A Practical Analysis of a National VMT Tax System

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ATRI American Transportation Research Institute

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ACRONYMS

AAA	American Automobile Association
ATRI	American Transportation Research Institute
BEVs	Battery Electric Vehicles
BLS	Bureau of Labor Statistics
CAFE	Corporate Average Fuel Economy
CAM	Commercial Account Manager
CBO	Congressional Budget Office
CPM	Cost-per-Mile
CRS	Congressional Research Services
DMV	Division of Motor Vehicles
DOF	Department of Finance
DOT	Department of Transportation
DSRC	Dedicated Short-Range Communications
ECM	Engine Control Modules
EEI	Edison Electric Institute
EPA	Environmental Protection Agency
EV	Electric Vehicle
FCC	Federal Communications Commission
FHWA	Federal Highway Administration
GAO	Government Accountability Office
GPS	Global Positioning System
HOT	High Occupancy Toll
HTF	Highway Trust Fund
IFTA	International Fuel Tax Agreement
IRS	Internal Revenue Service
IT	Information Technology
MBUF	Mileage-Based User Fee
MPG	Miles-per-Gallon
NAS	National Academies of Sciences
NHCCI	National Highway Construction Cost Index
NYC	New York City
OBD	Onboard Device
OBU	Onboard Unit
OEM	Original Equipment Manufacturer
ODOT	Oregon Department of Transportation
RAC	Research Advisory Committee
RFID	Radio Frequency Identification
RUC	Road User Charge
UHF	Ultra High Frequency
VMT	Vehicle Miles Traveled
WLAN	Wireless Local Area Network

1. Introduction

Problem Statement

The Highway Trust Fund (HTF) is the primary source of federal funding used by state governments to maintain and improve U.S. surface transportation infrastructure. The majority of annual federal HTF revenues, which typically total nearly $40 billion, derive from a per-gallon federal excise tax on motor fuels used to power automobiles and trucks. In part, this tax acts as a road user fee, with larger vehicles (e.g. Class 8 tractor-trailers with low miles-per-gallon [MPG]) paying substantially more per mile for use than smaller vehicles (e.g. compact cars with very high MPG).

The current federal fuel tax rates of 18.4 cents (gasoline) and 24.4 cents (diesel) were last increased in 1993. Though fuel consumption has increased since 1993 along with HTF revenues, the HTF now annually faces a shortfall. These shortfalls are due, in part, to normal inflation, which was more than 79 percent from 1993 to 2020.[1] While annual HTF revenues have increased since 1993, the funds raised have still fallen short of transportation funding needs simply because the buying power of 18.4 and 24.4 cents per gallon has decreased. There has been no indexing of the per-gallon tax rate to counteract the effects of inflation.

Another factor is improvements in the fuel efficiency of the U.S. fleet. The average car and truck manufactured in recent years can travel farther on a gallon of fuel than vehicles from the early 1990s.[2] Likewise, an increasing number of electric vehicles are slowly replacing gasoline- and diesel-powered cars and trucks, and these vehicles do not pay any federal motor fuels taxes.[3]

Surface transportation spending has continued to fall far short of what is needed.[4] In response to HTF shortfalls, Congress has periodically made large transfers from the general fund to fill transportation funding gaps.[5] The U.S. Congress has not however opted to raise the fuel tax. Many members of Congress are reluctant to raise fuel taxes since such actions will noticeably increase the cost of fuel for nearly all constituents in the short-term. Additionally, some members of Congress have publicly committed to “no new taxes.”

As a result of the myriad fuel tax issues outlined above, the Congressional Budget Office (CBO) found in 2019 that the HTF will be exhausted by 2022.[6]

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[1] U.S. Bureau of Labor Statistics. Databases, Tables & Calculators by Subject. Available Online: https://www.bls.gov/data/

[2] United States Environmental Protection Agency. (January 26, 2021). “Automotive Trends Report.” https://www.epa.gov/automotive-trends/highlights-automotive-trends-report#main-content

[3] Rudman, Kristin. (November 30, 2018). “EEI Celebrates 1 Million Electric Vehicles on U.S. Roads.” Edison Electric Institute. https://www.eei.org/resourcesandmedia/newsroom/Pages/Press%20Releases/EEI%20Celebrates%201%20Million%20Electric%20Vehicles%20on%20U-S-%20Roads.aspx.

[4] For example, “to achieve a state of good repair, USDOT’s 2015 Conditions and Performance Report estimates highway and bridge needs at $836 billion and transit needs at $90 billion, which would require significant additional investment.”
AASHTO. (December 17, 2019). “2020 AASHTO Legislative Action Agenda.” https://policy.transportation.org/wp-content/uploads/sites/59/2020/02/2020-AASHTO-Legislative-Action-Agenda-FINAL-2019-12-17.pdf

[5] Kirk, Robert and William Mallett. (May 11, 2020). “Funding and Financing Highways and Public Transportation.” Congressional Research Service. https://fas.org/sgp/crs/misc/R45350.pdf

[6] Beider, Perry, and David Austin. (October 2019). “Issues and Options for a Tax on Vehicle Miles Traveled by Commercial Trucks.” Congressional Budget Office. https://www.cbo.gov/publication/55688.

The political aversion to tax increases by many U.S. congressmen has led to a discussion of alternatives to the fuel tax, often through mechanisms that are coined as "user fees." It should be noted that while the excise tax on motor fuels is traditionally viewed as a tax, it does resemble a user fee in many ways. While the fuel is directly purchased and consumed by the road user, the revenue from the tax portion of the fuel cost is deposited in the HTF for distribution to a larger network of roadways and facilities.

It should also be noted that a separate transportation revenue collection approach, tolling, is typically categorized as a user fee since it is a charge to access a specific road facility. That said, some entities that impose tolls (e.g. the state of Rhode Island) have argued that tolls are a form of taxation.[7]

Beyond fuel taxes and tolling, and in parallel with the advancement of vehicle tracking technologies, the concept of a per-mile road user charge or tax has been discussed in recent years. A system for levying a per-mile charge on drivers is known by many names:

- Vehicle Miles Traveled (VMT) Tax/Fee
- Road User Charge (RUC)
- Mileage-Based User Fee (MBUF)

Such a system would enable the federal government and potentially other levels of government to charge drivers or vehicle owners for each mile driven. This research will informally refer to the concept as a "VMT tax," which is the term used in the Congressional Budget Office's 2019 report. Though the research team did elect to use the term VMT tax in this report, that should not be construed as a final determination on whether the VMT tax is a tax, a fee or a hybrid of the two.

On a national scale, a VMT tax system would likely be applied to all vehicles operating in the country. That said, the VMT tax concept is of particular concern to the trucking industry; in February 2020 several U.S. Senators proposed a VMT tax exclusively on trucks as a means for raising revenue for surface transportation infrastructure.[8] In response, the American Transportation Research Institute (ATRI) Research Advisory Committee (RAC) voted in March 2020 to proceed with a thorough cost-benefit study of the VMT tax concept.[9]

Research Goals

The goal of this research is to explore the requirements, costs and benefits of a national system for collecting revenue based on miles driven in the U.S. This report is presented in five parts that cover: 1) a detailed discussion of VMT tax definitions and descriptions; 2) the technical and administrative requirements of a functioning system for collecting federal revenue through a VMT tax; 3) an assessment of the costs of such a system; 4) a framework for the design of a national VMT tax system; and 5) a summary of the research findings.

[7] Lamb, Eleanor. (December 6, 2019). "Trucking Scores a Win in Rhode Island Tolls Case." Transport Topics. https://www.ttnews.com/articles/trucking-scores-win-rhode-island-tolls-case

[8] Courtney, Shaun. (February 25, 2020). "Trucking Groups Resist New Mileage Tax Proposal to Fund Highways." Bloomberg Government. https://about.bgov.com/news/trucking-groups-resist-new-mileage-tax-proposal-to-fund-highways/

[9] ATRI's RAC is comprised of industry stakeholders representing motor carriers, trucking industry suppliers, labor and driver groups, law enforcement, federal government, and academics. The RAC is charged with annually recommending a research agenda for the Institute.

2. VMT Tax Background

Motivations for Switching from a Fuels Tax to a VMT Tax

Taxes on motor fuels both at the federal and state level are currently the primary revenue source for the nation's roadway infrastructure. The fuel tax has been the primary user-pays approach to funding roadways at the federal level for nearly 90 years, and it is likely to remain a key source of revenue for some time. While the fuel tax is critical to transportation funding, past research has found that "fuel tax receipts, measured in real dollars per mile of travel, have fallen precipitously over recent decades, leaving insufficient revenue to maintain, let alone expand, the road network."[10]

The literature offers several key reasons why fuel tax receipts per mile of travel have fallen.

Weak Governance that does not Address Inflation. An increase in the federal fuel tax requires legislative action. This has not happened since 1993 – more than a quarter century ago. The federal fuel tax is a per-gallon charge and does not take into account the price of fuel. Therefore, fuel taxes "must be periodically raised to offset the effects of inflation and improved fuel economy, and elected officials have grown increasingly reluctant to take on this unpopular task in recent decades."[11] Without a net increase or an adjustment for inflation, the only means to increase revenues is with increased fuel consumption, which has in fact occurred. From 2003 to 2019, annual gallons of fuel consumed in the U.S. increased by 9.2 percent.[12] This has helped offset the impact of inflation as seen through the National Highway Construction Cost Index (NHCCI), which was 88.2 percent from December 2003 to December 2019 compared to 39.4 percent between December 2003 and December 2019 for regular inflation.[13] That said, every dollar of revenue collected in December 2019 had the buying power of only 53 cents in 2003 using the NHCCI (or 72 cents in December of 2003 when looking at regular inflation).[14]

Fuel Economy Improvements. Much of the literature reviewed for this report cites fuel economy improvements in the U.S. vehicle fleet as a reason for adopting a VMT tax. As an example, the Government Accountability Office (GAO) states that Corporate Average Fuel Economy (CAFE) standards require cars and trucks to increase fuel economy to 54.5 MPG by 2025, which is more than double the MPG that was required in 2000.[15] These higher standards will in part be met by increased use of hybrid electric vehicles. While vehicle manufacturers have improved fuel economy as measured by Environmental Protection Agency (EPA) standards, the U.S. fleet overall has not greatly altered its consumption of fuel per mile. To put this in perspective, in 2000 the U.S. fleet consumed 5.93 gallons of fuel per 100 miles driven; by

[10] National Academies of Sciences, Engineering, and Medicine. (2009). "Implementable Strategies for Shifting to Direct Usage-Based Charges for Transportation Funding." Washington, DC: The National Academies Press. https://doi.org/10.17226/23018.
[11] National Academies of Sciences, Engineering, and Medicine. (2009). "Implementable Strategies for Shifting to Direct Usage-Based Charges for Transportation Funding." Washington, DC: The National Academies Press. https://doi.org/10.17226/23018.
[12] U.S. Department of Transportation Federal Highway Administration. (December 24, 2020). "Motor-Fuel Volume Taxed – 2019." Table MF – 2. https://www.fhwa.dot.gov/policyinformation/statistics/2019/mf2.cfm
[13] U.S. Department of Transportation Federal Highway Administration. "National Highway Construction Cost Index (NHCCI)." https://explore.dot.gov/views/NHIInflationDashboard/NHCCI Date Accessed: March 8, 2021.
[14] U.S. Bureau of Labor Statistics. CPI Inflation Calculator. Available Online: https://www.bls.gov/data/inflation_calculator.htm
[15] United States Government Accountability Office (GAO). (December 2012). "Pilot Program Could Help Determine the Viability for Certain Vehicles." https://www.gao.gov/assets/660/650863.pdf

2019 that figure was only down to 5.75 gallons of fuel per 100 miles driven.[16] [17] This could be explained, in part, by the congestion that has resulted from increasing annual VMT on a static supply of urban infrastructure.

Electric Vehicles. In the past decade approximately one million battery electric vehicles (BEVs) have been sold in the U.S.[18] The literature finds that electric vehicles, along with hybrid-electric vehicles, "represent a significant violation of the user-pays-and-benefits principle since a substantial part of their propulsion is powered by electricity and thus not subject to fuel taxes."[19] By their very nature, BEVs do not pay the fuel tax. Presently, with 272 million private vehicles registered in the U.S., the purely electric BEV segment makes up less than half a percent of the total U.S. fleet. This is a small figure, but there are predictions for large-scale growth in electric vehicle sales in the coming decades. The Edison Electric Institute (EEI) anticipates 18.7 million BEVs by 2030.[20] This figure would still be less than seven percent of the current U.S. vehicle fleet. The 18.7 million BEVs face a separate challenge as well – EEI anticipates 9.6 million charge ports must be deployed to support these vehicles – which is roughly one charge port for every two BEVs. This is a significant increase over the 96,356 estimated public charging ports available in 2020.[21]

[16] U.S. Department of Transportation Federal Highway Administration. (December 24, 2020). "Highway Statistics Series: Annual Vehicle Distance Traveled in Miles and Related Data – 2019." Table VM – 1. https://www.fhwa.dot.gov/policyinformation/statistics/2019/vm1.cfm

[17] U.S. Department of Transportation Federal Highway Administration. (January 8, 2021). "Highway Statistics Series: Motor-Fuel Volume Taxed – 2019." Table MF – 2. https://www.fhwa.dot.gov/policyinformation/statistics/2019/mf2.cfm

[18] Office of Energy Efficiency & Renewable Energy. (September 28, 2020). "FOTW #1153, September 28, 2020: Cumulative Plug-In Vehicle Sales in the United States Reach 1.6 Million Units." https://www.energy.gov/eere/vehicles/articles/fotw-1153-september-28-2020-cumulative-plug-vehicle-sales-united-states-reach

[19] Coyle, David. et al. (August 2011). "From Fuel Taxes to Mileage-Based User Fees: Rationale, Technology, and Transitional Issues." University of Minnesota. https://conservancy.umn.edu/bitstream/handle/11299/112579/CTS%2011-16.pdf

[20] Rudman, Kristin. (November 30, 2018). "EEI Celebrates 1 Million Electric Vehicles on U.S. Roads." Edison Electric Institute. https://www.eei.org/resourcesandmedia/newsroom/Pages/Press%20Releases/EEI%20Celebrates%201%20Million%20Electric%20Vehicles%20on%20U-S-%20Roads.aspx.

