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Texas Transportation Institute

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**EXPLORATORY STUDY:
VEHICLE MILEAGE FEES IN TEXAS**

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This research was performed in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the FHWA or TxDOT. This report does not constitute a standard, specification, or regulation.

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EXECUTIVE SUMMARY

The fuel tax serves as the primary funding source for the state's transportation system, but its ability to continue providing sufficient revenue to sustain transportation development has become a concern. In the present system, the tax generates revenue in proportion to the amount of fuel each vehicle consumes, not the amount of the transportation system each vehicle actually uses. This weakness has left the fuel tax vulnerable to the various forces that are working to raise vehicle fuel efficiency. Increased fuel efficiency reduces overall fuel consumption, thus negating the ability of the fuel tax to raise the revenue that ultimately pays for our transportation network.

Among the principal candidates to replace the current fuel tax-based funding system is a vehicle mileage (VM) fee, also referred to as:

- vehicle-miles traveled (VMT) fee,
- mileage-based user fees (MBUF), and
- time/distance/place (TDP) charging.

In their simplest form, vehicle mileage fees levy a charge on each mile that a vehicle drives rather than a tax on the amount of fuel used, meaning that the revenues generated would more accurately reflect actual use of the roadway network and would not be affected by future increases in fuel efficiency. The VM fee concept can serve broader policy aims as well, by enabling policy makers to vary the fee in different network areas to reduce congestion during peak travel times, a critical issue in larger, metropolitan areas.

This study evaluated the feasibility of vehicle mileage fees as a potential funding mechanism to meet Texas' long-term transportation needs, and it joins simultaneous research efforts nationwide as other states search for ways to pay for their future needs.

A. Background Information

Research into applying VM fees has been evolving since 2000 with a number of completed and ongoing studies of road user fee systems in states like Oregon and Minnesota and regional efforts such as those undertaken by the Puget Sound Regional Council and the University of Iowa. Various policies and frameworks have been proposed as a result of these efforts.

In 2008, the Texas Transportation Institute (TTI) worked with the Northeast Texas Regional Mobility Authority (NETRMA) on preliminary research into alternatives to the fuel tax. Although this research led to proposed legislation for the establishment of a VM fee pilot program, the 81st Texas Legislature adjourned without further action.

In late 2009, recognizing the impending funding problem for state highways and the discussions held in consideration of the proposed pilot study legislation, the Texas Department of Transportation (TxDOT) tasked TTI to build on the preliminary research and explore whether a VM fee system could address some of the major deficiencies in the fuel tax and provide policy direction.

In early 2010, TTI began an exploratory study on the feasibility of a VM fee system in Texas, including describing potential system architecture, engaging in public and stakeholder dialogue to gather input, and recommending a concept design for a future demonstration or deployment.

B. What the Researchers Did

Researchers used a multi-faceted approach to learn about the state-of-the-practice in vehicle mileage fees, both domestically and internationally, and to hear different perspectives from around the state. Researchers collected input from:

- focus groups conducted with the general public in five communities of varying size and geography;
- interviews with 13 transportation stakeholder groups representing a variety of interests; and
- online discussions with a nationwide panel of technology experts who reviewed public opinions about possible deployment options

C. What They Found

The researchers identified the following challenges and opportunities to the implementation of vehicle mileage fees in Texas.

1. Challenges: Public Acceptance Barriers

The challenges facing implementation of a VM fee system in Texas include:

- The perception by both the general public and transportation stakeholders that vehicle mileage fees would not work in Texas. Both groups cited concerns about privacy, administrative costs, and enforcement.
- The lack of a clearly articulated and communicated rationale for replacing the current fuel tax system in favor of a vehicle mileage fee system. Without such a “value proposition,” Texas drivers are likely to view any change as a more expensive way to collect taxes.
- Any new funding mechanism such as a vehicle mileage fee will raise fairness/equity concerns among rural and low-income drivers.

2. Opportunities: Potential Applications of Vehicle Mileage Fees

Despite these significant challenges, the researchers found that vehicle mileage fees present opportunities to address several transportation financing issues:

- Study results indicate that vehicle mileage fees are a logical and sustainable long-term funding solution when compared to the fuel tax, particularly because mileage fees better embody the “pay for use” principle.
- When discussing potential implementation scenarios, both stakeholders and the general public expressed a preference for simplicity and were more likely to support low-tech solutions.
- Demonstrations can show how the concept might work in Texas, particularly demonstrations that address public concerns while addressing the full spectrum of

implementation issues from roadway use assessment through fee payment, administration, and enforcement.

In online discussions, the technology panel emphasized that public policy design plays a significant role in addressing public concerns. Clear public policy direction allows for the development of technology systems that can address various privacy, administration, and enforcement issues.

D. What This Means

Lingering questions about the long-term prospects for the fuel tax have many in the transportation community looking at mileage fees as the logical replacement. But significant public resistance to such a transition is expected. A mileage fee demonstration that fully addresses objections, reflects a capability to adapt to future technology innovations, and explains the need to switch to a user fee system will be necessary. Based on its findings, the research team has provided several deployment options for consideration.

E. Recommendations

The researchers recommend a trial deployment of vehicle mileage fees in Texas, focusing entirely on fully electric vehicles that will soon appear on the market. This vehicle class represents approximately 0.1 percent of the statewide vehicle fleet and will constitute a class of vehicles that falls outside the existing fuel tax collection system and hence pay no direct road user fees outside of vehicle registration. Implementing this approach will involve a very small percentage of the overall vehicle fleet and would serve as both:

- a complete vehicle fee implementation that can test the full range of system, administration, and enforcement aspects; and
- a demonstration of how state officials might conduct a future phase-in of standard passenger vehicles.

This recommended deployment would take two forms:

1. a base system of odometer readings tied to vehicle inspections, and
2. an opt-in system for a high-tech configuration that would use global positioning system (GPS) aftermarket devices that would enable drivers to discount out-of-state mileage.

The consensus from feedback received in this study is that deploying vehicle mileage fees so that they apply to vehicles that do not currently pay fuel taxes makes the most sense in the near-term.

I. INTRODUCTION

Around the country, researchers at the state and national levels are studying the potential for fee systems that would charge vehicles per mile driven, known as vehicle mileage fees (or VM fees), to succeed the motor fuel tax as the long-term funding source for our transportation infrastructure. This report covers a research effort by the Texas Transportation Institute (TTI), on behalf of the Texas Department of Transportation (TxDOT), to study the feasibility of VM fees as a funding and financing mechanism to meet Texas' specific long-term transportation needs.

The current research has revealed a variety of ways to structure a VM fee system, using either low-level technology or the most advanced Intelligent Transportation System (ITS) available. This versatility has proponents of VM fees touting them as an effective cure for the flaws in the current transportation funding system and a means to achieve a wide range of policy goals. At the same time, however, it also presents a barrier to eventual implementation and administration as experts disagree on an ultimate program design.

As part of the Texas study, researchers adopted a four part research approach involving a literature review, general public focus groups, stakeholder interviews, and a panel of technology experts.

A. Literature Review

Researchers first conducted a survey of literature on existing VM fee systems and VM fee pilot projects to establish the current state of the practice. They examined international and domestic applications of VM fees with a focus on the policies supporting these systems, the technologies deployed, and any implementation issues encountered. Researchers looked at various literature studies related to trends in transportation funding and financing that establish the need for examining alternatives to the fuel tax.

B. Focus Groups

After reviewing the current state of practice, TTI researchers conducted five focus groups to gauge the public's interest, perceptions, and preferences on transportation funding. The focus groups were made up of members of the general public and took place around the state at different sites including:

- a metro area (Dallas),
- a rural area (Yoakum),
- a coastal urban area (Corpus Christi),
- an urban area with a substantial rural population (Abilene), and
- an urban area on the Texas/Mexico border (Laredo).

The team selected these sites to produce feedback as widely varied as possible regarding the public's knowledge about the current transportation financing system, opinions on VM fees, and input on various implementation models and transition strategies for VM fees.

C. Technology Panel

After the focus groups were completed, a technology panel of experts provided input on the various technology issues associated with VM fees. Panel members represented various transportation industry sectors from around the country including each of the following:

- tolling systems industry,
- departments of motor vehicles,
- wireless technology industry,
- pay-as-you-drive insurance companies,
- satellite tolling systems,
- transportation systems engineering firms,
- traffic data and services,
- transportation policy consulting, and
- intelligent transportation systems industry.

Using an online forum managed by TTI researchers, the panel members discussed how technologies could be deployed and administered to address the concerns and issues raised by the focus groups.

D. Stakeholder Interviews

Researchers conducted interviews with representatives from randomly selected interest groups, who either have an impact on or are impacted by transportation, and asked about their opinions toward the concept of VM fees. Questions addressed policy decisions incorporating the broadest range of perspectives and experience. The researchers interviewed:

- advocacy groups, such as those representing general road users, the construction industry, and the trucking industry;
- business groups; and
- governmental entities such as metropolitan planning organizations, councils of government, and regional mobility authorities.

In conjunction with the aforementioned outreach activities and TTI's ongoing research into VM fees, researchers prepared a decision matrix that could aid policy makers in evaluating the various policy trade-offs and system/technology configurations that they will likely encounter in developing a VM fee system.

II. VEHICLE MILEAGE FEES

In 1919, Oregon implemented the first U.S. fuel tax at the rate of 1 cent per-gallon as a user tax to pay for road development. Within 10 years, all 48 of the contiguous United States had implemented fuel taxes. By 1932, the U.S. government had instituted the federal gasoline tax in response to strain on federal revenue sources stemming from the Great Depression (1). With the subsequent creation of the Highway Trust Fund and the development of the national highway system, fuel taxes became (and still remain) the primary vehicle for sustaining U.S. roadway development.

In Texas, fuel tax revenues provide the largest percentage of funding for state transportation programs. Estimates show that for the 2010 and 2011 biennium, both state fuel tax revenues and federal fuel tax reimbursements will account for 34 percent and 45 percent of State Highway Fund revenues, respectively. The Texas Department of Transportation (TxDOT) accounts for the largest share of expenditures on highway and roadway development (2), and, in turn, receives more than 80 percent of its funding from these two sources (3).

Transportation officials are becoming increasingly concerned about the fuel tax's ability to continue sufficiently funding transportation development. As currently applied, the tax generates revenue in proportion to fuel consumption, not actual use. This is problematic because of the various factors that are depressing overall fuel consumption that will likely erode the fuel tax's ability to adequately fund infrastructure development. The Transportation Research Board (TRB) estimates that government regulations and sustained fuel price increases could drive a 20 percent reduction in fuel consumption per vehicle mile by 2025 (4). As vehicle fuel efficiency increases and the market for alternative fuel vehicles grows, the fuel tax system will no longer serve as a reasonable proxy for road use into the future, creating a deficit between the funding needed for road maintenance/expansion and the funding secured through fuel tax revenues. In 2008, the Texas Transportation Commission formed a committee of transportation and business experts (the "2030 Committee") to independently assess the state's transportation infrastructure and mobility needs from 2009 through 2030. In its report, the committee identified \$315 billion in funding needs over that same period (5).

Like many states, Texas' struggle with billions in shortfalls to fund, build, maintain, and operate the roads it needs over the coming years has policymakers looking for a funding source that could potentially replace the gas tax in the future. Among the principal candidates to do so is the vehicle mileage (VM) fee. Also known as the vehicle miles traveled (VMT) fee, mileage-based user fee (MBUF), and time/distance/place (TDP) charging, this type of fee would charge drivers for each mile driven. Although rates can vary based on vehicle type, roadway, and location, the revenues generated by VM fees would more closely reflect drivers' actual use of the roadway network and would not be affected by increases in fuel efficiency.

A. The Case for Pursuing Vehicle Mileage Fees

Around the country, groups that study transportation funding and financing have evaluated and endorsed the use of VM fees. From their efforts, the following general themes have emerged (4, 6, 7, 8, 9):

- The nation's transportation system is facing a crisis in terms of long-term financial sustainability.
- Fuel taxes should remain the short-term primary source of transportation revenue.
- Transportation officials should evaluate funding alternatives to the fuel tax.
- Any ultimate solution should incorporate the "user pays" principle.

The appendix at the end of this report provides a more detailed breakdown of the findings of the various commissions, committees, and research bodies that have studied transportation finance and VM fees.

The reason that VM fees lead the choices to replace the fuel tax as the primary funding source for roadways is that their structure provides revenue generation in proportion to actual road use. Vehicle fuel efficiency and fuel type do not directly affect the amount of the fee.

VM fees' potential to achieve other transportation-related goals also makes it an attractive choice as a funding source. One of the most common criticisms of the current funding system is the disconnect that exists between revenues generated and overall system performance. For example, fuel taxes do not currently force drivers to account for the strain they add to the area road network by traveling during congested periods of the day. Drivers pay the same during peak and off-peak hours. However, VM fees, like congestion pricing (another potential funding source), could have a strong focus on reducing congestion. If the price to access a given facility varies by time of day or by congestion levels, drivers would make low-value trips during off-peak periods or use alternate modes or routes, thereby reducing congestion.

The current collection method for the fuel tax prevents policy makers from determining revenue generation on anything but a large-scale, regional basis. Thus, politics and complex funding formulas determine what facilities and areas receive funding. Fuel distributors pay fuel taxes when fuel is initially removed from the bulk terminal/transfer system and then distributed throughout the states, so policy makers can trace revenue only to the point of initial collection. It is impossible to determine, even at the state level, where consumers generate revenues. And because state and federal governments collect fuel taxes based on the amount of fuel drivers consume, drivers are essentially paying taxes for the use of facilities that are not funded with fuel taxes, such as city streets and on private property. Furthermore, drivers pay state fuel taxes for travel that occurs in other states if the vehicle is not refueled there. Some mileage-based user fee proposals can determine where revenue is generated down to the facility level, freeing transportation officials to target funding to areas that are the most heavily used. Officials could discount mileage accrued on non-state maintained facilities or out-of-state mileage if a state entity applies the VM fee.

Yet another potential benefit derived from the VM fee is the provision of various value-added services to consumers such as those related to:

- Safety – in-vehicle signing, curve speed warning, stop signal and stop sign violation warning, road and traffic condition warning, and collision warning;
- Mobility – congestion pricing, provision of traffic data for travel time and planning studies, routing assistance, and real time traffic information; and
- Personal application – parking location and payment, pay-as-you-drive (PAYD) insurance and personal navigation.

B. Domestic Studies

To date, actual VM fees have seen only international applications, but researchers have completed numerous pilots and studies in the U.S.

1. Oregon Department of Transportation

The state of Oregon conducted the first domestic demonstration of VM fees under the Oregon Mileage Fee Concept and Road User Fee Pilot Program. Launched in 2006, the Oregon Department of Transportation's (ODOT) road user-fee study equipped vehicles with an onboard unit that recorded mileage driven within specified zones. These odometer-connected units tallied mileage and utilized Global Positioning System (GPS) satellite signals to determine the vehicle's location. Mileage totals were transmitted to a billing center whenever a study participant would fuel his/her vehicle at a participating service station. Since program participants still paid fuel taxes whenever they refueled their vehicle, the VM fee was credited against the state fuel taxes paid. More than 90 percent of the participants stated they would agree to continue paying the mileage fee in lieu of the gas tax if ODOT extended the program statewide (10). Oregon is interested in moving to a new phase with potentially broader implementation (11). In its final report, ODOT concluded that (10):

- The VM fee concept is viable;
- Motorists can pay these fees at the pump with minimal difference in process or administration;
- ODOT can phase in the fee alongside the fuel tax and integrate the fee with existing revenue systems;
- Congestion and other pricing options are viable;
- The system allows for protection of driver privacy; and
- Officials can implement the VM fee system with minimal burden on business, can minimize evasion potential, and can keep implementation and administration costs low.

2. Puget Sound Regional Council (Seattle, WA)

Completed in 2008, the Puget Sound Regional Council's *Traffic Choices Study* was an evaluation of driver response to network tolling that, while not a direct demonstration of VM fees, nonetheless tested a potential implementation model. The aim of the Traffic Choices Study was to determine the feasibility of using GPS-based onboard units (OBUs) with a cellular-based transmission system to influence driver behavior in terms of number, mode, route, and time of vehicle trips by varying the charge for road use. The study involved 275 participants who were

offered monetary incentives to reduce their travel in response to the pricing system (12). Puget Sound's primary goals were to reduce vehicular trips and maintain a high level of public acceptance as opposed to just generating transportation funding. In its final report, the regional council concluded that:

- The drivers' responses to tolling suggested that a dramatic opportunity exists to significantly reduce traffic congestion and raise revenues for investment.
- While not all aspects of a road network tolling system have been fully demonstrated yet, the core technology for road network tolling systems is mature and reliable.
- A large-scale U.S. deployment of a GPS-based tolling program will depend on proven systems, a viable business model, and public acceptance of underlying concepts.

3. University of Iowa National Evaluation

The University of Iowa is currently conducting a national evaluation of technological and pricing options for a potential VMT-based fee. The Iowa system uses onboard receivers that work in conjunction with GPS satellite technology to determine each vehicle's location in relation to geographic information system (GIS) files stored in its OBU. Based on the vehicle's location, the system affixes a price per mile to that particular trip. It then applies this price per mile to the number of miles traveled, as recorded by the vehicle's odometer, which is connected to the onboard unit through the vehicle's onboard computer. A price change can occur whenever the GPS system indicates that the vehicle has entered an area with a different per mile price or a new jurisdiction. Data stored in the onboard unit transmits through a cellular network to a billing and dispersal center on a pre-programmed schedule (13). The first phase of the system has been tested by 1,207 participants in six areas throughout the U.S., including:

- Austin, Texas;
- Boise, Idaho;
- San Diego, California;
- Eastern Iowa;
- the Research Triangle area of North Carolina; and
- Baltimore, Maryland.

Phase I tested two types of billing systems. Researchers designed the first to provide the maximum level of privacy. Study participants received billing statements that contained only the total charge and total mileage, meaning that auditability was minimal. Researchers designed the second system to provide maximum auditability, so participants received billing statements that showed mileage and charges accrued daily. Preliminary study results indicate that participants preferred a system with maximum auditability.

As part of this evaluation, researchers assessed participants' acceptance of mileage-based fees prior to, during, and after the Phase I demonstration. At the conclusion of the first phase, about 70 percent of participants had a "very positive" or "positive" view of mileage-based user fees as a replacement for the fuel tax, up from 30 percent at the beginning of the study. About 17 percent of participants had a "very negative" or "negative" perception of the system at the close of the evaluation, up from 15 percent. Preliminary analysis of this acceptance data indicates that participants who switched their preferences from positive to negative were more likely to (14):

- be between 25 and 44 years of age,
- have less than a high school education or some college,
- be unemployed, and
- self-identify as being conservative or extremely conservative.

Those switching their opinions of mileage-based fees from negative to positive were more likely to:

- be 45 years or older,
- have a bachelor's or graduate degree, and
- be in households with incomes of \$75,000 or more.

Iowa researchers are planning a second round of evaluations (Phase II) with 1,400 participants in 6 new areas including:

- Albuquerque, New Mexico;
- Billings, Montana;
- Wichita, Kansas;
- Chicago, Illinois;
- Miami, Florida; and
- Portland, Maine.

C. International Applications

A particular jurisdiction's public policy goals will drive system development and define the various technology requirements of a VM fee system. Thus, the underlying primary policies surrounding many of the systems in this next section are not related to revenue generation. In Europe and other parts of the world, for example, environmental goals and congestion reduction play a very large role in countries that have chosen to implement VM fee systems.

1. Singapore Electronic Road Pricing

Since the mid-1970s, the city/state of Singapore has operated a road pricing system focused on controlling congestion in the city's central core with adjustable rates that vary by time of day based on 85th percentile speed. Singapore also uses permit auctions to control the growth rate in vehicle ownership. This process ensures that the congestion charge does not rise too high and also preserves a higher level of service. In 2008, net revenues for this system were \$75 million.

Two things have supported Singapore's pricing system: 1) the government's single party leadership that allows for a longer-term decision making process; and 2) a master transportation plan that determines how road pricing is integrated with public transit, expansion of roads, and land use issues. Promoting transit use is one of the secondary goals of the pricing system (15).

2. German Heavy Vehicle Tolling

The structure of Germany's heavy vehicle pricing system is a result of the European Union's (EU) restrictions on truck tolls. The EU restricts truck tolls to those vehicles over 12 tons, limits

the roadways that the state can toll, and dictates that transportation officials apply the aggregate charge only to direct capital and operating costs imposed by truck traffic.

As such, the main objectives of the German system are to recover the system costs associated with heavy truck use and to finance ongoing maintenance and improvements. Other system goals include environmental mitigation via shifts to lower emission commercial vehicles and shifting freight transport to rail (15, 16).

More than just a revenue collection mechanism, the German system aims at recovering the various user costs imposed on certain roadways. To guide public fee assessment, Germany developed categories of different costs including (16, 17):

- Causality: is based on the operational parameters of the vehicles participating in the program and includes factors such as axle loads.
- Specificity: applies to the design of roads and may vary based on factors such as the thickness of roadway layers, curvature, and width of lanes.
- Fairness: applies to minimized cross subsidization between user categories for the fair allocation of pure common costs.

3. Stockholm, Sweden

Stockholm, Sweden, has used road pricing since 2006 to manage demand within the city's congested core. The stated goal of the program was to reduce traffic congestion, cut greenhouse gas emissions, and increase public transit ridership.

The system operates via a congestion fee levied on vehicles (excluding alternative fuel vehicles, emergency vehicles, and buses) entering a cordon area surrounding the central inner city between 6:30 a.m. and 6:30 p.m., Monday through Friday.

The amount of the fee varies, with peak periods being the highest. To assess the fee, transportation officials have equipped vehicles with a transponder that communicates with 18 gateways that border the cordon area. Mounted cameras photograph front and rear license plates for enforcement purposes. During the initial trial of the fee system, public transit use increased by 7 percent, while the number of vehicles entering the priced cordon area dropped 18 percent, and CO₂ emissions dropped 10 percent (15).

4. Australia

Austrroads is an Australian government coalition of road and transport authorities. The coalition is currently developing its Intelligent Access Program (IAP) that will incorporate onboard equipment featuring GPS and Dedicated Short Range Communications (DSRC) technology to monitor freight vehicle compliance. Although the system will collect more information than the authorities need for a domestic mileage-based fee system, compiling this level of information is possible because the system is voluntary and applies only to freight vehicles.

The IAP program will collect the following data from participating vehicles:

- vehicle identification,
- vehicle location,

- time,
- distance traveled,
- speed, and
- communications.

Using GPS technology and various digital roadside networks to calculate time and location, the system will also rely on DSRC to communicate with roadside equipment. Austroads is also exploring ways to determine driver identification, trailer identification, and vehicle mass.

Estimates predict that participation in the Austroads IAP program will cost from \$30 to \$50 per month for vehicles that are already equipped with the necessary information transmission technology (telematics) and \$110 to \$190 per month for vehicles that are not equipped. Estimates also predict that the IAP in Australia will generate from \$118 million to \$212 million per year with an estimated benefit-to-cost ratio from 3.1:1 to 5.0:1.

