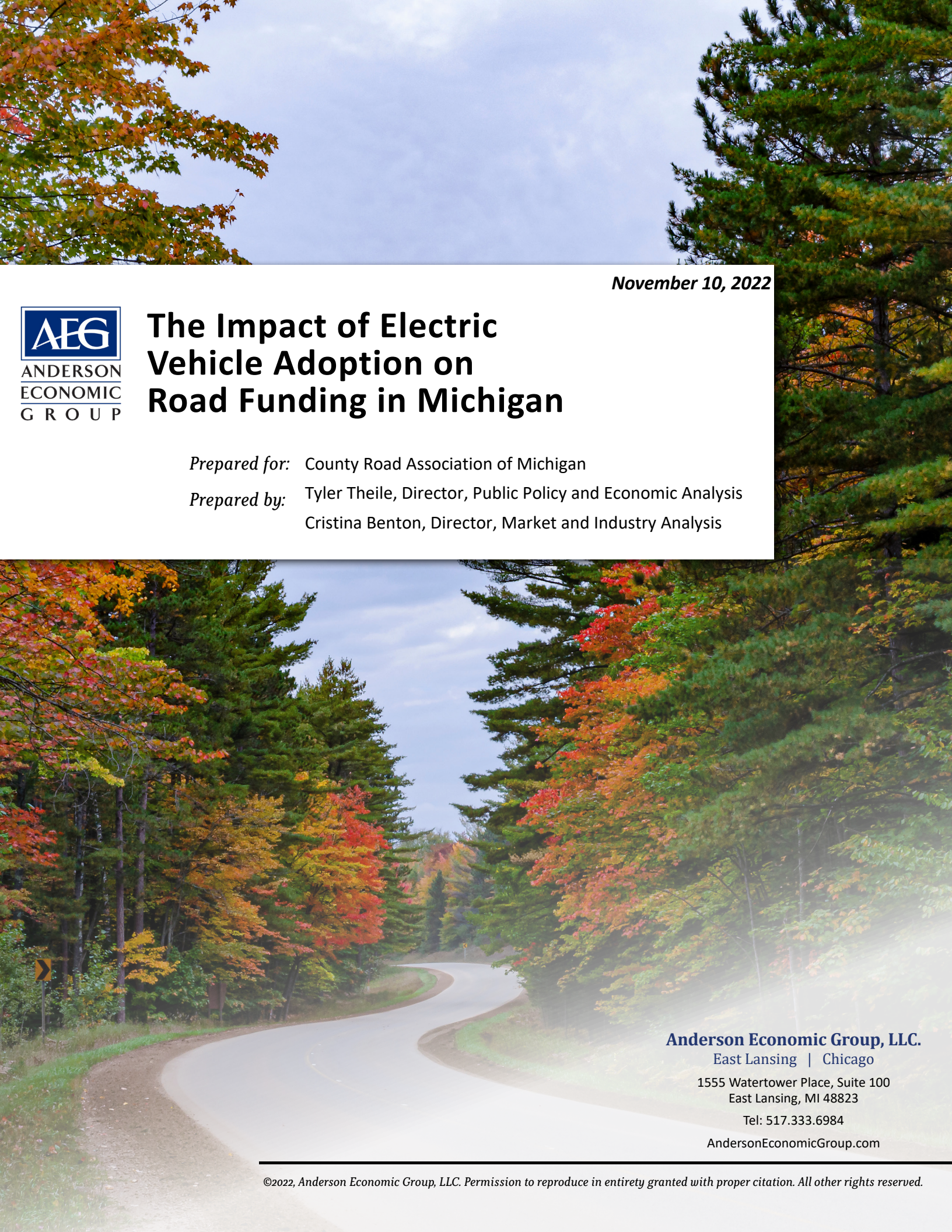

November 10, 2022

The Impact of Electric Vehicle Adoption on Road Funding in Michigan

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I.Executive Summary

PURPOSE OF REPORT

The State of Michigan, the federal government, public transit, and county and local road agencies, rely heavily on revenues from excise taxes on motor fuel to maintain road networks in Michigan. Both the federal government and the State of Michigan impose excise taxes on each gallon of diesel and gasoline fuels sold at retail to drivers in the state.

Internal combustion engine (ICE) vehicles have been the primary mode of transportation for Michiganders. As electric vehicles (EVs) have emerged, and do not consume fuel (or consume considerably less in the case of hybrid vehicles), drivers do not pay the related sales and excise taxes. This tax avoidance creates a gap related to road usage and contributions to road funding. The general public, and many policymakers, often appear unaware of this tax avoidance for electric vehicle drivers. Indeed, the current debate at both the state and federal level involves increased subsidies for purchasing electric vehicles, as well as for building charging stations.

Road funding via vehicle registration fees, along with sales and excise taxes on fuel, is a fair way to align road funding with road usage, However, the road funding shortage in Michigan will grow as electric vehicles continue to increase in market share. A properly designed set of policies must be enacted to generate the necessary revenue.

A coalition spearheaded by the County Road Association of Michigan, and also including:

- Michigan Transportation & Infrastructure Association,
- Michigan Association of Counties,
- Michigan Municipal League,
- Michigan Public Transit Association,
- Michigan State Chamber of Commerce, and
- Michigan Townships Association

retained Anderson Economic Group to conduct a study on the following:

- The nature of road funding and the growing gap in funding required to properly maintain roads and bridges in Michigan.
- The existing losses in road funding due to the emerging transition to electric vehicles.
- Projections of the escalation in lost revenue in Michigan over several years, using two electric vehicle adoption scenarios: 15% new vehicle sales by 2030, and 25% new vehicle sales by 2030.
- A set of possible public policy measures that could be implemented to address this road funding problem.

OVERVIEW OF APPROACH

We undertook the following steps:

1. We defined the types of vehicles to be included in our analysis:
   - Internal combustion engine (ICE)
   - Battery electric vehicle (BEV)
   - Hybrid electric vehicle (HEV), also known as self-charging under the hood
   - Plug-in hybrid electric vehicles (PHEV)
   - Electric Vehicles (EV), meaning all BEV, HEV, and PHEV.

   See "Key Terms Used in This Report" in Appendix A on page A-1.
2. We compiled legal documents outlining sources of Michigan's road funding.
3. We analyzed relevant government policy initiatives and automotive manufacturer objectives encouraging the transition to electric vehicles.
4. We analyzed electric vehicle trends on Michigan roads based on active fleet and annual new vehicle registration data.
5. We collected relevant data on taxes, fees and surcharges levied on vehicles, including:
   - State and federal excise taxes, and other road funding information.
   - Title and registration fees levied in Michigan.
   - Registration information on make, model, and fuel type of vehicles registered in Michigan.
   - Additional fees levied on electric vehicles during registration.
   - Fuel economy of sample vehicles registered in Michigan as reported to the U.S. environmental protection agency (EPA).
6. We separately estimated the road funding revenue shortfall to the Highway Trust Fund (HTF), Michigan Transportation Fund (MTF) and Comprehensive Transportation Fund (CTF), which included the following steps:
   - Projecting the unit sales and active fleet penetration of electric vehicles in Michigan under two scenarios, 15% and 25% market share, for 2019-2030.
   - Projecting the fuel consumption and cost of fuel over the same period.
   - Estimating the amount of revenue generated during the refueling process, disaggregating it across the federal and state levels, and estimating the share earmarked for road funding versus general funds.
7. Completed a comprehensive review of road funding policy options that could be implemented in Michigan. Future analysis will be required to estimate feasibility and total revenue generated by a combination of these policies, to properly fund roads and bridges in Michigan.

OVERVIEW OF FINDINGS

Using the information available to us and the methodology described above, we concluded the following:

1. *With relatively few electric vehicles on the road, Michigan has been operating with a significant deficit as compared to what would be required to fully fund good-condition road and bridge infrastructure in Michigan.*

a. Road and bridge funding in Michigan is primarily based on the revenues from state and federal motor fuel taxes, and title and annual vehicle registration fees, in addition to supplemental appropriations from the Legislature. The state-generated taxes and fees revenue form the majority of the state road and bridge funding and is attributed to the Michigan Transportation Fund.

b. From the two primary revenue sources contributing to the Michigan Transportation Fund, the state government, public transit, county and local municipal road agencies rely most heavily on revenues from motor fuel taxes to maintain road networks in Michigan and other states.

c. The revenue generated from excise tax and registration fees has been insufficient over the years, and the gap in costs versus revenue is expected to increase. The Michigan Department of Transportation and County Road Association of Michigan each estimate substantial gaps between the need for and the availability of funds in Michigan.

See “Road and Bridge Funding in Michigan” on page 10 for more information on the state’s road funding sources and distribution of revenue. See Figure 1 below for Michigan Transportation Fund revenues by source and fiscal year.

FIGURE 1. Michigan Transportation Fund Revenue, Fiscal Years 2003-2022 (millions)

Notes: Figures reflect actual revenue, except for fiscal year 2021-22, which reflects revenue estimates. Vehicle registration taxes include title fees of approximately $35 million annually; other state resources include $69 million transferred from the Budget Stabilization Fund in fiscal year 1997-98, an earmark on income tax revenue beginning in fiscal year 2018-19, and an earmark from the marijuana excise tax revenue in fiscal year 2020-21.

Source: House Fiscal Agency, “MTF Distribution Formula to Local Road Agencies,” March 2022.

Analysis: Anderson Economic Group (2022)

2. Electric vehicles represented just 1.9% of all vehicles on the road in Michigan in 2021. Consumer adoption of electric vehicles will grow dramatically in Michigan in the coming years.

a. The adoption of electric vehicles, particularly battery electric vehicles, has been increasing in Michigan. However, as a share of total new vehicles registered in Michigan, battery electric vehicles represented only 1.3% of total new vehicle sales in the state in 2021. Overall, electric vehicles including battery electric, hybrid, and plug-in hybrid electric vehicles, were 6% of the new vehicles registered in Michigan in 2021.

b. The number of active electric vehicles on Michigan roads increased in 2021. At the end of 2021, about 1.9% of all vehicles on the road were electric vehicles.
See "Transition Trends in Michigan" on page 21 and Table 1 below.

c. Available data for 2022 indicate that consumer adoption of battery electric vehicles continued to grow in the U.S. In the second quarter of 2022, battery electric vehicles sold as a share of total new vehicles reached 5.5% for the first time.
See "Transition Trends in Michigan" on page 21.

d. Recent federal and state policy initiatives on electric vehicles are expected to encourage Michigan's transition from internal combustion engine vehicles to electric vehicles. These include the federal electric vehicle tax credit for a new electric vehicle purchased of up to $7,500, investments in electric vehicle charging station infrastructure, and developing a domestic EV battery supply.

e. While there are concerns about the electric grid capacity, the recent policy in California, the largest auto market in the U.S., to ban all new internal combustion engine vehicles by 2035 will likely be adopted in several other states, impact auto manufacturers, and affect EV adoption throughout the U.S.
See "Government Initiatives" on page 19.

f. Auto manufacturers have set aggressive targets for electric vehicle sales and production. In particular, Detroit's Big 3 investments to produce and retail a high volume of electric vehicles is expected to affect consumers' choices in the automotive market.
See "Auto Manufacturer Goals" on page 22.

TABLE 1. Electric Vehicles Penetration in Michigan, 2021

Vehicles	Share of Total New Vehicle Sales	Total New Vehicles Sales	Share of Total Vehicles in Operation	Total Vehicles in Operation
Battery Electric	1.3%	6,435	0.2%	17,060
Hybrid Electric	3.9%	19,103	1.5%	129,658
Plug-in Hybrid Electric	0.8%	4,052	0.2%	16,021
Total Electric Vehicles	**6.0%**	**29,590**	**1.9%**	**162,739**
Memo: Internal Combustion Engine Vehicles	*94.0%*	*46,2159*	*98.1%*	*8,299,277*

Note: This data is changing steadily, see Anderson Economic Group's Automotive Dashboard, at www.andersoneconomicgroup.com/auto-dashboard/ for regular updates on EV market penetration.
Source: IHS Markit (units in operation, new vehicle registrations)
Analysis: Anderson Economic Group

3. From 2019 to 2021, electric vehicle adoption represented a cumulative $50 million additional deficit in road funding in Michigan.

a. At 6.0% of the new vehicle market, the electric vehicle transition has already driven a significant additional deficit in road funding in Michigan.