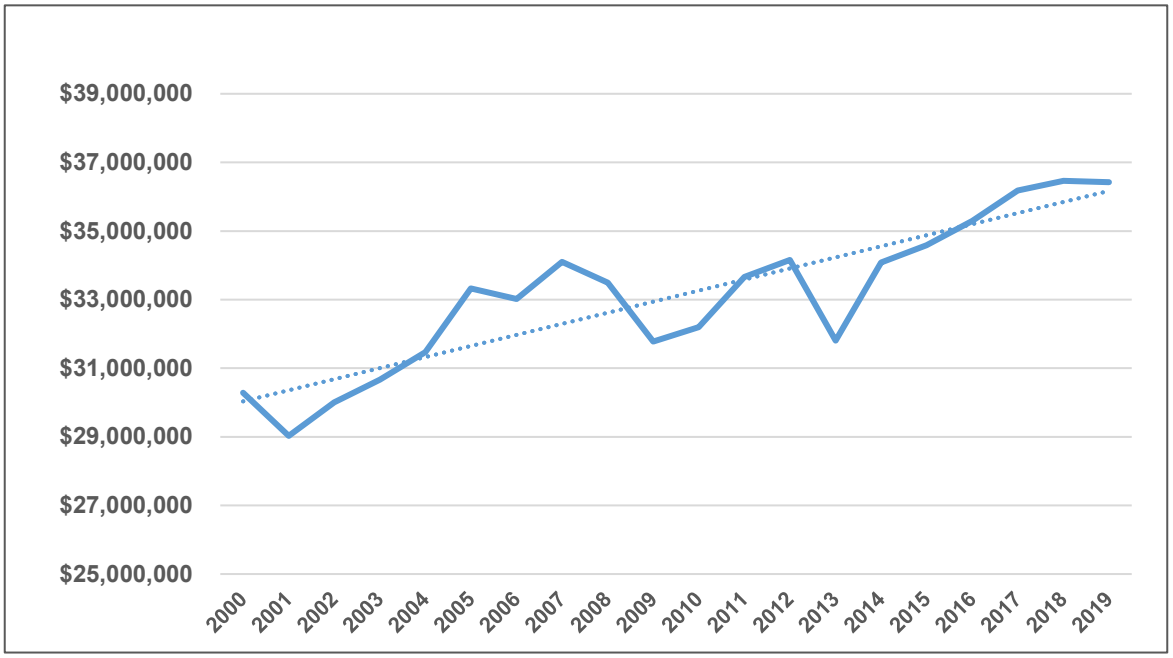
[21] McDonald, Loren. "Charging Stats." https://evadoption.com/ev-charging-stations-statistics/#:~:text=As%20of%20December%2031%2C%202017,average%20of%202.75%20stations%2Foutlets. Date Accessed: February 25, 2021.

Policy Goals of a VMT Tax

The literature generally focuses on one clear and ubiquitous policy goal of a VMT tax, which is to generate transportation revenue. According to the literature, however, many additional goals could be met through a VMT tax and its supporting technology. A 2009 National Academies of Sciences (NAS) report suggested that a VMT tax would allow policy makers to tackle "challenging transportation policy goals, such as reducing traffic congestion or harmful pollutant emissions."[22] Additionally, the idea of revenue apportionment at the state and local level has been discussed.[23]

Revenue for Transportation Spending. As referenced throughout the literature, there is evidence that policy-makers and transportation agencies are concerned about the long-term buying power of fuel taxes if they remain at static rates. Infrastructure investment needs continue to increase, making revenue generation the leading politically palatable goal of a VMT tax. It is important to note that, while tax rates remain static, fuel economy has improved and electric vehicles are becoming more common, federal fuel tax revenues have been growing. Across the past two decades, annual fuel tax revenues have increased approximately 20 percent as show in Figure 1.[24]

Figure 1: Federal Fuel Tax Revenue 20 Year Trends



[22] National Academies of Sciences, Engineering, and Medicine. (2009). "Implementable Strategies for Shifting to Direct Usage-Based Charges for Transportation Funding." Washington, DC: The National Academies Press. https://doi.org/10.17226/23018.

[23] Sorensen, Paul, Liisa Ecola, and Martin Wachs. "Mileage-Based User Fees for Transportation Funding: A Primer for State and Local Decision Makers." Santa Monica, Calif.: RAND Corporation, TL-104, 2012. As of February 16, 2021: https://www.rand.org/pubs/tools/TL104.html

[24] U.S. Department of Transportation Federal Highway Administration. (January 22, 2021). "Highway Statistics Series: Status of Highway Trust Fund." Table FE – 210. https://www.fhwa.dot.gov/policyinformation/statistics/2019/fe210.cfm

This is the result of growth in vehicle travel, though each vehicle, on average, is paying less into the trust fund due to improved fuel economy.

Transportation Demand Management. The literature suggests that, much like congestion pricing, a variable VMT tax could be employed to decrease demand for road use by increasing the cost-per-mile (CPM) charge for a given location and/or during certain time-periods. Decreasing demand through a variable pricing schema would, according to the literature, "accomplish other social objectives such as reducing the amount of driving, reducing energy usage, reducing greenhouse gas emissions, and reducing congestion through pricing."[25] While these strategies typically shift vehicles to other roads or time periods (which does not create a net benefit for social engineering goals), it has been suggested that pricing could shift drivers to other modes such as transit.[26] It should be noted that most employees are not in charge of their own work schedules; thus, pricing schemes that force commuters to pay rush-hour charges become inflationary to the users as they pay an additional tax for no increase in travel benefits. Such pricing strategies are not possible through a fuel tax, and transportation demand management practices raise social equity issues whereby certain road users would be "priced-out" of driving during certain times and in certain locations.

Revenue Apportionment. A third policy goal found in the literature is to attribute or apportion revenues to specific roadways. A VMT tax system that employs Global Positioning System (GPS) technology, for instance, could "increase transparency with regard to roadway use costs and how funds collected for that use are spent."[27] It is even suggested that a federal system could also be used by multiple jurisdictions, allowing for "simultaneous collection and apportionment of federal, state, and even local VMT fees."[28] Thus, if a roadway had more VMT usage, that roadway might receive more revenue or revenue equivalent to what it raised. This would generate different formulas for state and local distribution than are presently used under the federal fuel tax formula.

VMT Technology Options

A wide range of possible technologies exist for implementing a VMT tax system, based on references found in the literature. While there are relatively low-tech options available, most researchers "envision the use of sophisticated in-vehicle metering equipment, which might be phased in with new vehicle purchases."[29] The use of the more sophisticated technologies would be necessary for meeting those policy goals that go beyond basic revenue collection, and would be required to ensure compliance. Table 1 shows high-level categories of commonly referenced Information Technology (IT) platforms for VMT deployment, as referenced in the literature. While many different configurations of hardware, software and communications platforms are conceivable, these systems are the most practical and are each described in more detail below Table 1.

[25] Baker, Richard. (March, 2014). "Vehicle Miles Traveled (VMT) Fees." Texas A&M Transportation Institute. https://tti.tamu.edu/tti-publication/vehicle-miles-traveled-vmt-fees/
[26] National Academies of Sciences, Engineering, and Medicine (2010). "System Trials to Demonstrate Mileage-Based Road Use Charges." Washington, DC: The National Academies Press. https://doi.org/10.17226/22910.
[27] Baker, Richard. (March, 2014). "Vehicle Miles Traveled (VMT) Fees." Texas A&M Transportation Institute. https://tti.tamu.edu/tti-publication/vehicle-miles-traveled-vmt-fees/
[28] National Academies of Sciences, Engineering, and Medicine. (2009). "Implementable Strategies for Shifting to Direct Usage-Based Charges for Transportation Funding." Washington, DC: The National Academies Press. https://doi.org/10.17226/23018.
[29] Ibid.

Table 1: Technology Options

Hardware	Software	Communication Protocol	Functionality	Geographic Tracking Capabilities
Odometer	N/A	Manual / Self-Report	Simple mileage tracking	None with existing vehicle models
Smartphone	VMT-specific applications	GPS; Terrestrial (cellular network); Bluetooth – short-range	Mileage management and reporting; possibly by roadway type and time	State, other jurisdictions, time-of-day, potential route level
Radio Frequency Identification (RFID) tag (active & passive) and gantry/reader systems	VMT-specific applications	Ultra High Frequency (UHF) – short-range	Simple mileage tracking to full functionality – depending on back-room system design	Limited to reader station network
Aftermarket: *Customized Device / Onboard Aftermarket Device*	Customized software	Terrestrial (cellular network); Bluetooth, RFID Wi-Fi, Dedicated Short-Range Communications (DSRC), GPS optional	Simple mileage tracking to full functionality – depending on GPS and/or client- and back-room systems	State, other jurisdictions, potential route level
Original Equipment Manufacturer (OEM)-Installed: *Vehicle / Onboard Computer w/ GPS*	Open source; OEM-proprietary	Terrestrial (cellular network) / Wi-Fi / DSRC	Simple mileage tracking to full functionality – depending on client-based data management	State, other jurisdictions, time-of-day, potential route level

Odometer. The odometer option is the least technologically sophisticated and least expensive to implement and administer.[30] A vehicle owner would simply report mileage annually, for instance, possibly through state inspections or through federal tax returns.[31] This option would have no geographic tracking capabilities unless location was reported by the driver. The odometer option is similar to the approach once favored for state fuel tax reciprocity in the

[30] Congress of the United States Congressional Budget Office. (October 2019). "Issues and Options for a Tax on Vehicle Miles Traveled by Commercial Trucks." https://www.cbo.gov/system/files/2019-10/55688-CBO-VMT-Tax.pdf
[31] Ecola, Liisa, et al. (2011). "Moving Toward Vehicle Miles of Travel Fees to Replace Fuel Taxes: Assessing the Path Forward.". RAND Corporation. https://www.rand.org/pubs/research_briefs/RB9576.html

trucking industry, through the International Fuel Tax Agreement (IFTA), by carriers that do not have telematics.[32]

RFID Tag. RFID tags can be both active and passive, and can carry a limited amount of data. Using UHF communication, RFID tags have communication ranges from 10 feet (passive) to 300 feet (active), but all rely exclusively on local readers or gantries. As there is limited data storage on tags, the full functionality needs of a VMT system would require additional back-room data processing. The need for a static reader network also makes an "open road" VMT network unfeasible.

Smartphone. The smartphone option would utilize a custom VMT application to track and communicate mileage via cellular network.[33] Such a system would require that users have a smartphone, and would require that the smartphone was functioning in the vehicle when mileage was accrued. This method does have the potential for GPS-level tracking. While a smartphone could technically do the full-function processing on the device, the digitized road network database needed to vary charges by road type essentially requires that back-room processing is used. In terms of compliance, simply turning off Location-Based Services, or the smartphone itself could create large mileage data gaps.

Customized Device/Onboard Aftermarket Unit. An aftermarket VMT unit is a customized device that plugs into the Onboard Diagnostics (OBD) port of a vehicle in order to track miles. The device may have one or more capabilities including:[34] [35]

1. GPS tracking capabilities
    a. Route level and potential latitude/longitude geographical capabilities
2. Wireless cellular capabilities
    a. Communicate mileage data, and
    b. Geographical tracking capabilities, although road type and jurisdiction data would not be resident.
3. RFID capabilities are possible, but data storage limitations, and line-of-sight and interference issues are possible based on the OBD location.
    a. High cost to implement due to reader/gantry infrastructure requirements, limiting the scale of the road network.
4. DSRC has limitations similar to RFID. Data transmissions are limited in scale and distance, and existing DSRC devices do not interconnect with vehicle components that manage VMT-related data. Finally, the transceiver network requirements would be as, or more extensive, than would RFID systems.

OEM Installed. An OEM-installed telematics system on new model vehicles would allow for all of the above aftermarket unit functionality but would not require an aftermarket installation and would also ensure that there are no integration issues. As noted above, for full functionality, the system would require GPS as well as robust data processing either onboard or back-room. A

[32] Congress of the United States Congressional Budget Office. (October 2019). "Issues and Options for a Tax on Vehicle Miles Traveled by Commercial Trucks." https://www.cbo.gov/system/files/2019-10/55688-CBO-VMT-Tax.pdf
[33] Ibid.
[34] Sorensen, Paul, Liisa Ecola, and Martin Wachs. "Mileage-Based User Fees for Transportation Funding: A Primer for State and Local Decision Makers." Santa Monica, Calif.: RAND Corporation, TL-104, 2012. As of February 16, 2021: https://www.rand.org/pubs/tools/TL104.html
[35] Congress of the United States Congressional Budget Office. (October 2019). "Issues and Options for a Tax on Vehicle Miles Traveled by Commercial Trucks." https://www.cbo.gov/system/files/2019-10/55688-CBO-VMT-Tax.pdf

third-party account and transaction service would need to be developed and managed in near-real-time.

VMT System Requirements

Based on the multiple objectives and requirements of a national VMT system proffered in the literature by policy-makers and VMT champions such as the Oregon Department of Transportation (ODOT), this research presumes that the system will require the following elements.

GPS – standard or high-resolution. A national VMT tax system will require travel details and granularity that exceed what can be generated by odometers and engine control modules (ECM). In nearly all instances, roadway type and location is a critical element of road use charging by facility. For instance, the road use data must separate federal interstate roads from adjoining county frontage roads. If a national VMT system were used to manage High-Occupancy Toll (HOT) lanes, then the granularity would need to be at the lane-level.

Vehicle Connectivity. Since VMT tracking dongles do need to be associated with a specific car during vehicle operations, a plug-in dongle with data, storage and cellular capabilities is the most efficient method for linking vehicles, miles traveled and specific account information.

Terrestrial/Cellular Connectivity. As will be discussed later in this report, pre-1996 vehicles would not be equipped to utilize wireless dongles. Furthermore, a percentage of the U.S. population does not have internet, banking products and/or credit cards. However, to be efficient, a national system will require electronic transactions and wireless connectivity. While it is essential that the system rely on wireless connectivity, many wireless technologies will be unfeasible. The implementation scale for installing and maintaining local Bluetooth transceivers would be cost-prohibitive. Wireless Local Area Network (WLAN) and other networks would create considerable privacy and security issues. The lowest cost, most ubiquitous solution would be to utilize existing cellular networks – as this is the primary method used in the few limited VMT tests presently underway.

VMT Tax System Costs

Collecting and allocating transportation revenue from system users is the central objective of most use-based collection systems, including fuel taxes, tolling and a VMT tax.

There are many costs associated with collecting transportation revenue that are ultimately borne by road users, and some revenue collection mechanisms are far more efficient than others. For example, federal fuel taxes have a very low (0.2%) collection cost because revenues are collected directly from a limited number of large fuel terminal operators (e.g. Exxon and Chevron).[36] These costs are very low because of the small number of transactions that must be made. A review of the Internal Revenue Service (IRS) January 2021 list of active terminals that must report fuel transfer volumes suggests that fewer than 270 companies own the active terminals that are found at approximately 1,323 locations; these terminal operators are

[36] Peters, Jonathan and Jonathan Kramer. (Summer 2003). "The Inefficiency of Toll Collection as a Means of Taxation: Evidence from the Garden State Parkway." *Transportation Quarterly, Vol. 57 No. 3.* https://tollfreeinterstates.com/sites/default/files/The%20Inefficiency%20of%20Toll%20Collection%20as%20a%20Means%20of%20Taxation.pdf

ultimately the companies responsible for transferring fuel tax to the IRS.[37] [38] Tolls are relatively costly to administer and collect, and 15 to 30 percent collection costs are common.[39] [40]

It is not known what the full costs of collecting a national VMT tax would be, but the literature does make a first attempt at outlining the costs. It is clear that, as noted in one NAS report, "there are no 'low cost' options that can be easily verified and enforced."[41] The administrative reality of a VMT tax system is:

- It is far more complicated to track and collect money from several hundred million vehicles than collecting the fuel tax from several hundred large fuel providers; and

- Collecting revenue from a remote user group is far more complex than collecting at the point of service, as is done by tolling.

