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# ***Louisiana Transportation Research Center***

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Technical Assistance Report 20-02TA-SS

## **Literature Review of Mileage-Based Road User Fees**

by

Raju Thapa  
Kirk Zeringue  
Julius Codjoe

**LTRC**

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4101 Gourrier Avenue | Baton Rouge, Louisiana 70808  
(225) 767-9131 | (225) 767-9108 fax | [www.ltrc.lsu.edu](http://www.ltrc.lsu.edu)

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13. Abstract  
A federal tax of 18.4 cents per gallon on gasoline and 24.4 cents on diesel fuel is currently the primary source of revenue for the Federal Highway Trust Fund, and those rates have not been raised since 1993. Gas tax revenue collections are declining each year for a number of reasons, such as the increase in the number of electric vehicles and other vehicles not subject to the gas tax, as well as increases in the vehicle fuel efficiency. Within the state of Louisiana, gas tax revenues are projected to decline by 62% by the end of 2026, with the state having one of the 10 lowest gasoline tax rates in the nation. The inevitable growth in the cost of construction and the construction needs of highway infrastructure are considered as the two major factors behind the state's failure to raise sufficient levels of revenue from gas tax. To address the problem, a new system with a charge based on the mileage driven has been a hot topic for several years.  
This study reviewed the relevant available literature and suggests that, despite having some concerns (especially during the implementation), the benefits of using a mileage-based road user fee system outweigh the challenges. Several states within the United States have already successfully conducted pilot tests/programs on the new system. In addition, some other nations have already successfully implemented a mileage-based system for trucks. Based on the available literature, a mileage-based road user fee system may be a viable alternative to the current gas tax system, but implementation of the system has its challenges.

# Literature Review of Mileage-Based Road User Fees

By  
Raju Thapa  
Kirk Zeringue  
Julius Codjoe

Louisiana Transportation Research Center  
4101 Gourrier Avenue  
Baton Rouge, LA 70808

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July 2020

## Abstract

A federal tax of 18.4 cents per gallon on gasoline and 24.4 cents on diesel fuel is currently the primary source of revenue for the Federal Highway Trust Fund, and those rates have not been raised since 1993. Gas tax revenue collections are declining each year for a number of reasons, such as the increase in the number of electric vehicles and other vehicles not subject to the gas tax, as well as increases in the vehicle fuel efficiency. Within the state of Louisiana, gas tax revenues are projected to decline by 62% by the end of 2026, with the state having one of the 10 lowest gasoline tax rates in the nation. The inevitable growth in the cost of construction and the construction needs of highway infrastructure are considered as the two major factors behind the state's failure to raise sufficient levels of revenue from gas tax. To address the problem, a new system with a charge based on the mileage driven has been a hot topic for several years.

This study reviewed the relevant available literature and suggests that, despite having some concerns (especially during the implementation), the benefits of using a mileage-based road user fee system outweigh the challenges. Several states within the United States have already successfully conducted pilot tests/programs on the new system. In addition, some other nations have already successfully implemented a mileage-based system for trucks. Based on the available literature, a mileage-based road user fee system may be a viable alternative to the current gas tax system, but implementation of the system has its challenges.

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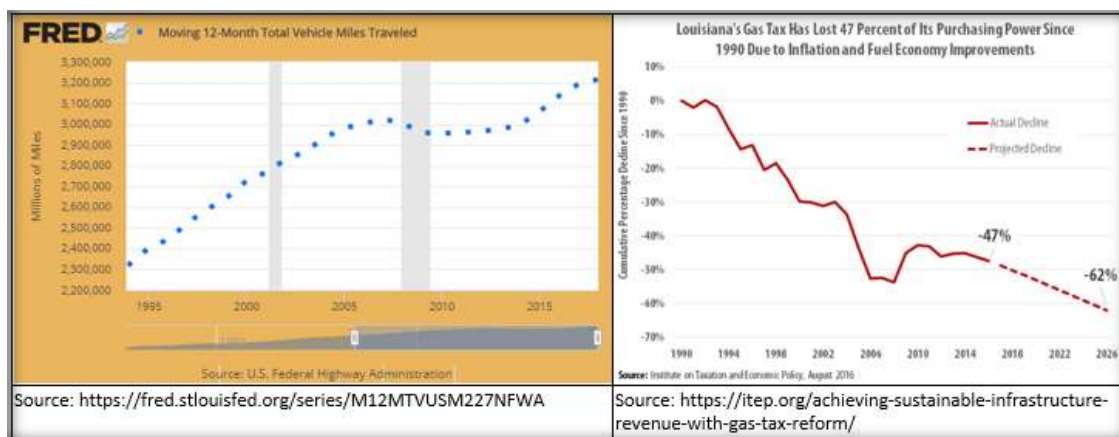


# Introduction

A federal tax of 18.4 cents per gallon on gasoline and 24.4 cents on diesel fuel is currently a primary source of revenue for the federal Highway Trust Fund. The tax rate has not been raised since 1993 and the revenue collection is declining each year [1]. A study by American Road and Transportation Builders Association shows a projected loss of more than \$65 billion dollars in the Highway Trust Fund between 2017 and 2023. In addition, increases in the number of electric vehicles and other vehicles not subject to the gas tax, as well as increases in vehicle fuel efficiency, have raised serious concerns about the revenue generated from the current gas tax system. While almost 20% of America’s roadways are in poor condition and require vital repairs, by 2030, almost half of gas tax revenue would be lost due to increases in the vehicle fuel efficiency alone [2].

