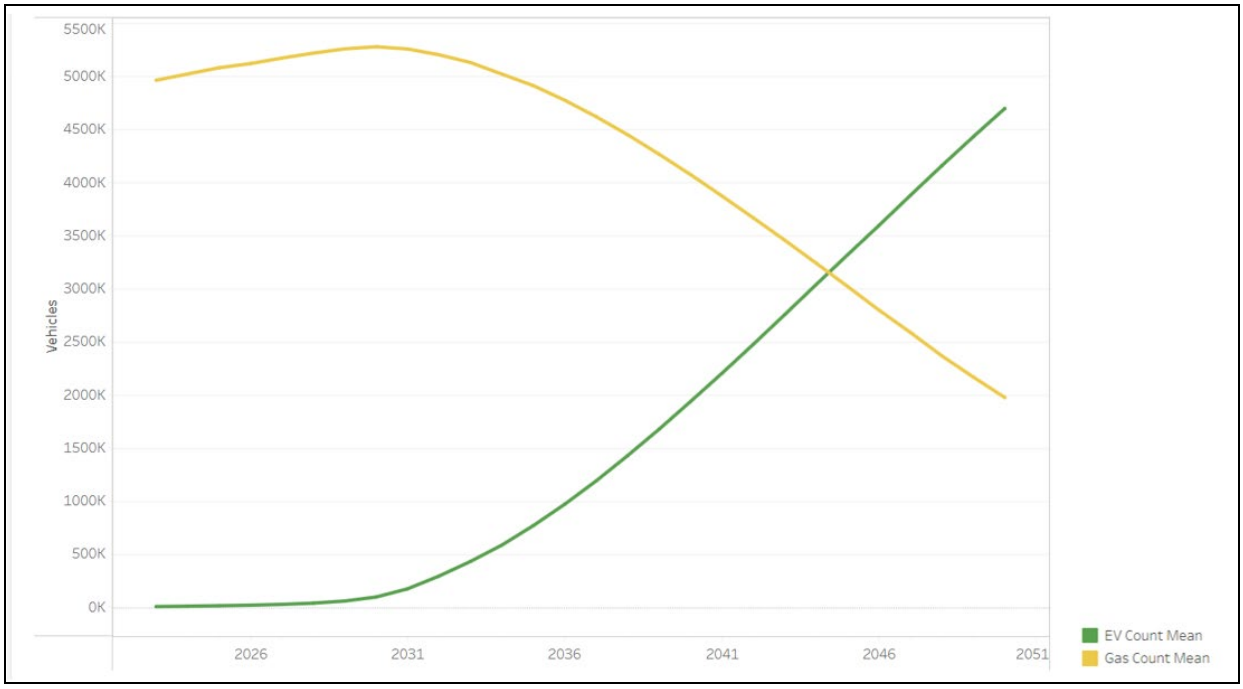


Figure 2: EVOLVE Forecasting Model: Alabama EV Adoption Forecast, "Most Likely" Scenario

The analysis accounts for the future annual fuel tax rate changes introduced by the Rebuild Alabama Act: "Effective October 1st, 2023, and on July 1st of every other year thereafter, the gasoline and undyed diesel excise tax rate will be adjusted by the percentage change in the yearly average of the National Highway Construction Cost Index and rounded to the nearest whole cent with the increase or decrease of the excise tax rate not exceeding $0.01 per gallon under the Rebuild Alabama Act" (Alabama Department of Revenue, 2023). The analysis of the historical performance of the National Highway Construction Cost Index (NHCCI) shows that between 2013-2023, the index's average annual rate of change was approximately 5.9%. This suggests that using the assumption of the bi-annual fuel tax rate increase of $0.01 may be appropriate when projecting gas and diesel tax rates for future years in the study period.

The total annual fuel tax revenue loss resulting from the usage of BEVs is calculated for each year in the study period (2022-2041) and the total tax amount for the 20-year period is estimated to be approximately $2.3 billion using the conservative scenario and $3.2 billion, using the "most likely" scenario.

3.2. Impact on Registration Tax Revenues

The impact of EV adoption on registration tax revenues is calculated as the difference between the annual tax revenue generated by EV registrations and the tax revenue that would be generated if the same number of ICE vehicles were registered instead of EVs in the given year.