As part of the program development, researchers conducted extensive stakeholder outreach to ensure broad program participation. Potential private sector IAP service providers noted that the government would need to perform several key tasks in setting up the program, including (17):

- providing a clear, concise, and consistent certification and auditing regime;
- providing standards for accuracy and evidence of tampering;
- providing government GIS map data;
- ensuring a stable regulatory environment, where all relevant issues have been tested in court;
- ensuring that any overhanging public policy issues are capable of being settled; and
- setting up clear communication arrangements and well-defined roles between jurisdictions and service providers.

Feedback from freight industry stakeholders indicated four key issues that will require attention to facilitate system adoption:

- ensuring the security and protection of commercial-in-confidence information held by IAP service providers;
- ensuring consistency in the approach for application and enforcement of IAP operators across participating jurisdictions;
- ensuring that jurisdictions continue to target non-IAP operators through enforcement and not treating IAP operators as “easy enforcement targets”; and
- ensuring that the IAP would not be treated as a revenue raiser through enforcement of minor breaches that would be more readily detectable.

5. Switzerland

The primary goal of the Swiss Heavy Vehicle Fee (HVF) Truck Program is to induce mode shift from roadway-based freight to rail. As such, three elements comprise the system’s pricing policies (17):

- a performance-related fee that allocates the cost of freight transport on roads according to a “user/polluter pays” principle;
- a drive to modernize railway infrastructure through voter-approved investments; and

- a railway reform act aimed at increasing productivity and competitiveness among rail companies.

The fee applied under the Swiss HFV program depends on the distance driven, the maximum laden weight of the vehicle, and the vehicular emissions class. Transportation officials primarily use revenues to finance railway infrastructure.

D. Technology Issues

Transportation officials could deploy a number of different technologies to support a VM fee system. The combination of the physical components used is known as the *system architecture* (18). The system architecture encompasses many interrelated aspects and affects every stage of the VM fee system from collection of raw data to the payment of the bill. Determining the technology architecture used should proceed first from a clearly articulated policy framework. The policy goals for a VM fee system will help determine technology requirements which, in turn, will help define how fee assessment and payment occur.

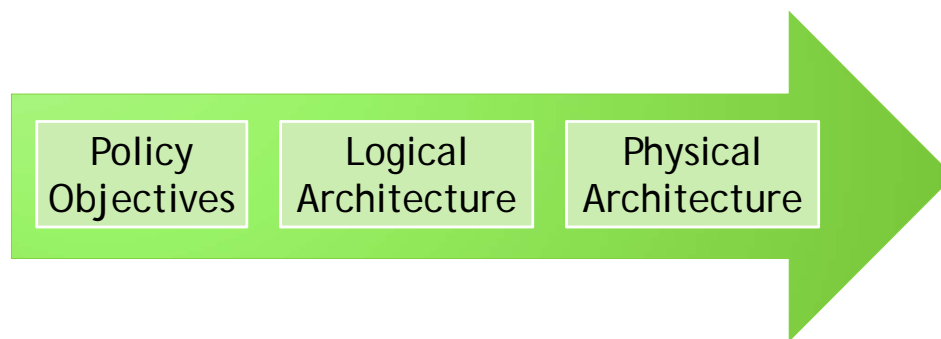


Figure 1. Road User Fee System Development Process.

Logical architecture, the processes that guide the flow of information, works with the system architecture where travel information is used to assess fees. It is a fee system's logical architecture that provides the structure within which the physical system architecture operates and defines how all components interact. For VM fee system logical architecture, there are three, at times overlapping, stages or phases (18):

- Roadway use **assessment**: the collection of raw data describing vehicular movement.
- Charge **computation**: data processing that uses raw data to assess an amount owed. Depending on system design, this stage may occur entirely on board the vehicle, a back office, or a combination of both and could also involve a third, private party.
- Vehicle-to-back-office **communication**: the transmission of data to calculate an amount owed or already-computed amount owed from the vehicle to a back office.

1. Roadway Use Assessment

a. Manual Odometer Readings

Assessing road usage does not necessarily have to involve modern technology. In fact, the simplest and most low-tech option would be to visually record mileage from the odometer and

use that reading to assess a fee. Manual odometer readings are reliable and highly accurate. But while this approach may be attractive because of the simplicity and privacy protection it offers, a manual odometer reading precludes the ability to vary charges based on time, location, and road type. This means that drivers will pay for all mileage accrued since the last odometer reading occurred, including mileage accrued out-of-state or on private property. In fact, all of the technologies that measure roadway use represent varying degrees of tradeoffs in technical simplicity and the level of detailed information provided.

- Advantages:
 1. Maximization of driver privacy.
 2. Simple and easy to understand.

- Disadvantages:
 1. Potentially high administrative cost.
 2. No differentiation of mileage.

b. Vehicle Speed Data

Another way to potentially measure road use is to calculate the miles driven through vehicle speed data. Transportation officials could do this with a device inside the vehicle that connects to its onboard computer, generally through the onboard diagnostic (OBD-II) port. All post-1996 vehicles contain an OBD-II that provides access to information on major engine components during emissions testing and engine diagnosis.

Through this connection, the in-vehicle device would receive a data feed containing information about vehicle starts, stops, and speeds. The device would then enter the data into a computational algorithm to accurately calculate mileage driven. If desired, transportation officials could configure the resulting distance information to work with a congestion pricing system. Officials could also equip onboard units with internal clocks that apply time stamps to mileage collected by the unit (19).

- Advantage: Mileage calculation occurs electronically, which enables the development of processes that can forward the information to a central billing office without the need for a manual odometer reading, thereby reducing the administrative burden.

- Disadvantages:
 1. Necessary diagnostic ports do not exist in all vehicles.
 2. Device does not generate information about geographic location.

In the future, it might be possible to install a system of beacons on roadway segments to determine where the vehicle is traveling. The density of this “beacon network” determines the quality of the data produced. Cellular towers could perhaps serve this purpose and many European pricing systems already use DSRC for similar applications. Another disadvantage is that not all vehicles contain the requisite OBD-II or other diagnostic port needed for in-vehicle devices. This would further complicate the transition to a vehicle speed data system, as those without the necessary devices would continue paying the fuel tax or operate under a different implementation model.

c. Detailed Time and Location Data

Yet another approach to assess roadway use is to build a complete record of travel (location and time) through a wide-area communications technology such as GPS. This technology would continually transmit location data to the in-vehicle device that uses the coordinates to triangulate vehicle location and calculate distance.

- Advantages:
 1. Generates a complete record of vehicle movement to allow for a wider array of pricing applications.
 2. Better facilitates driver auditing of charges.
- Disadvantages:
 1. Distance measurement through triangulation is not as accurate as other assessment methods.
 2. System reliability is lower than other applications. Dense urban canyons, tunnels, and atmospheric disturbances interfere with signal penetration and can cause long-range data transmission to fail (18).
 3. Driver privacy could potentially be compromised.

d. Mileage Estimation

A fourth approach envisions using fuel consumption to calculate mileage (11). This approach would use radio frequency identification (RFID) tags through the vehicle registration sticker or license plate that would contain each vehicle's estimated fuel efficiency. Each time a driver refuels, a reader affixed to the gas pump would detect the RFID. A computer program would then use the vehicle's estimated fuel efficiency to calculate the miles driven based on the amount of fuel purchased and affix a fee to the gas receipt.

- Advantage: The payment of the mileage fee will occur at the gas pump, so there is no need to discount the fuel taxes paid.
- Disadvantages:
 1. Drivers would pay for all mileage much like a manual odometer reading.
 2. Precludes the ability to implement location and time of day pricing.

2. Charge Computation

The two primary means of computing charges, known as *thick client* and *thin client*, each represent a trade-off in terms of driver privacy versus the ability to audit.

a. Thin Client

In a thin client configuration, the level of functionality is low. The onboard unit is the least complex and merely collects and transmits raw data to a billing center to process and generate a bill. It is also potentially more flexible as changes to the network map and rate schedule need not be communicated to all vehicles. A manual odometer reading is essentially the thinnest client because there is no in-vehicle device (hence, zero functionality), and the fee calculation occurs outside of the vehicle.

- Advantage: Results in detailed bills that increase the ability to audit and give system operators access to travel records which would enable the delivery of value added services.
- Disadvantage: From a driver privacy perspective, however, the prospect of large amounts of travel data being forwarded to another entity, particularly governmental, may be problematic.

b. Thick Client

A thick client configuration offers a high level of functionality. The in-vehicle device itself, not a billing center, collects, stores, and processes travel data. The unit transfers a limited amount of information such as the amount owed.

- Advantages:
 1. Processes data within the unit itself.
 2. Clears memory at regular intervals thereby protecting driver privacy.
- Disadvantages:
 1. Requires transportation engineers to equip in-vehicle devices with internal maps and rate schedules to determine charge amounts.
 2. Lack of provider access to travel information precludes the opportunity to offer value-added services.
 3. Limited access to travel information complicates the process by which users could audit their travel and dispute the charges. Engineers would have to grant access to the in-vehicle device itself.

The ability to audit is likely to be important for public acceptance for these systems. Results from research at the University of Iowa, as well as this effort, have shown that a significant percentage of the public will tolerate reduced privacy protection if it increases their ability to audit travel and to potentially dispute charges (14).

c. Hybrid

Transportation officials can also use hybrids of the thick and thin clients depending on the policy concern. Potential examples of such approaches include:

- A thin client system where a third-party entity could act as a “privacy shield” to receive the raw travel data before they are transmitted to a governmental or other billing entity.
- A thick client system with the option to adopt a thin configuration.
- An “anonymous loop-back proxy” system, where maps and rate schedules would be stored off the vehicle. The system would upload detailed travel information, stored in the in-vehicle device, to the entity possessing the appropriate fee schedules and system maps. This entity would then calculate the fees and forward that information to the billing office.

3. Vehicle-to-Back-Office Communication

Systems can transmit information, from vehicle movements to charge amounts, in several ways.

a. Manual Reading

Manual odometer readings are the simplest method to transmit information. Personnel at a certified or otherwise approved location collect data and calculate charges on the spot.

- Advantages:
 1. Data transfer is likely to occur less periodically than with other technology options.
 2. Transportation officials could tie enforcement to registration and/or inspection processes, where they could require certified readings to verify actual mileage.
- Disadvantages:
 1. Although self-reporting of mileage is an option, it is likely to decrease the ability of an implementing entity to enforce accurate fee assessment and payment.
 2. Auditing procedures are likely to be complicated, as auditors would have to check self-reported mileage against the certified odometer reading.

b. Localized, Detection-Based Transmission

Another option is a localized, detection-based transmission that requires a network of roadside readers to download data from vehicles and transfer it to the appropriate location. This configuration could use a variety of technologies DSRC, wireless local area networks (WLANs, chiefly Wi-Fi), and Zigbee. Communication between the reader and the billing center would occur via a landline connection.

- Advantages:
 1. The frequency of data uploads would depend on the density of the reader network. A higher density network means more frequent uploads.
 2. Transportation officials could create a hybrid detection-based system in case a vehicle does not pass a reader within a specified time. This would enable a variety of safety and traveler information-oriented value-added applications, such as in-vehicle signing or warning messages.
- Disadvantage: More frequent uploads are more costly.

c. Wide-Area, Constantly Online Transmission

A third option would be a wide-area, constantly online configuration that would use a network of readers that download data from vehicles over a very large area. Cellular-based technologies, such as global system for mobile communications (GSM), are among the most viable options for this configuration.

- Advantages:
 1. GSM networks are widely available throughout the nation, and infrastructure costs are likely to be low compared to a localized, detection-based system.

2. GSM networks can facilitate mobility-oriented, value-added applications such as real-time routing or dynamic roadway price as these systems require vehicles to maintain constant communication.
- Disadvantage: GSM networks have high operating costs because cellular transmissions can be expensive if aggregated over a large enough area.

4. Open versus Closed Systems

An important technology element is the notion of “open” versus “closed” systems. Closed systems are those with narrow and very specific operating standards and specifications. They are more likely to be anchored by the capabilities of the earliest deployed technologies (11).

By contrast, open systems are those where only very basic aspects of the system are defined and specified. The Internet is an example of an open system. It supports numerous types of software applications and interfaces and allows for development and implementation of new systems. Open systems allow for implementation to evolve over time in response to technological changes and allow for the development of new applications.

For VM fees, the choice between an open versus a closed system comes into play when deciding between the use of after-market devices versus built-in equipment already inside the vehicle or equipment that an implementing entity mandates. Should a VM fee system support numerous types of in-vehicle devices that allow private vendors to develop and market their own units, or should the system accommodate only one specific type of technology with standards and specifications that the implementing entity sets?

To answer such questions, transportation officials should consider the growing presence of personal navigation devices and cellular phones with positioning abilities. It is possible that officials could make VM fees work in conjunction with these devices such that the pricing system itself would be just a small part of the overall device. The potential result is onboard technology that “piggybacks” on these aftermarket devices thus lowering the cost of the onboard technology and allowing older, pre-ODB-II vehicles to participate in the system. The use of these devices is also likely to increase public acceptability and the attractiveness of the system to potential users.

5. Enforcement

Transportation officials must address enforcement to both ensure that users are making payments and to maintain high levels of public acceptance. Enforcement could be particularly problematic with implementations that are technology-dependent and thus vulnerable to user tampering. Researchers envision three methods to deal with VM fee enforcement.

a. Tying Payment into Enforcement

This method requires building enforcement directly into the means of payment. Fuel taxes currently operate in a similar manner, as drivers cannot operate vehicles without refueling and cannot refuel without paying fuel taxes. An odometer reading-based system could tie the

payment of VM fees into the payment of other, more easily enforced fees such as vehicle registration and inspection. Paying mileage fees at the fuel pump, in a manner similar to the system tested in Oregon, also features a built-in enforcement mechanism.

b. Mobile Enforcement

A mobile enforcement method shifts responsibility to various law enforcement entities. In-vehicle devices would transmit unit “health signals” along with fee information to the billing or back office. If the back office did not receive these signals from a particular vehicle or the health signal indicates evidence of tampering, the billing office would notify the appropriate authorities. This method would work best in a system that covers a wide area with a constantly online data stream where unit health signals relay in real time rather than a system that depends on the roadside collection equipment or pre-determined upload schedules.

c. Automatic Number Plate Recognition

Automatic number plate recognition (ANPR) would use roadside cameras that scan license plate numbers to look for drivers with unpaid bills or detect unit health signals that indicate vehicles with defective units. As with mobile enforcement, the burden of actual enforcement falls on various law enforcement entities. This system would also require the development of a potentially extensive ANPR network.

E. Administrative Issues

Transportation officials must examine administrative issues (such as billing and back office operations) because of their effect on the overall system cost, a major factor in the public acceptance of these systems. Administrative issues also determine how the implementing agency will manage data, affecting public acceptance issues like privacy.

The fuel tax is a relatively cheap, non-intrusive, and anonymous means to collect fees for using the roadway network. Distributors initially pay the tax when receiving fuel. As the fuel moves along the supply chain to the point of sale, the end users (motorists) essentially reimburse the distributors. Because the tax collection occurs in a point-of-sale context, a built-in mechanism ensures that users pay their taxes without extra enforcement – motorists who do not fill their cars with gasoline and pay their taxes cannot use the roadways. Fuel taxes are very cheap to administer. Estimates of the cost to administer and enforce federal gas taxes range from 0.2 percent to 1 percent of gross receipts. This amount can vary for state fuel taxes. In Texas, the State Comptroller for Public Accounts retains 1 cent of every dollar in fuel taxes collected for administration and enforcement efforts.

This simplicity and ease of collection could present a major public acceptance problem for mileage-based user fees. The public is generally wary about how the state would administer such fees so that they remain as low cost as the fuel tax. The public has shown skepticism that the state could develop such a system without new administrative procedures and protocols, including billing offices, new collection systems, and personnel to do billing and collections in cases where users do not pay fees at the point of sale.

1. Privacy

Among the challenges likely to face development and implementation of a VM fee system, the privacy issue remains one of the most challenging. As stated earlier, fuel taxes are easy to pay, cheap to collect, and most importantly, anonymous. The potential use of geo-spatial information, for what could be a GPS-based system, is particularly problematic. While the most commonly cited privacy concern about VM fee systems is the fear of being actively tracked, there are others, including the security of the information, the information storage methods, the type of identifying information retained, and how long the information is stored.

The possibility of having a large database filled with driver information will also likely raise the question of whether transportation agencies can share that driver information with law enforcement agencies and private entities such as insurance and credit card companies. If VM fees are to ever gain high public acceptance, transportation officials will have to demonstrate the ability to secure information and protect privacy. Some potential strategies for addressing these privacy concerns include (20):

- not allowing the collection of more data than needed for the primary purpose of the system,
- clearly articulating the level of accuracy expected from data collection tools,
- clearly stating data collection timeline and purpose,
- refraining from using data for new purposes without consent,
- ensuring data are safe and secure and retaining only needed data,
- allowing users the opportunity to correct faulty data, and
- proactively supporting the above principles.

In the Oregon study, researchers helped protect driver privacy by establishing a zone-based system that required only general location data to determine the zone of the driver. This system allowed for accurate in-state mileage calculations without the need for specific trip data. In Iowa, the onboard units used in the university's assessment study keep location data for only the minimal time necessary to calculate fee charges. The unit computes all charges on the vehicle itself and transmits only the aggregated mileage charges to the network operation center. It is impossible for the system to track participants.

2. Payment Options

Four payment options are available to pay the mileage fees, but the need to accommodate different groups in the future may require more than one of these payment options.

a. Point-of-Sale (Pay-at-the-Pump)

Paying a vehicle mileage fee at the pump would capitalize on the public's familiarity with the current pay-at-the-pump system for gasoline purchases (and fuel taxes). This option would likely use localized data transmission technology with a reader affixed to a gas pump. The reader would download the vehicle's travel information (or amount owed, depending on the logical architecture) and then add the amount owed to the driver's gas purchase bill.

- Advantages:
 1. Operates similar to the current pay-at-the-pump system with which the public is already familiar.
 2. Fee payment coincides with the fuel purchase so it is easy to credit drivers for fuel taxes to avoid being charged two road user fees.
 3. Drivers are free to choose how they pay the bill (cash, check, or credit card).
 4. Has a built-in enforcement mechanism – drivers who evade payment through tampering with the OBU pay the fuel tax by default.

- Disadvantages:
 1. The cost of outfitting every gas pump in the state with the appropriate technology could be high. In 2003, ODOT economists estimated that the capital costs of implementing the system tested in their pilot program would be about \$33 million (10).
 2. The operation and maintenance of the readers would be an additional burden on either gas stations or the state.
 3. Adding the mileage fee into drivers' gas bills would require the ability to access gas stations' point-of-sale (POS) software. It is not clear if all gasoline vendors would grant this access.
 4. Payment at the pump does not accommodate non-gasoline vehicles and thus does not align with the goal of preparing for alternative fuel vehicles, which transportation officials touted as a central objective of mileage-based fees.

b. Periodic Billing

Periodic or monthly billing would work in any logical architecture and enforces the “driving as a utility” message that a user fee needs to convey.

Option 1: A back office would process information such as travel data or amount owed.

- Advantages:
 1. A back office generates, prints, and sends bills to users.
 2. Improves upon the current system that collects fees from only a few hundred sources (fuel suppliers); has the potential to collect fees from millions of users.

- Disadvantages:
 1. Requires a more involved back office than other payment options. The public perception exists that this may translate to a clumsy, bureaucratic agency.
 2. Collecting fees from more users complicates the collections process.
 3. Public reluctance toward receiving an additional bill each month.
 4. High cost to print and mail thousands (or millions) of bills.
 5. Enforcement problems if bills are ignored or undelivered.
 6. Crediting drivers for fuel taxes paid at the pump becomes more difficult.

For this option, agencies may need to use private entities to collect these fees. In North America, the tolling industry collects about 20 billion payments annually (21) and uses private entities that are equipped to handle payments through transponders, cash payments, or license plate recognition software. Toll industry officials are also exploring accepting toll payments by mobile

phones, and they are including private financial institutions such as Chase Payment Tech and Wells Fargo Systems to increase processing capability.

Option 2: System would tie payments to vehicle inspections or registrations.

- Advantages:
 1. Significantly reduces the number of billing statements.
 2. Ensures a constant revenue stream because vehicle registrations and inspections take place throughout the year.
 3. Provides built-in enforcement because drivers who fail to pay their bills would be denied their registration or inspection approval.

- Disadvantages:
 1. Annual payment collection weakens the user fee message.
 2. Users may find the cost of payment all at once to be too high.
 3. Places an additional burden on the departments of motor vehicles and state vehicle inspection outlets.

c. Online Travel Accounts

This method would function much like monthly billing statements, except users could have more flexibility about when they pay.

- Advantages:
 1. Users could deposit money into the account when convenient or even set up links with bank accounts so that deposits happen automatically.
 2. The account could also permit users to view their travel history, making it easy to verify that the system charges them correctly. This would depend on the amount of data that the system's logical architecture allowed off the vehicle.

- Disadvantages:
 1. Less technologically inclined users may be uncomfortable with the idea of online billing, so it may be necessary to retain a monthly billing statement option alongside travel accounts in the short term.
 2. System administrators would find it more problematic to accommodate payment by cash or from non-computer owners. Under the current fuel tax system, all customers (cash and credit) pay at the point of sale, so the burden of payment is equal. Establishing cash payment centers could address this, but the burden of compliance is greater on cash customers than those who pay electronically.

F. Public Acceptance

Public acceptance is likely to be one of the biggest hurdles to the implementation of a VM fee system. As researchers will discuss later in the Focus Group section of this report, the public's three primary concerns about VM fees relate to (22, 23):

- Privacy – the public sees VM fees as intrusive and is wary of being tracked by governmental entities;

- Administration – the public believes that VM fees require too much administrative oversight or bureaucracy to be administered properly;
- Enforcement – the public feels that VM fees are too complex and, therefore, too easy to evade.

As discovered by two studies of the public acceptance and VM fees, the public’s lack of knowledge about transportation funding and financing makes this issue even more complicated.

1. Minnesota Department of Transportation (MnDOT) Public Opinion Study

In 2007, the Minnesota Department of Transportation (MnDOT) embarked on a three-phase public opinion study of mileage-based user fees that incorporated an expert panel, focus groups, and a telephone survey.

- Phase I involved 10 focus groups with Minnesota drivers to gauge initial reactions to funding issues and the general concept of mileage-based user fees.
- Phase II was an in-depth look at nine smaller, mini-focus groups. The purpose was to gauge changes in perceptions and knowledge due to the heightened focus on transportation funding and financing process following the collapse of the I-35W bridge in Minneapolis and a February 2008 increase in the state’s fuel tax rate.
- Phase III conducted 821 telephone surveys with Minnesota drivers to assess perceptions and attitudes toward mileage-based user fees and two technology approaches for implementing these fees.

a. Phase I

The Phase I focus groups revealed that participants did not fully grasp the amount of tax dollars they spent per year on the transportation system and failed to recognize the sources of funding for the transportation system. The research showed that drivers would be more accepting of changes in transportation funding methods, regardless of the method implemented, “if the reason for the change is clearly explained.” When focus group moderators pointed out that fuel taxes had not increased in many years and that the Minnesota governor had recently vetoed a \$0.05 tax increase, participants responded that they would be willing to pay an increased gas tax if the state assured them that the increase in revenues would be spent on transportation.

