Mileage-Based User Fees: Prospects and Challenges

Final Report

A Report by Regional Plan Association

NYSERDA Agreement Number 21144

NYSDOT Task Assignment C-10-22

June 2012

Jeffrey M. Zupan and Richard E. Barone with Jackson Whitmore

Notice

This report was prepared by the Regional Plan Association Inc. in the course of performing work contracted for and sponsored by the New York State Energy Research and Development Authority and the New York State Department of Transportation (hereafter the "Sponsors"). The options expressed in this report does not necessarily reflect those of the Sponsor or the State of New York, and reference to any specific product, service, process, or methods does not constitute an implied or expressed recommendation or endorsement of it. Further, the Sponsors and the State of New York make no Warranties or presentation, expressed or implied, as to the fitness for particular purpose of merchantability of any product, apparatus or service, or the usefulness, completeness, or accuracy of any processes, methods, or other information contained, described, disclosed , or referred to in this report. The Sponsors, the State of New York, and the contractor make not representation that the use of any product, apparatus, process, methods, or other information will not infringe privately owned rights and will assume no liability for any loss, injury, or damage resulting from, or occurring in connection with, the use of information contained, described, disclosed, or referred to in this report.

Disclaimer

This report was funded in part through grants(s) from the Federal Highway Administration, United States Department of Transportation, under the State Planning and Research Program, Section 505 of Title 23, U.S. Code. The contents of this report do not necessarily reflect the official views or policy of the United States Department of Transportation, the Federal Highway Administration or the New York State Department of Transportation. This report does not constitute a standard, specification, regulation, product, endorsement, or an endorsement of manufacturers.

<table>
<tr><td>1. Report No. C-10-22</td><td>2. Government Accession No.</td><td colspan="2">3. Recipient's Catalog No.</td></tr>
<tr><td colspan="2" rowspan="2">4. Title and Subtitle
Mileage-Based User Fees: Prospects and Challenges</td><td colspan="2">5. Report Date
June 2012</td></tr>
<tr><td colspan="2">6. Performing Organization Code</td></tr>
<tr><td colspan="2">7. Author(s)
Jeffrey Zupan and Richard Barone with Jackson Whitmore</td><td colspan="2">8. Performing Organization Report No.</td></tr>
<tr><td colspan="2" rowspan="2">9. Performing Organization Name and Address
Regional Plan Association
4 Irving Place, 7th Floor
New York, NY 10003</td><td colspan="2">10. Work Unit No.</td></tr>
<tr><td colspan="2">11. Contract or Grant No.
NYSERDA No. 21144</td></tr>
<tr><td colspan="2" rowspan="2">12. Sponsoring Agency Name and Address
New York State Energy Research and Development Authority (NYSERDA),17 Columbia Circle, Albany, NY 12203; New York State Department of Transportation (NYSDOT), 50 Wolf Road, Albany, NY 12232</td><td colspan="2">13. Type of Report and Period Covered Final Report April 2011 – June 2012</td></tr>
<tr><td colspan="2">14. Sponsoring Agency Code</td></tr>
<tr><td colspan="4">15. Supplementary Notes
Project funded in part with funds from the Federal Highway Administration. Joseph D. Tario from NYSERDA and Robert Ancar from NYSDOT served as project managers.</td></tr>
<tr><td colspan="4">16. Abstract
This report reviews the current research regarding mileage-based user fees for vehicle travel (MBUF), possibly as a replacement or supplement to fuel taxes, which is currently the primary source of transportation revenues in New York State and the nation. The report finds that there are significant but not insurmountable issues associated with the implementation of MBUF. The report also traces and projects the current motor vehicle based funding sources for New York State's transportation capital needs, concludes that there will be a substantial and growing problem, for which MBUF might be able to address. However, there are numerous issues associated with MBUF implementation, primary among these are issues related to the transition from fuel taxes to MBUF, technical matters, privacy concerns, equity among motorists, and higher collection costs.</td></tr>
<tr><td>17. Key Words
VMT, mileage-based user fees, tax, fuel, gasoline, revenue, travel, congestion, funding, transportation, trucks</td><td colspan="3">18. Distribution Statement

No Restrictions</td></tr>
<tr><td>19. Security Classif. (of this report)
Unclassified</td><td>20. Security Classif. (of this page)
Unclassified</td><td>21. No. of Pages 123</td><td>22. Price</td></tr>
</table>

Form DOT F 1700.7 (8-72)

Table of Contents

List of Tables

List of Figures

List of Acronyms

ANPR – Automated Number Plate Recognition

AVI – Automatic Vehicle Identification

DMV – Department of Motor Vehicles

GPS – Geographic Positioning System

HGV – Heavy Goods Vehicle

HUF - Heavy Unit Fee

HUT - Highway Use Tax

IAG – Interagency Group

IFTA – International Fuel Tax Agreement

IMS – Intelligent Manufacturing Systems

IRP – International Registry Plan

MBUF - Mileage Based User Fees

NYSDOT – New York State Department of Transportation

OBD – On Board Diagnostics

OBU – On Board Unit

OEM – Original Equipment Manufacture

PAYD - Pay as You Drive

RFID – Radio Frequency Identification

VMT - Vehicle Miles of Travel

Summary

This report reviews the current research regarding mileage-based user fees for vehicle travel (MBUF), possibly as a replacement or supplement to fuel taxes, which is currently the primary source of transportation revenues in New York State and the nation. The report finds that there are significant but not insurmountable issues associated with the implementation of MBUF. The report also traces and projects the current motor vehicle based funding sources for New York State's transportation capital needs, concludes that there will be a substantial and growing problem, for which MBUF might be able to address. However, there are numerous issues associated with MBUF implementation, primary among these are issues related to the transition from fuel taxes to MBUF, technical matters, privacy concerns, equity among motorists, and higher collection costs.