The average annual vehicle registration amount paid by an ICE vehicle driver registered in Alabama is estimated using the data from the *State of Alabama Accounting and Resource System Reports* for the calendar year 2022. Particularly, the annual tax revenue amounts generated by state tax categories directly related to ICE vehicle registrations are included in the analysis. The average annual license plate fee amount paid by an ICE vehicle driver in 2022 is estimated to be $51.75. This average amount includes the standard license plate fee (varies between $23-$105, depending on vehicle weight and plate type), and the issuance fee of $1.25. It is assumed that the ICE vehicle registration fee amount will remain constant throughout the study period (2022-2041). Such an assumption is made because to the best knowledge of

the authors of this study, no information regarding expected future changes to the registration fees for ICE vehicles in Alabama is currently available.

The BEV annual registration fee includes the standard license plate fee of $23 and EV registration surcharge, which in 2022, was $200 for a BEV. Beginning July 1, 2023, and every fourth year thereafter, the EV registration fee would increase by $3, pursuant to the Rebuild Alabama Act. Additionally, the analysis accounts for the fact that the annual registration fees will be reduced to $150 for EVs when the total number of EVs and PHEVs in the state exceeds 4% of all vehicle registrations, while the $3-increase in the registration fee will continue to occur once every four years. Using the EV Adoption Forecasting Tool *EVOLVE* and the historic PHEV registration data, the total number of EV and PHEV registrations is projected annually for the period between 2022-2041, along with the annual projections for the total number of vehicle registrations in the state for the same period. Using the EV adoption forecasts generated by EVOLVE, it is estimated that by 2031, the proportion of EVs and PHEVs will exceed 4% of all vehicle registrations in the state in the case of both the Conservative Scenario and "Most Likely" Scenario. The total revenues generated by ICE vehicle and EV registrations are calculated annually for the period between 2022-2041.

3.3. Total Annual Tax Revenue Loss due to EV Adoption, Per-Car and Statewide

Using the results from Steps 1 and 2, the total annual tax revenue loss related to EV adoption is estimated for each year in the analysis period (2022-2041) on a per-vehicle basis and in the aggregate for the state. The results are presented below.

4. Results

The summary of the analysis for the Conservative Scenario and Most Likely Scenario are provided in the Tables 3-4. The information presented in Tables 1 and 2 below allows for comparison of the per-vehicle total annual tax amounts paid by an EV and ICE vehicle drivers in the first year (2022) and the final year (2041) of the analysis period for (the values are the same for both the Conservative and Most Likely scenarios). While the total annual tax collected from an ICE vehicle driver is expected to grow from $256.37 in 2022 to $329.37 in 2041 (28% increase over the period), the total annual tax amount paid by an EV driver is supposed to decrease from $224.25 in 2022 to $183.25 in 2041 (18% decrease over the period). As a result, while in 2022, an ICE vehicle driver would pay on average $32.12 more in total annual taxes than an EV driver, the difference will increase to $146.12 by 2041.

Table 1: Average Annual Tax Amounts Paid by EV and ICE Vehicle Drivers in 2022

2022	ICE Vehicle	EV
2022 Average Annual Fuel Tax Cost	$204.62	-
2022 Average Annual Vehicle Registration Rate	51.75	$224.25
2022 Total Annual Tax Cost	$256.37	$224.25

Table 2: Average Annual Tax Amounts Paid by EV and ICE Vehicle Drivers in 2041

2022	ICE Vehicle	EV
2022 Average Annual Fuel Tax Cost	$277.62	-
2022 Average Annual Vehicle Registration Rate	51.75	$183.25
2022 Total Annual Tax Cost	$329.37	$183.25

In addition to the growing per-vehicle difference in the total annual tax amounts paid by EV and ICE vehicle drivers, the number of EVs on the road is expected to increase significantly over the course of the analysis period: from 7,449 vehicle registrations in 2022 to over 1.2 million registrations in 2041 in the case of the Conservative Scenario and from 7,449 vehicle registrations in 2022 to over 2.2 million in the case of the Most Likely scenario. As a result, the total annual tax revenue loss associated with EV adoption is expected to increase from $0.24 million in 2022 to about $177.4 million in 2041 in the case of the Conservative Scenario, and to over $322 million in the case of the Most Likely scenario. The total revenue loss for the period between 2022-2041 will be approximately $1.1 billion in the case of the Conservative Scenario and about $1.6 billion in the case of the Most Likely scenario (Table 3-4).

