Alternative Funding Approaches for Iowa Roads

Final Report
May 2022

Sponsored by:
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(IHRB Project TR-790)

HDR

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16. Abstract

The purchasing power of Iowa's primary transportation revenue source, the fuel tax, has decreased over time due to annual fuel tax revenues not keeping pace with the growth in costs. This study evaluated Iowa's existing transportation funding sources and through a literature review, identified approaches being used around the country to increase transportation revenues. These approaches included indexing fuel taxes and registration fees to an index; implementing fees to reflect emerging mobility and technology trends; and the continued research of mileage-based user fees. Based on an evaluation of potential approaches to increase transportation revenues, short term recommendations to supplement Iowa's existing revenues included: indexing existing fuel tax and registration fees to the consumer price index or a construction cost index; implementing a fee on e-commerce deliveries and a fee on trips using transportation network companies; and implementing an agricultural fee to offset the wear and tear on rural roads and bridges caused by agricultural vehicles and equipment. The long-term recommendation is to continue to monitor the development of a mileage based distance fee or mileage and weight based distance fee research around the country and to pursue a federal grant to conduct a pilot study.

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Executive Summary

TR-790: Alternative Funding Approaches for Iowa Roads provides the Iowa Highway Research Board (IHRB) with near-term and long-range funding recommendations to address ongoing road and bridge needs across the State of Iowa (the State) based on transportation industry research, academic research, technical analyses, and feedback from the project's Technical Advisory Committee (TAC).

A review of the existing road and bridge funding sources identified several challenges that will continue to impact the State's ability to achieve near-term and long-range financial sustainability. The primary funding sustainable challenge is the continued reduction in revenue from the State's largest single funding source for transportation - the fuel tax. Three key factors are negatively impacting fuel tax revenues: 1) continued improvements in fuel economy of vehicles, 2) the accelerated growth in ownership of electric vehicles (EV) and plug-in hybrid vehicles (PHEV), and 3) slower growth of vehicle miles traveled (VMT) due to the COVID-19 pandemic, the increase in working remotely, and other cultural shifts.

Revenue from the State's second and third largest funding sources, annual registration fees, and fees for new registrations, are experiencing higher annual growth rates than the fuel tax. However, the combined annual revenue from these three sources is not keeping pace with annual increases in construction costs. Using data from Iowa DOT's Construction Cost Index (CCI), since Iowa's 2015 fuel tax rate increase, construction costs have experienced an average annual increase of approximately 11 percent. Meanwhile, revenue from the fuel tax has experienced a 1 percent average annual *reduction*, and revenue from the vehicle registration fees and fees on new vehicles has increased about 4 percent per year. The impact of costs increasing at a faster rate than revenues results in a significant decrease in purchasing power from the State's primary transportation revenue sources. The current funding structure has to be adjusted to combat the continued erosion in purchasing power.

According to the Iowa DOT's *2021 Road Use Tax Fund (RUTF) Study*, over the next 20-years, it is estimated that costs for administration, maintenance, and construction of city, county, and State roads and bridges will exceed federal, state, and local revenue sources by approximately $15.620 billion, with the counties experiencing the largest share of this shortfall at $9.629 billion. The 2021 RUTF Study also looked at the stewardship needs across the state which are the projects that would extend the life and modernize existing infrastructure without adding capacity.[1] The projected funding shortfall for the stewardship needs alone is approximately $5.754 billion. On an average annual basis, the funding shortfall for all road and bridge projects would be $781 million per year, and the average annual shortfall for stewardship projects would be $288 million.

[1] Capacity projects in the 2021 RUTF Study include projects that would add lane miles to the system- either additional lane capacity on existing roadways, or new roadways and roadway extensions.

With these projected shortfalls in mind, a variety of potential supplemental funding sources were identified and evaluated. The potential sources reflect a combination of research of what other states are doing to address similar issues and input received from the TAC. The evaluation process resulted in the following recommendations to generate additional revenue to supplement the existing transportation funding sources in the short term and to transition away from the fuel tax in the long-term with an alternative source.

- **Short-Term Recommendation**: Implement the following package of fees to supplement the current funding structure.

    1. **Improve the Stability of Statewide Funding by Indexing and Increasing the Existing Fuel Tax Rate and Registration Fees:** The public is already familiar with the connection between paying these taxes and fees to use a vehicle and how the revenue generated is then invested to improve the transportation infrastructure. The recommendation is to adapt legacy rate structures for fuel tax and annual registration fees to increase annually so that revenue growth would better align with the annual construction cost increases. Specifically, the recommendation is to increase fuel tax and registration fees using a cost growth index. Ideally, the index would be tied directly to trends in construction cost growth alone or in combination with other growth indices. Additionally, it is recommended that the existing fee on new registration be increased from 5 percent to 6 percent to align with the existing state sales tax rate and provide additional support in addressing the funding shortfall. Because these are existing sources, the incremental revenue increases would be allocated to the Iowa DOT, counties and cities using the current RUTF and TIME-21 Fund distribution processes.
    2. **Increase Urban and Rural Funding by Implementing Transportation Network Company (TNC) Fees and E-commerce Delivery Fees:** With the increasing use of food and product delivery through services like Amazon and Grub Hub, not all those who benefit from the roadway system must use them or leave the comfort of their home. Product delivery services and rideshare services, like Uber or Lyft, are redefining how people are using the roadway system and governments are redefining fee structures to provide revenue to keeps pace with the new burdens these services place on the roadway network. While TNC and E-commerce delivery services may be a small portion of overall roadway traffic today, it is reasonable to assume that they will evolve and expand over time. The recommendation is to implement a TNC fee, either as a percentage of the total fare or a fee per trip, and a fee per E-commerce delivery. Additionally, revenue from these fees should be dedicated to the cities and counties since that is where much of the impact of these services will occur. It should be noted that the State currently collects a Personal Transportation Service sales tax on TNCs, however the revenue collected does not support investment in the transportation system. The existing sales tax legislation may need to be adjusted if the new TNC fee moves forward.

3. **Increase Rural Funding by Implementing One or More Agricultural Fees:** The State currently has no weight limits for agricultural vehicles and County Engineers are concerned about accelerated road and bridge deterioration caused by these unregulated heavy loads. Agricultural equipment is also currently exempt from paying vehicle registration fees even though some of the equipment is being driven on-road. The intent of this recommendation is to offset the impact of this equipment on Iowa's rural roads and bridges by implementing one of more fees associated with the shipping requirements to raise and sell livestock and crops, the on-road use of tractors and heavy equipment, and the diesel fuel used by the agricultural industry. The agricultural fees considered included implementing a per bushel fee, a per livestock head fee, a registration fee for tractors and other farm equipment, and/or a fuel tax on red dyed diesel. Further it is recommended that the revenue collected from these fees would be returned to the county where it was generated

If the entire package of fees were implemented, conceptual estimates developed for this report indicate total annual revenue could range from $155 million to $290 million. While these conceptual estimates would significantly close the average annual funding shortfall for stewardship projects defined in the 2021 RUFT Study, it may be a challenge to obtain political and public support to move all fees forward at the same time, and therefore annual revenue would not reach these levels. However, this recommendation provides a blueprint to start discussions with potential partners, stakeholders, and elected officials to supplement the current funding structure and offset the ongoing reduction in purchasing power.

- **Long Term Recommendation:** Continue research and analysis associated with the implementation of a mileage-based user fee incorporating vehicle weight and distance driven, and incrementally implement the fee over time as a replacement for the fuel tax. There is recognition at both the state and nationally level that the fuel tax, which has historically been the primary funding source for transportation infrastructure, is not a sustainable source due to the continued improvements in vehicle fuel economy and the growth in EV sales. Industry and academic research have reached the same conclusion that implementation of a fee based on miles driven provides the best option to generate revenue equivalent to the fuel tax. Additionally, a mileage-based user fee would be more sustainable than the fuel tax since it would not be negatively impacted by vehicle efficiency or technology improvements.

  In the past, implementation of a mileage-based user fee may have been perceived as funding source option that was many years away. However, based on research and pilot programs conducted around the country, it is likely a large-scale implementation will occur soon as the ongoing research is generating answers to the data collection, technology, policy, and equity challenges that would be associated with the transition from the fuel tax to a mileage-based user fee. At the federal level, this is reinforced by direction from Congress to the USDOT in the IIJA as part of the Strategic Innovation for Revenue Collection Program. Specifically, the USDOT must submit a report to Congress in 2024 with recommendations on a national alternative revenue mechanism based on results from previously completed state pilot projects. The IIJA also includes a new $50 million program, the National Motor Vehicle Per-Mile User Fee Pilot Program that directs the USDOT

implement a nationwide pilot project that will solicit volunteer participants from all 50 states, including commercial and passenger vehicles. The legislation requires the pilot program to offer different methods for participants to track their mileage and directs USDOT to set annual per-mile fees for different types of vehicles.

This report evaluated two mileage-based user fee options: a flat fee per mile approach and an approach that would incorporate weight along with distance (weight and distance fee or per ton-mile fee) to help account for the effect of heavy loads on the longevity of pavements and bridges relative to the impact of passenger vehicles. The revenue estimates indicate that depending on the fee structure; either option has the potential to generate revenue that would match or exceed the FY 2023 budget estimate for fuel tax ($669 million). These estimates assume all vehicles in operation today would be paying the mileage-based user fee. It is possible that for a transitional period, the weight-and-distance fee would apply only to electric vehicles, with conventional vehicles continuing to pay their share of roadway costs through fuel taxes.

The State may want to consider implementing a pilot mileage-based user fee program for EV and PHEV which would provide data to compare the State's current registration fee approach for these vehicles with a fee per mile or fee per ton-mile approach and designed to generate revenue in line with historical fuel tax revenue levels. Federal funding for this pilot project is available through the Surface Transportation System Funding Alternatives Program. The IIJA include $75 million over the next five year for this program to test the feasibility of a road usage fee and other user-based alternative revenue mechanisms. The grant award could cover up to 80 percent of the total project.

In addition to the programs mentioned above, the IIJA will provide a significant increase in federal funding to the State over the federal fiscal year (FFY) 2022 to FFY 2026 period. This includes increased levels of annual formula funding and new and expanded discretionary grant opportunities. While this infusion of federal funds will benefit state and local roads over the next five years, there is no guarantee that the level of annual federal formula funding or the potential availability of discretionary grant programs included in the IIJA will continue beyond 2026. More specifically, funding from the IIJA will not address the long-term financial sustainability needs of the State.

Finally, the discretionary grant program opportunities included in the IIJA will be highly competitive. A potential option to improve Iowa's competitiveness for these programs over the next five years would be for the State to consider passing a one-time appropriation to provide a local match pool for potential project sponsors. As an example, in January 2022, the Governor of Colorado asked the State Legislature to appropriate $100 million in the FY 2023 budget to be used as local matching funds for future IIJA federal discretionary grant applications.

1 Introduction

The purpose of this report is to provide the IHRB with near-term and long-range funding recommendations that will support ongoing road and bridge investment needs across Iowa. The report reflects a combination of transportation industry research, academic research, technical analyses, and feedback from the project's TAC. TAC members included:

- Stuart Anderson, Transportation Development Division - Director
- Joe Cory, P.E., City of West Des Moines – Deputy Public Services Director
- Ron Knoche, P.E., City of Iowa City - Public Works Director
- Craig Markley, Systems Planning Office - Director
- Andrew McGuire, P.E., Keokuk County Engineer
- Brian Moore, P.E., Secondary Roads Research Engineer
- Nicole Moore, P.E., Local Systems Bureau - Director
- Sarah Okerlund, P.E., Local Systems Bureau - Deputy Director
- Thomas Rohe, P.E., Plymouth County Engineer
- Nicky Stinn, P.E., Local Systems Bureau - Secondary Roads Engineer

This report documents the results of the following activities that were completed during the course of the project:

- Review of the existing road and bridge funding sources and the challenges associated with these sources in achieving near-term and long-term financial sustainability.
- Identification of a range of potential funding sources based on a review of how other states are addressing similar funding challenges.
- Evaluation of a targeted list of potential revenue sources and development of near-term and long-range recommendations to move toward a more sustainable funding system to accommodate Iowa's road and bridge needs.
- Identification of policy considerations and strategies to support the process to implement the recommendations.
- Identification of potential equity effects associated with the potential funding sources (Appendix A).

2 Existing Funding Allocation Process, Revenue Sources, and Investment Needs

This section describes the existing sources that fund Iowa's roads and bridges. Additionally, the section includes a summary of the key factors impacting Iowa's ability to achieve a long-term sustainable transportation funding system.

2.1 Allocation of Transportation Funds

As shown in **Figure 2-1**, on an annual basis almost all state revenue for transportation is collected and distributed through the Road Use Tax Fund (RUTF)[2]. The fiscal year 2022 budget estimates for the RUTF total $1.57 billion. By statute (Iowa Code Section 312.2), the Treasurer of State is required to allocate RUTF monies by formula to the following funds: Primary Road, Secondary Road, the Farm-to-Market (FM) Road, and Street Construction. However, prior to these formula allocations occurring, RUTF revenue is diverted to the Transportation Investment Moves the Economy in the Twenty-First Century (TIME-21) Fund, and several statutorily required "off-the-top" allocations and other appropriations by the General Assembly.

2.1.1.1 TIME-21 FUND

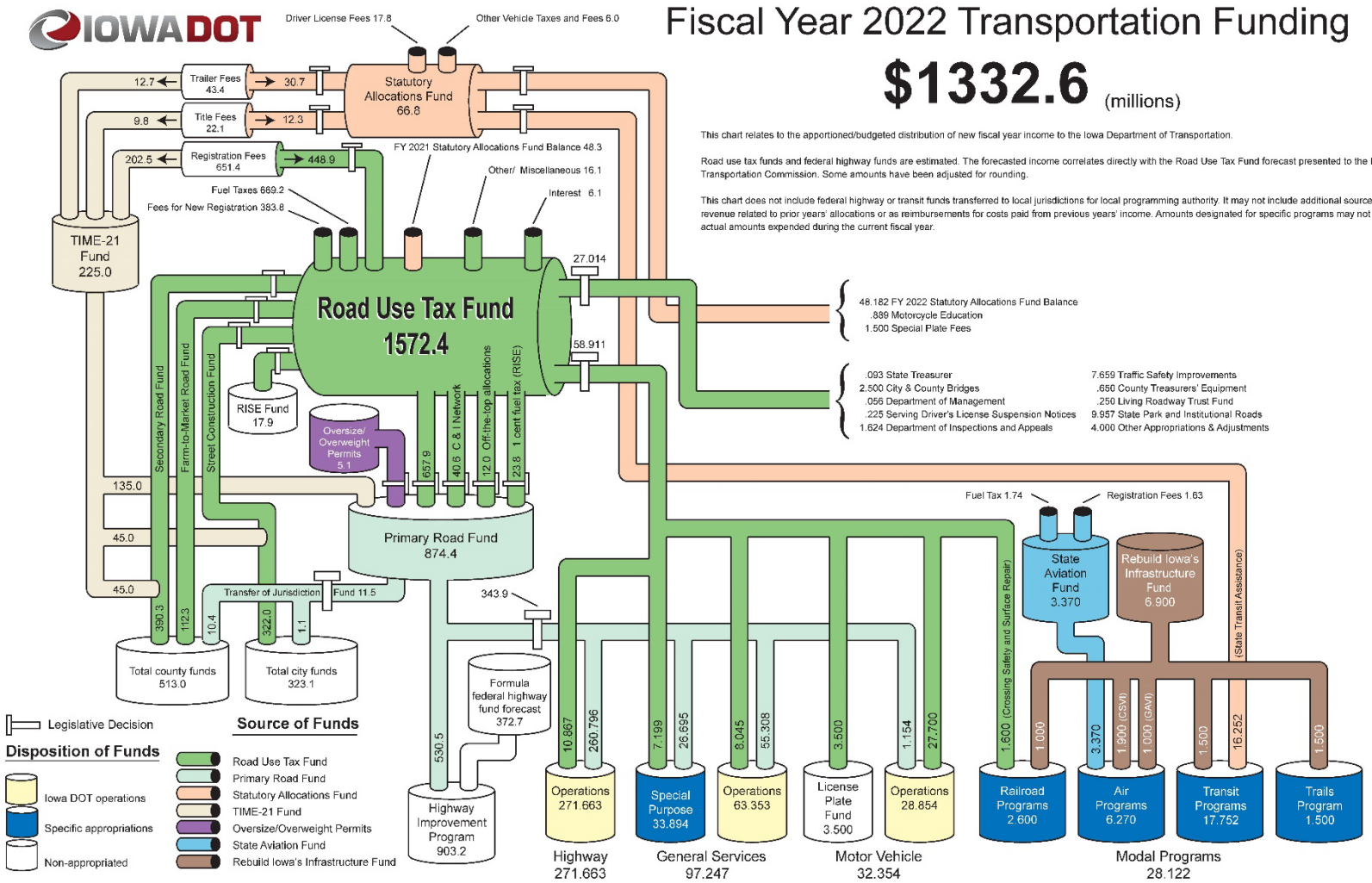
In 2007, the TIME-21 Fund was created as an additional revenue source to help fund maintenance and construction of the State's roadways. TIME-21 allocates monies from the RUTF on a monthly basis from the following sources:

- $10 from each fee collected from the issuance of a certificate of title, $8 from each fee collected for issuance of a certificate for a returned vehicle, and each fee collected for issuance of a salvage certificate of title.
- One-half of the amount received from trailer registration fees with an empty weight of 2,000 pounds or less, two-thirds of the amount received from trailer registration fees collected from trailers with an empty weight of more than 2,000 pounds, and one-third of trailer registration fees received from travel trailers and fifth-wheel trailers.
- The revenue collected from annual motor vehicle registration fees for passenger cars, multipurpose vehicles, and motor trucks.

Revenue from the fees listed above is deposited into the RUTF until it reaches $392 million. The fees in excess of $392 million are credited to TIME-21 until a cap of $225 million is reached. Fees collected in excess of $225 million are again credited to the RUTF. The revenue allocated to TIME-21 has steadily increased since the fund was created. In FY 2018, the fees deposited in TIME-21 reached the $225 million cap for the first time and then reached the cap in FY 2019 and FY 2020 as well.

[2] In addition to the RUTF, revenue from trailer fees, title fees, drivers license fees and other vehicle taxes and fees are collected and distributed through the Statutory Allocations Fund. The FY 2022 estimate for this fund is $66.8 million.

Figure 2-1: FY 2022 Transportation Funding Allocation



The TIME-21 formula reflects the following distribution among the Primary Road Fund (PRF), Secondary Road Fund (SRF), and Street Construction Fund of Cities (Street Construction Fund):

- **PRF**: 60 percent is deposited into the PRF to be used exclusively for highway maintenance and construction. This includes the purchase of right-of-way but does not include project planning and design. Projects that are eligible for funding under TIME-21 are given priority depending on the type of project. The completion of projects on highways designated as access highways have the highest priority. Projects on highways in the commercial and industrial highway network that are included in Iowa DOT's five-year plan for the primary road system are given the next priority. Within these projects, priority is given to projects in areas of the State that have existing biodiesel, ethanol, or other biorefinery plants. Projects on interstate highways are the lowest priority. Based on the TIME-21 cap, the maximum annual amount available is $135 million.
- **SRF**: 20 percent is deposited in the SRF to be used by counties for construction and maintenance on secondary road bridges and on highways in the farm-to-market road system. At least 10 percent of the monies allocated to counties is to be used for bridge construction, repair, and maintenance, with priority given to projects that support economic development and job creation. Based on the TIME-21 cap, the maximum annual amount available is $45 million.
- **Street Construction Fund**: 20 percent is deposited in the Street Construction Fund to be used to sustain and improve the municipal street system. Based on the TIME-21 cap, the maximum annual amount available is $45 million.

Finally, the TIME-21 Fund is scheduled to expire on June 30, 2028.[3]

2.1.2 Off-the-top Allocations and General Assembly Appropriations

Table 2-1 summarizes the FY 2022 off-the-top allocations and appropriations that will occur prior to the RUTF monies being allocated by formula to the PRF, SRF, Farm-to-Market (FM) Road Fund, and the Street Construction Fund. The off-the-top statutory allocations amounts are based on static levels set in the Iowa Code, formula, or Iowa DOT requirements. Based on the values shown in **Figure 2-1**, for FY 2022, the off-the-top allocations are estimated to be $198.9 million.

[3] https://www.legis.iowa.gov/docs/publications/FTNO/1156174.pdf

Table 2-1: FY 2022 Budget Off-the Top Allocations and General Assembly Appropriations

Off-the-Top Allocations	FY 2022 Budget Allocation ($ in millions)
Primary Road Fund (Commercial and Industrial Network)	$40.60
Primary Road Fund	$11.50
Secondary & Urban Roads	$0.50
Revitalizing Iowa's Sound Economy (RISE) Program	
State (to Primary Road Fund)	$23.80
City and County	$17.90
State Transit Assistance	$16.25
Motorcycle Education	$0.89
Special Plate Fees	$1.50
State Treasurer	$0.09
City & County Bridge	$2.50
Department of Management	$0.06
Serving Driver's License Suspension Notices	$0.23
Department of Inspections and Appeals	$1.62
Traffic Safety Improvements	$7.66
County Treasurer's Equipment	$0.65
Living Roadway Trust Fund	$0.25
State Park and Institutional Roads	$9.96
Other Appropriations & Adjustments	$4.00
Railroad Crossing Surface Repair Fund	$0.90
Railroad Crossing Safety Fund	$0.70
License Plate Production	$3.50
Highway Operations	$10.87
General Services Operations	$7.20
General Services Special Purpose	$8.05
Motor Vehicle Operations	$27.70
Total Off-the-Top Allocations	**$198.86**

2.1.3 RUTF Formula Allocations

Based on Iowa Code Section 312.2, following the TIME-21 allocation and the off-the-top allocations, the remaining monies in the RUTF are distributed based on a statutory formula. The RUTF formula has evolved since it was first enacted in 1949, as depicted in **Table 2-2**. The most significant change to the RUTF formula over the years is the increased allocation to the Street Construction Fund - from 8 percent in 1949 to 20 percent in the current formula. Allocations to the PRF have increased slightly over the years, while the percentage allocated to the two county funds (the SRF and FM Road Fund) have decreased from a total of 50 percent in 1949 to 32.5 percent in the current formula.

In general, revenues distributed through the RUTF formula can be used for construction and maintenance activities, except for the FM Road Fund, which can only be used for construction. The PRF is used by the Iowa DOT to fund statewide improvements on the Primary Road

System both outside of and within cities. The SRF is distributed among Iowa's counties for use on all secondary roads. The FM Road Fund is distributed among the 99 counties for construction improvements on the FM Road System. Both the SRF and FM Road fund are distributed to counties through a formula based on roadway miles, traffic, area, rural population, and bridge data. The Street Construction Fund is distributed for use on the municipal street system based on each city's share of total statewide city population.[4]

Table 2-2: RUTF Formula Allocation Percentages: 1949 to Present

Road Fund	1949	1962	1969	1978	1989 - Present
Primary Road	42%	47%	47%	45%	47.5%
Secondary Road	35%	30%	29%	28%	24.5%
Farm-to-Market	15%	10%	9%	9%	8%
Street Construction	8%	13%	15%	18%	20%

2.2 State and Local Revenue Sources

The three primary State revenue sources used for transportation in Iowa are: fuel tax, annual registration fees, and fees for new registrations.

- **Fuel Tax**: The fuel tax is imposed on each gallon sold for use in motor vehicles. The type of fuels that provide revenue for the RUTF include gasoline, diesel fuel, liquefied petroleum gas, liquefied natural gas, compressed natural gas, and ethanol blended gasoline. Fuel tax is the largest single funding source in the State's FY 2022 Budget with a $669 million revenue estimate. Current fuel tax rates are summarized in **Table 2-3.**

Table 2-3: Iowa Fuel Tax Rates (as of July 1, 2021)

Fuel Type	Per Gallon Rate
Gasoline	$0.300
Alcohol	$0.240
Ethanol Blended Gasoline E-10 to E-14 (Gasohol)	$0.300
Ethanol Blended Gasoline E-15 or Higher	$0.240
Diesel including biodiesel B-10 and lower (Special Undyed Fuel)	$0.325
Biodiesel B-11 or Higher Undyed	$0.304
Liquefied Petroleum Gas (LPG)	$0.300
Liquefied Natural Gas (LNG)	$0.325
Compressed Natural Gas (CNG)	$0.310
Hydrogen	$0.650

- **Annual Registration Fees:** This fee is calculated based on vehicle age, list price, and vehicle weight.[5] **Table 2-4** summarizes the percent of list price paid based on the age of the car. In addition to this calculation, the formula includes a weight fee of $0.40 per hundred pounds. The State's FY 2022 Budget estimates annual registration fees would generate $651 million.

[4] http://publications.iowa.gov/39691/1/RUTF%20Study%202021.pdf
[5] https://www.iowataxandtags.org/vehicle-registration/registration-fees-by-vehicle-type/

Table 2-4: Annual Vehicle Registration Fee Calculation

Model Years Old	Percent of List Price / Flat Fee	Weight Fee
1 - 7	100%	$0.40 per hundred pounds
8 - 9	75%	
10 - 11	50%	
12 and after	$50 flat fee	

- **Fee on New Registrations**: This is a one-time five percent fee based on the vehicle's purchase price. The State's FY 2022 Budget estimates annual registration fees would generate $384 million.

As shown in **Table 2-5**, these three sources account for approximately 91 percent of the State's total transportation revenues in the FY 2022 budget, and account for 96 percent of the monies used for the RUTF allocation.

Table 2-5: Iowa DOT FY 2022 Budget - Funding Sources

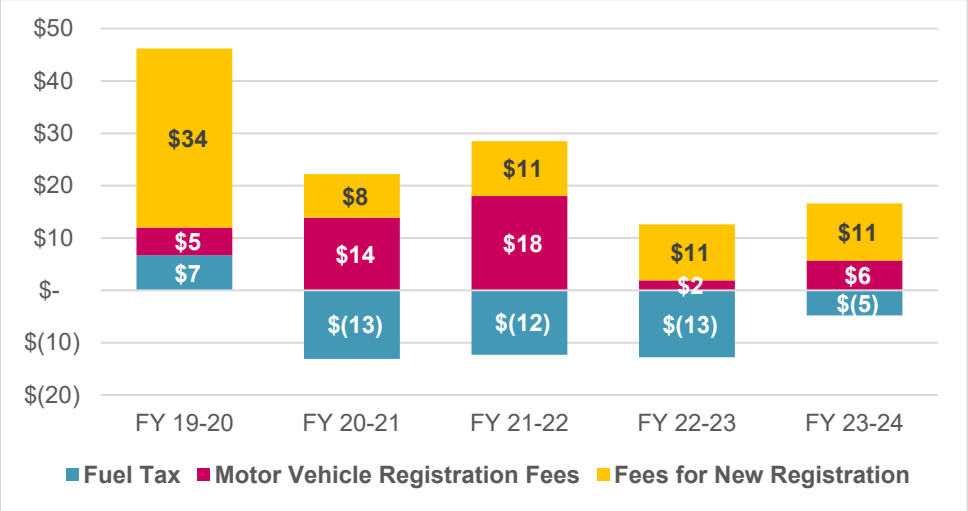
Source	FY 2022 Budget Total	Share of Total	Fund Allocation		
			TIME-21	Statutory Allocation	RUTF*
Fuel Tax	$669.2	36%			$669.2
Annual Registration Fees	$651.4	35%	$202.5		$448.9
Fees on New Registrations	$383.8	21%			$383.8
Trailer Fees	$43.4	2%	$12.7	$30.7	
Title Fees	$22.1	1%	$9.8	$12.3	
Driver License Fees	$17.8	1%		$17.8	
Other Vehicle Taxes and Fees	$6.0	0%		$6.0	
FY 2021 Statutory Allocations Fund Balance	$48.3	3%			$48.3
Interest	$6.1	0%			$6.1
Other / Miscellaneous	$16.1	1%			$16.1
Total	**$1,864.2***	**100%**	**$225.0**	**$66.8**	**$1,572.4**

* Total before off-the-top allocations

While fuel tax is the single largest funding source (36 percent), the combination of the two registration fees generates more revenue (56 percent). Based on a 2019 revenue forecast, it was anticipated that fuel taxes' share of total revenue would decrease over the next five years. As shown in **Figure 2-2**, it was estimated that there would be an annual decrease in fuel tax revenue ranging from $5 million to $13 million over the FY 2020 to FY 2024 period. However, total annual registration revenue was expected to increase between $13 million and $29 million over the same period.[6]

[6] https://iowadot.gov/about/2019-2024FundingForecast.pdf

Figure 2-2: FY 2019 – FY 2025 Revenue Forecast: Year-over-Year Change by Source, $ in millions



Finally, since these three sources account for a significant share of total state transportation funds and the monies used in the RUTF allocation, their importance can be carried forward in terms of county and city transportation budgets. As shown in **Figure 2-3,** based on the counties' Annual Reports over the 2010 to 2019 period, state funding, primarily through the SRF and FM Road Fund, accounted for 54 percent to 63 percent of total annual funding of statewide county transportation expenses. Similarly, based on the cities' Street Finance Report, **Figure 2-4** indicates that state funding, primary through the Street Construction Fund, accounted for 28 percent to 41 percent of total annual funding of statewide city transportation expenses. Additionally, as shown in the figures, cities and counties are also highly dependent on locally generated revenue, as the combination of state and local funding accounts for approximately 97 percent of funding for counties and cities,with the remainder coming from Federal funds.

Figure 2-3: Funding Share of Statewide County Transportation Expenses: 2010 to 2019

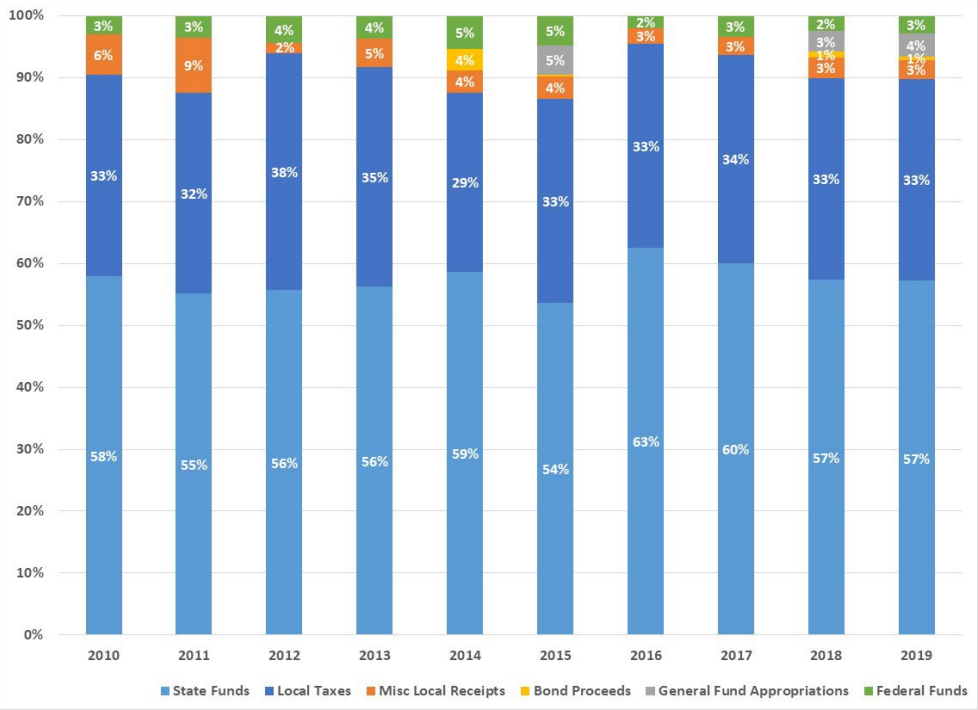
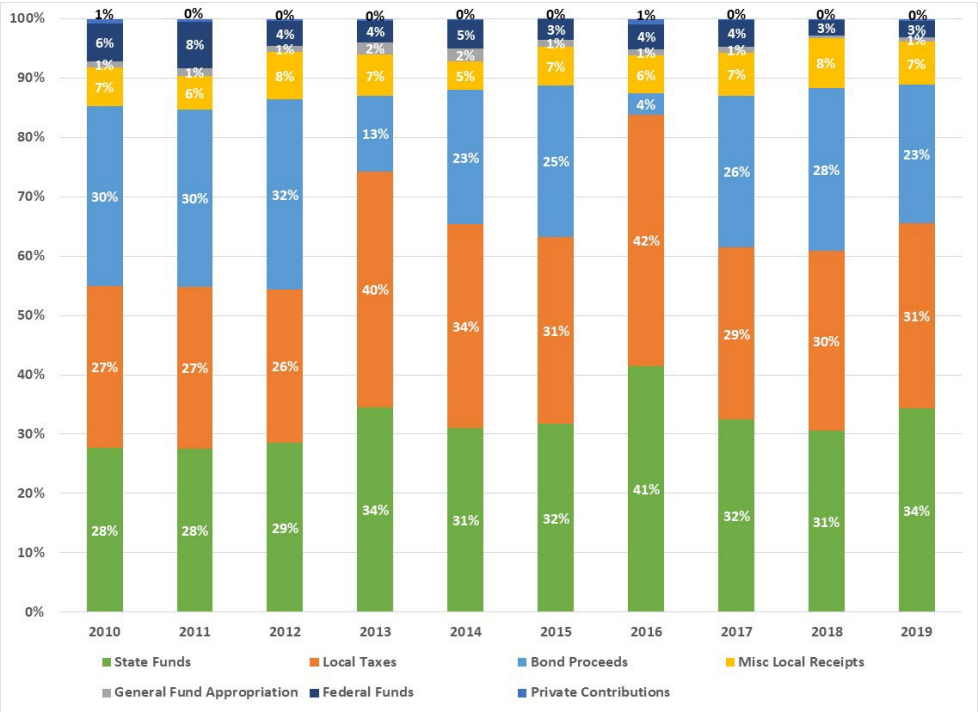


Figure 2-4: Funding Share of Statewide City Transportation Expenses: 2010 to 2019



Revenue sources for counties and cities in the local taxes category include General Fund property taxes and assessments and local option sales taxes (LOST), while the miscellaneous local receipts category primarily reflects licenses, permits, fines and fees, the sale or lease of real estate and parking revenues. Additionally, counties and cities receive local funding from general fund appropriations, bond proceeds and private contributions. Cities issued a significantly higher level of bonds compared to the counties. Over the 10-year period, total annual bond proceeds for the cities ranged between $95 million and $314 million and averaged $226 million a year. Bond proceeds supported county road projects in only four of the ten years with amounts ranging between $2 million and $20 million.

Figure 2-5 and **Figure 2-6** summarize the annual funding sources used by counties and cities statewide for road and bridge projects between 2010 to 2019 period. Over this time, total funding used statewide by counties increased from approximately $480 million to $700 million, which is an average annual increase of 4.2 percent. For cities, total funding used on statewide increased from approximately $860 million to $1.1 billion, which is an average annual increase of 2.1 percent per year.

Figure 2-5: Annual Transportation Revenues Used Statewide by Counties ($, in millions)

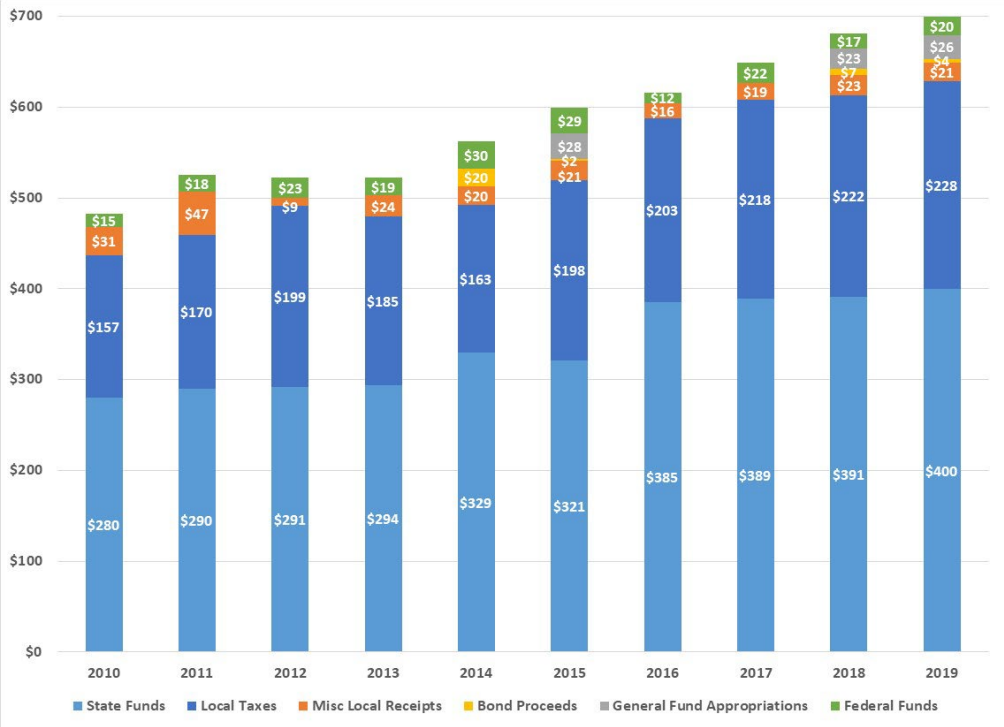
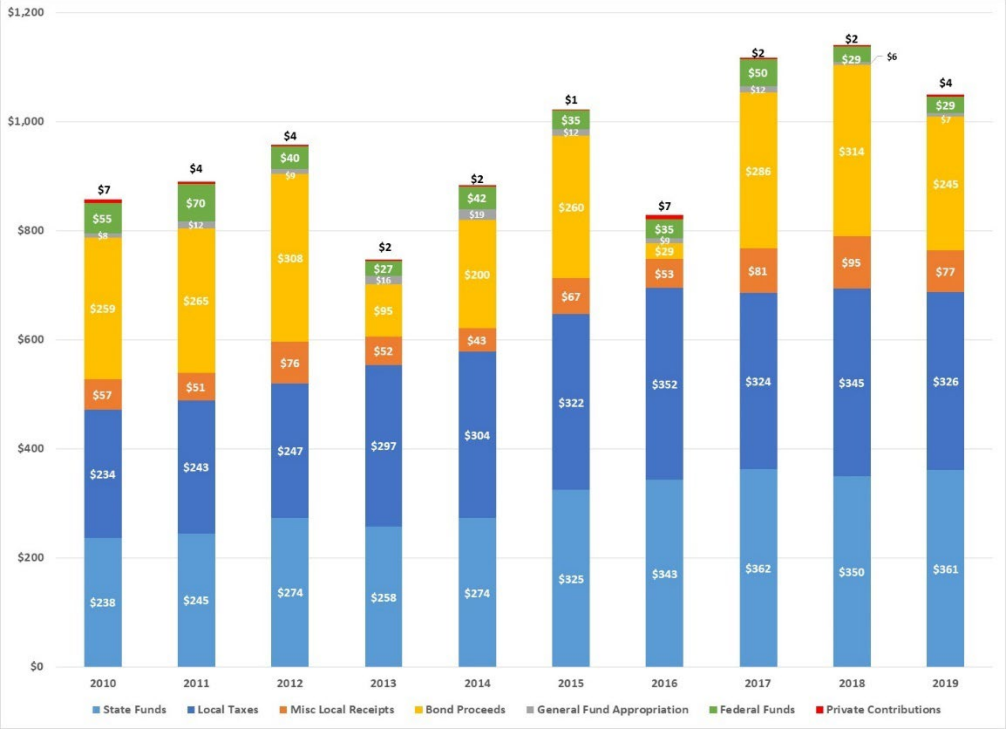


Figure 2-6: Annual Transportation Revenues Used Statewide by Cities ($, in millions)



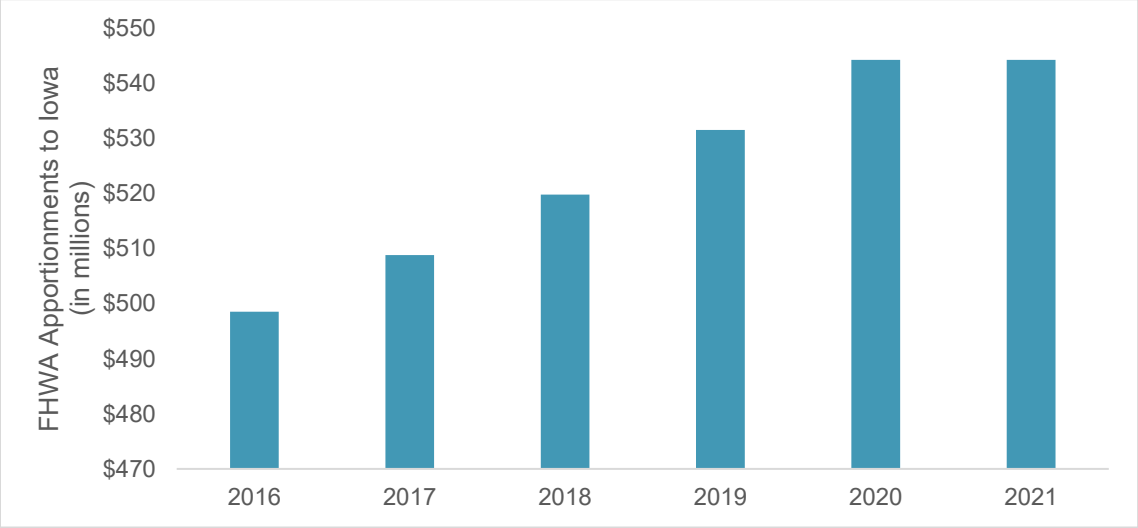
2.3 Federal Funding

From a national perspective, the State of Iowa receives annual appropriations from the Federal Highway Administration (FHWA). In terms of evaluating federal funding trends, the analysis needs to be considered within the context of the recently passed Infrastructure Investment and Jobs Act (IIJA), also known as the Bipartisan Infrastructure Law (BIL).

- **Prior to the IIJA: Figure 2-7** summarizes the State's annual federal formula apportionments between 2016 and 2021 based on the prior federal surface transportation authorization bill (the Fixing America's Surface Transportation Act [FAST Act]) and the Continuing Resolution which provided FFY 2021 funding until the next authorization bill is approved.[7] Over this period, the level of FHWA apportionments to Iowa increased from $499 million to $544 million in FFY 2020 and FFY 2021. Iowa's annual apportionments had increased 9 percent since 2016, representing a compound annual growth rate (CAGR) of 1.8 percent.

[7] https://www.fhwa.dot.gov/fastact/funding.cfm

Figure 2-7: Total Apportionments from FHWA to Iowa, FFY 2016 to FFY 2021 ($, in millions)



Note: Reflects total initial apportionments under the FAST Act.

- **IIJA Funding:** The passage of the IIJA provides a significant increase in annual federal formula funding, introduces new discretionary grant programs, and expands existing discretionary grant programs for FFY 2022 through FFY 2026. Based on estimates from the USDOT[8], Iowa will receive approximately $3.8 billion over five years in federal highway formula funds for highways and bridges. On an average annual basis, this is about 31.4 percent more than the State's received under the FAST Act. While this infusion of federal funds will benefit state and local roads over the next five years, there is no guarantee that the level of annual funding or the potential availability of discretionary grant programs included in the IIJA will continue beyond 2026. More specifically, funding from the IIJA will not address the long-term financial sustainability needs of the State.

2.4 Future Fuel Tax Revenue Sustainability at Risk

In addition to being Iowa's largest state-generated transportation revenue source, fuel taxes are also the primary transportation revenue source for federal transportation funding programs. As described below, improvements in fuel efficiency, increased sales of EVs, and changes in driving behavior will continue to have a negative impact on the revenue generation ability of the fuel tax at the state and federal level.