Transition issues would be eased by an opt-in approach, whereby motorists would have a choice as how to pay for the use of the road network. Technical issues associated with MBUF have been shown in pilot projects to be resolvable. Still, issues of redundancy for billing and verification and of tampering prevention require further research. Privacy concerns are probably the single-most difficult issue, at least from the public perception perspective. To gain public acceptance, a system designed to process the data using on-board units that transmit only aggregate data. Equity concerns will always be part of any fee or tax system and MBUF is no exception. But these concerns can be dampened through a package of other features such as pay-as-you-drive insurance and earmark revenues to communities where the revenues are collected. The higher cost of collection for MBUF will be a significant barrier to implementation unless it can be resolved; fuel tax collection today is only about one percent of the gross collection costs, but MBUF has not been shown to approach that. Until it does the gross revenue collected for MBUF will have to be greater than fuel taxes to yield the equivalent net revenue.

Despite these issues, as this report shows, the risk of staying with our current funding system for funding New York State's transportation network is high. Therefore, MBUF deserves a careful examination, as other states have been doing. Where pilot projects have been instituted there is wide agreement that there are many prerequisites for MBUF implementation, including legislative changes, pilot demonstrations, installation of the necessary infrastructure, all working concurrently. This would be followed by an incremental approach where fees change in phases, perhaps incorporating flat and dynamic tolls as well as parking rates and public transit fares. Implementation would best be done on a volunteer basis to allow drivers to opt-in to the program.

Privacy and equity concerns, along with the public's aversion to paying any new taxes or fees, will make gaining public support for MBUF difficult. Convincing the public that the benefits of MBUF outweigh the downsides will need to be clearly articulated. These will require concurrent services that could save money and add convenience, ease of use, and earmarking of funding for widely supported improvements.

Initiation of MBUF will be difficult to achieve given the multiplicity of jurisdictions through which vehicles pass. And while there is consensus that federal government will have a role in setting standards and resolving interstate and interoperability issues, there has been an equally strong consensus that states and coalition of states, possibly working with existing tolling agencies that will have to take the lead.

Any steps toward implementation must be preceded by an understanding and agreement among policy makers of the goals they see MBUF achieving, i.e., revenue, congestion reduction, equity among them. This begins with the recognition of MBUF capabilities to raise needed revenues, and as systems become more sophisticated to shift vehicle demand to less congested times and to less congested roads.

Recent and projected trends in fuel tax revenues point to a significant decline in revenues for transportation purposes. There is a perfect storm consisting of declining growth rates of vehicle travel, more efficient vehicles and static tax rates. Vehicle miles of travel in New York State is projected to increase by only 1.6 percent in the next decade and a half; vehicles in New York State will become more efficient, increasing from 24 to 36 miles per gallon by 2025 as new federal fuel standards take effect. National travel growth and fuel efficiencies improvements will follow similar trends, and the federal fuel tax will yield less too, translating into less returned to New York State. The effect will be that by 2025 New York State will have 20 percent less fuel tax revenue than it receives today from both state and federal fuel taxes. When coupled with declining buying power caused by inflation, the results could mean drop of more than half in the annual funds available for transportation capital purposes.

The capital needs have been estimated to be slightly less than $16 billion annually for both New York State Department of Transportation and the Metropolitan Transportation Authority combined. This compares with recent average expenditure of less than $8 billion per year. By contrast, current fuel taxes yield only about $3 billion today and will decline to about $2.4 billion by 2025.

Over the last few years, New York State has attempted to counter these trends with large increases in motor vehicle registration and drivers' license fees, but these increases are pressing against the tolerance for further increases.

To close the capital gap through large increases in fuel tax rates alone would require huge rate increases, more than $ 2 per gallon to meet all the capital needs and about $0.75 per gallon just to meet current spending levels. Converting from a per gallon to a sales tax would be similarly massive, require a sales tax of about 60 percent to meet all needs, and about 30 percent to meet current spending levels.

Borrowing to partially close these gaps could ease the problem significantly, but only in the short run; the gaps would rise to similar levels by 2025 to cover mounting interest payments, and beyond 2025 the gap would continue to grow with most funding used to pay for interest rather than for capital investments. Still a combination of short term borrowing, if combined with a long term answer could be effective.

This discussion about what it will take to close the capital program gap for highways and transit in New York State is sobering. Higher fuel taxes, whether remaining as a per gallon levy or converted to sales taxes will require substantially more outlays from the consumer and taxpayer.

This brings the conversation around to MBUF which might be a longer term solution. If MBUF were used to close the funding gap, a uniform rate per mile could be as low as 2.5 to 3 cents a mile to fund the program at current levels, but 8 to 9 cents a mile to meet all needs. A compromise program of about $12 billion could be funded with a 5 cent rate. If MBUF were used to replace the current fuel tax these rates would be about one cent higher. A ten cent per mile rate would cover all capital needs and replace the fuel tax and do it with no borrowing. Seven cents per mile would be required if the compromise program gap was targeted.

These rates would be varied by vehicle type, with trucks paying much more, and with more efficient vehicles paying less to keep the incentive to retain the national objective of lower fuel consumption.

Rates could ultimately be varied by time of day and location to encourage travel at less congestion times and in less congested places, but this would require more sophisticated technology, and would require resolution of real and perceived issues of privacy and data recording and retention.

Mileage based user fees, while having the potential to match the amount paid more closely to the use of the highway network, will still require much higher costs to users. Any of these options will require political leadership that recognizes the economic cost of not funding our massive and aging transportation infrastructure, and is then willing to act and lead to solve the problem.

What then might be the way forward?