Figure 1 below shows the increasing trend of vehicle miles travelled (on the left) and the declining purchasing power of the state of Louisiana’s gas tax, which is projected as 62% at the end of 2026 (on the right corner). The inevitable growth in the cost of construction and construction of highway infrastructure are the two different major factors behind the state’s failure to raise sufficient levels of revenue from gas tax [3]. In addition, the state also has the tenth lowest gasoline tax rate in the nation.

**Figure 1. Vehicle-miles travelled and Louisiana’s gas tax purchasing power since 1994**



To increase the gas tax revenue, a few states have already approved plans to raise fuel tax rates. For example, in 2015, Iowa enacted the legislative plan to increase the fuel tax by 10% and increase the vehicle permit fee to increase the revenue (Senate File 257 – Enacted 2/24/15). It raised the revenue of \$215 million for roadways and highways

annually. Similarly, California enacted Senate Bill 1 in 2017 to increase gasoline and diesel by 12 cents and 20 cents, respectively, to raise \$52 billion transportation revenue [4]. However, despite increment changes in the fuel tax rates, the alternative, most sustainable, and situationally demanding concept of mileage-based road user fees is currently a hot topic of discussion.

## **What is Mileage-Based Road User Fee?**

Different from a motor fuel tax, a mileage-based road user fee involves assessing the owner of the individual vehicles based on the distance the vehicle is driven [4]. A mileage fee can be a simple flat charge to a more complex charging system varying by the geographic location, traffic congestion, vehicle type, and vehicle emissions [5]. As discussed earlier, the federal gas tax of 18.4 cents has not been raised since 1993. Due to limited funding from existing gas tax rates collected on a per-gallon basis, the widespread use of electric vehicles, and increasing vehicle fuel efficiency, a new collection method based on “user-based revenue systems” has been introduced [6].

The mileage-based road user fee would result in requiring all vehicles, regardless of fuel source, to pay the charge. A Congressional Research Service report mentioned the cost of the charge under this system could range from a flat cent per mile to a variable charge depending on the data provided by global positioning system (GPS). An adjustment of the charge could vary depending on the place of travel, the time of a day trip, the weight of the vehicle, and the emission rate of the vehicle’s engine [6]. Though practitioners often used tolling, congestion pricing, and road use charge interchangeably, these are significantly different terms [7]. Toll charges are to be paid for permission to use a particular highway, bridge, or tunnel, while congestion charges are assessed at a particular time and location in order to change the travel behavior to better manage the congestion in that specific location [7].

## **Technical Aspect of the System**

The design of the system should determine fees on an individual vehicle (billing) based on the mileage driven on it (metering). In addition, the system should be able to collect data on the odometer readings, assign correct charges for the right type of vehicle, and have appropriate legal measures for the unpaid charges [6]. Data on the odometer can be collected using an on-board unit (OBU) installed at each vehicle, paying directly at the pump, or prepaying for a certain number of miles. Metering, billing, and enforcement are the three basic functions for the implementation of a mileage-based road user fee system. Metering technology possibilities include: Odometer, Simple On-board unit (OBU), OBU with cellular location, OBU with GPS, and Smartphone applications [8]. The summary of different metering technologies to collect the mileage driven on each vehicle and billing procedure is described below in detail.

### **Odometer Reading**

This is the simplest metering method currently available. An odometer reading is reported initially and subsequently to assess the mileage driven during that period. Another strength of this method is that it does not rely on an installed GPS, so there are no user privacy concerns. However, the system has numerous limitations: (1) Vehicle users can install devices or software to report the false odometer reading; (2) The system is not able to address the effect of congestion and location specific fare; and (3) Users are subject to double charges while driving on toll roads. Oregon has implemented a system called OReGO based on the odometer reading, which can be installed with or without a GPS device. The plug-in device collects fees of 1.5 cents per miles driven by the user [6].

### **On-board Unit (OBU)**

The OBU technology is installed in vehicles via the OBU detection port that automatically detects the estimated mileage [8]. The technology can be either installed with cellular technology, a GPS system, or without either depending on the location information and privacy preferences of the user. This technology is quite different from the electronic tolling technology (e.g., E-ZPass), but the experience would be quite similar [6]. However, cars produced before 1996 do not have the capability to connect with on-board diagnostic (OBD) port.