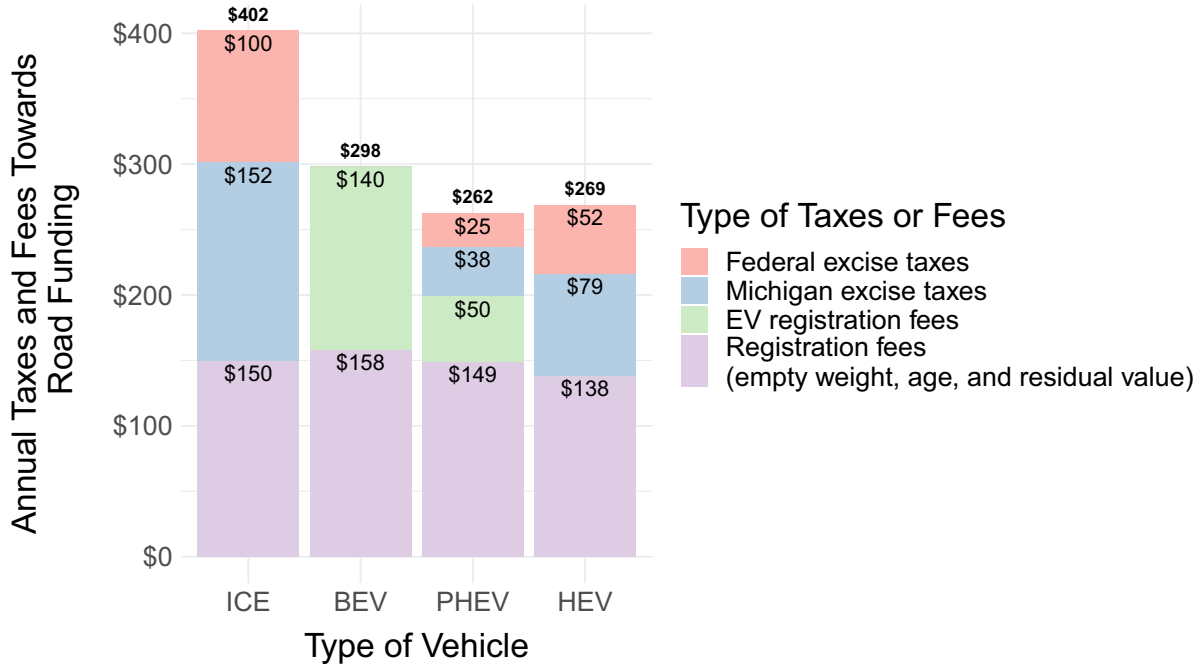
b. Federal and state excise taxes on gasoline and diesel are directly allocated to road funding. As electric vehicles do not consume motor fuel (or consume them in minimal quantity), they do not pay this tax.

c. Michigan imposes an additional electric vehicle registration fee to recoup these lost taxes, but this tax is lower than a typical internal combustion engine driver's road funding burden.

d. A typical electric vehicle driver in Michigan pays about 70-80% of the road funding burden on a comparable ICE driver. See Figure 2 on page 5.

e. Electric vehicles tend to be about 1,000 lbs heavier than their internal combustion engine counterparts. This means electric vehicles are likely to cause greater road damage and increase the cost of construction and maintenance of roads. See "Illustration of the Road Funding Gap" on page 23.

FIGURE 2. Contribution to Road Funding Across Comparable Drivers in Michigan, 2022



Notes: Representative vehicles refer to comparables amongst the most sold vehicles between the $30,000 to $45,000 in Michigan between 2019-2021 before any federal or state tax credits; all averages are weighted based on unit sales of vehicles between 2019-2021 (harmonic mean used for fuel economy); all drivers are presumed to travel 14,300 miles per year; PHEVs are presumed to travel 50% of the miles using gasoline; all prices and tax rates are from 2022. See Table 8 on page 25 for detailed calculations.

Source: EPA (combined fuel economy); EIA (federal and state excise taxes); IHS Markit (2019-2021, unit sales of vehicles in Michigan); Edmunds.com and manufacturer's websites (price and curb weight of vehicles); Kelly Blue Book (average mileage of Michigan drivers); Michigan Secretary of State website (ad valorem fees, and weight based fees).

Analysis: Anderson Economic Group (2022) research.

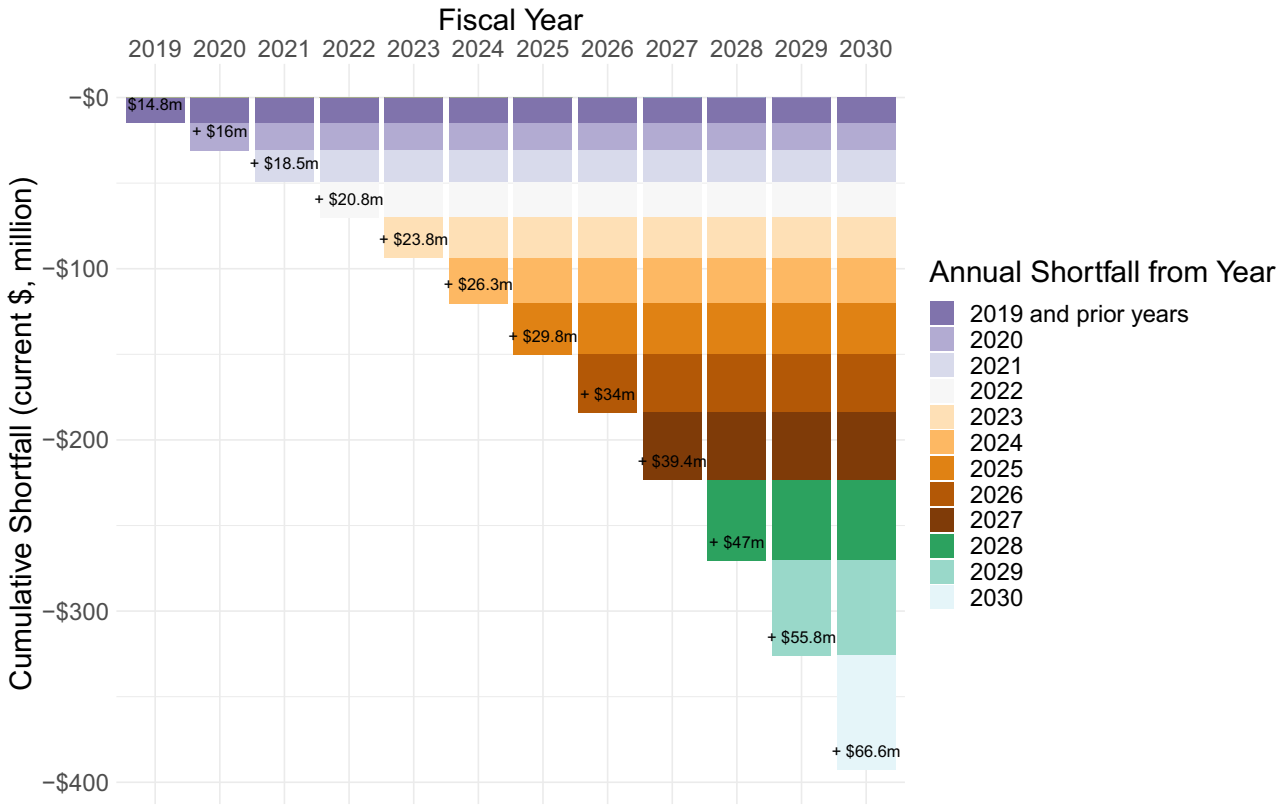
4. By the year 2030, the road funding deficit in Michigan due to electric vehicles usage will be $390 to $470 million, under current policies and notwithstanding all other market conditions.

a. As electric vehicles gain a larger share of the market, the annual shortfall will grow every year. At 15% market penetration of electric vehicles by 2030, this would reach upwards of $65 million per year. At 25% market penetration of electric vehicles by 2030 this would be over $95 million per year. This annual shortfall will accumulate over time. See Figure 3.

b. The federal Highway Trust Fund's (HTF) annual shortfall by 2030 will be twice that of the Michigan Transportation Fund (MTF). This is shown in Figure 4 on page 7.

c. The Michigan's Comprehensive Transportation Fund will lose between $1 to $1.3 million by 2030 from sales taxes levied on gasoline alone.

FIGURE 3. Cumulative Road Funding Shortfall, "15% Battery Electric Vehicle Sales by 2030" Scenario, 2019-2030

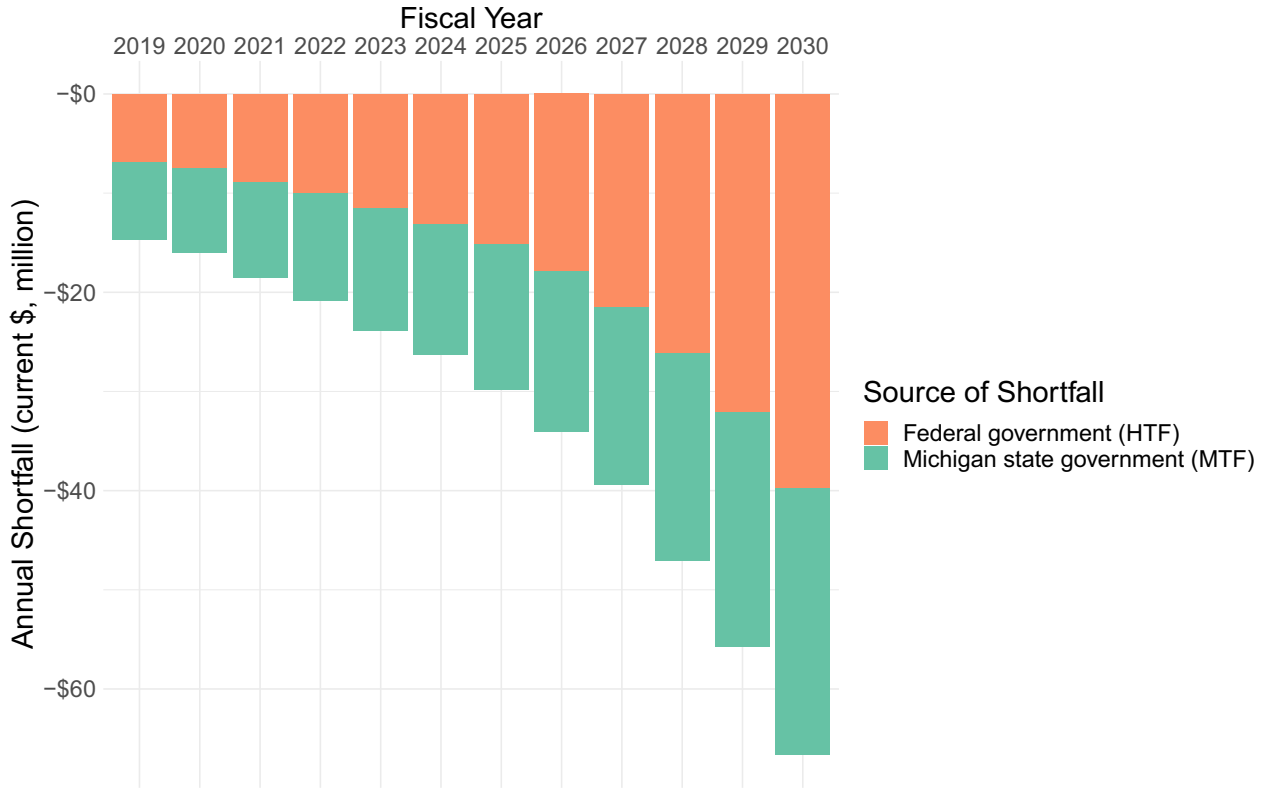


Notes: Road funding shortfall includes losses from federal and state fuel excise taxes after accounting for EV registration fees; fuel efficiency of vehicles is a weighted harmonic mean of a sample of the most popular vehicles in operation at the end of 2021; all vehicles are presumed to travel 14,300 miles.

Source: EPA (combined fuel economy); EIA (federal and state excise taxes); IHS Markit (unit sales of all vehicles by fuel type, 2019-2021; vehicles in operation, 2019); Kelley Blue Book (average mileage of Michigan drivers); Michigan Secretary of State website (EV registration fees on BEVs and PHEVs).

Analysis: Anderson Economic Group (2022) research.

FIGURE 4. Annual Highway Trust Fund and Michigan Transportation Fund Road Funding Shortfall, "15% Battery Electric Vehicle Sales by 2030" Scenario, 2019-2030



Notes: HTF shortfall includes revenue from federal fuel excise taxes; MTF shortfall includes revenue from Michigan fuel excise taxes after accounting for EV registration fees; fuel efficiency of vehicles type is based on a weighted average of a sample of the most popular vehicles in operation at the end of 2021; all vehicles are presumed to travel 14,300 miles.

Source: EPA (combined fuel economy); EIA (federal and state excise taxes); IHS Markit (unit sales of all vehicles by fuel type, 2019-2021; vehicles in operation, 2019); Kelley Blue Book (average mileage of Michigan drivers); Michigan Secretary of State website (EV registration fees on BEVs and PHEVs).

Analysis: Anderson Economic Group (2022) research.

5. The State of Michigan will need a fair and properly crafted set of policies to replace road and bridge infrastructure funding revenue that is lost to electric vehicle usage.

We completed a thorough review of enacted and theoretical road funding policies from several states and countries. Those that may be most feasible in Michigan may include those outlined below. Additional analysis will be required to estimate the amount of revenue required, and the amount that could be generated by a set of these policies. A pilot study will be a sensible approach to testing one or more road funding policies for feasibility in Michigan.

a. An additional surcharge on the existing Vehicle Registration Fees applied specifically to battery electric vehicles and plug-in hybrid electric vehicles may help quickly equalize road user fees. However, a flat registration fee does not provide an apple-to-apple comparison with the mileage and ad valorem/weight based taxation structure of the existing motor fuel taxes.

b. Mileage Based User Fees is calculated using miles driven. Its advantage lies in that it is already implemented by a number of states and has shown promise as a feasible road user fee. However, there are concerns regarding its potential impact on user privacy.

c. A Per Kilowatt Hour Fees measures road usage on the basis of units of electricity used. It may be implemented to avert privacy concerns but requires further research on efficient and cost effective implementation.

d. Miles at Registration is a relatively feasible measure to implement alternative that would require users to report mileage during their annual vehicle registration. The disregard over weight of the vehicle and costs relating to the development of infrastructure on data collection are two primary drawbacks of this alternative.

e. Technological improvements have made tolling a feasible road user fee. Current infrastructure for tolling may be expanded and implemented on more roads. However, this alternative would most likely require a large scale shift in public opinion towards tolling.

We discuss all of the above alternative road user fees at length in “Policies to Replace Lost Road Funding Due to Electric Vehicle Adoption” on page 31.

ABOUT ANDERSON ECONOMIC GROUP

Founded in 1996, Anderson Economic Group is a boutique research and consulting firm, with offices in East Lansing, Michigan, and Chicago, Illinois.

Anderson Economic Group is one of the premier consulting companies in the automobile industry as well as in public policy and economic analysis. The experts at AEG have conducted nationally-recognized economic and fiscal impact studies for private, public, and non-profit clients across the United States. Some examples include, the impact of the Obama Presidential Library, and annual benchmarking study for the University Research Corridor, national sporting events, and many others. The experts at AEG have particular expertise in the automotive industry. They have worked with clients in all three tiers within the industry, including hundreds of automotive dealerships across the United States. The firm's work has included markets throughout the United States, as well as in Turkey, Canada, and Mexico.