Participants also discussed funding shortfalls in relation to the fuel tax and heard a brief description of mileage-based user fees. After these discussions, participants were generally comfortable with the concept of paying their “fair share” of roadway use and viewed mileage-based fees as a “fair and reasonable way to tax.” The study noted, however, that the participants did not reach a consensus on the actual need for more funding for transportation. Some participants even indicated that revenue for transportation was sufficient but mismanaged.

Phase I identified several other public acceptance issues related to mileage-based user fees (24):

- “While varying the fee based on size and weight of the vehicle was seen as logical, some thought it would unfairly penalize those who have chosen to drive fuel-efficient or hybrid vehicles.”
- “The congestion pricing model was seen as less fair as it negatively impacts those drivers (particularly those in the Twin Cities metro area) who need to travel for work during standard rush hours.”
- “It was also perceived as an attempt at social engineering, which some thought appropriate for MnDOT’s role and others not.”
- “Participants were skeptical of the claim that the information would not be tracked and being watched by ‘Big Brother’ was mentioned frequently.”
- “While the technology exists, many believed it would be expensive to implement and maintain, and often wondered why, if additional funds were needed, they didn’t simply increase the existing fuel tax or registration fee or bill in some other way.”

Researchers concluded that the general public “has not yet linked increased vehicle efficiency, alternative fuels, and inflation to the availability of financial resources for transportation in the future.”

b. Phase II

In Phase II, MnDOT found that while the participants were more aware of transportation funding and financing issues and their effect on transportation infrastructure, they had yet to connect these issues. Most members concluded that future decreases in fuel consumption would result in less revenue from fuel taxes, but they perceived the transportation funding situation as “zero sum,” whereby more fuel-efficient vehicles will likely cause less wear and tear on the roadway system so it will require less revenue for upkeep (25).

As with the first group, the Phase II participants had heard little of mileage-based user fees but still understood the concept and perceived it as “paying for use.” Among the key questions raised (25) were:

- Would the program be state or nationally based?
- Who would send the bill?
- How would international driving be handled?
- Would the program be based on more than simple mileage – for example, include the weight of vehicle to account for wear and tear?
- What will be the cost per mile?

Again, these participants viewed mileage-based fees as costly to implement and expressed concerns about government access to travel information. From this, researchers concluded that the participants’ comfort levels were related to the level of information being gathered. For example, the idea of collecting fees to allocate funds throughout the system was not well received, as participants preferred using simpler methods of data collection and determining need and revenue allocation.

With regard to a potential transition to a VM fee system, the Phase II research noted that transportation officials would need to (25):

- educate the public on transportation funding issues and make the case for change,
- plan for implementation to occur in stages, and
- allow for the public to become comfortable with each stage before proceeding to the next one.

c. Phase III

In Phase III, MnDOT used telephone surveys and found that the public ranks education and healthcare funding as more important than transportation funding. The Phase III findings supported earlier observations that initial public resistance to the mileage fee concept was still prevalent, but that respondents having more information increased the likelihood that they would make the connection between fuel taxes and transportation funding. Overall, respondents generally understood the mileage fee concept but still reacted “less than positively” toward it (26).

The Phase III study recommended that transportation officials emphasize how the current fuel tax system and a proposed mileage-based user fee system are similar in terms of “paying for use.” This is important because the survey respondents cited fairness as a major concern. They believed that user fees would unfairly penalize drivers living in rural areas or those traveling long distances. Yet under the existing system, both classes of drivers already pay more in fuel taxes than those who drive shorter distances.

Communication of this concept might help some drivers overcome their objections because as the study stated, “uncertainty breeds apprehension” (26). This uncertainty is a potential barrier to acceptance, but one that a more fully developed model could address (26). But right now, mileage-based user fees are simply an idea being discussed, and officials can offer few concrete ideas about how to structure or implement them.

Phase III respondents also preferred low-tech implementation models over high-tech options, but researchers noted that this resulted from a strong dislike of the high-tech models, not necessarily the acceptance of the low-tech options. Respondents viewed low-tech models as less invasive, less costly, and fairer. The researchers’ recommendation: a simple, odometer reading-based system with a gradual transition to a more high-tech approach (26). The Minnesota results largely corroborate both previous and current Texas-based public acceptance research into VM fees.

2. Texas Transportation Institute (TTI) Research

In 2008, TTI researchers evaluated the issues surrounding a potential transition to VM fees from the perspective of small urban and rural areas. Specifically, researchers conducted a series of public outreach efforts that included a Community Advisory Committee (CAC), stakeholder interviews, and focus groups in Tyler/Longview area of northeast Texas. While the purpose was to develop a framework for implementing a rural mileage-based user system, researchers gained valuable insight in the public acceptance issues that must be addressed before moving forward.

In the CAC meetings and focus groups, researchers found a general lack of knowledge about the fuel tax and transportation funding. While CAC members knew that the fuel tax funded state and federal transportation development, most did not understand how the government structured and assessed the fuel tax. Very few members knew the actual amounts of the state and federal fuel tax, and only those CAC members whose jobs required extensive travel or to maintain fleet vehicles were familiar with how much they spent on fuel taxes. This lack of knowledge was even more apparent among the focus groups. Very few participants could answer questions about how the government assesses the fuel tax, the amounts of the federal and state taxes, or how much they spent. Many in the focus groups believed that the fuel tax operated like a sales tax, assessed as a percentage of the purchase price (23).

One common theme developed from the CAC, focus groups, and stakeholder interviews was that state and federal officials neglect rural areas for funding of transportation projects. The participants felt that rural areas receive very little actual fuel tax revenues compared to urban areas, and that rural areas do not get the “attention” of state and federal officials for projects that have sufficient local matching funds. Most of the CAC and focus group participants also wanted to see more local control of funds and liked the idea of local officials retaining and allocating VM fees as they see fit (23).

There was also a consensus among the CAC and focus groups that politics, not structure, was the real cause of the fuel tax’s problems. They felt that a new funding system would not solve the underlying problem: state and federal diversions to “cover earmarks.” Participants also believed that assessing “tax usage” was the real priority because officials “divert” too much revenue to non-highway uses (23).

Both the Minnesota and Texas studies showed that a VM fee system will still be a tough sell to the public even if transportation officials address privacy, administration, and enforcement issues. In brief, until the public knows more about transportation funding, the case for a new revenue generating mechanism will be difficult to make, especially if too many “easy fixes” remain unexplored, such as raising fuel taxes and ending diversions to non-transportation related uses.

3. Equity (Fairness) Issues

Equity is the actual (and perceived) costs and benefits that accrue to different segments of society. These are often classified by income, location of residence, or minority status, but other social categories also fit within the definitions of equity.

The public generally sees mileage-based fees as fair. The focus group research from Minnesota, Oregon, and Texas showed that the public generally sees the concept of paying for roads based on use, in a manner similar to utility payments, to be equitable. But while the public may agree that it is fair, that does not necessarily mean they will accept mileage fees as a whole or that equity issues do not exist.

a. "Punishing" Fuel-efficient Drivers

A common criticism of mileage based-user fee systems, especially ones that do not vary the fee based on vehicle type or weight class, is that it "punishes" responsible drivers who purchased fuel-efficient vehicles. However, as the figure below illustrates, as gas prices go up, the percentage of the total cost of fuel attributed to the \$0.20 per-gallon state fuel tax decreases (Figure 2). In other words, fuel taxes make up a smaller portion of the overall cost of fuel whenever fuel prices are high.

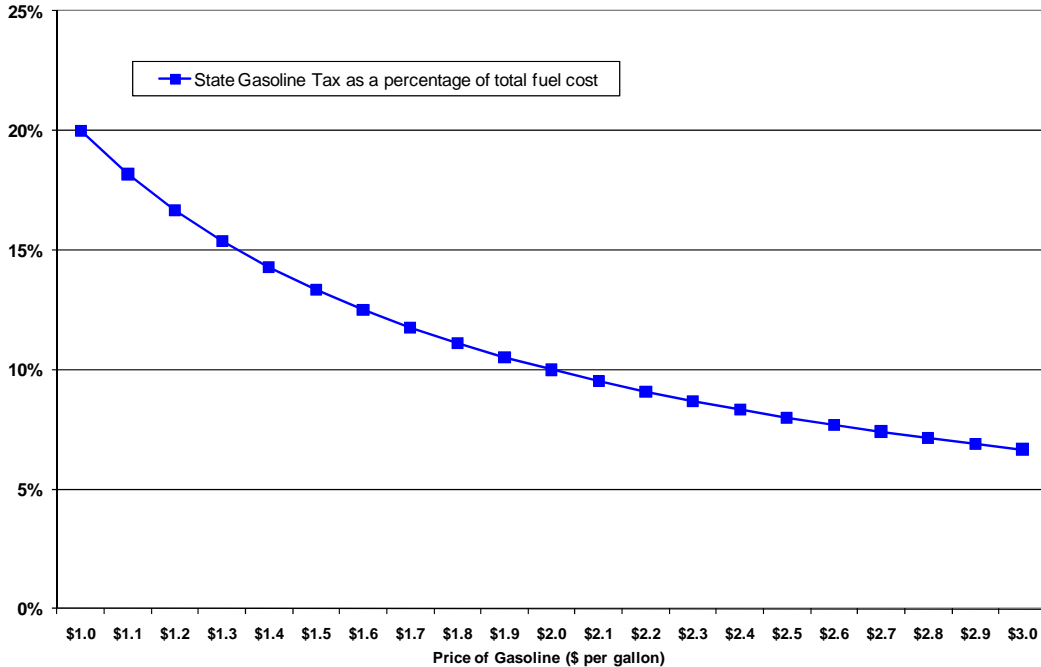


Figure 2. State Gasoline Tax as a Percentage of Total Gasoline Purchase Price.

TTI conducted a simple analysis to evaluate the change in total vehicle ownership that would result from imposing a \$0.0093 per-mile charge to replace the state fuel tax. (Researchers selected this amount because current trends showed that it would generate the same amount of revenue in 2010 as was expected from the state fuel tax for that year.)

Researchers compared the yearly costs of owning a 2008 Ford Taurus versus a 2008 Toyota Prius. As shown in Figure 3, a VM fee of \$0.0093 would reduce the total taxes and fees paid by the Taurus owner by \$1 per year, while the Prius owner would pay more than \$80 more a year. But while the Prius owner would pay more taxes annually, his/her overall cost of ownership is still much lower because fuel purchases would be less than half that of the Taurus owner (27).

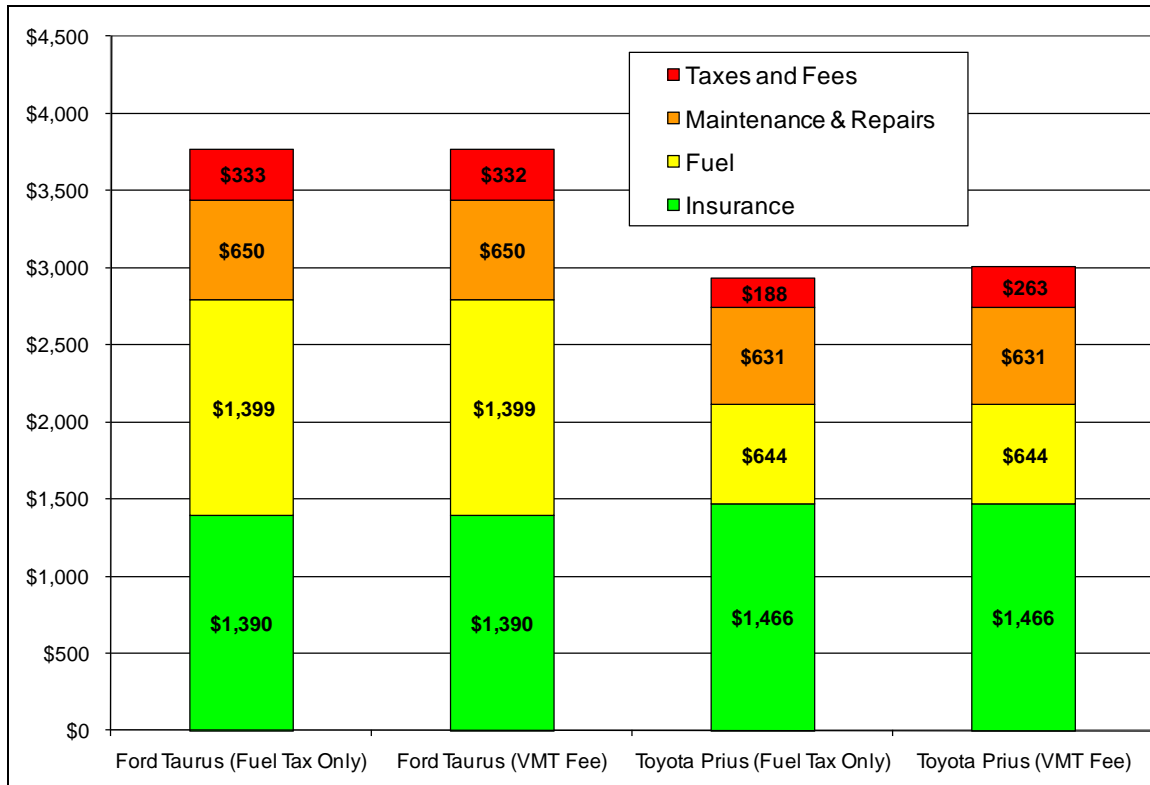


Figure 3. Estimated One-Year Cost of Ownership Comparison Under the Fuel Tax versus a Vehicle Mileage Fee (27).

Therefore, while it may be difficult to counter the argument that a mileage-based fee would punish fuel-efficient drivers, because they would pay more in taxes, the cost of the fee does not compare to the savings the vehicles generate in fuel purchases and overall cost of ownership.

But a system based on a flat fee per-mile driven is not the only potential solution. Developing a pricing system that varies based on factors like vehicle weight and emissions class is also possible, but adopting it will depend on the policymakers' overall goals for the system. For example, if policy makers want to mitigate air pollution, then they should consider a variable price system that preserves incentives to buy fuel-efficient vehicles. This could be accomplished by levying a smaller VM fee for lighter and more fuel-efficient vehicles.

b. Fairness to Low Income Drivers

Another common criticism relates to income equity, the notion that taxation should apply to members of different income groups differently. Income equity proponents believe that lower income groups should pay less (as a percentage of total income) to fund the transportation network than higher income groups. These proponents frequently attack road pricing applications on income equity grounds because price for access does not vary based on income, so lower income drivers will pay a higher percentage of their income for road use than higher income drivers. These proponents generally regard the federal income tax as being equitable because the government assigns higher income taxpayers a higher tax rate.

In the transportation sector, transportation officials have often addressed income equity concerns through public transit development. Lower income groups typically lack access to personal vehicles and use public transit to a greater extent, so they may not benefit from roadway development. In areas where tolls have appeared on facilities that were once free, officials have viewed directing a portion of the revenues toward transit development as an acceptable remedy for any inequity that may affect lower income groups who cannot use the tolled roads. Designing a mileage-based user fee system that dedicates a portion of revenues to transit development might offset potential income equity objections.

c. "Punishing" Rural Drivers

Unfairness is still another recurrent theme in the research on public acceptance of VM fees. Some believe that because VM fees charge per mile driven, they punish rural drivers who routinely drive longer routes. Structuring a mileage fee such that the rate varies depending on the area of travel (rural versus urban) is a logical solution since the highway maintenance and congestion costs are lower in rural areas. It might also be necessary for transportation officials to develop fee systems that accurately account for and discount mileage accrued on private property. This issue is particularly important for ranchers and farmers who are the drivers most likely to generate significant mileage on private property.

III. FOCUS GROUPS

Researchers conducted five focus groups to gauge the public's awareness of various issues associated with transportation funding and VM fees in general, and to assess public perceptions on three specific technological implementations of VM fees. Locations for these groups were selected to generate a participant pool that reflected, to the greatest extent possible, the demographics of the State of Texas. Whenever possible, researchers selected the participants for each specific group so as to accurately reflect the demographics of the area in which they were conducting the focus group. The cities where focus groups took place include:

- Yoakum – small rural town (2009 population: 5,745),
- Laredo – urban area, located along an international border (2009 population: 221,599),
- Dallas – large metropolitan area (2009 population: 1,278,484),
- Corpus Christi – coastal urban area (2009 population: 288,241), and
- Abilene – urban area with large rural population (2009 population: 116,741).

Researchers recruited focus group participants from the general population via the use of posted flyers, print advertising, online advertising, and the use of social media groups as available. They also contacted various public venues such as city and county government offices, educational institutions, civic organizations, social organizations, and retail establishments and asked to post flyers with information relating to the focus group.

A. Structure

The structure of all five focus groups was the same:

1. discussion of transportation funding and financing basics and the fuel tax, and
2. discussion of VM fees, specific technology options, and administrative issues.

1. Introductions and Initial Transportation Funding and Financing Discussion

After receiving information regarding the research study and signing various forms, participants discussed what they knew about transportation funding and financing. Specifically, a moderator asked participants if they knew the amount of the fuel tax, how it is levied, when it was last raised, and other basic factual questions related to the tax. The moderator also asked participants to estimate how much they pay on a regular basis in fuel taxes. Participants then received a handout containing basic information on the fuel tax and transportation funding and financing that included:

- state and federal fuel tax rates,
- sources of revenue for the State Highway Fund,
- state allocations of fuel tax revenues to transportation and other non-transportation related programs (diversions),
- a chart illustrating state and federal fuel taxes as a percentage of the purchase price of fuel,
- a table that enabled participants to calculate what they pay per mile and per month in fuel taxes based on fuel efficiency,

- a chart showing projections of estimated fleet fuel efficiency through 2030, and
- a chart showing expected percentage change in miles traveled per person relative to state fuel taxes collected per person through 2035.

After reviewing the handout, participants provided feedback on the information presented. The group also discussed trends in vehicular fuel efficiency and how that might affect future fuel tax revenues.

2. Discussion of VM Fees, Technology Options, and Administrative Issues

Discussion next turned to the general topic of VM fees. The moderator first asked participants if they had heard of VM fees and then provided basic information on the theory behind them. Participants then provided feedback on the concept in terms of what they think about the idea and if they think it could ever be implemented. Next, the moderator presented three potential technology configurations and asked participants a series of questions related to each configuration.

a. Technology Option 1: “Low Tech” Odometer Reading-Based System

The first configuration discussed was a low-tech, odometer reading-based system where drivers would pay a flat fee per mile driven (Figure 4).

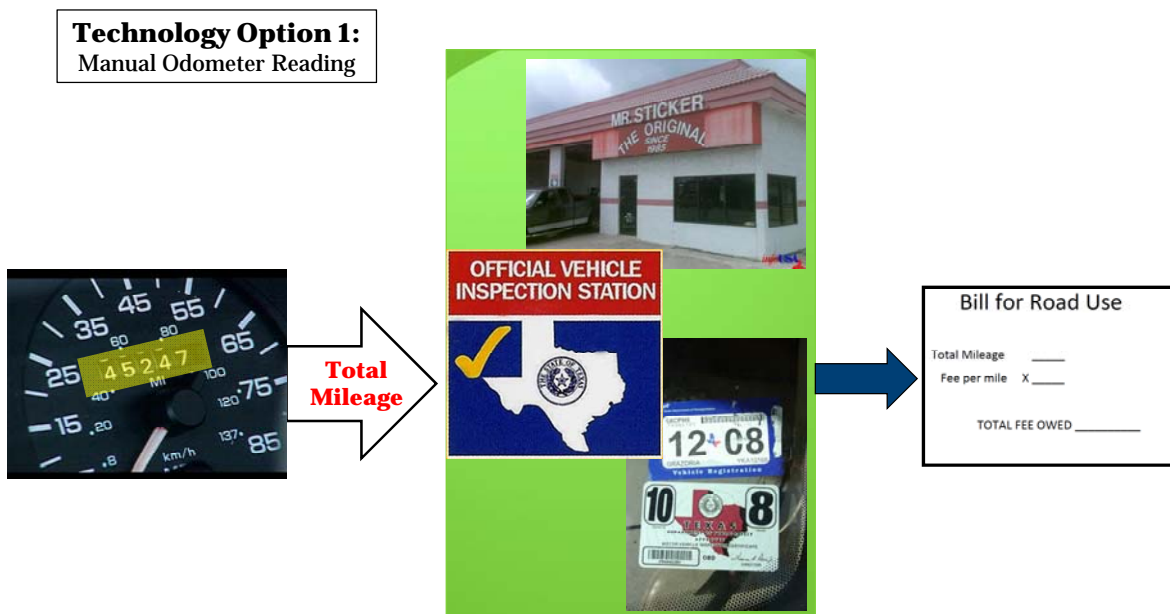


Figure 4. Low-Tech, Odometer Reading-Based Model.

b. Technology Option 2: “High Tech” Cellular/Zone-Based System

The next configuration discussed in the focus group was more high tech and would rely on cellular signals to determine vehicle location (Figure 5). It would utilize a professionally

installed unit that would connect to the vehicle’s onboard diagnostic port (OBD-II port). Through this connection, the unit would obtain a record of vehicular stops, starts, and speed data that it would use to estimate mileage. The unit’s memory would contain a map of the area as well as a fee schedule. The detail of this internal map was limited to simply “Texas” and “Not in Texas,” and signals from area cell phone towers would be used to determine whether it was in Texas or outside of the state. The unit would log all in-state mileage but not out-of-state mileage. At specified times the unit would calculate an amount owed and then transmit it to a billing center.

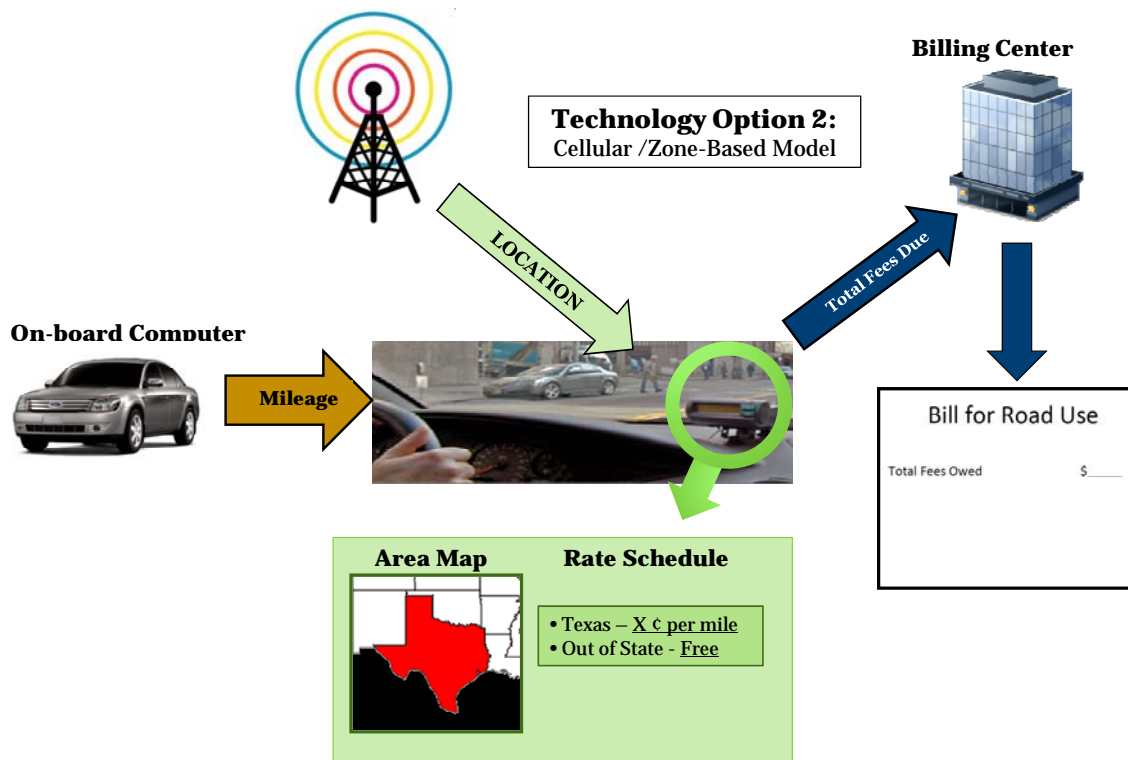


Figure 5. High-Tech, Cellular/Zone-Based Model.

c. Technology Option 3: “High Tech” GPS-based, Facility Specific System

The third technology configuration presented was a high-tech, GPS-based system (Figure 6). Like the cellular system, it would also use an in-vehicle device.