## **Automatic Vehicle Identification (AVI)**

Based on the AVI device installed in the vehicle (such as radio-frequency identification tags), it determines the vehicle's fuel economy, which is then multiplied by the total gallons purchased at the pump, and thus estimating the mileage of that vehicle in order to determine the road user fee. This is a very complicated method of estimating the road user fee [9]. The system only works with a GPS device and is challenging to administer, especially at the local level [8].

## **Smartphone Application**

A smartphone application synchronized with the communication system and GPS would automatically report the mileage of the vehicle. It is easier to use as everyone can download the application in their mobile; however, there are concerns related to the accuracy of the mileage data collected from the application [8].

## **In-vehicle Telematics**

Instead of reporting mileage through smart applications, OBU, and other equipped external devices, this technology works on the system already built into the vehicle. This technology would report highly accurate mileage but would be available only on the newer model of vehicles [8].

## **Pay at the Pump**

This is another simple approach similar to the current gas tax system. During the time drivers stop at the gas station, a transponder installed in the vehicle would automatically transmit mileage to the transponder at the pump, which would estimate the charge automatically [6]. However, this kind of approach does not account for charges at peak hours, congestion, and vehicles already using toll roads.

## Pilot Studies

Road users should have a choice on which technology they use based on their own preference and they should also be given options, or plans, for mileage reporting and payment like cell phone and wireless networks provide [10]. For example, Figure 2 shows different metering reporting plan options the Oregon Department of Transportation (ODOT) used for their participants during the pilot test program. ODOT did not encourage or discourage the selection of the particular plan. Participants had the freedom to select the plan that works best for them. More than half of the participants selected the Sanef Advanced Plan to report the mileage. Similar plans were available for the pilot participants in Washington and Nevada. The majority of the participants in Washington selected the Sanef Advanced Plan, while participants in Nevada generally selected the Sanef Basic Plan. The major difference between the basic and advanced plan was the installation of the location determination technology (GPS device) inside the vehicle. Participants under the basic plan had no location tracking, so the device only recorded miles driven. While in the advanced plan, the location determination technology was installed [10].

**Figure 2. Different plan options available during the pilot study at Oregon [10]**

Plan Options					
	Miles Reported	Invoice	Payment	Online account management	Uses GPS?
ODOT Basic Plan	All	Mailed Monthly	Check	No	No, does not report where miles are driven
ODOT Flat Rate Plan	N/A	Once, at start	Check	No	No device
Sanef Basic Plan	All	Emailed Monthly	Credit/debit card	Yes	No, does not report where miles are driven
Sanef Advanced Plan	Public roads in Oregon only	Emailed Monthly	Credit/debit card	Yes	Yes
Sanef Smartphone Plan	With application running, only roads in Oregon; without application running, all roads	Emailed Monthly	Credit/debit card	Yes	Yes, when the application is running

The California Department of Transportation (Caltrans) used different mileage reporting options during their pilot study. The reporting options were categorized as manual and automated. As shown in Figure 3, time permit, mileage permit, and odometer charge were grouped under the manual reporting method. For the time permit method, instead of paying a charge based on the mileage, the participants pre-pay a charge for unlimited

mileage for a fixed time period. While in the mileage permit method, the participants pre-paid for a fixed number of miles, and the odometer verification was done at the end to check if participants drove beyond the pre-paid limit. In the odometer reading method, the participants had to report the mileage every three months and postpaid for the mileage travelled during that period. Automated reporting was also offered with the option of either using GPS feature or avoiding it for the sake of privacy. Some of the technologies used in automated reporting were using a plug-in device (similar to On-Board Diagnostic), in-vehicle telematics, and smartphone applications with and without the use of location [11].

**Figure 3. Comparison of the mileage reporting methods [11]**

Method/ Technology	Provider	Prepay or Post-pay	Manual or Automated	Fuel Tax Credits?	Value-Added Services?	Vehicles supported
Time Permit	CalSAM	Pre	Manual	N	N	All
Mileage Permit	CalSAM	Pre	Manual	N	N	All
Odometer Charge	CalSAM	Post	Manual	Y	N	All
Plug-in Device with NLNo Location	Azuga, IMS	Pre (Azuga), Post (IMS)	Automated	Y	Y	Most Post 1996
Plug-in Device with General Location	Azuga, IMS	Pre (Azuga), Post (IMS)	Automated	Y	Y	Most Post 1996
Smartphone with No Location	Azuga	Pre	Automated+ Images	Y	N	All
Smartphone with General Location	Azuga	Pre	Automated+ Images	Y	Y	All
In-vehicle Telematics	Azuga, IMS	Pre (Azuga), Post (IMS)	Automated	Y	N	Limited Post 2013
Commercial Vehicle Electronic Logging	EROAD	Post	Automated	Y	Y	CVs