ODOT currently has the most advanced VMT tax program in the U.S. Operating under the name OReGO, the program contracts with private sector third-parties to collect and process the VMT tax revenue. In exchange, third-party companies are authorized to keep 40 percent of the gross per-mile payment to cover costs and presumably some level of profit.[42] In doing so, however, the technology companies must bear many of the following costs associated with a comprehensive VMT program.

Deployment Costs. Deployment costs are those related to developing and implementing a viable program. There are several groups of deployment costs depending on the technology architecture. For the aftermarket technology approach, the literature suggests that the "two greatest obstacles to near-term implementation … are the high cost of retrofitting the existing fleet with the needed technology, and overcoming current public concerns regarding privacy."[43] The following categories cover most of the startup costs for a national VMT program.

- Public Information. The public will need to be educated and trained on how a VMT tax program works and why such a program is needed. Public acceptance and willingness to participate is a key step to the implementation process, and acceptance by as many as 230 million U.S. vehicle drivers is critical.[44]

- Technology Deployment. The system requirements for tracking and reporting mileage vary based on the choice of technologies used. There are numerous system designs,

[37] Internal Revenue Service. (February 12, 2021). "Approved Terminals 01/31/2021." https://www.irs.gov/pub/irs-utl/tcn_db.pdf
[38] Cornell Law School: Legal Information Institute (LII). "26 CFR 48.4081-2 – Taxable Fuel; Tax on Removal at a Terminal Rack." https://www.law.cornell.edu/cfr/text/26/48.4081-2 Date Accessed: March 8, 2021.
[39] Short, Jeffrey. (May 2007). "Defining the Legacy for Users: Understanding the Strategies and Implications for Highway Funding." The American Transportation Research Institute (ATRI). Alexandria, VA.
[40] Short, Jeffrey; Jonathan Peters. (January 2020). "A Financial Analysis of Toll System Revenue: Who Pays & Who Benefits." American Transportation Research Institute (ATRI). Arlington, VA.
[41] National Academies of Sciences, Engineering, and Medicine. (2009). "Implementable Strategies for Shifting to Direct Usage-Based Charges for Transportation Funding." Washington, DC: The National Academies Press. https://doi.org/10.17226/23018.
[42] "California Road Charge Pilot Program." (2017). California State Transportation Agency. https://dot.ca.gov/-/media/dot-media/programs/road-charge/documents/rcpp-final-report-a11y.pdf
[43] National Academies of Sciences, Engineering, and Medicine. (2009). "Implementable Strategies for Shifting to Direct Usage-Based Charges for Transportation Funding." Washington, DC: The National Academies Press. https://doi.org/10.17226/23018.
[44] Wagner, Isabel. (December 16, 2020). "Number of Licensed Drivers – United States 1990 – 2018." https://www.statista.com/statistics/191653/number-of-licensed-drivers-in-the-us-since-1988/

and the technologies associated with each design will require hardware and/or software installation, after-market installations and maintenance, or installed as standard equipment in new vehicles.

- Account and Financial Management. An IT infrastructure will be needed to allow up to 230 million new users to create accounts, transfer revenue, and register 272 million vehicles.[45] Additionally, the Federal Communications Commission (FCC) reports that 44 million households lack a standard broadband connection due possibly to their financial situation or due to a lack of access.[46] For those who do not have internet access or electronic payment options, a secondary mail-in program will be required.

Collection and Administrative Costs. Collection, administrative and other associated costs will accrue as part of a VMT tax program's day-to-day operations. Several organizations, both public and private, may be involved in these operations. The central function of these organizations will be tracking, billing, account management and collecting payment. For example, in the OReGO program, the state DOT has a management office and staff that oversees the private sector contracts, evaluates both the program and the contractors, and manages the financial transactions managed by the contractors. Separately, the contractors have redundant departments and staff that manage the users, technologies and user revenue.

The Congressional Research Service (CRS) juxtaposed and compared fuel tax costs with VMT tax costs as follows:

"One of the advantages of the federal motor fuels tax is that nearly all of the revenue is collected … when the fuel is removed from the refinery or tank farm. This has been the case since 1986, when the U.S. Treasury shifted its collection of the gas tax to the refinery or 'rack' to reduce tax administration problems and curb fuel tax evasion. The federal government has no need to assess taxes at 111,000 gasoline stations or charge millions of vehicle owners individually. Tax administration costs are generally estimated to be less than one cent per dollar of revenue. The road user charge would reverse this by taking a small and simple tax administration problem and making it large. A mileage-based road user charge that encompasses all private vehicles could require as many as 256 million points of collection."[47]

Thus, it is rational to assume that administrative costs will be far greater for a VMT tax system than the existing fuel tax system.

[45] Ibid.
[46] Shelton, Chris and Angela Sieffer. (October 28, 2020). "Many Americans Still Don't Have Internet Access – Congress Should Help." https://thehill.com/opinion/technology/523179-many-americans-still-dont-have-internet-access-congress-should-help
[47] Kirk, Robert; Marc Levinson. (June 22, 2016). "Mileage-Based Road User Charges." Congressional Research Service. https://fas.org/sgp/crs/misc/R44540.pdf

Case Study Analogies: Collection and Administrative Costs. Evidence of what the administrative and collection costs will be vary greatly, ranging in the literature from 5 percent to 40 percent.

Costs Based on E-Z Pass. A first analysis of possible administrative costs as a percentage of revenue is found in a CRS report. CRS bases its cost estimates of 7 to 12 percent of revenue based on electronic collection systems used by the toll industry. CRS states, "The New Hampshire Turnpike system reported that its E-Z Pass processing fees were 7.3% of total E-Z Pass revenues in FY2015. Fees charged by banks for processing transactions and enforcement costs are not included in that percentage. While a federal system based on equipping all vehicles with standardized OBUs with GPS technology could bring the costs down eventually, the cost of operating the system seems likely to be above 5% of revenue under the best of circumstances."[48] The CRS example, however, likens E-Z Pass at specific locations within a closed system to a national system of open-road mileage tracking, but there are many exponential differences from an EZ Pass-like system, including the geographic scale, data tracking and processing requirements, enforcement and the total amount of revenue collected. Tolls charge far higher rates per mile than any proposed VMT tax system – with higher revenues the cost of collection as a percentage can be lowered.

CRS found that additional credit card and bank fees would be necessary. Looking again at the E-Z pass experience, the report found that in Washington State "credit card fees paid on collections by toll facilities were equal to 3.45% of adjusted gross revenue" and that "bank and credit card fees were 2.7% of [New Hampshire's] electronic E-Z Pass Revenues."[49]

Costs Based on OReGo Program. As mentioned previously, OReGO is the one functioning statewide VMT tax system in the U.S., though it applies to only a small volunteer group of Oregon's driving population. The literature states that "OReGO created a nascent, regulated, open commercial market for mileage measurement and account management services. OReGO established a 'market rate' of [third-party] compensation for account management services, currently 40 percent of gross revenue collected for up to 5,000 volunteer vehicles, with expectations that the rate will decline to under 10 percent as the number of vehicles increases to the hundreds of thousands."[50]

Other Estimates. Finally, Gordon and Peters find that a conceptual New York State VMT charge system would have collection costs of 17.87 percent of revenue.[51]

[48] Kirk, Robert; Marc Levinson. (June 22, 2016). "Mileage-Based Road User Charges." Congressional Research Service. https://fas.org/sgp/crs/misc/R44540.pdf
[49] Ibid.
[50] "California Road Charge Pilot Program." (2017). California State Transportation Agency. https://dot.ca.gov/-/media/dot-media/programs/road-charge/documents/rcpp-final-report-a11y.pdf
[51] Peters, J. R., & Gordon, C. (2009). "Analysis of Alternative Funding Sources." University Transportation Research Center.

Compliance and Enforcement Costs. An intended benefit of the federal government moving to a limited number of federal fuel taxpayers in the 1980s was to dramatically reduce fuel tax evasion.[52] However, a VMT tax model counters these efforts to curb evasion, moving payment from an estimated 270 companies to more than 272 million vehicles.[53] To put this in perspective, for each federal fuel taxpayer there would be one million vehicles that would be tracked and billed – a 1:1,000,000 ratio. With such a large number of vehicles to track, there will be individuals who opt to evade a VMT tax, and others that are simply unable to pay or comply with the VMT tax due to their circumstances.

Obviously, widespread evasion would undermine the entire VMT tax system, as it would the fuel tax system. The simple perception that many users are cheating the system could lead to significant resentment among law-abiding citizens. Thus a VMT tax system will need to:

- Ensure Mandatory Participation. Those who do not track their miles are evading their responsibility to pay for road miles driven. A method for identifying illegal behavior will be needed. Noncompliance and evasion could come in the form of non-participation, device tampering, or manipulating data to impact locations or variable pricing models. The necessary enforcement may be reliant on state or local police enforcement, as is done with proof of license, registration and insurance. For those not complying, fines and judicial system action will be required. In either case, motorists will need some form of active compliance certification – a concept that does not yet exist anywhere in the U.S. Without a certification system, cars that do not use active VMT tracking technologies are invisible black holes in the system.

- Collect Delinquent Payments. To ensure compliance, strict terms-of-service agreements between road users and VMT tax administrators will be required with a clear process for addressing those who do not pay. For non-payers, a legal process will be needed for collecting monies owed, with the potential for civil or criminal prosecution. The associated costs to law enforcement and the judicial system are unknown but must be calculated and accrued. An example of the costs of collecting unpaid bills can be found through the example of New York City (NYC) parking.[54] The NYC Department of Finance (DOF) pays outside collection agencies to collect on summons of less than $350. The DOF uses two collection agencies, a primary collection agency and a secondary collection agency if the primary is unsuccessful. From 2016 through 2018, the DOF paid commissions of $5.5 million to its primary collection agency to collect $114 million. During that same period, the DOF paid $2.6 million in commissions to its secondary collection agency for $36 million in collections. Combined, NYC's collection efforts – costing over $8 million – only achieved a 53.8 percent recovery rate with $106.9 million in parking tickets uncollected from 2016 to 2018.

[52] United States Government Accountability Office (GAO). (May 1992). "Tax Administration: Status of Efforts to Curb Motor Fuel Tax Evasion." https://www.gao.gov/assets/ggd-92-67.pdf
[53] Internal Revenue Service. (June 11, 2020). "Excise Summary Terminal Activity Reporting System (ExSTARS)." https://www.irs.gov/businesses/small-businesses-self-employed/excise-summary-terminal-activity-reporting-system-exstars
[54] Kim, Tina, et al. (December 2019). "New York City Department of Finance: Selected Aspects of Parking Violations Operations to Collect Fines and Fees." Office of the New York State Comptroller. https://www.osc.state.ny.us/files/state-agencies/audits/pdf/sga-2020-17n8.pdf

In the case of U.S. toll authorities, CRS finds that there is "a 'leakage rate' – the share of transactions for which payment is not received – of 5 to 10 percent."[55] Arguably this figure is likely to be much higher on a system that covers all roads in the U.S., and not just a single toll facility. This uncollected revenue would not be available for infrastructure investment.

User Concerns

Legitimate systems of taxation are those where compliance is high. When there is significant cheating or a sense of unfairness, tax systems begin to break down and those following the rules no longer buy into them. Previous research presented evidence that "if a public feels increasingly over time that taxes are unfairly imposed, it will be increasingly likely to evade paying these taxes."[56]

Considering this, it is clear that taxpayer perceptions are key to a successful VMT tax system. The following are general guidelines to address potential taxpayer concerns. There are many user concerns discussed throughout the literature. Though user concerns often are secondary considerations to VMT tax system planning, there are many issues that could undermine the viability of a VMT tax including:

- Lack of Full Participation
- General Public Perceptions
- Perceptions of Fairness
- Privacy Concerns
- Bypassing the Democratic Process

Lack of Full Participation. The burden of paying for roadways should not fall on a single segment of road users. The current fuel tax spreads the cost of roads across both personal and commercial vehicles, and is able to differentiate costs based on vehicle weight and fuel economy. It has been suggested by some that commercial vehicles, particularly tractor-semitrailers, should bear much or all of the cost through a VMT tax, which is the practice in some parts of Europe. To counter this argument, as will be described later in this report, trucks represent a minority of registered vehicles and vehicles miles traveled. Secondly, trucking operations utilize a limited amount the total U.S. system of roadways, focused mainly on interstate highways. Following the user-pays principle, roadways that do not have truck travel would not receive funding from trucks.

General Public Perceptions. A meta-study of focus groups, public opinion surveys and media articles found little public support for a VMT tax system. Across 33 survey questions that queried respondent support for a VMT tax, mean support was found to be 24 percent.[57] A separate set of 23 questions that specifically asked whether the motor fuels tax should be replaced with mileage charges was also analyzed – the researchers found that 23 percent of respondents were supportive of VMT tax concepts.[58]

[55] Kirk, Robert; Marc Levinson. (June 22, 2016). "Mileage-Based Road User Charges." Congressional Research Service. https://fas.org/sgp/crs/misc/R44540.pdf
[56] Etzioni, Amitai. "Tax Evasion and Perceptions of Tax Fairness: A Research Note." April 1986. The Journal of Applied Behavioral Science, 22(2). 177-185.
[57] National Academies of Sciences, Engineering, and Medicine (2016). "Public Perception of Mileage-Based User Fees." Washington, DC: The National Academies Press. https://doi.org/10.17226/23401.
[58] Ibid.

Perceptions of Fairness. Baker et al. conducted a survey to gauge public acceptance among urban and rural residents in northeast Texas.[59] Rural residents were largely dissatisfied with this new tax method, expressing concern that rural locations already receive inadequate funding for road maintenance and repairs. Additionally, rural residents noted that they must drive farther distances on average than urban residents to purchase necessities – creating an inflationary effect on goods purchased in rural areas.

Privacy Concerns. Privacy concerns were described as one of the largest impediments to implementing a VMT tax.[60] In 2016, the U.S. GAO found that "mileage fees for passenger vehicles … continue to face significant public concerns relating to privacy as well as cost challenges. Privacy concerns are particularly acute when GPS units are used to track the location of passenger vehicles."[61] GPS technology is necessary, however, to employ many of the aforementioned policy goals, and to employ some level of enforceability. Separately, CBO also found that GPS utilization created privacy concerns among drivers, which would likely be the greatest barrier to acceptance of a VMT tax.[62,63]

- Privacy in the OReGO Program. One potential remedy to alleviate privacy concerns is enabling a dynamic choice-of-technology model, which would permit users to select the recording device they feel most comfortable with. Oregon launched a study to assess technology preferences among drivers, with nine percent of participants favoring the most secure technology that omitted location and time from reports, while 60 percent of participants preferred detailed statements – thus preferring VMT tax accuracy over privacy concerns.