Table 3: Estimated Tax Revenue Loss due to EV Adoption (Conservative Scenario)

	Total Annual Fuel Tax Loss	EV – ICE Vehicle Registration Tax Difference (EV Regs*EV Reg Rev - EV Regs*ICE Reg Rev)	Total Annual Tax Revenue Loss
2022	$1,524,206.93	$1,284,952.50	$239,254.43
2023	$2,303,771.45	$1,891,554.00	$412,217.45
2024	$3,418,677.31	$2,831,166.00	$587,511.31
2025	$5,634,366.74	$4,510,701.00	$1,123,665.74
2026	$10,975,199.24	$8,786,407.50	$2,188,791.74
2027	$20,153,395.43	$15,747,690.00	$4,405,705.43
2028	$29,277,580.75	$23,071,125.00	$6,206,455.75
2029	$42,361,222.05	$32,339,023.50	$10,022,198.55
2030	$55,002,880.10	$41,989,804.50	$13,013,075.60
2031	$72,386,817.23	$37,226,288.00	$35,160,529.23
2032	$88,896,476.28	$46,269,716.50	$42,626,759.78
2033	$111,281,526.82	$56,218,854.50	$55,062,672.32
2034	$131,161,008.88	$66,261,866.50	$64,899,142.38
2035	$157,980,129.57	$78,459,076.00	$79,521,053.57
2036	$182,069,115.09	$91,490,586.50	$90,578,528.59
2037	$212,410,199.12	$103,774,672.50	$108,635,526.62
2038	$239,999,577.12	$117,253,680.00	$122,745,897.12
2039	$272,622,658.52	$131,107,860.00	$141,514,798.52
2040	$300,949,386.53	$146,400,528.00	$154,548,858.53
2041	$337,031,131.71	$159,641,789.00	$177,389,342.71
Total	$2,277,439,326.85	$1,166,557,341.50	$1,110,881,985.35

Table 4: Estimated Tax Revenue Loss due to EV Adoption ("Most Likely" Scenario)

	Total Annual Fuel Tax Loss	EV – ICE Vehicle Registration Tax Difference (EV Regs*EV Reg Rev - EV Regs*ICE Reg Rev)	Total Annual Tax Revenue Loss
2022	$1,524,206.93	$1,284,952.50	$239,254.43
2023	$2,349,545.95	$1,929,138.00	$420,407.95
2024	$3,108,639.81	$2,574,409.50	$534,230.31
2025	$4,139,073.94	$3,313,615.50	$825,458.44
2026	$5,272,216.95	$4,220,775.00	$1,051,441.95
2027	$7,147,807.05	$5,585,235.00	$1,562,572.05
2028	$9,792,189.85	$7,716,376.50	$2,075,813.35
2029	$14,789,987.03	$11,290,839.00	$3,499,148.03
2030	$23,586,257.81	$18,006,009.00	$5,580,248.81
2031	$42,926,897.81	$32,045,760.00	$10,881,137.81
2032	$71,816,088.56	$37,379,547.50	$34,436,541.06
2033	$108,264,229.65	$54,694,531.50	$53,569,698.15
2034	$146,471,320.27	$73,996,557.00	$72,474,763.27
2035	$197,610,437.32	$98,141,028.00	$99,469,409.32
2036	$249,071,073.16	$125,159,385.50	$123,911,687.66
2037	$314,071,776.96	$153,442,235.50	$160,629,541.46
2038	$376,513,802.65	$183,948,778.00	$192,565,024.65
2039	$454,012,384.22	$218,340,590.00	$235,671,794.22
2040	$524,394,260.97	$255,098,033.50	$269,296,227.47
2041	$612,443,060.66	$290,096,364.00	$322,346,696.66
Total	$3,169,305,257.52	$1,578,264,160.50	$1,591,041,097.02

4.1 Potential Solutions to Tax Revenue Shortfall

Potential solutions to the tax revenue shortfall related to the adoption of electric vehicles were identified by conducting an overview of the policies and practices adopted by other states in the attempt to supplement fuel tax revenues for transportation infrastructure funding. The identified strategies include EV registration surcharges, distance-based charges, taxation on charging at public EV charging stations, and tolling mechanisms/congestion charges. These methods are summarized in Table 5 and discussed in the sections 4.2-4.6 below.