Whether the fuel tax is raised on a per gallon basis or as a sales tax, the price at the pump, so ubiquitous displayed along our highways, insures that the average consumer is continually reminded of the price to fill up. This fact alone dampens any willingness to raise the price at the pump to the levels presented her, at least precipitously. This suggests a way forward with the following characteristics:

- Initiate a program of education regarding the capital gap and the critical role of our transportation infrastructure in strengthening the economic well-being in the State of New York;
- Set our sights a bit lower regarding the capital gap of $12 billion annually;
- Legislate increases in small annual increments in the per gallon or percent rate as a sales tax on fuel;
- New York State becomes more fully involved in the programs in other states regarding the initiation of mileage based user fees;
- Peg the MBUF rates to the relative fuel efficiency of passenger cars and light trucks and factor upwards for heavy trucks equivalent to today's fuel efficiency variations between passenger cars and trucks;
- MBUF legislation should provide for increases in the per mile rates to account for additional funding needs or adjustments for inflation;
- Consider the use of toll road agencies as a transition step toward MBUF;

- Explore survey techniques, currently lacking to determine the characteristics of VMT generation, not just for the purposes of mileage based user fees consideration, but for other transportation planning applications;
- Monitor advances in technology that will make location and time based mileage rates more publicly acceptable; and
- Consider borrowing at a modest rate, but only if and when either additional revenue is in place either with higher fuel tax rates, a shift to a sales tax and/or mileage-based user fees in sufficient combination.

Introduction

Over the last few years the potential for the decline of the fuel tax as a source of revenues for investments in transportation infrastructure in the United States, and closer to home in New York State, has become clearer. The confluence of reduced rates of growth in vehicle miles traveled (VMT), more efficient vehicles, and little inclination to increase the fuel tax rate have produced the “perfect storm.” Fuel taxes, both in New York State and in the Nation, are the major source of funding for highway and transit infrastructure investment, raising the specter of declining revenues, even as the needs of our aging transportations systems grow larger. The U.S. Congress and federal administrations of both major political parties have repeatedly rejected fuel tax increases. The federal fuel tax rate has not increased since 1994 and the New York State tax rate has remained essentially the same for a similar period.

Success in finding other revenue sources has been spotty. In 2007, the congestion pricing program advocated by New York City Mayor Bloomberg, which could have provided a substantial level of funding for the Metropolitan Transportation Authority (MTA), failed to receive the necessary support in Albany. The imposition of a Mobility Fee in 2009 in the MTA’s 12-county district has been met with stiff resistance, with the resulting rollback of some of the categories of entities taxed, with the strong possibility of further rollbacks, if not outright repeal. It is true that motor vehicle registration and drivers’ license fees have been raised significantly, but they still constitute a minority share of the funds collected and further increases are likely to be met with strong opposition given the large recent increases.

One concept that could step into the breach is to charge motorists according to how much they drive – a mileage-based user fee or MBUF. Interest in this concept has grown for a number of reasons, the declining yield from fuel taxes being but one. Technological advances have made it easier to institute a fee on a per mile basis by recording and billing vehicle mileage. Moreover, the concept has the inherent logic of fairness -- “the more you use the highways, the more you pay.” It also makes it possible to consider variations in fees according to when and where the driving occurs, in essence establishing a congestion price at times and places where discouraging driving would provide widespread benefits. In at least a half dozen states, serious consideration of MBUF is underway, as documented elsewhere in this report.

This report is designed to explore the concept for New York State. It is organized in four sections. In the first MBUF is discussed, outlining the challenges that implementation of the concept would face. The second section traces the history of vehicle and fuel use in New York State and in the United States and of the revenues derived from them. In the third section the anticipated transportation capital investment needs of New York State are estimated and compared to the expected revenue yield from expected fuel taxes. Finally, the various means of closing the transportation funding gap are explored, concluding with a discussion of how MBUF could close the funding gap. These sections are buttressed by more detailed appendix material where appropriate.

Section I – Mileage-Based User Fees: Issues and Outlook

Mileage-based user fees, charging according to the number of miles that are driven by a vehicle, is a significant departure from the way funds have been collected for transportation purposes, which has been through fuel taxes, vehicle registration fees and drivers' license fees. The prospects for MBUF will depend on overcoming many barriers to implementation, not the least of which is convincing a skeptical public that there is a problem needing a solution and that it is worth the considerable change in funding transportation projects that will be required.

This section explores the issues associated with the implementation of MBUF, and is in large part a distillation of the considerable ongoing literature on the subject, which is presented in detail in annotated fashion in Appendix A. The reader wishing to more fully understand the complex issues regarding MBUF is referred to this literature review.

A. Issues

The deployment of MBUF brings with it numerous difficult issues, especially given the long history of using fuel taxes to fund transportation investments, which has been in place since the 1930s. These barriers to implementation, in addition to the resistance to change, include transition from fuel taxes, higher collection costs, technical issues, public acceptance because of privacy concerns, and possible inequities.

1. Transition from Gas Tax

MBUFs could potentially replace the gas tax or be part of a dual system that requires all drivers to pay both taxes, or target certain vehicle classes that do not pay their fair share under the existing gas tax – electric vehicles and/or trucks. Some research suggests that voluntary, opt-in approach, whereby drivers can choose to continue to pay via fuel taxes or shift to MBUF, might ease the transition and help to gain public acceptance of the program. Equipping vehicles for more sophisticated VMT tracking schemes might further complicate the transition. Installation of mileage detection units by the manufacturer is the more straightforward approach due to the lower per-unit costs, but would be slow, requiring decades until the entire U.S fleet is equipped with the technology.

A pilot study of the VMT system for trucks could be implemented that operates alongside the current tax structure. This way, the carrier would continue to pay current motor fuel and other taxes but receive either a receipt with money returned or a bill to pay more based on the VMT-based system, making the VMT-based system the effective payment with the user aware of the changes it has on pricing.

2. Collection Costs

A major concern that might affect the feasibility of MBUF is higher collection costs than currently experienced with fuel taxes. These typically include the annual administrative and equipment/system maintenance costs. However, the initial capital investment required to setup an MBUF system can also impact collection costs since this would typically be funded by issuing long-term debt backed and paid by system revenues. The current motor fuel tax system requires less than 1 percent of gross revenues to cover administrative costs. The cost of collection is so low because the tax is collected at only 350 refineries nationwide, rather than at the huge number of retail outlets. Acceptable administrative costs tend to be in the 5 to 10 percent range, which some operational VMT-based charging systems meet (conventional tolling and congestion pricing administrative costs are much higher, typically between 20 to 30 percent). While feasibility studies of proposed MBUFs vary in their administrative cost predictions, some do demonstrate that operating below 10 percent is possible. Combining vehicle registration fees with MBUF collection may address the problem, and the use of credit card companies and banks to lower collection costs merits exploration.