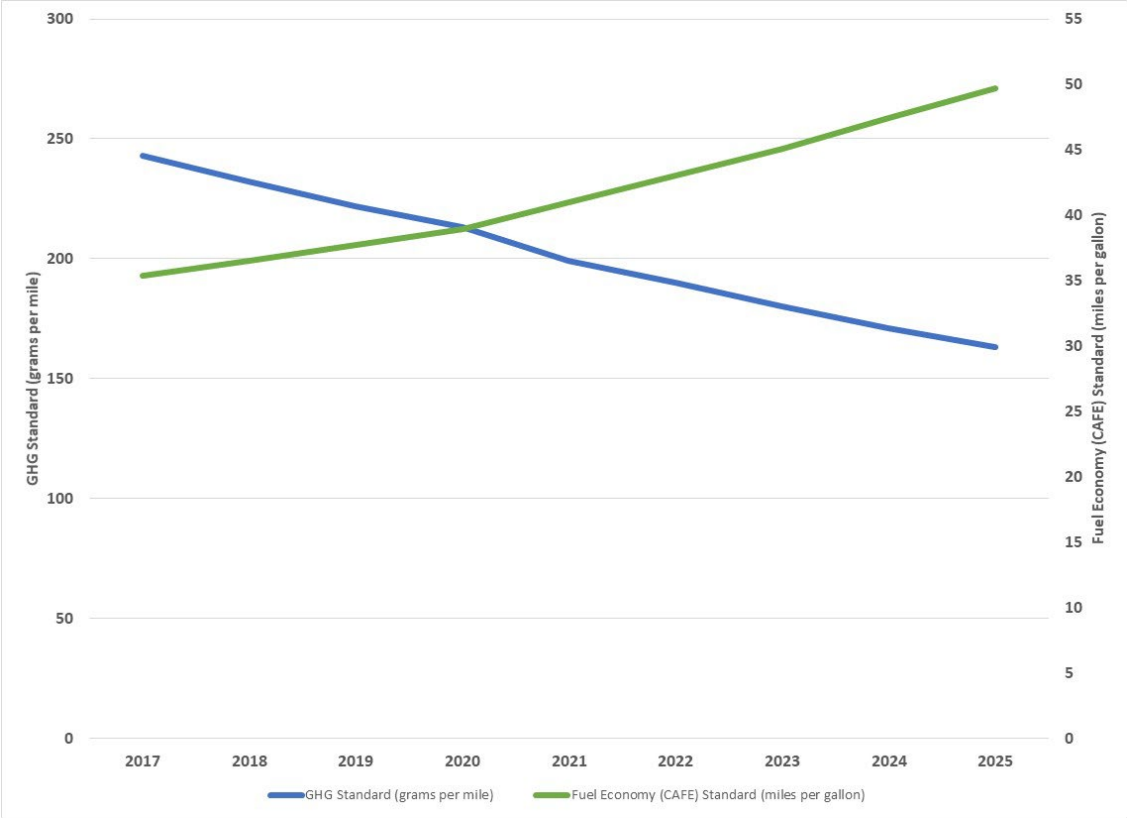
1. **Improved Fuel Economy:** Among the nation's non-electric vehicle fleet, fuel economy for all new vehicles has increased 32 percent since 2004[9]. This trend is expected to continue with the implementation of federal greenhouse gas (GHG) emissions reduction standards. In August 2012, the U.S. Environmental Protection Agency (EPA) issued final rules for GHG emissions reductions related to fuel economy. The final rule resulted in the National Highway Traffic Safety Administration (NHTSA) establishing new Corporate Average Fuel

[8] https://www.transportation.gov/briefing-room/bipartisan-infrastructure-law-will-deliver-iowa
[9] https://www.epa.gov/automotive-trends/highlights-automotive-trends-report#:~:text=Preliminary%20data%20suggest%20improvements%20in,0.8%20mpg%20to%2025.7%20mpg.

Economy (CAFE) standards that defined the miles per gallon targets that future model year passenger cars and light trucks must meet to achieve the GHG emissions reduction targets. As shown in **Figure 2-8**, the standards dictated that the industry emissions average (consisting of all passenger cars, light-duty trucks, and medium-duty passenger vehicles with model years of 2017 through 2025) should be no more than 163 grams per mile of carbon dioxide in 2025. If this reduction was achieved exclusively through fuel economy improvements, the CAFE fuel economy in 2025 would be 49.7 miles per gallon (mpg).[10]

Further, in December 2021, the Biden Administration revised the GHG emissions reduction standards and requires automakers to increase mpg targets starting in the 2023 model year.[11] Future fuel tax revenues will continue to decline as auto manufacturers produce more fuel-efficient vehicles to meet the federal GHG emissions reduction standards.

Figure 2-8: Model Year 2017-2025 Combined Average Passenger Car and Light Truck CAFE and GHG Emission Standards



[10] https://nepis.epa.gov/Exe/ZyPDF.cgi/P100EZ7C.PDF?Dockey=P100EZ7C.PDF
[11] https://www.epa.gov/regulations-emissions-vehicles-and-engines/final-rule-revise-existing-national-ghg-emissions

2. **Increased EV Sales.** A second cause of reduced fuel tax revenue is the global shift to EVs. Based on research conducted by Deloitte Insights,[12] key factors driving the shift to EVs include consumer sentiment, policy, and original equipment manufacturer (OEM) production strategy.

   - **Changing Consumer Sentiment**: Based on Deloitte's Global Auto Consumer Survey, from 2018 to 2020 there were noticeable changes in consumer attitudes toward EVs. Focusing on the United States survey results in **Figure 2-9**, while concerns over the cost/price premium for EVs decreased, the two largest concerns were lack of vehicle charging equipment and driving range.

Figure 2-9: Consumer Priorities for EV Adoption

Greater concerns are shown in orange.

2020 Global Auto Consumer Study												
	FRANCE		GERMANY		ITALY		UK		CHINA		US	
In your opinion, what is the greatest concern regarding all battery-powered electric vehicles?	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020	2018	2020
Driving range	31%	28%	35%	33%	4%	27%	26%	22%	25%	22%	24%	25%
Cost/price premium	32%	22%	22%	15%	19%	13%	24%	16%	9%	12%	26%	18%
Time required to charge	11%	15%	11%	14%	18%	16%	13%	16%	12%	15%	10%	14%
Lack of electric vehicle charging infrastructure	16%	22%	20%	25%	44%	32%	22%	33%	18%	20%	22%	29%
Safety concerns with battery technology	4%	11%	5%	10%	7%	10%	6%	12%	22%	31%	8%	13%
Others	6%	2%	7%	3%	8%	2%	9%	1%	14%	0%	10%	1%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Sample size	1,083	1,266	1,287	3,002	1,048	1,274	965	1,264	1,606	3,019	1,513	3,006

The decreased concern for the cost of an EV reflects a trend in the cost to produce lithium-ion batteries. Since 2010, the price of lithium-ion battery packs has fallen 89 percent from $1,100 per kilowatt-hour to $137 per kilowatt-hour in 2020. It has been estimated that by 2023, the average price of lithium-ion battery packs will be approximately $100 per kilowatt-hour, which would make the overall cost of an EV comparable to the cost of an internal combustion vehicle.[13]

Deloitte's Global Auto Consumer Survey indicated the lack of EV charging infrastructure was the top concern for consumers. This reflects the possibility that consumers are starting to see EVs as a realistic option and are considering the practicalities of ownership. In terms of the charging infrastructure availability, the Biden Administration is providing a significant increase in federal funding to accelerate implementation of

[12] https://www2.deloitte.com/us/en/insights/focus/future-of-mobility/electric-vehicle-trends-2030.html
[13] https://about.bnef.com/blog/battery-pack-prices-cited-below-100-kwh-for-the-first-time-in-2020-while-market-average-sits-at-137-kwh/

charging infrastructure across the country, as seen by changes to existing FHWA formula programs and new grant programs included in the IIJA:

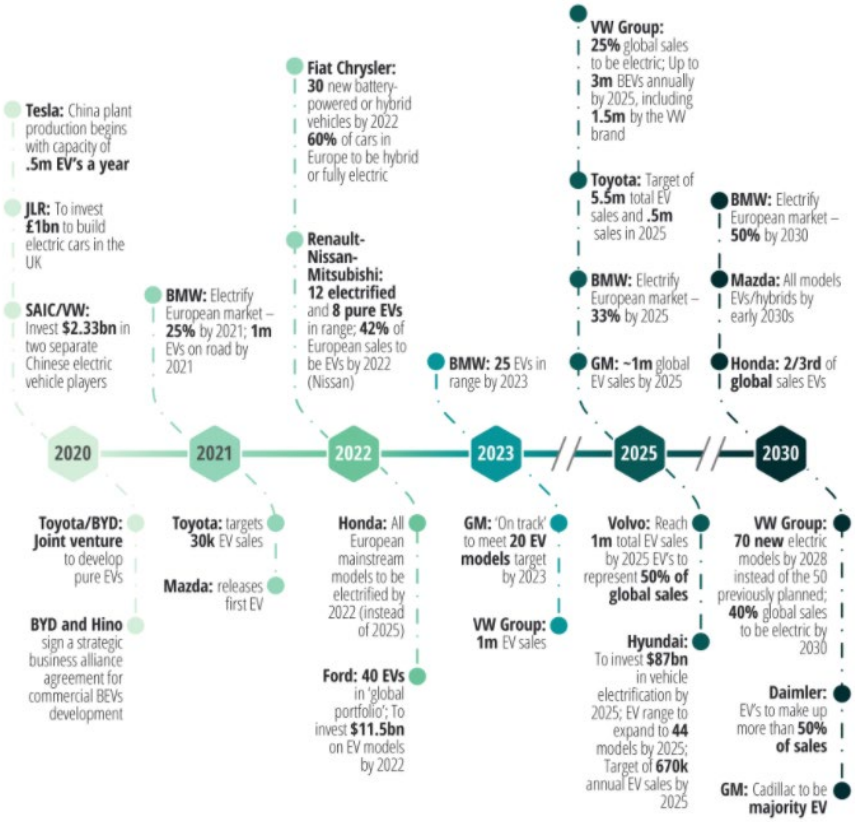
- **Changes to existing federal formula programs**: The Surface Transportation Block Grant Program (STBG) expanded the list of eligible projects to include EV charging equipment. Additionally, the Congestion Mitigation and Air Quality Improvement Program (CMAQ) now includes the purchase of medium- or heavy-duty zero emission vehicles and related charging equipment as an eligible grant funded expense.
- **New federal formula program**: The National Electric Vehicle Infrastructure (NEVI) Formula Program will provide nearly $5 billion over five years to help states create a network of EV charging stations along designated Alternative Fuel Corridors, particularly along the Interstate Highway System. However, before accessing these funds, states must submit an EV Infrastructure Deployment Plan. Iowa's NEVI formula allocation over the five-year period is $51.3 million[14].
- **New discretionary grant program**: The Grants for Charging and Fueling Infrastructure will support the strategic deployment of publicly accessible EV charging, and hydrogen, propane or natural gas fueling infrastructure along designated alternative fuel corridors, as well as support the expansion of fueling infrastructure or filling gaps at locations such as schools, parking facilities, and public parks.

Finally, while the survey results indicate that driving range is still a major concern, Deloitte notes that EV driving range is already comparable to that of internal combustion engine vehicles. As EV sales continue to grow and consumers see more of them on the roads, or travel in EVs owned by family or friends, Deloitte expects personal experiences to outweigh the driving range concerns.

- **OEM Vehicle Production Strategy**: According to the Deloitte analysis and shown in **Figure 2-10,** recent announcements from auto manufacturers have made it clear that there will be substantially more EV models commercially available over the next decade. For the United States, Deloitte references research from IHS Markit, which predicts there will be 130 EV models available by 2026, offered by 43 vehicle manufacturers.

[14] Bipartisan Infrastructure Law - 5-year National Electric Vehicle Infrastructure Funding by State | Federal Highway Administration (dot.gov)

Figure 2-10: Timeline of Strategic OEM Targets for EVs

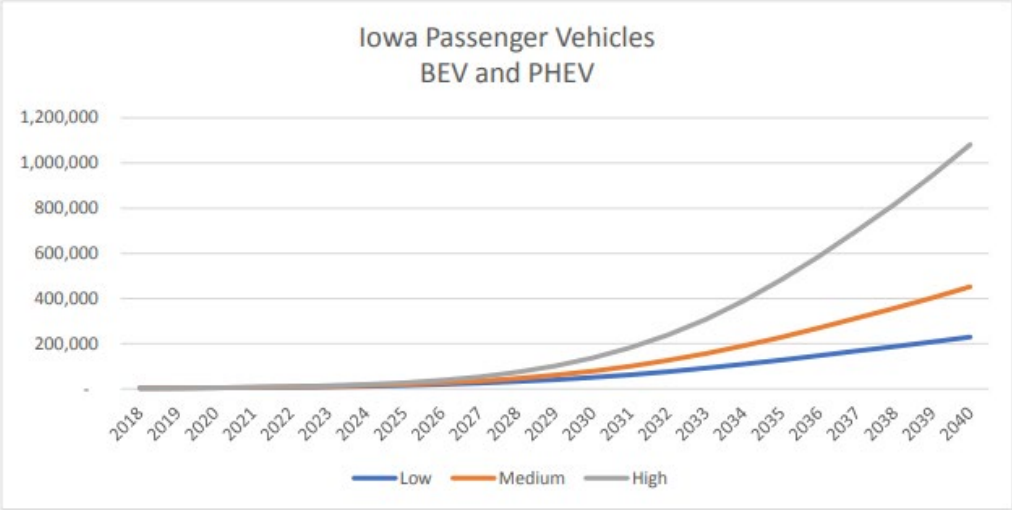


Within Iowa the potential increase in EV sales and the associated impact on fuel tax collection has been studied for several years. This includes the 2016 *Advancing Iowa's Electric Vehicle Market* commissioned by the Iowa Economic Development Authority (EDA)[15] and the 2018 *Report on the Impact of Electric Vehicles to the Road Use Tax Fund* that was submitted by the Iowa DOT to the State legislature. Both studies estimated the potential growth in market share of EVs and the Iowa DOT study developed multiple scenarios to estimate to the potential fuel tax revenue reduction impact on the RUTF over the next 20 years[16].

Figure 2-11, presents three forecast scenarios of passenger car battery electric vehicles (BEVs) and PHEVs over the 2018 to 2040 period that were developed by Iowa DOT. Based on the assumptions in each scenario, the number of BEVs and PHEVs could increase from 2018 levels of approximately 3,000 vehicles to between 200,000 and 1.1 million vehicles in 2040.

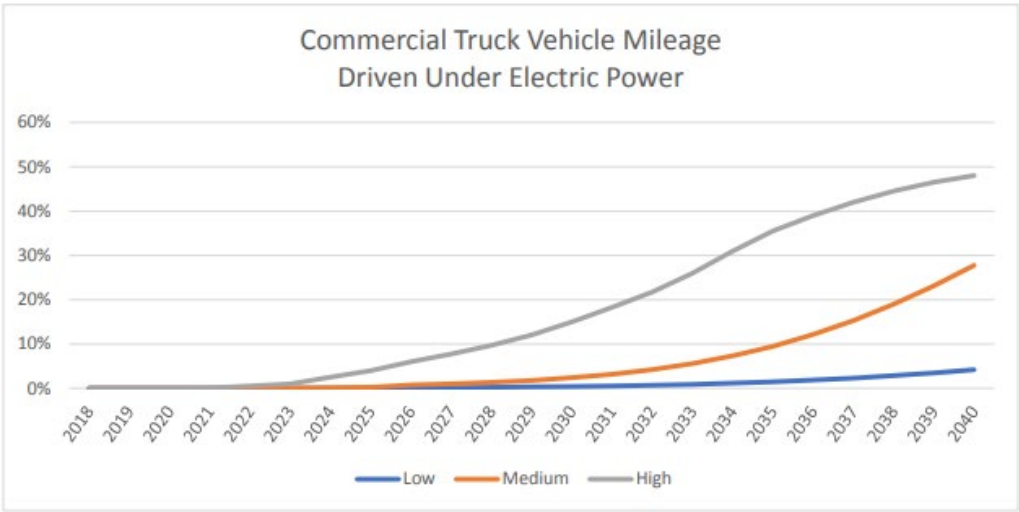
[15] https://www.iowaeda.com/UserDocs/AdvancingIowasElectricVehicleMarketReport.pdf
[16] http://publications.iowa.gov/29142/1/EV%20RUTF%20Impact%20Report%20123118.pdf

Figure 2-11: Forecast of Passenger Car BEVs and PHEVs in Iowa



The 2018 Iowa DOT Report also developed multiple scenarios to estimate the share of total annual vehicle miles traveled from commercial trucks that would be powered by electricity. **Figure 2-12** provides the results and reflects the forecasted passenger EV growth assumptions as a starting point with adjustments to account for later availability of commercial truck EVs and quicker turnover of commercial truck vehicle fleets. Additionally, because a significant portion of Iowa's RUTF fuel tax from commercial trucks is paid by out-of-state vehicles, the impact of commercial truck EVs considered more than just the estimated number of vehicles registered in Iowa. Therefore, commercial truck EV impacts on the RUTF fuel tax were calculated by forecasting the share of commercial truck mileage in Iowa that is forecasted to be driven by EVs over time.

Figure 2-12: Forecast of Commercial Truck Vehicle Mileage Driven Under Electric Power



As shown in **Table 2-6**, based on the forecasted growth in EVs and PHEVs, Iowa DOT estimated the potential impact of RUTF fuel tax revenue could range from a $318,000 reduction in 2018 to between a $1.9 and $11.1 million reduction in 2025, depending on the scenario. Additionally, over the next 15 years there is the potential for a significant reduction of fuel tax revenue due to the increased utilization of EVs.

It is important to note that these forecasts were developed well in advance of the new federal formula and discretionary grant programs included in the IIJA. While EV infrastructure implementation plans will vary across Iowa, based on the increased federal funding available over the next five years, it is likely EV and PHEV use will increase at a faster rate than the Low Scenario results from the Iowa DOT Study.

Table 2-6: Potential Reduction in RUTF Due to Increased BEV and PHEV Sales ($ in millions)

Year	Low Scenario	Medium Scenario	High Scenario
2018	$0.317	$0.317	$0.317
2020	$0.488	$0.520	$0.564
2025	$1.858	$2.684	$11.117
2030	$7.083	$14.207	$45.210
2035	$19.603	$47.748	$129.260
2040	$39.975	$115.200	$241.316

3. **Changes in Driving Behavior:** The final variable impacting annual fuel tax revenue is changes in driving behaviors, which can be seen in VMT trends.[17] As shown in **Table 2-7**, between 2015 and 2019 total VMT within Iowa increased an average of 0.5 percent per year. This was slightly less than the nationwide average annual increase of 1.4 percent. Further, the COVID-19 pandemic caused a sudden drop in travel across the country in 2020. Iowa experienced an 11.5 percent reduction in VMT between 2019 and 2020, which was slightly lower than the national reduction which was 13.4 percent. Multiple factors contributed to these reductions, including higher unemployment, and flexible or remote work options.

Table 2-7: Statewide and National Vehicle Miles Traveled: 2015 to 2020 (in millions)

Year	State Total	US Total
2015	33,109	3,095,373
2016	33,263	3,174,408
2017	33,751	3,212,347
2018	33,507	3,240,327
2019	33,779	3,269,088
2020	29,882	2,829,705
2015 - 2019 CAGR	0.5%	1.4%
2019 - 2020 Change	-11.5%	-13.4%

[17] https://iowadot.gov/maps/msp/vmt/30yearvmt.pdf

While the pandemic is ongoing, it is difficult to forecast when VMT levels will return to pre-2019 levels. Based on a Congressional Budget Office employment forecast, FHWA estimated that national VMT will not return to pre-pandemic levels in the next few years, as shown in **Figure 2-13**.[18] It is possible that Iowa's recovery will be faster than the national estimate. Nevertheless, it is probable that Iowa's annual fuel tax revenues in the near future will continue to be impacted by the economic and workplace changes that occurred due to the COVID-19 pandemic.

Figure 2-13: COVID Impact on National VMT

Sources: StreetLight VMT Monitor and US Department of Transportation, Federal Highway Administration, Traffic Volumes and Trends. Forecasts based on Congressional Budget Office employment forecast.

2.5 Decreased Purchasing Power and Increased Investment Needs

Increasing construction costs and investment needs will compound the impact of the ongoing and long-term reduction in fuel tax revenue generation. As described below, this includes annual construction cost growth exceeding the growth for all of Iowa's transportation funding as well as increased needs associated with maintaining the existing transportation infrastructure.

2.5.1 Construction Costs Growth Outpaces Revenue Growth

As part of the 2021 RUTF Study, Iowa DOT provided a comparison of the year-over-year change in actual state revenue to adjusted revenue levels in constant 1997 dollars based on the Iowa Construction Cost Index.[19] As shown in **Table 2-8**, since 2012 there have only been three years where the growth in revenue adjusted to constant 1997 dollars exceeded the actual revenue growth rate. These three years represent the only years which annual revenue generated resulted in increased purchasing power.

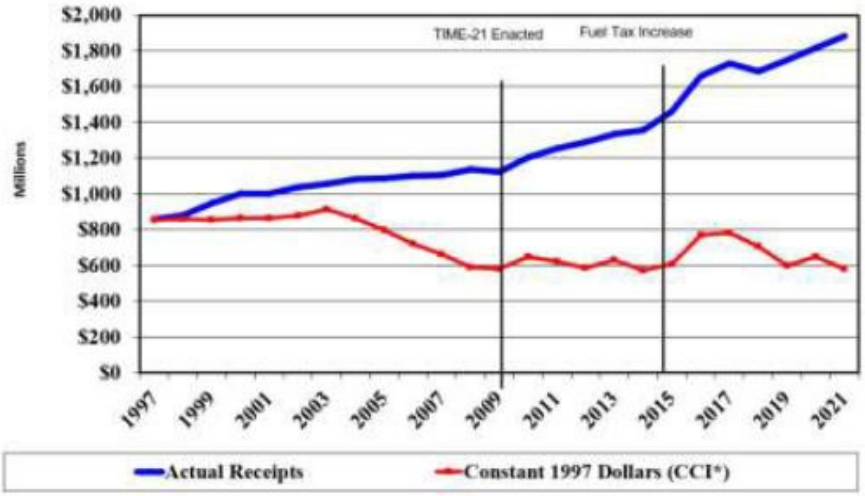
[18] https://www.apta.com/wp-content/uploads/APTA-COVID-19-Funding-Impact-2021-01-27.pdf
[19] http://publications.iowa.gov/39691/1/RUTF%20Study%202021.pdf

Table 2-8: State Revenue, Actual and Adjusted to Constant 1997 Dollars

	Actual Revenue (millions)	% Change from Previous Year	Revenue Adjusted to Constant 1997 Dollars based on Iowa Construction Cost Index (millions)	% Change from Previous Year
2012	$1,290	2.8%	$524	-5.8%
2013	$1,335	3.5%	$565	7.8%
2014	$1,358	1.7%	$513	-9.2%
2015	$1,462	7.7%	$542	5.7%
2016	$1,658	13.4%	$686	26.6%
2017	$1,729	4.3%	$699	1.9%
2018	$1,687	-2.4%	$632	-9.6%
2019	$1,749	3.7%	$535	-15.4%
2020	$1,816	3.8%	$578	8.1%
2021	$1,881	3.6%	$517	-10.5%

Additionally, as shown in **Figure 2-14**, since 1997, actual state revenues have increased from $856 million to $1.881 billion, which reflects an average annual increase of 3.3 percent. This growth was supported by the enactment of TIME-21 in 2009 and the 2015 fuel tax rate increase. However, as shown in the figure, when the revenues are adjusted to constant 1997 dollars using the Iowa Construction Cost Index, the purchasing power of the state revenues has diminished over time due to the construction cost increases.

Figure 2-14: Historic Trend in RUTF Revenue Purchasing Power



* Iowa Construction Cost Index, which reflects the inflation of roadway costs in Iowa and corresponding loss in buying power

Specifically related to the fuel tax, the Construction Cost Index was used to provide a comparison of annual increases in costs to changes in annual fuel tax revenue levels. The comparison evaluated the CAGR of fuel tax revenues and construction costs before and after the 2015 fuel tax rate increase.

While **Figure 2-15** indicates a general increase in fuel tax revenues over the 2010 to 2019 period, the majority of the increase was the result of a $0.10 increase in the fuel tax rate that went into effect in March 2015. This change resulted in a 47 percent increase in the gas tax rate, a 53 percent increase in the ethanol (E-85) tax rate, and a 44 percent increase in the diesel tax rate. Prior to the fuel tax increase, fuel tax revenue was increasing approximately 1 percent annually. Following the fuel tax rate increase, annual fuel tax revenues have declined approximately 1 percent annually.

Figure 2-15: Iowa Fuel Tax Revenue CAGR: 2010 to 2014 and 2016 to 2019

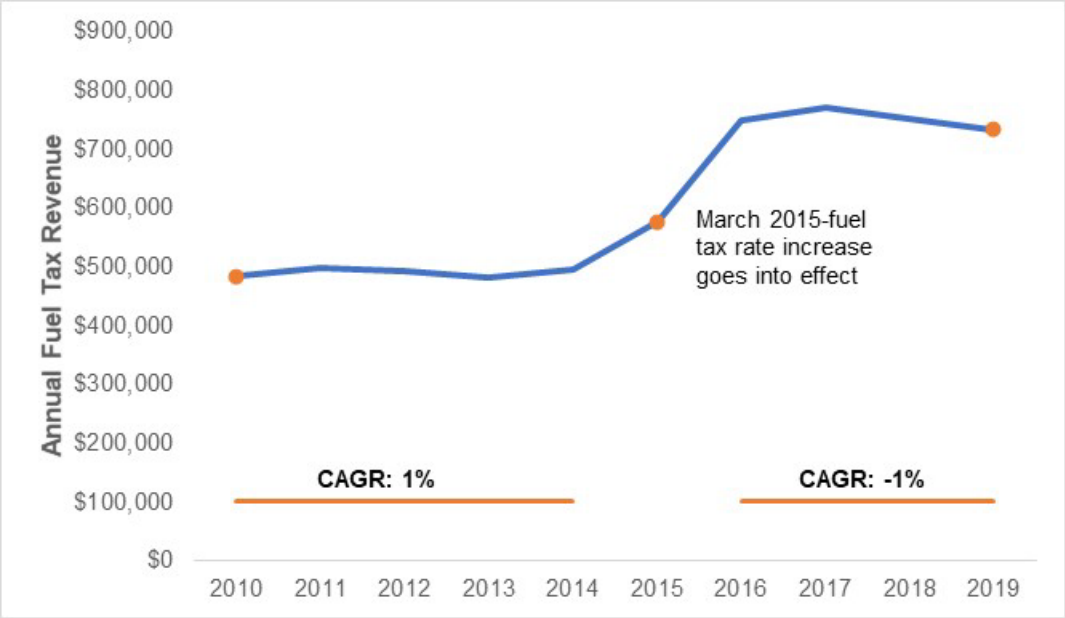
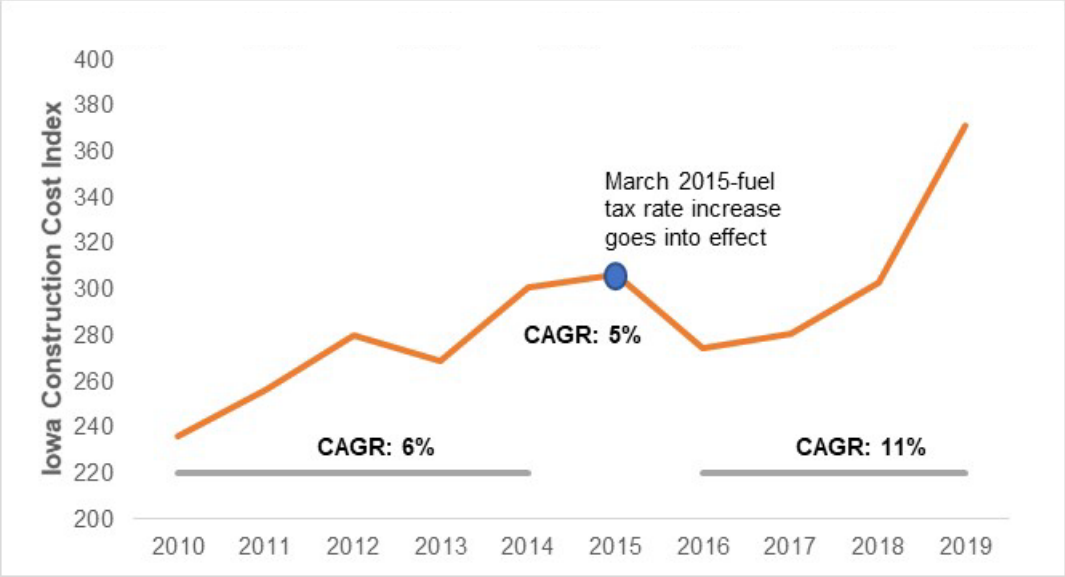


Figure 2-16 provides the CAGR for the Composite Index from the Iowa DOT's Price Trend Index for Iowa Highway Construction. As show in the figure, the CAGR for the Composite Index between 2010 and 2014 was 6 percent and the CAGR from 2016 to 2019 was 11 percent. Except for 2015 when the fuel tax rate increased, construction costs have increased at a significantly higher rate than fuel tax revenue.

Figure 2-16: Iowa Construction Cost Index CAGR: 2010 to 2014 and 2016 to 2019



2.5.2 Impacts of an Aging Transportation System

Based on data collected for the 2021 Annual Bridge Report,[20] **Table 2-9** summarizes the total number of bridges and the owners of the bridges across Iowa[21]. As shown in the table, counties are responsible for maintaining the largest share of bridges (77.4 percent), while the State has the largest bridge deck area to maintain (48.5 percent) followed closely by counties at 43 percent. The average age for state owned bridges on the Primary Highway System is 41 years. Nationally the average age for bridges on the Primary Highway System is 46 years and the common age used to describe how long a bridge should last is 50 years. The average age of county and city owned bridges is 46 years, while the national average for locally owned bridges is 43 years.

Table 2-9: Statewide Bridge Ownership

Owner	Number of Bridges	% of Bridges	Deck Area (SF)	% of Deck Area
State	4,184	17.6%	46,766,635	48.5%
Cities	1,209	5.1%	8,210,645	8.5%
Counties	18,440	77.4%	41,481,071	43.0%
Total	**23,833**	**100.0%**	**96,458,351**	**100.0%**

Following FHWA guidance, all bridges were inspected an assigned a classification of Good, Fair, or Poor based on the bridge's condition ratings for the deck, superstructure, substructure, and culverts. As shown in **Table 2-10**, county owned bridges represent the largest share of poor

[20] https://iowadot.gov/bridge/2021%20Annual%20Bridge%20Report.pdf

[21] Note: The FHWA definition of a bridge is any structure including supports erected over a depression or an obstruction, such as water, highway, or railway, and having a track or passageway for carrying traffic or other moving loads, and having an opening measured along the center of the roadway of more than 20 feet between undercopings of abutments or spring-lines of arches, or extreme ends of openings for multiple boxes; it may also include multiple pipes, where the clear distance between openings is less than half of the smaller contiguous opening.

rated bridges. It should be noted that the poor category does not indicate there is a safety issue. Rather these bridges have deterioration or damage that may need repair or replacement in the near future.

Table 2-10: Bridge Categorization (2021)

Owner	Good	% Share	Fair	% Share	Poor	% Share
State	2,022	22%	2,130	21%	32	1%
Cities	504	5%	512	5%	193	4%
Counties	6,814	73%	7,354	74%	4,272	95%
Total	**9,340**	**100%**	**9,996**	**100%**	**4,497**	**100%**

The Average Daily Traffic (ADT) crossing a bridge is a major factor for making decisions to repair or replace a bridge. Many bridges owned by the counties and cities do not have a very high ADT. Half of the Poor bridges on the County highway system carry fewer than 35 vehicles per day which is considered “Low Volume”. According to the 2021 Annual Bridge Report, counties do a good job maintaining the bridges that carry the majority of the traffic. Additionally, over half of the counties’ poor bridges are posted for weight restrictions which allows the safe use of these bridges. However, it is also important to keep in mind that the agriculture industry is a primary user of the county bridges and requires large and heavily vehicles and equipment to transport supplies, equipment, products, and waste and could be negatively impacted by further weight restrictions or potential closures.

Table 2-11: Average Daily Traffic on Bridges

	Owner		
	State	County	City
Average ADT - all bridges	6,655	201	3,337
Median ADT - all bridges	3,540	45	1,600
Number of bridges	4,184	18,440	1,209
Average ADT - poor bridges	6,293	138	2,289
Median ADT - poor bridges	3,220	35	790
Number of poor bridges	32	4,272	193
Percent poor bridges	0.8%	23.2%	16.0%

2.6 Prior Actions by Iowa Legislature to Increase Funding

Since 2015, Iowa has taken steps to increase revenue for the RUTF, including increasing gas tax rates and introducing an additional registration fee for electric and hybrid vehicles.

2.6.1 Fuel Tax Rate Increase

As part of the 2006 Study of Iowa's Current Road Use Tax Funds and Future Road Maintenance and Construction Needs for the Iowa Legislature,[22] the Iowa DOT included a recommendation that a study be conducted every five years to evaluate the conditions of Iowa's public roadway infrastructure and assess the ability of existing revenues to meet the needs of the system. This recommendation was included in legislation that was signed into law in 2007 and specified the following:

- "The department shall periodically review the current revenue levels of the road use tax fund and the sufficiency of those revenues for the projected construction and maintenance needs of city, county, and state governments in the future. The department shall submit a written report to the general assembly regarding its findings by December 31 every five years, beginning in 2011. The report may include recommendations concerning funding levels needed to support the future mobility and accessibility for users of Iowa's public road system.
- The department shall evaluate alternative funding sources for road maintenance and construction and report to the general assembly at least every five years on the advantages and disadvantages and the viability of alternative funding mechanisms."

To comply with this requirement, the Iowa DOT prepared a 2011 RUTF Study[23] to assess the condition of Iowa's roadway system and evaluated current and future funding available to best address system needs. The 2011 RUTF Study led to the passage of Senate File 257 in the 2015 legislative session that was signed into law on February 25, 2015. The major component of this bill was the increase of the state fuel tax rate on March 1, 2015, to address a portion of the funding shortfall identified in the study. It was originally estimated that the fuel tax rate increase would generate an additional $213 million in the first full year the rate increase was effect. Between the last full year of the previous rates (FY 2014) and the first full year of the new rates (FY 2016), fuel tax revenue increased by $231.6 million,[24,25] due to the rate increase and an increase in miles driven (3 percent increase) over these years.[26]

As shown **Table 2-12,** the 2015 legislation resulted in the largest single year rate increase since the fuel tax was implemented in 1925.

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22 https://iowadot.gov/transportation2020/RUTF%20Study%20FINAL%20122906.pdf?ver=vuRpgNY9npuJHDDoDkPcaQ%3d%3d

23 https://iowadot.gov/pdf_files/RUTFStudy2011.pdf

24 https://das.iowa.gov/sites/default/files/acct_sae/cafr/fy14_cafr.pdf

25 https://das.iowa.gov/sites/default/files/acct_sae/cafr/fy16_cafr.pdf

26 https://iowadot.gov/maps/msp/vmt/30yearvmt.pdf

Table 2-12: Iowa Historical Gas Tax Rates

Effective Date of Change	Gasoline Tax Rate	Ethanol (E-85) Tax Rate	Diesel Tax Rate
1925	$0.02	NA	$0.02
1943	$0.03	NA	$0.03
1945	$0.04	NA	$0.04
1953	$0.05	NA	$0.05
1955	$0.06	NA	$0.06
1957	$0.07	NA	$0.07
1965	$0.07	NA	$0.08
1978	$0.09	NA	$0.10
1981	$0.13	NA	$0.135
1982	$0.13	NA	$0.155
1-Jul-85	$0.15	NA	$0.165
1-Jan-86	$0.16	NA	$0.170
1987	$0.16	NA	$0.185
1988	$0.18	NA	$0.205
1989	$0.20	$0.19	$0.225
1-Jul-02	$0.201	$0.19	$0.225
1-Jul-03	$0.203	$0.19	$0.225
1-Jul-04	$0.205	$0.19	$0.225
1-Jul-05	$0.207	$0.19	$0.225
1-Jul-06	$0.210	$0.19	$0.225
1-Jul-07	$0.207	$0.19	$0.225
1-Jul-08	$0.210	$0.19	$0.225
1-Mar-15*	$0.310	$0.29	$0.325

Note: the current fuel tax rates reflect Senate File 2403 that adjusted rates in July 2020.

2.6.2 Electric Vehicle Registration Fees

Following Iowa DOT's 2018 *Report on the Impact of Electric Vehicles to the Road Use Tax Fund*, House File 767 was passed which added new annual registration fees for BEVs, PHEVs, and motorcycles that are electric or plug-in hybrid. The fees are intended to help sustain transportation funding in Iowa as fuel tax revenues decrease due to the rise of electric and hybrid vehicles. These fees established in House File 767 are additive to the standard annual registration fees assessed based on the vehicle's weight and value, or in the case of motorcycles, model year.[27]

The fee levels were calculated so that electric and hybrid vehicles contribute approximately the same amount to the RUTF as vehicles with internal combustion engines; in other words, the fees reflect what a vehicle would pay in annual fuel tax, minus what EVs pay in charging fees (per kilowatt-hour) when charging away from home. The fees were phased in over three consecutive years, with the first additional fee required starting January 1, 2020. **Table 2-13** provides the fee schedule by vehicle type and year.

[27] https://iowadot.gov/mvd/ctmanual/memos/IM19-27.pdf

Table 2-13: House File 767: Registration Fee Increases for Electric Vehicles

Vehicle Type	Fee Effective January 1, 2020	Fee Effective January 1, 2021	Fee Effective January 1, 2022
Battery electric (BEV)	$65.00	$97.50	$130.00
Plug-in hybrid electric (PHEV)	$32.50	$48.75	$65.00
Motorcycle (battery electric or plug-in hybrid electric)	$4.50	$6.75	$9.00

At the time the legislation passed, it was estimated these registration fees would generate $185,000 in FY 2020, $485,000 in FY 2021, $647,000 in FY 2022, $872,000 in FY 2023, and nearly $1.2 million in FY 2024 (the first full year of the ultimate fee increase).[28] Based on Iowa DOT's EV / PHEV Supplemental Fee Reports,[29] the actual revenue collected has been slightly higher than the original estimates. For FY 2020, the total fees collected were $282,264 (about $100,000 more than projected) and through June 2021, revenue collected was $430,014, which is about $50,000 less than the forecasted amount for the full year.

House File 767 also introduced the concept of "electric fuel" and established a tax of 2.6 cents per kilowatt-hour for "electric fuel delivered or placed into the battery or other energy storage device of an electric motor vehicle at a location…other than a residence." The tax is scheduled to go into effect on July 1, 2023.

According to the 2018 *Report on the Impact of Electric Vehicles to the Road Use Tax Fund*, it was estimated that over 80 percent of EV charging currently occurs at a driver's residence. Since it is difficult to distinguish the power consumed for charging from other household electrical loads, taxing residential EV charging is not likely to be a feasible source of revenue.

The legislation may need to be updated to keep pace with the evolution of charging technology, such as the introduction of swappable batteries. In September 2021, a consortium of four Japanese and European motorcycle companies announced the formation of the Swappable Batteries Motorcycle Consortium (SBMC).[30] The group intends to standardize removable battery packs for electric motorcycles, mopeds, and scooters. The group's current work covers battery capacities of up to 11 kilowatts along with charging systems and infrastructure supporting the exchange of discharged batteries for ones that have been fully charged. Retail outlets such as convenience stores would offer the service.

Battery swapping systems for automobiles have also been proposed. For example, in March 2021, a California startup announced that it is working with "five of the 10 largest" automakers to establish swappable modular EV batteries. The business claims its system allows battery swaps to be completed in about 10 minutes, which is on par with the time required for fueling a conventional vehicle.

[28] https://www.legis.iowa.gov/docs/publications/FN/1046918.pdf
[29] https://iowadot.gov/mvd/FactsandStats#vehiclestats
[30] https://hondanews.eu/eu/en/motorcycles/media/pressreleases/345405/swappable-batteries-motorcycle-consortium-agreement-signed-between-honda-motor-ktm-fande-piaggio-gro

Although battery swapping services may fall within the scope of the $0.026 per kilowatt hour tax, it might be desirable to clarify this in future legislation. A potentially competing theory is that the transaction is subject to state sales and use tax, similar to the rental or sale of any other battery. Since retail prices for battery swapping have not yet been established, it is unclear which taxation approach would generate more revenue.

2.7 Estimated Future Funding Gap

Based on the analysis described in the prior sections, the State of Iowa has been and will continue to face a funding shortfall for roads and bridges. For the purposes of this report, the estimated future funding shortfall is based on Iowa DOT's 2021 RUFT Study.[31] Based on cost projections for administration, maintenance, and construction needs for city, county, and state roads and bridges and forecasts for federal, state, and local revenue sources, it was estimated that over the next 20-years the total funding shortfall would be $15.620 billion, with the counties experiencing the largest share of the shortfall at $9.269 billion. The 2021 RUTF Study also looked at just the stewardship needs across the state – the projects that would extend the life and modernize existing infrastructure without adding capacity.[32] The projected funding shortfall for stewardship needs is approximately $5.754 billion. On an average annual basis, the funding shortfall for all road and bridge projects would be $781 million per year, and the average annual shortfall for stewardship projects would be $288 million. The average annual shortfall totals were used to support the evaluation of potential funding sources in **Section 4.**

Table 2-14: Projected Shortfall for Iowa's Public Roadway System, 2021-2040 (YOE $, in millions)

	City (millions)	County (millions)	State (millions)	20-Year Total (millions)	Average Annual (millions)
Projected total needs	$26,830	$28,062	$32,757	$87,649	$4,382
Projected total revenues	$24,691	$18,793	$28,545	$72,029	$3,601
Projected total shortfall	($2,139)	($9,269)	($4,212)	($15,620)	**($781)**
Projected stewardship needs				$77,783	$3,889
Projected stewardship shortfall				($5,754)	**($288)**

[31] http://publications.iowa.gov/39691/1/RUTF%20Study%202021.pdf

[32] Capacity projects in the 2021 RUTF Study include projects that would add lane miles to the system- either additional lane capacity on existing roadways, or new roadways and roadway extensions.

3 Potential Sources: What are Other States Doing?

Iowa is not alone in looking for solutions to address the decrease in fuel tax revenue and the reduction in purchasing power for all transportation funding sources. Over the last several years, states around the country have evaluated and, in some cases, implemented new funding sources or adjusted existing funding sources. However, to date, no state has identified and implemented a single source to address the declines in fuel tax revenue and associated reduction in the purchasing power due to the increase in construction costs.

To provide context in terms of how other states currently fund transportation, **Table 3-1** provides a summary of the primary funding source categories that are used across the country based on the National Conference of State Legislatures (NCSL) *50-State Review of State Legislatures and Departments of Transportation.*[33] The table also highlights which categories are currently used within Iowa as well as those that are not which includes toll revenue, general sales tax revenue, and the State's general fund. Descriptions of new funding sources or adjustments to existing funding sources that have been considered or have been recently implemented by other states are provided after the table.

Table 3-1: Existing State Funding Source Categories

Funding Source Categories	Total No. of States	Used in Iowa
Fuel Tax	50	Yes
Passenger Vehicle Fees	42	Yes
Truck Registration Fees	45	Yes
Tolls	*39*	*No*
General Sales Tax	*44*	*No*
General Funds	*31*	*No*
Interest Income	45	Yes
Other Sources (oversize permit fees, logo signing, underground storage tank fees, special plates)	45	Yes

3.1 Index the Fuel Tax Rate

According to the *50-State Review of State Legislatures and Departments of Transportation,* the motor fuel tax is the largest single source of state transportation revenue. This dependence on fuel tax revenues has contributed to the current transportation funding crisis nationwide. Like the experience in Iowa, over the past decade, fuel tax revenues have fallen in real terms due to more fuel-efficient vehicles and changing driving behaviors. Further, the federal fuel tax and many states fuel taxes have remained static, fixed cents-per-gallon rates that have resulted in reduced purchasing power as construction costs have continued to increase over time.