Work by Anderson Economic Group has been utilized in legislative hearings, legal proceedings, and public debates, as well as major planning exercises and executive strategy discussions. For more information, please see "Appendix C. About Anderson Economic Group" on page C-1 or visit www.AndersonEconomicGroup.com.

II.Road and Bridge Funding in Michigan

In this section, we discuss revenue sources for Michigan's road transportation funds and distribution of the State's primary road fund. We then outline the gap between state road funding needs and the revenue allocated to the construction and maintenance of roads and bridges.

ROAD REVENUE SOURCES

Michigan's road system is categorized by three types of roads: state highways, county roads, and city or village streets. These fall under the jurisdiction of MDOT, county road agencies, and cities or villages, respectively. The state and federal government both contribute to the construction and maintenance of these roads.

In fiscal year 2022, Michigan will spend approximately $5.2 billion on roads and other transportation infrastructure. A significant amount ($1.45 billion) of this funding will come from the federal government through federal motor fuel taxes. Most spending, however, will be funded by state taxes and fees ($3.70 billion).[1] These consist primarily of motor fuel taxes and vehicle registration fees, income tax revenue transfers and, more recently, the marijuana tax.

We describe the state's transportation revenue sources in greater detail below.

State Motor Fuel Taxes

Excise Tax. Michigan imposes an excise tax of 27.2 cents per gallon on gasoline and diesel fuel. This tax has increased over the years. In 2017, the excise tax rate increased to 26.3 cents per gallon, with future increases pegged to inflation. This increase represented an additional 26% in excise taxes, previously 19.0 cents per gallon, and a 53% increase in diesel taxes, previously 15.0 cents per gallon. In 2021, the gasoline tax generated $1.1 billion in revenue, while the diesel fuel tax generated $240 million in revenue.[2]

Table 2 below shows these tax rates in Michigan and peer states. Total motor fuel tax revenue by fiscal year is shown in Figure 5 on page 14.

TABLE 2. Michigan Excise Tax Rate on Motor Fuel, as of January 1, 2022

State	Gasoline Tax (per gallon)	Diesel Tax (per gallon)	Structure
Michigan	$0.272	$0.272	Indexed to inflation, last increased 2022

Source: American Petroleum Institute State Motor Fuel Taxes, January 1, 2022.

1. William Hamilton, House Fiscal Agency, "Budget Briefing: Transportation," January 2022.
2. William Hamilton., "Fiscal Brief: MTF Distribution Formula to Local Road Agencies," 2021.

Sales Tax on Motor Fuel. Motor fuel in Michigan is also subject to the state's 6% general sales tax, sometimes described as the "auto-related sales tax."[3] While revenue from the state sales tax on motor fuel does not fund Michigan's road system directly, a portion is earmarked to public transportation via the Comprehensive Transportation Fund (CTF).[4] The CTF receives a significant portion of this auto-related sales tax,[5] which is the fund's second largest revenue source after the 10% earmark from the Michigan Transportation Fund (MTF).[6]

Road Taxes Linked to Usage. For drivers of ICE vehicles, motor fuel taxes are closely linked with their use of roads and bridges, because the more an ICE vehicle travels on public roads, the more fuel it consumes and the more tax is paid. Table 3 on page 12 shows state and federal motor fuel taxes and fees paid by ICE vehicle drivers.

Additionally, a heavier ICE vehicle has lower fuel economy than its lighter counterparts. That additional weight directly translates to marginally higher fuel consumption, resulting in higher tax payments. Thus, drivers of heavier ICE vehicles explicitly pay more for their increased wear and tear on roads. The close link between the fees paid and actual road usage makes the tax structure demonstrably fair for those who drive ICE vehicles.

Because electric vehicles do not consume motor fuel, EV drivers do not pay the taxes that are built into the cost of gasoline or diesel fuel. Thus, they do not support Michigan's road infrastructure in a way that reflects miles driven or the weight of their vehicles.[7]

3. Although several states also allow for local motor fuel taxes, Michigan does not.
4. MCL 205.75(4) requires not less than 27.9% of 25% of the general sales tax on motor fuel imposed at the rate of 4% be allocated to the comprehensive transportation fund. MCL 247.660b creates the "comprehensive transportation fund" as a separate fund within the state treasury. Sec. 10b.(3) of the statute defines the function of the comprehensive transportation fund to include projects related to development and improvement of public transportation.
5. MCL 247.660b creates the "comprehensive transportation fund." MCL 205.75(4) requires no less than 27.9% of 25% of the general sales tax on motor fuel imposed at the rate of 4% be allocated to the CTF.
6. For more information, see "Presentation to Michigan Public Transit Association," August 25 2017, *The Comprehensive Transportation Fund and State Support for Local Public Transit Agencies*, by William E. Hamilton, senior fiscal analyst at https://www.house.mi.gov/hfa/PDF/Transportation/CTF_and_Local_Bus_Operating_Presentation.pdf.
7. Although the EV registration fee is different for vehicles above and below 8,000 lbs., no EVs currently in the market weigh more than 8,000 lbs. Among comparable ICE vehicles, EVs weigh significantly more for their size and utility. This higher weight does not result in higher revenue for the MTF.

TABLE 3. Taxes and Fees Levied on Motor Fuel Sold in Michigan, as of June 2022

	Gasoline	Diesel	Allocated Directly to Road Funding?
Federal Government			
Federal excise tax	18.3¢/gal	24.3¢/gal	Yes
Leaking Underground Storage Tank (LUST) fee	0.1¢/gal	0.1¢/gal	No
Michigan State Government			
Michigan excise tax	27.2¢/gal	27.2 ¢/gal	Yes
Retail sales tax	6%	6%	No[a]
Environmental protection regulatory fee	1¢/gal	1¢/gal	No

a. Although not directly allocated to road funding, a portion of the collected revenue is allocated to public transportation programs. See "Shortfall to the Comprehensive Transportation Fund from Auto-Related Sales Taxes" on page 29.

Source: U.S. Energy Information Administration (June 2022) for taxes and fees; House Fiscal Agency for information on allocation to road funding.

Title and Annual Registration Fees

Every vehicle owner in Michigan is subject to title and annual registration fees. This is the second most common road user fee in Michigan that contributes to road funding in the state. Revenue from vehicle registration fees totaled $1.4 billion in fiscal year 2021.[8]

Vehicle registration fees. In Michigan, the registration fees for all vehicles are based on a combination of factors that include the vehicle's list price, age, and empty weight.[9] This fee is similar across all types of vehicles, with a slight variation between comparable vehicles.[10] The fee for new cars and light trucks

8. Note: This number includes a small amount of miscellaneous aviation fees.

9. See MCL 257.801 for fees based on weight at http://legislature.mi.gov/doc.aspx?mcl-257-801, and for details of fees by age and residual value (*ad valorem* fees) under "Ad Valorem fees" at https://www.michigan.gov/sos/vehicle/ownership/vehicle-base-prices.

10. Fee variation between comparable vehicles is due to marginal differences in weight, and the birth date of the driver based on which the fee is assessed. Nevertheless, it is often argued that average base registration fee from EVs is significantly higher than the average registration fees from ICE vehicles. This is true only in so far as the EVs that are currently being sold in the market are primarily in the "luxury" segment, which are bound to be more expensive. See Anderson Economic Group, Automotive Dashboard (https://www.andersoneconomic-group.com/automotive-dashboard/).

If drivers must transition from ICE to EVs over time, prices of comparable vehicles must be similar; i.e., *ceteris paribus*, a given driver will transition from ICE to an EV only when both their prices converge within a narrow band. Consequently, the revenue from registration fees on comparable vehicles will be similar.

begins at 0.6% of list price and decreases to 0.44% of list price after four years. The average fee for passenger vehicles of all ages and prices is about $135 per year. Commercial truck registration fees are based on the maximum weight of the truck and cargo. The fee is approximately 2.5 cents per pound per year. Farm, logging, and dairy truck owners pay reduced fees.

Passenger vehicles registration fees totaled almost $1.1 billion in FY 2021, while commercial vehicles registration fees totaled $264 million.[11] We show annual registration fees for Michigan in Table 4 below, and total Michigan Transportation Fund and Vehicle Registration Fees revenue over time in Figure 5 on page 14.

TABLE 4. Annual Michigan Registration Fees by Vehicle Model and Year as in August 2022

	2012 Toyota Camry SE	2022 Toyota Camry SE	2012 Chevrolet Equinox LS	2022 Chevrolet Equinox LS
Registration Fees	$91	$123	$116	$129
Memo: Empty weight (lbs)	*3,240*	*3,350*	*3,777*	*3,274*
Memo: MSRP (base price)	*$23,220*	*$27,385*	*$23,530*	*$29,295*

Note: As noted on the Michigan Department of State's website under "Registration Fee Calculator," these registration fees are only an estimate, and does not include any other additional taxes and fees levied during registration. We assume the vehicle is not being titled for the first time, and the owner's birth date is 1st of January. Registration fee includes fee based on residual value (ad valorem fee) and empty weight.

Source: Vehicle's MSRP and empty weight from the manufacturer's website and Cars.com.

Analysis: Anderson Economic Group analysis of fees based on residual value and empty weight.

Additional registration fee for battery electric and plug-in hybrid electric vehicles. Since electric vehicles do not consume motor fuel and their drivers do not pay motor fuel taxes,[12] in the State of Michigan, an additional fixed registration fee is levied on BEVs and PHEVs to recoup revenue from lost motor fuel taxes.[13] Table 5 on page 14 shows the additional registration fees paid by BEV and PHEV drivers in Michigan.

In FY 2021, surcharges on electric and hybrid vehicle registration fees generated $1.5 million and $0.6 million in revenue, respectively. This fixed fee, however, is lower than the amount ICE vehicle drivers contribute to road revenue through motor fuel taxes each year.

11. Michigan Department of State, Summary of Fees Collected and Number of Transactions, FY 2020-21, p1

12. EV drivers do not pay any taxes and fees associated with motor fuel, such as Michigan's general sales tax and its environmental protection fee. However, as these taxes and fees are not directly linked to road funding, we omit them from our description.

13. Michigan Department of Transportation, *The Official Guide to Michigan Department of Transportation 2019*, 41-42.

TABLE 5. Additional Registration Fees on Plug-in and Electric Vehicles in Michigan, January 2022

Vehicle Type	Weight less than (or equal to) 8,000 lbs.	Weight more than 8,000 lbs.
Battery Electric	$140	$240
Plug-In Hybrid	$50	$120
Hybrid	-	-

Source: Michigan Vehicle Code, 257 M.C.L. 801

Other State Taxes

In addition to the sources identified above, the MTF also receives revenue from an Income Tax Act earmark. Beginning in 2022, it will gain revenue generated by an excise tax on recreational marijuana sales under the Michigan Regulation and Taxation of Marijuana Act. In FY 2020-21, the income tax earmark generated $600 million in revenue for the MTF. In FY 2021-22, the fund's revenue from the marijuana tax will total $49.3 million. We show Michigan Transportation Fund revenues by source and fiscal year in Figure 5 on page 14.

FIGURE 5. Michigan Transportation Fund Revenue, Fiscal Years 2003-2022 (millions)

Notes: Figures reflect actual revenue, except for fiscal year 2021-22, which reflects revenue estimates. Vehicle registration taxes include title fees of approximately $35 million annually; other state resources include $69 million transferred from the Budget Stabilization Fund in fiscal year 1997-98, an earmark on income tax revenue beginning in fiscal year 2018-19, and an earmark from the marijuana excise tax revenue in fiscal year 2020-21.

Source: House Fiscal Agency, "MTF Distribution Formula to Local Road Agencies," March 2022.

Analysis: Anderson Economic Group (2022)

Federal Funding

The bulk of Michigan's transportation funding comes from state tax and fee revenues. However, Michigan also receives funds from the Federal Highway Administration's Highway Trust Fund (HTF). The HTF is funded by the federal gasoline and diesel tax revenue attributed to the state trunkline system and local road agencies. In addition, the 2021 Infrastructure Investment and Jobs Act (IIJA) will direct about $645 million toward Michigan's transportation system. Of this funding, 75% will go to the state trunkline, and 25% will go to a total of 533 local municipalities across Michigan.

ROAD REVENUE DISTRIBUTION

The state's road revenue is allocated primarily to the Michigan Transportation Fund (MTF). The MTF receives a combination of state fuel taxes, federal funds, and vehicle registration fees. A portion of the fund supports various state agencies, as well as highways, county roads, and municipal streets.[14] The state trunkline and comprehensive tax funds are additional, smaller funds that receive revenue from federal and local agencies, public transportation services, and from licenses, permits, and the motor fuel tax.

Revenues are distributed to the MTF following the steps below as shown in Figure 6 on page 16, in accordance with Public Act 51 of 1951 (Act 51). Estimated total funding amounts for fiscal year 2020-21 are shown parenthetically in millions.