However, the device employed in this configuration would be similar to a commercial navigation device. Unlike the second configuration, drivers could purchase the device and install it themselves in the vehicle without the need for professional installation. The unit employed in this configuration would have a much more detailed map within its memory and would rely on signals received from a GPS satellite to not only determine location on the map but calculate miles driven. Due to the precise level of detail that the unit could provide, drivers would only have to pay for mileage driven on state maintained roads, and they would be able to benefit from various value-added services. (During the focus group, the moderator would mention a few potential value-added applications and ask participants to think about new ways the data could be

used.) Also resulting from the level of travel of detail provided, users of the system would be able to receive a detailed bill of their travel over the billing period, which would allow them to more easily contest erroneous charges.

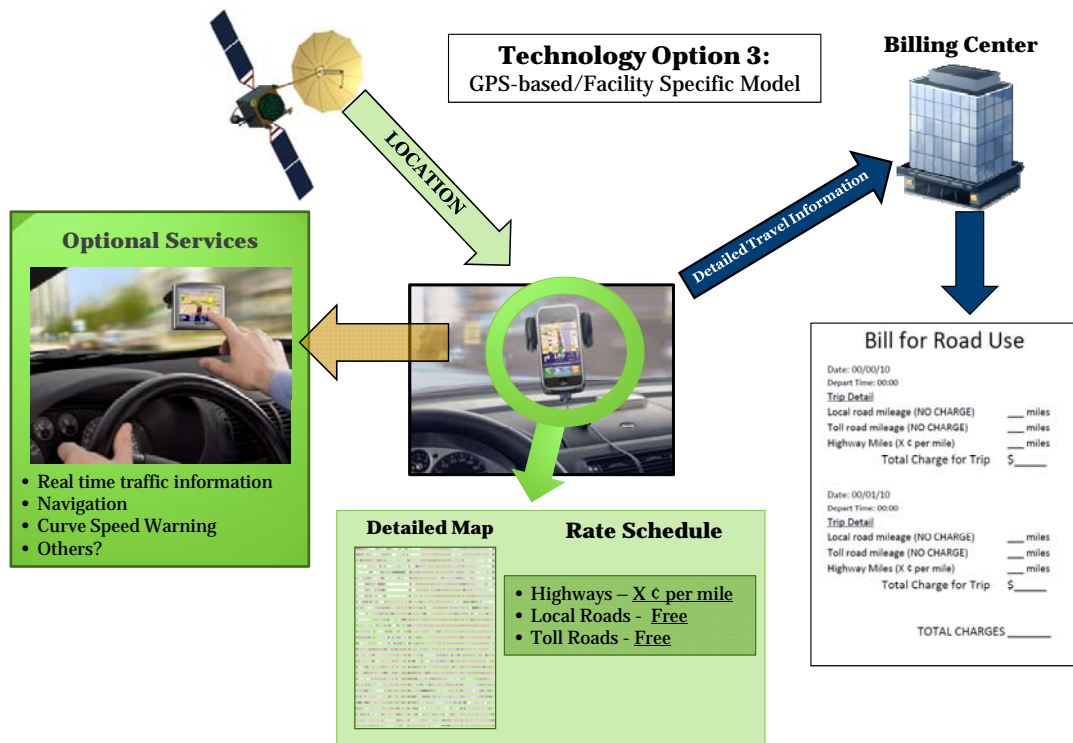


Figure 6. High-Tech, GPS/Facility Specific Model.

The two high-tech configurations presented were amalgamations of various systems currently being developed, evaluated, and/or demonstrated in other VM fee research. Researchers designed the configurations for this focus group effort to assess participant reactions to the various components of the overall systems and therefore do not reflect how VM fees might actually be deployed. Researchers did not believe that providing significant technological detail on how these systems would operate and be administered would drastically affect participants' preferences for certain aspects. As such, researchers grouped the various components into configurations that would allow them to determine which components were most desirable to participants (Figure 7).

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

Figure 7. Summary of System Components for Vehicle Mileage Fee Models.

Participants also discussed preferred payment options, with potential transition strategies for moving to VM fees being the final topic discussed. The moderator asked participants questions pertaining to how they would like to pay these fees, who should pay the fees, should participation be optional, and what they perceived as being the biggest challenges facing a transition to VM fees. Finally, the moderator asked what other information related to the topic participants would like to have access to.

The nature of focus group research is to obtain feedback and document concerns and perceptions, as opposed to educating group participants. Therefore, the focus group moderator did not work to correct the various misconceptions regarding the technologies discussed. The moderator simply documented the feedback, and the next section presents the findings.

B. Focus Group Findings

1. Transportation Funding and Financing

Previous focus group research into knowledge of the fuel tax indicates that the public is largely ignorant on transportation funding and financing (22, 23), conclusions that this research effort affirmed. In general, the focus group participants:

- did not know fuel tax “basics” in terms of how the fuel tax is assessed, fuel tax amounts, and how fuel tax revenues are spent;
- could not estimate their fuel tax expenditures; and
- had trouble grasping long-term issues related to fuel tax sustainability.

Participants often requested additional information that the “fuel tax basics” handout did not contain. This information included:

- What does the portion of fuel tax revenues allocated to the Department of Public Safety actually pay for?
- What portion of vehicle registration fees goes to transportation? Is any of that revenue diverted to non-transportation uses?
- How does Texas compare to other states in terms of state fuel tax amounts?
- Where is the federal money going that Texas is not getting reimbursed for?
- How many electric vehicles will there be in the future?

a. Fuel Tax Basics

In general, when the focus group moderator asked each group how transportation is paid for, the answer involved taxes, with “federal taxes” being the most common answer. Very few in each group specified “fuel taxes and even fewer specified “state fuel taxes.”

When asked about the amount of the fuel tax, even fewer individuals within each group knew the actual amount, with the exception of:

- one participant each in the Corpus Christi and Laredo groups knew the amount of the federal fuel tax but not the state levy, and
- one participant in the Yoakum focus group knew the amount of the state fuel tax but not the federal levy.

Other than these participants, no individuals in any of the five focus groups knew the correct amount of both the state or federal fuel taxes. In many cases there were guesses, with several participants coming within 5 cents of guessing the correct amounts, but otherwise there were no correct answers provided. Many participants stated that the fuel tax is assessed on the purchase price of fuel, not the physical amount purchased. Many participants simply stated that they pay “too much.”

Participant reaction to the information provided in the handouts varied. In several of the groups participants indicated that they did not know the amount of the fuel tax or how much they spent in fuel taxes at any given time, but still indicated that fuel taxes were too high. On the other hand, some participants were surprised that fuel tax amounts are so low. One participant in Abilene noted that the state is getting “ripped off.”

When the moderator asked participants if they were surprised by any of the information presented, they generally indicated that the biggest surprise was that the current system allocates 25 percent of state fuel tax revenues to education. A few participants in all five groups were aware of this allocation, but none of them were aware of the actual allocated amount. Furthermore, none of the participants were aware that the allocation is constitutionally mandated.

There was no consensus on the merits of funding education with fuel tax revenues. Some participants felt that the allocation was necessary, as public education is an important state function and should be adequately funded from any necessary sources. Others believed that there

are already mechanisms in place, namely local property taxes and the state lottery, to provide sufficient funding for education. In terms of other non-transportation related use of revenues, a significant portion of focus group participants indicated that they did not approve of fuel tax revenue allocations to the Texas Department of Public Safety (DPS). A general consensus existed in all groups that it would not be possible to end the education allocation, and participants expressed little optimism about the potential for ending the use of fuel tax revenues for non-transportation related uses.

b. Fuel Tax Expenditures

Discussion next turned to monthly expenditures on fuel taxes. Using the data provided, participants calculated what they spent in fuel taxes and discussed how they felt about that amount.

As with the actual fuel tax amount, there was no consensus as to whether the amount each participant paid on average was appropriate. Some stated that the amount was appropriate, noting that roads are “worth it.” Others stated that it was too much. However, those indicating that they pay too much generally expressed so in terms of everything being too expensive. These participants noted that they already had strained family budgets and that the amount paid, which they had previous to this exercise been unaware of, would be better served paying for other things. Essentially, these participants did not state that the amount paid on a monthly basis was inappropriate for the benefit received from roadways. They would simply rather spend the money elsewhere. There was, however, a general consensus that roads need to be paid for and the amount being paid by participants was reasonable for what they receive in terms of benefits. There was a small minority of participants that believed they should pay more relative to the benefit they receive.

c. Long-Term Issues

Discussion next turned to long-term sustainability issues and specifically the effect of fuel efficiency on future fuel tax revenues. It became apparent that a majority of focus group participants did not, and many could not, grasp the various factors undermining the long-term ability of fuel taxes to fund infrastructure development. For example, one of the charts that the moderator provided showed VMT steadily increasing over time. Many questioned why that alone was not an indicator that fuel taxes would continue to provide sufficient revenues in the long term, stating:

- *“But there are more people driving, so we should be getting more money.”*
- *“So if we have more cars and more miles then it looks like a pretty good source of revenue.”*

Even after previous discussion of the fuel tax as being assessed on the gallon purchased, and a discussion of how the amount paid in fuel taxes declines as fuel efficiency increases, many in these groups still did not see why ever increasing fuel efficiencies posed a long-term threat to the fuel tax base. Many in attendance could not grasp the concept of inflation, and it had to be pointed out by the moderator in all five groups that fuel taxes have lost purchasing power due to inflation alone, as the state fuel tax had not been increased since 1993. Even after all of these discussions regarding the structure of the fuel tax and the effect of fuel efficiency on fuel tax

revenues, many were still unconvinced as to the declining purchase power of the fuel tax. In fact, participants in Corpus Christi and Yoakum questioned the information itself, noting that it was not possible to do these kinds of forecasts over such a long period of time.

However, that is not to say that this sentiment was universal. In fact, during discussions of future fuel efficiency some participants in Corpus Christi, Laredo, and Dallas stated that charging based on mileage might help to alleviate this issue. These participants made this recommendation during a portion of the focus group dedicated to discussing how electric vehicle drivers, who do not pay fuel taxes, should pay for road use. One participant in each of these groups introduced the mileage charging concept, and other participants did not raise any significant objections to the concept. Other suggestions for capturing road user costs from electric vehicles included:

- increased vehicle sales taxes,
- increased vehicle registration fees, or
- extra fees on utility bills for electricity consumed by electric vehicles.

This discussion of fuel efficiency highlighted another division among participants groups: providing incentives for fuel efficiency. In almost every group there was a small contingent of participants (ranging from 1 to 3) who felt that fuel-efficient vehicles should continue to pay less for use of the highway system, and electric vehicles should “drive for free.” The reasoning of these participants was that these vehicle owners had made a “responsible” choice in purchasing these vehicles and should not be “punished” for that decision:

- *“We should be encouraging the use of alternative fuels.”*
- *“Isn’t this what the government wants?”*

However, there were just as many participants in each focus group that believed all cars should pay for use of the roadway network (outside of fixed fees such as registration fees), stating:

- *“But they are using our roads. They should pay what we are paying.”*
- *“Every car puts wear and tear on the road, and they [electric vehicles] should be paying for roads somehow.”*

There were elements in some of the groups, most notably in Yoakum, that did not believe the issue was even worth consideration. These individuals did not have an opinion on subsidies and indicated that there were not enough of these vehicles on the roadway to warrant concern, saying:

- *“So what? There aren’t that many electric vehicles.”*
- *“(Electric vehicles) are not made for rural areas. They are made for a city setting.”*

2. Vehicle Mileage Fees in General

After discussing transportation funding and financing in general, as well as the various factors undermining the fuel tax’s long-term sustainability, the focus group moderator next turned the discussion to the general concept of paying for road use by the mile. Participants voiced several general issues, including:

- VM fees will reduce overall travel,
- various administrative concerns,
- various fairness and equity issues,

- VM fees could serve as a platform for taxes levied by local entities, and
- how to charge out-of-state drivers.

a. Reduced Travel

Upon introduction, there was a general sense of mild outrage at the concept of paying by the mile. In all five of the groups, participants commented that a VM fee would reduce driving. This comment is not surprising in and of itself, but participants made the comments from the standpoint of reduced driving being an undesirable outcome, such as:

- *“People will take fewer trips”*
- *“I like to drive, just for fun.”*

b. Administrative Concerns

Many of the concerns voiced about VM fees related to administrative issues, such as how officials would calculate and collect the fees. Participants raised administrative issues in general and mentioned them as a major barrier to acceptance of each of the implementation models they were presented with. Participants’ primary concern dealt with the perceived administrative oversight that these systems would require due to their complexity:

- *“So who gets burned with having to calculate that?”*
- *“Will we be getting taxed more to cover the administrative cost of this?”*
- *“This just creates more jobs for government.”*
- *“We are talking about a whole new bureaucracy.”*

c. Fairness and Equity

Equity issues were also prevalent in discussions about VM fees:

- *“This penalizes anyone who has to be on the road.”*
- *“I don’t like this. We put a lot of miles on our vehicle.”*
- *“It punishes rural people. I have to drive a long way to get anywhere.”*
- *“It puts rural people at a disadvantage.”*

It is important to center these discussions on VM fees and participants’ opposition to the concept within the context of the participants’ general lack of awareness on fuel taxes. For example, participants in every session noted they drive a considerable distance for either work or for day-to-day household activities, and that they would therefore have to pay more under a VM fee. In all these cases the moderator asked these participants why they did not believe that they were already paying more in fuel taxes relative to someone who drove less. In general participants were not able to give a response when questioned. All of these comments occurred just a few minutes after the discussion regarding the basics of the fuel tax, during which time the moderator asked participants to calculate what they are paying on a per mile basis in fuel taxes.

d. Platform for Additional Taxes

With the high-tech options, there were concerns about the potential for VM fees to serve as a platform for the levying of local transportation fees, such as:

- *“I don’t like the added complexity. Everybody is going to pile on the fees.”*
- *“The cities will have some way of tacking onto this.”*
- *“Won’t cities get in on this? Won’t they want to charge?”*

These statements are interesting in that they contradict observations from previous research conducted in northeast Texas. That prior research effort concluded that presenting VM fees as a possible mechanism for generating local transportation funds would increase their acceptability. It is possible that this conclusion results from the context within which researchers presented the fees. For example, in this exercise, the moderator presented VM fees as a source of state transportation revenue. Focus group participants received very little information regarding the actual funding process and little information regarding the funding process for local projects. However, in the northeast Texas research, researchers discussed fees as part of a larger discussion that focused on the actual process by which the federal government allocates revenues through the states and to local entities. The context within which researchers presented the fees was more complicated (and complete), so northeast Texas participants had a greater understanding of the challenges facing local entities attempting to get money. Northeast Texas participants were supportive of both fuel tax increases and VM fees if the federal government allocated revenues to projects that their local leaders identified as being in need of funding. While participants did not discuss this issue in these focus groups, it is possible that a more in-depth discussion regarding local control of revenues would have yielded higher levels of support for the concept.

e. Charging Out-of-State Drivers

A recurring theme in all the focus groups was the question of how fees would be collected from out-of-state drivers. As one participant noted, *“The thing about the fuel tax is that people coming into the state are paying. We would lose that with this.”*

Respondents voiced similar comments in all of the focus groups on the larger issue of enforcement. After hearing about all three of the configurations, focus group participants were generally very skeptical about the ability of the state to collect these fees from all drivers in a manner as efficient as the fuel tax.

- *“With the current system you pay upfront and it had a built-in enforcement mechanism. It’s just more fair.”*
- *“We can’t enforce the laws we have now.”*

In the course of these discussions, some participants made recommendations as to other alternatives to the fuel tax that might be more acceptable than VM fees. These included:

- increasing vehicle registration fees by an amount equal to what the average driver pays annually in state fuel taxes, and
- using the manufacturer’s estimated fuel efficiency, calculate the total amount for state fuel taxes that will be paid over the life of the vehicle and roll this amount into a vehicle sales tax.

3. Vehicle Mileage Fees – Technology Options

In discussions regarding these various technology options, focus group participants' major concerns generally fell into one of three categories:

- privacy,
- enforcement, and
- administration.

a. Odometer Reading-Based Model

In general, participants preferred the odometer reading-based system but it still scored low on acceptability. While participants saw potential value in the system in terms of halting the decline in the fuel tax's purchasing power, many simply felt that such a system was unnecessary. As one participant stated, *"You're reinventing the wheel. Why introduce a huge bureaucratic element to this?"*

In three groups (Yoakum, Dallas, and Laredo) there was a question as to why simply raising vehicle registration fees would not be a viable solution as opposed to imposing an odometer reading-based VM fee. To participants in these groups, it did not seem to make sense for the state to develop a whole new fee assessment and collection system if the state was going to collect the fee in a manner similar to other states fees.

Participants in the Yoakum group noted that it would be unfair to charge drivers for mileage accrued on private land. All participants in this session held this sentiment, and none of these participants made the connection that they are already paying for mileage driven on their land through fuel taxes. There were no farmers or ranchers in this group, so none of the participants currently utilize tax free fuel. As such, they were all already paying for travel on their private property, a distinction that those in attendance did not make. There were no participants in any of the other focus group sessions that brought up the issue of charging a state fee for mileage accrued on non-state maintained roadways or private land.

1. Privacy

Privacy issues were not much of a concern with regard to the odometer reading-based system. Participants liked the fact that entities collecting the fees would not be able to tell where travel occurred.

2. Enforcement

All five groups expressed concerns about the potential for vehicle owners to "roll back" their odometers prior to fee assessment. There was no discussion in any of the groups as to how easy of a process this would be or how prevalent the practice is. However, there was a strong sentiment in all five groups that an odometer reading-based VM fee would present enough of an incentive for an "odometer tampering industry" to develop. The moderator asked group participants for suggestions on combating this potential development but few were offered. One participant in Corpus Christi said that officials could use "satellites" to verify how far vehicles were actually traveling. A participant in Yoakum stated that odometer tampering could perhaps be identified during vehicle inspection.

The logical point for odometer readings to occur, as participants noted, appears to be at the time of vehicle registration or inspection. The problem, however, is that many drivers drive with expired registration and inspection stickers. One participant stated that, *“When I was having trouble, paying inspection and registration was the least of my worries compared to feeding my kid.”*

This evasion potential presented a major issue for almost all participants in all the focus groups, as they did not view it as fair to have a system that is as easy to evade as the registration and inspection process. Several participants in each focus group session noted that there are substantial numbers of drivers who do not renew their vehicle inspection and registration stickers in a timely manner, if at all. Participants suggested substantial fines for failure to register as the most common remedy.

3. Administration

Participants also had concerns with how the state would handle payment of these fees. Most did not like the idea of paying for a year’s worth of mileage in one lump sum:

- *“Nobody wants to plunk down that kind of money at inspection.”*
- *“The annual sticker shock is big.”*
- *“I don’t like this lump sum. It will be too hard for people to come up with.”*
- *“It’s already too much for a registration sticker!”*

The moderator in many cases pointed out that this fee would be a replacement for the fuel tax and that people would be paying less in overall fuel costs as a result. Participants generally responded in one of two ways:

1. The price of fuel will not, in fact, drop, because the “oil industry” will simply raise prices to capture the decline.
2. People do not (and presumably would not) budget for a onetime road use fee payment of the amount being discussed.

In response to the issue of a large onetime payment, the moderator asked focus group participants to provide recommendations on structuring payments. Most recommendations were generally along the line of:

- developing an “estimated payment” program similar to the what is used with the federal income tax system;
- developing a system that allows for pre-payment of mileage, that could accommodate online payments;
- offering installment plans;
- paying for road fees through other regular payments, such as vehicle liability insurance; and
- allowing for payments to occur in conjunction with fuel purchases.

b. Cellular/Zone-Based Model

Participants next discussed the cellular model. It was the least preferred of the three options due mostly to the fact that it was technology intensive and did not provide a high level of detailed travel information. Participants were also generally opposed to a system that would require

professional installation of technology in their vehicle, especially if the consumer had to pay for such installation.

However, upon initial introduction this particular model was met with interest as well as skepticism. The interest in the system stemmed primarily from its reliance on innovative technology. However, this same reliance on technology is what prompted most of the skepticism, as a majority of participants in all sessions simply did not see how such a system could be implemented on such a large scale.

1. Privacy

Participants in all five groups raised privacy issues, but these issues were most prevalent in the Yoakum focus group. These participants were skeptical that any governmental entity would refrain from keeping travel information, even if officials designed the system so that charge computation occurred in vehicle and no travel information was transmitted:

- *“This is an invasion of privacy.”*
- *“My truck is pre-computer. The government doesn’t belong in my car anyway.”*
- *“The police might like this because they can track you.”*

The other four focus groups raised privacy issues but not as strongly. In particular, Dallas participants noted that “others” and the rest of the state would have concerns, but not necessarily them.

2. Enforcement

Enforcement, in terms of making sure that motorists use the onboard units properly and do not tamper with them, was also a major issue. Most participants believed that an externally affixed onboard unit would be too easy for tech savvy drivers to tamper with and would present too many avenues for evasion. One participant in Laredo recommended that officials use odometer readings to verify that the onboard technology’s accounting of mileage is accurate.

3. Administration

One of the principal drawbacks of the cellular system, in the minds of those who did not outright oppose it, was that it did not appear to offer a viable means of auditing travel and disputing erroneous charges. The cellular model, as presented in these focus groups, was designed to safeguard privacy by allocating mileage on a zone basis. A billing entity would not know specifically where and when travel occurred, only that a vehicle had accrued mileage in certain zones. This means that users of the system would be very limited in their ability to audit and dispute charges they perceive to be erroneous, as the system does not retain accurate location data. There is therefore an inherent tradeoff in terms of privacy versus ability to audit, and focus group participants who were open to technology intensive systems clearly favored an increased ability to audit. These participants were neutral on the concept of zone-based charging. While there were many who saw a potential advantage in allocating mileage based on travel within zones as a protection of driver privacy, there were also many participants who saw zone-based pricing as a means of other governmental entities (namely counties and cities) to “pile on” their own local charges.