3. Technical Issues

MBUF vehicle technical issues have been extensively researched and tested in pilots in U.S. and abroad and have found to not be a barrier to implementation. There are two technical issues that standout in the research: the various ways to track/record VMT and the transmission of the data for tax collection purposes. These require system redundancy to make certain data is captured for billing and verification and dispute resolution, and hardening of the system to prevent tampering. Each requires additional research. Changes in technology continue to accelerate and these technical issues are likely to be resolved through innovation – "let the future come to us" is one way of expressing it.

4. Privacy

Privacy concerns are potential barriers to implementing a MBUF system; addressing them will be critical to gaining public acceptance. The type of system dictates whether privacy safeguards are required, a system that relies on manual odometer readings does not compromise an individual's privacy, whereas sophisticated systems that record driving behavior and vehicle location could be used by law enforcement to track a driver and punish certain behavior. Much of the public is aware of these potential uses and is sensitive to them, particularly in areas where electronic tolling systems are already in place. One way to address these concerns is to design MBUF systems to process the data using the on-board unit and then transmit only aggregate data.

5. Equity

If MBUF replaces the gas tax then it will likely be considered a tax by the public as well. Most taxes are regressive, placing a greater burden on the poor than the rich. MBUF is no exception, but it has the potential for being less regressive than the gas tax is today. One example is pay-as-you-drive (PAYD) insurance, a similar concept to MBUF, which has proved to be progressive since PAYD rates are based on VMT, resulting in higher income individuals being charged more since they typically drive more, which then lowers the average premium.

Equity can also be expressed in spatial terms, i.e., rural vs. urban users. The most equitable situation would have the funds collected in a community spent for improvements in that community, distributing the benefits in rough proportion to where the revenues are collected.

B. Outlook

1. Pilots

Despite these considerable challenges, the risks of inaction demand that MBUF, as a prospective response, should be fully explored. Some states have begun to look into the possibility on their own. The implementation of MBUF for passenger cars continues to be limited to pilot demonstrations, the most sophisticated of which have been carried out in Oregon and Washington. These programs have been catalyzed by State legislation, by the creation of task forces, and by research grants, but despite early interest have not always led to implementation following their successful completion. There is wide agreement that there are many prerequisites for MBUF implementation, including legislative changes, pilot demonstrations, installation of the necessary infrastructure, all working concurrently. This would be followed by an incremental approach where fees change in phases, perhaps incorporating flat and dynamic tolls as well as parking rates and public transit fares. Implementation would best be done on a volunteer bases to allow drivers to opt-in to the program.

Little research on MBUF has been done in New York State, with one major exception. In 2011, the consultant firm Delcan completed a study for the New York State Department of Transportation

(NYSDOT), examining several MBUF strategies and outlined a framework for an MBUF pilot for trucks. The study detailed the projected growth in truck VMT and their impacts on the road network, specifically freight bottlenecks and revenue loss.

2. Pricing Schemes

VMT fee rates can be set to modify behavior, to replicate the existing gas tax or to maximize revenues. Several studies have suggested that trucks should be targeted with higher fees to discourage their travel on certain segments of the network and to recapture their true infrastructure costs. Some international truck pricing schemes, already in place have set fees to recover the external costs of trucks to the environment – impacts of pollution on respiratory health, noise and accidents.

3. Public Acceptance

Privacy and equity concerns, along with the public's aversion to paying any new taxes or fees, will make gaining public support for MBUF difficult. Convincing the public that the benefits of MBUF outweigh the downsides will need to be clearly articulated. These include value-added services that could save them money or assist them in their travel. Researchers found that the public was more receptive if the system was easy to use and understand. Congestion relief and environmental benefits must also be explained, i.e. how would MBUF reduce the amount of time they sit in traffic. Earmarking MBUF transportation revenues beforehand, so the public knows where they will be spent or presenting transportation services as a public utility might help with public buy-in. Especially since research has shown that fuel tax and transportation funding is not well understood and that gas prices drive the discussion on transportation-related issues. Furthermore, in public opinion polls, initial reaction to replacing the fuel tax has been mostly negative. However, as understanding of the current problems increased, so has the public's openness to a new system.

4 .Who Leads?

Implementation of MBUF will be difficult to achieve given the multiplicity of jurisdictions through which vehicles pass. These issues can be a barrier to implementation, or if an effective implementation agency is identified, become the impetus for success.

There is a consensus that the federal government will have to coordinate revenue collection and the system's technical standards. While MBUF could be implemented by states and localities on an individual basis, there is agreement that there should be a body to govern standards and to assist in multi-state jurisdictional issues. The same is true regarding the private sector, if the market was to take the lead, a considerable effort would need to be made to coordinate standards to ensure technical interoperability and to police the system, which might be a federal role.

To be sold as a program worth pursuing, MBUF would benefit from including added value to the driving public such as PAYD insurance and instant consumer information systems made possible by the advanced technology that MBUF will require.

Any steps toward implementation must be preceded by an understanding and agreement among policy makers of the goals they see MBUF achieving, i.e., revenue, congestion reduction, equity among them. This begins with the recognition of MBUF capabilities to raise needed revenues and shift vehicle demand to less congested time periods and less congested roads.