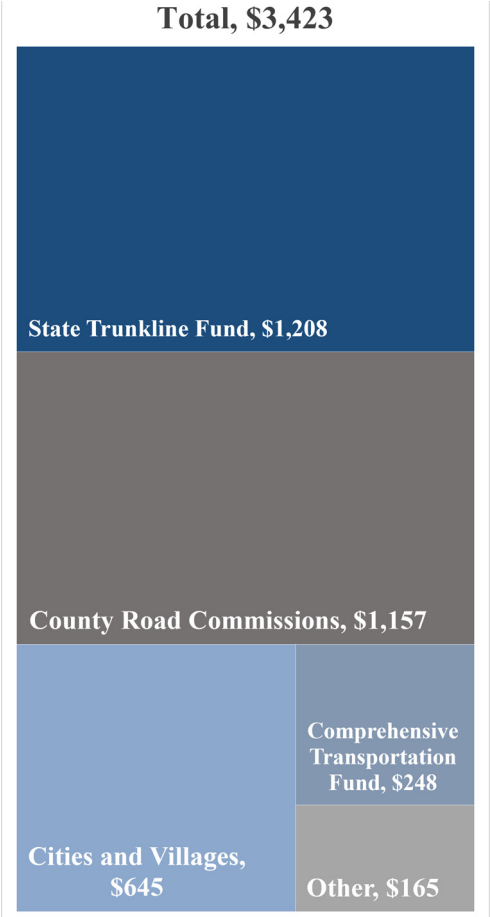
1. Tax revenues are credited to the Michigan Transportation Fund (MTF) ($3,423M).[15]
2. A portion of the MTF is distributed to the Comprehensive Transportation Fund to fund public transportation, to state agencies that provide collections and other support, and to other statutory funds and grants ($248M).
3. MTF funds are distributed to the various entities responsible for public roads using the following 'external' Act 51 distribution formula:
    - 39.1% to the State Trunkline Fund (STF) for state roads, with additional STF bridge debt reduction funds and gas taxes ($1,208M).
    - 39.1% to county road agencies, with funds from the Local Program Fund (LPF) ($1,157M).
    - 21.8% to cities and villages, plus funds from the LPF ($645M).
4. County and city or village funds are distributed using 'internal' Act 51 formulas:
    - The county internal formula distributes funding for different kinds of roads (e.g., primary vs. local) based largely on the road's mileage and the number of resident vehicle registrations.

14. House Fiscal Agency, "A Guide to 1951 Public Act 51 and Michigan Transportation Funding," February 2007.

15. Hamilton, William E., "Fiscal Brief: MTF Distribution Formula to Local Road Agencies," 2021.

- The city or village internal formula distributes funding based on the jurisdiction's population and road mileage.[16]

FIGURE 6. Michigan Transportation Fund Distribution, FY2020-2021 (Millions)



Source: AEG analysis using data from the Michigan House Fiscal Agency.

TRANSPORTATION FUNDING GAPS

As illustrated in Figure 5 on page 14, the revenue allocated to MTF has decreased over the years, and is projected to shrink further. MDOT estimates that the gap between the need for and the availability of funds will total $73.7 billion between FY21 and FY45.[17] Additionally, CRA estimates an annual funding gap of $1.8 billion for county roads in 2021.[18]

16. Hamilton, William E., "Fiscal Brief: MTF Distribution Formula to Local Road Agencies," Michigan House Fiscal Agency, May 6, 2019.
17. "Michigan mobility 2045," Michigan Department of Transportation, July 22, 2021.
18. L.W. Brown Consulting, "2021 Michigan County Road Investment Plan," County Road Association of Michigan, June 2021.

The funding gap can be attributed to factors that include increasing fuel efficiency, increasing prices, and, more recently, supply-chain shortages and the high cost of fuel. A portion of the gap can also be attributed to an increase in electric vehicles, whose drivers do not pay motor fuel taxes.

III. Transition to Electric Vehicles

This chapter discusses the electric vehicle transition in the U.S. and Michigan. In particular, it offers an overview of EVs and summarizes key government initiatives encouraging EV growth. The chapter also highlights EV transition trends in Michigan and summarizes recent announcements by key automakers.

ELECTRIC VEHICLES OVERVIEW

Types of Electric Vehicles

The concept of electric vehicles in the U.S. is not novel. In the early 20th century, electric vehicles accounted for a third of all vehicles on U.S. roads. In comparison, internal combustion vehicles gained popularity in the mid-20th century and have remained a preferred choice for most U.S. drivers. Due to heightened interest in recent years, primarily by the government and auto manufacturers, EVs are becoming popular again.[19]

Currently, most electric vehicles driven in the U.S. are hybrid vehicles, plug-in hybrid vehicles, and battery electric vehicles. Collectively known as EVs, these groups of vehicles compete with internal combustion engine (ICE) vehicles in the U.S. automotive market. In particular:

1. **Internal Combustion Engine Vehicles.** These vehicles use fuel that combusts inside a chamber commonly powered by a regular internal combustion engine.
2. **Electric Vehicles.** These vehicles use a combination of batteries and fuel to power their engine. For instance, HEVs are charged by storing energy from the regenerative braking; PHEVs can be charged at a charging station or using a regenerative braking system; BEVs can only be charged at a charging station.[20] For a detailed description of each type of vehicle, see "Appendix A. Sources and Methodology" on page A-1.

Weight of Electric Vehicles

Electric vehicles, on average, weigh significantly more than their ICE counterparts, and their additional weight translates directly to increased ton-miles on the roads. The weight difference is primarily due to the large battery pack and additional suspension and reinforcement required for its protection.[21]

19. U.S. Department of Energy, "The History of the Electric Car," found at www.energy.gov/articles/history-electric-car, accessed on July 7, 2022.
20. U.S. Department of Energy: Alternative Fuels Data Center, "Fuels and Vehicles," found at afdc.energy.gov/, accessed on June 14, 2022.
21. See for example the electric trucks released by General Motors, Ford, and Rivian. Adele Peters, "Electric vehicles have a weight problem," *FastCompany*, accessed at www.fastcompany.com/90686171/electric-vehicles-have-a-weight-problem, October 2021.

GOVERNMENT INITIATIVES

All levels of government have developed policies with set goals to encourage the growth of electric vehicles. Typically, the U.S. federal government sets the tone with regulations to stimulate EV production and consumption. Similarly, state and local governments also participate in programs that upgrade EV infrastructure. The following is an overview of some recent government initiatives at various levels of the government.[22]

Federal Government. The EV transition at this level gained prominence in 2006 during the Bush administration.[23] In the early 2010s, President Obama undertook several actions that accelerated EV adoption in the country.[24] For instance, most consumers purchasing electric vehicles since 2010 have become eligible to receive up to $7,500 in federal income tax credit.[25] During the four years of President Trump, federal policies mainly remained supportive of the transition towards EV vehicles.[26]

Since 2021, President Biden has pursued a detailed transition plan through the Infrastructure Investment and Jobs Act. Some key objectives of the law are:[27]

- Setting up a target of 50% EV share of new sales by 2030 in the U.S;[28]
- Building a network of 500,000 EV chargers in the country; and[29]
- Developing a domestic EV battery supply chain infrastructure to minimize dependency on foreign resources.

The Inflation Reduction Act, signed into law in August 2022, revised the federal income tax credit for both manufacturers and buyers of electric vehicles.[30]

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22. This section also offers a brief overview of some initiatives at the global level expected to impact the U.S. auto industry during the transition.
23. The American Presidency Project, "Fact Sheet: President Bush's Four-Part Plan to Confront High Gasoline Prices," accessed at www.presidency.ucsb.edu, April 2006.
24. The White House: Office of Press Secretary, "Fact Sheet: Obama Administration Announces Federal and Private Sector Actions to Accelerate Electric Vehicle Adoption in the Unites States," accessed at obamawhitehouse.archives.gov, July 2016.
25. The federal policy put a cap of 200,000 vehicle-per-manufacturer for $7,500 tax credits before 2022. Amongst automakers, GM and Tesla no longer were able to offer tax credits after selling 200,000 EVs in the automotive retail market.
26. The White House: Remarks by President Trump, "Remarks by President Trump Congratulating Lordstown Motors on the 2021 Endurance Vehicle," accessed at trumpwhitehouse.archives.gov/, dated September 28, 2020.
27. The White House, "Fact Sheet: The Biden-Harris Electric Vehicle Charging Action Plan," accessed at whitehouse.gov, December 2021.

    Library of Congress, "H.R.3684 - Infrastructure Investment and Jobs Act," accessed at www.congress.gov/bill/117th-congress/house-bill/3684/text, November 2021.
28. The current BEV share of total U.S. vehicle unit sales is 5.0% as of Quarter 2 of 2022.
29. Infrastructure Investment and Jobs Act dedicates $5 billion in formula funding for states with a goal to build a national charging network.

State Government. The transition at this level gained prominence in selected states in the mid-2000s. In particular, California has adopted multiple policy initiatives since 2006. For instance, through its executive order, California has set a target to introduce 5 million electric vehicles on its roads by 2030 and 250,000 EV charging stations by 2025. The state also aims to sell EV-only new cars and trucks by 2035.[31] The California Air Resources Board approved rules in August 2022 that require all new cars sold in the state by 2035 to have zero emissions.[32] It is expected that this rule would be later adopted by other states across the U.S.

The transition pace in other states varies based on the local automotive retail market, charging infrastructure, the electric grip capacity, and consumer attitude toward non-conventional vehicles. Several states endorsed multi-state agreements based on regional similarities to boost EV infrastructure. For instance, Michigan, Illinois, Indiana, Minnesota, and Wisconsin formed a coalition in 2021 known as the REV Midwest (Regional Electric Vehicle Midwest Coalition).[33] See "Adoption Strategies by Michigan Government" on page 21.

Local Government. Several municipalities have enacted incentive programs and regulations to promote EVs within local communities. For example:[34]

- Battery Electric Vehicle Taxicab Pilot Program in New York City, NY;
- Hybrid and Electric Vehicle Parking Program in San Antonio, TX;
- Green Fleet Policy of Minneapolis, MN; and
- Electric Vehicle Charing Stations at Public Facilities in Pittsburgh, PA.

EV Trends at the Global Level. Countries in the EU, UK, Japan, and India continue to support the electric vehicle transition. Some examples are:

- European Union to target 30 million EVS on its roads by 2030;
- United Kingdom to end the sale of ICE vehicles by 2040;
- Japan to target 100% electric car sales by 2035; and
- India to target 30% of its new auto sales as all electric by 2030.

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30. Library of Congress, "H.R.5376 - Inflation Reduction Act of 2022," accessed at www.congress.gov/bill/117th-congress/house-bill/5376, August 2022.
This Act eliminates the cap available to buyers of electric vehicles from manufacturers, including those that have already hit the cap, namely Tesla, GM, and Toyota. Several provisions of the Act would impact electric vehicle sales and production.
31. California Public Utilities Commission, "Transpiration Electrification," www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/transportation-electrification.
32. The California Air Resources Board, "Proposed Advanced Clean Cars II (ACC II) Regulations," accessed at ww2.arb.ca.gov/rulemaking/2022/advanced-clean-cars-ii, August 31, 2022.
33. Bill Chappell, "5 Midwestern governors agree to create a network to charge electric vehicles," *NPR,* accessed at www.npr.org/2021/10/01/1041987104/midwest-electric-vehicles-charging-evs-cars, October 2021.
34. U.S. Department of Energy: Alternative Fuels Data Center, "Examples of Local Laws and Incentives," accessed at afdc.energy.gov/laws/local_examples.

TRANSITION TRENDS IN MICHIGAN

Michigan aims to become a prominent EV-friendly state. The following trends underscore the state's transition rate based on the key factors discussed below.

Transition Trends on Michigan Roads

Michigan roads continue to experience a steady rise in electric vehicles. In particular:

1. **New Vehicle Sales.** There were 16,919 new electric vehicles sold in Michigan in 2020. In 2021, this increased by nearly 75% to 29,590 units. In 2021, electric vehicles as a share of total vehicles sold reached 6.0%. See Table 6 below.
2. **Vehicle in Operations.** At the beginning of 2021, the total number of active electric vehicles in Michigan was 144,277. By October 2021, the figure increased by nearly 10% to 162,739. During this period, EVs as a share of total operational vehicles remained at 1.9%. See again Table 6 below and Exhibits B-1 through B-4 in Appendix B.

TABLE 6. Electric Vehicles Penetration in Michigan, as of 2021

Vehicles	Share of Total New Vehicle Sales	Total New Vehicle Sales	Share of Total Vehicles in Operation	Total Vehicles in Operation
Battery Electric	1.3%	6,435	0.2%	17,060
Hybrid Electric	3.9%	19,103	1.5%	129,658
Plug-in Hybrid Electric	0.8%	4,052	0.2%	16,021
Total Electric Vehicles	**6.0%**	**29,590**	**1.9%**	**162,739**
Memo: Internal Combustion Engine Vehicles	*94.0%*	*462,159*	*98.1%*	*8,299,277*

Note: This data is changing steadily, see Anderson Economic Group's Automotive Dashboard, at www.andersoneconomicgroup.com/auto-dashboard/ for regular updates on EV market penetration.
Source: IHS Markit (units in operation, new vehicle registrations)
Analysis: Anderson Economic Group

Adoption Strategies by Michigan Government

Michigan government has undertaken several strategies to facilitate its transition into an EV-friendly state. Some examples are:[35]

1. **Michigan EV Friendliness Program.** It is a $40 million investment proposal to enhance the state's EV charging infrastructure and innovation.
2. **National Electric Vehicle Infrastructure (NEVI) Plan.** It is a federal funding formula program in which Michigan intends to participate.
3. **Regional Electric Vehicle (REV) Midwest Plan.** It is a regional pact between several Midwestern states to increase collaboration on EVs.

35. See Appendix A for data sources for these programs.

AUTO MANUFACTURER GOALS

Most light vehicle manufacturers operating in the U.S. have publicly announced strategies and investments to transition their lineups from conventional vehicles to electric vehicles. The following table highlights recent EV goals announced by key auto manufacturers in the U.S.