Participants raised strong concerns in all five groups about the system's technical reliability. Two of the groups (Laredo and Yoakum) noted that cellular coverage can be spotty and is not very reliable. All five groups had participants who expressed strong misgivings about the technology being reliable and not malfunctioning. One participant in the Dallas group commented that calls on cellular systems are often dropped.

System costs were also a major issue of discussion. This was expressed in terms of:

- onboard unit cost (and who will bear that cost),
- installation cost (and who will bear that cost),
- operating costs in terms of use of private cellular technology, and
- administrative cost, in terms of the levels of staffing necessary to administer the system.

c. GPS/Facility Specific-Based Model

The GPS-based model was the next system discussed. In general, this model had slightly higher levels of acceptability than the cellular-based model, but participants nonetheless raised significant objections to several aspects, particularly about privacy:

- *“Except for the big brother thing this is the best.”*
- *“I think most people would like this last option (GPS) if you could address the privacy issues.”*

Younger participants were generally more comfortable with level of detail provided but were still not necessarily accepting of the system.

1. Privacy

The biggest issue raised in all five focus groups with this model was privacy. The configuration discussed in these sessions would rely on time and specific location detail as opposed to the zone-based location readings utilized under the cellular model. While many saw this aspect as an improvement over the cellular model, this model increased existing privacy concerns. For participants who had not previously had privacy concerns, the GPS model presented a means for auditing travel and disputing charges. Many participants, and in particular younger participants in the more urban areas, saw value in having the detailed travel data as it would allow for better planning of trips so as to reduce fees paid. The presence of value-added services was particularly attractive to these participants. For others, there simply were no privacy concerns because other everyday technologies already compromise privacy:

- *“Privacy is not an issue. We have credit cards and use the Internet.”*
- *“My car already tracks me.”* (OnStar user)

However, participants previously expressing privacy concerns with the cellular model were even more opposed to the GPS-based system. These participants tended to view the level of data collected as necessary to fulfill the purpose of the system, namely allocating travel based on location, but viewed the gathering of such data by a governmental entity as improper. There was concern by many participants, most notably Yoakum, that the data would be used for “social engineering” purposes by policy makers. There were also concerns expressed about the technology's ability to calculate vehicle speed, and many participants were worried about insurance companies and law enforcement having access to vehicle speed information.

An interesting observation from these groups on data collection is that there was little difference between participants' acceptance of using a direct data feed from the vehicle OBU to calculate mileage as opposed to using GPS data from a satellite to calculate mileage. While there were concerns expressed in all groups about the need to be able to audit data, implying that participants felt the technology employed had accuracy issues, there was no discernable difference in opinions regarding the two technology options.

2. Enforcement

Participants viewed enforcing use of the unit as a potential drawback of this system, especially in that it utilized "off the shelf" commercial technology and did not rely on a physical connection to the vehicle. Participants in all five groups stated that relying on a self-installed model would mean that drivers could simply turn off the unit and not be charged for mileage:

- "Well I'll just take it out."
- "How can you force people to do this?"

3. Administration

Cost was also a major issue, both in terms of the technology cost and administrative cost. A more in-depth discussion of monitoring costs occurred in the Corpus Christi session, where participants noted that this system would require constant monitoring of all cars on the roadway.

The advantage of the cellular system, in their minds, was that data uploads occurred periodically. However, the GPS system would be "on all the time" and many in attendance were worried about that associated cost. This was a perception based on focus group participants' knowledge about GPS systems. The focus group moderator did not state that the system would upload data on a continual basis. These participants were also worried about the administrative burden of generating such detailed bills for all drivers statewide, saying, "*Do you realize how hard it would be to monitor all cars in Texas? That would require a lot of equipment.*"

While private participation in the administration of these systems was not a topic that the moderator raised, participants in the Abilene group brought up and discussed the issue in great detail. One participant commented that the information being gathered is already collected to some extent by cellular operators and used in commercial navigation devices. This participant remarked that by gathering similar data from all drivers, better traffic information systems could be accommodated: "*It seems like this could be handled by private information providers like AT&T. What I see here is existing technology with supplemental information being incorporated. This could be synced with existing commercial technologies so yeah.... I kind of like it. I like the value added, especially the information aspect like travel information. That is something that drivers need.*"

Other participants said that collections would still be an issue and that acceptance of such a system would likely be generational in nature with younger drivers being more eager to adopt. In general, the Abilene group agreed that a system utilizing private provision of these services, including payment, might be a good option for implementation. There was also general agreement that since these data are "already out there," that this might be an "easier sell" for the state to make to the public. However, this discussion does not mean that the majority of the

group was in favor of the system. In fact, most of the group was opposed to the system on privacy grounds. As one participant put it, *“This (value-added service) is not as important when weighed against the loss of privacy.”*

d. Payment Options

The moderator did not center discussion of payment options for VM fees on a specific technology model, as researchers felt that focus groups could discuss this particular component outside of technology options. As such, a discussion of how focus group participants would like to pay these fees followed the discussion of the actual technology options. The general conclusions from this portion of the focus group discussion include:

- Participants clearly preferred a pay-at-the-pump system.
- The system will likely need many payment options.
- The groups had no clear consensus on how to enforce payment.

1. Pay-at-the-Pump

Some sort of pay-at-the-pump option was the preferred method in all five groups by a wide margin. In fact, many participants indicated that they would be more accepting of any of the three models discussed if there was a viable means of collecting the fees in a manner they are used to, saying:

- *“A system where you pay when you get gas would be the best.”*
- *“You need to keep these payments tied to gas payments.”*
- *“I would rather pay the fee at the gas pump because people who are not budgeting can’t afford this. The way it is now, you drive whenever you can afford to.”*

However, participants expressed much concern about how this would be accomplished, especially in an odometer reading-based model, which was their preferred model.

2. Varied Payment Options

While participants generally agreed that the system should provide lots of payment options, it is difficult for researchers to draw any more detailed conclusions. For example, numerous participants in each session paid bills online and had no problem paying road user charges online. However, a substantial percentage opposed paying bills online, primarily because either they did not already pay bills online or felt that such a system would unduly burden less technology proficient drivers such as the elderly. Similarly, there were participants who liked the idea of having road user charges appear on credit card statements or other monthly statements such as cell phone bills or through vehicle insurance statements; however, just as many participants opposed this concept:

- *“People are already in credit card debt.”*
- *“We’re not talking about a perfect world here. I guess debit cards could work.”*
- *“There will be no perfect system, so we need to have options.”*

In short, the best option will likely be to offer a range of payment options and allow users to pick the system they wish to participate in.

3. Enforcing Payment

Participants in all of the groups brought up the topic of enforcing payment at various times throughout the focus group sessions, and discussions about this topic revealed an interesting schism among participants. The issue was particularly evident in Laredo and Yoakum and related to disabling vehicles for non-payment. The current deployment options being evaluated for VM fee implementation are not capable of disabling a vehicle for failure to pay fees, and this issue was not at any time brought up by the moderator. However, participants themselves raised the topic.

What is most interesting is the division in opinion of focus group participants as to whether this is warranted. Those who opposed disabling vehicles for non-payment generally stated that driving was a necessity and that it would be wrong to take that away from people who have to drive. On the other hand, those who supported disabling vehicles for non-payment stated that driving was a privilege, and that those who did not pay for their use of the roadway network should not be able to drive on it, saying, “*Roads are a necessity, too, and it is a social responsibility to pay for them.*” The split between these two opinions was generally even in all of the groups.

e. Transition Issues

After discussing the three implementation models, discussion next turned to potential transition issues. The primary purpose of this discussion was to gauge how participants see VM fees being phased in and to discuss any potential barriers and challenges they foresee with such a transition.

There was a strong consensus in all five groups that if the state is going to implement VM fees, the transition should occur through some sort of voluntary program. This would especially be the case, in the eyes of participants, if the state decided to pursue a high-tech option that would rely on the some type of in-vehicle device.

Participants indicated a general consensus that the fuel tax, in spite of the problems highlighted in the initial discussions, still represents a great revenue generator and should be maintained. As such, any VM fee system should target those types of vehicles that will not be paying into the system in the future: namely electric vehicles. As previously noted, the notion of charging electric vehicles for road use was by no means a unanimous opinion, as anywhere from one to three participants in each session thought that these vehicles should enjoy a privileged status. However, a majority of participants believed that all vehicles should pay for use of the roadway network, and since these vehicles fall outside of the fuel tax collection framework they should be subject to some sort of use-based fee mechanism.

C. Focus Group Conclusions

Based on these focus group sessions, researchers drew the following conclusions on developing and implementing VM fees in the State of Texas:

- Information on transportation funding is needed, but the public will have different reactions to that information.
- The public does not perceive the fuel tax as a user fee.
- Any MBUF system implemented in Texas should start simple.

- There may be generational differences in terms of technology acceptance.
- A state VM fee system should target electric vehicles first.
- Technology dependent systems will have to demonstrate that they are resilient to tampering and are highly enforceable.
- Drivers will likely want detailed billing.
- Additional research is necessary to help establish administrative costs.

1. Make More Information on Transportation Funding Available

There is a profound need for education on transportation funding and financing issues as they relate both to how the transportation system is currently funded and the issues affecting its long-term health. State officials need to begin advancing the discussion of transportation funding beyond simply ending “diversions” and legislative “pork barrel” spending and begin addressing issues affecting the sustainability of the current framework. There are many potential solutions to the long-term issues that the state is facing, but discussion of these alternatives cannot begin until the public has a better understanding of how the system currently functions and the constraints within which it must operate if the state takes no action.

While there was a strong anti-tax sentiment in much of the focus group proceedings, the sentiment was by no means ubiquitous. Upon receiving information on the fuel tax, information that the majority of participants previously had no knowledge of, many participants indicated that fuel taxes were still too high while others indicated that they were too low. In other words, simply providing information on the fuel tax and the various factors undermining its long-term sustainability will not necessarily convince the public of the need for an alternative. Those that believed taxes are too high generally cited the need to end “diversions” and spend more efficiently as a desired alternative to increasing taxes or levying new fees. The portion of the focus group sessions that related to future fuel efficiencies was successful in stimulating discussion on problems with the fuel tax, so researchers recommend that any future outreach efforts incorporate an element centered on future trends in auto technology and the effect it will have on fuel tax revenues. Researchers also recommend that any public outreach efforts regarding transportation funding include a discussion of the factors affecting highway construction cost, as participants generally did not grasp the influence of inflation on the purchasing power of the fuel tax.

2. The Public Does Not Perceive the Fuel Tax as a User Fee

Most focus group participants believed that they are essentially driving for free. The fuel tax is effectively hidden and, in the words of one Laredo focus group, “*people just don’t think about it.*” As a result, the public will respond to any reform to the fuel tax with considerable resistance, especially if it takes the form of a new VM fee. A more visible fuel tax, or at least more information on the tax itself, would be a good way of illuminating the ways in which drivers support infrastructure development.

3. Start Simple

While all five groups expressed some opposition to mileage fees in general, when pressed by the moderator to choose their preferred system model, focus group participants chose the odometer

reading-based model almost 5:1 over the GPS model. Only one participant out of all five groups preferred the cellular model. Participants most often cited the simplicity of the odometer reading-based model as their reason for favoring it over the other two models.

4. Generational Differences in Terms of Technology Acceptance

Although researchers based this conclusion on anecdotal evidence gathered in the course of the focus group sessions, it is likely that older drivers will be less accepting of high-tech system configurations relative to younger drivers. Several older participants indicated that while they were not comfortable with the technologies that could be deployed in support of VM fees, they believed that younger drivers would likely embrace them. Likewise, many younger participants who were supportive of these technologies expressed concerns about the ability of older drivers, namely their parents and grandparents, to properly operate the equipment.

5. Electric Vehicles May Be the Optimal Target of a Future VM Fee System

Participants widely recognized that, in the future, a potentially large segment of the vehicle fleet may pay nothing aside from vehicle registration and titling fees for use of the state roadway network. As such, they strongly preferred leveling VM fees on this class of “non-users.”

6. Technology Dependent Systems Will Have to Demonstrate Reliability and Enforceability

After privacy, enforcement was the second most predominant concern on the minds of focus group participants. Fuel taxes are easily enforced, but mileage fees appear to offer numerous avenues for evasion, be it from users not getting a vehicle registered to tampering with onboard equipment. Any new system will have to demonstrate that it has a robust enforcement mechanism that will ensure that all (or at least a significant majority) drivers will pay their fees.

7. Provide a Detailed Bill

While respondents did not strongly support the technology intensive systems, when discussing these configurations, they did express a strong preference for any billing statements to contain a detailed record of travel. This concern stems from respondents’ general lack of trust in the technology being deployed coupled with a desire to audit any erroneous charges and suggests that any technology intensive system deployed in Texas must collect detailed travel information. This means that the most likely technology candidate for mileage assessment is GPS or some technology that generates location data at a detailed resolution.

8. Potential Administrative Costs Need to Be Established

While evaluations of the potential capital costs of VM fee systems, in terms of in-vehicle devices and information collection equipment, are necessary, a more pressing cost issue (in terms of public acceptance) is the ongoing administrative costs that these systems will require. Moving the point of collection for road user fees from the fuel supplier to the individual driver will increase the overall number of fee collections by several orders of magnitude. As it now stands, there is no solid research on the ability of public entities to handle this monumental undertaking. If private entities are to handle fee collection and/or data administration, the state needs to assess

the associated cost as well as evaluate the institutional structures that it would have to implement in order to promote information sharing between these entities and the public sector. The public is acutely aware of these issues, and in order to generate public support for the imposition of VM fees, the state will have to show that it can implement these fees with a minimal administrative cost.

IV. TECHNOLOGY PANEL

As part of this research effort, researchers developed a technical advisory panel comprised of various industry experts. The purpose of this panel was to provide input on how transportation officials could deploy the various technologies employed in a VM fee system to address the critical issues as raised in the focus group sessions. The panel included:

- Department of Motor Vehicles (DMV) representative;
- wireless technology applications consultant;
- mechanical engineer;
- Global Navigation Satellite System (GNSS) and GPS tolling systems representative;
- transportation systems engineering consultant;
- traffic data and services representative;
- transportation policy, economics, and finance consultant; and
- intelligent transportation systems representative.

Members of the technology panel interacted with the researchers and fellow panel members through the use of an online forum. Researchers posted topics and various questions to the forum, and panel members logged-in and posted responses for a period of three weeks. Researchers encouraged panel members to check in at regular intervals and respond to comments left by other panel members and even pose new topics for discussion. Discussion topics centered on five main areas:

- general privacy issues,
- the odometer reading-based model,
- the cellular/zone-based model,
- the GPS/facility specific model, and
- demonstration and implementation suggestions.

A. General Privacy Issues

Focus group participants raised privacy issues with both the cellular and GPS-based user fee systems, stemming primarily from their reliance on the collection of travel information through the use of onboard technology. One panel member remarked that to address general privacy issues for data collection, transportation officials might find it useful to look to the International Working Group on Data Protection in Telecommunications (IWGDPT). This panel member noted that officials have no obligation to comply with IWGDPT recommendations, but the recommendations do provide guidance on how “privacy commissioners” are likely to view the management of data that the state would collect as part of the proposed systems. This panel member went on to say that it is likely that some countries will establish and enforce regulations based on the IWGDPT’s guidance.

The IWGDPT has been addressing matters related to privacy since the early 1980s when it was founded as part of the framework of the International Conference of Data Protection and Privacy Commissioners. The IWGDPT itself formulates recommendations to improve the protection of privacy in telecommunications, and its “Sofia Memorandum,” issued in 2009, deals specifically with metering systems for road pricing.

The IWGDPT has made the following recommendations, which are designed to “protect the privacy of drivers and owners of vehicles”:

- “The anonymity of the driver can and should be preserved by using the so-called smart client or anonymous proxy approaches that keep personal data of the drivers under their sole control and do not require off-board location record keeping.”
- “Road pricing systems can and should be designed so that the detailed trip data are fully and permanently deleted from the system after the charges have been settled in order to prevent the creation of movement profiles or the potential for function creep.”
- “Processing of personal data for other purposes (e.g., pay-as you drive insurance or behavioral-based marketing) should only be possible with clear and unambiguous consent from the individual.”
- “In terms of enforcement, the system should not ascertain the identity of the driver or owner of a vehicle unless there is evidence that the driver has committed something which is defined as a violation of the road pricing system.”

The panel member noted that “it is doubtful that any country will permit GNSS telematics that do not provide extreme privacy protection, even anonymity, i.e., likely disallowing methods to permit location data to leave the vehicle without driver/owner control.” This member stated that Brazil’s Federal Government recently made it illegal to mandate “tracking-enabled telematics,” and concluded that thin-client approaches for road-user charging “will likely have little market in countries that follow this guidance except for commercial vehicles.”

B. Odometer Reading-Based Model

Panel members discussed two primary issues with regard to the odometer reading-based model:

- odometer tampering, and
- how to account for out-of-state mileage.

1. Odometer Tampering

A major point of discussion among focus group participants on the odometer reading-based model was the potential development of a whole “odometer tampering industry” in response to the fee. Researchers were interested in finding out from the panel how difficult odometer tampering is, how prevalent the practice currently is, and any potential deterrents that could be (or are currently) implemented to the practice.

Odometer tampering is indeed an issue that the state will need to evaluate. In fact, according to the GNSS and GPS tolling systems representative, state officials will need to rigorously assess all potential means of “gaming” the VM fee system, as honest drivers will be tempted to cheat the system if they perceive that a substantial number of their fellow drivers are doing so. According to this panel member, “Any metering system must be very hard to cheat and must be known and seen as very hard to cheat.”

One panel member noted that odometer tampering is actually quite hard to accomplish and is not that widespread. Entities like CarFax collect odometer readings and title histories from vehicle

inspections and work to reduce the incidence of odometer tampering. However, no one generally audits these systems, and the state would need to do so in the future if it were to build a VM-based fee system upon an odometer reading platform. Another panel member stated that while people can tamper with current odometers, the effort itself requires the use of special software and expertise that is beyond the reach of a casual offender. One panelist said that it might be possible to utilize time stamped photographs of odometers at various points in time (such as vehicle registration).

One panel member noted that “sealed” odometers can be used at a cost of about \$100 but are not standard on all vehicles. Another panel member mentioned law enforcement officers requiring mandatory odometer checks every time they stop a vehicle for a traffic offense or to spot-check for some other licensing or registration purpose.

Due to the effort involved in tampering with odometers, the issue becomes a matter of cost versus benefits. “At what point do the potential savings from cheating (not the total bill) justify the effort?” This member stated that it may be possible to estimate a break-even point at which the cost of cheating is lower than the cost of simply paying the bill, but this would require more knowledge as to the true cost to tamper with an odometer. Officials could then perhaps mine various data sources to look for potential violators.

2. Accounting for Out-of-Jurisdiction Mileage

While not a major concern for most participants in the focus group sessions, some participants did raise questions about how the state could implement an odometer reading-based VM fee system so as to account for mileage that drivers accrue outside of the jurisdiction of the levying entity. As such, researchers posed the issue to the technology panel for input.

One of the panel members noted that the question itself was peculiar, in that the government allocates vehicle registration fees to the state (and county of registration) but does not allocate across other states based on usage. This panel member noted that VM fees could function in a similar way. This will likely not be an issue unless fees vary a great deal from jurisdiction to jurisdiction. This panel member went on to note that the International Fuel Tax Agreement requires interstate truckers to log their mileage so as to allow the government to allocate diesel tax revenues among the various states based on use. The government audits this system, but studies suggest that evasion may be significant. The panelist also noted that it might be possible to apply a similar system in Texas given the size of the state. Another panelist suggested that the best way to account for out-of-jurisdiction mileage would be to develop an opt-in system that would allow users to install an onboard unit capable of metering mileage and transmitting it to a back-office facility.

C. Cellular/Zone-Based Model

The technology panel discussed several primary issues with regard to the cellular/zone-based model including:

- mandating participation,
- how to address the need for professional installation,
- addressing privacy with regard to this model specifically,

- how to address the potential for tampering,
- the reliability of the technology,
- auditing
- enforcement, and
- how to account for out-of-state vehicles.

1. Mandating Participation

For the cellular model, mandating in-vehicle equipment will be unpopular. Therefore, the state should make the adoption of any onboard technologies used in the administration of the system optional and then provide incentives to encourage vehicle owners to adopt the technology. This would be similar to the manner in which toll transponders are promoted, which enable vehicles increased access to high speed toll lanes and/or discounted toll rates. Another panel member stated that all “legacy” vehicles (those without the necessary OBD-II connections) would likely continue paying the fuel tax. This member said that non-participants could also be subject to an annual fee assessed through an odometer reading. If the vehicle having its odometer assessed is OBD-II equipped then the per-mile fee should be greater than the fee assessed through the use of the optional onboard equipment.

The panel also discussed pricing incentives. In-vehicle systems themselves can offer a variety of additional incentives to vehicle owners who choose to participate. The wireless technology applications consultant noted that “a well executed system would permit the necessary technology to be incorporated into other devices (rather than mandating a sole-sourced single-purpose system which will quickly become obsolete).” This could be an open system architecture with regard to data management. Such an arrangement would allow other onboard services and equipment, such as vehicle navigation systems and/or entertainment systems, to double as a VM charging device. Facilitating this would likely require state issuance of criteria, such as rate plans, auditing, tampering, and data format requirements, for which device manufacturers would apply and receive certification from the state to provide.

2. Installation Issues

Focus group participants raised one concern on the cellular model about the need for a professionally installed onboard device. One panel member stated that actual installation might be quite simple and would “not require any substantive skill.” The only skill an installer would need would be to locate and recognize each vehicle’s OBD-II port and physically mount the unit. Some additional data entry might be required, but this panel member did not believe that the term “professionally installed” was warranted. The system really only requires certified installation so that agents may read the odometer when initiating the system and at regular intervals so as to prevent fraud.

Another panel member said that an additional challenge with a system that connected to the vehicular OBD-II port would be making sure that those vehicles not pre-equipped with the necessary interface (or vehicles that otherwise cannot accommodate the technology) can participate in the system. This panel member commented that no single onboard technology can work, and that the transition cannot be an all-or-nothing choice due to the time and expense that would be required to equip every single vehicle.

3. Privacy Issues

A panel member said that the cellular system-based VM fee systems currently being tested are not collecting specific latitude and longitude location data. Cellular tower location is proprietary and not required by the system to determine location. The units themselves are incapable of reading or otherwise determining location. They are only capable of identifying a zone of travel.

4. Issues with Tampering

The cellular location-based units currently under development would be located under the dashboard and would connect to the all post-1996 vehicles' OBD-II ports. The pins on the connector provide all power to the device and ground it, and the device requires no other connections to the vehicle and users cannot accidentally remove the unit. It would be possible for unit designers to develop a virtual odometer within the unit that could be read and compared to the actual odometer for verification that mileage accrued is accurate.

5. Cellular and Onboard Unit Reliability

While there are areas that do not have cellular coverage, back-office personnel can still aggregate mileage on a zone basis using readings obtained from the OBD-II connection. As a vehicle accrues mileage, it would be stored in the unit until the vehicle passes through an area with cellular coverage, at which time the unit would send the mileage. Personnel could lump all rural areas, or in general areas with poor cellular coverage, into a single zone.