[33] http://www.financingtransportation.org/pdf/50_state_review_nov16.pdf

However, 22 states and Washington, D.C., have implemented a variable-rate fuel tax (indexing) that adjusts with inflation, prices, or construction costs without regular legislative action, to offset a portion of the reduced fuel tax revenue purchasing power. **Table 3-2** summarizes the indexing approaches used by other states.[34]

Table 3-2: States that Index Fuel Tax Rates

State	Index Structure	Year of Last Increase
Alabama	Tax indexed annually to the National Highway Construction Cost.	2019
Arkansas	Tax based on the average wholesale price of gas and diesel, with a floor (prevents the tax from dropping if the 12-month average wholesale price of fuel is less than the previous year) and a ceiling (limits the increase to no more than 0.1-cent per gallon.	2019
California	Tax varies with inflation.	2020 (per 2017 legislation)
Colorado	Beginning in fiscal year 2032-33 the 8-cent road user fee, which is levied on gasoline, will be indexed to Highway Construction Cost Index inflation.	(2032) (per 2021 legislation)
Connecticut	Tax varies with gas prices.	2013
Florida	Tax varies with CPI.	2015
Georgia	Tax varies with vehicle fuel-efficiency and CPI.	2015
Hawaii	Variable rate only because general sales tax applies to gas.	**
Illinois	Tax varies with CPI.	
Indiana	Tax varies with inflation and general sales tax applies to gas.	2017
Kentucky	Tax varies with gas prices.	2015
Maryland	Tax varies with gas prices and CPI.	2013
Michigan	Tax varies with inflation.	2022 (per 2015 legislation)
Nebraska	Tax varies with gas prices and appropriation decisions.	2016
New Jersey	Tax varies with gas prices and revenue collection.	2016
New York	Tax varies with gas prices.	2013
North Carolina	Tax varies with population and CPI.	2015
Pennsylvania	Tax varies with gas prices.	2015
Rhode Island	Tax varies with CPI.	2015
Utah	Tax varies with gas prices and CPI.	2015
Vermont	Tax varies with gas prices.	2015
Virginia	Tax varies with CPI.	2020
West Virginia	Tax varies with gas prices.	2017
D.C.	Tax varies with CPI.	2020

[34] https://www.ncsl.org/research/transportation/variable-rate-gas-taxes.aspx

Additionally, there are two examples of states passing major transportation funding legislation to both increase existing fees and establish new fees. In both examples indexing the fuel tax rate was an element of the larger funding legislation.

- **Colorado Senate Bill (SB) 21-260: Sustainability of the Transportation System.**[35] It is estimated that new and expanded fees in this legislation will provide over $5 billion in new transportation revenue over the next 10 years and nearly $950 million in new funding will go directly to local governments. The new funding will be generated through combination of changes to existing fees and the implementation of new fees. Related to fuel tax rates, SB 21-260 included the following new fee rates that charged to the fuel distributors and with the rates indexed to inflation based on the National Highway Construction Cost Index (NHCCI).
    - **Road Usage Fee**: Each fuel distributor that pays excise taxes on gasoline and special fuels must also collect a Road Usage Fee. This fee is paid per gallon of gasoline and diesel, and starts at $0.02 in 2021, increases $0.01 per year and reaches $0.08 in 2032. Beginning in FY 2032-2033, this fee will be annually adjusted for inflation based on the NHCCI. Revenue from the Road Usage Fee is credited to the State's Highway Users Tax Fund (HUTF).
    - **Bridge and Tunnel Impact Fee**: Each fuel distributor that pays excise taxes on special fuels must also collect the Bridge and Tunnel Impact Fee, which is deposited in the Statewide Bridge Enterprise Special Revenue Fund. The fee starts at $0.02 in 2021, increases $0.01 per year and reaches $0.08 in 2032. Beginning in FY 2032-2033, this fee will be annually adjusted for inflation based on the NHCCI.
- **California SB 1: The Road Repair and Accountability Act of 2017.**[36] SB 1 increased several taxes and fees to raise over $5 billion annually in new transportation revenues. A key element of SB 1 is the inclusion of inflationary adjustments so that the purchasing power of the revenues does not diminish as it had in the past in California. SB 1 prioritizes funding towards maintenance and rehabilitation and safety improvements on state highways, local roads, and bridges, and to improve the state's trade corridors, transit, and active transportation facilities.[37] With regards to fuel tax rates, SB 1 increased the gas excise tax by $0.12, increased the diesel excise tax by $0.20, and increased the diesel sales tax by 4 percent. Additionally, the gas and diesel excise tax rates are adjusted annually based on the CPI.

A final fuel tax rate increase example is the State of Missouri's Senate Bill 262 that passed in 2021 and increases the State's current fuel tax rate over the following five years. Specifically, beginning in October 2021 the current motor fuel tax rate ($0.17) will be increased by two and one-half cents per year and will be $0.295 starting in July 2025. This legislation also included a rebate program to offset the impact of the annual rate increases. Owners of vehicles weighing less than 26,000 pounds are eligible to receive a refund of the tax increases on an annual basis. The rebate is not cumulative over the five-year period; it is limited to an annual 2.5 cent

[35] http://leg.colorado.gov/sb21-260-bill-summary
[36] https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB1
[37] https://www.counties.org/post/sb-1-road-repair-and-accountability-act-2017

incremental increase. Vehicle owners must fill out a rebate form that documents where the fuel was purchased, gallons purchased, and sales tax charged. Vehicle owners must also keep receipts for three years.[38]

Missouri's rebate approach is like what South Carolina implemented in 2017. For the 2020 rebate filing season, more than 79,000 South Carolinians returned claimed forms and received an average rebate of $43.05, which totaled $3.4 million in rebates statewide.[39] While the legislation offered the political benefit of providing residents the opportunity to be reimbursed for the fuel tax increase, only a small portion of the state drivers are taking advantage of the opportunity.

3.2 Sales Tax

At least 32 states have enacted legislation dedicating taxes derived from selling, leasing, renting, or using a passenger vehicle to transportation purposes. Additionally, 8 states dedicate a portion of their general sales to support transportation investments.[40]

- 19 states dedicate sales taxes imposed on car rentals: Arizona, Arkansas, Colorado, Florida, Hawaii, Iowa, Maine, Minnesota, Montana, New York, North Carolina, Pennsylvania, Rhode Island, South Dakota, Vermont, Virginia, Washington, West Virginia, and Wyoming.
- 18 states dedicate sales taxes imposed on the purchase or lease of a vehicle: Connecticut, Iowa, Kansas, Kentucky, Massachusetts, Minnesota, Missouri, Nebraska, New Jersey, New Mexico, North Carolina, Oregon, Pennsylvania, South Carolina, South Dakota, Texas, Vermont, Virginia, Washington, and West Virginia.
- 8 states dedicate a portion of their general sales taxes: Arkansas, Kansas, Michigan, Minnesota, Pennsylvania, Texas, Virginia, and Utah.
    - Arkansas and Virginia dedicate a portion of sales tax rates.
    - Michigan and Minnesota dedicate a percentage of tax revenues from the purchase of automobile parts, accessories, and equipment.
    - Kansas, Michigan, Pennsylvania, Texas, and Utah specify a percentage of tax revenues for transportation.
- 2 states impose a tax on the gross earnings of certain companies in the transportation sector: Connecticut and New York.

[38] https://dor.mo.gov/faq/taxation/business/motor-fuel-senate-bill-262.html
[39] https://dor.sc.gov/communications/gather-your-receipts-for-the-state%E2%80%99s-motor-fuel-income-tax-credit
[40] https://legislature.maine.gov/doc/3444

3.3 Tolling

According to the NCSL,[41] a total of 42 states, the District of Columbia, and Puerto Rico have some form of tolling authorization or facility.

- 28 states and Puerto Rico have toll facilities operated by statewide entities.
- 14 states have toll facilities operated by regional entities.
- 20 states and Puerto Rico have privately operated toll facilities.
- 9 states (including Iowa) and the District of Columbia authorize tolling but have no state or regional toll facilities currently.

The following provides two tolling examples that may support future discussions of tolling in Iowa:

- **Wyoming I-80 Corridor:** In the summer of 2019, an interim committee was established to study tolling on Interstate 80 and proposing legislation in the 2020 session. Results of the study recommended:[42]
    - Applying to the FHWA for the Interstate Reconstruction and Rehabilitation Pilot (IRRP) Program. The IRRP Program allows a state to collect tolls on a facility on the Interstate System to reconstruct or rehabilitate an interstate highway corridor that could not otherwise be adequately maintained or functionally improved without the collection of tolls.[43]
    - Requesting approval from the legislature to grant tolling authority to the Wyoming Department of Transportation (WYDOT), authorizing bonding and loans to initiate work before tolling commences and allowing WYDOT to complete a tolling master plan and developing financial strategies.

    Two toll-related bills were proposed to the Wyoming State Legislature in early 2020 but neither one advanced.

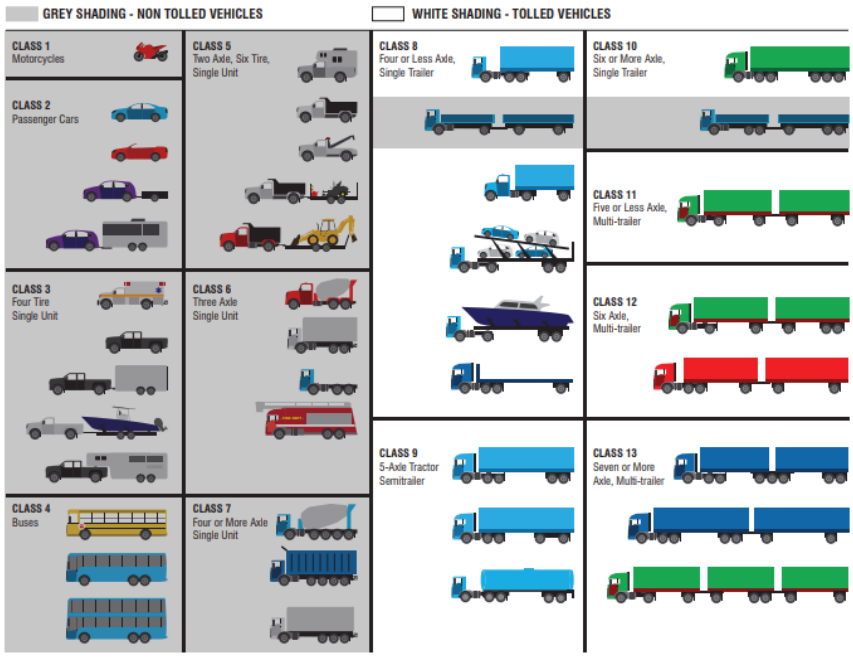
- **Rhode Island's RhodeWorks Tolling Program:**[44] This program is a unique approach to repairing bridges by tolling only specific types of tractor trailers shown in **Figure 3-1**. The tolls collected at each location will go to repair the bridge or bridge group associated with that toll location. The tolling program is part of the RhodeWorks legislation, which became law in February 2016 to rebuild Rhode Island's infrastructure. RhodeWorks provides for the planning, execution, management, and funding to bring the state's roads and bridges into a state of good repair by 2025. The full budget for RhodeWorks is about $4.9 billion over ten

[41] https://www.ncsl.org/research/transportation/toll-facilities-in-the-united-states.aspx
[42] https://www.wyoleg.gov/InterimCommittee/2019/08-2019081215-02I-80TollingAppendixA.pdf
[43] https://www.fhwa.dot.gov/ipd/pdfs/tolling_and_pricing/interstate_rr_fact_sheet.pdf
[44] http://www.dot.ri.gov/tolling/index.php

years, and about one tenth of that amount will come from the tolling program. The RhodeWorks law prohibits tolls on cars and small trucks.

Tolls are collected along six major highway corridors at 12 locations. Each location is associated with a bridge or bridge group. The toll rates vary from site to site, ranging from $2.25 to $9.50. The median cost is $5.63. For radio frequency identification equipped tractor trailers (e.g., E-ZPass), tolls are limited to once per day per direction, and there is a cap of $20 for a through-trip on I-95 as well as a daily cap of $40 per day no matter how many tolls a tractor trailer goes through. Toll collection began in June 2018.

Figure 3-1: RhodeWorks: Truck Types Tolled

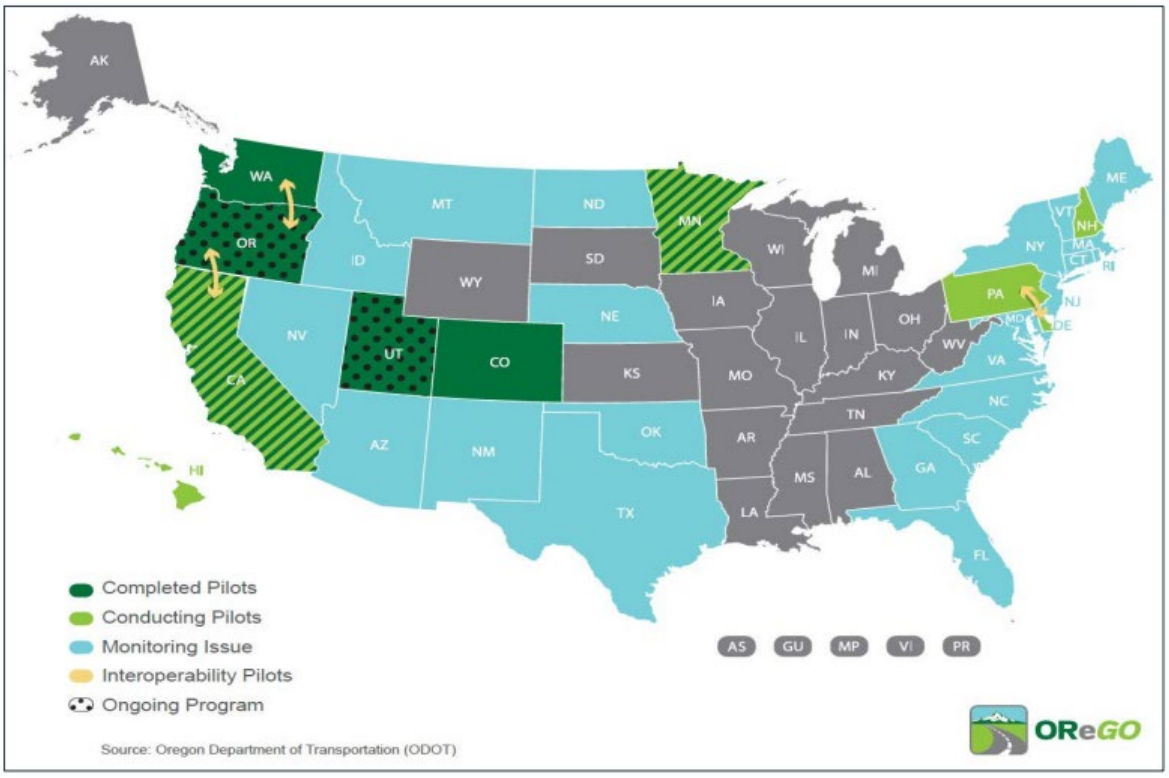


3.4 Mileage-Based User Fees

A mileage-based user fee, sometimes called a mileage fee, a VMT fee, or RUC, is a fee charged to drivers based on the distance driven. This transportation funding mechanism seeks to more closely link transportation taxes to the actual use of the roadways by a driver, as compared to traditional fuel taxes. As shown in **Figure 3-2**, since 2013 at least 10 states have enacted studies or pilot programs examining the feasibility of a milage-based user fee at both the state level and regional (multiple states) level. These efforts have been supported by the federal government through the FHWA's Surface Transportation System Funding Alternatives (STSFA) grant program, which provides funding to evaluate alternative transportation funding mechanisms such as a mileage-based user fee.[45] So far, no single state has transitioned from the fuel tax to a mileage-based user fee, but several states are taking the results of their research to develop system design and transition strategies. Descriptions of mileage-based user fee pilot projects are provided after the figure.

[45] https://www.ncsl.org/research/energy/new-fees-on-hybrid-and-electric-vehicles.aspx

Figure 3-2: Milage-Based User Fee Research Status



- **Oregon**: Oregon has been a leader in researching and implementing mileage-based user fee pilot programs dating back to 2001 when the Oregon Legislature formed the Road User Fee Task Force. Through the task force, the state identified a per-mile fee as the best of 28 alternatives to a gas tax, and Oregon launched pilot programs in 2006 and 2012. The first pilot program lasted 12 months and included 285 volunteer vehicles outfitted with a temporary short-range communication device. The state developed the fee to be revenue neutral relative to the gas tax. More specifically, the state calculated that a flat $0.012 per-mile fee would generate the same total revenue as the $0.24 per gallon gas tax and chose to collect payment at the gas pump to ease the transition. The key findings from the first pilot program were:[46]
    - The concept is viable.
    - Paying at the pump works.
    - The mileage-based fee can be phased in.
    - Integration with current systems can be achieved.
    - Congestion and other pricing options are viable.
    - Privacy is protected.

[46] https://www.myorego.org/wp-content/uploads/2017/07/RUFPP_finalreport.pdf

- The system would place minimal burden on business.
- Potential for evasion is minimal.
- Cost of implementation and administration is low.

The second pilot program focused on addressing privacy concerns raised by the public. Specifically, the second pilot program included open architecture, no mandate for location-based technology, motorist choice of reporting mechanism, and private sector involvement for data collection and analysis.[47] The program ran from November 2012 to March 2013 and included 88 drivers from three states. Drivers were charged $0.0156 per mile, which resulted in generating revenue that was 28 percent higher than would have been paid through gas tax.

Following successful completion of the second pilot program, the Oregon Senate passed Bill 810, which authorized a per-mile road usage charge program for up to 5,000 volunteers to be implemented by July 1, 2015. The road usage charge program is called OReGO. The bill reflected the policy evolution, lessons learned, and stakeholder input gathered over the course of the two pilot programs. Specific policy provisions included:[47]

- Inclusion of up to 5,000 volunteer light vehicles registered in Oregon, with no more than 1,500 vehicles having a fuel efficiency rating of less than 17 mpg, and no more than 1,500 vehicles with a fuel efficiency rating between 17 and 22 mpg.
- A road usage charge rate of $0.015 cents per mile for travel on public roads in Oregon to be paid by volunteer owners or lessees.
- A refund/credit of Oregon fuels tax paid by these motorists, attributable to taxable miles charged and paid.
- Refunds for travel on private roads in Oregon.
- Choices for volunteers to select from multiple methods for how their billable mileage will be collected and reported.
- The establishment of an integrated, open-systems architecture for technology components of the Road Usage Charge Program, utilizing common standards and a published operating system that will enable components provided from different sources to be readily substituted or supplied by multiple providers.
- The establishment of contracted private sector partners under statutes and guidelines of the Oregon Innovative Partnerships Program to provide volunteers the option of private sector administration for their participation.
- The protection of personally identifiable information from disclosure and the elimination of all location-based and daily metered use data according to strict timelines unless the volunteer consents to retention.

[47] https://www.myorego.org/wp-content/uploads/2017/07/RUCPP-Final-Report.pdf

- Enforcement of the new law via penalties for false statements, non-payment, and tampering with the in-vehicle technology.

Starting January 1, 2020, OReGO introduced an incentive to register drivers of electric and high-mpg vehicles (40 mpg or better). Oregon's electric and high-mpg vehicle registration fees increased in 2020 and are planned to increase again in 2022, but drivers who enrolled in OReGO are exempt from the registration fee increases.[48]

Other recent adjustments to OReGO include removing the 5,000-vehicle cap, restricting volunteers to vehicles that get 20 mpg or better (the breakeven point compared to gas tax), and increasing the fee to $0.018 per mile.[49] The program is still considered a success, but to date the state has not passed legislation to make the program mandatory for all drivers. A bill has been introduced that would require owners of new, fuel-efficient cars and trucks to pay a fee for every mile they drive beginning in 2026.[50] House Bill 2342 fee would apply only to owners of new vehicles (2027 model year or later) that do not use gas or get 30 miles or more per gallon of gasoline. Drivers would also be able to opt out of tracking their mileage and pay a flat annual fee of $400, a provision that would expire in 2030.

- **Utah:** In 2018, the state legislature instituted an alternative fuel vehicle (EV, PHEV, and gas hybrid) fee to cover a portion of those vehicles' contribution to building and maintaining Utah's transportation system since the owners pay little or no gas tax revenue compared to conventional vehicles. The alternative fuel vehicle fee, shown in **Table 3-3,** is in addition to the annual vehicle registration fee assessed on all vehicles in the State.

  At the same time the legislature established Utah's Road Usage Charge program to provide a choice for EV, PHEV, and gas hybrid vehicle owners to pay by the mile (mileage-based user fee) in lieu of paying the alternative fuel vehicle fee.

  Table 3-3: Utah Alternative Fuel Vehicle Annual Registration Fee Schedule

Alternative Fuel Vehicle Type	2021	2022
Electric	$120.00	$123.00
Plug-in Hybrid	$52.00	$53.25
Gas Hybrid	$20.00	$20.50

  Under this voluntary program, owners of electric and hybrid vehicles have two options:

  - Pay the additional alternative fuel flat fee when the annual vehicle registration is due; or
  - Enroll in the Road Usage Charge program and be charged 1.52 cents per mile up to the additional flat fee amount. Under this option, depending on the number of miles driven, an owner may pay less by than the alternative fuel fee.

  The enrollment and tracking process for the Road Usage Charge program includes:

[48] https://www.oregon.gov/ODOT/Programs/Pages/OReGO.aspx
[49] https://content.govdelivery.com/accounts/ORDOT/bulletins/24c7950
[50] https://www.oregonlive.com/commuting/2021/04/oregon-considers-making-vehicle-miles-traveled-fee-mandatory-come-2026-for-some-cars-trucks.html

- Creating an account with emovis, a third-party commercial account manager, that includes vehicle information and a valid credit or debit card to set up a prepaid wallet.
- Installing an on-board diagnostic (OBD) mileage reporting device that plugs into a vehicle's OBD port. Additionally, participants download a smartphone app and record an initial odometer reading by submitting a picture of their current odometer reading. At this point the participant is fully enrolled.
- Participants pay $0.0152 per mile which is deducted from the prepaid wallet. The prepaid wallet uses three simple concepts: an initial charge, a standard top-up charge, and a minimum threshold balance. The initial charge is $15 and is charged upon enrollment. Mileage fees will be automatically deducted from the available balance as miles are driven following the registration of a vehicle. Once the balance drops below $5 (the minimum threshold balance), the prepaid wallet will be automatically replenished with $10 per vehicle (the standard top-up charge).

  Once the account reaches the amount of the annual flat fee applicable to the vehicle type, the mileage fee charges will stop for the current 12-month registration period. Any remaining balance from the last top-up charge is carried forward to the next registration year. Both minimum threshold balance and top-up charge amounts are multiplied by the number of vehicles within the account. [51]

- **California**: With the passing of Senate Bill 1077 in 2014, California authorized a road charge pilot study to investigate a transition away from gas tax toward a mileage-based user fee. The pilot program launched in July 2016, ran for nine months, and enlisted 5,000 volunteers from across the state. Vehicle types spanned passenger vehicles, agency and business fleets, and commercial trucking,[52] which was excluded from the previously described Oregon pilot programs.

  California hired a third-party vendor for account management, used an open system to avoid proprietary technology issues, set the per-mile fee to be revenue neutral with fuel taxes ($0.018 per mile), and offered participants a wide range of reporting devices, including manual reporting, a plug-in device, smartphone with no location, smartphone with general location, in-vehicle telematics, and a commercial vehicle mileage meter. Privacy protection and data security remained top priorities. Feedback from pilot participants included:

  - 86 percent were satisfied with the mileage reporting method.
  - 74 percent were satisfied with the account manager.
  - 62 percent using technology (as opposed to manual reporting) chose a location-based mileage reporting method.
  - 73 percent said a road charge was a more equitable transportation funding solution than the gas tax.
  - 85 percent were satisfied with the pilot program overall.

[51] https://roadusagecharge.utah.gov/
[52] https://caroadcharge.com/media/j0qjsjjv/final-report-summary-a11y.pdf

In 2016, the FHWA awarded a multi-year STSFA grant to the California Department of Transportation (Caltrans) to enhance the road charge pilot program. The primary project objectives were to 1) expand education and outreach, 2) develop an organizational structure and compliance program, and 3) demonstrate a pay-at-the-pump/charging station model.[53]

- **Eastern Transportation Coalition**: The Eastern Transportation Coalition (ETC) is a partnership of 17 states and the District of Columbia dedicated to supporting the economic engine along the I-95 corridor through transportation solutions.[54] It was the first entity on the East Coast to conduct a mileage-based user fee pilot program.[55]

  The FHWA awarded the ETC an STSFA grant in 2016 to address three major items: 1) education and outreach; 2) analysis of issues associated with a mileage-based user fee; and 3) a mileage-based user fee regional pilot. The regional pilot program ran from May through July 2018. The focus areas of the pilot program were managing out of state mileage, interoperability with tolling, multi-state trucking, and value-added benefits.

  The regional pilot program registered 155 participants representing 13 of the ETC member states. Registration was by invitation only and consisted of senior staff from departments of transportation, members and staff from state legislatures and the U.S. Congress, thought leaders from national organizations, local officials, representatives from the trucking industry, toll authorities, and the media. Therefore, the pilot program served as an important step in education and outreach of stakeholders and elected officials.

  Participants were offered three choices for reporting devices: plug-in device with location, plug-in device without location, and a smartphone application with location. Plug-in device with location was the most popular, with 76 percent of participants choosing this option. Like pilots completed in Oregon and California, to address privacy concerns, the ETC hired a third-party account manager to record mileage and calculate user fees owed.

  Milage-based user rates were calculated separately for each ETC member state to provide a revenue neutral source at the state level and ranged from $0.0076 per mile in South Carolina to $0.0265 per mile in Pennsylvania. For participants who chose to forgo location-based reporting, proxies were used to distribute mileage across state boundaries. Specifically, the ETC used census data and an assumption that most out-of-state travel occurs in states bordering the participants' own states. For example, it was assumed that District of Columbia residents drive 30 percent of their miles in neighboring states, Virginia, and Maryland, at equal portions. In a District of Columbia resident's fee calculation, 70 percent of miles were charged at the District of Columbia per-mile rate, 15 percent at the Virginia rate, and 15 percent at the Maryland rate. To streamline this process, the ETC developed in-state and out-of-state rates for each member state; the out-of-state rate reflects a weighted average of the neighboring states' rates multiplied by the assumed

[53] https://caroadcharge.com/media/sr1nwy02/california_fast_act_annual_report_ffy_2017_ada.pdf
[54] https://tetcoalitionmbuf.org/
[55] https://tetcoalitionmbuf.org/wp-content/uploads/2020/07/2018-Coalition-Passenger-Pilot-Factsheet.pdf

distribution of mileage traveled in each.[56] Takeaways from the regional pilot program included:

- Participants ranked "privacy of my personal data" as a high concern dropped from 57 percent to 30 percent after the pilot.
- 94 percent of participants supported doing more research on the mileage-based user fee.
- 31 percent of participants perceived the gas tax as higher than what they actually paid.
- 5 percent of participants changed from disliking to liking the mileage-based user fee concept, bringing the total to 80 percent in favor.

The ETC was awarded subsequent STSFA grants to conduct additional pilot programs with differing emphasis areas. For example, the next pilot program expanded the geographic boundaries to include Delaware and Pennsylvania.

This pilot program enrolled 889 participants from 14 member states and the District of Columbia. The pilot ran from July through October 2019 and offered two reporting technologies: plug-in devices with and without location. For this pilot no money was collected from participants and a 19 percent administration and compliance fee was added to each per-mile rate.[57] Takeaways from the 2019 pilot program included:[58]

- 67 percent of participants supported implementation of a mileage-based user fee.
- Participants that ranked "privacy and security of my personal data" as a high concern dropped from 49 percent in the original pilot study to 20 percent.
- 69 percent of participants were more aware of the amount they paid in fuel tax after the pilot.

The ETC conducted a third pilot program to investigate a mileage-based user fee specifically in the context of the trucking industry. This pilot took place from October 2018 through March 2019 and included 55 class 8 tractor-trailers, representing 4 motor carrier fleets, that traveled more than 1.4 million miles across 27 states. Once again, ETC calculated a revenue neutral rate relative to each state's diesel excise tax using a truck fuel efficiency of 6 mpg. Among the 27 visited states, rates ranged from $0.0333 per mile in South Carolina to $0.1235 cents per mile in Pennsylvania. On-board units that are used to collect data to provide regulatory and commercial services and to monitor driver and fleet performance, were used to collect location data to assess relevant charges. Throughout the

[56] https://tetcoalitionmbuf.org/wp-content/uploads/2020/07/2018-Coalition-Passenger-Pilot-Final-Report.pdf
[57] https://tetcoalitionmbuf.org/wp-content/uploads/2021/03/TETC-2019-Passenger-Vehicle-Pilot-Report-1.pdf
[58] https://tetcoalitionmbuf.org/wp-content/uploads/2020/07/2019-Coalition-Passenger-Pilot-Factsheet.pdf

pilot, statements were provided to each of the four carriers for informational purposes only; no fees were collected.[59] The takeaways from the trucking industry pilot program included:

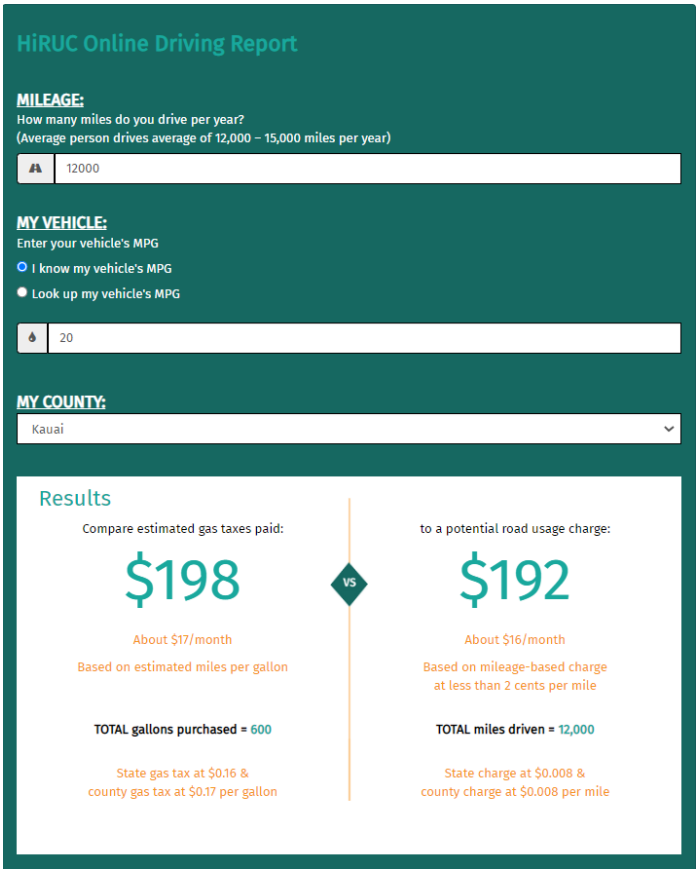
- Bringing the trucking industry's voice to the table is essential.
- Trucks cannot simply be treated as big cars in a mileage-based user fee system.
- Existing regulations provide guidance for mileage-based user fee implementation.
- One rate for all trucks does not work.
- There is a need for further education and outreach.

The ETC continues to study implementation of a mileage-based user fee for trucks. With a goal of registering 200 participants, the ETC launched the first national truck pilot project in October 2020 that concluded in March 2021. The objectives of the study were to expand the pilot footprint nationally, explore alternative rate structures in partnership with the trucking industry, continue analyzing the feasibility of integrating mileage-based user fees into existing regulatory frameworks, and provide a more comprehensive view of motor carrier cost complexity (e.g., tolls, fuel, state and federal fuel tax, tire tax, and other taxes and fees). Results for the national truck pilot project are not yet available.[60]

- **Hawaii**: Hawaii's Department of Transportation started a community outreach and demonstration project in 2018, called the Hawaii Road Usage Charge (HiRUC) with a goal of gathering community input through focus groups, telephone surveys and community outreach meetings.[61] In a subsequent phase, the community provided feedback about a customized driving report comparing what they would pay under the road user charge with the amount they currently pay in fuel taxes. Key findings from this research included:
  - Of the approximately 40,000 residents that responded to the invitation to participate in a driver preference survey, 86 percent said they would prefer to have their mileage charges based on odometer data from the state's existing vehicle inspection program, 10 percent said they would prefer an onboard device that reports mileage automatically, and 4 percent preferred to upload photos of their odometer periodically through a mobile phone app.
  - 1,896 volunteers participated in a pilot project where they chose one of three different technologies to report the miles they drove and provided feedback on their experience. In all, the volunteers drove more than 4 million miles. The volunteers received regular reports comparing what they pay in gas taxes and what they would pay with a per mile usage.
  - Based on the completed research, an online tool comparing fuel tax cost and potential road user charge fee costs was developed and is shown in **Figure 3-3**.

[59] https://tetcoalitionmbuf.org/wp-content/uploads/2020/08/TETC_Phase2_Truck-Pilot_Evaluation_Report_FINAL_REV_20200811.pdf
[60] https://tetcoalitionmbuf.org/wp-content/uploads/2020/08/2020-Coalition-Truck-Pilot-Overview.pdf
[61] https://hiruc.org/

Figure 3-3: Hawaii Department of Transportation Estimated Fuel Tax and Potential RUC Comparison Tool



- **Federal Government Involvement**: As stated earlier, the federal government is an active partner in evaluating the future implementation of a mileage-based user fee. Historically, FHWA has awarded discretionary grants for pilot projects through the previously mentioned STSFA program. As part of the IIJA, this program has been renamed the Strategic Innovation for Revenue Collection and will provide $75 million for additional completive grant opportunities for mileage-based user fee pilot projects over the next five years. Grants are available for pilot projects at the state, local and metropolitan planning organization level. Additionally, the federal share for a new pilot project is 80 percent, while the federal share for recipients who previously received an STSFA grant is 70 percent.

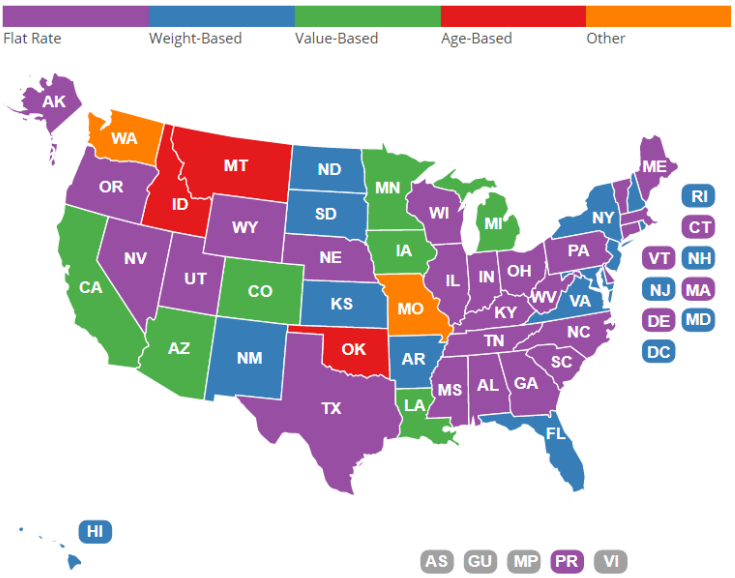
  Additionally, IIJA includes a new $50 million program, the National Motor Vehicle Per-Mile User Fee Pilot Program that directs the USDOT to implement a nationwide pilot project that will solicit volunteer participants from all 50 states, including commercial and passenger vehicles. The legislation requires the pilot program to offer different methods for participants to track their mileage and directs USDOT to set annual per-mile fees for different types of vehicles.

  Finally, the IIJA explicitly requires USDOT to submit a report to Congress in 2024 with recommendations on a national alternative revenue mechanism based on results from the various state mileage-based user fee pilot projects.

3.5 Traditional and Alternative Vehicle Registration Fees

Every state has a process by which vehicles and/or trucks are registered and titled. Determination of fee structures varies by state and can be based on a flat rate, or dictated by weight, value, age, as well as other factors. Flat rate fees are the most common among all states. **Figure 3-4** shows how each state determines its respective registration and title fee structure.[62]

Figure 3-4: Registration and Title Fees by State



Depending on state policy, the revenue from these registration fees can be directed toward transportation or to the State's general fund. Most states restrict using registration fee revenue to transportation projects; however, Alaska and Georgia allocate their vehicle registration fee revenues to their respective general funds.[63]

According to the NCSL,[64] since 2017, at least 12 states: Arizona, California, Connecticut, Illinois, Indiana, Oregon, South Carolina, Tennessee, Utah, West Virginia, Wisconsin, and Wyoming have enacted legislation to increase registration fees for passenger vehicles. Examples of these increases include: $5 in Connecticut, $10 in Wisconsin, $15 in Indiana, $21.50 in West Virginia, $32 in Arizona, $50 in Illinois, and up to $250 in South Carolina for an initial registration.

Meanwhile, other states have indexed vehicle registration fees to the consumer price index (CPI). California's SB 1 an annual Transportation Improvement Fee that ranges from $25 to $175 based on vehicle value with the fee indexed to CPI. Oregon also indexed vehicle registration fees, and via Oregon House Bill 2017, implemented a tiered registration fee based

[62] https://www.ncsl.org/research/transportation/registration-and-title-fees-by-state.aspx
[63] https://www.fhwa.dot.gov/ipd/value_capture/traditional_transportation_revenue/state.aspx
[64] https://www.ncsl.org/documents/statefed/NCSL-Testimony-Senate-Environment-and-Public-Works-Committee04-14-21.pdf

on vehicle mpg. This translates to an 83 percent higher fee for a vehicle with a fuel efficiency of 40 mpg compared to a vehicle with a fuel efficiency of 19 mpg. Finally, in 2018, Utah's SB 136 increased annual registration fees from $46.50 in 2019 to $93 in 2021 and indexed the fee to CPI if the CPI in the prior year was positive or maintained the prior year registration fee rate if the CPI was negative in that year.[65]

State are also implementing or refining registration fees for EVs and PHEVs. According to research by the NCSL:[66]

- Thirty states have laws requiring a special registration fee for EVs. Of those, 14 states also assess a fee on PHEVs. These fees are typically in addition to traditional motor vehicle registration fees.
- Ten states—Alabama, Arkansas, Hawaii, Illinois, Iowa, Kansas, North Dakota, Ohio, Washington, and Wyoming—enacted laws in 2019 amending or adding new fees for EVs and PHEVs, more than any previous year. As of November 2020, 28 states have laws requiring a special registration fee EVs. Of those, 14 states also assess a separate, slightly lower fee on PHEVs.
- The fees range from $50 per year in Colorado, South Dakota, and Hawaii to $225 for a plug-in electric vehicle in Washington. Alabama, Arkansas, Ohio, and Wyoming all enacted bills in 2019, setting or increasing fees for electric vehicles to $200 annually. Most recently, Oklahoma and South Dakota both enacted legislation in 2021 to impose new EV fees. South Dakota now imposes a flat $50 fee for all EVs, while Oklahoma has tiered EV fees based on vehicle weight, with a $110 fee for EVs under 6,000 pounds. Idaho introduced legislation in April 2021, currently pending, that would increase the state's EV registration fee from $140 to $300 annually. If enacted, it would also create an alternative 2.5 cents per mile fee system, which drivers can pay in lieu of the $300 fee.
- Revenue from these additional fees is most often directed toward a state transportation fund. However, a few states also allocate some fee revenue to support electric vehicle infrastructure. For example, Alabama allocates $50 of its $200 fee for new electric vehicle infrastructure and Washington added an additional $75 fee in 2019 to support charging stations. Colorado dedicates $20 of the $50 EV fee to the Electric Vehicle Grand Fund to support charging stations.
- Fourteen states also impose a fee for PHEVs. Examples include Iowa's $48.75 fee, and $100 fees in Alabama, Arkansas, Ohio, and West Virginia. South Carolina is the only state without an annual fee, and instead requires a payment of $120 for EVs and $60 for PHEVs, every two years.
- Six states—California, Colorado, Indiana, Michigan, Mississippi, and Utah—structure the additional EV and PHEV registration fees to grow over time by tying the fees to the CPI or another inflation-related metric. In Colorado, as part of SB 21-261, the EV registration fee will annually increase based on inflation plan an amount that is estimated to achieve parity

[65] https://le.utah.gov/~2018/bills/static/SB0136.html
[66] https://www.ncsl.org/research/energy/new-fees-on-hybrid-and-electric-vehicles.aspx

between the aggregate amount of motor vehicle registration fees and motor fuel excise taxes paid per vehicle by owners of EVs and vehicles fueled by gasoline, diesel, or other special fuels.

3.6 Emerging Mobility and E-Commerce Fees

Emerging technologies are beginning to have a significant impact on the way people and goods are transported. A practical example of this can be found in existing transportation network companies (TNC), such as Lyft and Uber. Several public agencies have explored and even implemented fees based on the way these companies operate, charging a per-ride fee (as a percentage of the fare or a flat rate) or taxing the operators themselves. **Table 3-4** shows a breakdown of existing tax and fee structures implemented by states in recent years.[67]

Table 3-4: Existing State Level TNC Taxes or Per Trip Fees

State	TNC Tax/Fee	Implemented	Disposition of Funds
Alabama	1% of total fare	2018	50% to Public Service Commission regulator
			50% to trip-originating cities and counties
California	0.33% of total TNC revenue	2013	100% to California Public Utilities Commission Transportation Reimbursement Account
Connecticut	$0.25 per trip	2018	General fund
Hawaii	4% of total fare	2018	General fund
Maryland	State law allows individual counties and municipalities to impose their own per-trip assessments up to $0.25	2015	100% to State Transportation Network Assessment Fund
Massachusetts	$0.20 per trip	2016	50% to trip-originating city's infrastructure
			25% to taxi industry assistance
			25% to Commonwealth Transportation Fund
Nevada	3% of total fare	2015	100% to State Highway Fund up to $5 million in a two-year period, then deposits into State General Fund
New York	4% of total fare on trips originating outside New York City	2017	100% to state general fund
	2.5% of total fare	2014	100% to Black Car Fund workers' compensation insurance
Rhode Island	7% of total fare	2016	General fund
South Carolina	1% assessment on total fare	2015	1% to Office of Regulatory Staff
			99% to State Treasury Trust / Agency Fund
South Dakota	4.5% of total fare	2017	General fund
Wyoming	4.% of total fare	2017	69% to state general fund
			31% to local governments

[67] https://www.enotrans.org/eno-resources/eno-brief-taxing-new-mobility-services-whats-right-whats-next/

As part of the package of fees included in Colorado's SB 26-261, the following fees related to TNCs and e-commerce deliveries, such as Amazon or Grubhub, were approved and dedicated for transportation uses:

- **Retail Delivery Fees**: SB 21-260 imposed new fees on retail deliveries that are subject to the state sales tax. This fee is assessed by the state and provides funding for the Colorado Department of Transportation's primary transportation funds (HUTF and Multimodal Transportation and Mitigation Options Fund), the existing Statewide Bridge and Tunnel Enterprise, and four new enterprises that were created as part of SB 21-261. The initial fee per delivery rates are shown in **Table 3-5**. In subsequent years, these fees will be adjusted for inflation based on the Denver-Aurora-Lakewood CPI. The fees will only be adjusted for inflation in future years if the sum of the adjustments to all the fees results in an increase of at least 1 whole cent.

Table 3-5: Colorado SB 262: Retail Delivery Fee Rates

Retail Delivery Fees by Fund/Enterprise	FY 2022-2023 Fee / Delivery Rates
State (Highway Users Tax Fund and Multimodal Transportation and Mitigation Options Fund)	8.4 cents
Bridge and Tunnel Enterprise	2.7 cents
Community Access Enterprise	6.9 cents
Clean Fleet Enterprise	5.3 cents
Clean Transit Enterprise	3.0 cents
Air Pollution Mitigation Enterprise	0.7 cents
Total of Retail Delivery Fees	**27.0 cents**

- **Passenger Ride Fee:** SB 21-260 created a new fees per passenger ride for TNC services. The passenger ride fees will be provided funding for the new Clean Fleet Enterprise and the new Nonattainment Area Air Pollution Mitigation Enterprise. The initial fee rates are shown in **Table 3-6** and includes a discounted rate for pooled rides or rides provided using an EV. In subsequent years, this fee will be adjusted for inflation based on the Denver-Aurora-Lakewood CPI. The fees will only be adjusted for inflation in future years if the sum of the adjustments to all the fees results in an increase of at least 1 whole cent.