TABLE 7. Recent EV Goals by Key Auto Manufacturers, U.S. Market, As of 2022

Manufacturer	Goals
Ford	Aims to produce 2 million annual EVs by 2026
GM	Cadillac aims to become an EV-only brand by 2030
Stellantis*	Targets 50% of its new U.S. sales to be BEVs by 2030
Audi	Plans to become an EV-only brand after 2026
BMW	Aims to achieve 50% new sales from EVs by 2030
Mercedes-Benz	Aims to sell nearly 50K new BEVs in the U.S in 2023
Honda	Aims to produce 30 BEV models over the next decade
Toyota	Aims to achieve 3.5 million new EV sales by 2030

** Formerly known as FCA Chrysler*
Note: Announcements are based on the research as of June 2022.
Sources: Manufacturer Websites
Analysis: Anderson Economic Group

Other Factors Contributing to EV Transition

In addition to sales and production goals by auto manufacturers, other factors contributing to the transition are:

1. **Rise of New Electric Vehicle Manufacturers.** Launched less than 20 years ago, Tesla, Rivian, and Lucid Motors are popular EV-only automakers who compete with established brands in the U.S. Tesla is the market leader for electric vehicles.
2. **Growing Investments by Auto Manufacturers.** Most automakers around the world are investing nearly $500 billion in electric vehicle production and battery development. These manufacturers are making significant investment in the US, and in Michigan, in electric vehicle production and battery development.[36]

36. Estimated investments announced by automakers in the U.S. on EVs total 82 billion. Paul Lienert and Tina Bellon, "Exclusive: Global carmakers now target $515 billion for EVs, batteries," *Reuters,* accessed at www.reuters.com/business/autos-transportation/exclusive-global-carmakers-now-target-515-billion-evs-batteries-2021-11-10/, November 2021. Note the financial incentives provided to Ford, General Motors, and others for investments in electric vehicle and battery production in Michigan and across the US in 2022.

IV.Estimating the Road Funding Gap

This chapter illustrates the origin of Michigan's road funding shortfall resulting from its drivers transitioning to electric vehicles. Next, it forecasts two separate scenarios of electric vehicle adoption in Michigan up to 2030. Finally, using these forecasts, it estimates the annual shortfall to road funding.

ORIGIN OF ROAD FUNDING GAP FROM TRANSITION TO ELECTRIC VEHICLES

Title and annual registration fees and excise taxes on gasoline are the two main sources of revenue for road funding in Michigan. When electric vehicle drivers do not pay excise taxes, and also drive heavier vehicles, a road funding gap is created. Therefore, two key factors are driving Michigan's road funding gap from drivers transitioning to electric vehicles.

1. Electric vehicle drivers do not pay excise taxes because they do not consume motor fuel. Michigan's EV registration fee is levied in lieu of excise taxes, but it is lower than the annual excise taxes from a comparable internal combustion engine driver.
2. The average curb weight of electric vehicles is significantly higher than comparable ICE vehicles. This additional weight causes greater deterioration of the roads, which remains uncompensated.

ILLUSTRATION OF THE ROAD FUNDING GAP

Insufficient Electric Vehicle Registration Fees

One gap in road funding originates from Michigan's EV registration fees being lower than the excise tax burden on its ICE drivers. Not counting the registration fees, the excise taxes from a typical ICE driver in Michigan with an annual mileage of 12,000 is between $160 to $240.[37] When adjusted for Michigan's average mileage of 14,300, the burden on an ICE driver is $190 to $285.[38] A battery electric vehicle driver in Michigan pays a fixed fee of $140 per year for the same distance.

Higher Obligations from Heavier Electric Vehicles

Moreover, if the battery electric vehicle variant is 1.25 times heavier than its ICE variant, it does not mean its road damage is also about 1.25 times. We reviewed a number of available methods on estimating the road damage from heavier vehicles. For example, the method is centered around weight per axle of

37. This estimate does not include the registration fees based on weight, age and residual value that is collected during registration. The lower estimate is for "entry" ICE vehicles with a higher fuel economy, and the higher estimate is for "luxury" ICE vehicles with a lower fuel economy. See Anderson and D'Souza (2022, p. B-10).

38. Kelley Blue Book Estimates, "Average Miles Driven Per Year: Why It Is Important", September 2021, https://www.kbb.com/car-advice/average-miles-driven-per-year/.

a vehicle estimates a BEV's road damage to be about 2.4 times of its ICE variant.[39]

Both these sources of funding gaps are illustrated in Table 8 on page 25, with comparables amongst the most sold vehicles in Michigan. These illustrations, and subsequent calculations on road funding shortfall do not estimate the monetary cost of higher road damage. Our estimates are based only on the shortfall from EV registration fees being lower than excise taxes from comparable ICE vehicles.

The illustration in Table 8 on page 25 highlights several noteworthy points:

1. Despite Michigan's EV registration fee, Michigan's Transportation Fund recoups only a portion from an EV driver as compared to an ICE driver. This is the origin of the road funding gap from Michigan's drivers transitioning to EVs.
2. Electric vehicles weigh significantly more than their ICE counterparts. This additional weight implies greater wear and tear. Therefore, an effective shortfall is created despite equalizing the nominal amounts of the EV registration fee and excise taxes from ICE drivers. Without calibrating the EV registration fee to account for the mileage on heavier vehicles, Michigan Transportation Fund's future receipts will be insufficient to cover its obligations.
3. Unlike the Michigan state government, the federal government does not levy any registration fees on electric vehicles. This is an effective shortfall of 100% to the Highway Trust Fund with every new EV transition. As the Highway Trust Fund predominantly supports highway and transit projects that are executed at the state and local level, shortfall to the HTF will impact the roads in Michigan.[40]
4. EV drivers in Michigan pay only around 70-80% towards road funding when compared to their ICE counterparts (combination of shortfall to the Highway Trust Fund and Michigan Transportation Fund). As more drivers transition to EVs, the combined gap towards road funding will grow.

39. See U.S. General Accounting Office's "Excessive Truck Weight: An Expensive Burden We Can No Longer Afford" at https://www.gao.gov/assets/ced-79-94.pdf. The method is centered around weight per axle of a vehicle. More precisely, the road damage is expressed as the fourth power of relative loads. For example, a 4,000lbs ICE variant with 2 axles has 2,000lbs/axle, but the BEV variant with 2 axles has 2,500lbs/axle. 2,500 = 1.25 * 2,000. Therefore, relative damage is 1.25 ^ 4 = 2.4.

40. For more information, see CRS Report R44332, *Federal-Aid Highway Program (FAHP): In Brief*, by Robert S. Kirk; CRS Report R41869, *The Donor-Donee State Issue in Highway Finance*, by Robert S. Kirk; and U.S. Federal Highway Administration, "Motor Fuel and Highway Trust Attribution," at http://www.fhwa.dot.gov/policyinformation/motorfuel/aboutmf.cfm.

TABLE 8. Illustration of Road Funding Gaps From the Most Sold Comparable Vehicles in Michigan, 2022.

	ICE	BEV	PHEV	HEV
Representative vehicles	Honda Accord Toyota Camry LE Chevrolet Malibu Chevrolet Equinox	Tesla Model 3 Chevrolet Bolt EV Nissan Leaf Volkswagen ID.4	Ford Escape Kia Niro Toyota Prius Prime Hyundai Tucson	Toyota Camry LE Hyundai Sonata Blue Honda Accord Hybrid Kia Niro LX
Average MSRP	$36,972	$37,787	$35,701	$32,686
Average fuel economy	26.0 mpg	3.8 mi/kWh	51.8 mpg 1.7 mi/kWh	50.2 mpg
Average curb weight (US ton)	1.6	1.9	1.7	1.7
Contribution to Road Funding				
To Highway Trust Fund (HTF)				
Federal excise taxes	$100.5	-	$25.3	$52.2
Share of ICE driver contribution	-	*(0%)*	*(25%)*	*(52%)*
To Michigan Transportation Fund (MTF)				
Michigan excise taxes	$151	-	$38.1	$78.7
EV registration fees	-	$140	$50	-
Share of ICE driver contribution	-	*(92%)*	*(58%)*	*(52%)*
Memo: Registration fees based on empty weight, age, & residual value	*$140*	*$158*	*$149*	*$138*
Total road funding contribution	$402	$298	$262	$268
Share of ICE driver contribution	-	*74%*	*65%*	*67%*

Notes: Representative vehicles refer to comparables amongst the most sold vehicles between the $30,000 to $45,000 in Michigan between 2019-2021 before any federal or state tax credits; vehicles are chosen to represent the a large share of Michigan's drivers, while also ensuring prices within each category are close to each other; all averages are weighted based on unit sales of vehicles between 2019-2021 (harmonic mean used for fuel economy); all drivers are presumed to travel 14,300 miles per year; PHEVs are presumed to travel 50% of the miles using gasoline; all prices and tax rates are from 2022.

Source: EPA (combined fuel economy); EIA (federal and state excise taxes); IHS Markit (2019-2021, unit sales of vehicles in Michigan); Edmunds.com and manufacturer's websites (price and curb weight of vehicles); Kelly Blue Book (average mileage of Michigan drivers); Michigan Secretary of State website (ad valorem fees, and weight based fees).

Analysis: Anderson Economic Group (2022) research.

PROJECTIONS OF ELECTRIC VEHICLE ADOPTION IN MICHIGAN

As established, road funding contribution from an EV driver in Michigan is less than a ICE counterpart. However, as ICE to EV transitions increase, the shortfall from individual drivers will continue adding up. Therefore, the rate of EV adoption will ultimately determine Michigan's total road funding shortfall.

Projections Under Two Scenarios

Projections of EV adoption are subject to large uncertainties in regulatory policy, macroeconomic conditions and technology breakthroughs. Therefore, it is prudent to forecast under multiple scenarios. We project EV sales and active fleet penetration in Michigan based on two scenarios:

- **Scenario # 1. 15% BEV New Vehicle Sales by 2030.** This scenario presumes that the current subsidy regime continues. This includes the limited number of purchase cost subsidies for each manufacturer; the charging facility subsidies embedded in the recent federal infrastructure bill;[41] implicit subsidies within manufacturers to encourage purchasing of newer EVs; and some incentives from utilities. Under this scenario, share of BEV to that of all new vehicle sales in Michigan is expected to be 15%, and share of HEV and PHEV sales will be proportional to BEV sales.
- **Scenario # 2. 25% BEV New Vehicle Sales by 2030**. This scenario presumes that the federal government and the Michigan state government increases existing incentives to manufacturers to shift to EVs, such as through Corporate Average Fuel Economy (CAFE)-style regulations and possibly regulations. This would also include some breakthroughs in manufacturing technology, and reduced cost of raw materials. Under this scenario, share of BEV to all new vehicles sales in Michigan is expected to be 25%.

A summary of our projections is presented in Table 9 on page 27.

41. Section 11101 of the Infrastructure Investment and Jobs Act, PA 117-58 of 2021, includes $2.5 billion in federal funds for electric, propane, natural gas, and hydrogen fueling stations. Other federal subsidies also exist.

TABLE 9. 2030 Electric Vehicle Active Fleet and Sales Projections in Michigan, Two Scenarios

EV Type	Projected 2030 Sales Penetration	Projected 2030 Active Fleet Penetration
Scenario #1: 15% BEV New Vehicle Sales by 2030		
BEV	***15%***	*1.4%*
PHEV	*7%*	*0.8%*
HEV	*19%*	*2.7%*
All EVs	41%	5%
Scenario #2: 25% BEV New Vehicle Sales by 2030		
BEV	***25%***	*2.1%*
PHEV	*13%*	*1.2%*
HEV	*31%*	*3.7%*
All EVs	69%	7%

Source: IHS Markit (sales in Michigan, 2019-2021; vehicles in operation in Michigan, 2019); Anderson Economic Group (projections).

Notes: Only about 1.3% of new vehicles sold in Michigan in 2021 were BEVs. See text for explanation of "15% BEV New Vehicle Sales by 2030" and "25% BEV New Vehicle Sales by 2030" scenarios. These estimates are based on the information available at the end of 2021, and are subject to large uncertainties. See "Methodology Description" on page A-7 for details.

Analysis: Anderson Economic Group (2022).

ROAD FUNDING SHORTFALL

As EVs replace ICE vehicles, two factors lead to a growing shortfall in Michigan's road funding revenue: (1) decrease in revenue from motor fuel excise taxes and (2) increase in obligations from higher wear and tear of roads. Our shortfall estimates only include decrease in revenue from motor fuel taxes. It does not include the monetary damage from heavier EVs.

Shortfall to Transportation Funds from Excise Taxes

Currently, the Highway Trust Fund (HTF) and Michigan Transportation Fund (MTF) cumulatively lose around $100 to $150 per year on each EV in Michigan. As the rise in EV adoption is expected to be geometric, the shortfall in road funding will also be geometric. Estimates for total shortfall in road-funding under the two scenarios are presented in Table 10 on page 28.

The annual revenue shortfall in road funding from transition to EVs in Michigan grows from $15 million in 2019 to $67 million in 2030 under the more conservative scenario. This includes the gap in the Michigan Transportation Fund (MTF) and the gap in the federal Highway Transportation Fund (HTF). Given the large number of variables, and the very recent (or not yet) introduction of electric vehicle models, these figures should be seen as a representation of the problem's order of magnitude. The actual revenue shortfall, however, will be higher or lower depending largely on the pace of EV adoption, and of course any tax policy changes. If the actual adoption rate is higher than our projections in Table 9 on page 27, the shortfall to road funding will be greater than the estimates presented in Table 10 below.

TABLE 10. Road Funding Shortfall from Transition to Electric Vehicles in Michigan, 2019-2030 ($, millions)

Fund		2019	2020	2021	2022 F	2023 F	2024 F	2025 F	2026 F	2027 F	2028 F	2029 F	2030 F
Under the "15% BEV New Vehicle Sales by 2030" Scenario													
HTF	*(a)*	6.8	7.4	8.8	9.9	11.5	13.0	15.1	17.9	21.4	26.1	32.0	39.6
MTF	*(b)*	7.9	8.6	9.7	10.9	12.4	13.3	14.7	16.2	18.0	21.0	23.8	27.0
Total	*(c)*	14.8	16.0	18.5	20.8	23.8	26.3	29.8	34.0	39.4	47.0	55.8	66.6
Under the "25% BEV New Vehicle Sales by 2030" Scenario													
HTF	*(a)*	6.8	7.4	8.8	10.0	11.8	13.8	16.7	20.6	26.1	33.6	43.8	57.6
MTF	*(b)*	7.9	8.6	9.7	11.0	12.6	13.8	15.8	18.1	21.0	25.9	31.1	37.4
Total	*(c)*	14.8	16.0	18.5	21.0	24.4	27.7	32.5	38.7	47.2	59.6	74.9	95.0

(a) Includes only shortfalls from federal fuel excise taxes.
(b) Includes only shortfalls from Michigan fuel excise taxes after adjusting for the EV registration fee.
(c) Sum of shortfalls to the HTF and MTF.