## Benefits of the System

A study by the RAND Corporation emphasized that the widespread use of hybrid, electric, and hydrogen vehicles whose owners pay little or no fuel tax may reduce revenue collection from fuel taxes in the near future [8]. The study discussed key advantages of using mileage-based user fees as follows:

- a. Reducing traffic congestion: Using a varying per-mile fee during different times of the day and different travel location could mitigate traffic congestion.
- b. Reducing road wear: Adopting a varying fee based on the axle weight for heavy commercial trucks would encourage truckers to change the axle configuration or reduce the axle loads, which ultimately reduces the road wear.
- c. Reducing harmful emission: Setting higher fees for more polluting vehicles and lower fees for less polluting vehicles would create an incentive for drivers to purchase less polluting vehicles in the future.
- d. Saving insurance cost: Instead of paying fixed annual amount for the insurance, drivers could have an opportunity to pay it by the mile.
- e. Improving Safety: The sophisticated in-vehicle equipment used for the system could support the safety features like warning drivers of imminent collision, work zone safety, and altering driver of school zones.
- f. Others: The use of in-vehicle wireless applications (e.g., applications can be used to access parking locations), in-vehicle metering equipment for automated payment parking, travel data collection, and location dependent travel service are additional potential advantages.

A report published from the Center for American Progress similarly discussed the benefits of mileage-based user fee systems. They found that implementing a mileage-based user fee would substantially raise revenue. The report suggested that revenue collected from a 1.3 cents per mile system would be equivalent to the revenue collected from current gas tax. Further, a charge of 2 cents per mile would be equivalent to increasing the current gas tax by 15 cents, while having the benefit of only charging drivers based on the miles they had actually driven. They also found that the system could address congestion problems and help to better manage the travel demand. Lastly they found that, though it might take time, the system could be implemented in a nationwide scale over a number of years, which would be more sustainable way of revenue collection. In the interim, the system could be implemented in newer vehicles



only with old vehicles still charging the gas tax instead of requiring the installation of new technology [12].

A recently published report highlighted the mileage-based road user fee as a way to ensure all road users contribute fairly to infrastructure costs [9]. Similar to previous studies, the study also discussed the availability of more fuel efficient and electric vehicles in the future making collection of future gas tax revenue unsustainable. As a preventive measure to the unsustainability, the author (like others previously mentioned) puts forward the idea of using a mileage-based road user fee system. Previously raised concerns were echoed regarding high tax to be paid by the rural drivers under the new system as rural drivers usually drove longer distances than the urban drivers. This scenario is true for a gas tax as well, so the existing condition is that rural drivers pay more than urban drivers in gas taxes would hold true for a mileage-based user fee. However, this report ultimately concluded that the system could actually be overall more beneficial to the rural drivers than urban drivers since the system enables congestion pricing in areas (urban) that experience recurring congestion. Concerns were also raised on the negative impact of the new system on the low-income drivers. However, the report summarized a few external papers who found that, in fact, low-income drivers would ultimately benefit as they would on average pay less based on mileage compared to what they are paying under a gas tax since low-income drivers typically drive less mileage and use older, less fuel-efficient vehicles. Overall, they found that the mileage-based road user fee system would not only have a positive impact on tax revenue collection but also help to provide more efficient transportation infrastructure, reduced travel times, reduced total vehicle trips, shift vehicle from peak to off-peak hours, and lower environmental impact (with lower vehicle emission). However, to transition from the current gas tax to a mileage-based user fee system, the authors emphasized the political and technical challenges will need thorough stakeholder discussion throughout the process [9].

A study based on the National Household Travel Survey revealed that rural drivers on average drive longer distances compared to urban drivers [13]. It ultimately led to higher charges for rural drivers based on the mileage driven. But a study by the Oregon Department of Transportation confirmed rural and urban drivers with almost equal driving levels in terms of average annual miles traveled. The study mentioned that though rural drivers drive longer distance for grocery shopping, clothes shopping, and school, the frequency of such activities is less compared to their urban counterparts [14]. In addition, another study mentioned that the system would be more beneficial to rural households than their urban counterparts due to less efficient vehicle owned by rural drivers [15].

However, critics of the mileage-based system argue the disproportional adverse effect of the system on the rural driver [7].

# Public Perception on Mileage-Based Road User Fee System

The National Cooperative Highway Research Program (NCHRP) undertook a synthesis project that explored the public perception of mileage-based user fee system [5]. The study analyzed 38 public opinion surveys, 12 qualitative research studies using focus groups and interviews, and 359 media stories that covered mileage-based fees, from 2010 to 2014. The surveys contained 167 unique questions to understand public perception (support or opposition) on the system. The result from 33 survey questions asking if they support the system showed only 24% supporting the system (range of 8 to 50%). The findings from the quantitative research found that most participants did not support the mileage-base fee system. In general, the surveys and the qualitative studies found that participants saw no reason to replace the existing gas tax-based system. However, the study suggested that high support amongst those participating the in the pilot program suggested that direct experience with the system would result in increased support in the future.