Table 3-6: Colorado SB 262: Passenger Ride Fee Rates

Ride Fees (Full Price)	FY 2022-2023 Fee Per Ride
Clean Fleet Enterprise	7.5 cents
Air Pollution Mitigation Enterprise	22.5 cents
Total of Ride Fees (Full Price)	**30.0 cents/ride**
Ride Fees (Discounted)	**FY 2022-2023 Fee Rate**
Clean Fleet Enterprise	3.75 cents
Air Pollution Mitigation Enterprise	11.25 cents
Total of Ride Fees (Discounted)	**15.0 cents**

4 Evaluation of Potential Sources

Table 4-1 summarizes the funding sources carried forward for evaluation based on the review of approaches other states have implemented to increase transportation funding and feedback from the TAC.

Table 4-1: Potential Sources Carried Forward in Evaluation Process

Potential Sources	Description
Existing Fees or Taxes	
Index Fuel Tax	Change the current fuel tax structure to increase annually based on an approved index which could be inflation (CPI), gas prices, a construction cost index, or a combination of multiple variables.
Index Annual Registration & Other Registration Fees	Change the structure of all existing fees that fund the RUTF to increase annually based on an approved index which could be inflation (CPI), gas prices, a construction cost index, or a combination of multiple variables.
Increase Fee on New Registrations	Increase fee percentage to be in line with the State's current 6 percent sales tax rate
Create Dedicated Transportation Sales Tax	Implement a dedicated transportation sales tax above the state's current 6 percent tax rate.
Mileage-Based User Fees	
Implement a VMT/ RUC Fee	Implement a fee that charges vehicle owners on a per-mile driven basis or per-ton mile driven basis.
Emerging Mobility Fees	
Implement Fee on TNC Trips	Implement a fee for all trips taken through services, such as Uber and Lyft.
Implement Fee on E-Commerce Deliveries	Implement a fee for all trips that deliver goods facilitated by online platforms, such as Amazon and Uber Eats
Agricultural Industry Related Fees	
Implement a Crop and/or Livestock Fee	Implement a fee on farm commodities, specifically per bushel of crop and/or per head of livestock.
Implement Red Dyed Diesel Fuel Tax	Implement a fuel tax on red dyed fuel which is used by agricultural equipment as well as construction equipment, railroads, barges and boats, electrical generators, and off-road vehicles. Currently red dyed fuel is tax-exempt.
Implement an Agricultural Equipment Fee	Implement a registration fee on tractors and other agricultural equipment that use rural roads and bridges.

Additionally, the following sources were considered but not carried forward for further evaluation.

- **State Appropriation or Issue Bonds Backed by General Fund Revenue**: An estimate was not generated for these two options that have been used in other states. While these options could be used to provide an immediate influx of funding for a specific major project or a program of projects, they would not address the long-term financial sustainability needs across the state. However, a current example of this approach may be of interest. The Governor of Colorado has asked the State Legislature to appropriate $100 million in the FY 2023 budget to be used as local matching funds for future federal discretionary grant programs available through the IIJA. While the governor is requesting the funds, the Legislature will have the power to define how the $100 million would be allocated across the state in consideration of geographic distribution, urban vs. rural projects, and categories of infrastructure investment.
- **Tax Increment Finance (TIF) Districts**: Within Iowa, cities and counties have the authority to create TIF districts to maximize property tax dollars within a defined area to pay for a portion of public improvement projects (streets, water, sewer, etc.) and other economic development activities. Activities required to create a TIF district include identifying an area that would qualify being designated a “slum,” “blighted,” or “economic development” area as defined by Statute. Further, an urban renewal plan is required that includes the specific projects to be implemented in the TIF district. TIFs allow cities and counties to address transportation issues in a specific area, providing a debt repayment mechanism for site-level reinvestments. As such, their overall contribution to total statewide revenues is limited.
- **Tolling:** Attempts were made during the project to develop high-level conceptual revenue estimates related to a potential tolling structure. However, based on further technical review, the decision was made to remove these estimates. Given the localized nature of tolling, which could include corridor tolling, bridge tolling, congestion pricing or managed lanes, the team felt this source would not be viable as providing supplemental revenue for statewide purposes. Rather, tolling should remain in the funding toolbox as a potential option to address a localized need, like what was evaluated during the Interstate-80 Planning and Environmental Linkage (PEL) Study.[68]

4.1 Evaluation Process

The evaluation process reflected the criteria and measures described below as well as consideration of the potential role and the geographic context of each source.

- Potential role: This defines how the source would relate to the existing sources. One role is the source would act as a supplement to existing funding with a focus on providing incremental short- and long-term increases in revenue to offset a portion of the reduction in purchasing power caused by the increases in construction costs. The second role is the source would provide a potential long-term replacement for the existing fuel tax.

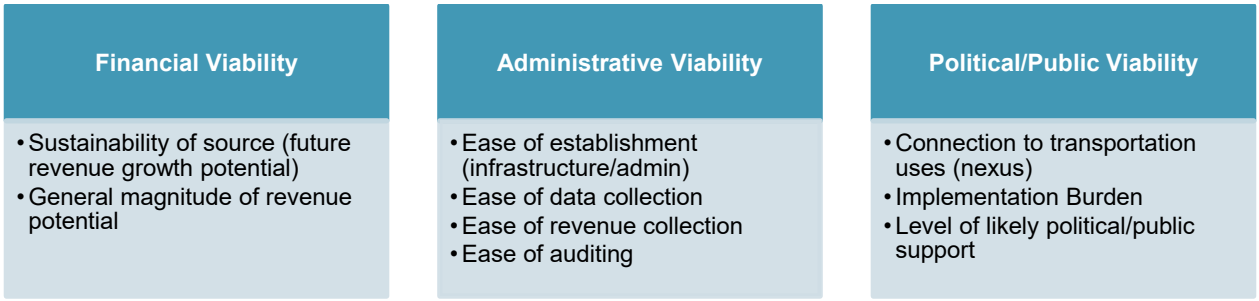
[68] https://iowadot.gov/interstatestudy/pdf/I80PEL-Final-Toll-Financing.pdf

- Geographic context: This is intended to define which residents would pay and benefit most of the proposed fee or tax: Urban, Rural, or Statewide. This assists in developing potential implementation approaches and stakeholder collaboration efforts as well as anticipating potential political or public challenges. As an example, the proposed agricultural-related fees would generate most of the revenue in rural areas, and a case could be made that those funds should be used to address transportation needs related to the impact of agricultural vehicles and equipment in rural areas. Similarly, the Emerging Mobility Fees would primarily be generated in urban areas, and these fees should be focused on areas that are most heavily impacted by the increases in delivery vehicles. Finally, statewide reflects changes to existing fees or taxes that already deposited into the RUTF. The assumption is that the revenue generated by the changes in these fees would follow the State's existing allocation processes.

4.1.1 Evaluation Categories and Criteria

Evaluation criteria shown in **Figure 4-1** were developed to differentiate the potential funding sources. As summarized in the figure, the evaluation criteria are broken into three major categories related to the implementation viability: Financial, Administrative, and Political/Public. Additional details on the evaluation categories and criteria are provided after the figure.

Figure 4-1: Evaluation Categories and Criteria



4.1.1.1 FINANCIAL VIABILITY

The first consideration for all potential sources is financial viability related to revenue potential, both in the near-term and long-term. Criteria used as part of the consideration of financial viability include:

- **Sustainability of source.** Does the source offer the potential for sustaining or growing revenue in the future, given expected demographic, technological, and other trends? From a technical perspective, can the rates be adjusted to match changes in revenue needs?
- **General magnitude of revenue potential.** What is the revenue generating potential associated with a source, given the scale of the product or activity on which the fee is based?

4.1.1.2 ADMINISTRATIVE VIABILITY

Administrative viability describes the barriers (or lack thereof) associated with implementing and maintaining a given source. This category is focused on the time, infrastructure, and other

resources required of state and local government staff to implement the potential source. Criteria used as part of the consideration of administrative viability include:

- **Ease of establishment.** How much effort is required to begin collecting revenue from the source? Does it require new physical infrastructure, programs, and/or systems?
- **Ease of data collection.** Is the basis of payment based on readily available information or data pertaining to a given activity or product?
- **Ease and efficiency of revenue collection.** Are the mechanisms for collecting the revenue readily available and/or used by other taxes or fees already in existence? Are there operational or administrative obstacles that make it difficult or expensive to administer the revenue collection process?
- **Ease of auditing.** How much effort is required to verify the accuracy of reported activities or products on which a given fee or tax is based?

4.1.1.3 POLITICAL/PUBLIC VIABILITY

The political/public viability of a given source is based on the perceived level of resistance it will face as it travels through the approval and implementation process. This includes existing legal frameworks, legislative hurdles, and expected public support. Measures used as part of the consideration of political/public viability include:

- **Connection to transportation uses.** Is there a clear nexus between the source and the activities it funds (namely, the movement of goods and people throughout Iowa)? Part of this evaluation includes a consideration of whether the revenue source is eligible for other uses (meaning a greater level of tradeoff associated with using it for transportation).
- **Implementation burden.** What is the legal requirement for implementation of a source? Specifically, does it require (in order of increasing difficulty) administrative rulemaking, legislative activity, or public vote?
- **Level of public support.** Does implementation of the source face a strong probability of resistance from citizens, special interest groups and/or elected officials based on its collection mechanism, magnitude, or other factors?

4.2 Estimated Revenue Potential

A critical element of the evaluation process was understanding how much annual revenue the sources could potentially generate. The following sections summarize the methodology used to generate conceptual annual revenue estimates for each source, as well as the data sources used in developing these estimates. The resulting conceptual annual revenue estimates are summarized in **Table 4-2**. These estimates were generated to support comparison of sources for this research study. If any of the sources move forward for potential implementation or legislative action, the estimates should be updated and adjusted to reflect the definition of the proposed action.

Table 4-2: Conceptual Annual Revenue Estimate ($, in millions)

Potential Sources	Assumed Rate, Tax, or Fee		Definition of Mechanism	Conceptual Annual Estimate ($, in millions)
Index or Increase Existing Fees or Taxes				
Index Fuel Tax	0.9%	2.6%	Annual increase in current fuel tax rate	Base estimate: $7 – $20 Sensitivity test: $36.5 - $38.5
Index Annual Registration & Other Registration Fees	0.9%	2.6%	Annual increase in current fee rates	Base estimate: $5.5 – $18.0 Sensitivity test: $31 - $35
Increase Fee on New Registrations	1.0%		Increase fee from 5% to 6%	$77
Create Dedicated Transportation Sales Tax	0.3%	1.0%	Dedicated transportation tax based on all sales applicable to current 6% rate	$112 – $400
Mileage-Based User Fees				
VMT/RUC				
Implement Fee on Miles Traveled	$0.01	$0.04	Fee per vehicle mile traveled on all roads	$320 – $1,307
Implement Fee on Ton-Miles	$6.00	$10.00	Fee per 1,000 ton-miles traveled on all roads	$764 – $1,413
Emerging Mobility Fees				
Implement Fee on TNC Trips	$0.27	$0.45	Fee per trip	$0.4 – $8
Implement Fee on E-Commerce Deliveries	$0.10	$0.75	Fee per delivery	$18 – $45
Agricultural Industry Related Fees				
Implement Red Dyed Diesel Fuel Tax	$0.295	$0.325	Fee per gallon	$6.4 - $19.5
Implement Crop Fee	$0.15	$0.20	Fee per bushel produced	$4 – $8
Implement Head of Livestock Fee	$5.0	$10.0	Fee per head	$33 - $88
Implement Agriculture Equipment Fee	$50		Fee per tractor and combine that use roads	$2.6 - $5.1

Note: Conceptual estimates for the purposes of this report. If the sources move forward for legislation action, new revenue forecasts and additional analysis would be required based on the decision of potential rates or fees, refined methodologies, and updated data, which for the emerging mobility fees would include more localized data.

4.2.1 Index or Increase Existing Taxes/Fees

The intent of the potential changes is to move towards a more sustainable funding future and enhance the purchasing power of these existing transportation funding sources to better align with increasing construction costs.

4.2.1.1 INDEX THE EXISTING FUEL TAX RATE

The analysis assumed the existing fuel tax rate per gallon would increase with forecasted fuel prices from the Energy Information Administration (EIA). Specifically, the percent increase reflects the 2020 to 2050 growth in petroleum and other liquids prices in the transportation industry.[69] The assumed high and low growth rates (2.6 percent and 0.9 precent) were applied to the highest and lowest annual fuel tax revenue levels over the 2015 to 2019 period, as reported in the Iowa Comprehensive Annual Financial Report for the Fiscal Year Ended June 30, 2019.[70] Over this time period, the low annual fuel tax revenue was $731.7 million in 2019 and the high revenue was $768.8 million in 2017. Based on these assumptions, the potential additional annual revenue would initially range from $7 million to $20 million and then would increase annually based on the index.

The EIA high growth rate is less than the growth in the State's Construction Cost Index over the last 10 years (greater than 6 percent). As a sensitivity test, a growth rate of 5 percent was used as a potential approach to close a portion the reduced purchasing power of the fuel tax caused by increasing construction costs. Under this sensitivity test, the initial potential additional annual revenue would range from $36.5 million to $38.5 million and then would increase annually based on a 5 percent annual growth rate.

4.2.1.2 INDEX OR INCREASE REGISTRATION & OTHER EXISTING FEES

For consistency purposes, the analysis assumed that the following existing fees would increase at the same percentages used in the Indexing of Existing Fuel Tax Rate analysis – Motor Vehicle Registration Fees, Motor Carrier Registration Fees, and Trailer Registrations & Title Fees to TIME-21. The existing revenue estimates are based on a 2019 to 2024 forecast of total RUTF/TIME-21 revenues for these three registration fee categories.[71] The low and high estimates were $613.2 million and $691.2 million. Multiplying these estimates by the proposed high and low growth rates (2.6 percent and 0.9 precent) results in potential additional annual revenue estimates that would initially range from $5.5 million to $18.0 million and then would increase annually based on the index.

Like the fuel tax, as a sensitivity test, a growth rate of 5 percent was as a potential approach to close a portion of the gap caused by increasing construction costs. Under this sensitivity test, potential additional annual revenue would initially range from $31 million to $35 million and then would increase annually based on the 5 percent growth rate.

Finally, the current fee on new registrations is a one-time 5 percent fee on the sales price of new and used vehicles and trailers. The analysis assumed this fee would be increased to 6 percent, which would put the fee in line with the current state sales tax rate. Based on the FY

[69] https://www.eia.gov/outlooks/aeo/data/browser/#/?id=3-AEO2021&cases=ref2021&sourcekey=0
[70] https://das.iowa.gov/sites/default/files/acct_sae/cafr/fy19_cafr.pdf
[71] https://iowadot.gov/about/2019-2024FundingForecast.pdf

2022 budget, the fee on new registrations is estimated to generate $383.8 million. A 1 percent increase in the fee would initially generate approximately $77 million.

4.2.2 Increase State Sales Tax Rate and Dedicate for Transportation Purposes

This option reflects an assumption that the legislature and voters would approve an increase in the State's existing sales tax that would be dedicated to transportation. Iowa's sales tax applies to any retail sale of tangible personal property unless specifically exempted by statute. The state's current sales tax rate is 6 percent. There are also a variety of other excise taxes handled separately from this umbrella guidance (such as beer and liquor sales, hotel and motel tax, and fuel tax)[72]. For the purposes of this analysis, sales tax refers only to the first, general category. For this analysis, it was assumed the sales tax rate would increase from its current rate of 6.0 percent by 0.3 percent on the low end to 1.0 percent on the high end. This range reflects recent measures advanced in other states.[73] Total taxable sales were calculated by dividing total sales tax revenue, as reported in the Iowa Department of Revenue Retail Sales and Use Taxes Annual Report,[74] by 1.06 to reflect the current sales tax rate. The high sales tax revenue reflects 2019 levels ($2.40 billion), and the low reflects 2015 levels ($2.24 billion). The incremental sales tax rate was multiplied by the taxable sales to calculate the potential incremental revenue. Using the high and low potential rates and the high and low taxable sales amounts, the initial incremental sales tax revenue could range from $112 million to $399 million.

4.2.3 Mileage-Based User Fees

The intent of the milage-based user feel is to provide a funding mechanism that is closely linked to the actual use of the roadways by a driver, as compared to traditional fuel taxes. Two revenue estimates were developed for the mileage-based user fee. Option 1 is a distance-based fee and reflects the use of a flat fee per mile approach. Option 2 incorporates weight along with distance (weight and distance fee) to help account for the effect of heavy loads on the longevity of pavements and bridges relative to the impact of passenger vehicles.

- **Option 1 - Distance Based Fee**: The analysis assumed that a flat fee would be applied to vehicle miles traveled on roadway systems throughout the state. For this analysis, the fee ranged from 1 to 4 cents per mile and was applied to statewide VMT for all vehicle types on all systems.[75] Based on the fee per mile assumptions, the potential range of annual revenue is between $320 million and $1.3 billion.
- **Option 2 – Weight and Distance Fee**: This option is sometimes referred to as a ton-mile fee, a term borrowed from the freight industry where a ton-mile refers to transporting one ton of freight a distance of one mile. For this analysis, the revenue potential reflects estimated annual ton-mile estimates for passenger vehicles and tractor-trailers.

  Ton-miles for passenger vehicles were estimated by multiplying the average gross weight for passenger vehicles (4,000 pounds) by miles driven per year per licensed driver. Low and high estimates for the number of licensed drivers reflect Iowa DOT licensed driver data from

[72] https://www.legis.iowa.gov/docs/publications/LG/15813.pdf
[73] https://fundingfinance.transportation.org/state-transportation-revenue-packages/
[74] https://tax.iowa.gov/sites/default/files/2021-02/Fiscal%20Year%202020%20Annual%20Report.pdf
[75] https://iowadot.gov/maps/data/vehicle-miles-traveled

2016 to 2020.[76] Over this time, the number of licensed drivers hit a low of 2.28 million in 2017 and a high of 2.32 million in 2019.

Ton-miles for tractor-trailers were estimated using Bureau of Transportation Statistics data,[77] which indicated the flow of all freight in the state was 109.3 billion ton-miles in 2012 and 129.3 billion ton-miles in 2018, which were used as the low and high estimates, respectively. Based on a national analysis of freight shipments by mode in 2017, approximately 65 percent of all freight is shipped via truck.[78] This percentage was applied to the statewide freight movement which resulted in an estimate of freight ton-miles driven on Iowa roads. The resulting low and high estimates of truck freight were 70.6 billion ton-miles and 83.6 billion ton-miles, respectively.

The low estimates for ton-miles driven by passenger vehicles and by tractor-trailers were summed to get a statewide low estimate of 127.3 billion ton-miles. Similarly, the high estimates were summed to get a statewide high estimate of 141.3 billion ton-miles. These estimates are likely both low, as they do not include ton-miles driven by farm vehicles.

This analysis used a fee range of $6 to $10 per thousand ton-miles and generated initial annual revenue estimates from $764 million to $1.4 billion.

4.2.4 Emerging Transportation Fees

With the increasing use of food and product delivery through services like Amazon and Grub Hub, not all those who benefit from the roadway system must use them or leave the comfort of their home. Product delivery services and rideshare services, like Uber or Lyft, are redefining how people are making use of the roadway system and the fees paid to support maintaining roadway facilities in good condition. While these activities and uses may be a small portion of overall roadway traffic today, it is reasonable to assume that they will evolve and expand over time.

4.2.4.1 E-COMMERCE DELIVERY FEES

This potential source assumes a fee could be applied to residential and commercial deliveries of online purchases. Since data on deliveries from private companies is not publicly available, the following approach was used to estimate the number of residential deliveries per person per year within Iowa. First, data was obtained based on the response to the following question on a 2017 National Household Travel Survey (NHTS) - “count of times purchased online for delivery in last 30 days”[79]. Statewide annual residential deliveries were estimated by multiplying annual deliveries per person and the Iowa statewide population in 2020. The low and high estimates for average deliveries per person per year are represented by the Iowa statewide average (about 22.5 deliveries per person per year) and the U.S. average (28.1 deliveries per person per year), respectively. For the purposes of this analysis, the high and low estimates of residential

[76] https://iowadot.gov/mvd/stats/licenseddrivers.pdf
[77] https://www.bts.gov/browse-statistical-products-and-data/state-transportation-statistics/freight-flows-state
[78] https://www.bts.gov/topics/freight-transportation/freight-shipments-mode
[79] http://nhts.ornl.gov.

deliveries were multiplied by the high and low fee levels, $0.25 and $0.50, for a potential initial annual revenue estimate of approximately $18 million to $45 million.

4.2.4.2 TNC FEES

This source assumes that a fee could be applied to trips requested from TNCs through rideshare apps. The number of TNC rides per year was estimated from a rate for rideshare trips per person multiplied by the Iowa statewide population in 2020. The 2017 NHTS responses to "how many times in the past 30 days they purchased a ride with a ridesharing app" provided the rideshare trip rate, where the low end was represented by the Iowa statewide average (1.4 rides per person per year) and the high end was represented by the U.S. average (3.2 rides per person per year). High and low fee rates (dollars per trip) were based on a previous literature review on TNC fees. A high-end rate of $0.75 per trip corresponds to rates in Chicago, IL, and Seattle, WA; and the low-end rate of $0.10 per trip corresponds to rates in Tacoma, WA, and California.[80] The product of the high and low estimates of trips and the high and low fee provides an initial annual revenue range of $0.4 million to $7.7 million.

4.2.5 Agriculture Industry Related Fees

The intent of these potential fees is to offset the cost to maintain and repair the wear and tear on rural roads and bridges caused by large and heavily vehicles and equipment associated with all aspects of the agricultural industry, including the movement of supplies, equipment, product, and waste.

4.2.5.1 BUSHEL OF CROP FEE

The United States Department of Agriculture (USDA) National Agricultural Statistics Service[81] tracks the production of key crops by state, including within Iowa: corn for grain, corn for silage, alfalfa hay, all other hay, oats, and soybeans. For this analysis, any crops reported in tons were converted to bushels,[82] and because the USDA provides two years of data per crop, an average of the years was taken. The resulting estimate was 3.31 billion bushels. Based on the average one-year change across all crops, the bushels of crops eligible for the fee was adjusted plus or minus 20 percent to get the high (3.97 billion bushels) and low (2.65 billion bushels) range. In terms of the potential fee per bushel, the analysis assumed $0.15 per bushel on the low end and $0.20 per bushel on the high end. The high and low estimates of annual bushel production were multiplied by the high and low fee estimates for a range of potential annual revenue of $4 million to $8 million.

4.2.5.2 HEAD OF LIVESTOCK FEE

Like the crop fee, this is a fee on each head of livestock. **Table 4-3** summarizes the low and high annual livestock population over the 2016 to 2021 period as reported in the 2021 Iowa Agricultural Statistics compiled by the USDA National Agricultural Statistics Service. Potential annual livestock fee revenue estimates were generated assuming a $0.50 per head fee on the

[80] https://www.codot.gov/library/studies/emerging-mobility-impact-study/emis-documents/2019-emis-report.pdf
[81] https://www.nass.usda.gov/Statistics_by_State/Iowa/Publications/County_Estimates/index.php
[82] https://grains.org/markets-tools-data/tools/converting-grain-units/

low end and $1.0 per head on the high end. Based on these assumptions the potential annual revenue range would be between $33 million and $88 million.

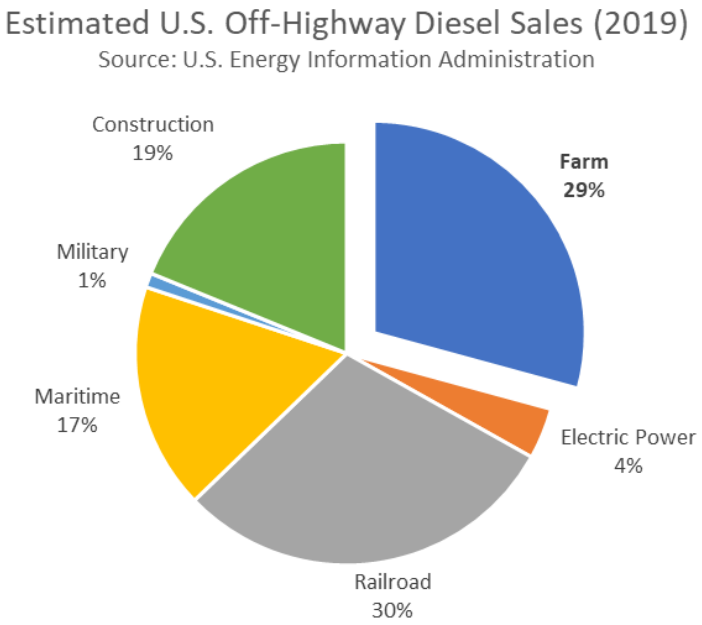
Table 4-3: Annual Livestock Population Assumptions

Livestock	Low Estimate	High Estimate
Cattle and Calves	3,650,000	4,000,000
Hogs and Pigs	22,800,000	24,900,000
Chickens	39,869,000	58,880,000
Sheep and Lambs	151,000	175,000
Total	**66,470,000**	**87,995,000**

4.2.5.3 RED DYED DIESEL FUEL TAX

The Iowa Department of Revenue currently tracks sales of red dyed diesel fuel in its Retailers Fuel Gallons Annual Report. Over the past five years, the total dyed diesel gallons sold peaked in 2016 (212 million gallons) and hit a low in 2018 (189 million gallons).[83] As shown in **Figure 4-2**, the EIA estimates that nationally, approximately 29 percent of diesel fuel consumed for non-highway purposes is used in agriculture[84]. Other users of red dyed diesel include railroad locomotives, maritime vessels, construction equipment, electricity generation, and military equipment. It should be noted that red dyed diesel is also used by tax-exempt entities such as school districts, and this appears to be categorized as on-road use by EIA and is not included as a use in the figure.

Figure 4-2: 2019 Estimated Off-Road Diesel Fuel Sales



[83] https://tax.iowa.gov/retailers-fuel-gallons-annual-report
[84] https://www.eia.gov/petroleum/fueloilkerosene/pdf/foks.pdf

For this analysis, it was assumed agriculture use of red dyed diesel accounts for between 20 and 30 percent of total gallons sold in Iowa. The per gallon rates used in the analysis reflects both the current diesel tax rate ($0.32 per gallon) and a partial tax rate of $0.16. Based on these assumptions, the potential annual revenue estimates are between $6.4 million and $19.5 million.

An additional note on this potential source, within Iowa fuel is currently subject to either the fuel tax or the sales tax, but not both. As a result, applying a fuel tax to red dyed diesel could result in a reduction in State sales tax revenue if only one tax is applied. At current prices of approximately $3.00/gallon, off-road diesel generates $0.18/gallon of state sales tax revenue, plus any applicable local-option sales taxes.

4.2.5.4 AGRICULTURAL EQUIPMENT REGISTRATION FEE

Agricultural equipment is exempted from paying registration fees. The equipment is also exempt from weight limits and potentially leading to overloading of county bridges. The intent of this funding source would attempt to capture revenue to offset the impact of this equipment on Iowa's rural roads and bridges by establishing a new fee.

Based on the 2017 Census of Agriculture,[85] there were 222,000 tractors in operation in Iowa, of which almost half (112,500) were 100 horsepower (power take off [PTO]) or larger. There were also 35,000 grain and bean harvesters (combines) in operation. For the purposes of this analysis, it was assumed only a portion of all agricultural equipment operates on road and bridges. As shown in **Table 4-4**, the low estimate assumed 20 percent of all equipment operate on roads and the high estimate assumed 40 percent. The annual fee was assumed to be $50 per tractor or combine which resulted in a range of potential annual revenue between $2.5 million and $5.1 million. Other farm equipment operated on Iowa roads includes crop sprayers and manure handling systems; these were excluded from the revenue estimates because publicly-available data on the number of such devices was found.

Table 4-4: 2017 Machinery and Equipment Estimates and Potential Registration Fee Revenue Estimates

	Total	20% Use Roads & Brides	40% Use Roads & Brides	Potential Registration Fee	Low Estimate	High Estimate
Total Tractors	221,693	44,339	88,677			
Less than 40 horsepower (PTO)	*36,243*	*7,249*	*14,497*	$50	$362,430	$724,860
40 to 99 horsepower (PTO)	*72,957*	*14,591*	*29,183*	$50	$729,570	$1,459,140
100 horsepower (PTO) or more	*112,493*	*22,499*	*44,997*	$50	$1,124,930	$2,249,860
Grain and bean combines, self-propelled	34,960	6,992	13,984	$50	$349,600	$699,200
Total					**$2,566,530**	**$5,133,060**

[85] 2017 Census by State - Iowa | 2017 Census of Agriculture | USDA/NASS

4.3 Evaluation Results

4.3.1 Index Existing Fuel Tax

Potential Role: Short- and long-term incremental increase to existing sources.

Geographic Context: Statewide – revenue generated would follow the State's existing funding flow and allocation approach.

Description: Change the current fuel tax structure to increase annually so that revenue growth would better align with the annual construction cost increases. Based on examples from other states, the index could reflect inflation (CPI), gas prices, a construction cost index, or a combination of multiple variables.

Evaluation

Criteria	Rating	Evaluation
Financial Viability		Even with the anticipated growth in EVs, there will still be a significant level of internal combustion vehicles on the road well into the future and the fuel tax will continue to be collected. Depending on how conservative or aggressive a potential index approach is implemented, the initial annual increase in revenue could range from $7 million to $38 million, which would then increase annually based on the index.
Administrative Viability		The state already collects fuel taxes – changing the rate on a periodic basis is within all existing administrative functions.
Political/Public Viability		While no tax increase is universally popular, incremental changes to an existing tax are less likely to create public resistance than the introduction of new taxes or fees. Additionally, the public is familiar with the use of this revenue to support investment in transportation infrastructure.
RESULT / SUMMARY		**Recommended for Implementation**. Indexing fuel taxes allows for the state's current largest single source of transportation funding to address a portion of the ongoing reduction in purchasing power. While increases in fuel efficiency and the introduction of EVs challenge the long-term sustainability of fuel taxes overall, indexing the existing tax could have a significant short-term impact on closing the gap between annual revenue and increasing construction costs.

4.3.2 Index Registration and Other Existing Fees

Potential Role: Short- and long-term incremental increase to existing sources.

Geographic Context: Statewide – revenue generated would follow the State's existing funding flow and allocation approach.

Description: Change the structure of existing registration fees (Motor Vehicle Registration Fees, Motor Carrier Registration Fees, and Trailer Registrations & Title Fees to TIME-21) that fund the RUTF to increase annually so that revenue growth would better align with the annual construction cost increases. Based on examples from other states, the index could reflect inflation (CPI), gas prices, a construction cost index, or a combination of multiple variables.

Evaluation

Criteria	Rating	Evaluation
Financial Viability		Unlike the fuel tax, registration and other existing fees will not be impacted with the transition to EVs. In FY 2022, registration fees are projected to account for 39 percent of Iowa's total transportation revenues. Depending on how conservative or aggressive a potential index approach is implemented, the initial annual increase in revenue could range from $10 million to $55 million and then increase annually based on the index.
Administrative Viability		The state already collects all fees – changing the rate on a periodic basis is within existing administrative functions.
Political/Public Viability		While no fee increase is universally popular, incremental changes to an existing fee are less likely to create public resistance than the introduction of a new tax or fee. Additionally, the public is familiar with the use of this revenue to support investment in transportation infrastructure.
RESULT / SUMMARY		**Recommended for Implementation.** Like indexing the fuel tax, indexing existing fees provides a near term opportunity for the State to address a portion of the revenue needed to keep up with increasing construction costs.

4.3.3 Increase Fee on New Registrations

Potential Role: Short- and long-term incremental increase to existing sources.

Geographic Context: Statewide - revenue generated would follow the State's existing funding flow and allocation approach.

Description: Increase the fee on new registrations from 5 percent to 6 percent, which would put the fee in line with the current state sales tax rate.

Evaluation

Criteria	Rating	Evaluation
Financial Viability		The fee on new registrations will not be impacted with the transition to EVs. In FY 2022, fee on new registrations accounted for 21 percent of Iowa's total transportation revenues. A 1-percent increase in this fee would generate approximately $77 million.
Administrative Viability		The state already collects the fee – changing the rate is within existing administrative functions
Political/Public Viability		While no fee increase is universally popular, incremental changes to an existing tax are less likely to create public resistance than the introduction of new taxes or fees. Additionally, the public is familiar with the use of this revenue to support investment in transportation infrastructure.
RESULT / SUMMARY		**Recommended for Implementation.** Increasing the fee on new registrations provides a near term opportunity for the state to address a portion of the revenue needed to keep up with increasing construction costs.

4.3.4 Increase Sales Tax Rate and Dedicate to Transportation

Potential Role: Short- and long-term incremental increase to existing sources.

Geographic Context: Statewide-revenue generated would follow the State's existing funding flow and allocation approach.

Description: This proposed new source would involve raising the State's existing base sales tax beyond the existing 6 percent and dedicate the incremental revenue for transportation purposes only.

Evaluation

Criteria	Rating	Evaluation
Financial Viability		Sales tax offers a significant and sustainable basis for revenue – accounting for approximately one-quarter of all state receipts.[86] Based on the dedicated transportation sales tax rates that have been implemented in other states, ranging from 0.3 percent to 1.0 percent, this new source could generate incremental annual revenues of about $112 million to $400 million.
Administrative Viability		Mechanisms are already in place to collect and administer sales tax funds. General sales taxes are not currently used to fund transportation in Iowa but based on our research there is no regulatory barrier preventing such a use.
Political/Public Viability		Because sales taxes are not currently used for transportation uses, establishing this use could face significant public resistance. Additionally, general sales tax funds can be used for nearly any public function, so significant political challenges to dedicating them for transportation uses would be expected. Finally, there is no clear nexus between collection of general sales tax revenue and transportation.
RESULT / SUMMARY		**Not Recommended.** Sales tax offers enormous revenue potential and is not subject to the technological and societal forces jeopardizing the traditional fuel tax. However, competition for the use of these funds and the public challenge of raising the base rate for transportation uses present major hurdles.

[86] https://www.urban.org/policy-centers/cross-center-initiatives/state-and-local-finance-initiative/projects/state-and-local-backgrounders/sales-taxes

4.3.5 Mileage-Based User Fee

Potential Role: Long-term replacement of fuel tax.

Geographic Context: Statewide - revenue generated would follow the existing approach used to allocate fuel tax revenue.

Description: Two revenue estimates were developed for the mileage-based user fee. Option 1 is a distance-based fee and reflects the use of a flat fee per mile approach. Option 2 incorporates weight along with distance (weight and distance fee) to help account for the effect of heavy loads on the longevity of pavements and bridges relative to the impact of passenger vehicles.

Evaluation

Criteria	Rating	Evaluation
Financial Viability		Mileage-based user fees could theoretically account for each mile traveled on Iowa roads, regardless of road or vehicle type and could be structured as a replacement for the existing fuel tax. Based on the two options estimated in this study, a fee structure could be implemented that would generate annual revenues more than what the fuel tax is generating today.
Administrative Viability		While pilot programs have been implemented in other places, those programs have typically relied on a small pool of volunteer drivers. There are some administrative barriers associated with collecting travel data from all vehicles statewide, and the existing data systems would need to be expanded. Data collection options could include added mandatory annual reporting of odometer readings to the annual registration renewal process or license tag renewals. Alternatively, drivers could prepay estimated fees monthly or quarterly through an optional web-based portal. Finally, there could be an optional vendor-supplied GPS device that allows people who frequently travel into other states to document their exemptions for out-of-state mileage.
Political/Public Viability		Because there is a clear connection between the proposed fee and the use of the funds it collects, a strong public argument can be made in favor of a mileage-based user fee. Still, the introduction of a major new funding mechanism and the associated change from the existing structure would face some challenges.
RESULT / SUMMARY		**Recommended – Long-Term Implementation**. If it could be implemented effectively and more-or-less universally, a mile-based user fee could offer the promise of a long-term sustainable funding future. Coordination with future regional and national efforts may be required.

4.3.6 Fee on TNC Trips

Potential Role: Short- and long-term incremental increase to existing sources.

Geographic Context: Urban and rural - all revenue generated would be return to the area where it is collected.

Description: Implement a fee for all trips taken through TNCs, such as Uber and Lyft.

Evaluation

Criteria	Rating	Evaluation
Financial Viability		While the initial level of revenue potentially generated by this source is not as significant as others in the study, prior to the pandemic the trend for TNC use was one of continuous growth. If TNC usage returns to pre-pandemic levels, this source could provide supplemental revenue to urban areas directly related to the impact of the additional vehicles and miles traveled by TNC drivers when carrying passengers and when travelling to pick up new passengers.
Administrative Viability		While the TNCs themselves already collect all the information necessary to institute a fee, the availability and consistency of this data is less certain. There are precedents for imposing TNC fees, especially at the municipal level, but it would be a challenge to collect, audit, and manage the necessary information.
Political/Public Viability		The public has been supportive of TNC fees in many places across the country but establishing the needed relationship with the TNCs themselves has proven more difficult. The resistance of these companies is likely to be felt at a political and public level, especially to the extent that TNCs work to pass those fees along to end users. One political challenge of note would be if this fee is implemented, it would eliminate the current Personal Transportation Service sales tax which currently goes to the State General Fund.
RESULT / SUMMARY		**Recommended.** TNC activity represents a small but growing part of the transportation system, especially in cities. Assuming TNC activity returns to pre-pandemic levels and growth trends, it makes good economic sense to implement a structure that will result in increasing revenue over time and will help offset the impact on road conditions caused by these services.

4.3.7 Fees on E-Commerce Deliveries

Potential Role: Short- and long-term incremental increase to existing sources.

Geographic Context: Urban and rural - all revenue generated would be return to the area where it is collected

Description: Implement a fee for all trips that deliver goods facilitated by online platforms such as Amazon and Uber Eats.

Evaluation

Criteria	Rating	Evaluation
Financial Viability		The COVID-19 pandemic hastened the emergence of online shopping and local delivery as significant source of demand on surface transportation facilities. Overall, the number of applicable trips to a delivery/e-commerce fee could be a quickly growing source of new funding. Based on the assumptions used for this study, per trip fees ranging from $0.25 to $0.50 could generate between $18 and $45 million
Administrative Viability		While the e-commerce companies themselves already collect all the information necessary to institute a fee, the availability and consistency of this data is less certain. It would be a major challenge to collect, audit, and manage the necessary information. However other states have implemented this fee and lessons can be learned from their experiences.
Political/Public Viability		The public has been supportive of e-commerce/delivery fees in many places across the country but establishing the needed relationship with the e-commerce themselves has proven more difficult. The resistance of these companies is likely to be felt at a political and public level, especially to the extent that e-commerce and delivery companies work to pass those fees along to end users.
RESULT / SUMMARY		**Recommended.** E-commerce is a rapidly growing practice that places a burden on roadway infrastructure. Implementation of a fee to recoup some of those costs is a logical step for Iowa to take.

4.3.8 Head of Livestock / Bushel of Crop ee

Potential Role: Short- and long-term incremental increase to existing sources.

Geographic Context: Rural – all revenue generated would be return to the area where it is collected.

Description: Implementing a fee on farm commodities, specifically per bushels of crop produced and/or per head of livestock.

Evaluation

Criteria	Rating	Evaluation
Financial Viability		Given the quantity of crops and livestock raised in Iowa, estimated annual revenue of $33 to $88 million could be generated through a $5 to $10 per head of livestock fee and $4 to $8 million could be generated through a $0.15 to $0.20 fee per bushel of crop.
Administrative Viability		This would be a new fee and would require establishing a reporting and accounting structure. Crop production data is reported annually to the USDA National Agricultural Statistics Service, so a system is already in place to that could be used to track bushels produced. A system would need to be established to receive payment from farmers.
Political/Public Viability		Based on feedback provided at TAC meetings, there is a willingness within the agricultural community to provide funding to improve county roads that are important to the movement of their supplies, equipment, and product. Building acceptance for such a fee would almost certainly require the funds generated to be used for facilities that serve the agricultural industry (typically county roads).
SUMMARY		**Recommended – Short Term Implementation.** Introducing new taxes or fees on agricultural activities in Iowa – to the extent that they connect with the use of public roads – could be a meaningful part of an overall approach to closing the funding gap for counties. However, use of these funds should be limited to the roads that have a direct connection to the agricultural industry.

4.3.9 Red Dyed Diesel Fuel

Potential Role: Short-and long-term incremental increase to existing sources.

Geographic Context: Rural – all revenue generated would be return to the area where it is collected.

Description: Implement a fuel tax on red dyed fuel which is primarily used by agricultural equipment as well as construction and off-road vehicles. The fuel tax would only apply to agricultural uses of the fuel.

Evaluation

Criteria	Rating	Evaluation
Financial Viability		Based on recent trends in red dyed diesel that has been purchased in recent years and the agricultural industry's estimated share of total usage, implementation of fuel tax between $0.16 per gallon and $0.325 per gallon could generate from $6.4 to $19.5 million dollars a year.
Administrative Viability		Implementing a fuel tax on red dyed fuel could build off the accounting structures and systems in place for the existing fuel taxes. For example, a 6 percent Rural Roads Tax on agricultural diesel fuel could be collected and administered in a manner similar to the 6 percent state sales tax, but the revenue would be dedicated to transportation.
Political/Public Viability		Based on feedback provided at TAC meetings, there is a willingness within the agricultural community to provide funding to improve county roads that are important to the movement of their supplies, equipment, and product. Building acceptance for such a fee would almost certainly require the funds generated to be used for facilities that serve the agricultural industry (typically county roads). One political challenge of note would be if this fuel tax were implemented, it would eliminate current sales tax that is collected which goes to the State General Fund.
RESULT / SUMMARY		**Recommended – Short Term Implementation.** Introducing new taxes or fees on agricultural activities in Iowa – to the extent that they connect with the use of public roads – could be a meaningful part of an overall approach to closing the funding gap for counties. However, use of these funds should be limited to the roads that have a direct connection to the agricultural industry.

4.3.10 Agricultural Equipment Road Use Fee

Potential Role: Short-and long-term incremental increase to existing sources.

Geographic Context: Rural – all revenue generated would be return to the area where it is collected.

Description: Agricultural equipment is exempted from paying registration fees and is exempt from weight limits and routinely overload county bridges. This new registration fee would attempt to capture revenue to offset the impact of agricultural equipment on Iowa's rural roads and bridges.

Evaluation

Criteria	Rating	Evaluation
Financial Viability		Based on the 2017 Census of Agriculture, there were 222,000 tractors in operation within Iowa. For the purposes of this analysis, it was assumed only a portion of all equipment (20 to 30 percent) operates on road and bridges. Based on $50 fee per tractor or combine the potential annual revenue range was between $2.5 million and $5.1 million.
Administrative Viability		Implementing a registration fee on agricultural equipment could build off the account structures and systems in place for the other vehicle registration fees.
Political/Public Viability		Based on feedback provided at TAC meetings, there is a willingness within the agricultural community to provide funding to improve county roads that are important to the movement of their supplies, equipment, and product. Building acceptance for such a fee would almost certainly require the funds generated to be used for facilities that serve the agriculture industry (typically county roads).
RESULT / SUMMARY		**Recommended – Short Term Implementation.** Introducing new taxes or fees on agricultural activities in Iowa – to the extent that they connect with the use of public roads – could be a meaningful part of an overall approach to closing the funding gap for secondary roads maintained by counties. However, use of these funds should be limited to the roads that have a direct connection to the agricultural industry.

4.4 Recommendations

Based on the analysis and discussions in the prior sections, the following recommendations are provided to generate additional revenue to supplement the existing transportation funding sources in the short term and to transition away from the fuel tax in the long-term with an alternative source.

- **Short-Term Recommendation**: Implement the following package of fees to supplement the current funding structure.