Notes: HTF refers to the Highway Trust Fund, and MTF refers to the Michigan Trust Fund. For assumptions used in the estimation process, see "Appendix A. Sources and Methodology" on page A-1

Source: Anderson Economic Group (2022) research.

Shortfall to the Highway Trust Fund Grows More Rapidly Than Michigan's Transportation Fund

The shortfall to Highway Trust Fund and Michigan Transportation Fund is almost the same in 2019. However, HTF's balloons to almost twice that of MTF's by 2030. The difference in terms of real prices will be much higher. This is mainly due to two factors:

1. Michigan Transportation Fund partially recoups lost excise taxes via EV registration fees on BEVs and PHEVs. The Highway Trust Fund has no such mechanism to offset losses.
2. Michigan's fuel excise taxes are calibrated to grow with rising inflation. No such provision exists for federal fuel excise taxes. The last hike in federal fuel taxes was in October 1993. Since then through June 2022, cumulative inflation in the US has been over 105%.[42] Therefore, as construction and material costs rise with time, the HTF's obligations in terms of real prices will be much larger.

Shortfall to the Comprehensive Transportation Fund from Auto-Related Sales Taxes

In addition to revenue losses from fuel excise taxes, Michigan also will lose revenue from general sales taxes levied on fuel. This "auto-related sales tax" comprises tax not only on the sale of motor fuel, but also on the sale of parts and accessories of motor vehicles, used car businesses, gasoline station businesses etc.

State law that outlines the Comprehensive Transportation Fund (CTF) requires not less than 27.9% of 25% of the general sales tax on motor fuel imposed at the rate of 4% be allocated to the fund. Therefore, as EV penetration increases, the auto-related sales tax from gasoline will decrease. This could potentially cause a decrease in funding for the Comprehensive Transportation Fund. Our estimates for the shortfall in CTF's funding are presented in Table 11 on page 30.

42. Calculated using Consumer Price Index data from the Bureau of Labor Statistics at https://www.bls.gov/cpi/.

TABLE 11. Funding Shortfall to CTF from Transition to EVs in Michigan, 2019-2030 ($, millions)

Fund		2019	2020	2021	2022 F	2023 F	2024 F	2025 F	2026 F	2027 F	2028 F	2029 F	2030 F
Under the "15% BEV New Vehicle Sales by 2030" Scenario													
CTF	*(a)*	0.24	0.23	0.38	0.58	0.59	0.67	0.78	0.93	1.12	1.36	1.68	2.08
Under the "25% BEV New Vehicle Sales by 2030" Scenario													
CTF	*(a)*	0.24	0.23	0.38	0.59	0.61	0.71	0.87	1.08	1.37	1.76	2.30	3.03

(a) Includes only shortfall from 27.9% of 25% of the proceeds from general sales tax levied at 4% on motor fuel.

Notes: MCL 205.75(4) outlines sources of funding for the CTF. These estimates include shortfalls to the CTF only from sales taxes collected on motor fuel. These estimates do not include possible shortfalls (or gains) from the sale of items listed under "auto related sales taxes" that are not motor fuel. For assumptions used during estimation, see "Appendix A. Sources and Methodology" on page A-1.

Source: Anderson Economic Group (2022) research.

V. Policies to Replace Lost Road Funding Due to Electric Vehicle Adoption

This section overviews potential alternatives to the current taxes and fees on road usage. The policy options mentioned below attempt to equalize the burden of road usage among drivers of electric and internal combustion engine vehicles. This section also discusses the advantages and disadvantages associated with each policy.

OVERVIEW OF POLICIES

With the market transition from ICE to electric vehicles, there is a need for discussion on alternative road user charges (RUC) that promote equity in road funding among ICE and electric vehicle drivers. In addition to the additional registration fees currently assessed, electric vehicle drivers will need to pay road usage taxes that they are currently avoiding. Below we elaborate upon five potential road user fees:

1. Annual flat registration fees
2. Mileage-based user fees
3. Per kilowatt-hour fees
4. Miles at registration fees
5. Tolling

ANNUAL FLAT REGISTRATION FEES

The state of Michigan charges an additional annual vehicle registration fee of $140 for BEVs and $50 for a PHEVs. While the state recomputes the annual registration rate each year to account for motor fuel tax hikes, it is not equivalent to the contributions made by ICE vehicle drivers to the MTF and HTF through the payment of motor fuels taxes. For a comparison of the vehicle registration fees paid by owners of comparable electric and internal combustion engine vehicles, see Table 8 on page 25.

Since drivers of EVs pay a lower road user fee than ICE vehicles on average, increasing the registration fee for electric vehicles to match the counter-factual revenue generated from motor fuel tax paid by ICE vehicle owners may bridge the revenue gap and equalize the road user fee for electric and ICE vehicles.

Vehicle registration fees as a supplemental road user fee for electric cars are already mandated via the Michigan Legislature.[43] Imposing a higher fee may not require major legislative hurdles. Higher registration fees, however, as an isolated solution to the road funding gap has a disadvantage—a higher registration fee for EV and hybrids will only equalize the burden of road user fee if all

43. Michigan Vehicle Code, 257 M.C.L. 801

drivers in Michigan drive exactly the same average miles per year. However, the user fee will be higher for drivers of ICE vehicles if they drive more than the average miles per year, owing to the higher motor fuel taxes paid by them. Hence, with high variance in the number of miles driven, the burden of road user fee is skewed toward ICE vehicle drivers.

MILEAGE-BASED USER FEES

Mileage-Based User Fees (MBUF) are an alternative that is already being tested by other states in varying forms. The MBUF taxes road users on the basis of the vehicle miles driven, and may balance the flat rate component of the existing registration fees.

Pilot programs of the MBUF have been implemented by several states. Through two trials in 2003,[44] the Oregon Department of Transportation (ODOT) was able to evaluate the feasibility of the mileage-based user fees, as well as congestion pricing. By 2015, ODOT launched OReGO, a voluntary program for all EV drivers where they may choose to pay 1.8¢ per mile as an alternative to a high vehicle registration fee. The miles are typically recorded by the vehicle's GPS system. Alternatives to using the vehicle GPS include applications that link to the GPS in a driver's phone. Devices that do not require GPS are also available.[45]

Other states have since followed in Oregon's footsteps. In Utah, the MBUF program sets a per-mile rate of 1.5¢ per mile for electric vehicle drivers until the accumulated total matches the annual flat fee of $120.[46] New Hampshire implemented a MBUF for all vehicles based on the Environment Protection Agency's estimates of a traditional vehicle's miles-per-gallon (mpg) range. Minnesota conducted a technical research project to evaluate the public understanding and attitude toward MBUF. The study recommended MBUF as an alternative funding method, but cautioned against the technical and operational complexities.

Since MBUF is based on miles driven, it ensures payment toward road funding that is proportionate to road usage and consequently, promotes equity. It can be linked to inflation or have a schedule of increases over a set period, in addition to being uninfluenced by fuel economy. A well-designed MBUF could adjust for income in order to tackle the regressive aspects of the motor fuel tax.[47]

44. The Oregon Legislature in 2001 created the Road User Fee Task Force to find viable alternatives to the state gas tax. The task force conducted pilot projects for MBUF between 2006 and 2012, following the launch of OReGO in 2015.

45. Road User Fee Task Force, Oregon Department of Transportation, "Report to the Oregon Legislative Assembly", 2021

46. Utah Department of Transportation, "Utah Road Usage Charge Report, as required by Senate Bill 150" May 2021

Additionally, pilot programs of MBUF that have already been implemented may provide evidence on the feasibility of this relatively dynamic road user fee.

A concern around the MBUF program is the secure collection and timely disposal of driver data by government entities. Possible resolutions include making MBUF flexible to use (charging a flat rate for users who don't wish to provide data, as in the case of OReGO),[48] or using private companies for data collection.[49] An implementation hurdle that still exists is the current lack of a systematic method for vehicle enrollment and revenue collection from non-residents traveling between states.

Interstate traveling and the subsequent revenue collection from tourists requires innovative problem solving. The following user fee is designed to secure driver privacy and be applicable to all road users, including out-of-state tourists.

PER KILOWATT HOUR FEE

A Per Kilowatt Hour Fee (PKHF) would charge drivers by the electricity units used to charge their vehicles. It is similar to the motor fuel tax as it measures road usage on the units of electricity used instead of miles driven. The system, first proposed in Vermont, would involve implementing a user fee at commercial or public charging stations, and hence, is less invasive than the MBUF with regards to driver privacy.[50] Public charging would allow the revenue collecting agencies to be able to charge out-of-state road users.

The user fee is similar to the motor fuel tax (as it is based on the amount of electricity used) and shows potential for measuring home-charging for EVs. However, cost effective methods to measure home charging are still underway. Algorithms that can be used to distinguish household use from EV charging have high software and labor costs attached. Current algorithms cannot monitor 120 V charging, which is a relatively time consuming alternative but may be used by drivers who are not constrained by time or are able to charge overnight.

MILES AT REGISTRATION

Miles at registration is a type of mileage based user fee that would require the owner of the EV to report mileage to the Secretary of State during annual registration; this would happen thorough periodic odometer reading, which is the key difference between it and the MBUF.

47. Weatherford, Brian A., RAND Corporation, “An Analysis of the Distributional Implications of Taxing Vehicle Miles Traveled, with Projections, 2010-2030”, March 2012
48. I-95 Corridor Coalition, “I-95 Corridor Coalition Mileage-Based User Fee Study”, September 2019
49. Pool R., Douglas C., Mackinac Center for Public Policy, “Michigan’s Road Forward: Replacing the Fuel Tax With Mileage-Based User Fees”, 2022
50. CDM Smith, Vermont Agency of Transportation, “Vermont Electricity Vehicle Road Usage Charge Study”, January 2022

This alternative RUC is feasible if implemented along with the development of infrastructure for data collection in order to protect against odometer tampering. It will also alleviate privacy concerns attached to the conventional MBUF programs. It will not, however, account for variability in vehicle weight and its impact on road deterioration. For example, the deterioration caused to the road by a Ford-150 electric truck is different when it is empty versus hauling a load.[51] This is accounted for in ICE vehicles, where heavier loads consume more energy and the owners pay a higher motor fuel tax.

TOLLING

Improvements in technology over the last few decades has made tolling a logistically feasible road user fee. Cost reductions caused by electronic tolling collection, in addition to variable pricing, may help generate revenue by charging fee to road users regardless of the type of vehicle, or the residency status of the driver. It is also relatively efficient for re-directing traffic and reducing congestion.[52]

Even with cost reductions, implementation of a universal network of tolling system would require a vast capital and non-negligible changes to federal and state laws. Additionally, although it is one of the oldest road user fees, tolling as an alternative would require significant change in public opinion in Michigan, given that the usage of toll roads has often been considered as a form of double taxation.

Hence, toll roads as a partial alternative may be feasible, but as a sole alternative, are expensive, time consuming, and may be inefficient.

51. Sorensen, P., Ecola, L.,Martin,W., RAND Corporation, “Mileage-Based User Fees For Transportation Funding”

52. Persad, K., Walton, M., Hussain, S., Centre for Transportation Research, “Toll Collection Technology and Best Practices”, January 2007

Appendix A. Sources and Methodology

In this appendix, we first describe the key terms used throughout the report, specifically the taxes and fees, the road funds, and types of vehicles. We also describe the methodology and data sources we relied on for our analysis.

KEY TERMS USED IN THIS REPORT

Taxes and Fees that Generate Funds for Roads in Michigan:

1. **Auto-related Sales Tax:** According to Section 25 of the General Sales Tax Act, at least 27.9% of 25% of the 4% general sales tax on motor fuel, motor vehicles, automotive parts, and automotive accessories is earmarked for public transportation programs like the Comprehensive Transportation Fund.
2. **Federal Excise Tax:** The federal government levies an excise tax on motor fuel purchases that contributes to the Highway Trust Fund.
3. **Michigan Excise Tax:** The state of Michigan levies an excise tax on motor fuel purchases that contributes to the Michigan Transportation Fund.
4. **Ad Valorem Taxes:** According to 257 MCL § 801, ad valorem fees are evaluated based on the value of the vehicle and charged at the time of registration.
5. **Registration Fees:** Both ICE and EV owners pay fees to the Secretary of State upon registration. The fees are assessed based on the vehicle's empty weight, age, and residual value according to 257 MCL § 801.
6. **Electric Vehicle Registration Fees:** Michigan levies an additional registration fees on plug-in hybrid vehicles and battery electric vehicles to recoup the cost of road wear that ICE vehicle owners normally pay for through excise taxes on motor fuel.

Funds that Allocate Money for Roads in Michigan:

7. **Comprehensive Transportation Fund (CTF):** Revenue for this fund comes from a portion of Michigan Transportation Fund revenue, the auto-related sales tax, and interest on CTF and other fund revenues. It is restricted for public transportation usage with the majority used for state public transit agencies.
8. **Highway Trust Fund (HTF):** Established under 26 U.S.C. § 9503. Most of its revenue comes from the federal gasoline and diesel tax and is directed to the state trunkline system and local road agencies.
9. **Michigan Transportation Fund (MTF):** The MTF receives a combination of federal funds, state fuel taxes, and vehicle registration fees. It supports various state agencies, highways, county roads, and municipal streets. This fund was created pursuant to 247 M.C.L § 51.