  Implementing a flat fee mileage system that is geographically agnostic might address many GPS and satellite-related privacy concerns. This strategy, however, could not distinguish mileage by roadway type or by miles driven in specific local and state jurisdictions.[64]

  One Commercial Account Manager (CAM) contractor for the pay-per-mile OReGO program requires individuals to exempt themselves from several state personal privacy protections when they sign up for an account. The privacy policy of this CAM contractor states that "Personally Identifiable Information" and "Personal Information," as defined by the state of Oregon, are categories of information that are collected, and potentially disseminated to certain parties, in order to manage each RUC account.

[59] Baker, Richard., et al. (October 31, 2008). "Feasibility of Mileage-based User Fees: Application in Rural/Small Urban Areas of Northeast Texas." University Transportation Center for Mobility, Department of Transportation. https://utcm.tti.tamu.edu/publications/final_reports/Goodin_08-11-06.pdf.
[60] Zupan, Jeffrey. et al. (June 2012). "Mileage-Based User Fees: Prospects and Challenges Final Report." Regional Plan Association. https://www.dot.ny.gov/divisions/engineering/technical-services/trans-r-and-d-repository/C-10-22-21144%20Mileage%20Based%20User%20Fees%20Final%20Report%2029June12.pdf
[61] United States Government Accountability Office. (December 2012). "Pilot Program Could Help Determine the Viability for Certain Vehicles." https://www.gao.gov/assets/660/650863.pdf
[62] Congress of the United States Congressional Budget Office. (October 2019). "Issues and Options for a Tax on Vehicle Miles Traveled by Commercial Trucks." https://www.cbo.gov/system/files/2019-10/55688-CBO-VMT-Tax.pdf
[63] Baker, Richard. (March, 2014). "Vehicle Miles Traveled (VMT) Fees." Texas A&M Transportation Institute. https://tti.tamu.edu/tti-publication/vehicle-miles-traveled-vmt-fees/
[64] Baker, Richard., et al. (October 31, 2008). "Feasibility of Mileage-based User Fees: Application in Rural/Small Urban Areas of Northeast Texas." University Transportation Center for Mobility, Department of Transportation. https://utcm.tti.tamu.edu/publications/final_reports/Goodin_08-11-06.pdf.

In the state of Oregon "Personally Identifiable Information" is defined very generally to include "any information that identifies or describes a person." "Personal Information," as defined by Oregon, consists of a much more extensive and intrusive list of identifiable information, including social security number, medical records, health insurance policy number, passport number, financial information and other forms of identification. While the privacy policy of this CAM contractor does not explicitly indicate the collection or use of such sensitive information as medical records, passport number, etc., that information is part of the larger category of "Personal Information" that could be collected by the service provider.[65]

The privacy policy does specify that Oregon State laws and statutes govern what private information can be collected, how the data is used and protected, and how the data is potentially disclosed and ultimately destroyed.[66] However, by signing up for the RUC account through this CAM contractor, OReGO participants are choosing to relinquish their travel pattern data, "Personal Information" and financial information (for billing purposes) in order to voluntarily participate in the OReGO program. See Appendix A for a detailed description of the Terms of Service.

Bypassing the Democratic Process. One of the major concerns of VMT systems, aside from privacy issues, is that they may bypass legislative and formal public participation processes.

For example, one well-known mechanism for quickly raising funds is *privatization*. The end goal of privatizing roadways is to quickly generate positive cash flow for transportation investments by entering into long-term roadway lease agreements with private sector firms. A number of the U.S. lease agreements for publicly owned roadways undermined public transparency when they were negotiated in private, with the final legally binding contracts being classified as confidential.[67] In several instances in the U.S., those same private sector firms later filed bankruptcy, potentially leaving the public sector agency with the original maintenance costs and management burdens.[68] It is conceivable that a more transparent negotiating and contracting process could have generated more financially viable agreements for both signatories.

Even with lease agreements, public sector risk still exists through contractual loopholes. In 2008, flooding in Indiana required an evacuation using the privatized Indiana Toll Road. Tolls were waived for citizens who had to evacuate, however the state of Indiana had to reimburse the private toll road operator nearly $450,000 for excused tolls during the evacuation.[69]

[65] Emovis. "Privacy Policy: RUC User Data Retention and Privacy Policy." Date Accessed: February 17, 2021. https://orego.emovis.us/privacy-policy/
[66] Ibid.
[67] Buxbaum, Jeffrey and Iris Ortiz. (June 2007). "Protecting the Public Interest: The Role of Long-Term Concession Agreements for Providing Transportation Infrastructure." USC Keston Institute for Public Finance and Infrastructure Policy. https://www.inthepublicinterest.org/wp-content/uploads/Protecting_Public_Interest_Long_Term_Concessions.pdf
[68] Fitzgerald, Patrick. (May 20, 2015). "Indiana Toll Road Exits Bankruptcy Protection." The Wall Street Journal. https://www.wsj.com/articles/indiana-toll-road-exits-bankruptcy-protection-1432907793#
[69] Dannin, Ellen. (Winter 2011). "Crumbling Infrastructure, Crumbling Democracy: Infrastructure Privatization Contracts and Their Effects on State and Local Governance." *Northwestern Journal of Law & Social Policy Volume 6, Issue 1.* https://scholarlycommons.law.northwestern.edu/cgi/viewcontent.cgi?article=1061&context=njlsp

As former Penn State professor Ellen Dannin noted, "language commonly found in infrastructure privatization contracts shifts substantial risk – and cost – to the public while also limiting the state and local governments' ability to make policy decisions."[70]

Another even more problematic issue is reclassifying VMT revenue as a "fee," rather than a tax, to avoid public processes such as legislative approvals and/or mandated public referendums. Multiple VMT advocates, including ODOT, are juxtaposing and equating VMT programs with open-road tolling.[71] Since most tolling proponents describe tolls as fees, designating a VMT charge as a fee may legally bypass any state laws or regulations relating to taxation.

Almost all states require unicameral or bicameral approvals for fuel tax increases, and more than a dozen U.S. states require or utilize public referendums to raise fuel taxes.[72] In other instances, state constitutions include clauses for managing fuel taxes. For instance, Minnesota's constitution requires that all fuel tax revenue be dedicated to the state's road and bridge network.[73]

If VMT charges are reclassified by states or other jurisdictions as administrative fees, many public processes, taxation management tools, and even revenue dedication for transportation could be endangered.

State and Local VMT Tax Research Programs

There have been a very limited number of state-level pilot studies, including one Oregon pilot that has transitioned into a functioning program that allows up to 5,000 participants.

Washington State released a report in 2020 outlining steps for transitioning from the gas tax to a VMT tax.[74] The year-long pilot program involved four different technology options that participants could choose from:

- Odometer Reading – manually capture mileage; pay tax quarterly; smartphone needed for taking photos.
- Smartphone Application called Mile-Mapper – pay tax quarterly; iPhone required.
- Plug-in Device with GPS – pay monthly; vehicle newer than model year 1996; some electric vehicles.
- Plug-in Device, no GPS – pay monthly; vehicle newer than model year 1996.

A pre-pay method, known as a Mileage Permit, was also offered and required drivers to pre-pay for a set of miles (1,000, 5,000 or 10,000 miles). Participants were surveyed about their

[70] Dannin, Ellen. (Winter 2011). "Crumbling Infrastructure, Crumbling Democracy: Infrastructure Privatization Contracts and Their Effects on State and Local Governance." *Northwestern Journal of Law & Social Policy Volume 6, Issue 1.* https://scholarlycommons.law.northwestern.edu/cgi/viewcontent.cgi?article=1061&context=njlsp
[71] Bock, Maureen. (February 16, 2021). Presentation at WA State Transportation Commission. https://wstc.wa.gov/wp-content/uploads/2021/02/2021-0216-BP2-ODOT-RUC-Update-OReGO.pdf
[72] National Conference of State Legislature (NCSL). (August 12, 2020). "Recent Legislative Actions Likely to Change Gas Taxes." https://www.ncsl.org/research/transportation/2013-and-2014-legislative-actions-likely-to-change-gas-taxes.aspx
[73] Minnesota Legislator. "Minnesota Statutes 2020: 239.7511 Gas Tax Sign on Petroleum Dispenser." https://www.revisor.mn.gov/statutes/cite/239.7511/pdf Date Accessed: March 8, 2021.
[74] WA RUC. "Washington Road Usage Charge Pilot Project & Assessment." https://waroadusagecharge.org/ Date Accessed: February 18, 2021.

experience during the pilot study and had the opportunity to provide feedback during focus group sessions.

The **California Road Charge Pilot Program** completed in 2017. The program tested six mileage-recording methods, and consisted of mostly private vehicles (87%), but also included heavy commercial vehicles (1%) and light commercial vehicles (5%).[75]

Minnesota completed a pilot test in 2012 that relied on smartphones to collect and transmit mileage data collected by participants. Participants who traveled in the Twin Cities region and those who traveled during the morning and evening rush hours in the same region paid varying fee rates during the pilot test.[76]

The **Eastern Transportation Coalition** (formerly, I-95 Corridor Coalition), a consortium of seventeen eastern U.S. states, has been conducting MBUF pilot programs with passenger vehicles and large trucks. A 2019 pilot study[77] included 889 passenger vehicle participants and included the following areas of interest:

- Out-of-state mileage handling;
- Impacts of current tolling with the MBUF;
- Additional benefits to encourage participation, such as engine reports, driver behavior scores, etc.;
- Trucking operations across multiple states.

At the end of 2018 and into 2019 a truck-only MBUF was launched by the Eastern Transportation Coalition that consisted of 55 trucks. The purpose of this study was to understand current trucking industry reporting requirements and how the implementation of a MBUF would impact trucking regulations. Both pilot studies are expected to include upcoming study phases to expand participation numbers and add participating states.[78]

The **Oregon Road User Fee** Task force was created in 2001 by the Oregon Legislature to research and develop methods to collect revenue for Oregon roadways with a core motivation to replace the state fuel tax. The one-year pilot study of the selected fuel tax alternative – a "mileage-based fee" – was launched in April 2006 with 285 vehicles, consisting of 299 total volunteers and two Portland service stations. Devices installed in each participating vehicle recorded the number of miles driven in the study area zones and the date and time.

Within the field test area, geographic zones were established to test the technological feasibility of collecting miles per zone in the event of a variable pricing model. When participants refueled at the participating custom-equipped service stations, the in-vehicle device electronically communicated the number of miles a vehicle drove in each zone to the point of sale system installed at the fueling station to assess the mileage-based fee.[79]

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[75] "California Road Charge Pilot Program." (2017). California State Transportation Agency. https://dot.ca.gov/-/media/dot-media/programs/road-charge/documents/rcpp-final-report-a11y.pdf

[76] Kirk, Robert; Marc Levinson. (June 22, 2016). "Mileage-Based Road User Charges." Congressional Research Service. https://fas.org/sgp/crs/misc/R44540.pdf

[77] "I-95 Corridor Coalition Mileage-Based User Fee – 2019 Pilot Results." (2019). The I-95 Corridor Coalition. https://tetcoalitionmbuf.org/wp-content/uploads/2020/07/2019-Coalition-Passenger-Pilot-Factsheet.pdf

[78] Ibid.

[79] Whitty, James. (November 2007). "Oregon's Mileage Fee Concept and Road User Fee Pilot Program Final Report." Oregon Department of Transportation. https://www.myorego.org/wp-content/uploads/2017/07/RUFPP_finalreport.pdf

The first half of the study established driving habits for all participants and required drivers to refuel at the participating service stations at least twice a month. During this first stage, miles were recorded and the gas tax continued to be paid by participants. The second half of the study period divided participants into three groups:

- Vehicle Miles Traveled Group – paying 1.2 cents per mile;
- Rush Hour Group – paying 10 cents per mile for driving during morning or evening rush hours;
- Small Control Group – continued paying the gas tax while also having their miles recorded.

While participants never actually paid the mileage fee during the pilot test, the fee was deducted from endowment accounts ODOT created for each vehicle.[80] Participants were rewarded with monetary compensation when they were able to meet certain participation milestones throughout the one-year pilot program. Once a milestone was completed by the required date, participants received a total of $300 by the end of the pilot program. In addition, pre-paid gasoline vouchers to use at the two participating service stations in the amount of $40 were offered to participants who completed equipment installation within two weeks of their training. The $40 vouchers were used throughout the study in order to compensate participants when any issues with equipment arose or to encourage participation in events related to the program.[81]

Applying the critiques from the first pilot study, another small (88 volunteers) pilot program occurred from November 2012 to March 2013. This program provided participants four options for mileage compilation: with a GPS device; with a non-GPS device; a smartphone option; or a flat-fee payment option (no mileage reporting). Unlike the first pilot test, program volunteers came from three states; Oregon, Nevada and Washington. With the exception of the flat-fee option, once volunteers chose their mileage reporting method, a device was mailed to participants to self-install in the vehicle. A rate of $0.0156 per mile was assessed in a monthly bill for participants in Oregon. The state of Oregon deemed this test a success and Oregon Senate Bill 810 was signed into law to solidify a mileage-based tax.[82]

In 2013, ODOT established OReGO, a volunteer program to test mileage fee charging with a provided plug-in device. After recruitment and certification of private sector account managers and enrollment of volunteer vehicles, the OReGO program went live on July 1, 2015. Within the first 18 months, 1,307 vehicles (1,111 volunteers) were enrolled in the program. All vehicles enrolled were required to be newer than model year 1996 to accommodate the provided plug-in device. To cover costs of the OReGO program and limit the size of the operations team, a maximum of 5,000 vehicles was set forth by Senate Bill 810. The program also limits the number of participating vehicles based on fuel efficiency. Vehicles with a fuel economy of 17 MPG are limited to 1,500 vehicles. The same limit applies to the number of vehicles with a fuel economy of 17 MPG to 22 MPG. The quantity of vehicles with 22 MPG or more in fuel economy are not limited in the OReGO program, so long as the total number of enrolled vehicles does not exceed 5,000.

[80] Ibid.
[81] Ibid.
[82] Jones, Kathryn and Maureen Bock. (April 2017). “Oregon’s Road Usage Charge: The OReGO Program Final Report.” Oregon Department of Transportation. https://www.oregon.gov/ODOT/Programs/RUF/IP-Road%20Usage%20Evaluation%20Book%20WEB_4-26.pdf

The OReGO program is ongoing and still accepting participants. The program allows volunteers to choose their account manager, device (with or without GPS tracking), and billing options. While the gas tax is still in place, if program participants refuel, the fuel tax is credited to their OReGO account and a mileage fee is assessed instead. Unlike the previous two pilot studies, the OReGO program is a tax system and must abide by all Oregon State Treasury tax laws.