The NCHRP study found two main contextual factors behind the low support of a mileage-based system in the studies: (1) generally, the “public knows virtually nothing about current sources of transportation revenues,” and (2) the complex mileage-based user fee system was not explained in detail, so the respondents were stating their preference based on a system they did not understand well at all and had no experience with.

Two common themes from the studies analyzed in the NCHRP project related to privacy and fairness. Around 70% of the respondents indicated privacy as a major concern. Related to fairness, one example cited was the concern that users who are driving high fuel efficient cars that positively contribute to protecting the environment through reduced greenhouse gas emissions would have to pay a higher price under the mileage-based system than they currently pay, and the participants perceive it as a type of penalty. However, respondents supported the system in the sense that it would ensure drivers of electric and highly fuel efficient vehicle pay their fair share of roadway costs. Some did mention mileage-based user fees as a sustainable, innovative source of funding for the future [5].

In 2014, the Social Science Survey Center at California State University, Fullerton, conducted a survey on behalf of the Mineta Transportation Institute's National Transportation Finance Center. The center interviewed a total of 1,503 adults nationwide by phone. The survey questionnaire was designed to test the public opinion on an increase in the federal gas tax, a new national mileage tax, and a new national sales tax. Around 69% of the respondents supported a gas tax increase of 10 cents per gallon for the support of the maintenance of street, roads, and highways. Only 19% of the respondents were in the support of new mileage-based tax with the flat rate, 1 cent per mile while the support increased to 43% for the varying mileage tax based on the pollution level of vehicles [16].

Another study used nationally available public opinion survey data to analyze public opinion on a mileage-based road user fee system. The survey was conducted in 2013, with a questionnaire focused on the adoption of a new mileage-based user fee system as an alternate to the current gas tax revenue collection. The web survey conducted nationwide across a sample of 3325 US adults (18 years of age or older) found that only 21% of the respondents supported a mileage-based user fee system as a replacement for the current gasoline tax system. The support for the system was not found to be associated with age, gender, race, education, and employment status [17].

# Implementation

Mileage-based user fee systems have not been widely implemented as of yet in the US, but other countries, including Switzerland, Austria, Germany, and New Zealand, have embraced and implemented this system for heavy vehicles (trucks). Presently, New Zealand is the only country using the system for light vehicles as well (that use diesel). Though the system is not implemented widely in the US, some states are exploring the system via different feasibility studies (pilot tests). The results from these pilot tests appear to be promising. These pilot studies conducted in the US have mostly focused on the feasibility of the system, an assessment of problems associated to the system (both technical and administrative), problems with the current gas-tax system, and the benefits of using a mileage-based user fee system. The pilot studies tend to agree on the benefit of using the new system from every perspective including, but not limited to, increases in revenue, user friendliness, safety improvements using in-vehicle devices, and insurance cost savings. The following sections provide a summary of the mileage-based user fee implementation both outside and inside of the US.

## Outside the United States

### Switzerland

To address the effect of road damage and environmental harm caused by heavy vehicles travelling through Switzerland on trips between Italy and Northern Europe, Switzerland imposed “performance-related fees” to heavy vehicles starting in January 2001. The fee is based on the weight and emissions of the loaded vehicle in addition to the number of kilometers driven. All heavy vehicles registered in Switzerland must be equipped with an OBU mounted behind the windshield. The system is enabled (turned on) and disabled (turned off) as the heavy vehicles crosses the border by an automated microwave beacon. Vehicles registered in other countries are not required to have an OBU but must display the vehicle’s weight and odometer reading at the time of crossing inside Switzerland [6].

### Austria

Austria started using a mileage-based road charge system for all trucks and buses weighing more than 3.5 metric tons in 2004. The rate was defined based on the size of

vehicles. Vehicles with three axles and four or more axles have to pay €0.2198 per kilometer [\$0.396 per mile], and a four-axle vehicle with an older engine pay as much as €0.4473 per kilometer [\$0.805 per mile]. Instead of using GPS, the system uses a microwave transponder mounted behind the truck that works only within Austria and not in the other countries. Currently, only select highways and expressways are subjected to the charge, but the transport ministers of Austria have proposed to extend those mileage-based user charges to all federal and state highways to address the issue of trucks avoiding those roadways to avoid charges [6].

## **Germany**

The Germans are also using toll rates based on the mileage driven where the rate varies by axle design of the trucks. The rate ranges from €0.125 per kilometer [\$0.225 per mile] for a truck with a low emission and three or fewer axles to €0.214 per kilometer [\$0.386 per mile] for a truck with four or more axles and high emission engines. In 2015, Germany collected €4.3 billion [\$4.77 billion] in revenue from truck road user charges [6]. In 2019, Germany's plans to introduce a similar autobahn (motorway) toll for foreign driver passenger cars was overturned by the EU court due to its discrimination against the foreign drivers since German citizens would have been effectively exempt (through credits) [18].