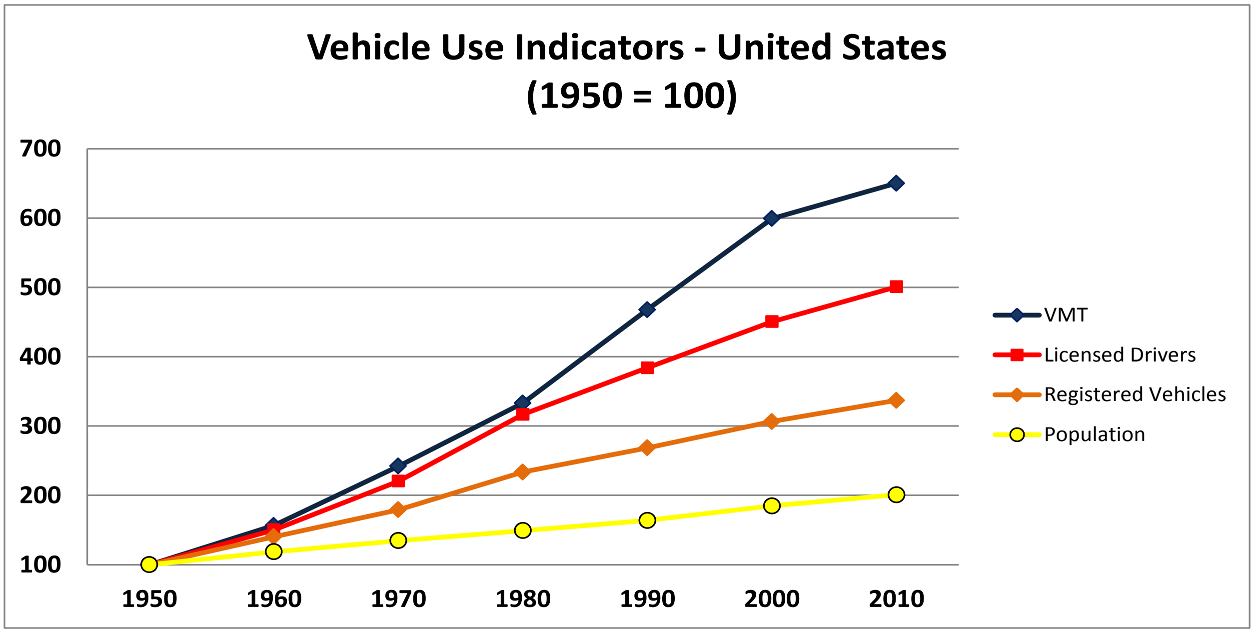
Section II - Vehicle Miles Traveled, Fuels Taxes and Revenues for Transportation

We are a driving nation. Each year three trillion miles are driven in the United States in one-quarter of a billion cars, trucks and buses on four million miles of roadway. Of our 309 million residents, two-thirds are licensed drivers, about 88 percent of all those of driving age. To fuel this driving we consume 170 billion gallons of petroleum products each year, mostly gasoline. New York State contributes 130 billion miles to the national VMT total, with over 11 million vehicles and over 11 million drivers, consuming seven billion gallons of petroleum, all of it imported because New York has no refineries.

A. The Past as Prologue: Not Likely

It comes as no secret that the United States has been transformed by motor vehicles and by the roads built to accommodate them. In the United States since the end of World War II, the number of drivers, vehicles, and the miles driven has increased many times. In the 60-year post-World War II period from 1950 to 2010, population in the United States has doubled, licensed drivers more than tripled, vehicle ownership quintupled, and vehicle use measured as VMT has increased over six times. Figure 1 illustrates these changes.

Figure 1 - United States Vehicle Use Indicators (1950 = 100)



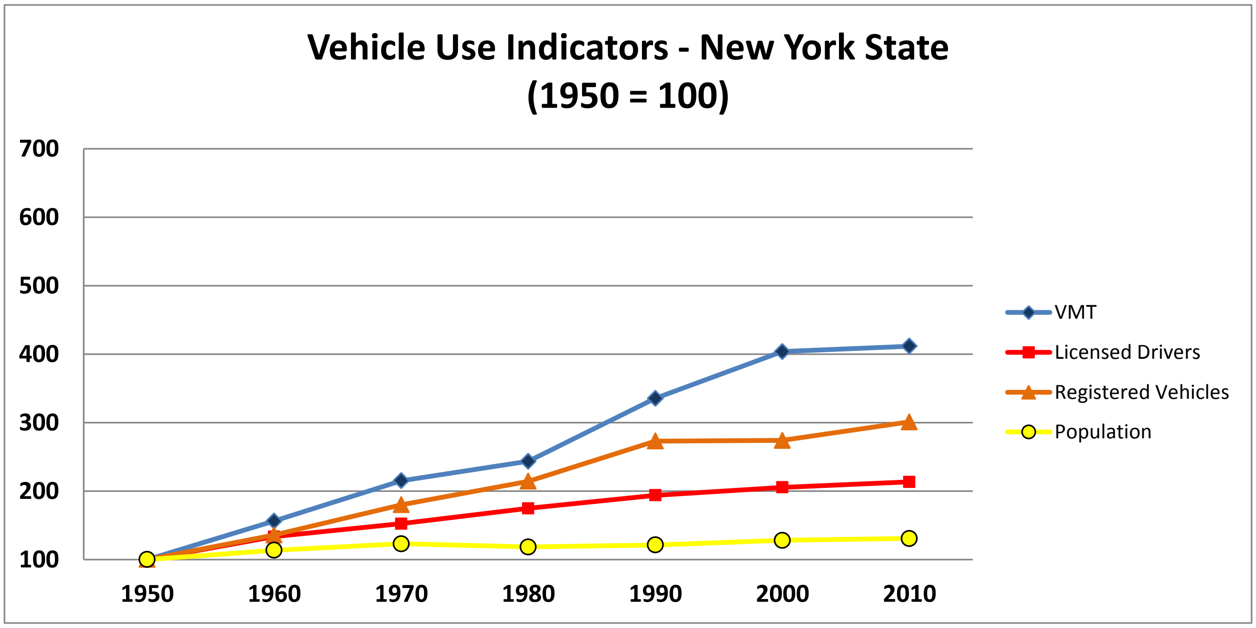
Sources: FHWA Highway Statistics series, US Census

Figure 1 highlights the consistent growth for each of these indicators in each of the three decades from 1950 to 1980; after that VMT growth began to accelerate faster than either licensed driver levels or vehicle registrations. VMT's faster growth translated to a more rapid growth in miles per driver, per vehicle and per capita. In 1980 about 1.5 trillion miles were driven in the United States; in only 30 years it doubled to 3 trillion miles.[1]

Figure 2 shows a similar, albeit less dramatic pattern in New York State, with lower population gains (31 percent), lower increases in licensed drivers (a little more than double), registered vehicles (three times) and VMT growth (four times). Table 1 displays these growth ratios.