3. Analysis of a National VMT Tax System

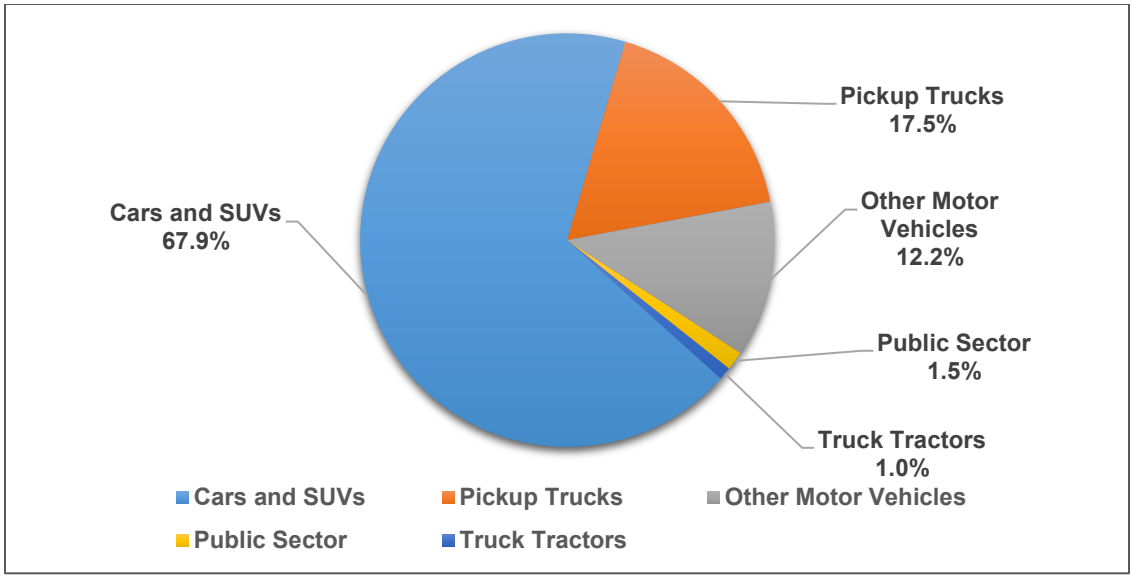
To conduct a thorough VMT cost analysis for a national system, numerous inputs and metrics must be obtained and incorporated. For instance, total vehicle registrations and vehicle miles traveled form the denominator of most of the cost metrics. To assess VMT tax equity issues, rural versus urban miles and vehicle miles traveled must be differentiated and incorporated to the formulas. For cost calculations, the research team acquired a range of hardware, software and transactions costs.

Fortunately, many of the necessary inputs are available in public databases; in particular, the Federal Highway Administration (FHWA) Highway Statistics datasets possess most metrics needed for the national cost calculations. Other cost-related metrics were obtained from publicly available documents.

Understanding the Scale of a National VMT Tax System

VMT Tax User Base. There are 276.4 million registered motor vehicles in the U.S.[83] For the most part, these vehicles are owned by the private sector (272.4 million) while 4 million are publicly owned. As shown in Figure 2, the majority of the U.S. fleet is made up of private cars and SUVs (187.7 million vehicles, or 67.9%). This is followed by pickups (17.5%) and other motor vehicles such as straight trucks, buses, vans and motorcycles (12.2%). Approximately one percent (1%) or 2.7 million vehicles are truck-tractors that are owned and operated by the trucking industry.[84] Thus, efforts to apply the VMT tax to only one vehicle type, such as large trucks, would apply to a small subsection of the overall vehicle population.

Figure 2: U.S. Fleet by Vehicle Type



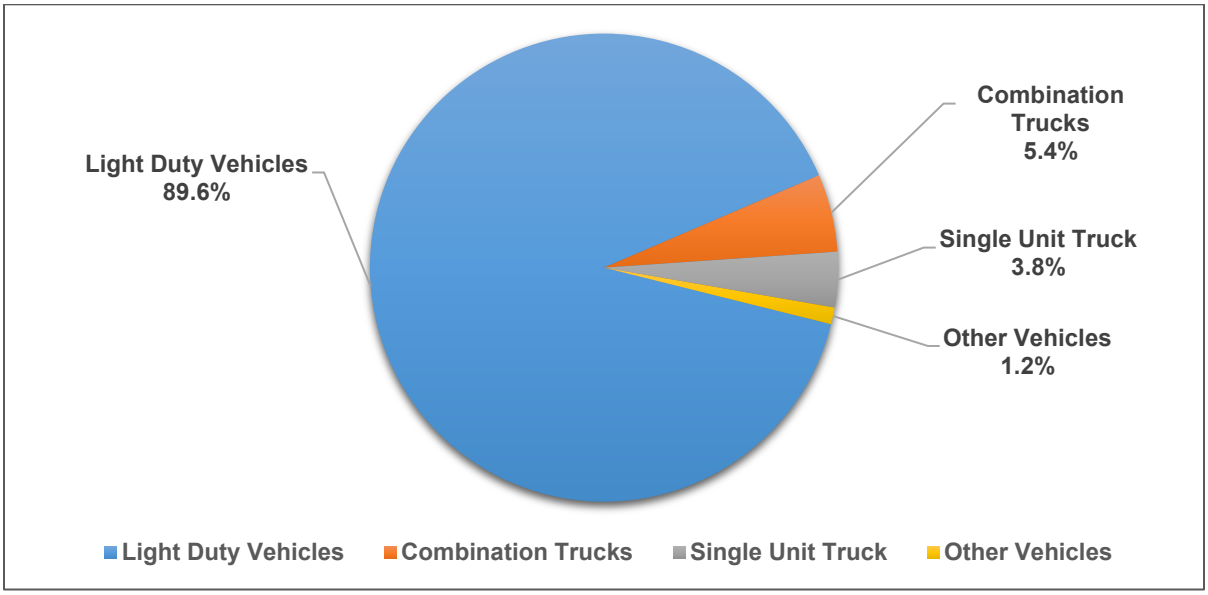
[83] U.S. Department of Transportation Federal Highway Administration. (December 9, 2020). "Highway Statistics Series: State Motor-Vehicle Registrations - 2019." *Table MV – 1.* https://www.fhwa.dot.gov/policyinformation/statistics/2019/mv1.cfm

[84] U.S. Department of Transportation Federal Highway Administration. (December 9, 2020). "Highway Statistics Series: Truck and Truck-Tractor Registrations." Table MV – 9. https://www.fhwa.dot.gov/policyinformation/statistics/2019/mv9.cfm

Documenting Vehicle Miles Traveled. Vehicle miles traveled statistics produced by FHWA establish how many potentially taxable miles are accrued each year by all registered vehicles.[85] [86] [87]

In 2019 there were 3.26 trillion vehicle miles traveled in the U.S. If each of these miles were charged one cent per mile, the funds raised would be $32.6 billion. The vast majority of these miles were driven by light duty vehicles such as cars and SUVs (89.6%). While tractor-trailers only comprise one percent of the U.S. fleet, they accrue more than five percent of the miles driven, as shown in Figure 3.

Figure 3: All VMT by Vehicle Type



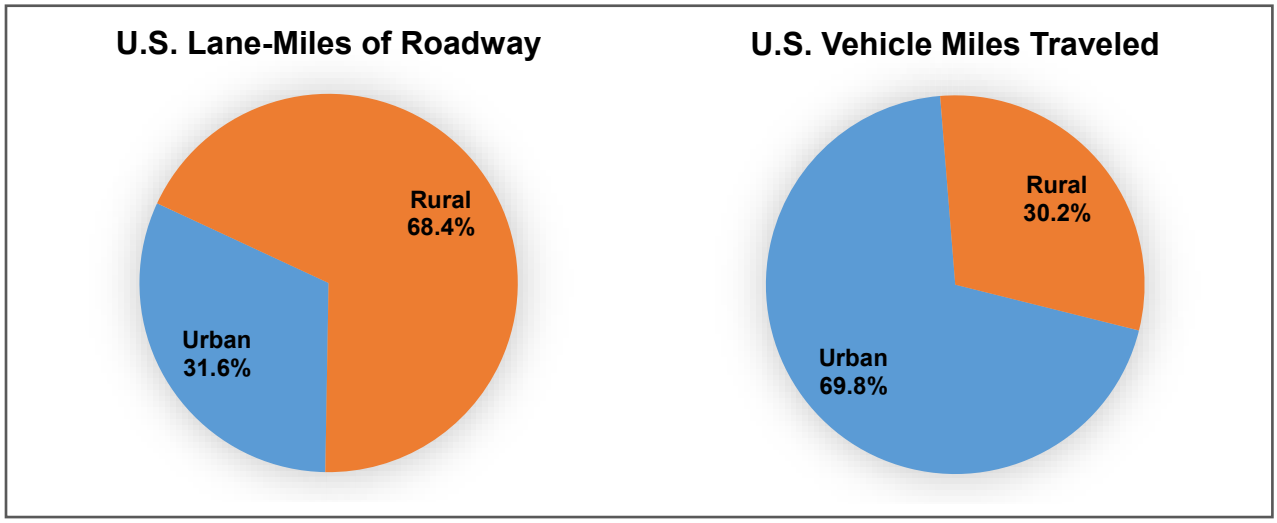
Understanding Rural versus Urban VMT. Figure 4 documents that most lane-miles of roadway in the U.S. are in rural areas while most of the driving, as measured in VMT, occurs on urban roadways.

[85] U.S. Department of Transportation Federal Highway Administration. (December 9, 2020). "Highway Statistics Series: State Motor-Vehicle Registrations - 2019." Table MV – 1. https://www.fhwa.dot.gov/policyinformation/statistics/2019/mv1.cfm

[86] U.S. Department of Transportation Federal Highway Administration. (December 9, 2020). "Highway Statistics Series: Truck and Truck-Tractor Registrations." Table MV – 9. https://www.fhwa.dot.gov/policyinformation/statistics/2019/mv9.cfm

[87] U.S. Department of Transportation Federal Highway Administration. (December 24, 2020). "Highway Statistics Series: Annual Vehicle Distance Traveled in Miles and Related Data – 2019." Table VM – 1. https://www.fhwa.dot.gov/policyinformation/statistics/2019/vm1.cfm

Figure 4: U.S. Lane-Miles of Roadway and U.S. Vehicle Miles Traveled



This fact highlights why most congestion occurs in urban areas, where demand for roadways is high and supply is low. It is also a key indicator of where VMT funds would be sourced; the majority of the money raised by a flat VMT tax would derive from urban areas, and those urban areas have relatively short segments of infrastructure compared with rural areas.

FHWA also produces statistics on fuel tax revenue allocation by road type; for those roadways that are designated rural or urban, FHWA indicates that nearly $17 billion are allocated to rural locations and $22.8 billion are allocated to urban (Table 2).[88]

Table 2: Fuel Tax Revenue Allocation by Road Type

	Federal Spending	% Allocation	Annual VMT	Spending Per VMT	Lane Miles
Rural	$16,995,571,000	42.6%	983,852,586,120	$0.017	6,005,113
Urban	$22,866,576,000	57.4%	2,277,919,076,721	$0.009	2,780,284
All	$39,862,147,000	100.0%	3,261,771,662,841		8,785,397

Presently, the federal government allocates nearly twice as much funding for rural miles traveled versus urban roadways ($0.017 vs $0.009). Assuming similar fuel economies exist in rural and urban settings, it is clear that urban drivers currently subsidize rural roadways.

Table 3 shows the difference between urban and rural mileage as a measurement of annual VMT per-lane miles. The numbers indicate that, on average, each urban lane-mile would accrue five times more annual VMT than rural lane-miles, and based on a flat VMT tax, urban miles would generate five times more revenue.

[88] U.S. Department of Transportation Federal Highway Administration. (March 01, 2021). "Highway Statistics Series: Obligation of Federal Funds by Functional Class" Table FA-4C. https://www.fhwa.dot.gov/policyinformation/statistics/2019/fa4c.cfm

Table 3: Annual Vehicle Miles Traveled Per Lane-Mile

	Annual VMT per Lane-Mile
Urban	819,312
Rural	163,836

A VMT tax is philosophically and literally a direct pay-per-mile-of-use system, similar to a toll road. In principle at least, tolls collected from toll users are meant to maintain the tolled facility. Based on this premise, the majority of VMT tax revenue would be derived from users of urban roadways – even though the number of urban road miles are fewer than those of rural road miles. That said, rural drivers will have to travel farther than urban drivers for similar purposes (e.g. work commutes, grocery stores, medical appointments) than would urban drivers. This is clearly seen in the accumulation of VMT by network type. According to the AAA Foundation's American Driving Survey from 2014 to 2015, a rural driver drives an average of 13,029 miles annually, and a driver residing in an urban area drives an average of 10,576 miles annually.[89]

VMT Rate Types and Rate Setting

Rate Types. As with any tax or fee, rates will have to be set – either administratively after a new law is passed, or through a legislative process. Rates would, in theory, be set at a level that will meet revenue goals and investment needs at the present time and in the future. There are two main models for per-mile rates; flat and variable.

- Flat Rate. A flat rate VMT tax has several advantages, but is generally not able to meet certain social or environmental policy objectives that go beyond revenue generation. A flat tax is simple and straightforward – a single charge would be assessed on each mile driven on the entire U.S. transportation system. The flat rate could vary by vehicle type – but the rate would not change based on road facility, jurisdiction, time-of-day or level of congestion. A flat rate could likely be deployed using many of the technologies previously discussed.

- Variable Rates. If the stated goal of a VMT tax goes beyond revenue collection, then a variable rate is necessary. Variable rates, as the name implies, would be different across the entire transportation system and could be adjusted for numerous travel and non-travel objectives. This variable rate option could allow state and local jurisdictions to set customized rates in addition to the federal VMT tax, and could allow the federal government to vary rates as well. Variable rates would enable governments to send price signals to drivers for the purposes of congestion pricing, modal diversion, or to decrease demand when air quality is poor. Governments could use the VMT tax system as a tool to adjust demand based on time-of-day and day-of-week.

  From a user perspective, such variability could be confusing, and it is unclear how price signals would be channeled to drivers. A worst-case scenario would have drivers not receiving the price signals, and unknowingly accruing expenses that they did not intend

[89] Triplett, Tim, Rob Santos, et al. (September 2016). "American Driving Survey: 2014 – 2015." AAA Foundation for Traffic Safety. Washington, DC. https://aaafoundation.org/wp-content/uploads/2017/12/AmericanDrivingSurvey2015.pdf

or could not afford. There is also an inflationary impact associated with congestion pricing in that few employees can unilaterally decide to change their work hours, resulting in higher travel cost for no requisite travel benefit. Finally, a variable rate would require precise GPS-level tracking technology.

- Hybrid Approach that Mirrors the Fuel Tax. A hybrid approach could be employed to follow current fuel tax rates at the state level. A flat federal rate could be utilized, while state rates could vary by state, though each state would have its own flat rate. The per-mile charge would be clearly defined at state boundaries, and there would be no variability based on time or below state-level boundaries. Such an approach would be somewhat similar to the IFTA system of fuel tax reciprocity found in the U.S. trucking industry. Like the variable rate approach, this option would require GPS-level tracking technology.

Rate Setting. Similar to the fuel tax and public utility rates, rate setting and adjusting could be conducted numerous ways. While most states require a legislative process, multiple states require public referendums.[90] If the VMT charge is defined as a fee, rather than a tax, some states may conclude that the VMT rates can be decided by a state agency and/or DOT commissioner. Regardless of the authorizing body, the literature is clear that "setting and adjusting of the road user charge rates … would likely face as much opposition as increasing the motor fuels taxes."[91] Rates would likely consider: 1) revenue needs; 2) implementation, collection, evasion and enforcement costs; and 3) "lost" revenue associated with non-compliant users and non-taxed government vehicles. It is possible that in a variable rate system, a fourth factor would be rates that are meant to modify behavior through charges – similar to so-called "sin taxes" on cigarettes and alcohol. Congestion pricing and air quality pricing programs would essentially become social engineering tools for managing society's demand for a good (in this case, consumption of miles driven that have specific negative characteristics).