## **New Zealand**

New Zealand is the only country that is using the system for all diesel vehicles – light and heavy (cars and trucks). Since 1997, New Zealand has had a distance-based road user charge (RUC) system on all diesel vehicles. The charges are applied to the diesel vehicles only as gasoline vehicle's users already pay a tax at the pump. The charges are dependent on the distance travelled and nominal weight of the vehicle rather than the actual weight of vehicle on each trip. If the vehicle belongs to the class where it is unsuitable for the regular road use (e.g., tractor, trailer, road rollers, and trailer scrapers), they are exempted from the charge.

The cost of the charge is \$0.07 per mile for standard passenger cars using diesel, and \$0.41 per mile for four-axle tractor trailer. All road users subject to the RUC system must purchase a distance license in units of 1,000 kilometers that must be displayed on the passenger side of the windshield. For heavy vehicles, the label can be either displayed or carried. The New Zealand Transportation Agency has recently published a report showing

varying rates for different vehicle types and for heavy vehicles depending on the configuration of the axles [19].

### **Inside the United States**

While the implementation efforts outside of the US have had the benefit of being country-wide, the efforts inside the US have been state- and city-driven pilot tests. Therefore, the US efforts have also been relatively small in scale and have not been able to solve the issues that arise with interstate travel. Table 1 shows a summary of the studies that have been conducted in the United States along with their findings.

**Table 1. Summary of studies in the US [6], [8]**

<b>State</b>	<b>Year</b>	<b>Study</b>	<b>Privacy Concern</b>	<b>System</b>	<b>Findings</b>
Oregon	First Study 2006-2010	300 voluntary participants studied from 2006-2010	GPS unit used in vehicle	Group 1 of drivers: Charged 1.2 cents per mile within Oregon  Group 2: Charged 0.43 cents per mile at non-rush hours and 10 cents per mile at peak hours in congested areas	Participants showing higher response to the system by reducing travel time
Oregon	Second study 2012-2013	Two pilot test conducted with 31 and 85 participants	Use of GPS unit in vehicle was optional	Participants had freedom to select available 5 different plans (see Figure 2)	Successfully measured and reported mileage  State consider it as a successful program

<b>State</b>	<b>Year</b>	<b>Study</b>	<b>Privacy Concern</b>	<b>System</b>	<b>Findings</b>
<b>State</b>	<b>Year</b>	<b>Study</b>	<b>Privacy Concern</b>	<b>System</b>	<b>Findings</b>
Oregon	Enacted Senate Bill 810 from July 1, 2015	Requirements of bill: Up to 5,000 volunteer light vehicles registered in Oregon.	Privacy concern addressed	Rate of 1.5 cents per mile  Multiple choices on the billing  Refund for travel on private road to avoid double taxation	Still ongoing
University of Iowa	October 2008 to June 2010	2,600 volunteer participants	GPS-based mileage-fee system was used	Created a hypothetical mileage fee for federal, state and local agencies	The study found mileage-based road user system feasible using current technology  Installation of equipment in the existing vehicles a significant challenge
Minnesota	36 months	500 participants or cars	GPS receivers were used	1.0 cent per mile during off peak hour and 3.00 cents during peak hours in Minneapolis-St. Paul  No charges for driving out of state	N/A