Table 5: Potential alternative options for revenue generation for EVs

Alternative Solution	Brief Description	Advantages	Disadvantages
Registration Surcharge	Annual surcharge for registering electric vehicles	• Relatively easy to implement from the administrative standpoint.	• Lack of consumer acceptance • May interfere with the efforts to promote EV adoption • Would not allow capturing tax revenues from out-of-state EV drivers

Distance-Based Charge Programs	Charges based on the number of miles or period of time driven by an EV	• Simple and easy to implement: a single tax rate per mile would be applied to all travel. • No sophisticated tracking equipment is needed, periodic reporting of odometer readings may be required. • High expected reliability in implementation, with minimum delay.	• Lack of public acceptance, largely due to data privacy concerns. • The program may not be feasible in states with no mandatory annual vehicle inspections. • In the future, BEVs may become subject to a higher tax per mile than some highly fuel-efficient ICE vehicles, if ICE vehicles are not subject to the distance-based charge. • Distance-based charges may be associated with high administrative and compliance costs. • There may be issues related to the lack of interoperability between the mileage-based user charge systems across different states and jurisdictions. • The program may require additional equipment to ensure that a driver is not charged for out-of-state travel or the travel on private roads.
Public Charging Station Tax	Tax on charging station users on a per-kWh basis	• Directly links funding to EV usage • Promotes the development of charging infrastructure.	Lack of public acceptance: the program may lead to increased charging costs among EV users
Congestion Charges	Fees for driving in congested areas to manage traffic and generate revenue	• Can usefully complement tax revenues • May help reduce traffic in congested areas and generate additional economic benefits such as travel time savings, vehicle operating savings, and environmental benefits.	• Lack of public acceptance • Congestion pricing may not be an equitable solution as it may have a larger effect on the behavior of lower-income drivers than higher-income drivers.

4.2. Vehicle Registration Surcharges for Electric Vehicles

As EVs become more prevalent, EV registration surcharges may help compensate for lost fuel tax revenues. These surcharges often coexist with positive incentives for EV adoption. Currently, 38 states levy these additional charges on BEVs, while 25 also impose them on PHEVs. The registration fees for passenger BEVs range between $50-$316 per year, while fees for passenger PHEVs range between $50-$151.50 (Table 6). Several states have indexed these fees to inflation. The revenue is usually earmarked for transport funding, although a few states have also dedicated a portion of the revenue to developing EV charging infrastructure. The main advantage of the EV registration surcharge program is that it would be relatively easy to implement from the administrative standpoint (no need for additional infrastructure or resources). The disadvantages of the program include the lack of consumer acceptance and the fact that the program would make EV ownership more expensive and may interfere with the efforts to promote EV adoption. Additionally, this method would not allow capturing tax revenues from out-of-state EV drivers who are traveling through the state or living in the state for extended periods of time

Table 6: EV and Hybrid Vehicle Registration Fee Rates, by State

State	Annual EV Registration Fee	Annual Hybrid Vehicle Registration Fee	Gasoline Tax Rate, 2024 ($/gallon)
Alabama	$203	$103	$0.29
Alaska	$100	-	$0.0895
Arkansas	$200	PHEV: $100; HEV: $50	$0.247
California	$53 (base registration) + $118 (road improvement fee for zero-emission motor vehicles model year 2020 or later) = $171	-	$0.596