Rules for Revenue Sources and Allocation

If the VMT system were similar to the federal fuels tax (i.e. the core focus is revenue generation with a flat rate), it will likely be distributed using current federal formulas. This may or may not also be the case for state revenues and disbursements.

Along with a federal VMT tax, other revenue options include state and local VMT taxes. Complications arise, however, when considering the transparency of a GPS-enabled VMT tax system. Each state and local jurisdiction will have precise visibility into how much revenue was generated within its boundaries. With such technology, it is possible even to see the origins and destinations of a vehicle's trip, and to assess the revenue potential of specific roadways.

The Potential Impact of a Local VMT Tax on the National System. An early principle of the OReGO project was to give "local government control of local revenue sources," asserting that "the state should not appropriate revenue sources that are traditionally and primarily the province of local governments."[92] Additionally, OReGO demonstrated that "different pricing

[90] BallotPedia. "Transportation on the Ballot." https://ballotpedia.org/Transportation_on_the_ballot Date Accessed: February 26, 2021.
[91] Kirk, Robert; Marc Levinson. (June 22, 2016). "Mileage-Based Road User Charges." Congressional Research Service. https://fas.org/sgp/crs/misc/R44540.pdf
[92] Whitty, James. (November 2007). "Oregon's Mileage Fee Concept and Road User Fee Pilot Program Final Report." Oregon Department of Transportation. https://www.myorego.org/wp-content/uploads/2017/07/RUFPP_finalreport.pdf

zones could be established electronically and the assigned fees could be charged for driving in each zone, even at particular times of day" – which demonstrated that a mileage fee program could support the "collection of local revenues and other 'zone-oriented' features."[93] Thus, it was demonstrated through a VMT tax program that local governments could have more power over the nation's transportation system in terms of collecting and spending revenue. In all of these cases, there is no over-arching requirement that the funds relate in any manner to the roadway or vehicle volumes. If state and federal fuel tax allocations are any indicator, it is likely that non-roadway programs would receive VMT funds. This, of course, violates the user-pays principle.

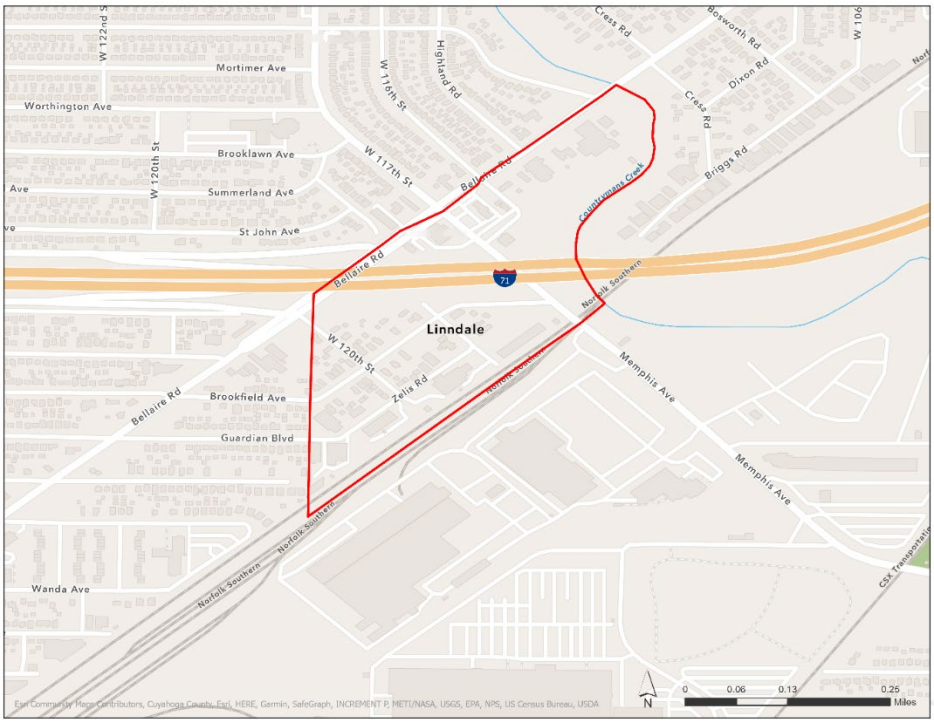
According to the latest Census of Governments, there were 90,106 local units of governments in the U.S.[94] Of those, approximately 38,000 are counties, municipalities and townships, all of which presumably each have a small piece of the 4.1 million miles of U.S. roadway within their purview.[95] Additionally, there are another 38,000 special district governments that may also have jurisdiction over roadways. Compared with one federal government and fifty state governments, this is a tremendous number of potential VMT authorities that could theoretically participate in a VMT tax program. Local-level coordination of VMT charges, revenue collection, revenue allocation and spending oversight would be exceedingly complex. Nevertheless, the VMT tax program would accrue substantial program cost increases to manage all the new transactions.

Sourcing revenue for miles driven within local jurisdictional boundaries would likely be attractive to local governments. Not only could such a system help generate revenue and balance budgets, it could also steer residents toward local policy goals such as increased use of transit or bicycle lanes. Additionally, in many situations a local VMT tax could be focused on roads that are heavily used by non-residents (who do not vote in local elections). In fact, a local option VMT tax could target non-resident drivers who simply pass through a jurisdiction to get from point A to point B. In theory, assuming no controls exist for charging for travel within a jurisdictional boundary, this would be a likely scenario, and one that could be particularly onerous to interstate travel and commerce.

This "pass-through" scenario would have some similarities to small-town speed traps like one found in Linndale, Ohio. The Linndale police department targeted out-of-town drivers on a quarter-mile stretch of Interstate to collect significant revenues ($400,000 annually) through fines.[96] Figure 5 illustrates the geographic relationship of the town to the roadway.

[93] Ibid.
[94] United States Census Bureau. (2017). "2017 Census of Governments – Organization." https://www.census.gov/data/tables/2017/econ/gus/2017-governments.html
[95] U.S. Department of Transportation Federal Highway Administration. (December 1, 2020). "Highway Statistics Series: Public Road Mileage, Lane-Miles, and VMT." *Table VMT – 421C.* https://www.fhwa.dot.gov/policyinformation/statistics/2019/vmt421c.cfm
[96] Ross, Jeffrey. (February 26, 2013). "Notorious Ohio Speed Trap Takes a Hit as State Laws Change." https://www.autoblog.com/2013/02/26/notorious-ohio-speed-trap-takes-a-hit-as-state-laws-change-w-vi/

Figure 5: Pass-Through Scenario – Linndale, Ohio



Strict rules would be required for a local VMT tax to avoid exploitation of drivers. Rules might include restrictions on how money is allocated, and applying local charges only to those roadways that are controlled by local governments. Under these rules there would be little incentive or ability for Linndale, as an example, to collect revenue from I-71.

State Taxes. State VMT taxes would require federal coordination with only 50 entities; thus state taxes would be far easier to administer than local taxes which would require federal coordination of thousands of entities. Additionally, assuming a national VMT tax system were in place using GPS technology, a state tax would be a simple addition to the program. The unwieldy alternative would be to create a separate system for each state, which is technically complex, makes interstate travel more difficult, and would not be cost-effective.

Federal Protection for Transportation Funds. The user-pays principle is one where vehicles pay for the costs of the transportation system they use. Since the VMT tax is for use of the transportation system, logic dictates that revenues would be directed toward that system. As part of a VMT tax program there should be protections placed on how these user-generated funds are allocated. Specifically, funds should be reinvested in surface transportation, and not directed outside of transportation or even to other modes of transportation (e.g. transit) – which are still heavily reliant on good infrastructure.

Cost Analysis of GPS-Enabled VMT Tax Systems

The premise for developing a national VMT tax system is that – at a future date and for a variety of reasons – federal fuel tax revenues will not meet basic highway funding needs. Based on this assertion it follows that state fuel taxes will meet the same end. For these reasons, the following cost analysis will look at a VMT system that has the ability to raise revenues for the

federal government and for state governments. Such a system would allow for the replacement of fuel taxes at both levels of government, and would be efficient in that 50 separate state VMT systems can piggyback on the same technologies used by the federal VMT program. It also assumes that political pressure to vary rates and modify driver behaviors is strong enough to warrant technologies that can differentiate roadways and day-periods. Thus, this analysis assumes a single efficient platform using terrestrial communications, GPS and system interoperability is used for tracking and taxing vehicle miles.

The technologies reviewed earlier in this report were next considered within the cost analysis, and one approach was selected as being the most practical, and cost-effective.

Exclusion of Odometer Method. Upon review of the technology options analyzed, it is clear that a system based on odometers would be fraught with administrative complexity, evasion and noncompliance. Self-reporting would not be accurate unless there was substantial documentation and enforcement, both which come with sizeable costs. Thus it is not a reasonable option for deploying a nationwide VMT tax system and its costs were not analyzed.

Exclusion of Smartphone Method. A smartphone system would be able to track miles accurately, but it is unclear how to ensure the phone is with the appropriate driver while driving. Drivers accidentally forgetting their phones (or lost/stolen/damaged phones) would cause significant revenue leakage and noncompliance. Additionally, smartphones are not ubiquitous in the U.S. Nearly 20 percent of Americans do not own a smartphone, and of people 65 and older, nearly 50 percent do not have a smartphone.[97] This segment of the population would each have to spend hundreds of dollars on a smartphone, and become adept in how to use VMT tracking apps. Therefore, this method was also excluded from the analysis

Exclusion of Roadway Sensors and Cameras. A nationwide system based on electronic toll collection technologies (e.g. E-Z Pass) would not be able to capture the majority of VMT accrued in the U.S. The technology is viable for tolling a bridge or small segment of roadway, but could not monitor the more than 4.1 million miles of U.S. roadway. To tax the full surface transportation system in this manner would come with a cost that far exceeds the revenue potential. Thus it was excluded from the cost analysis as well.

Based on the rationale above, it can be assumed that no combined state and federal VMT tax system would be feasible without some level of onboard GPS tracking capability.

Onboard GPS Tracking Technology. A nationwide VMT tax system that replaces the federal fuel tax (and has the additional ability to replace state fuel taxes) would need to have several attributes that can only be met with onboard vehicle tracking technology. First, the system must have the ability to identify the granular location of a vehicle as it moves along the transportation system, particularly the state boundaries in which vehicle miles are accrued. Second, for efficiency and accuracy, the system needs to be vehicle-based and have no reliance on a costly and extensive network of roadway sensors or cameras. Finally, while evasion is inevitable, the system would have to ensure a high degree of compliance.

As established earlier, there are three core cost areas for a VMT tax system; deployment, administration and compliance.

[97] Pew Research Center. (June 12, 2019). “Mobile Fact Sheet.” https://www.pewresearch.org/internet/fact-sheet/mobile/

Estimated Deployment Requirements

Deployment requirements are the components need to implement a national VMT tax program. These include deploying the necessary technologies to more than 272 million private vehicles in the U.S. and, equally important, educating the public on the new program to ensure compliance and acceptance. Other additional activities include setting up federal and state departments to oversee deployment and contract management. To understand the full impact of these costs it is necessary to consider this category in terms of per-vehicle costs.

Educating the Public. The driving public will have to be educated on the details of the new program, why it is important and necessary, and how to comply with the program. For many tech-savvy drivers, this process will be straightforward. For others it may take longer.

A VMT tax system would be a significant change for U.S. drivers. Federal and state governments will have to educate drivers on why the shift from a fuel tax is important, what the funds will be used for, and how to properly comply. Likewise, those who will enforce the law will also require training. Some driver technical training will also fall on the government, unless this is built into the third-party management contracts (e.g. how to install a device into the OBD, how to set up a payment account, where to return defective devices). There are no programs similar to this that have been deployed in the U.S.

Technology Costs. There are two types of technology approaches, with the first being an aftermarket device for the U.S. fleet. The insurance industry has been using safety monitoring devices for more than a decade that plug into the OBD port, collect information such as miles driven, and report the information to the insurance company via cellular networks. Some estimates for the device, often called a dongle, have been in the $100 - $300 range.[98]

There are multiple versions of such a device for sale on the internet. After plugging the device into the OBD, it generates driving event reports based on engine and GPS data, and transfers tamper-proof information over a cellular network (cellular costs are a separate monthly fee).[99] Of the devices currently available, one of the lowest costs was $67 per unit, although it is not certain that it would meet all future requirements for an aftermarket VMT device. It is possible that device costs could be brought down due to manufacturing efficiencies (272 million devices would likely be needed).

If a cost of $50 per device were realized due to economies of scale, the cost for national deployment would be approximately $13.6 billion. It should be noted that such a device could only be used in vehicles manufactured in 1996 or later, when the OBD-II specifications became mandatory for new vehicles in the U.S. These costs have been annualized over five years to reflect a realistic time period for rolling out the program. Since the devices have typical 5-year lifespans, this also reflects a realistic ongoing annual cost for replacement and repair.

The OReGo program shipped dongles to each user's home address. ATRI's cost calculation analysis does not include device packaging and shipping costs to either residential addresses or DMV offices. If the packaging and shipping costs were as little as $5.00 per dongle, initial shipping costs for 272 million dongles would be approximately $1.36 billion.

[98] Dr. Dataman. (November 20, 2018). "Telematics in Auto Insurance." https://towardsdatascience.com/telematics-in-auto-insurance-a886a03b5a88

[99] Bouncie Website: Features. Available Online at https://www.bouncie.com Date Accessed: March 8, 2021.

Collection and Administrative Costs

One model for administering a VMT tax program, as utilized by the OReGO program, is to: 1) charge a flat rate to drivers (in the case of OReGO it is $0.018 per-mile); and 2) assign all critical duties of the program (e.g. tracking the charges and collecting revenue) to a CAM. In exchange for administering the program, the Oregon third-party CAM is allowed to charge a 40 percent administrative fee on top of the collected revenue. For example, if $1.00 per mile is needed by transportation agencies for infrastructure investment, the road user will be charged approximately $1.67 per mile so that the 40 percent fee is covered.

In the following analysis the research team takes steps to better understand the implication of a 40 percent administrative fee for managing a VMT program.

Cost Analysis Step One: Calculating a Truck VMT Fee Using Car Data. The first step of this analysis was to determine an appropriate per-mile charge for trucks that: 1) maintains the current per mile fuel tax ratio between cars and trucks; and 2) assumes the car VMT charge is 1.8 cents per mile. This was necessary because the OReGO program does not charge trucks. It was determined that if cars pay $0.018 per mile, trucks would pay $0.090 cents per mile.