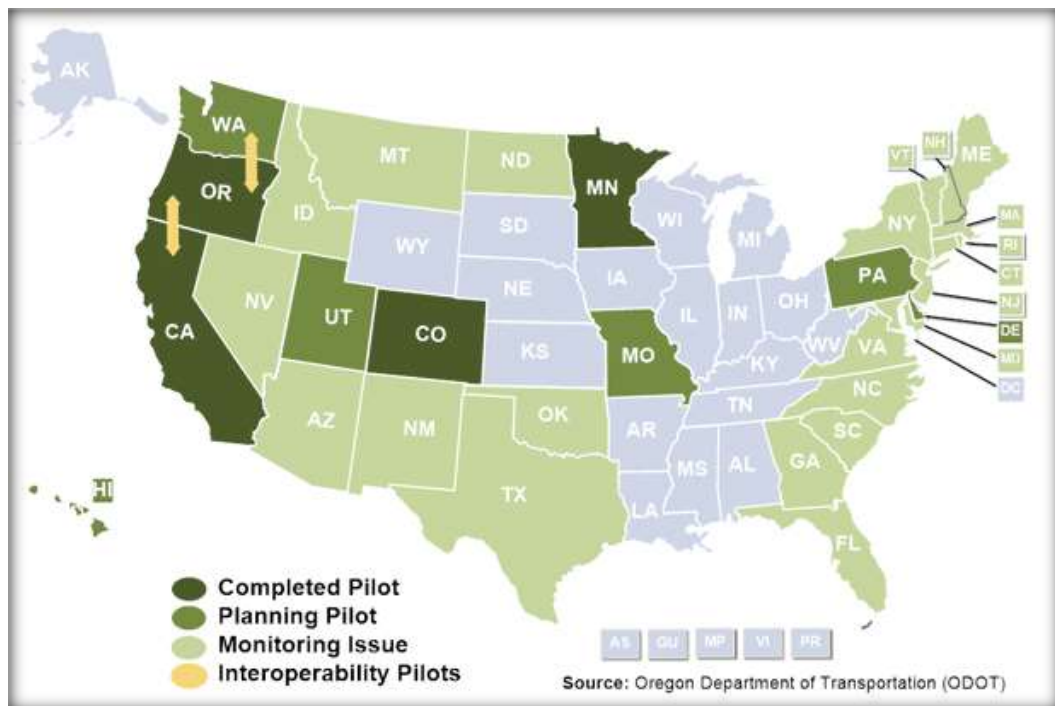


<b>State</b>	<b>Year</b>	<b>Study</b>	<b>Privacy Concern</b>	<b>System</b>	<b>Findings</b>
Washington State	12 months	2,000 voluntary participants	Use of GPS unit in vehicle was optional	Reporting options include GPS, smartphone apps, in-dash plug-in devices and odometer readings	N/A
<b>State</b>	<b>Year</b>	<b>Study</b>	<b>Privacy Concern</b>	<b>System</b>	<b>Findings</b>
California	July 1, 2016	5,000 volunteers from private vehicles, commercial trucks and government vehicles	Used third party data to collect mileage	Included heavy vehicle for the first time Used six recording and reporting method 1.8 cents per mile road charge	87% found the pilot test to be easy  73% found mileage based charge more equitable than current gas tax
Colorado	Dec. 2017	150 volunteer participants	N/A	Three mileage reporting options	Some policy-related issue were identified, but no major technical problem
Colorado	Dec. 2017	Colorado is currently conducting a study to examine the mileage-based fee, which includes both flat and variable fees in addition to several metering and payment options [8]			
I-95 Corridor Coalition [20]	Phase 1, December 2009: project was focused on functional requirements, state and federal legal and regulatory issue associated with the adoption of mileage-based road user fee. Phase 2, December 2010: Project was focused on the analysis of operating environments and current conditions on Delaware, Maryland and Pennsylvania.				
Delaware [21]	May 2018 (Three-month pilot study with the I-95 Corridor Coalition)				

State	Year	Study	Privacy Concern	System	Findings
Nevada					Nevada started examining the system in 2008, and their key concern relates to out-of-state drivers (around 18 times greater than the population of in-state drivers) [8]
Texas					Texas Department of Transportation conducted an interview with stakeholders and experts and issues were raised over privacy of the user, cost, enforcement and fairness [8].
New York City					New York City Department of Transportation launched Drive Smart program in 2015 as a concept that could support mileage-based road user fee system as well [8].

Figure 4 shows the states across the country conducting the pilot test for mileage-based road user fee. It shows that most of the states are still monitoring the issue while few of the states like Oregon, California, Colorado, and Minnesota have already completed the pilot programs.

**Figure 4. Map compiled by Oregon Department of Transportation showing states conducting the pilot program [map extracted from reference [22]]**



## **Common Concerns**

A study by the RAND Corporation mentioned that though a mileage-based user fee could make a stable source of funding for future decades, it may have significant challenges in design, implementation, and cost to administer [8]. The major concerns requiring attention prior to implementation in the US include privacy, policy issues, cost of implementation, administrative challenges, and enforcement.

### **Privacy**

The public is concerned about threats to their personal privacy that can result from the devices required to facilitate the system. For example, a GPS location-based system that involves tracking of the actual vehicle and securing personally generated data is a major challenge. This type of privacy concern will likely lead to strong public opposition to the system if it is not adequately addressed [11].

### **Policy Issues**

Since each state has its own limitations and legal boundaries related to tax collection, a mileage-based road user fee system could vary by state, especially in terms of generating tax from the new system [23]. For instance, policies in California might be different from Louisiana, with California having more out-of-state vehicles with more urban area. In addition to the specific state-associated policy, overall policy of the system should be defined to favor the new system like the financial sustainability of the system, and implication of the overall system.

Caltrans presented the policy challenge for the program as within the state (Intrastate Jurisdictional Issues) and with the other state (Interstate Jurisdictional Issues). The second is of major concern as it deals with the impact of out-of-state driving within the state, which is especially high in California. In addition, the local government may set their own rate in their local setting and use the data for other purpose like safety, planning, and asset management [11].