Figure 2 – New York State Vehicle Use Indicators (1950 = 100)

[1] The detailed data for this section of the report for each decade since 1950 and every year since 1990 for the United States and for New York State are presented in the Appendix.



Sources: FHWA Highway Statistics series, US Census

Table 1 – Growth of Key Factors: 1950 to 2010

	US	NYS
Population	2.03	1.31
Licensed Drivers	3.37	2.13
Registered Vehicles	5.01	3.01
Vehicle Miles of Travel	6.54	4.12

Sources: FHWA Highway Statistics series, US Census

The growth in VMT is a response to multiple factors. Not only is population greater, but the average amount of travel per capita, per licensed driver and per vehicle have grown too. These changes can be attributed in part to shifts in settlement patterns, with many more Americans living in areas designed to serve motor vehicles, where there are fewer realistic mobility alternatives. Land uses are more spread out, extending the distances to reach activities and the vehicle miles traveled required to reach them.

And the more miles that are driven, the more fuel purchased and consumed to operate them. Higher incomes certainly play a part, with more Americans being able to afford an automobile, and when purchased, vehicles tend to be used more, abetted by the slower rise in fuel costs than other consumer products, at least until recently.

1. A Shift in Historic Patterns

These trends appear to be changing. Table 2 shows VMT trends for each decade up to 1990 and then every year thereafter for both the US and New York State. Since 2005, US VMT has grown by only 0.32 percent per annum, after increasing by an average of 2.23 percent in the previous 15 years. In New York State the annual increase from 1990 to 2005 was 1.78 percent, but in the last five years VMT has declined by an average of 1.18 percent per year. This shift is confirmed and reinforced by the trends in VMT per driver, per vehicle and per capita. VMT per vehicle in the United States seems to have peaked in 1998, remained static for the next seven years and is now declining from a high of about 12,400 miles per vehicle to about 12,000 today. New York mirrors this pattern. VMT per licensed driver and per capita follows a similar pattern, peaking in 2005 or 2006 and dropping thereafter in both the United States and in New York. Each indicators high point is shown in bold; all are no more recent than 2007.

In the last four years, each of these indicators have dropped consistently from year to year, with the only exception being the VMT per vehicle for New York State (NYS), which may be subject to vehicle registration reporting anomalies. Table 2 also highlights the consistently lower VMT use in NYS compared to the US on per driver and per capita bases, about 2,000 fewer miles per driver and 3,000 miles per capita. Much of the differences are undoubtedly a result of the impact of the Nation's largest metropolitan area – New York City and its environs, where lower vehicle ownership and use is attributed to higher densities, greater transit use, and more walking-depressed-driving in NYS.

The rise of fuel prices in 2006 and 2007, and then the recession that began in September 2008 almost certainly contribute to the flattening of VMT and its slight downturn. This is borne out by Figure 3, which shows the close historical relationship between US per capita income and per capita VMT. The two data points on the lower left are for 1970 and 1980 and the other plots are annual from 1990 through 2009. In the last few years both income per capita and VMT per capita have declined, indicated by the sequence of years "turning back" on itself, with both indicators dropping. This suggests that if incomes do not rise appreciably, all else being equal, then it can be expected that VMT per capita will not increase either.