To reach this 1 to 5 ratio, the following steps were taken and are shown in Table 4:

1. The 2019 FHWA Highway Statistics for car and truck VMT were first divided by a well-accepted average MPG for cars and trucks of 24.5 and 6.5, respectively.
2. This calculation resulted in a gallons-of-fuel-consumed estimate for cars and trucks; it was assumed that cars consumed gallons of gasoline and trucks consumed gallons of diesel.
3. Gallons of fuel consumed was next multiplied by the federal fuel tax for gasoline and diesel respectively to produce a separate federal fuel taxes paid estimate for cars and trucks.
4. Federal Fuel Tax Paid was divided by 2019 VMT to get a cents-per-mile paid conversion.
5. The result is a 1 to 5 ratio for cars to trucks.
6. Following this ratio – if cars pay $0.018 per mile, trucks would pay $0.090 cents per mile.

Table 4: Calculating a Truck VMT Fee Using Car Data

Vehicle Type	Avg MPG	2019 VMT	Gallons of Fuel Consumed	Federal Fuel Tax per Gallon	Federal Fuel Tax Paid (Gallons * Fuel Tax)	Federal Fuel Tax Cents per Mile	Cents Per Mile Ratio
Car	24.5	2,961,721,254,307	120,886,581,808	$0.184	$22,243,131,053	$0.0075	1
Truck	6.5	300,050,408,534	46,161,601,313	$0.244	$11,263,430,720	$0.0375	5
Total					**$33,506,561,773**		

Cost Analysis Step Two: The Cost of Collecting $33.5 Billion in Gross Revenue. Next, the research team identified the "net revenue for transportation" – in theory the net funds available exclusively for infrastructure investment, based on the existing federal fuel tax gross revenues. In Table 5, note that: 1) $33.5 billion gross revenue is collected for each tax method; 2) the 0.2 percent fuel tax administrative cost is subtracted from the gross revenue for the fuel tax; and 3) the 40 percent administrative cost is subtracted from the gross revenue. The results are shown in Table 5.

Table 5: Cost to Collect $33.5 billion in Gross Revenue

Tax Method	Gross Revenue Collected	Cost to Collect (% of Gross)	Collection Cost	Net Revenue for Transportation
Existing Federal Fuel Tax	$33,506,561,773	0.20%	$67,013,124	$33,439,548,650
VMT Tax with 40% Overhead	$33,506,561,773	40.00%	$13,402,624,709	$20,103,937,064

Cost Analysis Step Three: Total VMT Revenue Needed to Maintain Existing HTF Spending Levels. Next, the research team identified the amount of gross VMT revenue that must be collected if net HTF revenue is fixed at $33.5 billion, as shown in Table 6.

Table 6: Total VMT Revenue to Maintain Existing Highway Trust Fund Spending Levels

Tax Method	Gross Revenue Collected	Cost to Collect (% of Gross)	Collection Cost	Net Revenue for Transportation
Existing Federal Fuel Tax	$33,573,709,191	0.20%	$67,147,418	$33,506,561,773
VMT Tax with 40% Overhead	$55,844,269,622	40.00%	$22,337,707,849	$33,506,561,773

Cost Analysis Step Four: Collection Costs, and Revenue Levels Separated by Vehicle Type. Finally, the $0.018 per mile charge for cars and $0.090 per mile charge for trucks was tested to see the results for a hypothetical federal VMT program, based on the OReGo administrative costs of 40 percent of gross revenue. Table 7 shows that a per-mile VMT charge at these rates would generate $48.1 billion in net revenue for transportation, but would cost $32.1 billion to collect, requiring a total VMT gross revenue charge to users of $80.32 billion.

Table 7: Collection Costs and Revenue Levels with 40% Collection Cost

Vehicle Type	2019 VMT	VMT Charge (Cost per Mile)	Gross Revenue	Collection Cost (40% of Gross)	Net Revenue for Transportation
Car	2,961,721,254,307	$0.018	$53,310,982,578	$21,324,393,031	$31,986,589,547
Truck	300,050,408,534	$0.090	$27,004,536,768	$10,801,814,707	$16,202,722,061
Total			$80,315,519,346	$32,126,207,738	$48,189,311,607

Cost Analysis Step Five: Results with a 10 percent Collection Cost. It is uncertain if a 10 percent collection cost for a national open-road VMT program is feasible. Based on the OReGO goal to reduce admin costs to 10 percent by way of the economies of scale reached through an expanded program, the research team ran an identical financial analysis using the 10 percent admin cost. Table 8 shows both gross and net revenue for transportation at the same VMT fee levels used in table 7, but with 10 percent admin costs, rather than 40 percent. The result is a significant increase in net revenue available for transportation investment – doubling from the original federal fuel tax revenue of $33.5 billion (Table 5) to $72.2 billion in the new 10 percent admin scenario. Nevertheless, administrative costs are still $8 billion annually. This lower 10 percent admin cost is more than 55 times higher than the $70 million it would cost to collect $72.2 billion at the existing federal fuel tax collection cost rate of 0.2 percent.

Table 8: Collection Costs and Revenue Levels with 10% Collection Cost

Vehicle Type	2019 VMT	VMT Charge (Cost per Mile)	Gross Revenue	Collection Cost (10% of Gross)	Net Revenue for Transportation
Car	2,961,721,254,307	$0.018	$53,310,982,578	$5,331,098,258	$47,979,884,320
Truck	300,050,408,534	$0.090	$27,004,536,768	$2,700,453,677	$24,304,083,091
Total			$80,315,519,346	$8,031,551,935	$72,283,967,411

Reasonable Cost Test. This analysis tests how reasonable the 40 percent collection and administrative costs are using market pricing for critical components of the VMT program. To determine the real-world cost of collecting a hypothetical $35 billion in HTF revenue, this analysis dissected several critical cost components of revenue collection including:

- VMT Hardware;
- Data Communication;
- Customer Account Management; and
- Credit Card Transactions.

These four cost areas are assumed to be absorbed by the third-party CAM as part of their admin cost burden.

- VMT Hardware Costs. Presumably, a third-party CAM would ship the technology – in this case a dongle that plugs into the OBD port – and cover that cost through the administrative fee. At a conservative $50 per device this would require a $13.6 billion up-front hardware investment. Considering, hypothetically, that the devices would last five years, this cost could be annualized to $2.72 billion each year. Additional shipping costs for the 272 million dongles would likely exceed $1 billion.

- Data Communication Fees. Data would be transferred from the dongle over a cellular network. These costs would be part of the service provided by the third-party CAM, and would be covered by the current commercial cellular data costs of $8 to $20 per month. Since this is a very large program, however, it could be estimated that cellular services could be negotiated to perhaps $4 per month, or $48 per year. This lower, more conservative figure is approximately $13 billion annually for the U.S. fleet.

- Account Administration. Third-party CAMs will require vehicle owners to set up user accounts. Administration of these accounts will require, at the very least, sophisticated large-scale data management systems with IT redundancy, account connectivity using a secured web interface, and a financial transaction system for billing. The research team obtained account management costs from a variety of account management firms, and several not-for-profit organizations, and generated per-account management calculations. Applying the lowest external account management fee of $15.95 annually per account – based on an analysis of VISA's network transaction information – the total VMT account management budget would be $4.3 billion annually.[100]

- Transaction Fees. Merchants are charged a processing fee when customers pay for goods or services with a credit card. The fees charged by a credit card company can be "between approximately 1.3 percent and 3.4 percent of each credit card transaction."[101] In a system where third-party CAMs collect and manage VMT tax revenues, the CAM would reasonably be defined as a merchant by credit card companies. The processing fees are determined by each credit card company and are often based on the merchant category code (which in this case would likely be Bridge and Road Fees, Tolls [4748]). An example of the rate charged by a credit card company might be 2.10 percent of the charge plus $0.10 per transactions.[102] Assuming $35 billion in revenue and 12 monthly transactions per vehicle in the U.S., transaction fees would reach more than $1 billion annually.

[100] Credit card services have overhead costs associated with managing accounts. VISA reported almost $8 billion in operating expenses for FY 2019. With an estimated 500 million accounts in 2019, this would lead to an estimated operating cost per account of $15.95. However, this does not fully encapsulate the cost associated with account management, as banks and other financial entities incur operating costs through partnerships with credit card companies.

Visa. (November 2019). "Annual Report 2019." https://s1.q4cdn.com/050606653/files/doc_financials/2019/ar/Visa-Inc.-Fiscal-2019-Annual-Report.pdf

Dwyer, Ben. (April 6, 2020). "Credit Card Processing: How it Works." https://www.cardfellow.com/blog/how-credit-card-processing-works/

[101] Daly, Lyle. (July 8, 2020). "Average Credit Card Processing Fees and Costs in 2020." https://www.fool.com/the-ascent/research/average-credit-card-processing-fees-costs-america/

[102] Florida Department of Financial Services: Treasury Division. (October 2012). "MasterCard Interchange Programs and Rate Schedule." http://fltreasury.org/treasury/cash_management/pdf/MasterCard%20Interchange%20Rates.pdf

Based on the summation of these figures, the annual cost to collect $35 billion would be $21.2 billion, as shown in Table 9. This 61 percent administrative cost of the gross revenue is considerably more excessive and egregious than the 40 percent fee applied in Oregon.

Table 9: Annual Administrative Costs for Collection of $35 billion in Federal VMT Revenue

Cost Category	Cost per Vehicle	Total Cost
Technology Cost Annualized over 5 Years	$10.00	$2,724,024,780
Cellular Transaction Costs	$48.00	$13,075,318,944
Account Management	$15.95	$4,344,819,524
Transaction Fees (2.1% plus $0.10 per transaction)	$3.90	$1,061,882,974
TOTAL	**$77.85**	**$21,206,046,222**

If, hypothetically, these costs were halved through negotiations with technology and data transfer manufacturers/vendors or general efficiencies, the cost of $10.6 billion would still be far too great for the collection of $35 billion annually, and is far greater than the approximate $70 million in estimated federal fuel tax collection costs. It should be noted that these costs also leave out any direct CAM fees and operating margins that would certainly be applied by a private sector CAM.

Adding State Tax Collections Improves the Math. Economies of scale would occur if state fuel taxes are replaced and state VMT charges are collected through the existing federal VMT tax system described above. Annually, approximately $50 billion in motor fuel taxes are collected through state fuel taxes.[103] Combined with federal revenue of $35 billion, the total collection of state and federal revenue through a single VMT tax system would be $85 billion. While certain variable costs such as transaction fees would increase, many of the other cost centers, such as hardware, are fixed, thus reducing the relative percentage of administration costs. Transaction fee costs would double due to the increase in charges (and assuming the number of transactions between the CAM and the credit card company remained the same) with the addition of state taxes, but overall, admin costs as a percentage of gross revenue would drop to roughly 26 percent.

Identifying the National VMT Tax System Operator. Tracking vehicles and charging taxes based on mileage for every vehicle in the U.S. is not something a government – or any private sector firm – has tried before. With the ongoing trend of increased government contracting, it is very likely a private sector entity or entities will be contracted to create such a system.

There are companies that are likely positioning themselves to deliver this type of service to governments. The OReGO program has several private sector CAMs including Emovis, which according to its website has capabilities that include in-vehicle tracking for VMT charging, but also has back-office capabilities that include billing, financial reconciliation and customer

[103] U.S. Department of Transportation Federal Highway Administration. (January 6, 2021). "Highway Statistics 2019: State Motor Fuel Tax Receipts (1963 – 2019)." Table MF – 201. https://www.fhwa.dot.gov/policyinformation/statistics/2019/mf201.cfm

management. Emovis is not a small, stand-alone startup company; it is a subsidiary of Abertis, a much larger establishment "dedicated to designing, implementing and managing technology and information services for electronic tolling."[104] Abertis Infraestructuras, S.A., based in Madrid, Spain, is a global toll road operator, and is a subsidiary of Atlantia. Atlantia SpA, which is based in Rome, Italy, is a holding company that "through its subsidiaries, engages in the construction and operation of motorways, airports and transport infrastructure, parking areas, and intermodal systems worldwide."[105] Prior to the pandemic, Atlantia had $12.6 billion in total revenue for 2019 and just under 30,000 employees. A large company like this, experienced in worldwide road tolling and VMT system management through its subsidiary Emovis, would be a very likely candidate to act as a third-party CAM for a national VMT tax system. In addition, credit card companies also have the IT infrastructure and capital to operate such systems.

Other Considerations: A VMT Program Could End Tolling Double Taxation. With the possibility of identifying VMT by roadway, a VMT tax system would end the double taxation issues (paying a toll and paying a fuel tax) related to toll roads. The unintended consequence would be a significant gap in federal revenues. Applying the $0.018 CPM (for cars) and $0.090 CPM (for trucks) charges discussed earlier, it is possible that several billion dollars in revenue could be excluded from the Highway Trust Fund if double taxation on tollways were ended. Table 10 illustrates the impact of excluding VMT accrued on 10 large toll systems from being charged a VMT tax.[106]

Table 10: Loss of Revenue on 10 Toll Systems

	Car	Truck	Total
VMT	31,597,640,808	4,952,960,342	36,550,601,150
VMT Tax Rate	$0.018 CPM	$0.090 CPM	-
Revenue Loss	$568,757,534	$445,766,430	$1,014,523,965

Compliance and Enforcement Costs

With more than 272 million vehicles in the U.S., enforcement will be challenging. While there are those who will actively avoid paying a VMT tax by choice, there will be others who simply are not able, for a variety of reasons, to participate in such a program. Regarding the ability of lawful users to participate in a VMT tax program, however, CRS found that:

- 7.7 percent of U.S. households have no bank account.
- An additional 20 percent are "underbanked" – i.e. rely on the services of "postal money orders, payday loans, pawn shop loans or auto title loans."
- 30 percent of consumers have no credit card.
- 20 percent of consumers have no debit card.

[104] Emovis. (December 2, 2020). "Emovis, Wins New Inovative Traffic Management Projects in Puerto Rico and Qatar." https://www.emovis.com/news/emovis-wins-new-innovative-traffic-management-projects-in-puerto-rico-and-qatar/

[105] Atlantia SpA (ATL.MI). Available Online https://finance.yahoo.com/quote/ATL.MI/profile?p=ATL.MI Date Accessed: March 8, 2021.

[106] The toll systems analyzed were: BATA, Central Florida, Harris County, Illinois Tollway, Maine Tollway, MDTA, North Texas, NJTP, Ohio Turnpike, Kansas Turnpike.

CRS concludes that "unbanked and underbanked road users would not be easily brought into a charging system based on electronic payments."[107] A cash payment/mail alternative would have significantly higher costs and likely evasion rates, however.

This creates both administrative and enforcement complexities. To generate estimates of enforcement and compliance costs, an estimate of annual number of vehicle account "issues" (i.e. non-payments, delinquencies, non-participation, etc.) was developed using the average number of credit card delinquencies from 2003 through 2020.[108] Assuming a similar number for the VMT tax, there would be nearly 26 million vehicles in the U.S. annually that have enforcement/compliance issues as shown in Table 11. It was assumed that each compliance/enforcement issue would require up to 8 hours of labor among those tasked with compliance, including program managers, courts, DMVs, collection agencies and others that might help resolve the case. This assumption results in more than 205 million annual labor hours ensuring that people comply with a VMT program. At an average hourly direct compensation of a civilian worker (which is $38.26 according to the Bureau of Labor Statistics [BLS]),[109] the total annual cost of compliance and enforcement would be $7.87 billion.