    1. **Improve the Stability of Statewide Funding by Indexing and Increasing the Existing Fuel Tax and Registration Fees:** The public is already familiar with the connection between paying these taxes and fees to use a vehicle and how the revenue generated is then invested to improve the transportation infrastructure. The recommendation is to adapt legacy rate structures for fuel tax and annual registration fees to increase annually so that revenue growth would better align with the annual construction cost increases. Specifically, the recommendation is to increase fuel tax and registration fees using a cost growth index. Ideally, the index would be tied directly to trends in construction cost growth alone or in combination with other growth indices. Additionally, it is recommended that the existing fee on new registration be increased from 5 percent to 6 percent to align with the existing state sales tax rate and provide additional support in addressing the funding shortfall. Because these are existing sources, the incremental revenue increases would be allocated to the Iowa DOT, counties and cities using the current RUTF and TIME-21 Fund distribution processes.
    2. **Increase Urban and Rural Funding by Implementing TNC Fees and E-commerce Delivery Fees:** With the increasing use of food and product delivery through services like Amazon and Grub Hub, not all those who benefit from the roadway system must use them or leave the comfort of their home. Product delivery services and rideshare services, like Uber or Lyft, are redefining how people are using the roadway system and governments are redefining fee structures to provide revenue to keeps pace with the new burdens these services place on the roadway network. While TNC and E-commerce delivery services may be a small portion of overall roadway traffic today, it is reasonable to assume that they will evolve and expand over time. The recommendation is to implement a TNC fee, either as a percentage of the total fare or a fee per trip, and a fee per E-commerce delivery. Additionally, revenue from these fees should be dedicated to the cities and counties since that is where much of the impact of these services will occur. It should be noted that the State currently collects a Personal Transportation Service sales tax on TNCs, however the revenue collected does not support investment in the transportation system. The existing sales tax legislation may need to be adjusted if the new TNC fee moves forward.
    3. **Increase Rural Funding by Implementing One or More Agricultural Fees:** The State currently has no weight limits for agricultural vehicles and County Engineers are concerned about accelerated road and bridge deterioration caused by these unregulated heavy loads. Agricultural equipment is also currently exempt from paying vehicle registration fees even though some of the equipment is being driven on-road. The intent

of this recommendation is to offset the impact of this equipment on Iowa's rural roads and bridges by implementing one of more fees associated with the shipping requirements to raise and sell livestock and crops, the on-road use of tractors and heavy equipment, and the diesel fuel used by the agricultural industry. The agricultural fees considered included implementing a per bushel fee, a per livestock head fee, a registration fee for tractors and other farm equipment, and/or a fuel tax on red dyed diesel. Further it is recommended that the revenue collected from these fees would be returned to the county where it was generated.

Based on the conceptual revenue estimates shown previously in **Table 4-2**, if the entire package of fees were implemented, conceptual estimates developed for this report indicate total annual revenue could range from $155 million to $290 million. While these conceptual estimates would significantly close the average annual funding shortfall for stewardship projects defined in the 2021 RUFT Study, it may be a challenge to obtain political and public support to move all fees forward at the same time, and therefore additional annual revenue would not reach these levels. However, this recommendation provides a blueprint to start discussions with potential partners, stakeholders, and elected officials to supplement the current funding structure and offset the ongoing reduction in purchasing power.

- **Long Term Recommendation:** Continue research and analysis associated with the implementation of a mileage-based user fee and incrementally implement the fee overtime as a replacement for the fuel tax. There is recognition at both the state and nationally level that the fuel tax, which has historically been the primary funding source for transportation infrastructure, is not a sustainable source due to the continued improvements in vehicle fuel economy and the growth in EV sales. Industry and academic research have reached the same conclusion that implementation of a fee based on miles driven provides the best option to generate revenue equivalent to the fuel tax. Additionally, a mileage-based user fee would be more sustainable than the fuel tax since it would not be negatively impacted by vehicle efficiency or technology improvements.

  In the past, implementation of a mileage-based user fee may have been perceived as funding source option that was many years away. However, based on research and pilot programs conducted around the country, it is likely a large-scale implementation will occur soon as the ongoing research is generating answers to the data collection, technology, policy, and equity challenges that would be associated with the transition from the fuel tax to a mileage-based user fee. At the federal level, this is reinforced by direction from Congress to the USDOT in the IIJA as part of the Strategic Innovation for Revenue Collection Program. Specifically, the USDOT must submit a report to Congress in 2024 with recommendations on a national alternative revenue mechanism based on results from previously completed state pilot projects. The IIJA also includes a new $50 million program, the National Motor Vehicle Per-Mile User Fee Pilot Program that directs the USDOT implement a nationwide pilot project that will solicit volunteer participants from all 50 states, including commercial and passenger vehicles. The legislation requires the pilot program to offer different methods for participants to track their mileage and directs USDOT to set annual per-mile fees for different types of vehicles.

This report evaluated two mileage-based user fee options: a flat fee per mile approach and an approach that would incorporate weight along with distance (weight and distance fee or per ton-mile fee) to help account for the effect of heavy loads on the longevity of pavements and bridges relative to the impact of passenger vehicles. The revenue estimates indicate that depending on the fee structure, either option has the potential to generate revenue that would match or exceed the FY 2023 budget estimate for fuel tax ($669 million). However, these estimates assume all vehicles in operation today would be paying the mileage-based user fee. In reality, and depending on policy decisions in future legislation, there will continue to be a need for the fuel tax as it will take time to fully transition away from gas powered vehicles and there would be a transition period where both the fuel tax and a mileage-based user fee would be collected.

The State may want to consider implementing a pilot mileage-based user fee program for EV and PHEV which would provide data to compare the State's current registration fee approach for these vehicles with a fee per mile or fee per ton-mile approach and designed to generate revenue in line with historical fuel tax revenue levels. Federal funding for this pilot project is available through the Surface Transportation System Funding Alternatives Program. The IIJA include $75 million over the next five year for this program to test the feasibility of a road usage fee and other user-based alternative revenue mechanisms. The grant award could cover up to 80 percent of the total project.

5 Policy and Implementation Considerations

Looking ahead to potential requests of the State Legislature to act on the Near-Term and Long-Term recommendations, there are policy and implementation design approaches that could improve chances of success for the proposed individual sources and funding framework. The sections below offer recommendations for framing the policy and implementation discussion to support moving forward with the recommended supplemental funding sources. Following an overview of the framing discussion is a preliminary set of policy and coalition-building considerations for each of the recommended funding sources.

5.1 Considerations to Support Policy Design

The exercise of requesting additional funding can reach beyond the simple conversation of how much revenue will be generated and often requires the consideration of relationships, relativity, connections, impact, and equity to both users of the transportation systems and their beneficiaries. These considerations document the thinking behind the funding options and results in building the key messages for policymakers, stakeholders, and the public. Each item below should be considered when moving forward with the recommendations although not all may be applicable.

5.1.1 Establish a Clear Connection Between User and Investment

Defining a direct connection between the fee/tax the user of a vehicle is paying and how the payment will be used to improve transportation infrastructure is critical to developing a key message to support the implementation of the recommended funding source. For example, traditionally, the most common understanding and application of a "user fee" has been through

the implementation of fuel taxes and vehicle registrations, whereby the user of a vehicle is paying a tax/fee, directly related to the use of the vehicle, and the revenue generated is invested back into the road or bridges the user drives on.

5.1.2 Users and Beneficiaries

With the increasing use of food and product delivery through services like Amazon and Grub Hub, not all those who benefit from the roadway system must use them or leave the comfort of their home. Product delivery services and rideshare services, like Uber or Lyft, have helped to redefine how people are making use of the roadway system and the fees paid to support maintaining roadway facilities in good condition.

5.1.3 Fair and Equitable Distribution of Fees

This consideration can be a bit more complicated as there can be many definitions of fairness and equity. How “fair and equitable” is defined determines what will need to be considered to support decision-making. Fair and equitable fee or tax application can be dependent on a variety of factors including economic, geographic, or technological. The consideration is around what the State is trying to accomplish with the fee/tax and where exceptions, modifications, or exemptions are needed. For example, when considering a VMT or RUC fee, application of fees is often determined by the number of miles traveled. That fee can be modified or adjusted based on the number of urban vs. rural miles driven or based on ton-miles to address equity concerns between passenger vehicle and commercial truck impacts. Appendix A provides an in-depth analysis of academic research pertaining to equity considerations in the design and implementation of a fee and tax structures considered in this report, with a focus on the VMT/RUC fee.

5.1.4 Distribution of Revenues Based on Needs or Goals

Road and bridge investment needs often exceed, if not significantly exceed, the amount of funding available. Prioritized needs can include, but are not limited to, projects based on the worst first approach (system rating), tiered system (Interstate, highways, etc.) or high profile/high dollar projects at either the state or regional level. Specific goals can be outcome-based like those projects that provide economic stimulus, environmental outcomes, or safety improvements. Additionally, funding can be program focused (i.e., bridges), regional, or shared with local entities. Regardless of the selected approach, how the revenues are proposed to be distributed and for what specified purpose(s) will help to further define the messaging strategy needed to gain both political and public support.

6.1.5. Timing of Payments

Surveys consistently show the public prefers to pay transportation-related taxes and fees a little at a time, as they do with the fuel tax. For most consumers, paying $10/week is easier than budgeting for an annual $520 lump sum payment. As a result, the way payments are structured is likely to affect public perception of any new revenue sources.

5.2 Considerations for Coalition Building

Building a coalition of support should be considered an early action item in moving forward with the funding recommendations. Summarized below are considerations to support coalition building efforts.

5.2.1 Constituencies and Stakeholders

Evaluating how a modified or new fee/tax affects different stakeholders and constituencies will assist in building coalitions or understanding where the opposition may reside. A few items to consider:

- *Who pays the modified or new fee/tax may differ from who is impacted:* Who pays can vary depending on the fee/tax. For example, a fuel tax is paid by all vehicle owners, whereas a sales tax applies to anyone who purchases an item. However, based on these examples, there may be differing economic impacts on those who pay, and certain products may have historical exemptions like sales tax on groceries. How a new tax/fee impact business may also differ from how it affects individuals or families. Understanding the impacts and related representative interests like those of Chambers of Commerce, the Farm Bureau, Motor Carrier Associations, AAA, AARP, etc.
- *Who benefits either directly or indirectly:* Once there is an understanding of how new revenue for the tax/fee proposal is to be invested, consideration of those who benefit either directly or indirectly comes into play. Beneficiaries can be as simple as all those who use the roadways or as broad as anyone who receives services or products delivered via roadways. Improving roadways for safety purpose is always a strong benefit of any improvement. It is recommended to define a list of potential beneficiaries as broad as possible to build a strong list of potential supporters.
- *Who are the most likely supporters:* This might be as easy as identifying those stakeholders who are advocates for increased transportation investment, those who are frustrated with inadequate or unsafe facilities, or those who see economic value in road and bridge improvements.
- *Who is the opposition:* Are there known groups that oppose taxes/fees in general regardless of purpose? Opposition may also depend on the type of fee, the timing of the fee or the intended purpose that defines this opposition.
- *Who could potentially be a champion for the proposal:* This could be an individual or group/organization, but any good message or campaign often starts with good leadership. Does anyone individual or group stand out to lead the discussion, strategy, or message? This can be someone with high profile or credibility, elected or otherwise.

5.2.2 Governance

Governance structure establishes the legal and statutory framework that enables and defines the funding source. Discussing the following questions can help when considering governance structures for the recommended new funding sources:

- Who determines or manages the distribution of the funding?

- Should there be criteria to determine funding distribution?
- Can the funding distribution be modified once it is established? If so, by whom and when?
- Is the process defined by statute or administrative rule?
- Once the optimal governance structure has been defined - is it based on an existing legislatively approved framework, or will it need to be established?
- If it is a new governance structure, what is the level of cost and effort associated with developing the needed political/public support and navigating the legislative/rulemaking process?

5.2.3 Administration

Administrative structure takes into consideration the ease or complexity of implementation of a new fee/tax. This can have an impact on how quickly new revenues can be collected, distributed, and used. New or complex administrative structures may require strategic messaging and careful efforts to educate coalition members to build necessary support. The following considerations are critical to defining administrative structure.

- How would the proposed fee/tax be collected?
- How would the proposed fee/tax be distributed?
- Once the optimal administrative structure has been defined - is it based on an existing legislatively approved framework, or will it need to be established?
- If it is a new administrative structure, what is the level of cost and effort associated with establishing the needed infrastructure and oversight?

5.3 Policy and Implementation Considerations for Recommended Sources

Building from the framework outlined above, the following provides an overview and recommendations related to policy and implementation for each of the recommended funding sources. Some of the considerations presented here relate to topics introduced in the qualitative evaluation of potential sources in **Section 4**. The policy design and implementation considerations for the recommended sources described below takes that evaluation one step further by focusing on practical issues and opportunities derived from academic and peer research.

This section is organized to include the following elements for each recommended funding source.

- **Opportunity.** The emerging or established dynamic that creates a given funding source's long-term viability, alignment with clearly identified need, or both.
- **Proposed Uses.** The recommended constraints governing the use of funds deriving from the proposed source, based on the project team's research and feedback from the TAC.

- **Policy Design and Coalition Building Considerations.** The critical elements or decisions required to successfully introduce and sustain a given funding source category. These considerations are intended as a starting point for framing the policy and implementation discussions for the recommended sources.

5.3.1 Near-Term Recommendation: Package of New Fees

5.3.1.1 INDEX OR INCREASE EXISTING FEES

- **Opportunity:** Currently, the existing fees are either assessed at a flat rate (i.e., fuel tax, on a cents per gallon basis) or correlated with economic forces (i.e., new vehicle registration fee, as a percentage of vehicle sale price). In both cases these are independent of the growth in construction costs. The public has an existing connection of revenue from these fees being invested back into the transportation infrastructure. While indexing will not completely address the reduced purchasing power of the existing sources in comparison to increasing construction costs, indexing and increasing the existing fees will offset a portion of the ongoing funding gap.
- **Proposed Uses:** Additional revenue generated by indexing existing fees would be distributed according to the existing RUTF and TIME-21 formulas. This formula accounts for a broad range of uses across every road and bridge type in the state of Iowa.
- **Select Policy Design and Coalition Building Considerations:** Indexing existing fees to address a portion of the ongoing loss of purchasing power is the most straightforward recommendation from a policy perspective. Connecting existing transportation revenue sources to inflation or cost indices is a common practice, used by about half of all states, that does not require any changes to collection or distribution mechanisms. Iowa indirectly indexes some fees – for example, the new vehicle registration fee is a function of sale price, meaning it is indexed to the cost of vehicles. However, this recommendation calls for a more consistent and direct connection between all existing revenue sources (including fuel tax, registration fees, and other state-generated sources) and ideally, the cost of building and maintaining transportation infrastructure. However, given the significant annual increases in construction costs, a compromise may be needed that results in using or creating an index that covers a portion of the annual construction cost increase.

5.3.1.2 FEES ON E-COMMERCE DELIVERIES AND TNC TRIPS

- **Opportunity:** Advancements in web- or app-based services have already begun to reshape the role of transportation in society. While these activities and uses may be a small portion of overall roadway traffic today, it is reasonable to assume that they will evolve and expand over time. In terms of developing support for the introduction of a new TNC fee, consideration should be given for the disproportionate impact of TNC activity on roadway use. One study estimates that, for every 100 miles a Lyft or Uber drives with a passenger, that same car drives an additional 69 miles (at least) with no passengers[87]. Understanding this dynamic can help underscore the way this activity is meaningfully different from private vehicle travel in terms of wear on infrastructure and therefore necessitates a separate

[87] www.sciencedaily.com/releases/2018/09/180927122934.htm

discussion about appropriate fees. Infrastructure owners such as Iowa DOT, counties, and cities can take proactive steps to ensure that revenue generation keeps pace with these new potential burdens on the roadway network by establishing policy and governance structures early. Iowa has already demonstrated success in adapting to changes in technology by introducing a fee for EVs – the recommendations of this study expand on that effort to include fees directed at e-commerce delivery and TNCs.

- **Proposed Uses**: This study acknowledges the disproportionate effect of e-commerce and TNC activity will be on local roadways. The recommendation is to focus the distribution of revenue associated with these fees on local uses.
- **Select Policy Design and Coalition Building Considerations:** One critical policy design question to be answered about both e-commerce delivery and TNC fees is the way the activity in question is defined. Unlike private vehicle travel, where there are comparatively few dimensions of activity to tax, these emerging mobility uses involve a broader system. In the case of TNCs for example, is the roadway demand being created by the person requesting the ride, the company facilitating the ride, the driver of the car, or some combination? As public agencies begin to establish fee structures for these activities, a the predominate approaches have reflected either a flat fee per trip; a fee as a percentage of fare charged; and fee as a percentage of overall TNC revenue. A fourth approach that is more challenging from a data collection and administrative standpoint is a per-mile fee – however, developing such a fee for a narrow use like e-commerce delivery could help facilitate a broader introduction of a mileage-based user fees in the long-term.

5.3.1.3 AGRICULTURE FEES

- **Opportunity:** Large and heavily vehicles associated with agricultural industry create disproportionate wear and tear on rural roads and bridges. Deteriorating conditions, in turn, cause disproportionate damage and delay to the agricultural vehicles, as well as the public that rely on the roadway system. Stakeholders participating in this study voiced a desire by some representatives of the agricultural industry to improve the rural roads and bridge conditions by implementing fees for agricultural activities and equipment.
- **Proposed Uses:** With a few exceptions, Iowa's State-generated transportation revenue is directed into two major funding programs—RUTF and TIME-21—and distributed by formulas to roadway owners across the state. While these general distribution approaches will likely always be the foundation for transportation funding, there is value in finding opportunities to implement "closed loop" funding sources dedicated to specific needs associated with those sources. The recommendation of this study is to return any new revenue collected from agriculture fees to the county where the revenue was generated.
- **Select Policy Design and Coalition Building Considerations:** Any new fee assessed on agricultural activities should be designed to limit the spillover of impacts as much as possible. For example, one challenge associated with the removal (or alteration) of the fuel-tax exemption on dyed diesel is that agriculture is just one of its uses.

5.3.2 Long-Term Recommendation: Replace Fuel Tax with a Mileage-Based User Fee

- **Opportunity:** The most significant source of transportation funding in Iowa, the fuel tax, has historically offered a credible nexus between use of the roads and bridges and the costs associated with building and maintaining these facilities. However, due to changes in technology (fuel economy and alternative fuels) the revenue generated from the fuel tax will not keep pace with the continued growth in construction costs. A mileage-based user fee system offers the potential to decouple funding from any fueling system or technology, and provides the flexibility to assess fees in a way that truly reflects roadway activity and/or achieves broader policy objectives.
- **Proposed Uses:** A mileage-based user fee or weight-and-distance fee would offer sustainable source of funding to support all roads in Iowa.
- **Select Policy Design and Coalition Building Considerations:** While there are few systems in place at a mass scale, targeted pilot programs have been conducted for at least the past 20 years. To support providing additional information to the public on what would be involved with this major transportation funding structure change, additional pilot projects could be helpful - specifically, pilot projects on different components of the overall users. These could include a sample of truck drivers to provide research and analysis that could support the per ton-mile fee collection concept. Another sample could be EV and PHEV owners which would provide additional data to compare the State's current registration fee approach with a fee per mile or ton-mile approach and determine which approach generates revenue that most closely resembles the current fuel tax structure.

  If a mileage-based user fee is incrementally implemented to initially supplement the fuel tax and eventually replace the fuel tax, states like Iowa will need to develop a set of rates and distributions, regardless of broader efforts to define technology and legal frameworks. In general, the equity effects of mileage-based fees are like those of the fuel tax, but this also depends on how the fee varies based on geography/location and vehicle type.

  Finally, based on results of prior mileage-based user fee pilot projects, feedback from the participants indicate a preference to pay transportation-related taxes and fees a little at a time, as they current do with the fuel tax. As a result, the way a mileage-based user fee would be structured is likely to affect public perception this new source. Providing EV and PHEV owners with payment plan choices would provide support this pay a little at a time approach. Additionally, providing multiple payment plan options based on where and how often a person drives could also help reduce potential concerns about privacy and being charged for driving out-of-state. Examples of potential weight-and-distance payment plans are provided below:

  - **Option 1: Flat-Rate Plan**
    - Applicable to: electric motorcycles, light-duty electric vehicles
    - Ideal for: people who drive a lot, people who are very concerned about privacy and do not want to disclose their odometer data

- Flat rate is based on the vehicle's actual gross vehicle weight and the 85th percentile of miles driven per year (assumed to be 20,000 miles per year for illustrative purposes)
- Annual payment with option to pay in quarterly or monthly installments (county treasurers pass along administrative and payment processing fees at actual cost as they currently do)
- Example: 2-ton vehicle @ 20,000 miles/year

  $0.0075 x 2 x 20,000 = $300.00/year

- **Option 2: Odometer-based plan**
  - Applicable to: electric motorcycles, light-duty electric vehicles
  - Ideal for: people who drive mainly in Iowa and do not want to share details of their driving patterns
  - Owner must provide odometer reading at least once annually, during registration renewal
  - Owner may update odometer readings as often as they wish through a web portal
  - Odometer readings automatically checked if driver is stopped by law enforcement; major discrepancies subject to investigation and prosecution under existing law (Iowa Code 321.71)
  - Annual payment with option to pay in quarterly or monthly installments (county treasures pass along administrative and payment processing fees at actual cost as they currently do)
  - Quarterly/monthly payments adjusted automatically based on most-recent odometer reading and a projection of the user's anticipated mileage during the next billing period
  - Example: 1.8-ton vehicle driven 10,000 miles:

    $0.0075 x 1.8 x 10,000 = $135.00/year

- **Option 3: GPS-based plan**
  - Applicable to: all on-road vehicles (motorcycles, light-duty vehicles, buses, and heavy trucks)
  - Ideal for: people who frequently drive in another state, people who want maximum convenience, operators of buses and heavy trucks
  - Certified third-party vendors provide a GPS device. Distance driven in Iowa is determined based on vehicle location data and odometer readings from the vehicle's on-board diagnostics (OBD) port
  - Odometer readings and mileage driven in Iowa are automatically transmitted to the Iowa DOT server by the vendor each night (no collection of route traces by the state)
  - Vendor handles all aspects of revenue collection and remits applicable ton-mile fees to Iowa DOT (perhaps through a daily electronic funds transfer)
  - Vendor may add a surcharge for equipment, administration, and payment processing. All fees must be disclosed to the user. Iowa DOT would establish a website listing all certified vendors and their fees, and a calculator that allows the user to estimate the fees they would pay under each vendor's payment plan(s).
  - Example: 2.5-ton vehicle driven 12,000 miles:

    $0.0075 x 2.5 x 12,000 = $225.00/year + vendor surcharges

Alternative Funding Approaches for Iowa Roads

Final Report

May 2022

Appendix A: Equity Effects of Transportation Funding Alternatives

Sponsored by:

Iowa Highway Research Board and

Iowa Department of Transportation

(IHRB Project TR-790)

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Executive Summary

Vehicle registration fees and fuel taxes are currently the main sources of state transportation revenue in Iowa. The long-term viability of fuel taxes is questionable due to inflation in the cost of providing highways and public transportation services, technical advances that reduce the amount of fuel consumed per mile driven, and growing use of electric vehicles. To support informed discussion, this literature review identified alternatives to the fuel tax, with emphasis on the equity and distributional effects of switching to alternative revenue sources.

Although fuel taxes are currently the main source of transportation revenue at the Federal level, Federal tax rates have not increased since 1993, and the resulting overspending of the Highway Trust Fund has been backfilled with borrowed money. Iowa has been more successful at aligning fuel tax rates with changes in fuel consumption and the costs of providing transportation infrastructure, but many state and local leaders in Iowa recognize the challenges of sustaining the fuel tax in the long term.

As a result of technical advances and emissions reduction policies, sales of electric vehicles appear to be poised to grow rapidly in the next few years. Declining battery prices allow vehicle manufacturers to provide substantially greater driving range than was possible when electric vehicles were introduced a decade ago, overcoming the biggest consumer objection. Electric vehicles now account for over half of all new vehicle sales in some European countries, and as economies of scale reduce electric vehicle production costs, several major US and European automobile manufacturers have announced plans to begin phasing-out production of gasoline vehicles. With nearly 60% of electricity generated from wind in 2020 (Eller 2021), Iowa has the potential for a vehicle fleet with very low emissions.

Although Iowa implemented registration fee surcharges for hybrid and battery-electric vehicles (BEVs) in 2019, these flat-rate charges are problematic from an equity perspective because they have no relationship to the distance driven, and the surcharges currently do not generate as much revenue per vehicle as the fuel tax. Perceptions of these fees are also influenced by the way in which they are paid, with surveys consistently showing that drivers prefer to pay in small increments. This is the case for conventional vehicles: the state gasoline tax for a typical 12-gallon fill-up is $3.60. In contrast, the Iowa registration fee and surcharges are paid annually in a lump sum, which was around $450 for a typical BEV in 2022.

Midwestern states including Illinois, Indiana, Kansas, and Ohio have tollway systems and Minnesota has toll lanes in the Twin Cities, but Iowa currently has no toll roads. Three relatively minor toll bridges connect Iowa with neighboring states, but the state does not derive any revenue from them. Specifically, two Missouri River crossings on secondary roads near Omaha are owned by Nebraska-based commissions, and the Highway 9 bridge over the Mississippi River at Fort Madison is privately owned.

A systematic literature search was conducted to identify alternatives to registration fees and fuel taxes, with emphasis on the equity effects of these alternatives. The search indicates the main alternatives are distance-based driving fees (also called vehicle miles travelled [VMT] charges, mileage-based user fees [MBUF], or road user charges [RUC]), various forms of tolling

(including special-purpose lanes), and cordon charges to enter congested areas. Some jurisdictions devote a portion of property or sales tax revenue to transportation. Agencies also augment their revenue with miscellaneous charges such as parking fees, utility permit fees, or land development fees. An extensive list of potential taxes and fees (and their strengths and weaknesses) prepared by Lambert (2012) can be found in Table 22.

Although tolling can be an attractive method for funding new infrastructure, imposing tolls on an existing untolled facility is both politically and technically challenging. The economics of tolling favor high-volume facilities—ideally routes frequented by commuters who are willing to pay extra to reduce their travel time. Public-private partnerships (PPPs) are a form of tolling, with debt incurred the private partner repaid from toll revenues.

Cordon charges (also called congestion charges) have been successfully used to reduce traffic congestion in major cities such as London and Singapore. Typically they involve a fee to drive into the central business district, and often the resulting revenue is used to offset the cost of better public transportation to reduce the need for driving. Currently it is unlikely that any Iowa communities have enough congestion to support a cordon charge.

Electricity taxes are sometimes mentioned as a method for collecting revenue from electric vehicles. In Iowa, an excise tax on energy supplied by non-residential charging stations is scheduled to go into effect in July 2023. Nevertheless, the majority of electric vehicle charging currently occurs at home, often on Level 1 chargers that draw about the same amount of power as a portable heater. This makes it difficult to distinguish the energy used for vehicle charging from other household electrical loads.

With these limitations in mind, distance-based road user fees are likely to be the most practical alternative to the fuel tax for Iowa. The literature search found several studies that evaluated the equity impacts of switching from per-gallon to per-mile fees. Typically these analyses compare equity effects based on personal or household income, geographical areas (urban vs rural, or county-by-county), race/ethnicity, or vehicle classification (personal vehicles vs commercial trucks). The equity concerns stem mainly from data indicating that low-income people tend to drive older, less fuel-efficient vehicles than their wealthier counterparts. In addition, when measured as a percentage of their income, low-income people and the elderly currently tend to contribute more transportation revenue than middle-class or upper-income people. In general, these problems are neither solved nor worsened by a switch to distance-based charging, with nearly all studies finding that the equity impacts of per-gallon and per-mile taxation are very similar. When the total revenue to be collected is the same under both revenue systems, differences in the amounts paid by individual drivers are small (typically a few dollars per year).

Public outreach conducted for distance-based charging pilot projects consistently finds rural drivers are concerned they would contribute more revenue than urban drivers under a distance-based driving system. Agencies have typically responded by reminding drivers that this is already the case with fuel taxes, which are nearly proportionate to distance driven. Detailed studies of revenue distribution find that under a distance-based charging system, the share of the revenue contributed by rural drivers actually decreases slightly, because rural drivers tend to use less fuel-efficient vehicles than their counterparts in urban and suburban areas. With either

system, rural drivers pay more because they use the roads more, which is consistent with the "user pays" principle.

The literature review found very substantial inequities across vehicle classes, especially when the pavement and bridge damage caused by heavy trucks is taken into consideration. As shown in Table 1, the fuel taxes and registration fees contributed by a typical SUV or pickup registered in Iowa are about $1.56 per 100 ton-miles driven, while the contribution from a tractor-trailer (semi) is about $0.18 per 100 ton-miles. An analysis from Indiana yielded broadly similar results, with drivers of passenger vehicles found to be subsidizing the pavement and bridge damage caused by heavy trucks. This could be resolved by charging for road use based on a combination of weight and distance, such as each vehicle's rated equivalent single-axle load (EASL) and the distance driven. Some sources note that weight-and-distance fees are the norm on toll roads (sometimes with length or number of axles serving as a proxy for the truck's weight).

Table 1. Comparison of per-mile and per ton-mile costs for vehicle registration and fuel taxes in Iowa

Vehicle Type	**SUV or Pickup**		**Farm Truck**		**Tractor-Trailer**	
Gross vehicle weight (lb)	4,000		64,000		80,000	
Iowa registration fee (typical)		$200		$705		$1,725
Typical miles Driven/yr [source]	12,415	NHTS	11,687	FHWA	63,374	FHWA
Typical Ton-miles driven	24,830		373,984		2,534,960	
Typical miles/gallon	20		6.5		6.5	
Fuel consumed/yr (gal)	620.8		1,798.0		9,749.8	
Iowa fuel tax/gal [fuel type]	$0.300	gasoline	$ 0.304	B11 diesel	$ 0.304	B11 diesel
Typical tax paid		$186		$547		$2,964
Total state revenue		**$386**		**$1,252**		**$4,689**
per mile driven		$0.0311		$0.1071		$0.0740
per 100 miles driven		**$3.11**		**$10.71**		**$7.40**
per ton-mile		$0.0156		$0.0033		$0.0018
per 100 ton-miles		**$1.56**		**$0.33**		**$0.18**

Several of the sources identified in the literature review discuss potential obstacles to the implementation of distance-based road user charges. These include privacy concerns, technical issues related to the method of charging, and the perceived cost of devices for monitoring the distance driven:

- Concerns about the complexity of collecting distance-driven data are prominent in publications from the pre-smartphone era, when it was assumed that it would be costly to equip each vehicle with a specially-designed GPS and data transmission system. Since the first smartphone became commercially available in 2007, uptake has been rapid. With the growing ubiquity of smartphones and the commercialization of GPS trackers for fleet applications, more recent publications compare and contrast the technical merits of competing products and systems. Concern over costs appears to

have declined; as of early 2022, the retail price of a GPS vehicle tracker with a lifetime data plan was around $75.

- Although privacy concerns continue to require policy consideration, data anonymization has become a field of study in itself (Raghunathan 2013). One approach is to aggregate the mileages driven in each jurisdiction within the on-board unit, and transmit only summary data to the central server. Several authors suggest offering road users the option of an odometer-based pricing plan that does not require disclosure of routes driven. In a recent survey of nearly 40,000 Hawaii drivers, 86% said they would prefer mileage fees to be based on odometer data from the state's existing annual vehicle safety inspections, an option that also avoids the need for any additional in-vehicle equipment.
- Some authors address the computation and allocation of revenue when a vehicle registered in one state is driven in another state. For commercial vehicles, this problem is addressed by the International Fuel Tax Association (IFTA). Each IFTA member state requires trucking companies and bus lines to log and report the mileages driven in each US state or Canadian province, and the IFTA acts as a clearinghouse to allocate revenue accordingly. This allows each state or province to collect fuel tax from trucks that are passing through, even if the fuel was purchased elsewhere.
- Relatively little research appears to have been conducted on the extent of revenue leakage when drivers of non-commercial vehicles purchase fuel in another state. An Indiana study focusing on fuel sales to non-commercial vehicles found that out-of-state vehicles purchase about 20% of the fuel sold at stations on Indiana Interstate highways and 12% of the fuel sold at stations on other Indiana roadways. The study did not attempt to determine how much fuel Indiana drivers purchase in other states, which would be necessary to evaluate the net effect on tax revenue. Cross-border fueling might be relatively high in Indiana due to the geography of the state's road network and the presence of metropolitan areas that straddle its state lines, such as Chicago-Gary and Louisville-Jeffersonville-Clarksville.
- To address revenue from out-of-state vehicles under a distance-based charging system, a few authors have suggested establishing a daily permit system for out-of-state non-commercial vehicles. The establishment of a Federal clearinghouse or multi-state collaboration similar to the IFTA could simplify cross-jurisdictional payments.

Several sources tackle the issue of phase-in of a distance-based charging system. One potential approach is to introduce weight-and-distance-based charging for electric vehicles, while retaining the fuel tax gasoline and diesel vehicles. Thus, by selecting a gasoline or diesel vehicle, road users could "opt out" of the distance-based charging system. A related suggestion is to have an odometer-based pricing plan as the default for distance-based charging, while also giving drivers the option of selecting a GPS-based plan to avoid charges for out-of-state mileage.

Taken as a whole, the research and policy papers found by the literature search provide the following insights:

- The main inequity in the existing transportation funding system is that the revenue contributed by heavy trucks is not proportionate to their impacts on roads and bridges. This could be addressed by a weight-and-distance based charging system for commercial motor vehicles. Such a system would be consistent with the way commercial vehicles are charged for the use of toll roads.
- For personal vehicles with conventional gasoline or diesel powertrains, the existing combination of registration fees and fuel taxes is generally consistent with the “user pays” principle.
- The equity of registration fee surcharges for hybrid and electric vehicles is doubtful because they are unrelated to distances driven, impacts to roads and bridges, or ability to pay. A weight-and-distance fee system for hybrid and electric vehicles would allocate these costs more equitably.
- Most drivers prefer to pay in small installments. For distance-based charging, most prefer simple systems based on odometer readings, which are also administratively efficient and can potentially be linked to odometer data already being collected for other purposes. Drivers who live in urban areas that straddle state lines (such as the Quad Cities, Omaha-Council Bluffs, and Sioux City) are likely to be interested in a GPS-based option that can determine the mileage driven in each state.
- Although the International Fuel Tax Association provides a platform for collecting weight-and-distance fees from out-of-state trucks, methods for collecting revenue from out-of-state personal vehicles have rarely been studied.
- In all cases, per-gallon or per-mile rates require periodic adjustments to account for changes in buying power, perhaps through indexing to inflation metrics.

To support an informed discussion of the revenue effects of a partial fuel tax on off-road diesel fuel (“dyed diesel” or “red diesel”), the literature review also gathered information about the proportions of off-road diesel that are used for various purposes, such as agricultural production, rail freight, maritime shipping, and electricity generation. The U.S. Energy Information Administration (EIA) estimates that nationally, approximately 29% of diesel fuel consumed for non-highway purposes is used in agriculture. When considering the revenue potential of a partial fuel tax on dyed diesel, it is necessary consider the quantities of tax-exempt fuel used by school buses, public transit buses, paratransit vans, and other government vehicles. It is also necessary to consider which uses of dyed diesel would be subject to state sales tax (at the current price of about $3.00/gallon, dyed diesel used for non-agricultural purposes generates approximately $0.18/gallon of state sales tax revenue).

1 Introduction

Transportation agencies in the United States have traditionally obtained the vast majority of their revenue from a combination of fuel taxes and motor vehicle registration fees, which are often augmented at the local level by property taxes. This combination of revenue sources is increasingly under pressure due to improvements in fuel economy and the growing market share of electric vehicles (EVs).

A recent report from a major oil company states that, “A healthy planet requires a transition of the energy system from one that relies primarily on fossil fuels to one that increasingly uses sustainable sources of energy to achieve net-zero emissions” (Shell International 2018, 2021). Several US states have established policies intended to stimulate adoption of electric vehicles or promote investment in industries related to vehicle electrification such as wind power and battery manufacturing. Thus, a central policy dilemma for the years ahead is how to incentivize the purchase and use of electric vehicles while still obtaining sufficient revenue for highways and public transportation.

The equity effects of altering the transportation revenue mix have been extensively studied. A systematic process was used to identify relevant research literature and white papers published since 2003. The process began with development of search terms, which were applied in four academic research databases (Ebsco Host Academic Search Ultimate, Gale Academic Onefile, ScienceDirect, and TRID [Transport Research International Documentation]). After removing duplicates, a total of 316 publications meeting the search criteria were found. The publications were then screened, first on the basis of their titles and abstracts, and then on the basis of the full text. This resulted in 58 publications relevant to the present study, which are summarized or referenced in this report, and two additional publications found separately.

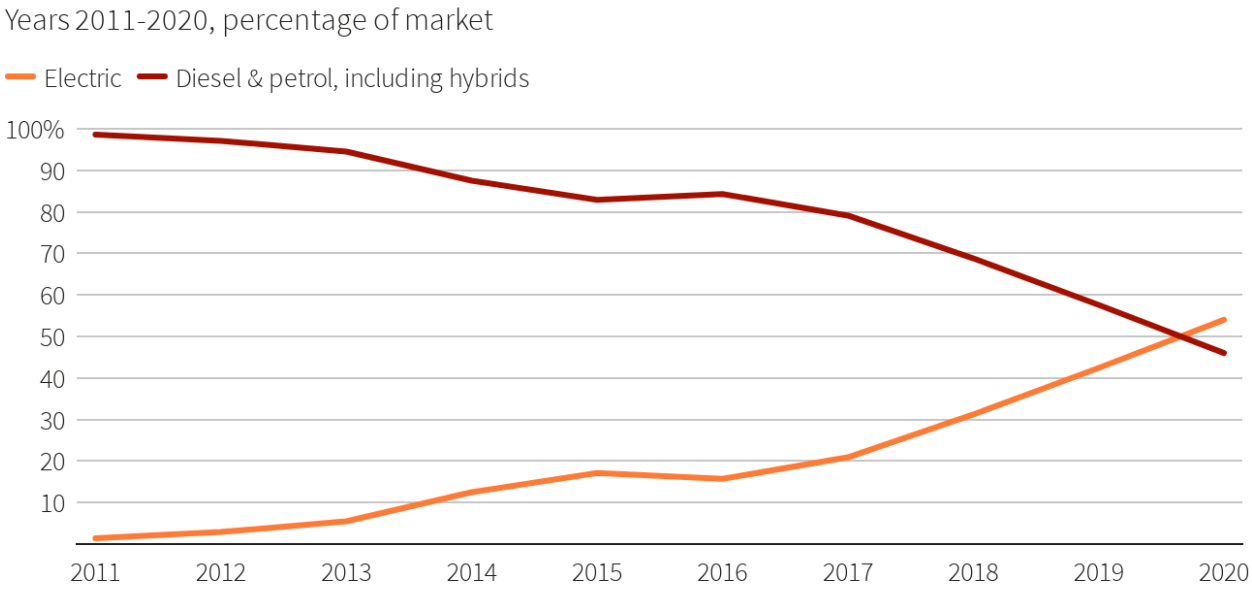
The extensive research literature on this topic in part reflects ongoing concerns about the sustainability of transportation funding at the national level, specifically the Highway Trust Fund which is funded primarily from the Federal taxes on gasoline and diesel fuel. For decades, the revenue generated by the Federal fuel tax has been insufficient to keep up increases in the cost of road construction and the declining condition of roadways that are eligible for Federal aid (Poole 2019). For example, in 2020 the Highway Trust Fund had income of $43 billion and expenditures of $58 billion (FHWA 2021). Shortfalls have been addressed mainly through transfers from the general Federal budget, contributing to the growth of the national debt. During the same time period, state fuel taxes in Iowa have been adjusted several times to keep up with inflation in the cost of road construction, growth of the roadway system, and improvements in vehicle fuel economy.

1.1 Vehicle Electrification

Electric vehicles (EVs) and plug-in hybrid vehicles have been commercially available for a decade, with technical advances leading to increasing customer acceptance. As the transition from petroleum-based fuels to electric propulsion continues, the need for alternatives to the fuel tax will intensify.

Uptake of electric vehicles has been particularly rapid in Northern Europe. For example, more than half of all new cars sold in Norway in 2020 were EVs (Figure 1). In November 2020, the British government announced plans phase out the sale of gasoline and diesel fuel powered cars by 2040, and in July 2021 the plan was extended to heavy trucks (Jolly 2020, Reuters 2021). In November 2021, six automobile manufacturers (Ford, Jaguar Land Rover, Mercedes-Benz, General Motors, Volvo, and Chinese automaker BYD) announced plans to phase-out gasoline-powered models in Europe and other major markets (Plumer and Tabuci 2021). Separately, Ford announced that by mid-2026, 100% of its European passenger vehicle models will be zero-emissions capable, all-electric, or plug-in hybrid; moving to all-electric by 2030 (Ford Europe 2021).

Figure 1. New car sales in Norway: market shares of electric vehicles (orange line) and conventional diesel & petrol/gasoline vehicles (red line)



Source: Norwegian Road Federation (OFV)

For Iowans, the introduction of electric pick-ups such as the Ford F-150 Lightning in the second half of model year 2022 could be a milestone in EV acceptance. According to reports in the automotive press, the Lightning is expected to outperform the F-150 gasoline models in horsepower, torque, towing capacity, and acceleration. Reportedly, the vehicle will offer up to 300 miles of driving range (slightly less than the distance from Davenport to Cedar Rapids) and will be priced comparably to the gasoline and hybrid versions with similar trim levels.

Finally, at least six manufacturers have begun commercial production of electric heavy-duty trucks, or plan to do so in calendar year 2022. These companies are Freightliner, Kenworth, Mack, Navistar, Tesla, and Volvo.

1.2 What is Equity?

With revenue shortfalls and changes fuel economy and energy sources forcing reconsideration of the way transportation infrastructure and public transit are funded, several authors have offered suggestions about the characteristics of an ideal revenue source. To some extent, these criteria reflect differing definitions of equity.

In an analysis of the equity impacts of revenue sources used to fund the local share of public transportation projects, Lowe and Hall (2019) summarize several philosophical notions of equity, which can be categorized as outcome, opportunity, or market equity. Outcome equity is achieved when expenditures are organized to provide equal levels of transportation services, regardless of revenue contribution patterns. For opportunity equity, all spending is equal, but not necessarily transportation system outcomes. Market equity is achieved when benefits received are proportional to revenue contributions. For public transit services, some examples are:

- Outcome Equity: All arterial streets in a city have bus service at the same frequency, say one bus every 20 minutes.
- Opportunity Equity: Per-capita expenditures for public transit service are proportional to the number of non-car-owning households in each district of the city.
- Market Equity: Per-capita expenditures for public transit service are proportional to the total bus fares paid in each district of the city.

Alternately, some transportation scholars speak in terms of vertical and horizontal equity. Horizontal equity considers whether all members of a group are treated the same by the financing mechanism. Vertical equity considers equity across different groups, often based on the “ability to pay” principle. Continuing the public transit examples:

- Horizontal Equity: All transit agencies in a state have the same fare structure.
- Vertical Equity: Low-income seniors get a discounted fare.

Each of these concepts can be analyzed across various stakeholder categories, such as income levels, age groups, racial/ethnic groups, geographical areas, or vehicle classifications.

Thus, depending on one’s point of view, contributions to transportation revenue should be:

- Proportionate to the distance each vehicle is driven
- Proportionate to the amount of damage each vehicle does to roads and bridges
- Proportionate to the distance driven (or pavement damage done) within each individual jurisdiction, e.g., individual cities, counties, and states
- Proportionate to each vehicle’s environmental impact, i.e., higher for vehicles that emit more pollutants
- Proportionate to each driver’s income or ability to pay

Table 2. Comparison of vehicle-miles traveled by Iowa households. Source: 2017 National Household Travel Survey

Area Type	Estimated Annual Vehicle-Miles Travelled per Driver
By Census Classification	
Urban (as defined by US Census)	9,864
Rural (as defined by US Census)	16,554
All	**12,415**
By Claritas Urbanicity Classification	
Second City*	6,644
Suburb	12,272
Small Town	11,041
Rural	16,821
All	**12,415**

* ***The Claritas Urbanicity Model defines "second city" as a population center with a population density that is moderate in comparison to cities such as New York and Chicago. All of Iowa's larger cities are in this category.***

Some sources suggest that an ideal revenue system would also support the implementation of financial incentives to encourage desirable behaviors. For example, drivers might be charged slightly less if they choose a safer or less-congested route.