In addition, the policy should address the sustainability of the system, potential double-taxation, and issues raised for long-distance commuters. [7].

## **Implementation Cost**

A recent report found that the high cost of implementation for mileage-based road user fees is the major challenge compared to the existing motor fuel taxes [9]. The report divided cost into three different components. One is the capital investment costs required to enable the agency to implement the system such as the cost for hardware, system development, and start up. The second is the cost associated to the installation of the technology like GPS receivers in existing vehicles. The third challenge is the cost associated with administering the system.

## **Administrative Challenge**

Currently, under the fuel tax collection system, there are relatively small numbers of locations of fuel wholesalers to administer, and thus, it would be cheaper to administer than a new mileage-based user fee system. With the implementation of a mileage-based road user fee system, there would be millions of road users with varying tax rates depending on how, when, and where they travel. The administrative part of collecting and tracking all the data would require tremendous effort. The cost of that administrative effort would come directly from the tax revenue and should be a consideration as well [8]. Currently in New Zealand, the mileage-based user fee system on 750,000 vehicles requires less than 5% of revenue to administer. New Zealand's experience can serve a reference, but more research needs to be done in the US to evaluate how much of the collected revenue must or should go towards the administrative cost [24].

## **Enforcement**

With millions of drivers on a mileage-based road user fee program, it would be a challenge to enforce the fee and the potential for fraud and evasion may be higher than the existing gas tax system. There are a variety of promising preventive measures being explored (e.g., tamperproof metering devices, periodic odometer inspections, roadside enforcement equipment, etc.), but there is currently no real information on what these measures would cost at scale. In addition, enforcement could be further complicated by drivers crossing jurisdictions that have different fee structures. This concern could be mitigated by implementation of a multistate or nationwide mileage-based road user fee system [8].

## Research

In addition to the state-specific research outlined previously, there have been other studies exploring the idea of mileage-based user fees and their impacts as well. Table 2 summarizes the findings of some of those studies.

**Table 2. Research studies on mileage-based road user fee system**

Study	Findings
Forkenbrock (2005)	<p>Mileage-based road user charge offers significant advantage over current motor fuel tax.</p> <p>Stable source of revenue collection.</p> <p>The system would support congestion pricing, lane-specific user charges for carpooling, travel demand analysis, and evaluation of impact of road damage by different classes of vehicles. [25]</p>
Caplan (2009)	<p>Vehicle miles travelled (VMT) of 0.3 cents per mile for cars and 1 cent per mile for light trucks would reduce the emission with positive impact on the environment [26].</p>
Baker et al. (2010)	<p>The model shows fee of 2.9 cents per mile to all commercial vehicles and 0.95 cents per mile to all personal vehicle will generate the same amount of revenue to the Texas state gas tax revenue in 2010. [27]</p>
McMullen et al. (2010)	<p>Under the VMT tax system, rural households are found to benefit more compared to urban households because of lower-fuel efficiency vehicles owned by them [28].</p>
Weatherford (2011)	<p>VMT tax set at \$0.98 cents per mile would shift the tax burden from low to high income household, older to younger households with children, and from rural to urban households [29].</p>
Greene (2011)	<p>Introduction of VMT tax does not provide additional environmental benefits [30].</p>

Study	Findings
Reilly (2016)	The study concluded the manual reading of the odometer through the regular maintenance as the best option to implement VMT tax system in the United States. It avoids implementation of new technology at the beginning stage [31].
Wang and Miao (2018)	VMT a viable alternative for gasoline tax. Might incur a significant upfront cost for the equipment installation [15].
Schrockenthaler and Fitzroy (2019)	Under mileage-based road usage charge (RUC), household in urban area found to pay slightly more than rural area [32].

## Concluding Remarks

Despite having slightly few concerns, especially during the implementation, the benefits of using a mileage-based road user fee system outweigh the challenges. Currently, the Federal Highway Administration has granted over \$10 million to seven different states: California, Delaware, Minnesota, Missouri, New Hampshire, Oregon, and Utah to evaluate mileage-based road user fee systems [33]. In addition, a recent report by Atkinson [9] suggested mandatory use for heavy trucks in the program. Since heavy trucks are fewer in number than cars and the benefit from trucks under the new system are higher than cars, the study prioritized the inclusion of trucks in the new system. As discussed previously, several nations have already successfully implemented a truck road user system. So as a strong alternative to the current gas tax system, a mileage-based road user fee system is the most sustainable and situational-demanding concept.

## **Acronyms, Abbreviations, and Symbols**

€	Euro
\$	United States Dollar
AVI	Automatic Vehicle Identification
Caltrans	California Department of Transportation
EU	European Union
GPS	Global Positioning System
NCHRP	National Cooperative Highway Research Program
OBU	On-Board Unit
OBD	On-Board Diagnostic
ODT	Oregon Department of Transportation
US	United States
VMT	Vehicle Miles Travelled



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