Types of Vehicles Included in the Analysis:

10. **Electric Vehicles (EVs)**: This term refers to all vehicles that use a battery to partially or completely propel itself. It includes Battery Electric Vehicles, Plug-in Hybrid Vehicles, and Hybrid Electric Vehicles.
11. **Battery Electric Vehicles (BEVs):** BEVs are a type of EV that are solely propelled by battery packs. Batteries in the under-carriage of the vehicle is the only

method of storing and delivering energy to its motors, and they cannot internally combust gasoline and generate electricity. All the electricity required to propel itself is delivered when it is plugged into a charging station. This study applies the definition from MCL 257.801 that states that an electric vehicle is any "vehicle that is propelled solely by electrical energy and that is not capable of using gasoline, diesel fuel, or alternative fuel to propel the vehicle...".

12. **Plug-in Hybrid Electric Vehicles (PHEVs):** PHEVs are a type of EV that are only partially propelled using battery packs; the remaining propulsion is via gasoline combustion in its engine. Therefore, they are also categorized as "hybrid vehicles." PHEVs consist of an internal combustion engine that can directly use gasoline to propel itself. The battery pack on a PHEV is large enough to store electricity and propel itself around 25 miles in a single charge. Since the battery on a PHEV can be plugged into a charger, it is called a "plug-in" hybrid. MCL 257.801 states that PHEVs are any vehicles "that can use batteries to power an electric motor and use another fuel, such as gasoline or, diesel, to power an internal combustion engine or other propulsion source, and that may use electricity from the grid to run the vehicle some or all of the time."

13. **Hybrid Electric Vehicles (HEVs):** HEVs are a type of EV that use a combination of electricity and gasoline to propel itself. Therefore, they are also categorized as "hybrid vehicles." HEVs lack the provision to charge via an external charger. Their battery is charged exclusively via the energy generated by the internal combustion engine. This charging of an HEV occurs via two methods: (1) directly via the alternator that converts mechanical energy from the engine to electrical energy in the battery and (2) via excess kinetic energy harvested from braking the vehicle (also called regenerative braking).

    HEVs can come in two forms: (1) a mild hybrid that improves fuel economy by shutting off the engine at vehicle stops and (2) full hybrids that use larger batteries to store electricity and propel the vehicle using electricity for short distances.

    In our analysis, we do not include mild hybrids as a type of EV. We classify them as ICE vehicles.

14. **Internal Combustion Engine vehicles (ICE):** ICE vehicles are solely powered by combusting gasoline and diesel. Although ICE vehicles also consist of a battery, they are not used to propel the vehicle in any significant way. The battery is largely used to power the on-board appliances such as the stereo, wipers, windows, etc. In cases where batteries are used to automatically turn the engine on/off at stop lights, these vehicles are sometimes referred to as "mild hybrids".

TABLE A-1. Comparison Between Different Types of Light Vehicles

	ICE	EV		
		BEV	PHEV	HEV
Contains batteries	Yes	Yes	Yes	Yes
Uses batteries for propulsion	No	Yes	Yes	Yes
Can plug propulsion battery to an external charging port	-	Yes	Yes	No
Combusts gasoline or diesel for propulsion	Yes	No	Yes	Yes

Source: Anderson Economic Group (2022).

SOURCES

We reviewed the following laws, reports, and data:

Datasets

- Active fleet and retail vehicles in operation (VIO) in Michigan at the end of 2019 from IHS Markit. This dataset is disaggregated along make, model, model year, fuel type and gross weight of the vehicle.
- Retail and fleet vehicle sales data from 2019 to 2021 in Michigan is from IHS Markit. This dataset is disaggregated along make, model, fuel type, retail or fleet binary and gross weight of the vehicle.
- U.S. Light Vehicle Sales by Nameplate from 2005 to 2021 from Automotive News Data Center.
- AEG proprietary datasets on fuel economy of vehicles that is obtained from EIA and curb weight of vehicles from Cars.com and Edmunds.com.

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METHODOLOGY DESCRIPTION

We describe below the factors considered in our analysis projecting the road funding gap in Michigan due to the transition to electric vehicles as well as the factors relied upon in projecting two scenarios for the adoption of electric vehicles in Michigan.

Factors Considered in the Estimation of Shortfalls

Overall Approach. Our estimates only include shortfalls to the HTF, MTF and the CTF from Michigan's drivers transitioning to electric vehicles. Shortfalls resulting from factors such as rising material costs due to inflation, changing vehicle usage patterns, increasing fuel economy of active fleet etc. are not a part of the analysis. Shortfalls in road funding from transitioning to EVs is estimated separately for BEVs, PHEVs and HEVs. We then sum these shortfalls to estimate the total shortfall. All the final shortfall figures are nominal numbers, and are not adjusted for inflation.

Scrappage of Vehicles. We also account for scrappage of vehicles over time. Due to very little data availability on the long-term usage patterns of EVs, we use a higher scrappage rate for BEVs than conventional gas vehicles.

Energy Prices. We used data from the U.S. Energy Information Administration for the historic and current prices of gasoline, diesel, commercial and residential electricity. These prices were then projected until 2030 based on the estimates published by the U.S. Energy Information Administration and other market watchers.

Sales and Excise Taxes. Michigan imposes different sales tax rates on motor fuel, residential and commercial electricity. We collected these differential rates from Michigan's General Sales Tax Code.

Excise tax rates on gasoline and diesel are obtained from EIA. These rates are adjusted to inflation when the statute included such a provision. We use an inflation rate of 5% for 2023, 2.5% for 2024 and 2% from 2025 onwards to adjust for an increase in excise taxes.

EV Registration Fees. The additional registration fee on BEVs and PHEVs registered in Michigan is pegged to increase with the state's excise taxes on gasoline. We have accounted for this increase in our analysis.

Note on Methodology for Projections

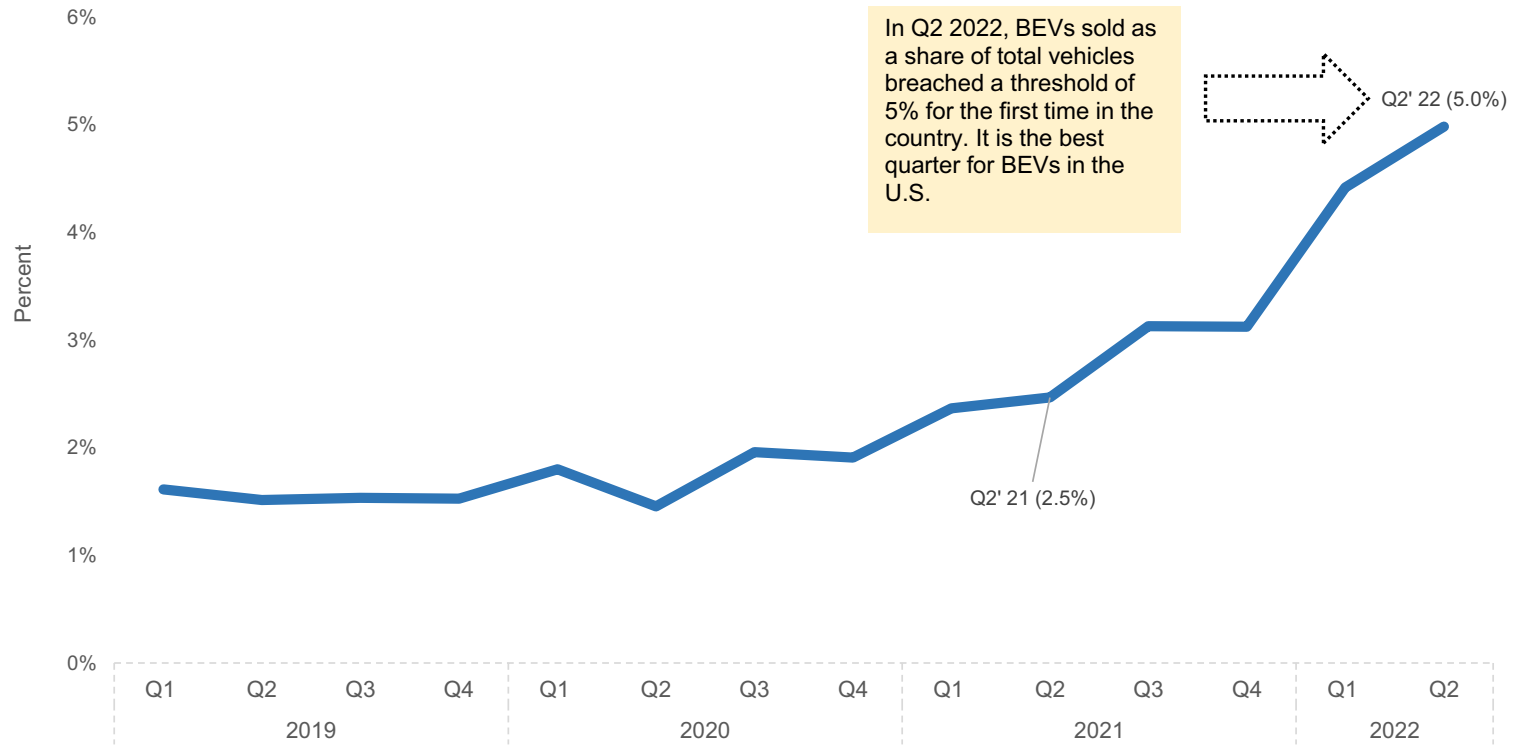
We are cognizant of EV penetration rates published by various government sources, manufacturers, market watchers, consultants and trade organizations. Our experts' work and experience in the automotive sector over several years found most of these to be quite ambitious. Therefore, our penetration forecasts are adjusted accordingly.

Moreover, we also studied the EV penetration trends in California, New Jersey and other relatively mature EV markets. Accordingly, we used different penetration rates for BEVs, PHEVs and HEVs.The primary drivers of adoption are:

- The cost of ownership
- The availability of charging infrastructure
- Consumer interest in EVs and their features.

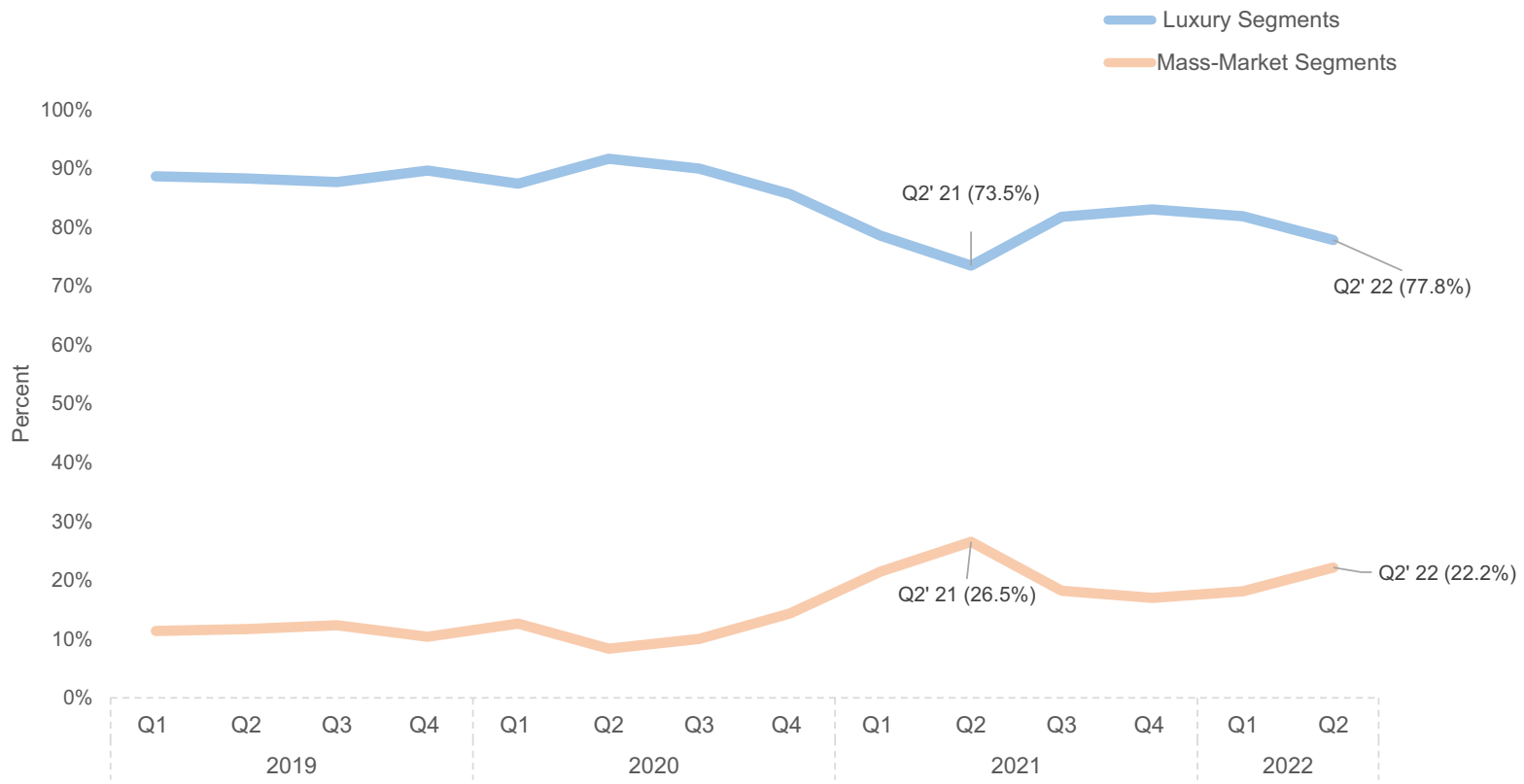
Appendix B. Electric Vehicle Sales

EXHIBIT B-1. Battery Electric Vehicles as Share of Total Industry Sales, U.S., 2019-2022 Q2