Beyond these equity considerations, revenue systems also need to be practical to implement, easy to understand, and difficult to cheat. Conventional fuel taxes generally score very well in these aspects: the tax is imposed at the producer level, so the number of organizations remitting revenue and being overseen for potential improprieties is quite small. A notable exception is tax-exempt diesel fuel intended for off-road or industrial use, which can easily be diverted to on-road vehicles (Marion and Muehlegger 2008).

Differences in the travel behavior of urban and rural road users present important challenges for the definition and measurement of equity. As shown in Table 2, according to the 2017 National Household Travel Survey (NHTS), an Iowa motorist living in an urban area typically drives a little under 10,000 miles per year, while a typical rural driver racks up more than 16,000 miles. When city size is taken into consideration the differences are even more dramatic: the average distance driven is about 6,600 miles per year for a driver living in a city such as Des Moines or Cedar Rapids, about 12,000 miles per year for a driver living in suburbia or in a small town, and nearly 17,000 miles for a rural driver.

Several authors have analyzed geographical differences in the allocation of costs under different policy proposals. Under the existing fuel tax, rural drivers tend to pay more tax than urban drivers because their trips are usually longer, and the Table 2 data suggests this is almost certainly the case in Iowa. A counterpoint is that some rural roads are so lightly traveled that they do not generate enough revenue to cover the cost of their operation and maintenance.

1.3 Responses to Revenue Challenges.

State and federal transportation funding mechanisms based on gasoline and diesel fuel taxes are becoming increasingly problematic due to improvements in fuel economy and inflation-related decreases in purchasing power (Aultman-Hall, Glitman, and Kenyan 2010). One potential response is to increase vehicle registration fees. The main difficulty with this approach

is that registration fees are not proportionate to distance driven. As revenue systems become more dependent on a fixed fee, a greater share of the overall cost of building, operating, and maintaining transportation infrastructure is borne by drivers who use their vehicles lightly, such as seniors and urban residents (Varn, Eucalitto, and Gander 2020). In addition, fuel taxes are paid incrementally (a few dollars per fill-up) which allows drivers to spread the cost over time. In contrast, registration fees are traditionally structured as a lump-sum annual payment.

Various alternative revenue sources have been proposed, such as distance-based road user fees and charging tolls for the use of major highways. Related research literature is summarized in the sections that follow, with emphasis on the equity and distributional effects of various policy options.

Off-Road Diesel Fuel. Although no research was found on the equity effects of taxing off-road diesel fuel, information about the uses of off-road diesel was obtained.

In Iowa, fuel used by agricultural equipment such as tractors, crop sprayers, harvesters (combines), irrigation pumps, and grain dryers is exempt from fuel tax. Typically this is accomplished by supplying the equipment with off-road diesel fuel, also known as “dyed diesel” or “red diesel” because it contains a colorant to distinguish it from on-road or “clear” diesel. Red diesel is subject to state sales tax when it is used in equipment such as boats, construction equipment, generators, and refrigeration units, but Iowa law allows producers to claim a sales tax refund for all supplies used in agricultural production, including diesel fuel.

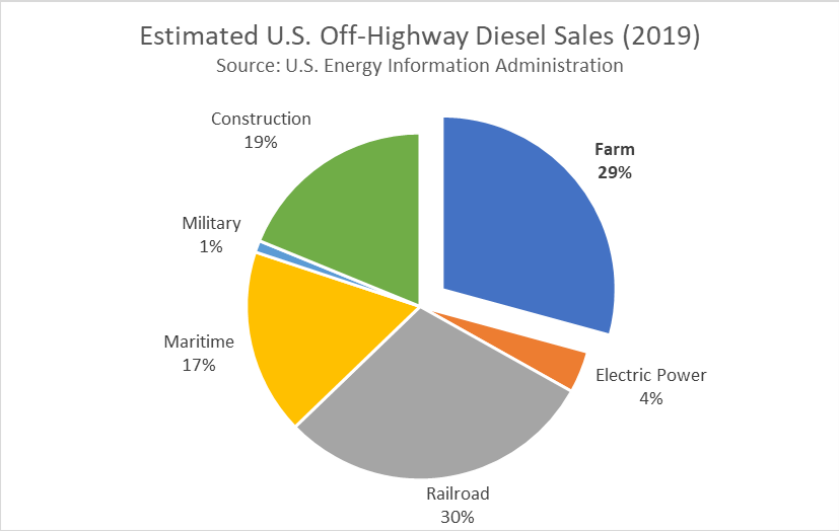
In recent years there have been proposals for a partial tax on dyed diesel (Petroski 2013). While this may be viewed primarily as a way to generate additional revenue, it also addresses concerns related to Iowa’s current taxation policy related to agricultural equipment:

- Agricultural equipment is frequently driven on highways to gain access to fields, or to dispose of waste from concentrated animal feeding operations (CAFOs). The equipment used for these purposes is large and heavy. Iowa law exempts overweight agricultural vehicles from the permitting process that applies to other traffic, leading to worries that weight limits on secondary roads are being exceeded regularly.
- Iowa has many unattended automatic diesel fuel dispensers, where anyone can purchase off-road diesel fuel using a credit card. These dispensers are usually in service 24 hours a day, and are typically located well away from settlements, so it is not particularly difficult to put off-road fuel in an on-road diesel vehicle surreptitiously. In addition, many agricultural, commercial, industrial customers receive bulk deliveries of off-road diesel to private storage tanks, creating the potential for diversion to on-road vehicles. Although there are substantial fines for the illegal use of off-road fuel, detection is labor-intensive, enforcement resources are limited, and the primary responsibility for enforcement is at the Federal level (Marion and Muehlegger 2008).

As shown in Figure 2, the U.S. Energy Information Administration (EIA) estimates that nationally, approximately 29% of diesel fuel consumed for non-highway purposes is used in agriculture (EIA 2021b). Other uses of red diesel include railroad locomotives, maritime vessels, construction equipment, electricity generation, and military equipment. Red diesel is also used

by tax-exempt entities such as school districts and public transit systems, and this appears to be categorized as on-road use by EIA.

Figure 2. Estimated off-road diesel fuel sales (2019). Source: US Energy Information Administration



1.4 Strategies Excluded from the Literature Reviews

The use of public-private partnerships (PPPs) was not considered in the review, as this is simply an implementation mechanism for a tolling system. In a PPP the private partner typically fronts the cost of the project (or part of the cost), and then endeavors to recover the investment (and eventually earn a profit) through road user fees or tolls. High Occupancy Toll (HOT) lanes were also excluded, because it is unlikely any Iowa locations have enough traffic to justify a dual system of tolled and untolled lanes for personal vehicles.

Another revenue-related policy proposal, already implemented in a handful of cities such as London, Gothenburg (Sweden), Milan (Italy), and Singapore, is congestion charging (also called a cordon charge). Under a congestion charging system, commuters pay a daily fee to use the streets in a designated, highly-congested area of a city (usually the central business district). Typically, the fees are quite high to discourage most commuters from entering the charging zone. This can greatly reduce delays for the remaining vehicles, allowing exempt vehicles such as buses, taxis, and bicycles to circulate freely. In most cases, revenue generated by the congestion charge is used to fund improvements to the public transportation system, such as more frequent bus and train services. A considerable amount of research has been conducted on the equity effects of congestion charging, but that literature was not reviewed for this report because it is unlikely any Iowa cities have enough traffic to warrant a congestion charging system.

1.5 Existing Iowa Transportation Revenue Sources

1.5.1 Fuel Taxes

As shown in Table 3, people who buy gasoline in Iowa currently pay a total of $0.4840 per gallon in Federal and state fuel taxes, which is close to the national average of $0.4856. Iowa buyers of on-road diesel fuel pay taxes totaling $0.5690 per gallon, which is similar to the national average of $0.5642 (EIA 2021a). Among the 50 states, Alaska has the lowest combined Federal and state taxes, $0.2735 for gasoline and $0.3335 for diesel. The highest rates are in Pennsylvania, $0.7710 for gasoline and $0.9960 for diesel. The Federal portion of the tax is $0.1840 per gallon for gasoline and $0.2440 for diesel fuel.

The Iowa fuel tax for standard diesel fuel is currently about 8% more than the tax on standard gasoline. This is slightly less than the difference in the energy content of the two fuels: a gallon of diesel contains about 14% more energy than a gallon of gasoline (137,381 BTU/gal for diesel; 120,286 BTU/gal for gasoline) (EIA 2021c).

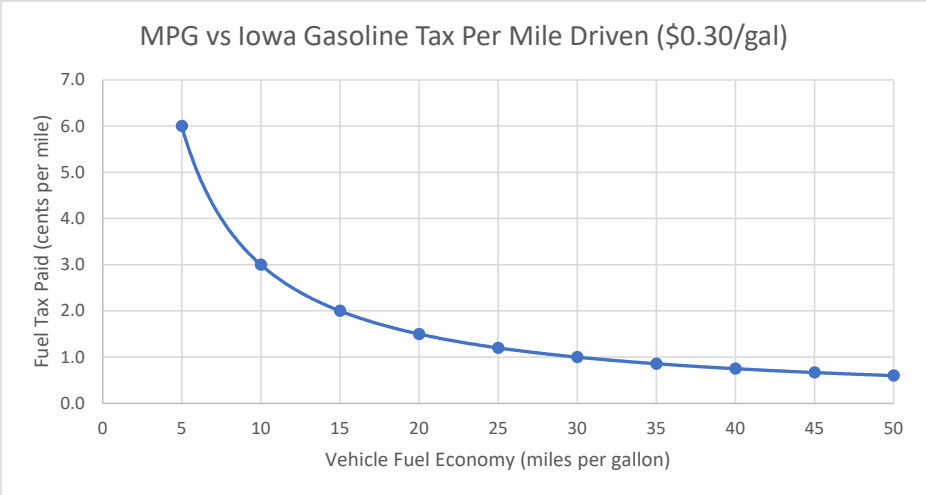
As shown in Figure 3, the fuel tax collected per mile driven is a function of the vehicle's fuel economy. For example, at the current Iowa tax rate of $0.30/gallon, a vehicle that achieves 15 miles per gallon pays $0.02/mile, while a vehicle that achieves 30 miles/gallon pays $0.01/mile. According to the US EPA, nationwide the average fuel economy of light-duty vehicles is around 25 miles/gallon; at the Iowa tax rate this is equivalent to 1.2 cents per mile.

The Federal motor fuel taxes of 18.4 cents per gallon for gasoline and 24.4 cents per gallon for diesel fuel have not changed since 1993. If the change in the Consumer Price Index (CPI) is taken into consideration, as of 2021 the real value (in 1993 dollars) had decreased to 9.72 and 12.9 cents per gallon, respectively (Bureau of Labor Statistics 2021). In other words, to have kept up with the rate of general inflation, the tax rates in 2021 would need to have been 34.8 and 46.2 cents per gallon, respectively.

Table 3. Federal and State of Iowa fuel tax rates effective July 1, 2021. Sources: U.S. Energy Information Administration, Iowa Department of Revenue

Federal fuel tax rates per gallon	
Fuel Type	**Tax Rate**
Gasoline (including $0.001 LUST fee*)	$0.184
Diesel (including B-10) (up to 10% biodiesel)	$0.244
*Leaking Underground Storage Tank Trust Fund	
Iowa fuel tax rates per gallon	
Fuel Type	**Tax Rate**
Gasoline	$0.300
Alcohol	$0.240
E-10 to E-14 (10% to 14% ethanol)	$0.300
E-15 or Higher (15% to 100% ethanol)	$0.240
Diesel (including B-10) (up to 10% biodiesel)	$0.325
Biodiesel B-11 or Higher Undyed (11% to 100% biodiesel)	$0.304
Aviation Gasoline	$0.080
Aviation Jet	$0.050
Liquefied Petroleum Gas (LPG)	$0.300
Liquefied Natural Gas (LNG)	$0.325
Compressed Natural Gas (CNG)	$0.310
Hydrogen (per diesel equivalent gallon)	$0.650
Combined tax per gallon (Federal + Iowa)	
Fuel Type	**Tax Rate**
Gasoline	$0.484
Diesel (including B-10)	$0.569

Figure 3. Vehicle fuel economy vs fuel tax paid per mile driven, based on a fuel tax of $0.30 per gallon.



1.5.2 Fuel Tax Exemptions

In Iowa, fuel used by government agencies, school districts, mass transit systems, and fire departments is exempt from taxation (Iowa Department of Revenue 2016). Diesel fuel used for non-highway purposes is exempt from fuel tax but subject to state sales tax, unless the fuel is used for a tax-exempt purpose such as agricultural production. Fuels subject to fuel tax are exempt from sales tax.

In Iowa, fuel used on-reservation by Native American tribes and their members is tax-exempt. The effect on overall revenue is limited, since Iowa has only one Federally-recognized tribe, the Meskwaki Nation (also known as the Sac & Fox Tribe of the Mississippi) with approximately 1400 members (Meskwaki Nation 2019).

1.5.3 Commercial Vehicles – Allocation of Taxes for Interstate Commerce

Membership in the International Fuel Tax Association (IFTA) allows Iowa to collect fuel tax from trucks that are passing through the state, even if the fuel was purchased elsewhere. Under the IFTA agreement, fuel taxes collected from interstate trucking companies and bus lines operating vehicles weighing over 26,000 pounds are adjusted based on the mileage driven in each state or Canadian province, regardless of where fuel was purchased (IFTA 2020). Nearly all US and Canadian jurisdictions participate in the IFTA (the exceptions are Alaska, Hawaii, and the District of Columbia in the US, and the Northwest Territories, Nunavut, and Yukon in Canada).

1.5.4 Vehicle Registration Fees

Vehicle registration fee structures vary significantly from state to state, making rate comparisons difficult. Some states assess a flat fee, while others tie the fee to characteristics such as gross vehicle weight, vehicle age, or fuel efficiency.

In Iowa, the factors considered for light-duty passenger vehicles are vehicle age, list price, and weight; a typical fee is around $200 per year. Supplemental fees for hybrid and electric vehicles were phased in from 2020 to 2022. As of January 2022, the supplemental fee is $65 for hybrid vehicles and $130 for plug-in electric vehicles.

Iowa annual registration fees for heavy trucks and buses are proportionate to vehicle weight, ranging from $150 or less for a three-ton vehicle to $1,695 for a 40-ton vehicle. Lower fees apply to trucks used in agriculture. The fee for a semi-trailer is $30. There are also specific fees for various types of two-wheelers, along with specialty vehicles such as antique cars, ambulances, and motorhomes. School buses and public transit buses pay no fee.

1.5.5 Commercial EV Charging Stations

Based on an analysis by Iowa DOT (Iowa DOT 2018), the Iowa legislature authorized a per kilowatt-hour (kWh) excise tax on electricity used for non-residential charging of electric vehicles. When implemented, the fee will apply to commercial charging stations. In 2018 it was estimated that 80% to 90% of all passenger electric vehicle charging occurs at residences, but this share could decline with build-out of fast-charging infrastructure.

1.5.6 Toll Facilities in Iowa

There are currently no toll roads in Iowa. Several bridges connect Iowa with neighboring states, but tolls are currently charged only at three bridges with limited traffic volumes:

- Mississippi River crossing on IA 9/IL 9 at Fort Madison, owned by BNSF Railway
- Missouri River crossing on Livingston Road/Lambert Avenue (County Highway L35) near Plattsmouth, Nebraska, owned by the Plattsmouth Bridge Commission.
- Missouri River crossing on Mission Avenue/County Highway H10 on the south side of the Omaha-Council Bluffs metropolitan area, owned by the Bellevue Bridge Commission.

The three facilities have no impact on the overall cost and revenue for transportation in Iowa, since the Fort Madison bridge is privately owned and maintained, and the Missouri River bridges are owned and maintained by independent commissions chartered in Nebraska.

1.6 Economics Glossary

Many of the publications identified by the literature review rely on concepts from the academic study of economics. Some frequently-used terms are briefly defined below:

- **Consumer Surplus:** The concept of consumer surplus begins with the idea that, in the long run, there is an equilibrium between supply and demand for transportation fuels. When fuel prices go down, households tend to drive more. When fuel prices increase, oil companies tend to produce more fuel. The market is in equilibrium when the fuel price reaches a level where the quantity demanded by households is equal to the quantity supplied by producers. At this level, some households are driving as much as they want to, but would have been willing to pay more than the current market price for fuel. These households benefit from a "consumer surplus" equal to the difference between the market price and what they would have been willing to pay. This consumer surplus can be saved, invested, or used to purchase other goods and services.
- **Externality:** A cost that is borne by someone else. For example when a trucking company fails to maintain its fleet properly and the company's drivers inhale soot that results in respiratory problems, the company is externalizing the health costs associated with poor maintenance to their employees, their health insurance company, or to public programs such as Medicaid.
- **Marginal cost:** The additional cost of producing or consuming one more unit of a product or service. For example, the cost of driving the extra mile when a detour increases the length of a trip from 100 miles to 101 miles.
- **Welfare:** The economic and social wellbeing of the public. (In the publications identified by the literature review, this term does *not* refer to public assistance programs for low income or elderly people).

1.7 Stakeholder Groups

Many of the publications identified in the literature review discuss the equity and distributional effects of transportation revenue policies from the perspective of specific stakeholder groups. As shown in Table 5, the most-frequently mentioned group is low-income drivers. Several publications discuss environmental impacts of revenue policies on vehicle emissions, noise, or traffic congestion, which affect a wide range of stakeholders. Some publications address

additional stakeholders such as elderly drivers, rural drivers, property owners, or the trucking industry.

Table 4. Stakeholder groups discussed in each publication

Year	Author	Stakeholder Groups Discussed						
		Environ-mental	Low Income Drivers	Elderly Drivers	Drivers in General	Property Owners	Trucking Industry	Other
2003	Mayeres	✓	✓					
2005	Link	✓					✓	
2010	McMullen, Zhang, and Nakahara		✓					
2010	Aultman-Hall, Glitman, and Kenyan	✓						
2010	Sana		✓					
2010	Zhao	✓				✓		Commercial real estate market
2011	Coyle et al.					✓		
2011	Weatherford, Brian A.				✓			
2011	Robitaille, Andrea M.							
2012	Dutta and Patel						✓	
2012	Lambert	✓	✓				✓	
2012	Weatherford		✓	✓				
2012	Zhang and Lu		✓					
2012	Junge and Levinson		✓	✓				
2013	Burris et al. 2013	✓	✓	✓				
2013	Zhang and Lu	✓	✓	✓				
2013	Ungemah	✓						
2014	Duncan				✓			
2014	Welch and Mishra		✓		✓			
2015	Zhao et al.	✓	✓					
2015	Niemeier	✓	✓					
2016	Yang, Kastrouni, and Zhang		✓					
2017	Agrawal	✓	✓				✓	In-state vs out-of-state drivers
2017	Dumortier, Zhang, and Marron	✓	✓					Rural drivers
2017	Pulipati	✓	✓				✓	
2017	Kastrouni		✓					
2017	Schleith		✓					Rural users
2018	Adler, Peer, and Sinozic	✓	✓	✓				
2018	Jenn		✓					
2018	Wang and Miao	✓	✓					
2019	Davis and Sallee	✓	✓					
2019	Bayen et al.	✓					✓	
2019	Wee, Coffman, and La Croix	✓						
2019	Jia et al.	✓						
2019	Lowe		✓					Racial minorities
2019	Van Velzen,	✓						
2019	Schroeckenthaler	✓	✓					
2019	Poole						✓	
2020	Agrawal				✓			
2020	Fisher	✓	✓					
2020	Varn		✓					
2021	Matthews	✓						

Sources that did not address stakeholder groups specifically are excluded from the table.

2 Literature Review Methodology

A systematic process was used to identify publications related to the equity effects of changing the revenue sources used for transportation. The process began with development of search terms, which were applied in four academic research databases to identify academic papers, research reports, and white papers (policy recommendations) published since 2003. Table 6 lists the search terms and databases, including search strategy customizations made necessary by technical limitations of certain databases.

As shown in Table 7, the database searches yielded a total of 450 publications, of which 134 were duplicates. A two-step process was used to screen the remaining 316 publications for relevance. In the first step, publication titles and abstracts were reviewed. This process resulted in the elimination of 118 non-relevant publications. The team then attempted to obtain the full text of each of the remaining 198 publications, and full-text was successfully obtained for 188. The full text of each of the 188 publications was then reviewed for relevance to the present study. This process resulted in the exclusion of 140 studies addressing topics such as public transit fare policies, tolling costs and benefits, effects of taxation on emissions or fuel consumption, and policies for promoting the purchase and use of electric vehicles. This resulted in the 58 publications deemed relevant to the present study, which are summarized or referenced in this report. Two additional publications found through subsequent manual searches are also included.

Table 5. Search terms for literature review.

Search Term	Database			
	TRID	Ebsco Host Academic Search Ultimate	Science Direct	Gale Academic Onefile
"fuel tax" AND (equity OR welfare OR fairness OR distributional effects)	✓	✓	✓	✓
("distance based charge" OR "distance based charging" OR "mileage base user fee" OR "mileage based user fee" OR "road user charging" OR "VMT tax") AND (equity OR welfare OR fairness OR distributional effects)	✓	✓	NO RESULTS	✓
"distance based charge" AND (equity OR welfare OR fairness OR distributional effects			□	
("mileage base user fee" OR "mileage based user fee" OR "road user charging" OR "VMT tax") AND (equity OR welfare OR fairness OR distributional effects)			□	
"distance based charging" AND (equity OR welfare OR fairness OR distributional effects			□	
(toll OR tolling OR "road pricing") AND (equity OR welfare OR fairness OR distributional effects)	✓	Unfocused Results	Unfocused Results	✓
transportation revenue AND (equity OR welfare OR fairness OR distributional effects)	✓	Unfocused Results	Unfocused Results	✓
transportation funding AND (equity OR welfare OR fairness OR distributional effects)	✓	Unfocused Results	Unfocused Results	✓

Legend	
✓	Search Completed
No Results	No results or results not relevant
Unfocused Results	Not usable due to excessive number of off-topic results

Table 6. Disposition of publications based on PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)

PRISMA Statistics – Literature Review

450 references imported for screening
- 134 duplicates removed

316 studies screened against title and abstract
- 118 studies excluded

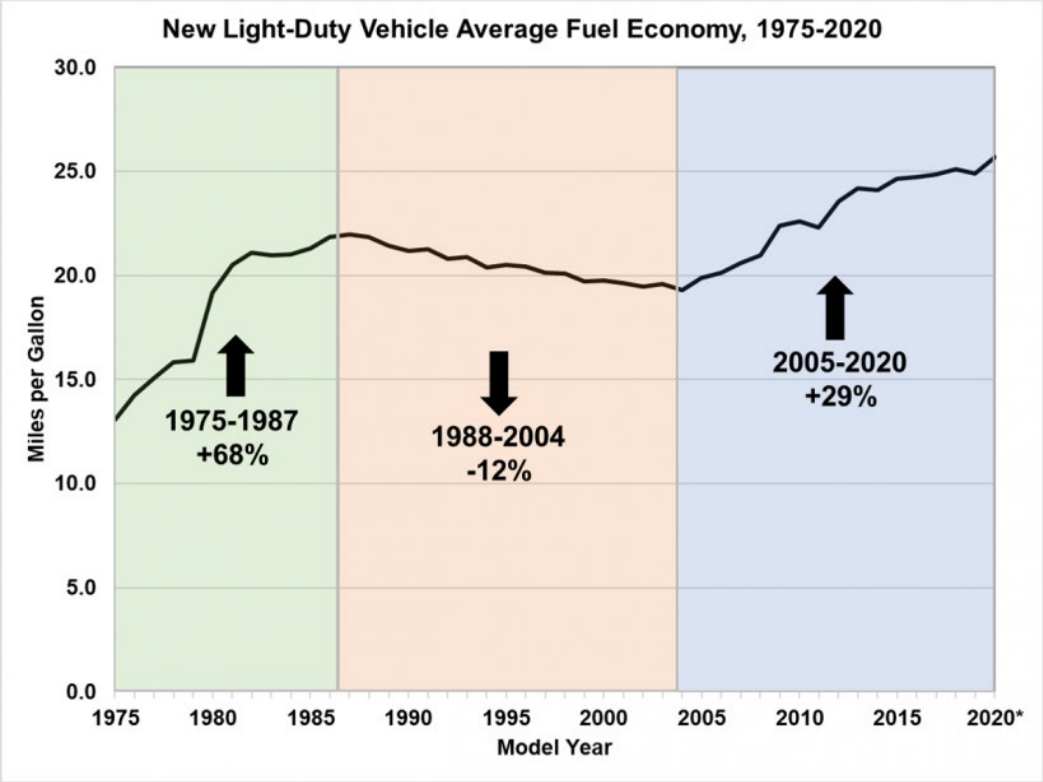
198 studies assessed for full-text eligibility
- 140 studies excluded
  - 30 Public transportation fare policies
  - 29 Tolling costs and benefits
  - 13 Not transportation-related
  - 10 Full text unavailable
  - 10 Non-academic articles (not peer-reviewed)
  - 8 General effects of taxation on emissions or fuel consumption
  - 6 Accelerate EV adoption
  - 5 Effects of electric vehicles on energy consumption
  - 4 Assessments of EV charging infrastructure
  - 4 Duplicates
  - 4 Tax policy effects on mode choice
  - 3 Congestion pricing and other urban solutions predicated on high traffic volumes
  - 3 Effects of tolling on route choice
  - 2 General economic effects of taxation
  - 2 Not available/canceled by library
  - 2 Other language than English
  - 1 Tax Evasion
  - 1 Emerging Challenges on Pricing
  - 1 Policy implications of shared-use autonomous taxis
  - 1 Wrong setting

58 studies included

3 Effects of Changes in Vehicle Fleet on Transportation Revenue

As shown in Figure 3, the US Environmental Protection Administration reports that the fuel economy of new light-duty vehicles sold in the US has improved by almost 30% since 2005 (EPA 2021). Part of this improvement is attributable to improvements in engine technology. Another important factor is the popularity of hybrid gasoline-electric drivetrains. Hybrid vehicles incorporate a battery and an electric motor that supply additional energy during acceleration. This allows the vehicle to utilize a relatively small internal combustion engine, yet still accelerate briskly. After the vehicle has reached cruising speed, or at idle, the engine recharges the battery. Many hybrid vehicles also incorporate regenerative braking, which feeds power back into the battery during deceleration.

Figure 4. Changes in fuel economy of new US light-duty vehicles 1975-2020. Source: EPA



Fully electric vehicles (EVs), also called battery electric vehicles (BEVs) are rapidly gaining popularity. These vehicles have no internal combustion engine, and are either trickle-charged (usually at home or work) or fast-charged (usually at public charging stations). The first mass-production EV in the US market was the Nissan Leaf introduced in December 2010 (model year 2011). Since that time, EV manufacturers have substantially increased battery capacity. The 2011 Leaf was equipped with a 24 kilowatt-hour (kWh) lithium-ion battery pack. By model year 2021, the standard Leaf battery had a 40 kWh capacity, with an optional upgrade to 62 kWh. Even this is small compared to some competing models, such as the 100 kWh battery supplied with the 2021 Tesla Model S. Reportedly, the 2022 Ford F-150 Lightning pick-up truck will have a standard battery capacity of about 115 kWh, with an optional upgrade to about 155 kWh (more than 6 times the capacity of the 2011 Leaf) (Kane 2021).

These increases in battery capacity have increased the distance a vehicle can be driven without recharging. Coupled with greater availability of fast-charging stations, this has helped calm consumer concerns related to driving range. Emerging EV battery technologies such as sodium-ion and solid state electrolytes are currently being commercialized as part of ongoing efforts to increase battery capacity, reduce costs, and make use of readily-available raw materials.

Plug-in hybrid vehicles such as the Chevrolet Volt introduced in December 2010 (model year 2011) represent a middle-ground between hybrid and BEV technologies. Like hybrids, they incorporate a small internal combustion engine that can run the car when battery power is low.

They use a larger battery pack than traditional hybrids, allowing most shorter trips to be made in battery mode, provided that the user is conscientious in charging the battery regularly.

Poole (2019) reports that one of the first serious studies of the revenue effects of fuel economy improvements and emerging vehicle propulsion technologies was commissioned by the Transportation Research Board in 2004. A special committee concluded that fuel taxes would not remain viable as the primary highway funding source for the 21st century, and that research and planning should begin to figure out alternatives. The panel's recommendations were published in TRB Special Report 285 in 2006. Several years later, Congress authorized the creation of the National Surface Transportation Infrastructure Financing Commission. Its members did research and held hearings, and after evaluating a large number of possible alternatives, concluded that (1) the users-pay/users-benefit principle that began with gas taxes should be retained, and (2) charging vehicle operators per mile driven was the best alternative. The commission's recommendations were published in 2009.

3.1 Summary of Relevant Research

Link and Stewart-Ladewig (2005) observed that like pricing everywhere in the economy, road pricing is a method of resource allocation and revenue generation. Road pricing strategies relevant to context of their paper include distance-based user charging, tolling, and cordon charges to enter a congested area.

In many situations policy objectives play a greater role than setting the "right" price. Several objectives are frequently mentioned in the public discussion, including financing infrastructure, reducing externalities (i.e., making sure costs from adverse impacts of transportation systems are not shifted to other payers), creating fair competition between modes, achieving modal shift (e.g., from single-occupant vehicles to transit, walking, or biking), cost recovery, and demand management. Diverse and potentially overlapping objectives of road pricing can be grouped as achieving: (a) allocative efficiency in infrastructure use; (b) allocative efficiency in infrastructure provision and expansion; and (c) financial viability.

Link and Stewart-Ladewig noted several categories of transportation-related costs. These include the direct costs of building and maintaining transportation infrastructure, environmental costs such as healthcare expenditures to treat diseases caused by exposure to vehicle emissions, medical costs attributable to crashes, and congestion-related costs. The latter include lost work and leisure time, increased fuel consumption, and increased vehicle wear and tear when driving in congested areas.

Ideally, all vehicles would be charged for the marginal costs generated by the trips they make. This requires advanced technical solutions that consider the distance travelled, vehicle characteristics such as weight and emissions, and the actual level of congestion. Available technologies and pricing strategies address these considerations to varying degrees, depending on whether the charges are implemented on a distance-traveled basis, using a zone system, or as a lump-sum fee.

Volovski et al. (2017) developed a methodology to measure the split of vehicle-miles traveled (VMT) and fuel purchases for in-state and out-of-state vehicles in the State of Indiana. A literature review showed that most states have faced challenges in quantifying this split due to the difficulty in acquiring appropriate data. The study focused on personal motor vehicles and excluded commercial trucks.

The study estimated the required sample size using statistical methods, and determined that data from approximately 25 fuel stations for each of the four sampling strata (highway classes) was needed. In analyzing the data, spatial interpolation based on Ordinary Kriging estimation was used to help provide reliable network-level estimates of the percent of passenger vehicle travel attributed out-of-state vehicles.

Like Iowa, Indiana is a "crossroads" state with substantial long-distance traffic passing through the state, and has metropolitan areas that straddle the state line. The analysis showed that rural interstate fuel stations experienced the highest percent of transactions by out-of-state vehicles (34.5%). The percent of fuel sold to out-of-state vehicles at urban interstates, rural non-interstates, and urban non-interstates were found to be 20.1%, 11.9%, and 4.8%, respectively, and the average was found to be 10.8%, The amount of fuel purchased, percentage of gasoline sold to out-of-state vehicles at each fuel collection location, and the average gasoline fuel efficiency of the vehicles purchasing fuel were used to estimate the amount of travel by out-of-state vehicles, with spatial interpolations using Kriging estimation. The resulting estimates of out-of-state VMT split were as follows: Interstate: 21.1%; Non-Interstate: 8.1%; statewide average: 11.1%.

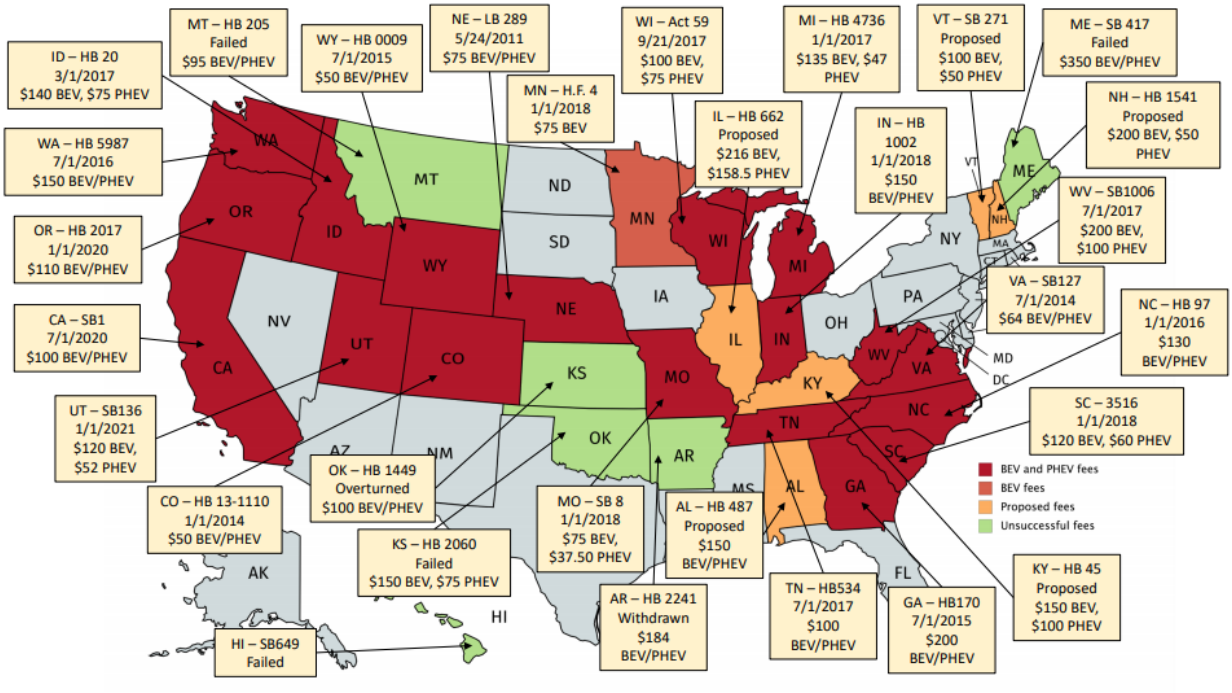
Table 7. Statewide Estimate of Fuel Sold to Out-of-State Vehicles in Indiana. Source: Volovski et al. (2017)

Stratum	% of Gasoline Sold at All Fuel Stations	
	In State	Out of State
Rural Interstate	3.10%	1.83%
Urban Interstate	16.72%	4.22%
Rural Non-Interstate	14.97%	2.03%
Urban Non-Interstate	54.39%	2.76%
Total	**89.17%**	**10.83%**

Agbelie, Labi, and Sinha (2018) prepared revenue forecasts for a proposed fuel tax increase in Indiana. The authors used a highway cost allocation study prepared in 2015 to compute "equity ratios" that compare the revenue generated by each class of vehicles with its share of pavement and bridge costs. The results indicated that at the previous tax rates, all classes of vehicles except buses underpaid their share of costs, with heavy trucks underpaying to a much greater degree than personal vehicles. Under the proposed legislation, Class 1 to 5 vehicles (motorcycles, automobiles, sport utility vehicles, buses, and single unit trucks) overpay their cost responsibilities, while heavy trucks in Classes 6 to 13 underpay. The most severe underpayment was for Class 6 vehicles, which are three-axle single-unit trucks. The authors concluded that although the current fuel tax system can be helpful for some period of time, in the long term it will need to be replaced with a system that reflects actual effects on roads and bridges.

Jenn (2018) assessed alternatives to California's existing electric vehicle registration fee, which has a structure similar to the fee in Iowa. Jenn observed that California infrastructure will become drastically underfunded with the current vehicle registration fee structure, given the long-term shift to Zero Emissions Vehicles (ZEVs), which include electric vehicles and fuel-cell vehicles. Jenn estimated that assuming 5 million ZEVs on the road in 2030, the current registration fee and gasoline tax would together lead to a decrease in California infrastructure funding by over $500 million annually.

Figure 5. Comparison of electric vehicle registration fees as of fall 2018. States in grey have not introduced electric vehicle registration fees.



As shown in Figure 5, several states (including California and Iowa) have proposed or implemented electric vehicle registration fee surcharges under the premise that electric vehicles (and fuel-cell vehicles) must pay their fair share to help fund road infrastructure because they do not pay a fuel tax. Jenn argued that while the structure of these fees may respond to political realities and avoid the implementation challenges of alternative mechanisms, they are inconsistent the "user pays" principle. The traditional gasoline tax is indirectly linked with road usage (the more a user drives, the more that is paid in gas taxes), but the registration fee does not take this into account: an electric vehicle driver pays the same amount per year no matter how may miles are driven.

As shown in Table 9, Jenn developed a table that concisely compares equity, efficiency, and ease of administration for four revenue strategies: the traditional gasoline tax, a ZEV registration fee, a ZEV fuel tax levied on electric vehicles in proportion to the electricity used, and a

distance-based road user fee. In general the distance-based fees (which are discussed in detail in the next chapter) scored best on nearly all criteria.

Table 8. Impact of transportation infrastructure funding mechanisms. Source: Jenn (2018)

	Traditional gasoline tax	Annual ZEV registration fee	ZEV fuel tax	Road User Charge
Revenue meets funding requirements	SB1 [legislation] has improved sustainability of funding.	Aligns neither with the gas tax nor with funding requirements.	Would address funding deficits from ZEV adoption.	Creates a long-term solution for efficiency improvement and ZEV adoption.
Responsiveness to inflation	Automatically adjusts with inflation.	Automatically adjusted with inflation.	Can be designed to be adjusted to inflation.	Can be designed to be adjusted to inflation.
Revenue stability	Stability hindered by improvements in fuel efficiency and shifts towards ZEVs.	$100 annual fee is significantly lower than the average CA vehicle, this will exacerbate with more ZEVs.	ZEV adoption solved. Fuel efficiency gains will continue to be problematic.	Robust to changes in efficiency and to adoption of ZEVs. Long-term VMT shifts could be problematic.
Administrative cost	Administrative costs are only 1% of revenue.	Coupling this fee to the existing registration fees results in little added costs.	Metering usage of electricity to charge PEVs is likely prohibitively expensive.	Higher costs due to hardware and fee collection. Potential to lower costs exists (e.g. telematics).
User pays	Efficiency benefits address some externalities but detract from stable funding.	Decouples fees from usage of roads.	Identical to gasoline taxes for all alternative fuel vehicles.	Similar to gasoline taxes without variation in fuel efficiency.
Equity	Gas tax is relatively neutral as it closely aligns with “user pays” principle.	ZEV users would pay more than they would with the gas tax (based on energy content).	Identical to gasoline taxes for all alternative fuel vehicles.	Less regressive than the gasoline tax: lower income users tend to pay slightly less.

= Very Poor = Poor = Fair = = Very Good

Jia et al. (2019) studied the impact of the growth of the electric vehicles on fuel tax in the state of Virginia. They forecasted that by 2025, utilization of electric vehicles will be in the range of 0.6-10% and most likely close to 2.4%. This will cut fuel tax revenue by 5-19% in comparison to 2016.

The study concluded that areas with a higher percentage of male drivers will experience increased use of battery electric vehicles (BEVs), while areas with higher commute times will see increased use of plug-in hybrid electric vehicles (PHEVs). People who live in populous areas, people with graduate degrees, and people age 65+ were deemed more likely to purchase BEVs and PHEVs. If the revenue system remains reliant on fuel taxes, rural residents will be paying a disproportionate share by 2025.

Davis and Sallee (2019, 2020) evaluated the geographic distribution of gasoline tax revenue foregone as a result of electric vehicle use, and found it to be highly concentrated in a small number of states, with $90 million of the foregone gasoline tax revenue in California alone. This concentration reflects the uneven geographic distribution of electric vehicles across states, as well as the fact that states with more electric vehicles tend to have higher-than-average gasoline taxes.

The authors stated that imposing a mileage tax (distance-based user fee) on electric vehicles would have two effects. First, assuming the mileage driven by gasoline vehicles remains unchanged, a distance-based user fee will reduce electric vehicle use through a price effect. In general, this will increase economic efficiency because it corrects an unpriced negative externality from EV use. Second, however, it causes drivers to substitute from electric vehicles to gasoline-powered vehicles. If the gasoline tax is inefficiently low, this will lead to inefficiencies in both scale and composition. The overall size of the transportation market will still be too large, and too large a fraction of miles will be driven in gasoline vehicles, as opposed to electric ones.

Although US gasoline taxes are the lowest among all countries that are members of the Organization for Economic Coordination and Development (OECD), each electric vehicle still results in $300+ in foregone gasoline tax revenue annually, according to the authors' calculations. At the time the analysis was prepared, electric vehicles were less than 1% of all U.S. registered vehicles, so the aggregate impacts are relatively modest ($250 million annually), but this could scale quickly under rapid increased adoption of electric vehicles. The authors argued that by combining an EV purchase subsidy with a distance-based user fee for electric vehicles, it is possible to encourage substitution toward electric vehicles, while discouraging driving and reducing externalities.

Varn, Eucalitto, and Gander (2020) prepared a policy analysis white paper summarizing the effects an increasingly large fleet of electric vehicles will have on state transportation revenue. The group argued that meeting transportation revenue needs for investment, maintenance and operations is a pressing challenge for governors. This challenge is made more difficult by the diminishing purchasing power of motor fuel taxes, driven primarily by inflation and the rising fuel efficiency of the overall fleet. Despite these trends, the gradually increasing popularity of EVs has attracted the attention of policymakers as an opportunity to bolster transportation revenue. However, creating an equitable user-pay revenue stream from EVs is a complex matter and one that may not necessarily align with broader state goals.

While general vehicle registration fees have become a mainstay in the transportation revenue system, Varn, Eucalitto, and Gander argued that the nature of an annual flat fee can have a disproportionate impact on low-income drivers and weaken fuel efficiency incentives. Further, some of the registration fees levied specifically on owners of EVs to date have been enacted at levels significantly higher than the fees and taxes collected from owners of an average new vehicle. Overall, EV fees, especially those set at exceptionally high levels, could have a detrimental impact on EV adoption rates.

Some measures that states are adopting or considering include:

- Increasing existing motor fuel tax rates
- Indexing motor fuels to inflation
- Implementing mileage-based user fees (MBUFs), also known as “road usage charges” (RUCs)
- Studying fuel-neutral fees, based on energy consumption
- Driver licensing fee increases
- Insurance background check fees
- Transportation network company fees

Among these, Varn, Eucalitto, and Gander selected six primary revenue options, whose main advantages and disadvantages are summarized in Table 10.

Table 9. Strengths and weaknesses of transportation revenue policy options as reported by Varn, Eucalitto, and Gander (2020)

	Motor Fuel Tax	Mileage-Based User Fees	General Registration Fees	Sales Tax	Fuel Neutral Fees or Taxes	Electric Vehicle Fees
Usage and Mileage	Accounts for usage and mileage.	Accounts for mileage.	Does not account for usage and mileage.	Does not account for usage and mileage.	Can account for usage, requires specific design to account for mileage.	Does not account for usage and mileage.
Fuel Efficiency	Encourages fuel efficiency.	Requires specific design to encourage fuel efficiency.	Requires specific design to encourage fuel efficiency.	Does not consider fuel efficiency.	Encourages fuel efficiency.	Requires specific design to encourage fuel efficiency.
Cost Distribution	Costs are spread over time.	Costs are spread over time.	Costs are upfront.	Costs are disassociated and spread over time.	Costs can be spread over time.	Costs are upfront.
Policy Considerations	Susceptible to inflation and long-term trends in fleet efficiency and electrification.	Majority of states have not studied how to enact an MBUF system.	Annual upfront fees affect the affordability of car ownership for lower-income households.	Obscures connection to transportation systems and competes with other policy objectives that rely on sales taxes.	EV charging fees require further testing to account for usage and avoid fare evasion.	Discourages EV adoption and requires additional design to support EV-specific infrastructure.