Designers could develop a system that, in the event a vehicle's unit does not transmit VM fee totals on schedule, notifies the owner of the vehicle that the unit is malfunctioning and requests that they take it to a certified agent for repair. The agent could then, upon repairing the unit and conducting an odometer reading, forward a mileage reading to the billing office.

Designers can also set up the system so that every time a set of data is transmitted to the back office, the device can expect to receive an acknowledgment signal (or other unique code) back from the billing center. In the event that the back office does not receive the data, and the device receives no acknowledgment signal, the unit will continue to aggregate VMT. At regular intervals the device will attempt to re-transmit until it eventually receives an acknowledgment. At that time, it would reset its VM readings and continue the process.

6. Auditing Issues

Panel members viewed the inability to audit charges accrued under the cellular model as a serious drawback to the system. However, they commented that transportation officials could adapt the system to allow for a minimal level of auditing or could facilitate more detailed auditing but with a reduction in driver privacy. The primary method by which officials could facilitate auditing would be by giving each device a unique serial and each driver a unique pin number. A user could then send requests to the billing office for travel information regarding the requested unit. The billing office would forward the vehicle identification number, estimated mileage associated time stamps, and other available information that the user requested. The user could then drive the vehicle over a selected route in order to verify that the information the billing office sent is accurate.

7. Enforcement

In the eyes of focus group participants it would not be possible to adequately enforce the use of an externally fixated unit for the counting of mileage due to the perceived ease of tampering and the fact that it can just be “disconnected or turned off.” To address this issue, the technology panel affirmed that officials would have to verify use of the equipment on an annual basis by taking an odometer reading and comparing this value to the value stored in a virtual odometer maintained by the device. Mileage amounts obtained through the odometer reading that are over the value obtained from the onboard device would presumably be subject to an additional fee and possible fine or revocation of vehicle registration.

8. Accounting for Out-of-State Vehicles

A major concern for focus group participants was how out-of-state vehicles, which would not be equipped with the necessary equipment, would pay under the system. These participants believed that it would not be fair to subject Texas drivers to a new fee mechanism without levying some sort of increased fee on out-of-state drivers (or other drivers not participating in the system) who nonetheless benefit from the use of the roadway system. The general opinion of the panel was that the best way of addressing this would be to increase fuel taxes such that, in the case of a VM fee system implemented as a replacement for the fuel tax, those participating in the pricing system would not pay. This would be difficult in that the increase in and of itself would be difficult to accomplish given public resistance. This presumes that a system for crediting fuel taxes against mileage fees paid at the pump (or through some other mechanism) is in place.

9. Other Issues

Participants in two of the focus groups expressed concern that onboard units might somehow be capable of shutting down vehicles and preventing them starting in the event that a driver has not paid the fees. Panel members noted that this would not be possible with either the GPS or cellular-based models that researchers presented to the focus groups.

A few focus group participants also raised the issue of the cost of cellular services used in conjunction with this system. Panel members estimated that costs would run no more than \$5 a month and perhaps as low as \$2 month. This cost would be comparable to sending about two text messages per week.

D. GPS-Based/Facility Specific Model

The main topics of discussion with regard to the GPS-based/Facility Specific Model included:

- perceived system complexity,
- how to address governmental access to travel information, and
- enforcement.

1. System Complexity

One panel member noted that the power of a GPS-based system to enable detailed time and location pricing presented two problems:

- Due to the number of options, the system could potentially become too complicated for the average driver to understand.
- The ability of subordinate jurisdictions to impose individual fees risks further complicating the system and overburdening drivers.

This panel member stated that work on truck VM fees in New York State has indicated that motor carriers tend to prefer simple, flat fees as opposed to fees that vary by class of road. This panel member recommended that the state consider limiting the ability of local entities to impose VM fees that vary based on various characteristics.

2. Government Access to Travel Information

The most predominant concern that focus group participants expressed was the level of detail that the GPS-based system collected and subsequent government possession of that data. Many participants feared that the system would use such data to either actively track participants, with government officials essentially monitoring their movements in real time. Another expressed concern was that various governmental entities would use the data to perform “social engineering” and attempt to influence driving behavior to suit governmental whims.

One panel member noted that much of the concern expressed in these focus groups likely stems from general mistrust of government. This panel member said that one of the best ways to garner the public’s trust on these systems would be through the government implementing pricing programs that are optional in nature and making these systems attractive to potential users. Offering value-added services would surely help this effort. This panel member went on to state that another way of addressing issues related to data collection would be through placing just enough intelligence and knowledge of map boundaries within onboard devices that they are able to aggregate travel during particular periods. Only accumulated miles per region (as researchers tested in the Oregon Road User Fee Pilot Study) would be transferred to the billing entity.

Another alternative that panel members identified would be to use private third parties as a “privacy shield.” These entities would be responsible for handling travel data prior to any transmittal to a governmental entity. Yet another alternative would utilize a cryptographic technique with a “zero knowledge protocol.” Such protocols involve using random vehicle identifiers and the utilization of multiple entities during the computation process (28). Implementing such a system would make it possible for the billing entity to collect charges while at the same time preventing it from knowing the specific whereabouts of each vehicle.

3. Enforcement

As with the cellular-based model, focus group participants expressed concern about the ability of any governmental agency to enforce use of the required technology, as it appeared to participants to be too easy to simply turn off, or simply not use, the required onboard units. A panel member noted that autonomous road-tolling systems involving telecommunications typically include:

- an in-vehicle telematics element;

- a computational element that at least manages the business rules (pricing rules in time and geography), and that at most manages the full calculation and preparation of a bill; and
- a back office that manages billing and collection.

This panel member stated that the fourth element of these systems is generally some sort of enforcement mechanism that is interconnected with “at least one and likely two and possibly all three of the first three components.” The panel member stated that no international privacy guidelines, such as the Sofia Memorandum, have addressed the interconnection of these components for the purposes of enforcement and that data encryption will be of critical importance.

The panel member continued that this presents an opportunity for domestic leadership in terms of privacy and recommended that the government form and fund a national standards group, using the Sophia Memorandum as a starting point in addressing these interconnection issues. This group would include technology experts such as those gathered for this research effort, an expert in privacy law, and representatives from the United States Department of Transportation (USDOT), the American Association of State Highway and Transportation Officials (AASHTO), and several states. The group could invite representatives from companies currently providing or managing RFID tolling systems.

V. STAKEHOLDER INTERVIEWS

A. Introduction

Researchers conducted 13 stakeholder interviews involving a total of 16 individuals as a part of this research effort. The purpose of the interviews was to gain insight and perspectives from a variety of interest groups and agencies that have a stake in the state's transportation system. In general, the individuals that researchers interviewed brought a fundamental knowledge of transportation funding as well as state and local transportation needs. In some cases they represent the interests of particular constituents and transportation user groups. Researchers assembled a master list of 80 stakeholders from across the state representing three categories:

- transportation advocacy groups,
- organizations oriented toward economic development, and
- TxDOT planning partners (metropolitan planning organizations, councils of government, regional mobility authorities, etc.).

Researchers used a random selection process to narrow the candidates within each group and then made adjustments to the final list to ensure representation by geography and community size. With one exception, all of the organizations are based in Texas. Interviews occurred in person or by phone and took place between April 2010 and July 2010. The 13 organizations and interviewees were:

- John Esparza and Les Findeisen, Texas Motor Transportation Association;
- Christopher Evilia, Waco Metropolitan Planning Organization;
- John Fishero, Greater Tomball Area Chamber of Commerce;
- Barbara Holly, Tyler Metropolitan Planning Organization;
- Kyle Ingham and Gary Pitner, Panhandle Regional Planning Council;
- Mike Joyce and Tom Weakly, Owner Operator Independent Drivers Association;
- Dan Kessler, North Central Texas Council of Governments;
- Robert Martinez, Greater Irving-Las Colinas Chamber of Commerce;
- Gabe Sansing, Georgetown Transportation Enhancement Corporation;
- Dan Ronan, AAA-Texas/New Mexico;
- Paul Sugg, Texas Association of Counties;
- Steve Stagner, Texas Council of Engineering Companies; and
- Raymond Telles, Camino Real Regional Mobility Authority.

Prior to each interview, researchers provided the subject with a description of the research study and a 25-page educational document on VM fees (29). The interviews revealed that the level of knowledge, understanding, and in-depth consideration of the subject varied considerably among interviewees. Less than half of the 16 individuals who participated in the interviews had given the topic any level of thought prior to reviewing the educational piece.

The interviews followed a common set of questions but varied in length and level of detail:

- What is your vision for transportation for Texas?
- What are your concerns about the future of transportation?

- What are your strategies for addressing concerns?
- What is your opinion of vehicle mileage fees?

The remainder of this chapter summarizes the major themes that emerged from the interviews.

B. What Is Your Vision for Transportation for Texas?

A number of participants responded to this question, with several commonalities among respondents. The most common responses, in no particular order, were:

- Keep up with population growth and the associated demands placed on the system.
- Support economic vitality.
- Provide for the safe movement of people and goods.
- Maintain investment in the current infrastructure.
- Develop a multi-modal system.
- Accomplish the vision through multiple partners, including regional and local entities.

Individual groups placed greater emphasis on certain goals than others based on their constituencies. Interestingly, only one interviewee specifically identified congestion relief, though several of the goals that interviewees communicated related to congestion reduction. In general, the vision represented by the interviewees largely aligns with that of TxDOT's strategic planning process (30).

C. What Are Your Concerns about the Future of Transportation?

The responses to this question fall into two categories. The first category is the inadequacy of funding, both now and into the future. The consensus among respondents is that highway funding is not keeping up with the growth in demand. Several interviewees expressed concern over the high reliance on debt. Stakeholders expressed an uneasiness with public perception that funding is adequate, partially by virtue of bond-supported construction activity that motorists regularly encounter in several of the state's large metropolitan areas. The concern relates to the reality that within several years available funding will experience greater limitations, and therefore result in much less construction activity, due to bond debt. Several respondents also felt there were too many restrictions on use of funds at the local level, which reduces the flexibility to apply the money to local and regional needs. Several interviewees had concerns about the impact that the strained relationship between TxDOT and the Legislature, as well as broader state budget issues, will have on the potential for additional transportation funding in the near future.

Approximately half of the respondents raised concerns over the long-term sustainability of the fuel tax due to vehicle fuel efficiency, alternative fuel vehicles, and the declining buying power of the fuel tax. Stakeholders also raised long-term equity concerns with the fuel tax, along with "misuse of user fees" through exemptions.

The second category is the diversion of transportation funding to non-transportation uses. There was overwhelming consensus among the interviewees that the government needs to strictly

dedicate any new funding sources to transportation, both from fairness and public acceptance standpoints.

D. What Are Your Strategies for Addressing Concerns?

Stakeholders proposed a variety of funding approaches, communicated as a “mix of fixes” and “blend of strategies,” as near-term funding policies:

- fuel tax increase,
- vehicle registration fee increase,
- tolling,
- taxes on driving-related products,
- bonding,
- fuel tax indexing,
- local option taxes for transportation, and
- local funding sources.

Some interviewees did not support some approaches, such as indexing, bonding, and local funding sources, and in some cases, interviewees strenuously opposed these approaches. A universal theme, however, was the premise of dedicating all new funding to transportation. For example:

- *“Moneys must go to transportation and not other services.”*
- *“How and what you use the money for is a compelling argument for increasing funding.”*

Most of the respondents believed it was important to begin exploring other long-term options, such as vehicle mileage fees, in recognition of long-term concerns with sustainability and equity of the fuel tax.

E. What Is Your Opinion of Vehicle Mileage Fees?

In all interviews, researchers directed most of the discussion on feedback regarding VM fees, covering topics such as perceived advantages and disadvantages, barriers to implementation, and issues to be addressed. Researchers distilled the general themes into five broad areas:

- support for the user fee approach,
- immense implementation hurdles,
- concerns about state interoperability,
- emphasis on simplicity, and
- the need for public education.

1. Support for User Fee Approach

There was strong consensus on the premise of VM fees as an equitable user fee approach and a preferred strategy as the current user fee (i.e., fuel tax) becomes less equitable and sustainable over time. Several respondents emphasized the notion of treating the transportation system as a utility with “pay for use”:

- *“The idea of a use tax is one that most people can embrace because it gives you a choice about paying for what you are using.”*

- *“The best thing for drivers is to pay for what you use.”*
- *“It makes sense to pay for your use.”*

2. Immense Implementation Hurdles

Despite the overwhelming response that a mileage fee system is a desirable user fee approach, the respondents largely expressed concern that implementation hurdles are too great, especially public and political acceptance as it relates to the areas identified in the focus groups: privacy, cost, and enforcement. Additionally, researchers noted the following specific public and political acceptance concerns.

a. Political Resistance

- *“I’m not trying to denigrate the notion of VMT fees, but the political side of it is a long way from being resolved. More experimentation is needed in the short run aimed at political acceptance, as it is not a reasonable political option in any shape, form, or fashion.”*
- *“I understand what is needed, but politically I don’t see how this can happen.”*
- *“We should be looking at political utility: what is doable, what works, and what is politically acceptable; until there is a technological solution with broad political acceptability, and scalable to a national level, it is a pipe dream.”*

b. Lack of Trust in Government

- *“The general political environment promotes a perception of government fraught with inefficiency and fraud; current politics tend to play upon these attitudes; that’s a big picture issue, not just transportation.”*
- *“There is a need to overcome the perception of fraud and waste.”*

c. Unanswered Questions: Technology, Fee Assessment, Setting Rates, Distribution of Funds

- *“One thing that absolutely has to happen for this to move up the food chain of possibility is there’s got to be some pilot programs with different technologies that allow sizable populations within an area to have a better feel for how it might work.”*
- *“A pilot study is needed to show people that this can work.”*

d. Concerns about Fairness, Particularly for Rural Drivers

- *“The impact on rural areas—perceived and real—will present some challenges.”*
- *“I don’t want rural or low income drivers to be considered the ‘other guy’ who is supposed to pay for this.”*
- *“There should be a premium on urban drivers who contribute to congestion, which is where the money will go.”*
- *“Urban drivers will make the transition to higher fuel efficiency vehicles more quickly; do rural drivers understand this? I don’t think it’s wrong to let people know that lower fuel efficiency vehicles are going to be paying a higher proportion for use. This fact can be framed as ‘your urban brethren are shifting the burden to you.’”*

3. Concerns about Interoperability among States

Interoperability is a significant concern, particularly for the trucking industry and is viewed as a barrier to implementation.

- *“If it is rolled out state-by-state, it could be nightmarish. If it came down from the federal government, and was mandated across the board, this would probably be a lot easier to do.”*
- *“There is frustration that the federal government is not leading, because we will end up with a patchwork quilt of systems.”*

4. Emphasis on Simplicity

Researchers repeatedly heard the assertion that a roll-out of VM fees should start simple, with pursuit of testing of alternative mechanisms to address technical viability, driver options, and increased public understanding.

- *“Initially forgo congestion pricing and other esoteric policies.”*
- *“Start with odometer readings, and as people get used to it, make it compatible and upgradable.”*
- *“People don’t like having only one option.”*
- *“GPS devices on cars from the get-go is not going to fly; it’s like telling them in a very direct way that their free road will now be tolled.”*
- *“Get people’s buy-in to change, which will happen if they see an advantage; provide something they can use on a daily basis that would be valuable.”*
- *“The simplest of the various options will demonstrate to people that they can, just as they do now, pay for their user fee and purchase of fuel in one transaction, even if the user fee component of that is calculated differently based on their amount of driving.”*
- *“Change needs to happen gradually to be accepted.”*

5. Need for Public Education

Stakeholders emphasized the need for education of the public and elected officials. Given the very limited level of public understanding, the interviewees recognize there is no compelling argument to migrate to a new taxation system. Stakeholders made a number of suggestions on how to raise awareness, particularly as it relates to messaging.

- *“People start tuning out when you give them big numbers, like \$385 billion in transportation needs. But they can understand \$24 per month and improvements to the route they use every day.”*
- *“We have become twisted in our thinking: we are willing to pay cell phone connectivity at high levels on a monthly basis and not other services like transportation that are completely taken for granted.”*
- *“Overall state context important, don’t lose that in the messaging.”*

VI. PRELIMINARY RESEARCH CONCLUSIONS

There are both opportunities and challenges associated with future examination, testing, and application of vehicle mileage fees. Researchers drew the conclusions presented below from the focus groups, stakeholder interviews, and technology panel interactions that resulted from this study.

A. Challenges: Public Acceptance Barriers

While there are numerous public acceptance barriers facing VM fee implementation, the three primary issues that researchers identified in this study are:

- feasibility,
- the rationale for transition, and
- fairness.

1. VM Fee Implementation Is Viewed as Infeasible and Unworkable

While study participants viewed VM fees as a logical and sustainable funding mechanism, they did not view them as being a workable solution. One stakeholder used the term “pie in the sky” in reference to these fees, and this description captures a general sentiment that researchers heard in the focus groups as well as stakeholder interviews. To put it quite simply, most do not view VM fees as being feasible to implement. Simple odometer reading-based systems appear to be too easy to evade and too onerous for the driver, while more high-tech options appear to be too complex to properly administer and just as difficult to enforce. The pessimism toward direct road user charging is due to the fact that such systems represent a fundamental shift over the current system, and public as well as political acceptability will be a major barrier.

2. The Rationale for Transition to VM Fees Has Not Been Adequately Established

The public in general does not see a compelling reason for transitioning to a new user fee system, even if that new system is logical and sustainable. While this sentiment owes a lot to the documented lack of knowledge of the current funding system, it is exacerbated by many other factors.

a. The Current Transportation Funding System Needs to be Fixed First

First, there is a strong conviction that the state should fix the current funding system before looking for new sources of revenue. For many stakeholders and focus group participants, the merits of pursuing VM fee implementation do not hold up when it becomes apparent that the state can adjust existing revenue mechanisms. For example, while electric vehicle market penetration may one day warrant consideration of fees based on mileage, these vehicles are not a substantial presence in the domestic auto fleet, and the state can easily address current and near-term revenue shortfalls by simply raising the fuel tax. However, there is also a consensus that there is a lack of political will to make these necessary decisions.

b. Lack of Consensus on Addressing Issues Related to Increasing Fuel Efficiency

Second, the effect of increasing fuel efficiency on fuel tax revenues is recognizable and salient, but there is no consensus on how to address the issue. Stakeholders and focus group participants recognized that continued increases in fuel efficiency will have a negative effect on future fuel tax revenues. The current fuel tax system essentially subsidizes travel by highly fuel-efficient vehicles and electric vehicles, as they pay less in fuel taxes or do not pay fuel taxes at all. Some of those participating in this research effort, in both focus groups and stakeholder interviews, felt that this practice should continue. However, there was a consensus among a larger percentage of study participants that the state needs to capture revenues to a greater extent from these particular users. Therefore, future VM fee implementation should incorporate outreach elements designed to highlight the relationship between fuel efficiency and fuel tax payments, and illustrate how VM fees more accurately reflect actual use of the roadway network.

c. Addressing “Diversions”

Third, perceptions regarding diversions distract from discussions about the long-term sustainability of the fuel tax. Regardless of the actual magnitude of various diversions of fuel tax revenues to non-transportation related uses, the perception that the government is spending large amounts of funding on non-transportation related uses will be a major impediment in discussions regarding the need to evaluate alternatives to the fuel tax. Focus groups participants and stakeholders alike indicated that the state needs to address diversions before looking to fuel tax alternatives. Implicit in this argument is that any new revenues, whether from an increase in the fuel tax or the implementation of a VM fee, must go to transportation-related uses in order to maintain a high level of public acceptance.

d. Distrust in Government

Finally, there is general distrust in government, which poses a significant barrier in terms of addressing transportation funding issues as they relate to new fee mechanisms. A general distrust of government characterized many of the focus group sessions, and several stakeholder interviews highlighted public perceptions about the inability of government to function efficiently and without fraud. This distrust presents a serious issue for the government, not only in implementing VM fees but in addressing long-term transportation funding and financing issues in general as well. It is difficult for transportation officials to make the case that change is needed in the structure of the transportation funding system when the public views existing resources as being wasted. For example, some focus groups participants indicated that imposing new fees would not address the real problems inherent in the system, as “corrupt politics” would still drive funding decisions. Addressing the concerns over perceived fraud and waste will therefore have to be a central component in generating support for reform of the transportation funding system.

This discussion regarding the lack of a well-defined rationale for moving away from fuel taxes has a common theme: to the public there are issues associated with transportation funding and financing that are more immediate, and the government should only address long-term issues after resolving these short-term “easy fixes.” Getting the public to think in the long term will, in and of itself, pose a major challenge. For example, several focus group participants noted throughout the sessions that they do not, and many could not, think in terms of the timeline being

discussed. In discussing the fuel efficiency of the U.S. auto fleet, there were several comments relating to the folly of trying to guess what the auto fleet will look like after 30 years. There were also participants that were skeptical of long-term revenue projections, noting that anything can happen over that time and that there are simply too many unknowns to be able to form an opinion about what should be done.

3. A New Funding Mechanism Will Inherently Raise Fairness Issues

The public will raise fairness issues on a number of different user classes in VM fee implementation. These are most likely to be expressed in terms of impacts on rural and low income drivers.

a. Fairness to Rural Drivers

However, in Texas the most prominent concerns are likely to relate to rural drivers. VM fees appear, on the surface, to unduly burden rural drivers who must drive farther for everyday basic services. The state will have to address these concerns, and a logical first step in the process is to engage the public in a broad-based discussion about what it currently pays in terms of road user fees. Many of the equity related concerns expressed in this research effort, and not just those dealing with rural issues, are rooted in misconceptions about the current system.

b. Fairness to Low Income Drivers

There are also likely to be fairness concerns as they relate to low income drivers. This is particularly true for an odometer reading-based system tied to vehicle registration or inspection or any other VM fee system that would require lump sum payments. As the focus group component of this research effort has illustrated, merely presenting VM fees as a replacement to the fuel tax, such that the average driver would be no worse off than under the fuel tax system, does not do anything to allay these concerns. Outreach programs oriented toward making drivers, and in particular low income drivers, more aware of what they pay for use of the roadway network would likely alleviate some concerns. This would be beneficial because much of the public opposition to VM fees observed thus far stems from a lack of understanding regarding the current funding system.

B. Opportunities: Potential applications of Vehicle Mileage Fees

In spite of the challenges facing a potential state implementation of VM fees, there are significant opportunities, namely because:

- VM fees are seen as a logical and sustainable solution,
- the public could support a simple application, and
- the public is interested in seeing demonstrations that show how such systems would work.

1. Vehicle Mileage Fees Are Seen as a Logical and Sustainable Solution

Study participants generally saw VM fees as a fair way of collecting fees for use of the roadway network. For example, in several instances focus group participants introduced the charging for mileage concept as a means of addressing various issues with the fuel tax before researchers introduced the concept. Many stakeholders interviewed for this research effort indicated that direct charging for road use should be the preferred model for funding infrastructure development. Overall, stakeholders and focus group participants recognized that a continual increase in fuel efficiency will have a negative effect on future fuel tax revenues, in that highly fuel-efficient vehicles will ultimately pay less in fuel taxes or pay nothing in fuel taxes for use of the roadway network. There was also a general consensus that revenues from these users need to be captured to a greater extent.