Colorado	From $65.19 to $222.57: $57.19 (adj. yearly) + $8 Electric Motor Vehicle Road Usage Fee (battery electric) OR $55.13-$165.38 Road Usage Fee for commercial EVs	$57.19 (PHEV); $5 Hybrid Electric Motor Vehicle Road Usage Fee (plug-in hybrid)	$0.22
Georgia	$210.87 for non-commercial motor vehicles and $316.40 for commercial motor vehicles	EV registration fee applies to those PHEVs that have elected an alt. fuel vehicle license plate	$0.323
Hawaii	$45 standard annual registration fee + $50 annual surcharge (starting on July 1, 2025, EV owners can substitute the $50 surcharge with the $0.008 per-mile road usage fee)	-	$0.16
Idaho	$140	$75	$0.32
Illinois	$100	-	$0.47
Indiana	$221	$74	$0.35
Iowa	$130	$65	$0.255 - $0.30
Kansas	$100	$50	$0.24
Kentucky	$120	$60	$0.264
Louisiana	$110	$60	$0.20
Maryland	$100-$125, depending on vehicle model emissions ranking		0.461
Michigan	$140 ($240 for vehicles that weigh 8,000 lbs or more)	$50 ($120 for vehicles that weigh 8,000 lbs or more)	$0.30
Minnesota	$75		$0.285
Mississippi	$150	$75	$0.18
Missouri	$75-$150 for passenger vehicles	$37.5 - $75 for passenger vehicles	$0.27
Montana	$130 - $340+, depending on vehicle weight	$70 - $210+, depending on vehicle weight	$0.3375
Nebraska	$250 and increases by $10 on July 1st of each subsequent year up to and including 2028	-	$0.296
Nevada	Optional fee: $90-$125 for initial registration and $46-$66 for renewal	-	$0.23
New Hampshire	$100	$50	$0.2383
New Jersey	$250 and increases by $10 on July 1st of each subsequent year up to and including 2028	-	$0.423
North Carolina	$180	$90	$0.385
North Dakota	$120	$50	$0.23
Ohio	$200	$150 for plug-in hybrid and $100 for hybrid vehicles	$0.385
Oklahoma	$110 - $2,250, depending on weight	$82 - $1,687, depending on weight	$0.19
Oregon	$316; if the driver enrolls in OReGO, the registration fee is $86 ($172 for a new vehicle)	-	$0.38
South Carolina	$120 (biennial)	$60 (biennial)	$0.26
South Dakota	$50	-	$0.28
Tennessee	$200; on and after Jan 1 2027 and prior to Jan 1 2028: $274; on and after Jan 1 2028: $274, adjusted for inflation	$100; on and after Jan 2028, adjusted for inflation	$0.26
Texas	200; $400 for initial registration for 2-year period	-	$0.20
Utah	$120	$52 for PHEV and $20 for HEVs	$0.365
Virginia	$64	-	$0.308
Washington	$150 additional EV registration fee and $75 transportation electrification fee	PHEVs: $150 additional EV registration fee and $75 transportation electrification fee; HEVs:	$0.494

		$75 registration fee and $75 transportation electrification fee	
West Virginia	$251.50	$151.50	$0.357
Wisconsin	$175	$75	$0.309
Wyoming	$200	-	$0.24

4.3. Undifferentiated Distance-Based Charges

Undifferentiated distance-based charges would strategy requires the use of mileage-reporting methods (e.g. reporting of odometer readings during annual vehicle inspections) for taxation of vehicles based on the number of miles or period of time driven. The main advantage of the program is that it would be simple and easy to implement from the administrative standpoint: a single tax rate per mile would be applied to all travel. It is also likely to be associated with a high expected reliability in implementation, with minimum delay.

The disadvantages of the program include the lack of public acceptance, largely due to data privacy concerns. Therefore, the program may be less feasible in states with no mandatory annual vehicle inspections, like Alabama. Another issue with distance-based charge systems is that if they are applied to EVs only, in the future, BEVs may end up paying a higher tax per mile than some highly fuel-efficient ICE vehicles. Additionally, Distance-based charges may be associated with high administrative and compliance costs. Research shows that the implementation costs of distance-based charge programs may fall in the range of 5-6% of the net revenue from the program. This is significantly higher than the administrative costs of the current fuel tax system which are estimated to be around 1% of the system's revenue. Furthermore, distance-based charge systems may create issues related to the lack of interoperability between the mileage-based user charge systems across different states and jurisdictions may arise. Also, the program may require additional equipment to ensure that a driver is not charged for out-of-state travel or the travel on private roads.

Existing Distance-Based Charge Programs

Currently, at least four states – Hawaii, Oregon, Utah, and Virginia – have moved beyond pilot programs and adopted distance-based charges as permanent "opt-in" schemes for vehicles that pay little or no charge.

Table 7: State Distance-Based Charge Programs

State	Program Details
Hawaii	Beginning July 1, 2025, the owner of an EV may elect to pay an annual mileage-based road usage fee in lieu of paying an additional registration fee. The fee is $0.08 per mile, up to $50 per year. Beginning June 30, 2028, the additional registration fee expires, and all EV owners must pay the state mileage-based road usage charge. Additional conditions apply.
Oregon	The program commenced in January 2020 and is available to drivers of EVs and other vehicles with a rated average fuel efficiency better than 40 miles per gallon. Enrolled vehicles are charged a road usage charge (RUC) of $0.02/mile but are exempt from vehicle registration surcharge beyond the base registration ($43). The opt-in scheme provides incentives for EV owners who travel long distances to pay the surcharge and those who travel limited distances to pay the RUC. (Oregon Department of Transportation, n.d.).
Utah	The scheme is similar to the system implemented in Oregon with the main difference being that the program applies only to alternative fuel vehicles (i.e. BEVs, PHEVs, and conventional hybrids). EV drivers can choose to continue to pay the flat fee for alternative fuel vehicles or enroll in Utah's Road Usage Charge program to pay for road usage based on the number of miles driven, up to the amount of