4 Distance-Based Road User Fees (Vehicle-Miles Traveled Charges)

Distance-based road user fees have been proposed as an alternative to fuel taxation, and as a potential option for collecting revenue from electric vehicles. Several terms have been applied to this concept, including mileage-based user fees (MBUF), mileage tax, pay-as-you-drive fees, per-mile pricing, road user charges (RUC), vehicle-kilometers traveled (VKT) fees, and vehicle miles traveled (VMT) fees, among others. There is disagreement as to whether the system should be called a charge, a fee, or a tax. For simplicity, “distance-based fee” is used in the remainder of this chapter.

A variation of this concept to charge for road use based on weight and distance to help account for the effect of heavy loads on the longevity of pavements and bridges. This is sometimes referred to as a ton-mile fee, a term borrowed from the freight industry where a ton-mile refers to transporting one ton of freight a distance of one mile. In contrast to freight industry practice, however, the weight element of the ton-mile fee is usually proposed to be based on the vehicle's legal maximum gross weight or the equivalent single axle load (EASL), rather than the weight of any specific payload. Thus, a truck would pay the same rate whether it is transporting a fully-loaded trailer or backhauling a completely empty trailer. For simplicity, "weight and distance fee" is used in this chapter.

As an example of this concept within Iowa, Table 4 compares the combined costs for vehicle registration and fuel taxes in Iowa for three types of vehicles: a typical sport-utility vehicle or pickup weighing about 4,000 pounds, a typical farm truck with a gross vehicle weight (GVW) of 64,000 pounds, and a typical tractor-trailer (semi) with an 80,000 pound GVW. Annual distance driven for the light-duty vehicles is based on the 2017 National Household Travel Survey (Table 2) and annual mileages for the heavy-duty vehicles were taken from the FHWA Highway Statistics series.

The computations indicate that the total revenue contributed by drivers of SUVs and pickups is approximately $3.11 for every 100 miles driven, while the revenue from a farm truck is about $10.71 and a semi contributes about $7.40.

A semi loaded to the legal weight limit weighs about 20 times as much as a typical SUV or pickup. When considered on a ton-mile basis (one ton driven one mile), the fees and taxes paid by light-duty vehicles are around $1.56 per 100 ton-miles, farm trucks pay approximately $0.33, and semis pay about $0.18.

Table 10. Comparison of per-mile and per ton-mile costs for vehicle registration and fuel taxes in Iowa

Vehicle Type	**SUV or Pickup**		**Farm Truck**		**Tractor-Trailer**	
Gross vehicle weight (lb)	4,000		64,000		80,000	
Iowa registration fee (typical)		$200		$705		$1,725
Typical miles Driven/yr [source]	12,415	NHTS	11,687	FHWA	63,374	FHWA
Typical Ton-miles driven	24,830		373,984		2,534,960	
Typical miles/gallon	20		6.5		6.5	
Fuel consumed/yr (gal)	620.8		1,798.0		9,749.8	
Iowa fuel tax/gal [fuel type]	$0.300	gasoline	$ 0.304	B11 diesel	$ 0.304	B11 diesel
Typical tax paid		$186		$547		$2,964
Total state revenue		**$386**		**$1,252**		**$4,689**
per mile driven		$0.0311		$0.1071		$0.0740
per 100 miles driven		**$3.11**		**$10.71**		**$7.40**
per ton-mile		$0.0156		$0.0033		$0.0018
per 100 ton-miles		**$1.56**		**$0.33**		**$0.18**

4.1 Determining Distance Driven

Various systems for tabulating the distance driven have been proposed (Baker and Goodin 2011). The simplest systems are odometer-based, with drivers reporting their odometer readings periodically and paying a specific amount per mile (or kilometer) driven. This system is easy to understand and provides a high level of privacy for the driver, since no records of the routes taken are generated. In some cases it can make use of odometer data already being collected from periodic vehicle emissions inspections or vehicle safety inspections (Hawaii DOT 2021).

Odometer-based fees are subject to some boundary effects, especially in metropolitan areas that straddle state lines such as Dubuque, Council Bluffs-Omaha, and the Quad Cities. These effects occur when the state where a vehicle is registered differs from the state where it is driven. For instance, when a vehicle registered to a home address in Council Bluffs, Iowa is used by a person who works in Omaha, Nebraska, that user might overpay Iowa and underpay Nebraska. If both states adopt odometer-based fees, the effect on revenue is potentially offset (fully or partially) by drivers with the opposite trip pattern (e.g., someone who lives in Omaha and works in Council Bluffs).

More elaborate distance-based fee systems use an in-vehicle GPS unit to track the vehicle's route. This allows the system to allocate fees precisely across multiple jurisdictions. For example, the Dubuque area is situated at the nexus of three states (Illinois, Iowa, and Wisconsin). If a motorist lives in East Dubuque, shops in Dubuque, and works in Platteville, a GPS-based system could accurately allocate miles driven to the states of Illinois, Iowa, and Wisconsin, respectively. This could avoid any revenue leakage that currently occurs when drivers cross state lines to buy fuel in the jurisdiction with the lowest tax rates.

In principle, GPS-based systems could also allow fees to be allocated in proportion to the distance driven on each jurisdiction's roadways. For example, a trip from a suburban residence to a downtown office could pass through several municipalities, and the charges could be allocated to each jurisdiction proportionately. In principle, advanced features of a GPS-based system could be used to provide incentives and disincentives for desirable or undesirable trip-making behavior. For example, surcharges could be implemented to discourage travel on congested routes, or discounts could be offered to encourage drivers to use the safest routes. In highly congested cities such as Atlanta and Chicago, charges could vary by time of day to encourage discretionary trips to be shifted to off-peak hours.

Under the International Fuel Tax Agreement (IFTA), trucks and buses that operate in interstate commerce must log the mileage driven in each state, and fuel tax revenues are allocated accordingly. To reduce the need for handwritten logs, most carriers already use GPS-based logging systems. Thus, there are very few technical barriers to implementing a GPS-based road user charging system.

4.1.1 Equity Research

A large number of research reports and policy papers (white papers) exploring distance-driven fees have been published since 2003. The text that follows summarizes many of these reports,

with emphasis on findings related to the equity and distributional effects of distance-based charging. These equity effects are typically evaluated by comparing the effects of distance-based charging for rural and urban drivers, for people of different ages or life-stages, or for people from differing socioeconomic strata. The reports are listed chronologically to illustrate the evolution of the technical and policy approaches to distance-based user fees. In particular, the literature reflects a shift in thinking from distance-based charging as a *substitute* for fuel taxes in a world where electric vehicles did not exist, to distance-based charging as a *replacement* for fuel taxes in a world where electric vehicles are becoming increasingly common.

Public outreach conducted for distance-based charging pilot projects consistently finds rural drivers are concerned they would contribute more revenue than urban drivers under a distance-based driving system (Nevada DOT 2010, Oregon DOT 2013, Ungemah et al. 2013, Caltrans 2017, Washington State Transportation Commission 2020). Drivers seem to overlook the fact that this is already the case with fuel taxes, which are also approximately proportionate to distance driven. Detailed studies of revenue distribution find that under a distance-based charging system, the share of the revenue contributed by rural drivers actually decreases slightly, because rural drivers tend to use less fuel-efficient vehicles than their counterparts in urban and suburban areas. With either system, rural drivers pay more because they use the roads more.

The majority of the research concludes that flat-rate distance-based charging systems result in very little change in the share of revenue collected from drivers in various income categories. A few authors have suggested offering discounts to lower-income drivers, but no studies were found that describe how such a system would be administered.

Mayeres (2003) analyzed cost externalities related to the transportation system. The concern is that the amount a user pays to use the transportation system only covers a portion of the actual costs. Other important costs (externalities) not paid by the user include congestion, environmental effects, crashes, road damage, and so forth.

Mayeres recommended that any pricing mechanism designed for the transportation system should also account for externalities. Generally, the government has three main tools to deal with externalities: pricing, regulation, and infrastructure policy. Pricing includes various taxation systems (fuel tax, vehicle tax, etc.) as well as insurance, tolling, cordon charges to enter congested areas, and parking fees. Regulatory instruments include vehicle rationing, emission standards, vehicle safety standards, and so forth. Infrastructure policy is related to the expansion or maintenance of the transportation systems. Mayeres argues that considerable gains can be achieved by using the available pricing, regulatory, and pricing tools to assure that transportation costs reflect both the direct costs of providing infrastructure and the marginal costs of externalities. This will become even more important in the future as demand for the transportation system increases.

McMullen, Zhang, and Nakahara (2010) analyzed the equity effects of implementing a revenue-neutral road user charge in Oregon. In Oregon, the impact of distance-driven fees differs considerably from region to region, and by level of urbanization. Under a revenue-neutral distance-based fee of approximately 1.38 cents per-mile, the overall statewide average

household would pay the same under the fuel tax and the distance-based fee. Households in some urban locations may pay slightly more (less than $20/year) and households in some rural locations would pay slightly less (less than $20/year). In all cases, the impacts of the change in fee structure to a distance fee are minimal, and are certainly less than impacts caused by changes fuel prices.

Contrary to expectation, the study found that households in rural areas would actually benefit from a change from a fuel tax to a distance-based fee. This is due to the fact that on average, rural households own vehicles that have lower fuel economy, as well as driving more miles than urban households.

The long run impact of changing to a road user charge would depend on how households respond to the change in the price of driving, which is a function of differences in the price elasticities of demand for driving in different regions. Household choices about whether to invest in fuel-efficient vehicles and policies that encourage or discourage the purchase of fuel-efficient vehicles could have greater equity impacts than switching to a road user charge. The authors felt that learning more about these vehicle purchase decisions would be a fruitful direction for future research.

Sana, Konduri, and Pendyala (2010) found that distance-driven fees of 0.5 cent per mile to 1.3 cents per mile can offer revenue streams that can replace current gas tax revenue. In addition, a mileage-based user fee system appears to have minimal, if any, differential impacts across income classes and thus eliminates any potential equity concerns that may arise from the implementation of such a user fee system.

Coyle et al. (2011) suggested a transitional structure for funding transportation based on a new transportation funding tax structure with three components:

- **Base Fuel Tax Component—Federal and State Levels.** Under the new transportation funding tax structure, fuel taxes would be reset to a lower base rate that would be sufficient to generate revenues for baseline transportation needs. Base fuel taxes would be designated for road and bridge maintenance and operation, and would include user and system safety and enforcement. The aim would be to ensure that ongoing funds are available to preserve the system and to protect the significant investment in federal and state infrastructure. Base fuel taxes would maintain their highly desirable built-in incentive for using fuel efficient, alternative-fuel, and light-weight vehicles, all of which use less fuel per mile and, therefore, would pay less in fuel taxes. In other words, base fuel taxes would continue to help achieve national and state policy objectives related to reducing energy consumption and tailpipe emissions.
- **Distance-Based Charge Component—Federal and State Levels.** The aim of this mileage-based pricing component would be to fund road and bridge reconstruction and expansion, including right-of-way acquisition. The distance-based user charge would be set at levels that compensate for the reduction in fuel taxes to the base rate. Because these charges would be set on a per-mile basis, the approach would complement the state and federal objectives that fuel taxes support. It is likely, however, that distance-

based would have a greater impact in reducing vehicle-miles, encouraging greater use of alternatives modes of transportation, and reducing cost externalities such as congestion and crashes.

- **Distance-Based Charge Component—Local Option.** The third component aims at funding local roads. As a basic approach, the distance-based fees would be a local option that would replace the patchwork of local taxes currently used to fund local roads. This would give local governments the ability to undertake their own transportation initiatives without using the taxes currently used. The fees would be paid only by those that choose to use the local road system. This third component could be implemented as a local voter option rather than being applied uniformly to all units of government.

Baker and Goodin (2011), Baker and Sabala (2011). Baker published two papers in 2011 related to distance-based user charging, one discussing potential application of distance-based user charging in Texas and another describing Texas focus group results for public acceptance of these concepts.

A significant gap has already developed in Texas between growth in roadway capacity and growth in the state's population of drivers and their vehicles. This gap will likely increase as fuel economy continues to improve and more funding is dedicated to preserving existing infrastructure.

To address the gap, the first paper identified alternatives for measuring the distance driven: vehicle odometer readings, odometer readings augmented with mobile phone data, and GPS (Figure 6). The available data elements are summarized in Table 11. With odometer readings, it was not possible to determine with certainty whether the miles traveled were in Texas or somewhere else. Augmenting the odometer with mobile phone data was sufficient to distinguish in-state from out-of-state mileage, but did not provide as much spatial detail as the GPS option.

Figure 6. Technology options for relating distance driven to jurisdiction (Baker and Goodin 2011)

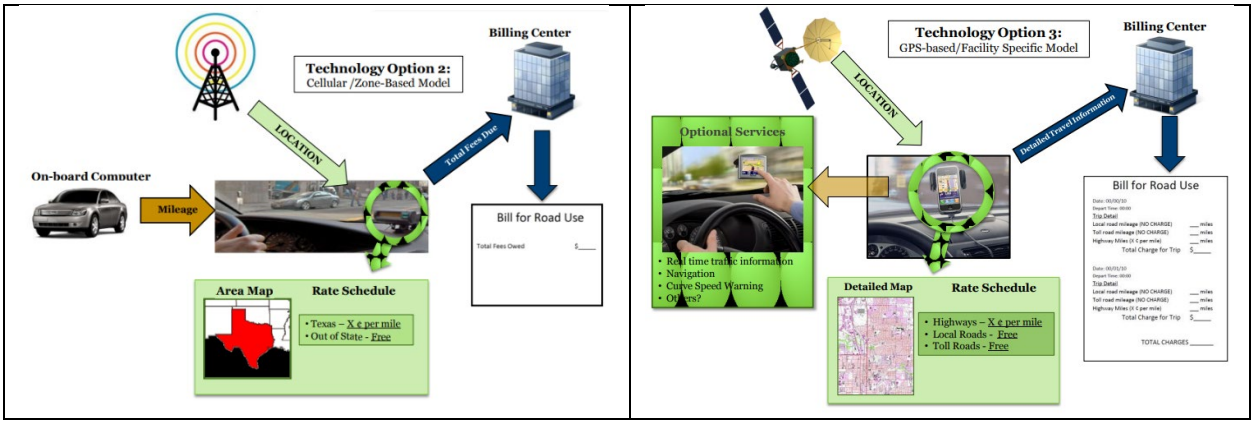


Table 11. Data elements that can be determined for three technologies.

	Odometer	Cellular	GPS
Detail of Travel Information	None	Low (In state/Out of State only)	Detailed (route specific, time of day)
Technology Installation	None	Required by certified professional	Required, but can be self installed
Mileage Discount	None	Out of state mileage discounted	Mileage on non-state maintained roadways and out of state mileage discounted
Mileage Calculation	Manual	Calculated from start/stop and speed data	Calculated through GPS-based location data
Other Services	None	None	Various Added Value Services
Bill for Mileage	No detail. All mileage (in-state and out-of-state) paid	No detail. Only amount due is shown. All in-state mileage paid.	Detailed travel record on bill. Only mileage on state roadways is paid
Information System Configuration	None	Closed	Open

The Baker group's second paper evaluated public opinion related to distance-based road user fees in Texas. Researchers conducted listening sessions with the general public and stakeholders to gather input on the concept.

This study identified both challenges and opportunities for implementation of distance-based fees:

- In general, the focus group participants did not know how the fuel tax is assessed, fuel tax rates, their own expenditures in terms of fuel taxes paid, or when the fuel tax was last increased
- Most study participants viewed the implementation of mileage fees as unworkable, with privacy, cost of administration, and enforcement as the most commonly cited concerns
- The rationale for transitioning to mileage fees has not been adequately established with the general public.
- A new funding mechanism will inherently raise fairness concerns among rural and low-income drivers
- Despite concerns, research shows that the vehicle mileage fees are a logical, sustainable, long-term option to supplement or replace the fuel tax
- If pursued, simple implementation solutions will engender the greatest public and stakeholder support

- Field demonstrations that illustrate the full spectrum of implementation aspects, including payment, administration, and enforcement, can show how the concept might work in Texas
- Effective policy design can address any major public acceptance issues

When pressed by the moderator to choose a preferred distance-based charging system, participants generally chose the odometer reading-based model almost 5:1 over the GPS model. The cellular model was only chosen by one participant out of all five of the groups. The simplicity of the odometer reading-based model was the most cited reason.

While there was not strong support for the technology-intensive systems, there was a strong preference by participants for billing statements with a detailed record of travel. This stems from a general lack of trust about the technology coupled with the desire to dispute charges perceived as erroneous, and would require a GPS-based system.

There were various other suggestions for capturing road user costs from electric vehicles including:

- Increased vehicle sales taxes
- Increased vehicle registration fees
- Charging extra fees on utility bills for electricity consumed by EVs

Based on the findings of the technology analysis and focus groups, Baker's group recommended a demonstration approach focusing solely on electric vehicles. This would involve a relatively small share of the fleet, but would test all aspects of payment, administration, and enforcement. The group suggested a low-technology deployment using odometer readings from vehicle inspections, along with the option for drivers who want to avoid being charged for out-of-state mileage to select a GPS-based charging plan.

Hanley and Kuhl (2011) conducted a two-year field study to assess the feasibility of allocating distances driven on a national and multijurisdictional scale. Approximately 2,650 volunteers from 12 areas throughout the country participated in the study. Mileages were apportioned to the federal, state, and local levels with the use of onboard computers installed in participants' vehicles. The onboard computers contained Global Positioning System (GPS) receivers with an associated geographic database to identify the taxing jurisdictions in which the vehicles traveled. The average participant drove approximately 9,000 miles during the study, resulting in more than 21 million miles of travel.

Approximately 92.5% of all driven miles were successfully measured by both the GPS and the onboard diagnostics system (OBD-II). Of the miles driven without GPS, 6.9 percent could be reliably assigned to jurisdictions by using straightforward interpolation techniques. Approximately 0.6 percent of total miles driven could not be reliably assigned to a state or local jurisdiction.

Participant attitudes regarding the system and the overall concept of mileage-based charging were assessed. At the end of the study, 71% had a highly or somewhat positive view, while 17% held a highly or somewhat negative view. Participants consistently (but to varying degrees)

preferred audit ability, which consisted of receiving detailed monthly invoices, over maximum privacy protection.

Robitaille, Methipara, and Zhang (2011) compared the economic impacts on household income for a $0.10 increase in federal fuel taxes and a distance-based charge of $0.015 per mile. The two proposals were designed to generate the same amount of revenue (about $98/yr per household). Impacts were compared on the basis of household income, age, ethnicity, and geographical region.

The research found very similar equity effects for fuel taxes and distance-based charging. On average, the $0.10 fuel tax increase was estimated to reduce consumer surplus by $104.38/year, while a $0.015 per mile charge would reduce consumer surplus by $105.33, a difference of $0.95 or 1%.

Both revenue mechanisms were found to be regressive in the sense that they result in large disparities between income groups, ethnic groups, and regions (Table 12 and Table 13). This is mainly due to differences in distance driven and vehicle fuel economy amongst the age, ethnic, and age strata. For example, high-income households drive more than low-income households, but under either proposal high-income households contribute a smaller percentage of their household income to transportation revenue as compared to low-income households.

Table 12. Average annual distributional effects by ethnicity for a $0.10 federal gasoline tax and a distance-based fee of $0.015/mile (Robitaille, Methipara, and Zhang 2011)

			$0.10 Gasoline Tax Increase				$0.015/mi VMT Fee			
Ethnicity	Fuel Efficiency Rate (mpg)	Total Annual Household Income (US$)	Change in Consumer Surplus (US$)	Household Revenue Generation (US$)	Change in Total Social Welfare (US$)	Percent Reduction in Annual VMT	Change in Consumer Surplus (US$)	Change in Revenue Per Household (US$)	Change in Total Social Welfare (US$)	Percent Reduction in Annual VMT
Hispanic	21.15	35,445	−97.08	88.88	−8.20	−3.57	−108.77	98.37	−10.40	−4.64
African-American	21.47	39,843	−82.28	75.92	−6.36	−3.27	−101.42	92.62	−8.81	−4.46
Asian	22.98	51,467	−88.65	83.73	−4.92	−2.55	−103.58	95.35	−8.23	−4.11
Other	20.54	47,023	−106.37	100.31	−6.06	−2.42	−105.50	98.76	−6.74	−2.88

Table 13. Household income effects for a $0.10 federal gasoline tax and a distance-based fee of $0.015/mile (Robitaille, Methipara, and Zhang 2011)

Income Group (US$)	$0.10 Gasoline Tax Increase			$0.015/mi VMT Fee		
	Change in Consumer Surplus (US$)	Change in Revenue Generated (US$)	Change in Social Welfare (US$)	Change in consumer Surplus (US$)	Change in Revenue Generated (US$)	Change in Social Welfare (US$)
Less than 10,000	-40.49	31.40	-9.09	-48.38	36.33	-12.05
10,000-20,000	-55.56	47.19	-8.36	-63.64	53.15	-10.50
20,000-30,000	-74.33	66.15	-8.18	-78.67	69.02	-9.65
30,000-40,000	-92.34	84.74	-7.60	-93.41	85.02	-8.39
40,000-50,000	-110.26	103.44	-6.82	-110.27	102.84	-7.44
50,000-60,000	-121.14	115.78	-5.36	-122.12	116.30	-5.82
60,000-70,000	-132.60	128.13	-4.47	-127.27	122.64	-4.63
70,000-80,000	-148.02	144.85	-3.17	-138.79	135.34	-3.45
More than 80,000	-154.49	153.20	-1.28	-155.10	153.89	-1.21

Weatherford (2011, 2012) published two papers estimating the changes in household welfare for various groups if the federal gasoline tax were to be replaced with a revenue-neutral flat-rate distance-based fee. These findings provide an empirical basis for discussing the equity concerns that are likely to arise with proposals to adopt a distance-based fee. The results indicate that distance-based fee winners include low-income, rural, and retired households. This challenges the conventional wisdom that distance-based fees will be inequitable to low-income and rural households.

Table 14. Group average annual vehicle-miles traveled (VMT), fuel economy, and federal tax burden (Weatherford 2011).

	VMT (mi)	Fuel Economy (mpg)	Tax Burden ($)	Tax Burden (% of income)	Fuel Tax (cents/mi)
National population	25,061	20.0	223.16	0.65	0.92
Income groups ($)					
Income < 20,000	15,509	19.4	134.99	1.49	0.95
20,000–40,000	20,693	20.0	182.84	0.61	0.92
40,000–60,000	27,627	20.2	246.35	0.49	0.91
60,000–80,000	31,778	20.3	283.55	0.40	0.91
80,000–100,000	33,195	20.4	297.02	0.33	0.90
Income > 100,000	33,412	20.0	303.77	0.20	0.92
Life-cycle groups					
Household with children	32,085	20.2	287.00	0.74	0.91
Retired household	14,921	18.8	135.63	0.55	0.98
All other types	22,988	20.5	201.45	0.60	0.90
Geographic groups					
Urban	20,394	20.7	174.26	0.56	0.89
Second city	21,225	20.1	185.48	0.66	0.92
Suburban	24,100	20.3	210.72	0.47	0.91
Rural	28,958	19.6	264.25	0.78	0.94

NOTE: All dollar values are in nominal 2001–2002 dollars as reported in the NHTS. Statistics include 19,043 households with complete information on vehicle VMT and mpg and exclude households with zero vehicles. Households are categorized into urban geographic groups according to Claritas, Inc., rural–urban continuum designations instead of U.S. Census designations to allow for a greater level of urban area disaggregation (*13*). For consistency with later data series, the Claritas group "town" has been aggregated with the "rural" group.
SOURCE: Data are from FHWA (*20*).

While the disaggregated analysis does support concerns about negative distributional effects on certain subpopulations of winning groups, policy makers and advocates, the authors cautioned to not ignore the positive distributional implications for the other households in these groups. The overall magnitude of the distributional implications further suggests that policy makers and advocates avoid weighing equity concerns too heavily in the overall debate about whether or not to adopt a distance-based fee because there are many other benefits to consider and challenges to address.

Weatherford in the second paper finds that a flat-rate distance-based fee would be no more or less regressive than fuel taxes, now or in the future. An increase in the tax rate, whether distance-based fee or a fuel tax, causes transportation revenue collection to become less regressive because low-income households have a more elastic response to changes in price than middle and high income households. Distance-based fee "winners" include retired households and households located in rural areas, since on average, distance-based fees would reduce the tax burdens of these groups. Distance-based fee "losers" are households in urban and suburban areas. The projections suggest that the distributional implications of distance-based fees are unlikely to change in future years. Changes in the cost of driving, either from a higher tax rate, or other factors [such as changes petroleum prices], appear to have a greater impact on the equity of transportation finance than whether the tax is collected by the gallon or by the mile.

The findings suggest that equity considerations based on ability to pay will not be a significant reason to oppose or support the adoption of distance-based fees. While the equity implications of distance-based fees are minimal, however, some groups, especially rural states, may find that the potential equity benefits of distance-based fees could be overwhelmed by an increase in the tax rate to cover the higher costs of collecting and administering them. Weatherford felt that concern about the impacts of flat-rate distance-based fees on vehicle fuel efficiency and greenhouse gas emissions are valid but, at current oil prices, the tax rate is a small percentage of the total cost of gasoline. Therefore, the overall price signals still encourage fuel efficiency. Regardless, it is possible to structure a distance-based fee that provides incentives for fuel efficiency while maintaining other favorable qualities such as economic efficiency and fiscal sustainability.

Table 15. Distribution of price per mile for current fuel tax and alternatives (Weatherford 2012)

Transportation Tax Alternative	Household Price in Cents per Mile of Travel						
	Min	10th Percentile	25th Percentile	Median	75th Percentile	90th Percentile	Max
Current, 2001-02	3.2	6.3	7.1	8.1	9.2	10.5	49.9
Current, 2008-09	4.4	11.9	13.5	15.3	17.5	19.9	53.4
Flat MBUF, federal only	5.1	12.0	13.5	15.3	17.4	19.6	51.4
Flat MBUF, state only	5.0	12.1	13.6	15.3	17.4	19.6	51.4
Flat MBUF, state & federal	5.7	12.2	13.7	15.3	17.2	19.3	49.4
Increased fuel tax	4.6	12.2	13.9	15.8	18.0	20.5	54.8
Increased flat MBUF	5.5	12.5	14.0	15.8	17.8	20.0	51.8
Add 1 cent MBUF	5.4	12.9	14.5	16.3	18.5	20.9	54.4
Tiered MBUF	4.4	11.6	13.3	16.2	19.0	21.3	53.4
17.7 cent MBUF	21.6	28.0	29.4	31.1	33.1	35.2	65.3

Note: Price includes state and federal tax and the price of fuel.

Dutta and Patel (2012) prepared a white paper based on the outcomes of distance-based charging research in Oregon, Texas, and Minnesota. The report endorsed the importance and viability of distance-based charging, which they contrasted with the unsustainability of fuel taxes at the Federal level in light of improving fuel economy (Table 16). The paper asserts that distance-based charging is fair, sustainable, flexible, and capable of integration with the current systems, and addressed issues such as cost, privacy and visibility of the accrued sums. The paper includes a to-do checklist for implementation of this approach.

Table 16. Ratings of funding alternatives and distance data collection technologies (Dutta and Patel 2012).

Subject	Finance Principles				
	Efficiency	Equity	Revenue Adequacy and sustainability	Environmental sustainability	Feasibility
Existing Fuel Tax	Weak	Moderate	Moderate	Moderate	Strong
MBUF	Strong	Strong	Strong	Moderate	Weak
Technology Option					
On-board diagnostic Units(OBD II)	Moderate	Moderate	Strong	Moderate	Strong
OBDII/Cellular	Strong	Strong	Strong	Moderate	Strong
Fine – resolution GPS	Very Strong	Very Strong	Strong	Moderate	Weak

Zhang and Lu (2012) modeled the distance-based driving fees that would be required to cover the full costs of motor vehicle use, including the effects of pollution, greenhouse gas emissions, congestion, and infrastructure deterioration. They then applied the results to the 2009 National Household Travel Survey data to study the influence of mileage cost on various criteria such as energy consumption and fuel efficiency, vehicle ownership, miles traveled, emissions, and equity.

Results show that with consideration of all aforementioned externalities, the marginal-cost vehicle mileage fee by vehicle make and model would range from 7.7 to 9.1 cents/mile, which is much higher than the per mile equivalent of the current fuel taxes (about 1.2 cents/mi, or six to eight times higher than the current federal gas tax rate). Household vehicle use behavior is much more sensitive to the marginal-cost vehicle mileage fee than vehicle ownership decisions, with a significant (27.1%) reduction in vehicle miles traveled, but a minor increase in vehicle fuel efficiency (up to 4.2%). They estimated that implementation of a marginal-cost vehicle mileage fee could reduce energy consumption, pollution, and greenhouse gas emissions by about a fourth. These sustainability benefits become even more significant as fuel prices increase. Without consideration of the benefits from revenue redistribution, lower-income households, as expected, would be hurt more than higher-income households (1.3%).

Burris et al. (2013) examined the equity impacts resulting from not only a change in how Texas transportation funding is assessed and collected, but also in how it is spent. Four scenarios were examined to evaluate equity impacts due to these changes during the years 2012 to 2021. The first scenario was the baseline of the current state fuel tax and the current funding disbursement. In the other scenarios, equity impacts of funding disbursement changes were analyzed for a mileage-based user fee (MBUF) replacing the state fuel tax.

Table 17. Scenarios analyzed by Burris et al. (2013)

Scenario	Gas Tax System	Funding Disbursement
Scenario 1	Current state and fed. gas tax	Same as the current disbursement
Scenario 2 (static and dynamic)	Flat MBUF and fed. gas tax	Same as the current disbursement and increased revenue by the MBUF
Scenario 3 (static and dynamic)	Flat MBUF and fed. gas tax	More disbursement to maintenance spending
Scenario 4 (static and dynamic)	Flat MBUF and fed. gas tax	More disbursement to environmental spending

Two types of geographical equity related to funding disbursements were examined. The first was geographical equity of funding disbursement based on the percentage of urban and rural households in each county of Texas. From this perspective, Scenario 3 where the distance-based fee is combined with the federal tax and expenditures are shifted to focus more on maintenance, was the least equitable because rural areas receive a larger percentage of the funding compared with the number of rural households. Conversely, when the geographical equity of funding disbursement was measured based on the percentage of revenues collected from each area, Scenario 3 was the most equitable. Through the results of these two measures, it was clear that the equity of a transportation funding disbursement policy depends on how it is measured. The first measure, the geographic equity of the funding disbursement based on the percentage of urban and rural households, can be used to examine a policy that aims to provide equal benefits based on the geographic location of the population. The second measure, the geographic equity of the funding disbursement based on the percentage of tax collected from each area, is useful to examine a policy that aims to distribute funding in relation to how much an area paid in taxes.

The group also analyzed vertical equity (across income strata) using the Gini coefficient, a measure of income inequality. (If everyone in a geographical area earns the same amount, that area's Gini coefficient approaches zero; if a small number of people in the area have vastly higher incomes than everyone else, that area's Gini coefficient approaches 1). The analysis indicates that switching from fuel tax to a distance-based user fee that generates the same amount of revenue has very little effect on vertical equity. Evaluating effects of expenditure policies on vertical equity was recommended as a topic for future research.

Munnich, Doan, and Johnson (2013) presented the results of a Minnesota policy task force convened to evaluate short-term and long-term transportation funding. They noted that the current system funded largely by fuel taxes has taken many years to evolve, and any replacement will take time to implement. Fuel taxes will continue to be an important source of revenue while any new system is developed, and a transition plan will be needed. Revenue contributions under the existing system vary with distance driven and vehicle fuel economy (Table 18).

Table 18. Minnesota state and Federal gasoline taxes paid annually, by type of vehicle and miles driven, 2011 (Munnich Jr, Doan, and Johnson 2013)

Variable	Light-Duty Truck (20 mpg)		Passenger Car (30 mpg)		Hybrid (40 mpg)		Electric Vehicle (non–gas powered)	
	State Tax ($)	Federal Tax ($)	State Tax ($)	Federal Tax ($)	State Tax ($)	Federal Tax ($)	State Tax ($)	Federal Tax ($)
Distance (mi/year)								
20,000	280	184	187	123	140	92	0	0
15,000	210	138	140	92	105	69	0	0
10,000	140	92	93	61	70	46	0	0
Equivalent cents/mi	1.40	0.92	0.93	0.61	0.70	0.46	0	0

NOTE: Minnesota tax on gasoline was $0.28 per gallon as of publication. Federal tax on gasoline was $0.184 per gallon as of publication.

While the federal role in a distance-based driving fee must eventually be addressed, the Munnich group noted that while national leaders have been reluctant to include distance-based fees as a national policy option, US states have traditionally served as "laboratories of democracy;" as new systems are proven effective, these systems are adopted nationally. This is how the gas tax developed, starting in Oregon in 1919, and then adopted over the years by other states and eventually at the federal level in 1932.

The general public remains skeptical about a distance-based fee, but most people recognize the need for a fair user-based approach to funding transportation. The issue of developing a transportation funding system in which everyone pays in proportion to the services received could be the most significant factor in moving the public toward considering distance-based fees as a replacement for the gas tax.

Peterson and MacCleery (2013) explored the perceived effects of distance-based pricing, tolling, and managed lanes (tolled lanes that might be free for buses or carpools) on future land use and public transportation. They noted that tolling and distance-based charging have a much stronger link to land use than revenue mechanisms such as sales taxes and income taxes (Figure 7).

Figure 7. Revenue mechanisms and their relationship to motor vehicle travel (Peterson and MacCleery 2013)

Land Use Impacts of Transportation Revenue Mechanisms: Real, but Modest

TWO SCENARIOS: VALUE PRICING ON MANAGED LANES

1. Bus toll lanes

- The network of lanes is part of the rapid transit system.
- Highest priorities are keeping transit users moving and providing a reliable travel time to all paying users.
- Excess revenue is used for transit service and to improve infrastructure at destinations.

Land use
Help meet demand for and foster development in compact, mixed-use, walkable nodes.

2. Optional toll lanes

- Toll lanes bypass existing congested bottlenecks.
- Highest priority may be speed, revenue, or reliability and is decided on a case-by-case basis.
- Excess revenue is used for highways elsewhere in the region and state.

Land use
Likely to support sprawl.

THREE SCENARIOS: INCREASED TAX RATES AND TOLLS

Revenue mechanism	Land use
Baseline: No expansion of revenue mechanisms	Existing conditions continue, providing no encouragement of market trends for development in compact, mixed-use, walkable nodes.
3. Increased federal tax rates for motor fuels	Encourage current market trends for compact, walkable development.
4. Federal tax on all vehicle-miles traveled	Accelerate development in compact, walkable nodes
5. Toll the Interstate Highway System	Interactions with land use depend on local and metropolitan factors.

Figure 8. Summary results of stakeholder discussions for five scenarios (Peterson and MacCleery 2013)

Since there is little empirical evidence on the effects of transportation revenue collection methods on land use, a group of transportation and land use experts was asked to consider how revenue mechanisms might affect metropolitan development and land use decision making over the next 20 years. This included the differences between tolling, distance-based charging, and value pricing (managed lanes); and the relationship between transportation revenue mechanisms and trends favoring development in compact, mixed-use, walkable nodes. Participants concluded that the impacts will be real, but modest, and will vary greatly by metropolitan area. Distance-based charging was seen as likely to have the most widespread impacts, while the land use impacts of tolling and value-priced lanes are more likely to appear on the corridor level. For lower-income groups, participants in the study identified the most significant areas of concerns as the connection between workers and jobs and the affordability of locations served by managed lanes connecting to compact, mixed-use, and walkable nodes.

Ungemah et al. (2013) explored the possibility of implementing a distance-based fee system that tries to account for differences between urban, suburban, and rural roadway needs and the

differences between revenue development for routine maintenance, rehabilitation, and expansion of roadways. The study explored ways to combine funding sources to encourage efficient use of roadway infrastructure while producing adequate revenue. They suggested implementing distance-based fees as a means to address policy goals beyond revenue generation, so that all Colorado drivers pay their proportional share of roadway system costs. The Ungemah group felt that significant technical, policy, and public acceptance issues required testing and evaluation before the state would be ready to commit to a statewide implementation of mileage-based fees. Thus they regarded distance-based fees as a long-term solution, with near-term funding shortfalls to be addressed through more traditional sources.

Zhang and Lu (2013) evaluated the practical requirements for a distance-based driving fee system in the state of Maryland and verified their results using data from neighboring states. They incorporated various parameters such as travel time, safety, pavement maintenance, vehicle emissions, and noise into the model to determine fee levels (cents/mile) for cars and heavy trucks.

The analysis was based mainly on data from the FHWA Highway Economic Requirements System (HERS) and Highway Performance Monitoring System (HPMS). The combination of these two databases was used to estimate costs related to pavement maintenance, travel time, emissions, safety and vehicle operation, with noise impacts modeled based on separate research. Based on the modelling they proposed a charge of 0.20 to 12.16 cents per mile for cars and 3.91 to 45.3 cents per mile for trucks. The exact value within these ranges would be determined by values related to the cost criteria.

According to their modelling, implementation of this marginal-cost distance-based charge (VMT fee) would reduce the overall vehicle miles traveled in Maryland by 7.7%. Greenhouse gas emissions and air pollution would reduce by 7.6% to 9.4%. The revenue generation under this marginal-cost VMT fee model would be 2.6 times more than the current revenue figures.

Duncan et al. (2014) studied public opinion on the implementation of distance-based road user fees. Prior research suggests that privacy concerns and opposition to tax increases are the main sources of resistance to mileage based fees. Motorists surveyed by the Duncan group also seem to be concerned about the one-time implementation cost of this system. To assess this, the group compared responses to two different survey questionnaires, one indicating government will pay for installation distance-measuring devices, and the other indicating the user will finance such costs.

Duncan et al concluded that adequate privacy protection measures need to be provided, and this can be attained through appropriate design features. Presence of third parties can induce stress among users. The extent of technology-related costs will affect public acceptance. They felt that post-implementation opposition will not be as strong as the pre-implementation resistance. Also they felt that the resistance will be lower if the customer is given the opportunity to select among various distance-measuring platforms. They recommended adjustment of the charges based on vehicle type and weight, road type, and timing, along with indexing to yearly changes in construction costs.

Welch and Mishra (2014) applied a large-scale behaviorally robust travel demand model to examine changes in consumer surplus and travel time savings as a result of replacing the Maryland state gas tax with a mileage-based road pricing mechanism. As noted in the glossary (page 10), “consumer surplus” is the difference between the actual cost of driving (including taxes and fees) and the amount consumers in higher income strata would have been willing to pay. Welsh and Mishra use the term “welfare” to refer to overall economic wellbeing; the term does not refer to public assistance programs for low-income or elderly people. The authors refer to distance-based charging as a “VMT tax.”

Five pricing scenarios were considered to analyze revenue generation alternatives. Two performance measures, traveler welfare and travel time savings, were computed for each scenario. Results were analyzed for five income groups and three area types (urban, suburban, and rural). The complete model set was applied in the state of Maryland. In addition to the base case, the five scenarios included: (1) Replace Gas Tax with a VMT tax, (2) Simple Gas Tax Increase, (3) Simple VMT Tax Increase, (4) VMT Tax with Revenue Recycling, and (5) VMT Tax with Transit Subsidy. The main conclusions were as follows:

- When each scenario was compared to the base case, the impacts of changing the basis of revenue collection on annual per capita consumer surplus were small in relation to the value of travel time savings.
- Replacing the state fuel tax with a distance-based charge (VMT tax) can have a positive impact on traveler welfare (economic wellbeing), particularly for lower-income groups and rural residents.
- Increasing either the gas tax or VMT tax will result in mixed effects on different income groups. Likely, a VMT tax increase would be the least detrimental to overall economic wellbeing, especially for low-income groups.
- Using revenue obtained from a VMT tax to reduce the federal retail gas tax burden has a significant impact (relative to the other scenarios) but subsidizing transit fares appears to be the only use that positively benefits all travelers. In other words, given Maryland’s current levels of traffic congestion, discouraging driving by increasing the taxes and fees paid by drivers and using the funds to expand public transportation would benefit people at all income levels.
- Using the revenue from a VMT tax can significantly benefit all drivers, but has different magnitudes of effect for income and location depending on the use. The best use may be a mix of revenue recycling and transit fare subsidy. If the objective is minimization of total system travel time, increases in revenue are required.

Table 19. Change in per-capita annual traveler welfare (economic wellbeing) by income level (Welch and Mishra 2014)

Scenario/income	<$29,000	$30,000–$59,999	$60,000–$99,999	$100,000–$149,999	$150,000+
Replace gas tax w/VMT tax	$27.10	$14.60	$1.10	-$34.17	-$173.17
Simple gas tax increase	–$47.25	–$46.68	–$47.70	–$41.03	–$10.75
Simple VMT tax increase	–$8.50	–$20.77	–$35.68	–$74.72	–$212.47
VMT tax revenue recycling	$126.89	$132.12	$49.82	–$13.27	–$313.90
VMT tax transit subsidy	$39.49	$31.78	$25.29	$38.33	$46.98

Table 20. Change in per capita annual traveler welfare (economic wellbeing) by location (Welch and Mishra 2014)

Scenario/Area type	Urban	Suburban	Rural
Replace gas tax w/VMT tax	–$1.99	–$5.72	–$25.19
Simple gas tax increase	–$2.06	–$5.04	–$31.58
Simple VMT tax increase	–$5.37	–$16.35	–$48.71
VMT tax revenue recycling	–$0.37	–$4.10	$0.81
VMT tax transit subsidy	$9.85	$12.80	$13.73

Zhao et al. (2015) explored the background of the fuel-based taxation system and its appropriateness based on four main criteria, which they termed economic efficacy, social fairness, revenue sufficiency, and administrative possibility. The group claims that despite the fact that fuel-based taxation has worked in the past, it will fail to be a reliable source of state revenue in the future. Instead they propose that states rely more on distance-based fees or general revenue.

The group's methodology scored each revenue source as either as weak, moderate, or strong on each criterion. While fuel-based taxation was rated "strong" in administrative feasibility, it scored less favorably in terms of economic efficiency, social equity, and revenue adequacy. While raising the fuel tax is politically challenging, keeping fuel prices low leads to higher levels of congestion and therefore faster deterioration of transportation infrastructure. In addition, fuel-based taxation is losing its base as more electric vehicles are utilized.

The Zhao group argued that distance-based charging is not only socially fair as it relies on the concept of user-pay principle, but also it has the potential to become economically efficient and financially sustainable. They recommend a fuel tax increase as a short-term solution to provide time for implementation of a distance-based charging approach.

Yang, Kastrouni, and Zhang (2016) used Maryland data to compare a flat-rate distance-based pricing strategy with alternative strategies designed to be progressive across income strata. The three income-based systems were all configured to double the existing revenue, and are thus comparable in terms of impacts on consumer surplus and travel behavior.

Table 21. Comparison of revenue options evaluated by Yang, Kastrouni, and Zhang (2016)

	Existing fuel tax	Policy 1 Flat VMT fee	Policy 2 Ramsey pricing	Policy 3 Fixed interval	Policy 4 Fixed percentage
Revenue	2,954,443.25	3,355,569.50	5,927,420.19	6,010,218.27	6,070,920.47
Increase	N/A	13.58%	100.63%	103.43%	105.48%

Results show that income-based distance pricing fees can better protect lower-income households while generating additional revenue (Figure 9 and Figure 10). A standard fee structure based on Ramsey pricing, or the inverse-elasticity rule, does not work as well as the fixed-interval incremental fee structure. The latter is progressive across all income groups while ensuring that equity and revenue goals are met. When the distance-based rate increases pro-rata with personal income, variable-rate fee structures would not have a significant impact on travel behavior compared to a flat rate per mile.