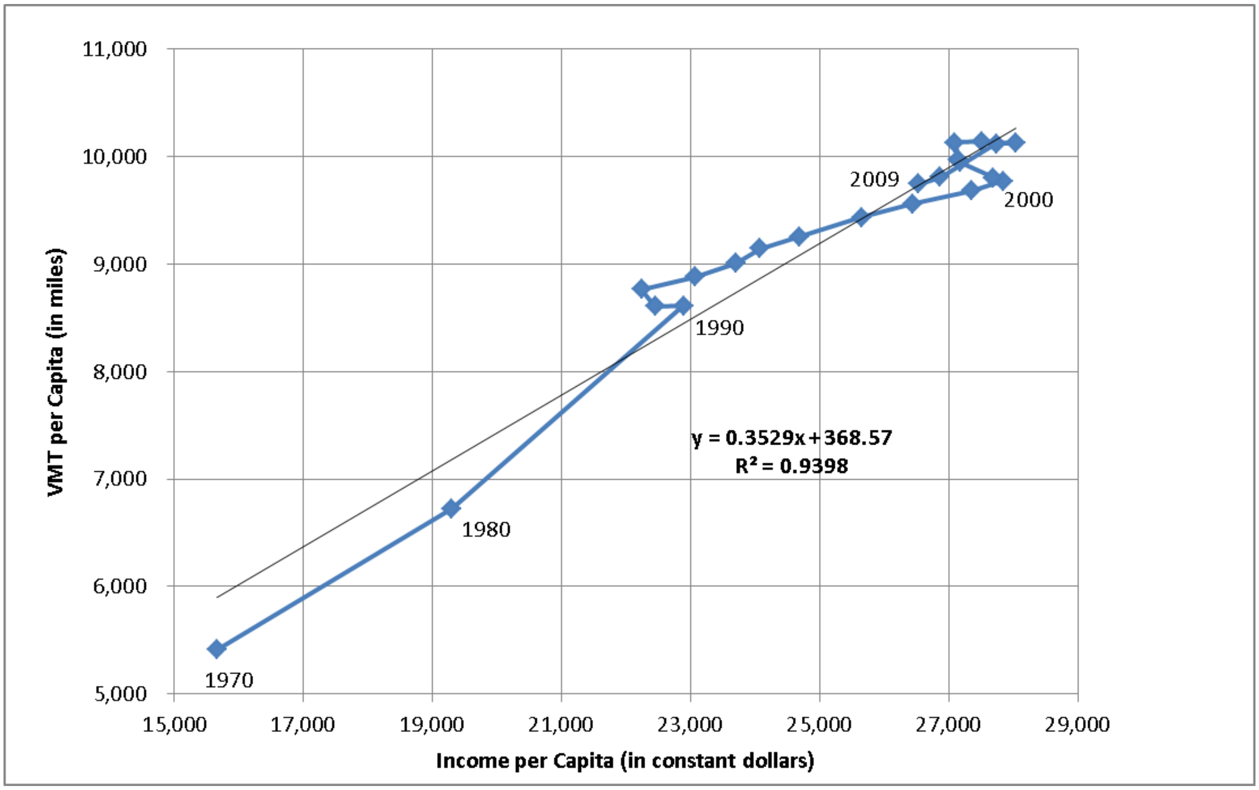
Table 2 - VMT Indicators: 1950 to 2010

	United States				New York State			
	VMT (millions)	VMT per Vehicle	VMT per Licensed Driver	VMT per Capita	VMT (millions)	VMT per Vehicle	VMT per Licensed Driver	VMT per Capita
1950	458,246	9,321	7,368	3,009	31,880	8,535	6,026	2,150
1960	717,762	9,718	8,226	3,973	49,780	9,824	7,049	2,958
1970	1,109,724	10,236	9,949	5,412	68,592	10,210	8,515	3,760
1980	1,527,295	9,803	10,512	6,722	77,622	9,701	8,401	4,421
1990	2,147,501	11,375	12,858	8,608	106,902	10,485	10,425	5,942
1991	2,172,050	11,531	12,853	8,603	107,661	10,797	10,486	5,952
1992	2,239,828	11,729	12,938	8,765	109,881	11,011	10,606	6,043
1993	2,296,585	11,834	13,264	8,879	112,240	11,045	10,869	6,140
1994	2,357,588	11,904	13,441	9,006	112,970	11,080	10,887	6,147
1995	2,422,823	12,022	13,717	9,144	115,091	11,202	10,989	6,229
1996	2,482,202	12,028	13,825	9,256	118,641	11,155	11,317	6,387
1997	2,560,372	12,324	14,013	9,433	120,779	11,108	11,470	6,467
1998	2,625,367	12,406	14,192	9,556	123,376	11,838	11,690	6,571
1999	2,691,335	12,442	14,379	9,679	126,491	11,760	11,903	6,701
2000	2,749,999	12,417	14,426	9,772	128,700	12,575	11,838	6,782
2001	2,784,361	12,083	14,557	9,803	130,830	**12,831**	11,878	6,880
2002	2,850,599	12,414	14,671	9,943	133,057	12,726	12,192	6,982
2003	2,885,418	**12,470**	14,709	9,972	135,047	12,502	11,891	7,072
2004	2,957,123	12,465	14,868	10,126	137,080	12,351	12,188	7,163
2005	2,988,620	12,391	**14,902**	**10,139**	139,200	11,734	12,572	7,259
2006	3,011,908	12,335	14,851	10,124	**141,348**	12,527	**12,681**	**7,355**
2007	**3,037,760**	12,285	14,765	10,117	136,060	11,837	11,967	7,065
2008	2,971,754	11,975	14,265	9,806	134,085	12,092	11,882	6,948
2009	2,979,717	12,099	14,215	9,742	133,491	11,871	11,783	6,903
2010	2,998,185			9,711	131,250		11,630	6,773

Note: Highest year shown in bold.

Sources: FHWA Highway Statistics series, US Census

Figure 3 – Income per Capita versus VMT per Capita



Sources: FHWA Highway Statistics series, US Census; US Department of Commerce, Bureau of Economic Analysis

B. Trends in Fuel Use and Fuel Tax Revenues

The potential for the flattening out of VMT or even its decline is of great concern because so much of the financing of our transportation system depends on fuel taxes, which is a function of how many miles are driven and fuel consumed. Table 3 documents these recent trends in fuel use and fuel revenues raised since 1990.

First initiated at one cent per gallon in 1932, federal fuel tax rates rose to 1.5 cents a year later. The rate increased in one cent increments to four cents in 1959, to nine cents in 1983 and then to 14.1 cents in 1990, and finally the last increase in the rate to 18.4 occurred in 1993. There were eight separate increases in that 51-year period. In sharp contrast, there have been no increases in the last 19 years. The federal diesel tax rate has grown in a similar pattern, standing at 24.4 cents per gallon today.

New York State's fuel tax rate history has followed a somewhat different course varying over time. However, the gasoline and diesel tax rates are today no higher than they were in the early 1990s.