	the set flat fee. The RUC is $0.0106/mile. Therefore, there is an incentive for BEV and PHEV owners to opt into Utah's RUC since there is no possibility of paying more than the flat fee (Utah Department of Transportation, n.d.).
Virginia	While the registration surcharges adopted in Oregon and Utah are flat amounts, the highway use fee (HUF) implemented in Virginia varies with the vehicle's fuel efficiency (Virginia Department of Motor Vehicles, n.d.). HUF applies to all passenger vehicles with a rated fuel consumption better than 25 mpg and gives those liable to pay the fee the option of enrolling in a distance-based charging scheme called the Mileage Choice Program (MCP).

Additionally, multiple states have participated in distance-based charge pilot programs. Road Usage Charge (RUC) America is the foremost authority on road usage charging in the United States, bringing together leaders from 19 state transportation organizations to share resources and explore innovative funding solutions to help improve and maintain transportation infrastructure nationwide (NCSL, 2022). The distance-based systems vary from state to state and often include a mix of high- and low-tech methods for mileage recording. Some of these methods include:

- **Time Permits:** participants purchase unlimited road use permit for a specified period.
- **Mileage Permits:** participants pre-pay to drive a certain number of miles.
- **Odometer Charge:** participants pay a fee per mile based on periodic odometer readings.
- **Automated mileage reporting without general location data**: vehicles contain equipment that measures and reports mileage automatically to an account manager - either provided by a state agency or a private company. The account manager periodically (monthly or quarterly) sends the motorist an invoice for their individual road use.
- **Automated mileage reporting with general location data**: in-vehicle equipment reports odometer readings to a third-party account manager which invoices the participant. The equipment also provides general location data so the participant is not charged for travel out-of-state or on private roads. These options include in-vehicle telematics, smartphone apps, and plug-in devices for the vehicle's on-board diagnostics data port.

4.4. Differentiated Distance-Based Charges

Distance-based charges differentiated by time and place (and potentially other factors such as vehicle mass and power) could deliver added efficiency and equity gains. However, they have not been implemented anywhere to date. This type of charge poses more complex challenges, both technically and in terms of legal and system design issues. Governments would also need to communicate the benefits of such schemes effectively to ensure public acceptance.

4.5. Electric Vehicle Charging Stations Taxation

Several states have introduced taxes on electricity purchased at EV charging stations. For example, Iowa, Kentucky, Montana, Oklahoma, and Texas are among the states that have imposed - or are about to introduce – a per-kilowatt-hour tax on public electric charging stations. Additionally, Georgia requires stations to track kilowatt-hour usage and collect a tax for every 11 kilowatt-hours (Table 6).

Table 8: EV Charging Station Tax Rates, by State

State	EV Charging Station Tax Rate
Georgia	Effective January 2025: charging stations will be required to track kilowatt-hour usage and collect a tax of $0.26 for every 11 kilowatt-hours
Iowa	$0.026 per kilowatt-hour tax on public EV charging stations (effective July 2023).

Kentucky	$0.03 per kilowatt hour on electric vehicle power distributed by an electric power dealer (effective January 1, 2024)
Montana	$0.03 per kilowatt hour or its equivalent on electric current from public charging stations (effective July 2023)
Oklahoma	$0.03 per kilowatt hour or an equivalent of thereof (effective November 1, 2023)
Texas	$0.03 per kilowatt hour (effective January 1, 2024)

The main advantages of the EV charging station taxation strategy include its high expected level of reliability in implementation and the fact that the program would allow collecting tax from out-of-state drivers not registered in the state. Importantly, public acceptance may be less of an issue for this taxation method because of the general public's familiarity with the gas tax mechanism. The disadvantage of the program is that it may require additional financial resources for the installation of technologies to ensure that different charging station taxation rates are used for in-state and out-of-state drivers (e.g., license plate reading systems). Also, the charging station tax system may require regular rate adjustment to ensure it remains adequate in the future.