2. Simple Solutions Will Engender the Most Support

If the State of Texas is to move forward with VM fee implementation, there is a clear preference, expressed both in focus groups and stakeholder interviews, for the implementation of simple systems. In the near term study participants prefer implementing an odometer reading-based system as this system is easy to understand and implementation could take place in conjunction with familiar fee payment systems. There is a level of discomfort with the technologies that might be employed with implementation of more complex VM fees. Implementing technology dependent systems on an optional basis will allow users to adopt the technology when they are comfortable with it, increasing the acceptability of the system. Large demonstrations of the technology will help to increase this comfort, as potential users are allowed to see how the technology operates and how the administrative systems supporting them will function.

3. Demonstrations Are Needed to Show That the Concept Can Work in Texas

The public in general does not see VM fees as a workable solution. Therefore, the state has an opportunity to address several public acceptance issues through demonstrations that would show that it can in fact implement these systems and generate sufficient revenue reliably and accurately. VM fee demonstration and implementation should incorporate outreach elements designed to highlight the relationship between fuel efficiency and fuel tax payments made on a per mile basis. A demonstration would then serve to illustrate how VM fees more accurately reflect usage of the roadway network. Demonstrations will also serve to show the public that the state can institute these systems without drastic change to the current status quo. The key will be to ensure that an eventual transition occurs gradually, in order to allow public and political acceptance to grow. This will help to engender greater support over a transition effort that is implemented quickly without the necessary support base.

Specifically, any demonstration should focus on addressing the three primary concerns as highlighted by the focus group proceedings and stakeholder interviews:

- *Privacy* – The state should perform any demonstration with the goal of showing how driver privacy can be safeguarded from a policy perspective and to address many of the misconceptions associated with the various technologies employed.

- *Administration* – The state needs to carry out demonstrations with an eye toward the eventual administration of the implemented system. As such, state officials should make efforts to determine the required institutional apparatus for administering the system and a cost attached to the upfront and ongoing functioning of that apparatus.
- *Enforcement* – The public must see that the state will collect these fees from those who use the roadway system. A system that is easy to evade will not have the support of the public. Therefore, the state will need to test enforcement mechanisms in any demonstration.

C. Addressing Public Acceptance Barriers

A significant outcome of the technology panel discussion was the fundamental premise that public policy design plays a significant role in addressing public concerns over specific technology applications. Public policy will drive system development, and officials should not view technology as a limiting factor in designing and deploying VM fee systems. While the various technology options discussed in this research effort generate significant public acceptance issues, officials can address the major issues with effective policy design.

For example, state officials can address privacy issues through demonstrations of the technologies employed, but structuring policies so that system aspects related to what information is collected, how and for how long it is stored, and who has access to it will better safeguard driver privacy. Before the state develops any VM fee system, it must first have a broad based discussion of policy as it relates to the public concerns highlighted in this research effort (privacy, administration, and enforcement). These discussions will ensure that any system deployed, and the technologies supporting that deployment, will be designed to address public concerns from the outset.

VII. RECOMMENDATIONS

This research presented three implementation models as distinct “packages”; however, transportation officials can combine various components and elements from each to form a “hybrid” implementation scenario.

Transportation officials should proceed with system development from clearly established and prioritized goals and policies. Policy development is generally the prerogative of legislative bodies or other entities directly accountable to the public and is outside of the responsibility of researchers. However, for the purposes of presenting these implementation models, researchers had to make assumptions regarding future policy development. Therefore, researchers based the implementation models presented in this section on an assumption that public acceptance of the system must be relatively high, and as such, these models are presented due to their abilities to address the three primary public acceptance issues as articulated in the focus group and stakeholder interviews:

- Privacy – Researchers designed the systems presented in this section to minimize privacy concerns by maximizing individual driver privacy for those who desire it and providing options for those with less concern for privacy.
- Administration – Although good estimates as to the actual cost of administering various VM fee implementation models are difficult to develop, these systems represent what researchers believe to be the “low end” in terms of administrative cost. They utilize the lowest cost options in terms of high-tech applications and rely, to the greatest extent possible, on existing institutional frameworks.
- Enforcement – These systems must have robust and reliable enforcement. Thus, the systems presented herein rely to the greatest extent possible on enforcement by associating fee payment with other purchases.

While policy makers should certainly consider these three policies in the development of VM fee systems, there is in fact a broad range of policy issues that they should also consider and evaluate. Researchers have developed a decision matrix, which is included in the appendix that can serve as a tool in evaluating these questions throughout the implementation process. Some of the issues that policy makers will need to address prior to implementing a VM fee system include:

- General revenue goals – Is the goal of the system to merely augment and supplement existing revenues, or is the goal of the system to completely replace an existing revenue base? The answer to this question will help establish many of the administrative requirements of the eventual system.
- Role of the private sector – To what extent will private sector entities be involved in the development and administration of the system?
- System flexibility – To what extent does the system need to be able to accommodate changes in rate structure and jurisdictional boundaries?

- Fee variability – To what extent will fees vary between vehicles? Will rates vary based on time and location? The answer to this question will depend greatly on the goals of the system.

Researchers do not necessarily address these various policy issues in the implementation models that follow, and because of this there is very limited detail on the potential cost for each model. This is largely due to that fact that questions regarding administration, in terms of what actual state entities would be responsible for the various elements of the system and to what extent fees would be applied to the statewide vehicle fleet, are unanswered.

A. Recommendation 1: Electric Vehicle Program Utilizing Odometer Reading with High-Tech Opt-in, Optional Implementation for All Other Vehicles

This recommended implementation model is designed to generate maximum public acceptance with regard to privacy, enforcement, and administration. It features the following elements:

- Upon initial implementation, only electric vehicles are subject to the VM fee.
- The base system features manual odometer readings that would occur at the time of vehicle inspection or registration for the mileage assessment. All mileage is assessed a single per-mile rate under this base system.
- System users would have the option of adopting a higher tech configuration that would utilize commercially available technologies to identify in-state and out-of-state mileage as well as mileage accrued on private property. Only mileage accrued in state and not on private property would be assessed the VM fee.
- If the system proves to be robust and acceptable to the public, policy makers can choose to extend the system to other vehicle classes.

Under this implementation scenario (Figure 8), all electric vehicles and other current non-user fee paying vehicles would be subject to a VM fee. One of the technology expert panel members estimated that there are approximately 22 million registered vehicles in the State of Texas. Of these, about 1 percent (220,000) are hybrids, and about 10 to 15 percent of these vehicles are electric vehicles. With a target vehicle class representing only about 0.1 percent of the entire statewide vehicle fleet, full implementation of this option would therefore encompass a very small percentage of the overall vehicle fleet. Such an approach would be advantageous, as it would serve as both a VM fee implementation as well as a demonstration for the potential phase in of standard passenger vehicles. The state could test the full range of system aspects, including fee assessment and payment, administration, and enforcement, on a relatively small number of vehicles while still collecting revenues. This would allow for a detailed assessment of the system needs and system costs that would be required of a VM fee system encompassing all vehicles.

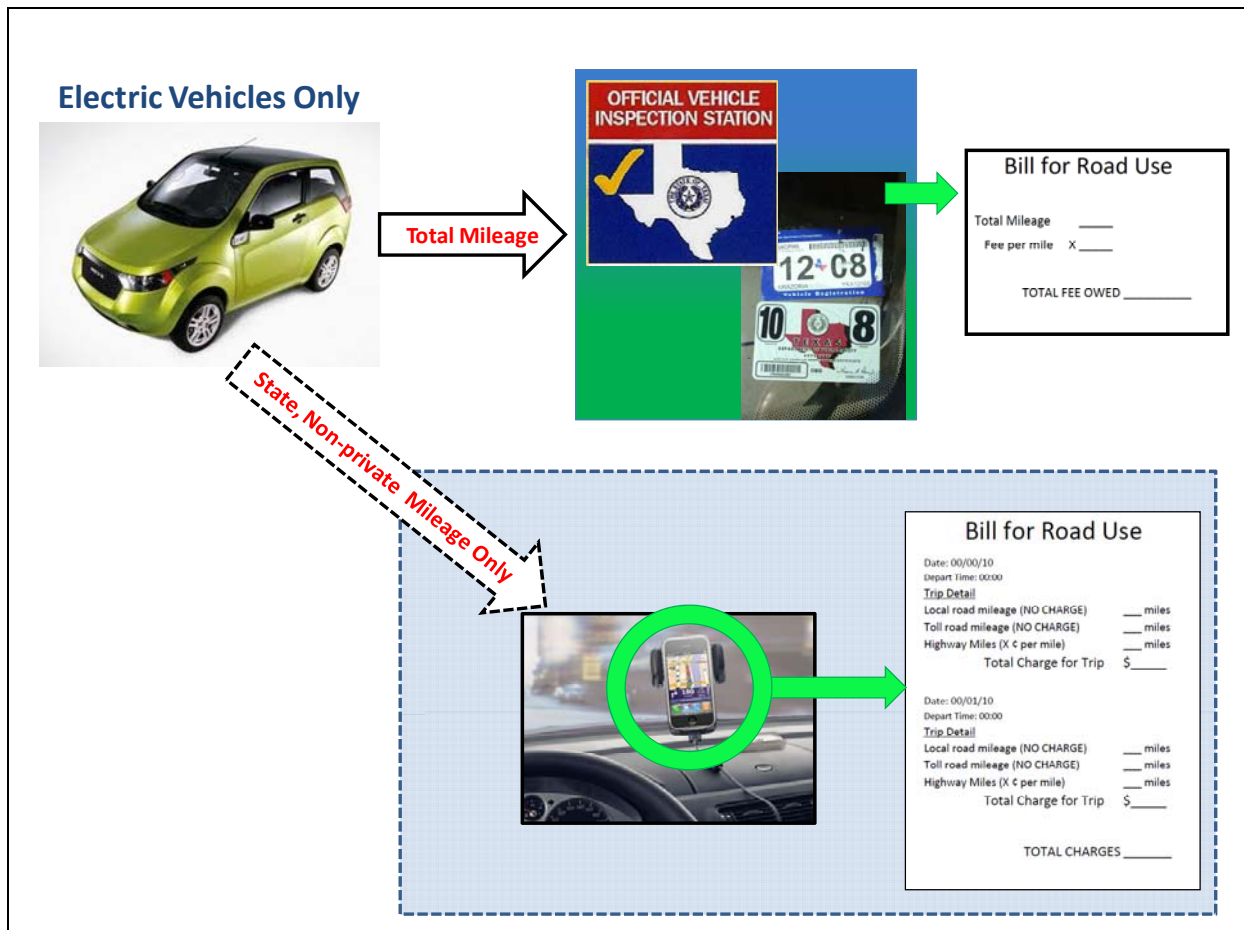


Figure 8. Electric Vehicle Oriented, Odometer Reading-Based Implementation Model.

From a public acceptance standpoint, this model is perhaps the easiest to implement. In the focus groups that were conducted as part of this research effort, participants were generally in favor of charging electric vehicles for their use of the roadway system. While there were elements within each group that were in favor of allowing these types of vehicles to drive without paying user fees, the majority of participants in each group felt that if the primary threat to the fuel tax's revenue base is increasing fuel efficiency, then applying a VM fee to those vehicles that are currently paying nothing in fuel taxes makes the most sense for near-term implementation.

The state would assess fees under this model based on an odometer reading that would be tied into vehicle inspection, the simplest and perhaps easiest method of implementing VM fees in the near term. In Texas, agents already collect odometer readings during vehicle inspections, so the information collection infrastructure is already in place. As an alternative to the odometer reading-based assessment system, the state would offer drivers the opportunity to participate in a more high-tech dependent system, which researchers discuss below.

The mileage fee assessed at the point of inspection would be a flat fee for all mileage accrued since the time of the last odometer reading. This means that all drivers participating in this tier would be paying for mileage accrued outside of the state or other mileage that would be discounted under the high-tech tier. This pricing aspect is one of several potential incentives for

the adoption of the high-tech tier. This system would require drivers wishing to not pay for mileage accrued outside of the State of Texas to adopt the high-tech tier.

Payment of this fee might be problematic from a public acceptance standpoint, as this research effort's focus groups have exhibited an aversion to having to pay such a potentially large lump sum on an annual basis. A possible solution to this would involve utilizing quarterly bills, similar to IRS quarterly estimated payments, where drivers could make estimated payments on their mileage over the course of the year. When the vehicle's inspection is due, and the odometer is read, the driver could then pay for the amount underpaid or have the amount overpaid credited to his or her next estimated payment.

The optional high-tech configuration would utilize aftermarket devices developed around an open systems logical architecture. Open systems configurations allow users to adopt and customize the units that are most desirable to them. Open systems are much more conducive to the development of value-added services, increasing the overall attractiveness of motorists adopting the high-tech option.

The optimal road assessment technology for use in these units would be one that collects detailed travel location in terms of time and location, which would most likely be GPS-based. This is necessary because it is likely privacy will be less of a concern to users adopting this configuration, and they will prefer to have a higher level of audit-ability as opposed to increased privacy protection. The ability to discount out-of-state mileage and provide value-added services through the onboard equipment will serve as additional incentives for adoption of the high-tech system.

In terms of actual implementation, one of the technology advisory panelists recommended that the state pursue legislation that would:

- allow the Texas Comptroller to be the lead agency on fee administration,
- permit the Comptroller's Office to promulgate highway user fee rules for electric and hybrid vehicles, and
- coordinate these efforts with the Texas Department of Motor Vehicles and the Texas Department of Transportation.

Agency rules would identify the "hybrid" fleet based on the vehicle identification number (VIN), make, and model in the Texas DMV data base. There are approximately 1,000 total VIN/make/model combinations each year, and very few of these are electric/hybrid. Therefore, agency officials could identify hybrid and electric vehicles fairly easily with only a few dozen combinations. Each model year the DMV would add a new set of VIN/make/model combinations as the electric/hybrid vehicle fleet evolves.

The success of this all electric vehicle VM fee implementation model could lead to the adoption of a wider VM fee system that the state could apply to all vehicles. The necessary administrative apparatus would already be in place but would likely require substantial expansion. However, because the system is already in place and functioning within the confines of a statewide fee system it should be fairly straightforward to estimate costs associated with the required expansion. Those electric vehicle drivers who have adopted the high-tech option will have

already served as participants in a statewide demonstration of the technology, and other state residents will be familiar with the technology.

1. Enforcement

With a vehicle inspection-based manual odometer reading-based system, enforcement of the mileage fee is built into a pre-established payment system. Enforcement of fees would occur concurrently with enforcement of vehicle inspections. Law enforcement officers will know, for example, that a driver has not paid VM fees whenever they encounter a vehicle with an expired registration tag.

Enforcement of the high-tech tier is more problematic but can nonetheless be addressed through the inspection process. Units can maintain a log of all mileage, regardless whether all mileage is assessed a fee. At the time of vehicle inspection, the entity performing the inspection would have access to the total mileage accrued per unit as per records maintained by the billing office. The inspection entity can then check the mileage recorded by the unit and maintained by the billing office and can assess a flat mileage fee for any discrepancies between the electronic record of total mileage and mileage as shown on the odometer. In other words, it will be in the best interest of users of the high-tech system to ensure that their units are activated and functioning if they are going to be traveling out of state or otherwise accruing mileage that would be discounted. A demonstration of a state VM fee system that involved a substantial assessment of enforcement capabilities by various state entities involved in the system would likely be beneficial.

2. Privacy

While privacy protections are lower under a road assessment architecture that utilizes time and location specific data, the availability of a low-tech, high privacy odometer reading-based system allows users with strong privacy concerns to choose to not participate in the high-tech option. The voluntary nature of this system thus reduces privacy concerns and increases acceptability, as the state is not forcing users to install equipment in their vehicles.

3. Administration

The administrative cost of the low-tech tier will be related to the extent that the state can facilitate data sharing between vehicle inspection entities and the back office. Odometer readings already occur with vehicle inspections in the state, and since fee payment will be occurring in conjunction with the payment of vehicle inspection fees, the presence of a back office staff would be minimal, as personnel would need to maintain only mileage records and fee amounts. This system would likely not need a substantial enforcement and auditing entity.

Administrative costs of the high-tech system are difficult to project, as a significant factor will be the handling of back-office operations. If the system developed does indeed rely on an open systems architecture, then the logical back-office configuration might be one that allows for private entities to handle driver data and payment of fees. This system can link VM fee payment to the payment for other services as provided by the unit.

4. Tax Policy Option: Implementation of VM Fees as a Supplemental Revenue Source, as Opposed to a Fuel Tax Replacement

If, after the successful implementation of the electric vehicle based VM fee system, state policy makers decide to implement a VM fee system for all vehicles statewide, the state will have to answer the question of whether it is implementing the VM fee as a replacement or a supplement to the fuel tax. While the public might prefer that the state implement such a fee as a replacement to the fuel tax, in that the fee will not be perceived as a “new tax,” the state might find it wise to consider implementing the fee as a supplemental fee instead.

Under this policy option, the state would phase in the VM fee alongside the fuel tax as a supplemental fee. The fee would act as an incremental increase in the fuel tax and would not be a true replacement for the fuel tax. Essentially, the state would set the initial mileage fee rate to an amount that is equal to a relative increase in the fuel tax. For example, the state would determine the amount needed or desired in terms of new revenues for funding roadway development. Rather than generate this needed revenue with an increase in the fuel tax, the implementing entity would establish a VM fee to generate the needed amount. The fee is a supplement, so the initial amount is likely to be smaller than what the typical driver pays in total fuel taxes. From that point on, the state could meet funding needs by either increasing the mileage fee or increasing fuel taxes, subject to legislative prerogative. The state could collect the mileage fee either through an annual odometer reading or through the high-tech approach.

This supplemental approach would be advantageous for numerous reasons:

- a) **The state would not need systems to address “double taxation”** – The supplemental mileage fee is not implemented as a replacement. Drivers would therefore continue paying fuel taxes as they always have and there would be no need to develop a system for crediting fuel taxes paid, as the phased mileage fee would be an additional fee levied for road use.
- b) **Annual payments are likely to be small relative to fuel taxes paid** – As this research has indicated, the annual lump sum payment of road user fees, especially fees designed as a replacement to the fuel tax, is not palatable to a large segment of the public. However, because this fee would initially be small relative to the fuel tax, annual payments are likely to be much lower than what the state would see if it implemented a VM fee as a complete replacement to the fuel tax.
- c) **The state maintains incentives for fuel efficiency, but electric vehicles still pay** – Under this implementation scenario, electric vehicles would continue to enjoy substantial savings over traditional fuel vehicles in that they would not be paying fuel taxes (or would be paying reduced fuel taxes for hybrids). However, this system would begin the process of capturing road user costs from these users. In the event that a legislative entity decides to increase funding, it can either raise the fuel tax, if the desire is to place more of the burden on the users of gasoline and diesel powered vehicles, or the VM fee, if it decides that all users should bear the burden equally. This approach also reduces the inherent conflict between generating funding for roads and environmental policy.

5. Administrative Option: “Piggyback” off of the Current State Liquefied Fuels Tax Program

The State of Texas currently levies a 15 cent per gallon fee on liquefied fuels (LF) used in the propulsion of motor vehicles. The state first imposed the tax in 1942 and levies it on fuels such as butane, ethane, propane, and compressed natural gas or any mixture of these gases. Although the state assesses the tax in statute on a gallon basis, it generally assesses the tax in practice on a mileage basis (Figure 9) through a decal program that the Texas Comptroller of Public Accounts administers. Prior to 1980, the state collected the tax from the permitted dealers and suppliers of these fuels whenever the fuel was purchased for consumption. However, in recent years the state has moved to the decal-based system, which involves individual drivers self-reporting their mileage. Since this represents an existing mileage-based system, researchers examined it as a possible mechanism upon which to build a future vehicle mileage fee system.

Class	Vehicle Weight	Less than	5,000 to	10,000 to	15,000 Miles
		5,000	9,999 Miles	14,999 Miles	and Over
A	Less than 4,000 lb.	\$ 30	\$ 60	\$ 90	\$ 120
B	4,000 to 10,000 lb.	\$ 42	\$ 84	\$ 126	\$ 168
C	10,001 to 15,000 lb.	\$ 48	\$ 96	\$ 144	\$ 192
D	15,001 to 27,500 lb.	\$ 84	\$ 168	\$ 252	\$ 336
E	27,501 to 43,500 lb.	\$ 126	\$ 252	\$ 378	\$ 504
F	43,501 lb. and over	\$ 186	\$ 372	\$ 558	\$ 744

Figure 9. State Liquefied Fuels Tax Decal Rates.

Drivers of LF vehicles must renew their LF fuel tax decal on an annual basis. The actual type of fuel that the vehicle utilizes has no bearing on the actual amount the driver pays; however, fee amounts do vary based on the weight of the vehicle. Certain types of LF vehicles are designed to utilize both traditional fuels, such as gasoline, as well as liquefied fuels. These types of vehicles are essentially double taxed in that the decal holder will pay for all mileage, not just mileage the vehicle accrues while being propelled by liquefied fuels, and also pay for any fuel taxes incurred while fueling the vehicle with traditional fuels.

It is possible for decal applicants to obtain a discount for any mileage they accrue out of state. They can do this by keeping a log detailing out-of-state travel and submitting it along with the decal application. Vehicles falling under the decal program are generally registered in Texas and are not participating in the International Fuel Tax Agreement (IFTA) program. According to the Texas Comptroller’s Office, about 90 percent of liquefied natural gas vehicles in Texas participate in the decal program. Program participants represent a mix of vehicle types from personal to commercial but most vehicles are ½ and ¾ ton vehicles. For vehicles registered in the state that are not participants in the IFTA, participation in the decal program is mandatory and

the state will not issue a state inspection sticker without a valid decal. Vehicle owners are responsible for reading their vehicle odometer at the time of application and reporting the mileage on the appropriate paperwork.

Due to the relatively small number of vehicles participating in the system relative to the statewide fuel fleet (there were 9,399 decaled vehicles in the State of Texas as of April 2010 according to officials at the Texas Comptroller's Office), the decal system essentially operates on the honor system. The state does not verify mileage readings, due in large part because the gains to be made in terms of revenue would be offset by the administrative cost of auditing. It is impossible to reconcile reported odometer readings with certified odometer readings taken at the time of vehicle inspection due to the fact that the periods of coverage for both decals are not on the same calendar basis. In other words, certified odometer readings do not occur at the same time as self-reported odometer readings. The number of vehicles running on these types of fuel has also decreased, reducing the need for a more robust verification and enforcement program. Automobile dealerships and fuel suppliers may be subject to audit.

According to officials at the Texas Comptroller's Office, this shift away from mileage verification was also a result of pressure exerted on the Comptroller's Office by various elements of the oil industry. Until the 1980s, the state assessed its LF tax program much like it currently assesses the fuel tax: at the wholesale level. Unfortunately, reporting and subsequent auditing of receipts proved to be quite onerous for the payers, who brought pressure to bear on the state to shift the burden of collecting the tax on down the supply chain. As such, the state collects the current LNG tax from individuals (in the case of the decal program) or from service stations (for the non-decal program).