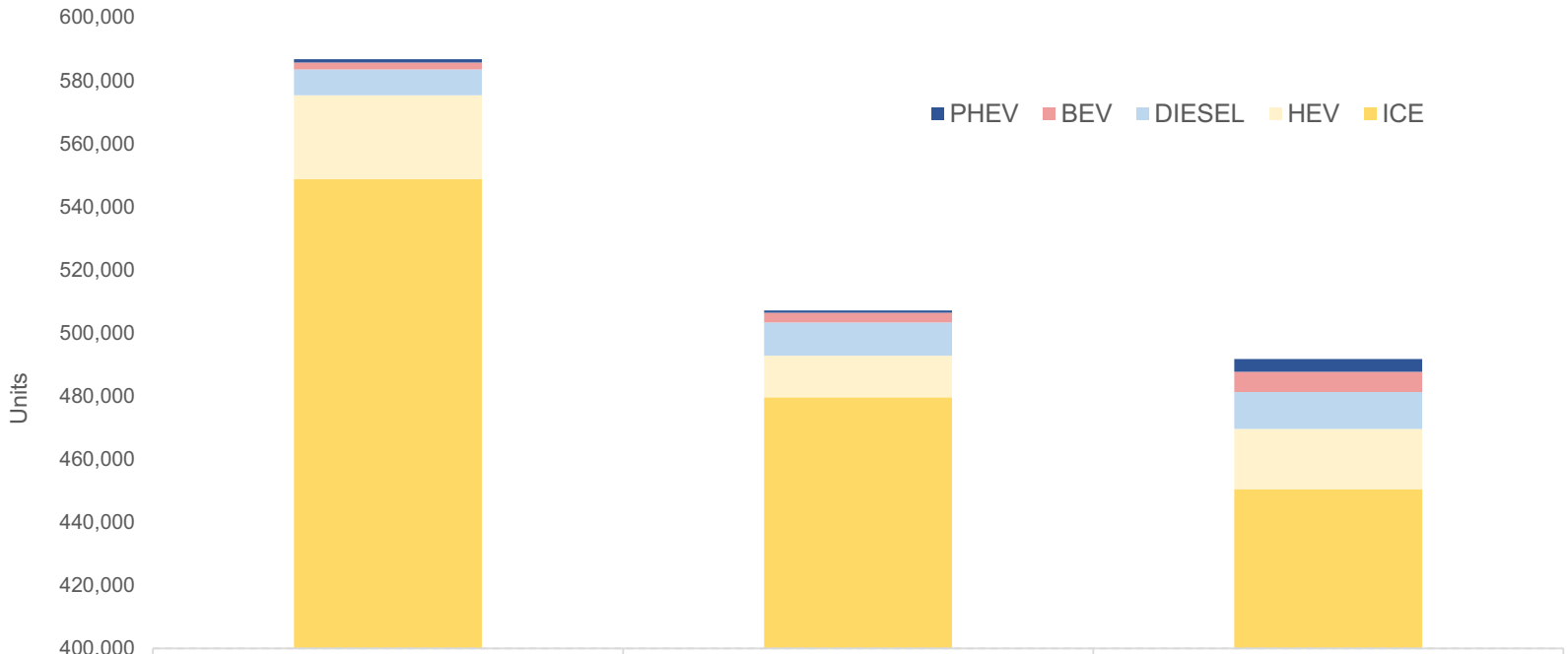
Notes: The analysis is based on unit sales of battery electric vehicles (BEVs) only. BEVs include vehicles such as all Tesla models, Ford Mustang Mach E, Hyundai Ioniq 5.
Source: Automotive News Data Center (U.S. Light Vehicle Sales by Nameplate)
Analysis: Anderson Economic Group

EXHIBIT B-2. Share of Battery Electric Vehicles by Segments, U.S., 2019-2022 Q2



Notes: The analysis is based on unit sales of battery electric vehicles (BEVs) only. BEVs include vehicles such as all Tesla models, Ford Mustang Mach E, Hyundai Ioniq 5.
Source: Automotive News Data Center (U.S. Light Vehicle Sales by Nameplate); IHS Markit (Segmentation)
Analysis: Anderson Economic Group

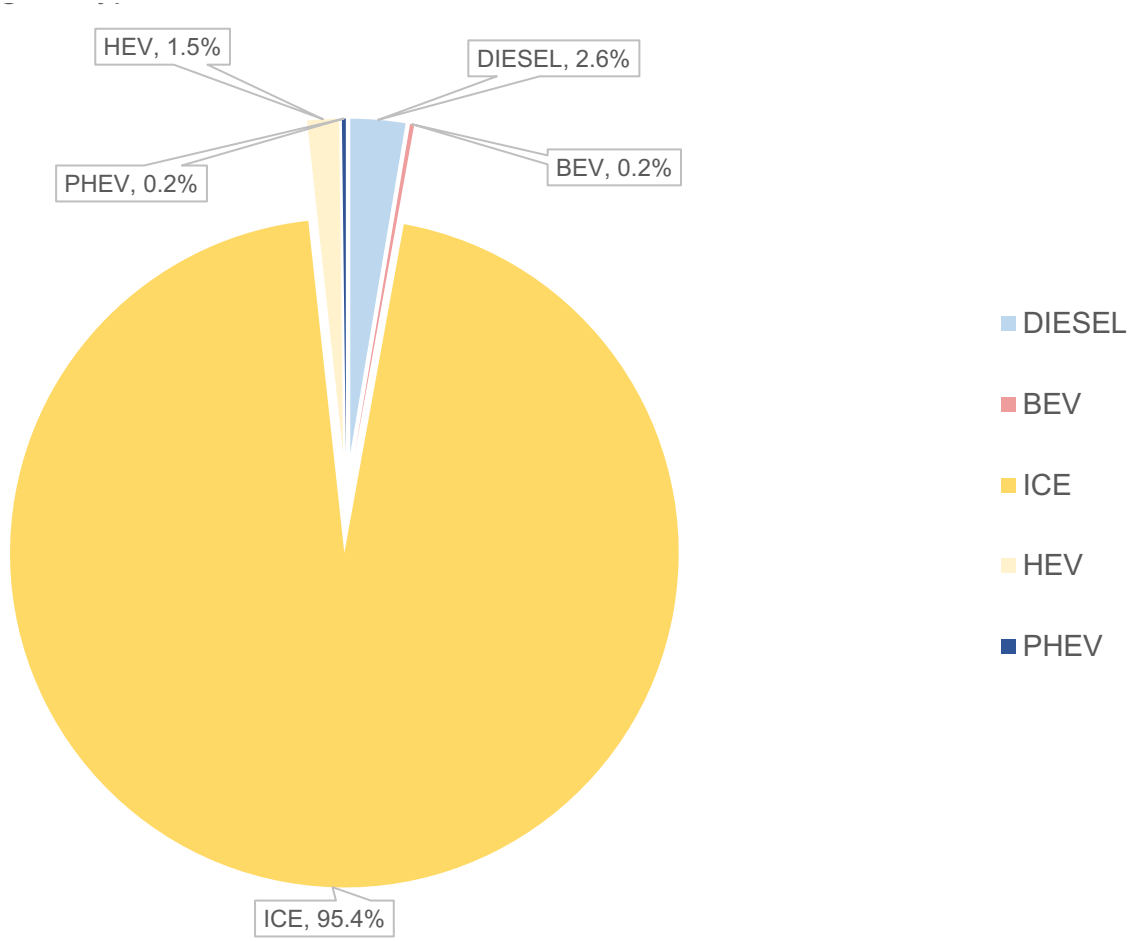
EXHIBIT B-3. New Vehicle Registrations by Type of Vehicle, Michigan, 2019-2021



	2019	2020	2021
PHEV	1,068	680	4,052
BEV	2,166	3,091	6,435
DIESEL	8,175	10,536	11,707
HEV	26,569	13,148	19,103
ICE	548,749	479,606	450,452

Notes: Total registrations include retail and fleet data; See Appendix A for powertrain definitions.
Source: IHS Markit (Michigan Registration Data by Engine Type)
Analysis: Anderson Economic Group

EXHIBIT B-4. Vehicles in Operation, By Vehicle Type, Michigan as of October 2021



Notes: Note: See Appendix A for powertrain type definitions
Source: IHS Market (Michigan Vehicles in Operation by Engine Type)
Analysis: Anderson Economic Group

Appendix C. About Anderson Economic Group

THE FIRM

Founded in 1996, Anderson Economic Group is a boutique research and consulting firm, with offices in East Lansing, Michigan, and Chicago, Illinois.

Anderson Economic Group is one of the premier consulting companies in the automobile industry as well as in public policy and economic analysis. The experts at AEG have conducted nationally-recognized economic and fiscal impact studies for private, public, and non-profit clients across the United States. The consultants at AEG have particular expertise in the automotive industry. They have worked with clients in all three tiers within the industry, including hundreds of automotive dealerships across the United States.

Publications from our team include:

- *Comparison: Real World Cost of Fueling EVs and ICE Vehicles,* 2021 and 2022.
- *Economic Impact of Michigan's University Research Council,* since 2007.
- *State Economic Competitiveness Benchmarking Report 2020*, 2021.
- *State of the Lansing Region* Report, 2021.
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- *The Economic Impact of the Barack Obama Presidential Library in Chicago*, 2014.
- *Annual State Business Tax Burden Rankings,* published since 2007.

Past clients of Anderson Economic Group include:

- *Governments:* The government of Canada; the states of Michigan, North Carolina, and Wisconsin; the cities of Detroit, Cincinnati, and Sandusky; counties such as Oakland (MI) and Collier (FL); and authorities such as the Detroit-Wayne County Port Authority.
- Businesses (*Automotive*): Manufacturers including General Motors, Ford Motor Company, American Honda Motor Co. and Lithia Motors; dealers and dealership groups representing Toyota, Cadillac, Honda, Chrysler, Chevrolet, Mercedes-Benz, Ford, Audi, Kia, Genesis, and other brands. (*Financial, Sports, & Retail*): ITC Holdings Corp., First Merit Bank, Bank of America Merrill Lynch, Meijer, Inc., and Relevent Sports. (*Food & Beverage*): National Wine & Spirits, Nestle, Labatt USA, InBev USA. (*Franchise*): US franchisees of Anheuser-Busch, Molson, Coors, Miller, Harley-Davidson, Suzuki, Avis, and others.
- *Nonprofit organizations:* higher education institutions including Michigan State University, University of Chicago, Wayne State University, and University of Michigan; trade associations such as the Michigan Manufacturers Association, Service Employees International Union, Automation Alley, and Business Leaders for Michigan; and convention and visitor bureaus of several major cities.

Please visit www.AndersonEconomicGroup.com for more information.

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Tyler Theile is the vice president and COO at Anderson Economic Group. She serves as director of AEG's public policy and economic analysis project area, but her work extends to projects in all three practice areas. She is also responsible for business management, operations, and administration of Anderson Economic Group's quality standards.

Ms. Theile's recent projects include an economic impact analysis for a mixed-use real estate development, a minority valuation for a beer distributor, an analysis of power transmission infrastructure projects, and an economic impact survey related to auto insurance legislation in Michigan. Other projects include salary surveys and competitiveness analysis, a global survey of water intensive companies in order to gauge the value of water management innovation, and The State Economic Handbook, 2008, 2009, and 2010 published by Palgrave Macmillan. She has also contributed to previous reports including Automation Alley's Annual Technology Industry Report and Michigan's University Research Corridor: Annual Economic Impact Report.

Ms. Theile is a graduate of Michigan State University's James Madison College, where she received a BA in international relations with a specialization in political economy.

Cristina Benton

Dr. Cristina Benton is a senior consultant with Anderson Economic Group, directing the market and industry analysis practice area. Her background is in research and data analysis, community and economic development, and urban planning.

While at AEG, Dr. Benton has conducted numerous economic development, retail, industry, and market analyses along with auto dealership franchise projects. She has led work for clients that include the State of Michigan; the Project Management Institute; the City of Trenton, New Jersey; Experience Grand Rapids; and Automation Alley. Dr. Benton has also worked with many automobile dealerships and their attorneys in matters of sales performance assessments, geographic territory analyses, market opportunity studies, and expert testimony.

Dr. Benton holds a PhD in geography and a master's degree in urban and regional planning, both from Michigan State University, along with a bachelor's degree in public administration from Babes-Bolyai University, Romania. She is a member of the Michigan Economic Developers Association and the National Association of Forensic Economics.

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Ms. Tina Dhariwal is a senior analyst in the public policy and economic analysis practice area at Anderson Economic Group. She has a background in economic and fiscal impact studies, public policy analysis, and data analytics.

At AEG, Ms. Dhariwal has applied her expertise across numerous industries. Her recent work includes economic and fiscal impact analyses in the higher education and renewable energy sectors, in addition to analyzing the economic scope of a prominent Michigan association. She has also worked on several projects requiring the evaluation of national and state economic indicators.

Ms. Dhariwal holds a master's degree in econometrics and quantitative economics from the University of Wisconsin-Madison. She earned her Bachelor of Arts degree in economics, graduating with honors from the University of Delhi.

Shay Manawar

Mr. Manawar is an analyst with Anderson Economic Group in the market and industry analysis practice area. His background is in industry research and data analysis, startups and venture capital, and urban redevelopment policy analysis.

At AEG, Mr. Manawar has been involved in numerous projects for automotive retail, alcoholic beverage, and communication technology clients involving market and industry analysis as well as expert testimony. His expertise involves examining key industry trends and analyzing national and regional economies. He also manages the firm's automotive dashboard, offering analysis and commentary on several auto and economic indicators.

Mr. Manawar holds a Master of Public Policy degree and a Bachelor of Arts degree in public policy, both from Michigan State University. He currently holds a leadership role at a local chapter of a global startup community, Startup Grind Lansing, and serves as a member of the Michigan Economic Developers Association.