Table 11: Calculating the Estimated Cost of Enforcement

Line 1	Total Number of Vehicles in the U.S.	272,402,478
Line 2	If 9.44% of vehicle have compliance Issues, total number of compliance issue cases annually	25,714,794
Line 3	Average hours spent by police, courts, DMVs, collection agencies to resolve cases	8
Line 4	Total Compliance Hours Annually (Line 2 * Line 3)	205,718,352
Line 5	BLS Average Total Hourly Compensation, Civilian Worker	$38.26
Line 6	Annual Cost (Line 4 * Line 5)	$7,870,784,148

[107] Kirk, Robert; Marc Levinson. (June 22, 2016). "Mileage-Based Road User Charges." Congressional Research Service. https://fas.org/sgp/crs/misc/R44540.pdf

[108] The 9.44% figure is based on percent of balance 90+ days delinquent for credit cards, average of quarterly figures from 2003-2020.
Federal Reserve Bank of New York. "Center for Microeconomic Data: Data Bank." https://www.newyorkfed.org/microeconomics/databank.html Date Accessed: March 8, 2021.

[109] U.S. Bureau of Labor Statistics. (September 17, 2020). "Economic News Release." https://www.bls.gov/news.release/ecec.t01.htm

4. Designing a National VMT Tax System Framework

Based on the research above, development of a national VMT tax system would require consideration of challenges in each of the following areas:

- System Design
- Program Implementation
- Program Governance
- Compliance and Enforcement

The tables below describe at a high-level the Opportunities and Obstacles in designing that framework with potential actions to address some of the challenges.

System Design. The most feasible and cost-effective architecture for a national VMT tax program is one based on cellular/terrestrial communications utilizing onboard dongles to monitor vehicle miles traveled.	
Opportunities	**Obstacles**
Cellular communications are generally ubiquitous in the U.S., with more than 349,000 cell towers providing 98.2 percent of geographic coverage.	There are urban canyons, cellular dead spots, and zones of electronic interference that can hinder or drop wireless data transfers. While 4G LTE networks utilize encryption, there are limited instances where cellular data has been hacked or compromised.
Dongles that plug directly into OBD sockets ensure that relevant VMT data accurately generates from the participating user's vehicle.	Dongle prices vary, but most relevant models are priced at $50 and above and have a limited lifespan.
Dongles have the capacity to generate and process a range of relevant VMT data, and transmit it using cellular networks.	The estimated cost to provide dongles to 272 million vehicles is approximately $13.6 billion. Vehicles manufactured before 1996 cannot use the dongle/OBD device, requiring a separate program.
Dongles are at a technology level where replacement is not costly, and would not require repairs.	In general, dongles are secure, but there have been tests confirming that dongle/OBD cyberattacks could stop or accelerate a vehicle remotely (using Bluetooth). It is unclear how VMT tax program compliance and enforcement will be managed when the dongle is broken or removed from the vehicle. If multiple dongles and related software are utilized, interoperability issues can arise.
Recommendations	
The federal government must develop technical standards, specifications and performance requirements for all hardware associated with the VMT tax program.	
Federal legislation must be developed to require all jurisdictions involved in VMT tax activities to utilize the federal VMT technology platform, and develop Terms of Service for all VMT tax parties that control data usage, access to and protection of personal information.	

Program Implementation and Administration. A feasible program will likely rely on one or more contracts with third-party vendors to develop and manage most aspects of a national VMT tax program.	
Opportunities	**Obstacles**
Many private sector firms have the technical capabilities and IT resources to manage large-scale technology-based programs.	Private sector firms have added profit margins, typically in the double-digit range. For example, the OReGO contractor charges 40 percent of all revenue collected.
Allowing many firms into the marketplace creates a competitive landscape, and could bring collection costs down.	If multiple vendor contracts are utilized, conflicting service requirements could arise, unless state and federal program specifications and performance requirements are put in place.
With a large demand and increased production of dongles for a national VMT tax program, the price of dongles may decrease per unit as manufacturers achieve economies of scale.	Up-front hardware and implementation costs will exceed $13 billion, likely requiring federal financial assistance to the contractor(s).
Recommendations	
Create a national program for highly qualified third-party CAMs that fosters competition as a means to lower administrative costs.	

Program Governance: Federal leadership is critical to ensure a single VMT tax program standard that enables seamless travel across the U.S. transportation system.	
Opportunities	**Obstacles**
In the coming years/decades, the federal government could lead a smooth and coordinated rollout of a viable replacement for the fuel tax.	States are very much ahead of the federal government in setting standards and practices with regards to VMT taxes, and one even has an operational program in place.
The federal government could ensure that VMT tax revenue is dedicated to surface transportation.	States and local governments may have different financial and social objectives.
The federal government could ensure that VMT tax program complexity is minimized.	States are currently researching and testing local option taxes and variable rates.
Recommendations	
It is essential that strong federal oversight and congressional enabling legislation is developed. Federal pre-emption is needed to ensure uniformity of VMT tax system design, hardware and software, and system performance standards across all 50 states.	
A fixed-rate VMT tax system at the federal level could flow down to the state level, eventually replacing the fuel taxes for both. When states use the existing federal system, additional costs of collection are limited, thus promoting efficiency. Variable rates at or below the state however should be prohibited so as not to undermine the overall goals of revenue generation and system simplicity.	
The federal government must develop regulations that minimize vendor administration costs and excessive operating margins, thus ensuring that the primary program objective of transportation infrastructure investment is maximized. Democratic and legislative processes must provide oversight; at no point should rates or rules be set by the private sector in this endeavor.	

Compliance and Enforcement. A successful program will require universal participation; to accomplish this the system must be easy to participate in and enforcement must be manageable.	
Opportunities	**Obstacles**
If the cost per mile is reasonable, compliance is simplified, and the penalties for noncompliance are severe enough, most people will participate.	Based on publicly available data sources for other similar tax/fee-related programs, a VMT tax program could expect evasion rates between 5% – 10% of expected revenue. Applied to existing annual HTF collections, this would equate to $7.87 billion in uncollected revenue.
Technology could improve to ensure compliance, especially with future model year vehicles.	At the present time, there is no known solution or approach for identifying evasion for the VMT tax system being proposed in this research.
Compliance becomes more difficult with complexity. If the VMT tax program is simple and straightforward (one rate nationally, and one rate within each state, for instance) then acceptable compliance rates could be easy to achieve. If there is complexity and confusion (e.g. thousands of local option taxes) drivers will want to avoid participation in the program.	State and local enforcement agencies could inspect vehicles for dongles plugged into OBDs, but that does not validate that the dongle is transmitting data or that the user is connected to a financial account and transaction. Because the vehicle is being tracked, not the driver, certifying people through a driver's license endorsement does not resolve the issue.
Recommendations	
Limit the number of revenue recipients to the federal government and the 50 state governments.	
Through federal leadership, develop a simple and efficient VMT tax system with the singular goal of funding the transportation system.	
Encourage technology providers to develop systems that allow for unobtrusive inspection and that prevent manipulation of mileage recording.	

5. Conclusions

As described in this report, there are myriad approaches to designing, developing, managing and enforcing a national VMT tax system, and all come with complex challenges. While a VMT tax program is technologically feasible today, very few of the pressing non-technology issues have been researched and addressed. Ideally, a successful user-pays program would see the vast majority of the collected VMT revenue go directly into the transportation system, rather than to administrative tasks, hardware, transaction costs or even outside of surface transportation in support of other modes.

Most advocates of VMT systems argue that users are underpaying for the roadways on which they travel. Since most of ATRI's financial analyses and cost calculations in this research use existing fuel tax rates and revenue levels, the findings reflect very conservative costs. Most infrastructure needs assessments propose dramatic increases in transportation investments, so it is safe to assume that most jurisdictions would utilize a VMT program to substantially increase revenue streams from roadway users.

In addition, a literal interpretation of the user-pays mantra in a VMT program creates many new challenges as described below.

- Some believe that roadway users should not have to pay for the roads they do not use.
- Rural roads, with fewer users, could receive less funding, regardless of their strategic role in connectivity.
- Travelers who do use rural roadways for longer trips will pay more for the same services and connectivity than their urban counterparts.
- Urban users could argue for more transportation revenue, but will not likely see improvements in travel times – due to limited opportunities to increase roadway capacity.

Based on the data and information developed in this research, there are multiple challenges that must be overcome before a sustainable path forward for a national VMT tax program is available.

National VMT Tax Program Realities
A VMT tax program will move fuel tax revenue collection from fewer than **300** federal taxpayers to **272 million** vehicle accounts.
As noted in the research, **millions of vehicles and/or households** will be **unable to participate** in a national VMT tax program, due to obsolete vehicles, and/or inaccessibility to bank accounts, internet transactions and/or cellular coverage.
The most realistic technology approach would involve an onboard device, or dongle. While dongle prices vary, most relevant models are priced at $50 and above.
The estimated cost to provide dongles to 272 million vehicles is approximately **$13.6 billion**. Vehicles manufactured before 1996 cannot use a dongle/OBD device, requiring a separate program.
The OReGo Program shipped dongles to each user's home address. This ATRI cost analysis does not include device packaging and shipping costs to either residential addresses or Department of Motor Vehicle (DMV) offices. If the packaging and shipping costs were as little as $5.00 per dongle, initial shipping costs for 272 million dongles would be approximately **$1.36 billion**.

National VMT Tax Program Realities
To include all road users, a secondary VMT account/payment system must be developed for vehicles/households that are not able to participate in the primary VMT system. The design and costs of such a program are unknown, but are likely considerable.
Collection costs of **40 percent** for a federal VMT tax would be **300 times more expensive** than collection costs for the federal motor fuels tax. The administrative cost to collect federal highway revenue will increase from 0.2 percent of federal fuel tax revenue collected, and 1 to 2 percent for state fuel tax administration, to 40 percent based on the existing Oregon VMT program administrative cost. If a long-term goal of dropping admin costs to **10 percent** is realized in a national VMT tax program, it will still require **$8 billion annually** to manage the program.
Based on public data from other programs and industries, it is estimated that evasion and noncompliance with the program will exceed **$7.87 billion annually**. Until a nearly 100 percent effective enforcement program is developed, this nearly $7.9 billion loss will either reduce infrastructure investment or could be added to the costs borne by compliant VMT taxpayers.
Presently, there is no clear mechanism for ensuring and enforcing compliance. When a vehicle dongle is missing, broken or deliberately tampered with, the vehicle becomes an invisible black hole among compliant vehicles.
Based on existing credit card transaction fees, VMT financial transaction costs will be **$4.3 billion annually**.
If variable rates are used for congestion pricing and other social engineering objectives, it will be nearly impossible to utilize the VMT technologies to notify users of changing rates. Physical signage will be needed, based on the VMT system design proposed herein, and based on the OReGo system used today.
A VMT tax program will be based on road use, not road mileage. The result is that **urban systems will generate far more revenue than rural systems** – although rural roadways possess far more miles and provide strategic connectivity between urban centers.
According to the latest Census of Governments, there were **90,000+ local units of government** in the U.S. Of those, approximately 38,000 are counties, municipalities and townships, all of which presumably would each have a small piece of the 4.1 million miles of U.S. roadway within their purview. It would be extremely complex to include these units of government in a VMT tax program.
The sophistication and granularity of the proposed VMT tracking technologies will allow for the elimination of “double taxation” payments associated with paying tolls on toll roads and concurrently consuming taxed fuels. Eliminating fuel taxes or VMT charges while using toll roads will create a new budget hole in the HTF of several billion dollars.

Beyond these technical and programmatic findings of a VMT tax program, numerous tangential issues remain, particularly public acceptance. Based on survey research, a federal VMT tax program concept is strongly disliked, and as road users learn the full scale and cost of a national VMT tax program, anecdotal research described herein indicates that the issues and dislikes will increase, rather than decrease.

For example, taxpayers today do not "see" the state and federal fuel taxes that are embedded in fuel prices, and they most definitely do not directly pay fuel taxes. This reality will change dramatically with a VMT tax program, particularly when the VMT fees are increased to meet infrastructure investment needs. Regardless of politics and income, it is rare for taxpayers to request considerably higher taxes (or fees).

Consequently, a critically needed VMT Tax Public Education Plan **must convince** people that the system will be:

- **Fair.** Compliance must be ubiquitous; cheating must be prosecuted.
- **Unintrusive.** Privacy must be insured and the data must not be used for any secondary purposes. The goal of the system is to pay for roadways, not track individuals, or overtly control human behavior.
- **Cost-efficient.** Administrative costs must be relatively minimal; on par with existing fuel tax efficiencies as that is the primary promise of technology utilization. Anything more will be viewed as inflationary and wasteful.

APPENDIX A: Example of Terms of Service[110]

WHAT INFORMATION DO WE COLLECT, AND WHAT DO WE USE IT FOR?

A. The information we collect, and the purposes for which we use it, include the following:

1. Road Usage Charge (RUC) user's name, company, residential address, mailing address, telephone number and e-mail address—used for identifying and communicating with the RUC user concerning his/her account.
2. License plate number, vehicle identification number, weight of the vehicle, odometer reading—used to identify the RUC user's vehicle with his or her RUC account, and, verify his eligibility to the program.
3. RUC user's travel pattern data—used to determine the amounts chargeable to the RUC user under the RUC Program, and, when aggregated with other users' travel pattern data, to analyze usage of the system as a whole.
4. RUC user's messages sent to emovis – used to respond to RUC user inquiries and questions.

PERSONAL INFORMATION

"Personal Information" is defined by the Oregon Consumer Identity Theft Protection Act (Oregon Revised Statutes Sec. 646A.600 and following), as:

A. the combination of an individual's first name or first initial with his or her last name, plus any of the data listed below, unless such data have been encrypted (without the encryption code being acquired by an intruder along with the data):

1. Social Security number;
2. Driver license number or state identification card number issued by the Department of Transportation;
3. Passport number or other United States issued identification number;
4. Financial account number, credit or debit card number, in combination with any required security code, access code or password that would permit access to a consumer's financial account;
5. Physical measurements used to authenticate identity as part of a transaction;
6. Health insurance information; or
7. Medical history.

B. The information described in Paragraph A above, without the consumer's first name or first initial and last name, if

1. Encryption or other methods have failed to render the data unusable by an unauthorized third party and
2. The data would enable a person to commit data theft against the consumer.

[110] Emovis. "Privacy Policy: RUC User Data Retention and Privacy Policy." Date Accessed: February 17, 2021. https://orego.emovis.us/privacy-policy/

Personal Information under the Oregon Consumer Identity Theft Protection Act does not include information in a federal, state or local government record, other than a Social Security number, that is lawfully made available to the public.

We are required to report to our customers immediately if we discover or are notified that any of their Personal Information held in our computer network has been breached. Such notice may be delayed, however, if a federal, state or local law enforcement agency requests a delay because it has determined that reporting the breach immediately would impede a criminal investigation. RUC users may instruct us to “freeze” their Personal Information, that is, to refrain from providing any of their Personal Information to credit reporting agencies.

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