If policy makers were to implement a state mileage-based fee program such that electric vehicles were the primary participants, then it is likely that an odometer reading would be the quickest method to achieve implementation. "Piggybacking" the system off the state's current LF tax program would likely not be possible absent a more robust enforcement mechanism, as the state rarely audits LF decal documentation. Thus, there would be substantial incentive for evasion. It is therefore more likely that an odometer reading would have to occur in conjunction with state mandated inspection or registration processes. Conducting an odometer reading in conjunction with registration processes would require the development of legislation since such readings occur at the time of inspection but not registration.

The Comptroller's Office believes that any fee enacted as a replacement to the fuel tax, especially one that is assessed at the point of inspection or registration, would require legislation to address the allocation of revenues. Without such legislation it is likely that the state would allocate any revenues generated under the new mileage fee system directly to the General Fund, and from there the fees would be subject to any and all associated allocation processes. There would be no guarantee that the state would use funding generated by the fee for transportation purposes.

B. Recommendation 2: RFID License Plate/Registration Sticker Reading at Gas Pump

If the state decides that an odometer reading-based system with high-tech opt-in is not the desirable implementation model for Texas, another option could be to utilize radio frequency identification tags (RFID) and RFID reader equipment located at fueling stations in a pay-at-the-pump configuration. RFID tags could be located on either the vehicular license plate or within the vehicle registration sticker. The most basic information that the system would require on the RFID tag for this implementation scenario would be the vehicle's estimated fuel efficiency, but the implementing agency could specify the storage of other data.

The system would work within a point of sale context tied to gasoline purchases. Whenever a vehicle is being refueled, RFID readers located on the fuel pump would detect the vehicle's RFID and read the vehicle's estimated fuel efficiency. Then using the amount of fuel purchased, a computer would estimate the number of miles driven. The system would then apply the appropriate mileage fee to the mileage and the total mileage fee to the fuel purchase.

1. Enforcement

From a pure collections standpoint, this model is simpler to enforce in that payment of road usage fees is tied to fuel purchases. However, enforcement activities will be needed to ensure that vehicles have the appropriate RFID tag. With implementation, vehicle makes and models with lower fuel efficiency would have RFID tags that are of a higher value to other drivers. For example, the driver of a very fuel-efficient vehicle, if in possession of an RFID tag coded with a lower fuel efficiency, would pay less for mileage accrued, as the computational algorithm would consistently underestimate his or her mileage. Permanently embossing registration stickers or license plates with vehicle identification information would allow for law enforcement officers to perform spot checks whenever stopping vehicles for infractions.

2. Privacy

Privacy concerns under this implementation would likely be minimal, as the system is essentially collecting no data from the vehicle other than what is transferred through the RFID reader technology at the time of purchase. There may still be concerns with the use of RFID technology. However, the inability of an RFID system to perform real-time data gathering in the absence of an extensive, network-wide system of readers should reduce privacy concerns related to active tracking of vehicles.

3. Administrative Costs

Of the implementation models presented here, this could perhaps have the smallest cost in terms of ongoing administrative and back-office billing costs. This model has no need for an extensive data system for the collection of mileage and the maintenance of billing records. Mileage assessment, charge computation, and charge communication all occur within the point of sale.

However, this system could require significant capital costs upon initial implementation. The state would have to place RFID readers on all gas pumps throughout the state. While the cost of this process is difficult to estimate, the effort could be substantial. The Oregon Department of Transportation estimated that statewide implementation of the model tested in their Road User

Fee Pilot would cost about \$33 million. However, it is not necessary to complete the entire installation of statewide readers all at once. In the absence of these readers, vehicles would continue to pay the fuel tax, but there could be significant market effects as vehicle owners attempt to locate filling stations that are not equipped with the appropriate technology. An increase in fuel taxes, or an initially low rate for mileage fees, could help to alleviate this effect.

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APPENDIX A: SUMMARY OF FINDINGS AND RECOMMENDATIONS ON THE FUTURE OF TRANSPORTATION FINANCING

The following is a summary of the findings of various committees, commissions, and research entities related to transportation financing in general and VM fees specifically.

The Transportation Research Board

In response to ongoing concerns about the present state of transportation funding and specifically the fuel tax, the Transportation Research Board (TRB) formed the Committee for the Study of the Long Term Viability of Fuel Taxes for Transportation Finance. The committee's goals were to "assess what recent trends imply for the future of traditional transportation finance, identify finance alternatives and the criteria by which they should be evaluated, and suggest ways in which barriers to acceptance of new approaches might be overcome."

In its final report, the committee noted that two factors are threatening the viability of the fuel tax as the primary mechanism for generating transportation infrastructure revenues: 1) advances in automobile technology, rising fuel prices, and energy and/or environmental regulations could depress fuel consumption and fuel tax revenue; and 2) the user fee principle of the fuel tax may be eroding as non-highway applications of these revenues proliferate and dependence on non-user fee sources escalates.

Among its numerous recommendations, the committee identified "road use metering and mileage charging" as the "most promising technique for directly assessing road users for the costs of individual trips." These types of fees would require a sustained national effort if governments are to utilize them as the primary mechanism for driving transportation infrastructure investment. The committee also stated that "governments must decide on the goals of the effort, authorities for setting fees and controlling revenue, the basis for determining fees, and how best to involve the private sector." The committee went on to state that the resolution of privacy and fairness concerns will be paramount in implementing these mechanisms.

The committee recommended that states, as well as the federal government, undertake "serious exploration of the potential of road use metering and mileage charging," and promoted the implementation of technical trials to evaluate the reliability, flexibility, cost, security, and enforceability of alternative designs.

National Surface Transportation Infrastructure Financing Commission

The federal government established the National Surface Transportation Infrastructure Financing Commission (NSTIFC) through Section 11142(a) of the Safe, Accountable, Flexible, Efficient Transportation Act: A Legacy for Users (SAFETEA-LU) to investigate and analyze the transportation funding crisis and to "make recommendations to address the growing transportation infrastructure investment deficit." While the primary focus of the commission was to examine highway and transit investment, it also examined investment in other modes of transportation including freight rail intercity passenger rail, waterways, and aviation. This

commission noted that “there is no ‘silver bullet’ solution to the problem of insufficient funding.” The commission also noted that not all approaches will work equally well given the diversity in geography and economy within the U.S. Therefore, the potential solutions presented in the commission’s final report represent a “broad and balanced menu of options” for addressing transportation investment. While the primary focus of the commission was to examine highway and transit investment, it also examined investment in other modes of transportation including freight rail intercity passenger rail, waterways, and aviation. In its final report, the commission stated that “the current federal surface transportation funding structure that relies primarily on taxes imposed on petroleum-derived vehicle fuels is not sustainable in the long term and is likely to erode more quickly than previously thought.” The commission noted concerns regarding global climate change and domestic dependence on foreign energy sources will create a drive for greater fuel efficiency and alternative fuel technology, undermining the ability of the fuel tax to sustain long-term transportation investment.

The commission also observed that fuel taxes do not send appropriate market signals to drivers, leading to inefficient allocation of roadway resources. The commission concluded that this is due to three factors:

- system users are typically unaware of what they pay in fuel taxes;
- fuel taxes and other indirect user fees currently account for less than 60 percent of total system revenue (including federal, state, and local sources); and
- fuel taxes have no direct link to specific parts of the national infrastructure that they provide revenue for.

In response to these issues, the commission noted the emergence of systems based on more direct forms of “user pay” charges, and specifically VM fees, as the “consensus choice for the future.” The commission concluded that in the medium and long term, user charges that are based directly on miles traveled (and potentially on other factors such as time of day, type of road, vehicle weight, and fuel economy) are indeed the best option available. To that end, the commission recommended that a federal mileage fee system, if developed, should serve as a foundation for state and local governments to develop their own mileage fee systems that can be “piggybacked” off of the federal system. In support of this, the commission made the following recommendations:

- “Commence the transition to a new, more direct user charge system as soon as possible and commit to deploying a comprehensive system by 2020.”
- “Ensure that, once implemented, mileage-based fees and any other charges are set to meet the designated federal share of national surface transportation investment needs, and index these rates to inflation.”
- “As the new mileage-based fee system is put in place, reduce and ultimately eliminate current fuel and other vehicle-related charges as the primary mechanism for funding the surface transportation system, recognizing that the fuel tax may play a role in meeting other important national policy objectives.”

- “Establish VMT technology standards and require original equipment vehicle manufacturers to install standardized technology by a date certain that will accommodate the desired 2020 comprehensive implementation.”
- “Initiate an extensive public outreach effort to create a broad understanding of the current funding problem, the proposed solution, the intended method of implementation, and the anticipated impact on individual system users.”

National Surface Transportation Policy and Revenue Study Commission

Like the NSTIFC, the federal government also formed the National Surface Transportation Policy and Revenue Study Commission (NSTPRSC) through SAFETEA-LU. The government specifically tasked the commission with conducting a comprehensive study of:

- the current condition and future needs of the surface transportation system;
- short-term sources of Highway Trust Fund revenues;
- long-term alternatives to replace or supplement the fuel tax as the principal revenue source to support the Highway Trust Fund, including new or alternate sources of revenue;
- revenue sources to fund the needs of the surface transportation system over at least the 30-year period, including new or alternate sources of revenue;
- revenues flowing into the Highway Trust Fund, including individual components of the overall flow of the revenues; and
- whether the amount of revenues are likely to increase, decrease, or remain constant absent any change in law, taking into consideration the impact of possible changes in public vehicular choice, fuel use, and travel alternatives that could be expected to reduce or increase revenues into the Highway Trust Fund.

The government also tasked the commission with “developing a conceptual plan, with alternative approaches, to ensure that the surface transportation system will continue to serve the needs of the United States, including specific recommendations regarding design and operational standards, Federal policies, and legislative changes.”

In its final report to Congress, the commission noted that if action is not taken to remedy the current state of transportation investment in the U.S., then:

- “The Nation’s transportation system assets will further deteriorate.”
- “Automobile casualties will increase, adding to the 3.3 million lives lost to traffic crashes in the last 100 years.”
- “Congestion will continue to affect every mode of surface transportation for ever lengthening periods each day, as a result of the mismatch between demand and supply of limited capacity.”
- “Underinvestment in all modes will continue.”
- “America’s economic leadership in the world will be jeopardized when we cannot reliably and efficiently move our goods.”
- “Excessive delays in making investments will continue to waste public and private funds.”
- “Transportation policies will remain in conflict with other national policy goals.”
- “Transportation financing will continue to be politicized.”

In its final report, issued in December 2007, the commission recommended developing a comprehensive, performance-based approach to allocating necessary maintenance and infrastructure expansion funding. The commission noted that in the short term, fuel taxes should remain a staple of transportation investment revenue, but in the long term (over 20 years) this would be unsustainable. To that end, the commission stated that mileage-based user fees are among the most preferred alternatives to the current fuel tax and recommended that “the next surface transportation authorization act require a major national study to develop the specific mechanisms and strategies for transitioning to an alternative to the fuel tax to fund surface transportation programs.”

The American Association of State Highway and Transportation Officials (AASHTO)

AASHTO is a national organization representing state transportation officials that advocates for transportation related policies and provides various services to states. One of its primary goals is to “reestablish transportation as a national priority,” and its first objective in pursuit of this goal is to “secure national support for sufficient, sustainable ‘net new’ revenue.” As such, AASHTO has partnered with other transportation coalitions to identify and advocate for new sustainable revenue sources for meeting long-term national transportation needs, one of the most prominent of which is VM fees. In its Summary of Legislative Recommendations for finance and funding, AASHTO recommends the following:

Recommendation 8 – Adopt a long-range approach to funding the surface transportation system that gradually moves away from dependence on the current motor fuels tax to a distance-based direct user fee such as a fee on vehicle miles traveled. To do this, Congress should set a timetable to complete development of a new system as soon as it is practical; fund research and development efforts to identify options for system design and technology; and fund a proof of concept test(s) of a VMT-based funding approach at \$50 million per year for 2010 through 2012 with a report to Congress by 2013.

The document goes on to recommend that if VM fees are to be implemented as a long-term transportation funding solution, Congress should direct “vehicle manufacturers to begin incorporating the necessary technology into the fleet so that a VMT fee can potentially be phased in over the 2016–2021 surface transportation authorization period.” Until that time, AASHTO believes that Congress should work to develop simple highway user fee options that would be based on self-reporting of annual mileage that states could collect in conjunction with annual vehicle registrations.

The Bipartisan Policy Center (BPC)

The BPC, a non-profit organization established in 2007 to develop and promote public policy solutions, has stated that federal investment in transportation programs should be centered on “maximizing valuable investments where the returns to society are measured on optimized.” The BPC has noted that the current system of federal transportation financing fails to take advantage of the fact that how users pay for a system can directly influence its performance. The BPC’s recommendations for 21st Century transportation policy include:

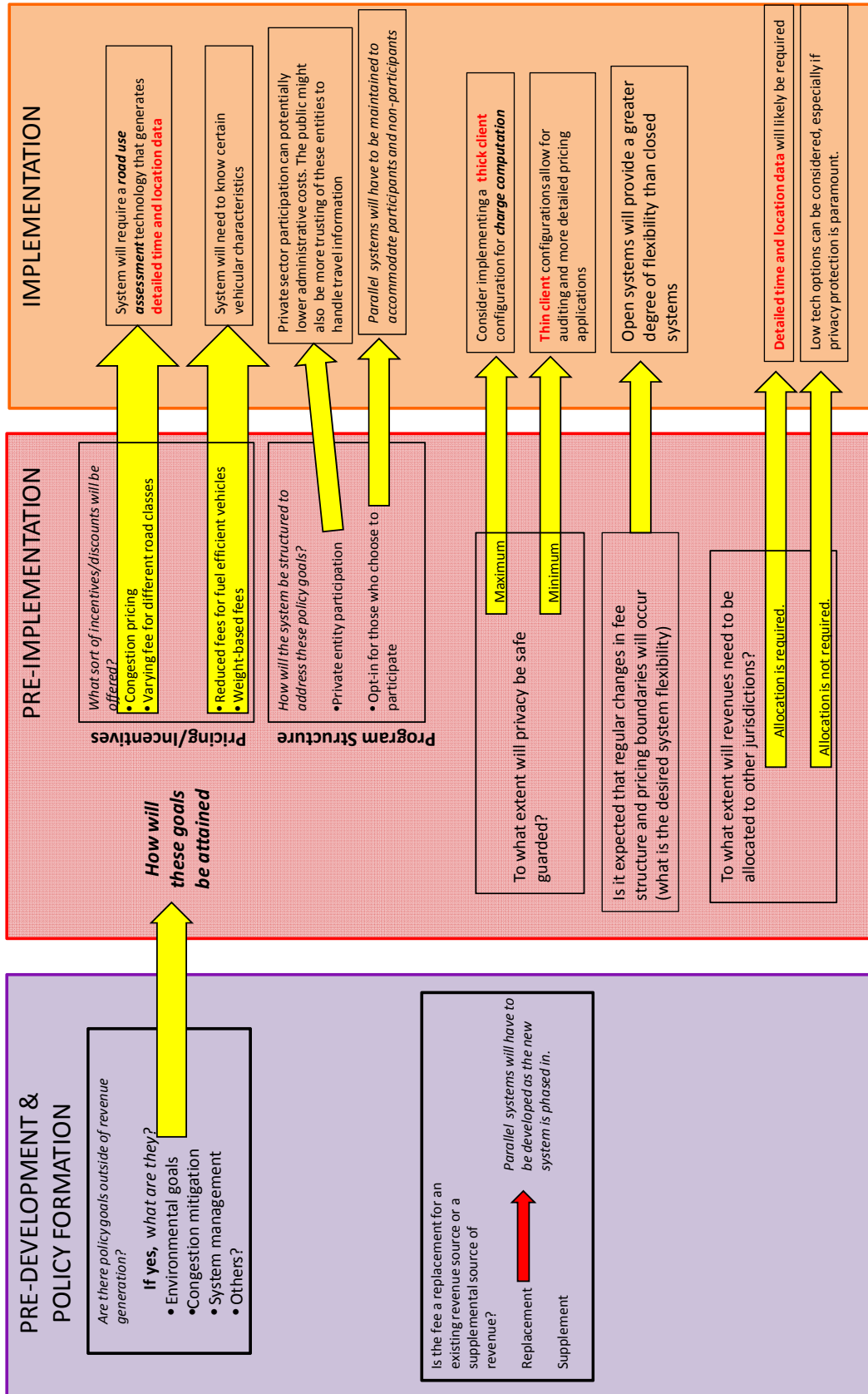
- “Assuring that the nation’s transportation networks are robust and flexible enough to provide for the efficient movement of people and goods while handling growing demands on our ports, trade corridors, and urban centers.”
- “Implementing effective strategies for addressing the growing transportation problems in major metropolitan areas.”
- “Addressing the continued and still growing dependence on petroleum as America’s primary transport fuel—and the economic and geopolitical insecurity that comes with this dependence.”
- “Dramatically reducing the transportation sector’s contribution to global climate change.”
- “Confronting still unacceptable levels of mortality and injury on the nation’s highways.”
- “The notion of equity; the proposition that no one should be excluded from the economic benefits brought about by transportation systems.”

The BPC points out that gasoline consumption has declined, and the BPC expects consumption to continue declining due to a number of factors. If fuel tax levels are not increased then funding for future transportation development will be imperiled. While the BPC does not make recommendations regarding specific revenue generating mechanisms, it does state that revenue collection can “enhance the performance of the system when users more directly understand and bear the full cost of the infrastructure they use.” The BPC goes on the recommendation that “new revenues should be user-based and applied to performance-based programs” and that “a national commitment be made to completing the needed research and planning to transition to a national user-pay funding mechanism.”

International Bridge, Tunnel, and Turnpike Association (IBTTA)

In a presentation at its March 20, 2006, Transportation Improvement Forum, the International Bridge, Tunnel, and Turnpike Association (IBTTA) noted that by 2010 policy makers should establish a vehicle fee as a mid-term solution that captures “fair payments regardless of the fuel used” as a means of addressing future funding gaps.

APPENDIX B: VEHICLE MILEAGE FEE POLICY DECISION MATRIX



Road Use Assessment

	Manual Odometer Reading	Speed-based Measurement (OBD Port)	Speed-Based Measurement w/ Location Stamping	Detailed Time and Location Stamping	Mileage estimation
Privacy	Provides maximum privacy protection	High level of privacy, in that location data is not collected.	Moderate level of privacy protection. Location data is collected but , depending on data transfer time frame, active tracking is generally not possible.	Lowest level of privacy protection. A complete record of travel data is generated. Privacy can be better protected by moving to a “thick” client configuration for fee calculation	High level of privacy, in that location data is not collected.
Data Security	<i>Assessment mechanisms do not affect data security</i>				
Enforcement	<i>Assessment mechanisms do not affect data enforcement</i>				
System Flexibility	<i>Assessment mechanisms do not affect system flexibility</i>				
Ability to Audit	Detailed auditing of charges is not possible with a manual odometer reading. Only aggregate mileage is known	Detailed auditing of charges is not possible with a manual odometer reading. Only aggregate mileage is known	Charges can potentially be audited from a location standpoint, but the time of travel is not known	Detailed travel records are generated in terms of time and location. Drivers can dispute charges and audit travel	Detailed auditing of charges is not possible with mileage estimation. Mileage is estimated based on fuel purchases.
Administrative Cost	Might be minimal provided that the reading occurs within already established registration or inspection protocols	Depend upon back office operations. Might be minimized if handled by a third party.	Depend upon back office operations. Might be minimized if handled by a third party. Roadside equipment maintenance raises cost	Depend upon back office operations. Might be minimized if handled by a third party.	Might be minimal provided that estimation software can be integrated in point of sale equipment.
Capital Cost	Might be minimal provided that the reading occurs within already established registration or inspection protocols	Dependent on technologies employed. The lack of roadside equipment reduces this cost.	Would require the placement of roadside equipment at a level sufficient to cover the priced area.	Dependent on technologies employed. The lack of roadside equipment reduces this cost.	Would require equipment to be placed on all state fuel pumps.
Revenue Allocation	Not possible with any degree of accuracy.	Not possible with any degree of accuracy.	Can occur on a limited basis. Accuracy of mileage readings will be dependent on coverage of the network with readers	Revenue can accurately be allocated based on where and when travel is occurring	Not possible with any degree of accuracy.

Charge Computation

	Thin Client	Thick Client
Privacy	Lowest level of driver privacy. Aggregate travel data leaves the onboard unit.	High level of privacy. Charge computation can occur within the onboard unit.
Data Security	Lowest level of data security. Aggregate travel data leaves the onboard unit.	High level of data security. Minimal data is transmitted from the onboard unit.
Enforcement	<i>Computation mechanism does not affect enforcement</i>	
System Flexibility	Better facilities system flexibility. Individual onboard units do not require updating with new fee schedules and pricing boundaries.	Less conducive to flexibility. Individual units must be updated when changes to rate schedules or pricing boundaries occur.
Ability to Audit	Use ability to audit is better facilitated, as travel records can be provided on a billing statement or travel history can be obtained from the billing entity.	Users must be able to access individual units in order to facilitate auditing of travel.
Administrative Cost	Varies depending on numerous factors, including private sector participation in the system .	Varies depending on numerous factors, including private sector participation in the system.
Revenue Allocation	Revenue allocation is more easily handled, as aggregated travel information is transmitted.	Revenue allocation can occur, but it will require an added level of functionality on the part of the onboard unit so as to delineate between fees accrued in various jurisdictions.

Private third parties can be brought on to act as a privacy shield to offset privacy concerns with regards to a thin client configuration

Vehicle to Back Office Communication

Manual Odometer Reading	Localized, Detection-based (DSRC, IntelliDrive)	Wide Area, Constant Online (GSM)
Privacy is maximized. There is no transmission of data.	Privacy is moderately protected. Uploads occur only when the vehicle is within range of collection equipment.	Privacy protection is lowest. Data uploads occur frequently.
Maximum security, as there is no transmittal of data.	Low because of short transmission distances that minimize opportunities for interception	Moderate, due to the long transmission distances; however, strong encryption methods can minimize this risk
Easy to enforce if tied with the payment of other fees. Self reporting of mileage would be the most difficult to enforce.	Moderate, in that readers would be able to detect offenders but only when they pass nearby. Unit tampering would be an issue.	Moderate in that vehicles can be programmed to offload charge data at some specified time and to send a unit health signal immediately after any malfunction. However, unit tampering would be an issue.
High, as changes in rate structure and jurisdictional boundaries can be easily accommodated.	Low, because of the need to build new infrastructure as the road network expands or patterns of utilization change	High. System can function anywhere that GSM networks are available.
<i>Audit-ability is not affected by communication methods</i>		
Potentially low due to potential synergies with Department of Motor Vehicle and Vehicle Inspection entities.	Moderate, as data transmission using is tantamount to a file download, making it relatively cheap, regardless of amount of data sent. Primary operating costs would be the maintenance and replacement of roadside readers.	Potentially high, as constant data transmission can be costly over GSM networks.
Low, as no equipment is needed.	High, due to the need for an extensive system of readers.	Relatively low because of the potential to use existing cellular infrastructure
<i>Revenue Allocation is not affected by communication methods</i>		

Privacy

Data Security

Enforcement

System Flexibility

Ability to Audit

Administrative Cost

Capital Cost

Revenue Allocation