EV Charging Station User Taxation Strategy for Alabama:

Currently, there is no tax imposed on drivers at EV public charging stations in Alabama. The only tax category imposed on EV charging at Alabama's public charging stations is the Utility Service Use Tax that applies to station operators. The utility service use tax is an excise tax levied on the storage, use, or other consumption of electricity, domestic water, natural gas, telegraph, and telephone services in the State of Alabama and the proceeds of the tax are deposited into the Alabama Education Trust Fun. The tax is computed monthly in accordance with the table below:

Table 9: Alabama Utility Service Use Tax

If the total sales price of the utility services furnished by a utility and stored, used, or otherwise consumed by a person in one month is:	The tax with respect to said utility service is:
Not over $40,000.00	4% of said sales price
Over $40,000.00 but not over $60,000.00	$1,600.00 plus 3% of excess over $40,000.00
Over $60,000.00	$2,200.00 plus 2% of excess over $60,000.00

To evaluate possible ways to fully offset the shortfall in fuel tax revenues due to the transition to electric vehicles, two options for a per-kWh tax rate for public EV charging in Alabama are recommended:

Table 10: Suggested Taxation Strategies for EV Public Charging Station Taxation in Alabama

Tax Rate Option 1 (Out-of-state Drivers)	This tax rate applies to out-of-state drivers traveling in Alabama. The calculated tax rate will offset the annual fuel tax amount lost due to EV usage.
Tax Rate Option 2 (Registered AL Drivers)	This tax rate applies to EV drivers that are registered in the state of Alabama. The tax rate is designed to compensate for the annual tax difference amount paid by an EV and ICE vehicle driver.

Tax Rate Option 1 (Applies to Out-of-state drivers):

The analysis assumed the average annual EV energy consumption of 4,310.65 kWh. In 2022, the average fuel tax amount lost from EV usage in Alabama was $204.62 per car. Therefore, by dividing $204.62 by 4,310.65 kWh, the tax rate of 4.7 cents/kWh is obtained. Likewise, since in 2024, the average fuel tax

amount lost from EV usage is $211.92, dividing $211.92 by 4,310 kWh allows obtaining the tax rate of $4.9 cents/kWh that would allow compensating for the fuel tax loss.

Tax Rate Option 2 (Applies to Registered Alabama Drivers):

In 2022, on average, a registered Alabama ICE vehicle driver paid $32.12 more in total annual taxes than a registered EV driver. Dividing $32.12 by 4,310.65 kWh allows obtaining the tax rate of 0.75 cents/kWh which would compensate for the average per-car annual tax difference between an ICE and EV driver. In 2024, on average, a registered Alabama ICE vehicle driver pays $36.42 more in total annual taxes than a registered EV driver. Dividing $36.42 by 4,310.65 kWh allows obtaining the tax rate of 0.85 cents/kWh which would compensate for the tax difference.

Considering that in Alabama, fuel tax is indexed to the National Highway Construction Cost Index and EV annual registration tax rate is designed to be updated at least once every four years, the difference in tax amounts paid by an EV and ICE vehicle drivers is expected to be changing from one year to another. Therefore, the EV charging station taxation rates may need to be revised and updated periodically to ensure that they remain adequate in the future.

4.6 Congestion Charges

Congestion pricing policies are a common strategy for addressing traffic congestion on busy streets and sections of highways by shifting traffic towards less congested roadways, off-peak travel periods and other transportation modes. Currently, congestion charges are more common in Western European cities (e.g.: London, U.K., Stockholm, Sweden, and Milan, Italy) than in the U.S. However, in the U.S., several cities have implemented congestion pricing systems, mostly in the form of high-occupancy toll lanes with variable pricing structures (e.g., San Diego CA, Minneapolis MN, Denver CO, and others). Research has shown that congestion charges can usefully complement simple distance charges, raising substantial revenue and yielding large economic efficiency benefits such as travel time savings, vehicle operating savings, and environmental benefits. Earmarking the revenues towards road and public transport investments is known to make them more publicly acceptable. The main issue associated with the implementation of congestion charges is the lack of public acceptance. Additionally, research suggests that congestion pricing may not be equitable as it may have a larger effect on the behavior of lower-income drivers than their higher-income counterparts.

5. Discussion

This study contributes to the ongoing body of research evaluating the impact of the transition to EVs on transportation infrastructure funding by evaluating the future burdens of growing EV adoption rates on state tax revenues in Alabama. The findings of this analysis are largely consistent with prior studies, which found a decrease in tax revenues as EV adoption increases. Our methodology may help inform the development of frameworks to evaluate the impact of EV adoption on tax revenues in other states. Additionally, our study offers insights into the strategies that other states have implemented to address revenue shortfalls.

Like most prior research, including Short and Crownover (2021) and Riciutti (2020), our research evaluated the effectiveness of state-level EV annual registration fee surcharge as a way to mitigate the loss of fuel tax revenue from the increased adoption of EVs. However, we find that Alabama's current EV taxation approach will leave the state with a significant tax revenue shortfall that will continue to increase over time.