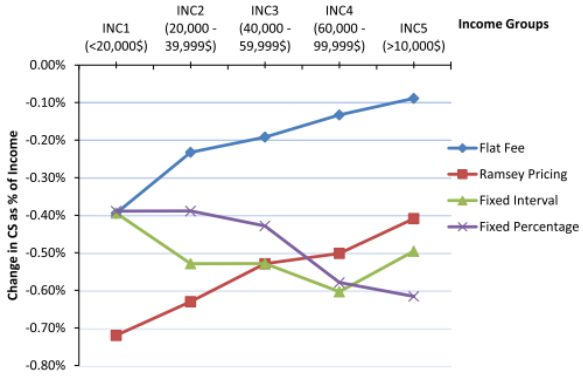


Figure 9. Distributional impacts by income group

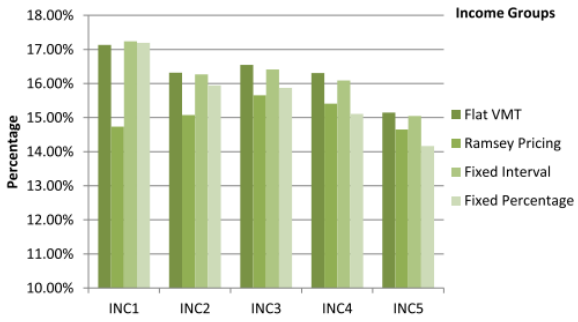


Figure 10. Changes in vehicle-miles traveled across income groups

The study did not address the administrative details of how each driver's income would be verified and linked to the relevant per-mile rate.

Agrawal, Nixon, and Hooper (2016) conducted an extensive review of studies related to distance-based road user fees and a survey of state DOT officials. The review included: (1) qualitative research studies, such as focus groups; (2) quantitative public opinion surveys; and (3) media stories covering mileage fees (national newspapers, journals, blogs, etc.). In all, there were 12 qualitative studies conducted since 1995, 38 public opinion surveys conducted between 1995 and 2015, and 359 media stories spanning the years 2010 to 2014. After analysis the researchers concluded that a while few of the media stories reflected public opinion, the majority described the concerns of policy makers and professionals.

Privacy was a prominent theme in both the focus group studies and media stories. The topic was discussed in virtually all the qualitative studies evaluated, and the authors of several of these studies highlighted privacy as one of the main objections to a distance-based fee system. Participants were most alarmed by technology that collected data on the location or time of travel, but even simple odometer-based systems raised concern. The media coverage analysis supports the notion that privacy is a common concern; half of the media stories discussed

privacy issues in some way. As for the survey data, responses to 7 of the 10 privacy questions showed that at least half of the respondents believed that privacy was a concern.

A second prominent theme in the qualitative studies and media stories was fairness, with distance-based charging systems framed as both fair and unfair. For example, many focus group participants were concerned that fuel-efficient vehicle owners would pay comparatively more in distance-based fees than they pay under the gas tax system, while owners of less fuel-efficient vehicles would pay comparatively less. These people thought it was unfair that a switch from the gas tax to a distance-based fee would penalize those who were "doing their part" to protect the environment and reduce greenhouse gas emissions. On the other hand, some people thought a distance-based fee would be fairer than the gas tax because all drivers, including drivers of fuel-efficient and alternative-fuel vehicles, would pay similar amounts of tax to maintain roads. Other fairness discussions centered on the impact distance-based fees would have on lower-income drivers, rural drivers, truckers, and commuters, and whether a distance-based system would allow some unethical drivers to cheat the system by avoiding payment altogether. The survey data do not provide clear evidence about which fairness issues are most important to individuals, but the data do support the notion that fairness is a serious concern.

Concerns about administering distance-based fees were widespread in the qualitative studies. The most common worries centered on distrust of either the technology to be used or the ability of government to administer a distance-based fee program. Respondents predicted that both factors would cause billing errors. To a lesser extent, study participants also expressed concern about the cost of the program and the logistics associated with billing in-state drivers who drive out-of-state miles or charging out-of-state drivers who drive in a state with distance-based fees.

Finally, the researchers provided several recommendations for future research in this field such as:

- Identification of the specific perception of populations of special concern
- Further studies on the issues discussed in the qualitative studies and media stories
- Identification of the new factors influencing public support
- Multivariate analysis of factors affecting public opinion (demographic characteristics, travel behavior, vehicle type owned, and attitudes, etc.)
- Necessity of performing the survey on a larger sample size
- Standardizing the surveys in this area (questionnaire, sampling plan, data analysis plan, etc.)
- Providing a model for publicizing results of these researches to assist further studies
- Organizing more pilot programs
- Gathering additional media stories from states that have tested distance-based fee systems
- Analyzing social media commentary about mileage fees

Dumortier, Zhang, and Marron (2017) noted the inadequacy of the revenue generated by the existing fuel tax system at the federal level and in most states, since per-gallon rates are only rarely adjusted for revenue shrinkage due to inflation and improved fuel efficiency. This has resulted in an increasing gap between tax revenue and the cost of providing transportation infrastructure in the United States.

Tax rates could be indexed to inflation or supplemented by a sales tax. In all cases, tax revenue is a function of vehicle miles traveled, the vehicle fuel economy, and the number of vehicles. If states were to enact policies that link fuel taxes to a measure of inflation, state governments would arrest the decreasing purchasing power of their current revenue streams. While the fuel tax would remain constant in real terms, increases in population and real income will increase vehicle miles traveled resulting in increased revenue. Nevertheless, the issue of increased fuel economy is not addressed by indexing fuel taxes to inflation.

A distance-based charging system could be made a function of vehicle weight, fuel efficiency, type of road, and time-of-use. Vehicle weight is especially important since most of the road damage is done by heavy trucks, with some research showing that damage done to the road is proportional to the axle weight raised to the fourth power. Current fuel taxes only partially account for vehicle weight, since the lower fuel economy of heavy trucks is not proportional to the additional damage done to roads. Some states and countries have already started to implement weight-and-distance fees. Examples include Oregon, New Mexico, New York, and Kentucky in the United States, along with Germany, Switzerland, and Austria in Europe.

If the Federal government took the lead in developing a distance-based charging system there would be economies of scale; state and local governments could take advantage of the collection infrastructure put in place by the Federal government. The transition from per-gallon to per-mile charging requires consideration. If only new vehicles are equipped to track vehicle miles traveled, it would take 10 and 20 years to have 63% and 95% of vehicles on the road compatible with a VMT system, respectively.

Pulipati, Mattingly, and Casey (2017) critiqued the prior research on transportation funding alternatives and developed a weighted multi-criteria analysis framework which included the following parameters:

- Revenue generation (24% weight)
    - Revenue generation potential
    - Revenue sustainability
    - Revenue predictability
    - Flexibility in investment
    - Ease of tax or fee increases when needed
- Equity and fairness (25% weight)
    - Equity in paying by benefit gained and cost imposed (user-pay)
    - Ability to pay equity
    - Geographical equity
- Ease of implementation (18% weight)
    - Cost of implementation
    - Simplicity of payment structure
    - Ability to prevent evasion
    - Ability to use existing payment infrastructure
    - Ease of coordination with bordering regions
- Public acceptance and political feasibility (27% weight)
    - Ease of explaining to the public
    - Acceptability to the public
    - Less need for legislative action (addition, deletion or amendment of laws)

- Potential secondary benefits (6% weight)
    - Promotion of efficient use of system by changing travel behavior
    - Promotion of fuel efficiency and use of low emission fuels

Although a transition to distance-based charging was considered, based on the multi-criteria analysis the group recommended a gradual increase in the state fuel tax (from the current level of $0.20/gallon to about $0.30/gallon). Indexing the fuel tax to inflation was recommended to enhance revenue sustainability, in spite of weak public acceptance. Continued tolling of all new freeway capacity was recommended, with a transition to variable tolls based on congestion. The group also recommended temporarily allocating sales tax revenue from vehicles, tires, and vehicle parts to transportation, but suggested this is not a permanent solution because the revenue is also needed for other purposes.

Wang and Miao (2018) simulated the vehicle usage, tax burdens, and total tax revenues generated under a possible nationwide revenue-neutral flat-rate distance based charge that would replace the Federal fuel tax. Their model considered the effect of changes in fuel prices on vehicle-miles traveled at the household level, along with existing VMT and fuel economy for 18 levels of household income, ranging from less than $5,000/year to more than $100,000/year.

The analysis confirmed that distance-based charging could be a more stable tax revenue source. For example, a 50% increase in average miles per gallon would lead to a 28% decrease in the total revenues raised by the current gasoline tax, while the same improvement in fuel economy would increase the distance-based charging revenues by 4.4 % (all relative to the 2009 baseline).

Wang and Miao found no significant difference between the two types of tax in their total revenues, when the pre-tax gasoline prices fluctuate by different magnitudes. Distance-based charging would be slightly more regressive than the gasoline tax, but the difference is negligible. They concluded that a distance-based charge could serve as a viable alternative to gasoline taxes.

Bayen et al. (2019) proposed dividing travel into three distinct segments: the long haul, the last mile, and the curb, with separate mileage-based fees for each segment. The long haul portion of a trip typically occurs on freeways, highways, or major arterials, whereas the last mile usually takes place on smaller streets, depending upon the context of the destination. The curb portion of a trip accounts for any time a vehicle is unattended or parked.

Using data provided from the California Road Charge Pilot Program (RCPP), the study developed a parametric road user costing formulation that was revenue-neutral, producing no more revenue than the incumbent gas tax. The formulation relies on five vehicle characteristics (weight class, vehicle use, level of automation, propulsion system, and value) to assign per-mile charges. The per-mile rate for a vehicle would be determined by multiplying a calibrated base fare with values corresponding to the appropriate vehicle classification level for each parameter.

The study explored various approaches for weighting charges based on the five parameters, for example finding that weights based on greenhouse gas emissions would substantially increase the proportion of overall system costs borne by heavy trucks. The choice of weighting

parameters allows the fees to reflect policy objectives such as incentivizing the use of hybrid and electric vehicles or discouraging excessive travel by heavier vehicles. Additionally, it provides a mechanism for addressing localized issues, such as discouraging vehicles from standing at the curbside in congested areas.

Hawaii DOT (2019) conducted a series of community meetings in the spring of 2019 in preparation for a three-year distance-based charging technology demonstration. The main questions raised by attendees included how administration of a future RUC system would work (such as how often drivers would be billed and by whom), whether the system's administrative costs would be reasonable, whether users would be charged for mileage driven on private roads, whether the charge would be based on odometer readings already collected annually through the state's vehicle safety inspection program, whether the charges would include a factor for vehicle weight, whether distance-based charges would fully replace the fuel tax or be in addition to the fuel tax, how rates would be determined, and whether there would be surcharges for rental cars used by tourists or discounts for low-income people. In Hawaii, each county has its own fuel tax in addition to the state tax, and participants were also interested in knowing whether distance-based fees would also be imposed at both the state and county levels.

Other questions raised by the public included why it is necessary to switch to a distance-based system, how the system would apply to electric and hybrid vehicles, whether enforcement of odometer fraud would be linked to the state's annual vehicle safety inspection program, whether fuel retailers would use the switch to distance-based charging as an opportunity to increase their profit margins, how privacy would be protected, whether other revenue alternatives were viable (tolls, tire taxes, congestion pricing, taxing electricity used by EVs, lottery, cannabis taxes, and taxing tires and other car parts), and whether switching to distance-based fees would change the way transportation revenue is used.

Subsequently, the project mailed reports to almost 360,000 drivers comparing the amount they would pay under a distance-based driving system with the amount paid in fuel taxes (Hawaii DOT 2021). The mailing invited drivers to participate in a survey indicating their preferred method for measuring road usage. More than 40,000 responded, with 86% indicating they would prefer to have their mileage based on the odometer readings collected during the existing annual vehicle safety inspection, 10% preferring a device that would plug into the vehicle's on-board diagnostics (OBD) port, and 4% preferring OdoFoto, a smartphone app that allows participants to periodically photograph their odometer and submit the photo for mileage processing. A total of 2129 participants were enrolled in the 9-month technology test, with 53% selecting OdoFoto, 30% selecting an OBD plug-in device with GPS, 6% selecting an ODB plug-in device without GPS, and 11% selecting other technologies. Publication of the project's final report is expected in 2022.

I-95 Corridor Coalition (2019) conducted a pilot study of distance-driven technologies and surveyed the opinions of participating drivers. The organization is a coalition of state transportation agencies and toll road authorities along the US East Coast from Maine to Florida. Devices for collecting distance-driven data were tested by a total of 155 drivers recruited by the

states of Delaware and Pennsylvania. The participants also completed opinion surveys before and after the demonstration. In all, nearly 460,000 miles were driven by the participants.

The research aimed to address some of the technical and administrative issues of concern to Coalition members, including integration of distance-based charging with existing tolling systems, incorporation of commercial trucks in the distance-based charging system, and accurate allocation of mileages to each jurisdiction.

Three technologies were utilized for the phase I testing. Two of the devices plugged into the vehicle's on-board diagnostics (OBD) port; one product incorporated a GPS, while the other did not. The third device computed the distance driven by combining a beacon in the car with a smartphone app. Participants reported greater satisfaction with the OBD plug-in devices than with the smartphone app. Approximately 20% of the total mileage was driven outside the participant's home state, and all three technologies were successful allocating mileages to the correct states.

Survey data suggested that data privacy and security were the most important participant concerns. Participation in the pilot program helped reduce these concerns, but privacy and the potential for data sale to third parties remained as prominent concerns in the post-demonstration surveys. Fairness was another concern, specifically the belief that distance-based fees are less fair to drivers of fuel-efficient vehicles.

Schroeckenthaler and Fitzroy (2019) explored the equity effects of a variety of parameters that could potentially be included in a distance-based changing system, including vehicle characteristics (fuel type, fuel efficiency, emissions, age, and weight); owner characteristics (place of residence and household income); location characteristics (travel on tolled facilities, in congested areas, or specific functional classes); and usage considerations (an initial mileage allowance, rate brackets for mileage tiers, and a maximum annual mileage billed). Fuel type and fuel efficiency were chosen for further study based on their ability to encourage operating efficiencies, influence perceptions of fairness and equity, and offer relatively high technological, administrative, and political feasibility.

Almost universally, under seven tested formulas in seven states, urban households pay more and rural households pay less under a mileage-based charging system compared with the fuel excise tax. For gasoline vehicles the changes are minor: the average annual change ranged from $-0.09 in Arizona to $-1.55 in California. For electric vehicles the changes ranged from $+59.17 in Hawaii to $+227.04 in the state of Washington. There is significant heterogeneity between census tracts within geographic classifications and between states and additional heterogeneity within census tracts that was not covered by this study.

When replacing a fuel excise tax with a distance-based charging system, adding a fuel efficiency parameter results in a smaller change in payments between urban, mixed, and rural tracts. A fuel efficiency parameter reduces how much payments change based on fuel type. It provides a way to explicitly influence how much convergence there is in payments between the most and least fuel-efficient vehicles. Fuel type parameters resulted in only small differences from flat-rate charging because of low alternative fuel penetration in most states. This could

change over time depending on the rate of integration of alternative fuels into the passenger car fleet.

Poole (2019) prepared a white paper advocating the transition to a distance-based charging and offering suggestions for overcoming some of the main objections raised by elected officials and the public. Poole argued that the main flaws with existing fuel taxes are as follows:

- They are not applicable to all vehicles, i.e. electric vehicles cannot be taxed on a per-gallon basis
- They are not keeping pace with roadway needs
- They are not transparent, i.e. the average motorist does not know how much is being paid for highway services
- They have no effect on congestion
- They are not fully dedicated to programs that benefit road users, i.e. some of the money is used for public transportation, air quality improvements, bicycle facilities, preservation of historic transportation facilities, and so forth

Poole advocated a "public utility" model of infrastructure financing that would treat distance-based charges as a "user fee" rather than a tax. Rates would vary based on vehicle weight, as they currently do for toll roads. He suggested implementation in two phases, beginning with Interstate highways and later encompassing the rest of the roadway system.

Poole offered the following suggestions for overcoming stakeholder objections to the transition:

- Make the charging system simple and understandable
- Replace the fuel tax, rather than increasing it
- Make it fair to all highway users
- Make it transparent
- Foster accountability for roadway providers
- Offer a choice of methods to record miles driven
- Report only miles, not travel details
- Include strict privacy protections

Agrawal, Nixon and Hooper (2020) have been conducting an ongoing series of public opinion surveys on Federal transportation taxes, including a survey of 2515 people in February 2020. The data collection was stratified by geographical regions of the United States (Northeast, Midwest, South, and West), as well as different genders, ethnicities, education levels, employment status and income levels.

The questions tested public opinions about raising the federal gas tax rate, replacing the federal gas tax with a new mileage fee, and imposing a mileage fee just on commercial travel. In addition to asking directly about support for these tax options, the survey collected data on respondents' views on the quality of their local transportation system, their priorities for federal transportation spending, their knowledge about gas taxes, their views on privacy and equity matters related to mileage fees, travel behavior, and standard sociodemographic variables. This large set of variables is used to identify personal characteristics and opinions correlated with support for the funding options.

The survey results indicate that support for distance-based charging systems is increasing over time. In the 2020 survey, large majorities supported transportation improvements across modes, only 3% of respondents knew that the federal gas tax rate had not been raised in more than 20 years, three-quarters of respondents supported increasing the federal gas tax by 10 cents-per-gallon if the revenue would be dedicated to maintenance, roughly half of respondents supported some form of mileage fee—whether assessed on all travel or just on commercial travel—and three-quarters of respondents would prefer to pay a mileage fee in small installments instead of one annual payment.

Matthews et al. (2021) analyzed nearly 120 million records from Pennsylvania's vehicle safety and emissions inspection programs to determine the distributional effects of switching to a distance-based driving fee. The records spanned a 15-year period, and were used to develop high-resolution estimates of annual vehicle miles travelled (VMT) per vehicle aggregated at the state, county, and ZIP code level. This data was combined with fuel economy estimates for each vehicle to develop estimates for fleetwide fuel economy in each area.

Based on these estimates of VMT and fuel economy, the group estimated the annual cost to vehicle owners of the existing fuel tax and compared it to the cost of distance-based driving fees at various rates. Based on these estimates, they found that the "balance point" fees (i.e., the per-mile rate at which 50% of the jurisdiction would pay less or as much per year as they currently do in fuel taxes) would vary by county and ZIP code, and ranged from 2.4 to 3.2 cents per mile. The study also found that vehicles registered in urban areas travel 10-30% fewer miles per year and tend to consume about 10% less fuel per year than average. This indicates that distance-based fees will, in general, lead to drivers in urban areas, and drivers of hybrid electric vehicles, paying a higher amount than they currently do, while drivers in suburban and rural counties will spend less each year.

5 Equity Studies of Other Transportation Revenue Sources

Seggerman et al. (2010) presented an exploratory analysis of a Florida mobility fee or impact fee emphasizing vehicle-miles traveled. The analysis focuses mainly on differences in the fee structures under two different valuation methodologies, the need for intra-regional policy coordination, the effects of differing levels of urban density on traffic generation and the resulting fees, and the ability of the policies to discourage development in areas designated to remain rural.

From an equity perspective, an important observation is that Florida case law allows development fees only if the public agency can establish a reasonable connection between the anticipated need for transportation system improvements and the growth generated by new development, as well as a reasonable connection between the fees collected and the benefit to the development. In addition, developers cannot be required to pay twice for the same service, for example they cannot be charged development fees in addition some other fee or tax on the same development impacts.

Zhao, Das, and Larson (2010) described characteristics of value capture, a public finance method in which the increase in the value of private land that results from a public investment is captured through real estate taxes or other taxes or fees. They argued that value capture promotes equity by distributing the burden of the public investment beyond transportation infrastructure users, to encompass all beneficiaries. Eight value capture strategies commonly used in the United States are land value taxes, tax increment financing (TIF), special assessment districts, transportation utility fees, development impact fees, negotiated exactions, joint development, and air rights.

The main focus of the paper is TIF, which they feel helps alleviate some of the financial burdens associated with development, and avoids the difficulties of imposing a new tax by reallocating revenues generated by the existing tax system. They argued that TIF promotes efficient development decision making, reduces development risks, encourages developers to maximize societal returns, and enables local governments to direct growth toward areas the governments believe are the most appropriate. TIF has successfully generated significant amounts of revenue to fund projects, in their view.

They note that TIF has some drawbacks because it relies on the aggregate increase in property values, which is dependent on exogenous factors such as the regional economic cycle and the condition of the real estate market. In some cases, TIF can be perceived as a corporate handout from local governments to attract large businesses into the jurisdiction, with the potential for private-sector benefits to outweigh the costs incurred by the private sector. In some regions TIF has been sharply criticized for its impact on overlapping jurisdictions such as school districts, which are denied access to tax increments while they may be facing increased service pressures. In addition, some TIF projects can lead to displacement of the original residents, and TIF districts tend to have high administrative costs. The Zhao group recommend a package of legal, administrative, and technical measures to mitigate these problems.

Junge and Levinson (2012) compared the concepts of treating transportation systems as “public utilities” and the use of land-value capture, using urban and suburban examples from the Minneapolis-St. Paul-Bloomington metropolitan area in Minnesota. They conclude that when designing a revenue system, it is necessary to strike a balance between equity, administrative concerns, and efficiency. While distance-based charging can be considered as the most accurate way to measure each user’s impact, it is necessary to assure that the system is not prone to tax/fee evasion.

Table 22. Evaluation of funding and financing options for transit and alternative modes (Lambert 2012)

Revenue Source	Transparency	Revenue Generating Potential and Financial Sustainability	Ease and Cost of Implement-ation	TDM [Demand Management] Effects and Transportation Efficiency	Technical Feasibility	Popularity/ Political and Legal Acceptability	Equity, Geographic and income
RELATED TO ALTERNATIVE MODES							
Raise Fares and Rvenue/Cost Ratio or Full Cost Recovery	●	◑	●	○	●	◔	○
Implement New Pass Types (e.g. U. Pass, Community Pass etc.)	●	◔	◑	◑	◕	◕	○
Increased Advertising Revenues	●	◔	◕	○	●	●	○
Increased Federal/ Provincial Grants	◑	◔	◔	○	●	●	◕
New Fare Media and Fare Collection Technology (e.g. SmartCards, Smart Phones, Debit Cards)	●	◑	◔	◑	◑	●	◕
DEVELOPMENT RELATED							
Value Capture	◔	◑	◔	○	◑	◑	◑
Raise Property Taxes	◑	◑	◑	○	◕	◔	◑
New Transit Development Levy	◕	◑	◑	●	◑	◕	●
BUSINESS AND ECONOMIC GROWTH RELATED							
Employer Payroll Tax	◕	◕	◑	○	◕	◑	◑
Implement or Raise Retail Sales Taxes	◑	◑	◑	○	◕	◔	◑
Cargo Tax on Containers	[Not Rated]	◔	◑	○	◑	◔	◔
TRANSPORTATION RELATED							
Parking Surcharge/ Levies	◕	◑	◑	◑	●	◑	◑
Vehicle Miles Driven & Type of Vehicle-VMT	●	●	◔	●	◔	◕	◕
Road/ Bridge Tolls & Pricing	●	●	◕	●	◑	◕	◕
Vehicle Registration Fees/ Levy	◕	◑	◕	◑	◕	◕	◕
Congestion Pricing	●	●	◑	●	◑	◑	◕

Gas Taxes	◕	◑	◕	◑	◕	◕	◕
VISITOR TAXES							
Rental Car Fee	◔	◔	◕	◔	◕	◔	◕
Hotel/ Motel Occupancy Tax	◔	◔	◕	◔	◕	◔	◕
Airport- Fuel and/ or Passenger Fees	◔	◔	◕	○	◕	◔	◕
OTHER							
Carbon Tax	●	◕	◕	◕	◕	◑	◑
Financing Means- Public-Private Partnerships	●	◑	◑	○	◕	●	◕

●	Revenue source meets criterion extremely well
◕	Revenue source meets criterion very well
◑	Revenue source meets criterion well
◔	Revenue source meets criterion extremely somewhat
○	Revenue source meets criterion poorly or not applicable

Lambert (2012) compiled information on a wide range of transportation funding sources used by various levels of government to fund roadways, public transportation, bicycle facilities, pedestrian facilities, parking, and other transportation infrastructure and services. Examples of jurisdictions using each of the sources are noted in the report. As shown in Table 22, each source was scored on several evaluation criteria including revenue generating potential, financial stability, income, geographical equity, the practicality/ease and costs of revenue collection and administration, and the extent to which the funding mechanisms support transportation demand management.

Lambert also discussed positive and negative externalities of the funding mechanisms. Negative externalities include air and noise pollution, congestion, traffic accidents, and property damage. Examples of positive externalities include increased land values, greater economic competitiveness, and more free time for transportation system users. Lambert noted the amounts users pay for transportation facilities and services are often less than the cost of providing the facilities and services (especially when negative externalities are taken into consideration), resulting in inefficient allocation of resources, congestion, environmental damage, and other problems.

Interviews with regional transportation authorities underscore the importance of having multiple sources of funding, which provides protection in case one or more sources of funding are adversely impacted by the economy or other factors. For example the 2008 financial crisis resulted in a decline in sales tax revenues, which necessitated transit service cuts in cities that were reliant on sales tax revenue to fund their systems.

Anderson and Thompson (2014) analyzed funding approaches suitable for predominantly rural states such as Nebraska. They suggested that the optimal approach is a combination of a flat fee and a variable charge. They noted that such fee structures are the norm for public utilities, where the flat element of the fee is typically designed to recover the cost of infrastructure and equipment required to produce and distribute energy or water, and the variable element of the fee reflects the quantity of energy or water supplied to each customer.

They argued that a two-part tariff is an efficient solution in markets with increasing returns to scale and falling long-run average cost curves. Efficiency requires pricing at the marginal cost of travel, and given low marginal costs in rural areas (with limited congestion), a flat fee is needed in combination with the variable charge, in order to make the financing mechanism sustainable.

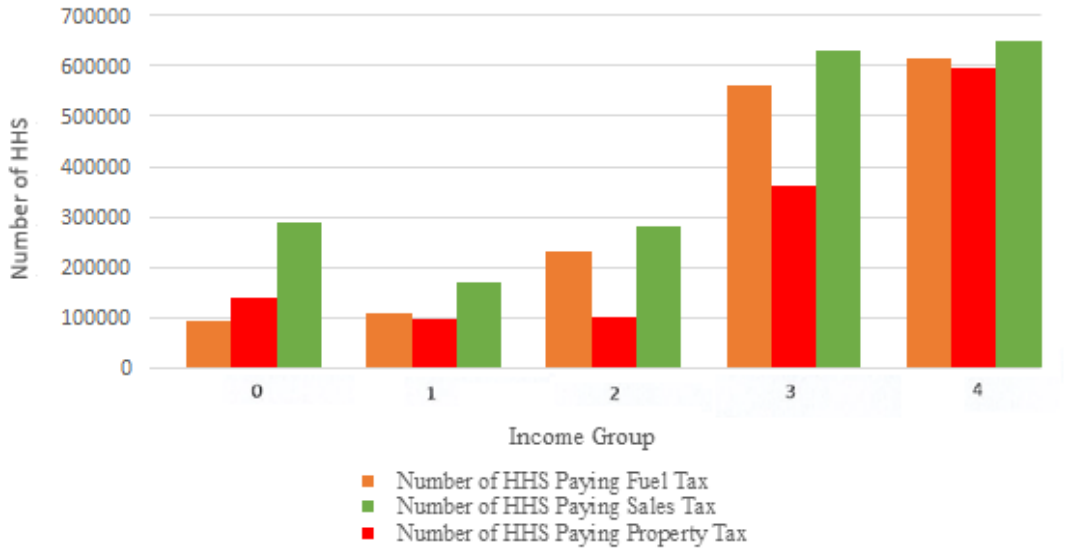
The current transportation funding system already includes flat fees (licensing and registration fees) and variable fees (gasoline and diesel taxes), but the allocation between these two elements requires consideration. Anderson and Thompson's analysis indicated that the incumbent gasoline and diesel fuel tax rates in Nebraska were consistent with the external marginal costs of travel for rural highways, and therefore, economically appropriate for rural regions. Since the revenue generated was not sufficient to cover the fixed construction and maintenance costs of rural highways, they recommended an increase in registration fees. To address the effects of inflation, they recommended replacing the per-gallon fuel tax with an *ad valorem* tax (also called a value-added tax) that would remain constant as a percentage of the fuel price.

Kastrouni, Carrion, and Zhang (2017) studied the influence of general-purpose taxes (sales tax and property tax) on the funding of the transportation projects. Despite the fact that sales taxes have been deemed regressive by various researchers, they have more revenue potential and are sometimes preferred by the public due to their gradual nature, especially if the voter approval has been gained and a predefined list of infrastructure projects has been communicated. This mechanism has already been implemented to a limited degree in some areas, such as the state of Virginia and Los Angeles County which allocate 0.125% and 0.5% of the sales tax, respectively, for transportation projects.

The Kastrouni group used statistical matching to create a synthetic sample of households in the Baltimore-Washington metropolitan area. The resulting data was used to study the distributional effects of replacing fuel taxes with either a sales tax or a property tax. They found that shifting to property taxes reduced the number of households who would pay tax, thus increasing the amount of tax borne by each tax-paying household, with 8.6% of the revenue coming from households that do not drive any vehicles. Shifting from fuel taxes to sales tax would increase the number of taxpayers, thus reducing the amount paid by each household, with 7.1% of the revenue coming from households that do not drive any vehicles. Both policies substantially

increased the number of very low income households that were subject to taxation and the income-to-tax ratios for these households.

Figure 11. Estimated income distribution of the tax-paying population for three taxation alternatives in the Baltimore-Washington metropolitan area; "HHS" means "households."



Lowe and Hall (2019) reviewed the equity implications of revenue sources currently being used to fund the local share of rail and busway projects funded by the Federal Transit Administration's New Starts program. They expressed concern about the increasing use of sales tax revenue as a source of transit funding, due to the fact that low-income people spend a high proportion of their money on taxable necessities. As a result, sales taxes are not progressive in relation to ability to pay. In addition, most New Starts projects primarily benefit transit users from higher income strata, who tend to prefer rail services and dedicated busways, and are less attracted to ordinary buses.

Lowe and Hall were also doubtful about the distributional effects of land value capture mechanisms such as tax increment financing. They noted that these projects often fail to address the transportation needs of those with the least accessibility. However, these mechanisms do potentially align with the market equity concept of beneficiary to pay, as land holders reap the majority of the benefits of the transportation investment.

6 Summary & Conclusions

A systematic search of four academic databases yielded more than 300 unique journal articles, reports, and policy papers that include words or phrases related to the equity effects of transportation revenue alternatives. After screening, about 60 sources were found to be relevant to the present study. Many of the papers are predicated on concerns about the long-term viability of fuel taxes as a major revenue source for highways and public transit. Key concerns include inflation in the costs of providing roads and transit, technical advances that reduce the amount of fuel consumed per mile driven, and growing use of electric vehicles (Aultman-Hall, Glitman, and Kenyan 2010, Poole 2019, EPA 2021, Jenn 2018, Jia et al. 2019, Davis and Sallee 2019, 2020, Varn, Eucalitto, and Gander 2020, Zhao et al. 2015). Authors also express concerns that existing revenue systems do not account for externalities such as the effect of road crashes on healthcare costs (Link and Stewart-Ladewig 2005, Zhang and Lu 2012). These issues affect funding at the federal and state levels, and in some cases at the local level.

As a result of technical advances and emissions reduction policies, sales of electric vehicles appear to be poised to grow rapidly in the next few years. Declining battery prices allow manufacturers to provide substantially greater driving range than was possible when electric vehicles were introduced a decade ago, overcoming the biggest consumer objection. Electric vehicles now account for over half of all new vehicle sales in some European countries, and several major automobile manufacturers have announced plans to begin phasing-out production of gasoline and light-duty diesel vehicles (Jolly 2020, Plumer and Tabuci 2021, Reuters 2021, Ford Europe 2021).

Although Iowa implemented registration fee surcharges for hybrid and battery-electric vehicles (BEVs) in 2019 (Iowa Department of Revenue 2016), these flat-rate charges are problematic from an equity perspective because they have no relationship to the distance driven or the owner's ability to pay (Jenn 2018, Varn, Eucalitto, and Gander 2020). In addition, the surcharges currently do not generate as much revenue per vehicle as the fuel tax. Perceptions of these fees are also influenced by the way in which they are paid, with surveys consistently showing drivers prefer to pay in small increments (Agrawal and Nixon 2010, Agrawal, Nixon, and Hooper 2016, 2017, Hawaii DOT 2019). With the current surcharges, the Iowa vehicle registration fee structure requires a large annual lump-sum payment.

Iowa does not have a toll road system, and imposing tolls on existing roadways could be both politically and technically challenging. Congestion charging (also called cordon charging) involves charging a daily fee to drive into a congested area such as a central business district. Congestion charges have been implemented in a few very congested cities (most notably London), but it is unlikely any Iowa communities have congestion levels high enough for such a system to be feasible. Distance-based driving fees (also called vehicle miles travelled [VMT] charges, mileage-based user fees [MBUF], or road user charges [RUC]) are one of the main alternatives to the incumbent revenue system. Other sources mentioned in the research literature are used mainly at the county and municipal levels, such as property taxes and local sales taxes (Kastrouni, Carrion, and Zhang 2017, Lowe and Hall 2019). There are also various supplemental revenue sources such as parking fees, utility permit fees, and land development

fees, along with value-capture systems such as tax increment financing districts for land developments (Seggerman et al. 2010, Zhao, Das, and Larson 2010, Junge and Levinson 2012, Lambert 2012, Lowe and Hall 2019).

Electricity taxes are sometimes mentioned as a method for collecting revenue from electric vehicles. In Iowa, an excise tax on energy supplied by non-residential charging stations is scheduled to go into effect in July 2023. Nevertheless, the majority of electric vehicle charging currently occurs at home (Iowa DOT 2018), often on Level 1 chargers that draw about the same amount of power as a portable heater. This makes it difficult to distinguish the energy used for vehicle charging from other household electrical loads.

With these limitations in mind, distance-based road user fees are likely to be the most practical alternative to the fuel tax for Iowa. The literature studied for this review spans nearly two decades. In general, the studies completed before electric vehicles were in commercial production contextualize distance-based charging as a *substitute* for fuel taxes. More recent studies frame distance-based charging as a *replacement* for fuel taxes that offers a practical way to collect revenue from electric vehicles. Distance based charging pilot programs have been completed in several states and a large pilot program is currently underway in Hawaii.

Equity can be defined and measured in various ways (Link and Stewart-Ladewig 2005, Lowe and Hall 2019). Depending on one's point of view, contributions to transportation revenue should be:

- Proportionate to the distance each vehicle is driven
- Proportionate to the amount of damage each vehicle does to roads and bridges
- Proportionate to the distance driven (or pavement damage done) within each individual jurisdiction, e.g., individual cities, counties, and states
- Proportionate to each vehicle's environmental impact, i.e., higher for vehicles that emit more pollutants
- Proportionate to each driver's income or ability to pay

A large number of research reports and policy papers (white papers) exploring the equity effects of distance-driven fees have been published. Analysts typically compare equity effects based on income, geographical area, race/ethnicity, or vehicle classification (personal vehicles vs commercial trucks). The equity concerns stem mainly from data indicating that low-income people tend to drive older, less fuel-efficient vehicles than their wealthier counterparts. In addition, when measured as a percentage of their income, low-income people and the elderly currently tend to contribute more transportation revenue than middle-class or upper-income people.

In general, the equity issues associated with the fuel tax are neither solved nor worsened by switching to distance-based charging. Numerous studies have found the equity impacts of per-gallon and per-mile taxation to be very similar (McMullen, Zhang, and Nakahara 2010, Sana, Konduri, and Pendyala 2010, Robitaille, Methipara, and Zhang 2011, Weatherford 2011, 2012, Burris et al. 2013, Welch and Mishra 2014, Yang, Kastrouni, and Zhang 2016, Wang and Miao 2018, Matthews et al. 2021). When the total revenue to be collected is the same under both

revenue systems, differences in the amounts paid by individual drivers are small (typically a few dollars per year).

Since the majority of the research concludes that flat-rate distance-based charging systems result in very little change in the share of revenue collected from drivers in various income categories, a few authors have explored ways to make the system more progressive, typically by offering some type of discount to lower-income drivers (Yang, Kastrouni, and Zhang 2016, Schroeckenthaler and Fitzroy 2019). No studies were found that describe how such a system would be administered.

Public outreach conducted for distance-based charging pilot projects consistently finds rural drivers are concerned they would contribute more revenue than urban drivers under a distance-based driving system (Nevada DOT 2010, Oregon DOT 2013, Ungemah et al. 2013, Caltrans 2017, Washington State Transportation Commission 2020, Hawaii DOT 2019). Drivers seem to overlook the fact that this is already the case with fuel taxes, which are also approximately proportionate to distance driven. In-depth revenue distribution studies have found that under a distance-based charging system, the share of the revenue contributed by rural drivers actually decreases slightly, because rural drivers tend to use less fuel-efficient vehicles than their counterparts in urban and suburban areas. With either system, rural drivers pay more because they use the roads more. As part of the ongoing study, Hawaii DOT sent mailers to thousands of drivers comparing the amounts paid under the current fuel tax with the amount they would pay under a distance-based revenue plan (Hawaii DOT 2021).

The literature review found very substantial inequities across vehicle classes, especially when the pavement and bridge damage caused by heavy trucks is taken into consideration. For example, a typical SUV or pickup registered in Iowa currently pays about $1.56 per 100 ton-miles driven, while the contribution from a tractor-trailer (semi) is about $0.18 per 100 ton-miles. An analysis from Indiana yielded broadly similar results, with drivers of passenger vehicles found to be subsidizing the pavement and bridge damage caused by heavy trucks (Agbelie, Labi, and Sinha 2018). This could be resolved by charging for road use based on a combination of weight and distance, which is the norm on toll roads (sometimes with length or number of axles serving as a proxy for the truck's weight) (Bayen et al. 2019, Poole 2019).

Several of the sources identified in the literature review discuss potential obstacles to the implementation of distance-based road user charges. These include privacy concerns, technical issues related to the method of charging, and the perceived cost of devices for monitoring the distance driven:

- Concerns about the complexity of collecting distance-driven data are prominent in research from the pre-smartphone era, when it was assumed that it would be costly to equip each vehicle with a specially-designed GPS and data transmission system (Baker and Goodin 2011, Baker and Sabala 2011, Agrawal, Nixon, and Hooper 2016, Bianco 2017). With the growing ubiquity of smartphones and the commercialization of GPS trackers for fleet applications, more recent publications compare and contrast the technical merits of competing products and systems (I-95 Corridor Coalition 2019, Hawaii DOT 2021).

- Although privacy concerns continue to require policy consideration, data anonymization has become a field of study in itself (Raghunathan 2013). One approach is to aggregate the mileages driven in each jurisdiction within the on-board unit, and transmit only summary data to the central server. Several authors suggest offering road users the option of an odometer-based pricing plan that does not require disclosure of routes driven (Baker and Sabala 2011, Agrawal, Nixon, and Hooper 2017). In a 2020 survey of nearly 40,000 Hawaii drivers, 86% said they would prefer mileage fees to be based on odometer data from the state's existing annual vehicle safety inspections, an option that also avoids the need for any additional in-vehicle equipment (Hawaii DOT 2019, 2021).
- Some authors address the computation and allocation of revenue when a vehicle registered in one state is driven in another state (Agrawal, Nixon, and Hooper 2016). For commercial vehicles, this problem is addressed by the International Fuel Tax Association (IFTA), which requires trucking companies and bus lines to log and report the mileages driven in each US state or Canadian province, and allocates revenue accordingly. This allows each state or province to collect revenue from trucks that are passing through, even if the fuel was purchased elsewhere.
- Relatively little research appears to have been conducted on the extent of revenue leakage when drivers of non-commercial vehicles purchase fuel in another state. An Indiana study focusing on fuel sales to non-commercial vehicles found that out-of-state vehicles purchase about 20% of the fuel sold at stations on Indiana Interstate highways and 12% of the fuel sold at stations on other Indiana roadways (Volovski et al. 2017). The study did not attempt to determine how much fuel Indiana drivers purchase in other states, which would be necessary to evaluate the net effect on tax revenue. Cross-border fueling might be relatively high in Indiana due to the geography of the state's road network and the presence of metropolitan areas that straddle its state lines.
- To address revenue from out-of-state vehicles under a distance-based charging system, a few authors have suggested establishing a daily permit system for out-of-state non-commercial vehicles. The establishment of a Federal clearinghouse or multi-state collaboration similar to the IFTA could simplify cross-jurisdictional payments.

Several sources address the issue of phase-in of a distance-based charging system (e.g., Coyle et al. 2011, Poole 2019). One potential approach is to introduce weight-and-distance-based charging for electric vehicles, while retaining the fuel tax gasoline and diesel vehicles (Baker and Sabala 2011). Thus, by selecting a gasoline or diesel vehicle, road users could "opt out" of the distance-based charging system. A related suggestion is to have an odometer-based pricing plan as the default for distance-based charging, while also giving drivers the option of selecting a GPS-based plan to avoid charges for out-of-state mileage.

Taken as a whole, the research and policy papers found by the literature search provide the following insights:

- The main inequity in the existing transportation funding system is that the revenue contributed by heavy trucks is not proportionate to their impacts on roads and bridges (Agbelie, Labi, and Sinha 2018, Zhang and Lu 2013). This could be addressed by a weight-and-distance based charging system for commercial motor vehicles (Dumortier, Zhang, and Marron 2017). Such a system would be consistent with the way commercial vehicles are charged for the use of toll roads (Poole 2019).

- For personal vehicles with conventional gasoline or diesel powertrains, the existing combination of registration fees and fuel taxes is generally consistent with the "user pays" principle.
- The equity of registration fee surcharges for hybrid and electric vehicles is doubtful because they are unrelated to distances driven, impacts to roads and bridges, or ability to pay. A weight-and-distance fee system for hybrid and electric vehicles would allocate these costs more equitably.
- Most drivers prefer to pay in small installments. For distance-based charging, most prefer simple systems based on odometer readings, which are also administratively efficient and can potentially be linked to odometer data already being collected for other purposes. Drivers who live in urban areas that straddle state lines (such as the Quad Cities, Omaha-Council Bluffs, and Sioux City) are likely to be interested in a GPS-based option that can determine the mileage driven in each state (Baker and Goodin 2011).
- Although the International Fuel Tax Association provides a platform for collecting weight-and-distance fees from out-of-state trucks, methods for collecting revenue from out-of-state personal vehicles have rarely been studied.
- In all cases, per-gallon or per-mile rates require periodic adjustments to account for changes in buying power, perhaps through indexing to inflation metrics or through an *ad valoem* tax remains constant as a percentage of the fuel price (Anderson and Thompson 2014).

In recent years there have been proposals for a partial fuel tax for off-road diesel fuel ("dyed diesel" or "red diesel") in Iowa (Petroski 2013). The literature review identified the following considerations:

- Off-road diesel is used for various purposes, such as agricultural production, rail freight, maritime shipping, construction equipment, and electricity generation. The U.S. Energy Information Administration (EIA) estimates that nationally, approximately 29% of diesel fuel consumed for non-highway purposes is used in agriculture (EIA 2021b).
- Currently off-road diesel is exempt from Iowa fuel tax, but subject to Iowa state sales tax. Nevertheless, production inputs used for agricultural purposes are exempt from Iowa sales tax, so agricultural users are not required to pay tax on off-road diesel.
- Taxing off-road diesel could potentially reduce illegal fuel diversion to on-road vehicles (Marion and Muehlegger 2008).
- When considering the revenue potential of a partial fuel tax on dyed diesel, it is necessary consider which uses (if any) would continue to be tax-exempt, and to account for the fuel quantities sold to tax-exempt entities such as state and local governments, school districts, and public transit systems.
- In Iowa, fuel is currently subject to either the fuel tax *or* the sales tax, but not both. As a result, making off-road diesel taxable might reduce sales tax revenue. At current prices of approximately $3.00/gallon, off-road diesel generates $0.18/gallon of state sales tax revenue, plus any applicable local-option taxes.
- If the policy objective is to offset costs related to road use by agricultural equipment, one potential solution is to eliminate the sales tax exemption for off-road diesel used in agriculture, and allocate the resulting revenue to transportation.

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