Furthermore, our research builds on the work of Xu et al. (2020), which estimated that an annual registration fee of $181 would be sufficient to cover the revenue lost from EV adoption in Alabama. Our study used the EVOLVE EV adoption forecasting tool developed at The University of Alabama, which also includes consumer beliefs in the projection model, and found that even with a surcharge of $200 per year, there would still be a significant tax revenue shortfall. This is caused by the fact that the difference between per-car tax revenue generated by an EV and an ICE vehicle in Alabama is expected to grow over time. The main reasons behind such growth are the differences in tax increase rates used for fuel tax and EV registration surcharge as well as the state law, according to which, the EV registration fee in the state will decrease to $150 per year in 2031 when EVs comprise 4% of the vehicles in the state.

As evidenced by the results, the transition to EVs in Alabama will greatly impact the state's tax revenues, even with the current methods adopted to mitigate the potential losses. Therefore, we examined the most common gas tax alternatives and surveyed what options have been adopted in states across the U.S. to understand the general trends and challenges associated with each option, and whether such taxation strategies may be feasible for Alabama.

In line with prior research, our study finds that although EV registration fees may seem like a straightforward alternative to gas taxes, but, alone, registration fees may not be enough to completely offset the loss in revenue states will face from increased EV adoption. As noted in Ricciuti (2020), annual registration fees may also discourage EV adoption, which could impact environmental or economic goals in states.

Prior studies, like Ricciuti (2020), have evaluated distance-based charges as another possible solution to the decline in revenues. Distance-based charges are often touted for being a more sustainable or equitable solution, but there are logistical and privacy challenges. For example, if odometer readings are used to record mileage out of state travel would not be excluded from the total amount of miles taxed. Additionally, in states without regular vehicle inspections, like Alabama, it would be difficult to measure odometer readings. Alternatively, using technology to track the miles traveled could be a possible way to track miles traveled, but is more complex due to the technology and reporting requirements. Furthermore, even though programs are currently in place in places like Oregon and Utah, widespread adoption in the short-term will likely face challenges due to a lack of public acceptance over privacy concerns associated with having their location tracked.

Some states have implemented EV charging station taxes at public charging stations. The majority of these programs are newly implemented, with most of them only having taken effect in July 2023 or later. This model may seem the most comparable to the gas tax since both scenarios involve a vehicle being taxed on the fuel source purchased from a public source. Another important strength of this taxation strategy is that it would allow collecting tax revenues from out-of-state drivers. This may make the EV charging station taxation strategy more advantageous than some of the previously discussed strategies such as EV registration surcharges and distance-based charging systems that may not be able to collect taxes from out-of-state drivers. However, unlike ICE vehicles, many EV owners have the ability to fuel their vehicles at home by installing a charging station at their residences so, they are not likely to use public charging stations at a rate similar to ICE vehicles refueling at public fuel stations. Therefore, there will likely still be revenue shortfalls unless this method is paired with another alternative.

6. Conclusion

This study estimated the impact of EV adoption on Alabama's tax revenues over the analysis period between 2022-2041. The analysis suggests that even though currently, EV adoption has a very limited impact on the total state tax revenues that are allocated for transportation infrastructure funding, such an impact is expected to increase significantly in the future. This impact is expected to occur even after Alabama has adopted strategies to reduce the impact from the growth of EVs. The increase in the impact in Alabama is caused by the quickly growing number of electric vehicle registrations in the state as well as the state taxation system where on average, an ICE vehicle driver is likely to pay a larger amount in total annual taxes than an EV driver and the difference is expected to grow in the future.

The overview of transportation revenue-generating practices and strategies implemented in other states has shown that most states have taken measures to prepare for an increase in EV market penetration and related fuel tax revenue shortfall. The four revenue generation strategies that were identified in this study include electric vehicle registration surcharges, distance-based charges, taxation of EV public charging stations, and congestion charges. The study found that there is a significant variation in how different states design and implement these four strategies. Additionally, the analysis showed that several states are using a combination of the approaches mentioned above to effectively supplement their tax revenues, which follows the current method of ICE vehicles, where there is typically an annual registration fee and a gasoline tax. More research and pilot programs may be needed to study and compare the effectiveness of different EV taxation approaches implemented in different states with the goal of limiting the negative impacts on transportation funding.

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