Table 3 - Fuel Consumed and Revenue Raised from Fuel Taxes: 1990 to Present

	United States				New York State			
	Gas Tax Rate (cents)	Diesel Tax Rate (cents)	Fuel Consumed (000's of gallons)	Revenue Raised (000's of $)	Gas Tax Rate (cents)	Diesel Tax Rate (cents)	Fuel Consumed (000's of gallons)	Revenue Raised (000's of $)
1990	14.1	20.1	133,033,933	12,978,998	14.38	16.33	6,856,604	534,978
1991	14.1	20.1	128,563,032	21,115,409	20.82	22.77	6,570,873	503,952
1992	14.1	20.1	132,887,559	23,833,034	22.89	24.84	6,491,774	1,462,274
1993	18.4	24.4	137,262,212	24,851,792	24.84	24.84	6,547,602	1,473,932
1994	18.4	24.4	140,839,438	25,859,483	24.51	24.51	6,460,450	1,364,813
1995	18.4	24.4	143,268,463	26,881,169	23.87	23.87	6,584,379	1,518,624
1996	18.3	24.3	146,675,200	27,554,989	22.46	22.41	6,556,953	1,325,956
1997	18.4	24.4	150,331,996	28,476,881	22.40	22.35	6,532,492	1,400,162
1998	18.4	24.4	154,883,560	29,802,864	22.65	21.85	6,588,375	1,462,288
1999	18.4	24.4	160,651,904	30,752,790	22.05	21.25	6,787,375	1,471,583
2000	18.4	24.4	162,260,196	31,291,017	21.45	19.65	6,633,813	1,405,604
2001	18.4	24.4	163,046,891	31,783,843	22.05	20.25	6,642,086	1,453,591
2002	18.4	24.4	167,730,186	32,275,459	22.65	20.85	6,976,256	1,518,616
2003	18.4	24.4	169,624,469	33,257,334	22.05	20.25	7,143,702	1,498,841
2004	18.4	24.4	173,809,810	34,491,295	22.65	20.85	**7,245,219**	1,587,258
2005	18.4	24.4	174,286,984	34,984,939	23.25	21.45	7,191,543	1,567,130
2006	18.4	24.4	174,930,342	35,818,306	23.95	22.15	7,158,718	1,553,291
2007	18.4	24.4	**176,202,668**	**37,009,690**	24.65	22.85	7,171,441	NA
2008	18.4	24.4	170,765,303	36,118,124	24.45	22.65	7,057,717	1,570,527
2009	18.4	24.4	168,140,031	35,019,410	25.15	23.35	7,002,961	**1,593,070**
2010	18.4	24.4	169,679,155	35,565,482	24.35	22.60	7,140,409	1,558,094

Note: Highest year shown in bold. NA = Not accurate data excluded from table.

Source: FHWA *Highway Statistics*

Table 3 shows the recent drop in fuel revenues collected both in the United States and in New York. From 1990 to 2005 the revenue raised national rose from $13 billion to $35 billion, but in the last five year the growth has been minimal. The pattern holds for New York State, but with hardly any revenue growth in the last ten years. New York State staved off the decline by small increases in the tax rate since 2003.

1. Rising Fuel Efficiency

Past increases in fuel efficiency have also impacted the revenue yield from fuel taxes. Table 4 depicts the impact of the introduction of corporate average fuel economy (CAFE) standards in 1975. These standards were initiated in reaction to the Arab oil embargoes of 1973, when it became clear for the first time to most Americans that the availability of foreign oil could not be guaranteed. The CAFE standard set financial penalties for vehicle manufacturers if the annual average fuel economy of the vehicles they sold did not reach the CAFE standard. The jump in average fuel use was substantial, first inching up from 12.0 to 13.32 miles per gallon between 1970 and 1980 and to 16.1 miles per gallon in 1990. Unfortunately, light trucks were exempt, creating a loophole which was exploited by the vehicle manufacturers, whereby large segments of the passenger car market could be defined as light trucks, and were not counted in the CAFE calculation. This gave rise to the so-called Sports Utility Vehicle (SUV) phenomenon, and as Table 4 shows, has helped to keep average fuel efficiency of the vehicles from growing substantially for almost 20 years; the slight increases in that period can be attributed to the auto manufacturers' response to consumer demand for more efficient vehicles as fuel prices rose. Similarly, New York State fuel efficiencies grew during the 1990s and then flattened out over the last ten years, but at higher fuel efficiency averages, undoubtedly a consequence of a lower share of truck registrations.

Table 4 - Fuel Efficiency History (Miles per Gallon)

Year	NYS	US	Year	NYS	US
1990	15.59	16.12	2000	19.40	16.93
1991	16.38	16.89	2001	19.70	17.15
1992	16.93	16.91	2002	19.07	17.02
1993	17.14	16.73	2003	18.90	17.04
1994	17.49	16.74	2004	18.92	17.06
1995	17.48	16.91	2005	19.36	17.15
1996	18.09	16.94	2006	19.74	17.23
1997	18.49	16.98	2007	18.97	17.20
1998	18.73	16.97	2008	19.00	17.43
1999	18.64	16.75	2009	19.06	17.59

Source: FHWA *Highway Statistics*, Regional Plan Association

2. State Motor Fuel and Vehicle Revenues

Funding the construction and maintenance of this vast roadway system depends on fuel taxes at both the federal and state level. Federal fuel taxes currently raise about $34 billion annually, as shown in Table 3. These funds raised from the federal fuel tax have gone into the Highway Trust Fund, and given back to the states in rough proportion to the amount raised from the states, with New York State receiving $1.4 billion (in 2009). Separately, the State's fuel tax raises about $1.6 billion annually.

The State of New York receives revenues for transportation purposes from sources other than motor fuel taxes. It collects state and local tolls revenues and receives an annual disbursement from the Federal Highway Trust Fund (federal gas and truck taxes). Combined, these revenues deliver over $5.6

billion annually to New York to fund highways and transit. This analysis will focus solely on the state motor fuel and vehicle collections, since these are the revenue that a mileage-based user fee would likely replace or augment. State motor fuel and vehicle taxes makeup more than half (51 percent) of the annual New York State highway user tax revenues – the federal, state and toll revenues. Only these state-imposed tax revenues have grown over the past decade, while toll revenues have declined and federal contributions have remained flat.

Table 5 presents the motor fuel and motor vehicle taxes/fees collected in New York from 1982 to 2010.[2] The detailed collection subcategories for the state motor fuel tax (i.e. gasoline, diesel or gasohol) and the most of motor vehicle taxes/fees (i.e. commercial and passenger licenses and registrations) have been consolidated, with just the total collections being shown for each major tax/fee category.

[2] The Motor Fuel revenues are reported by fiscal year, which for the NYS starts in April of the prior year and ends on March 31st of the reported year, and the Motor Vehicle revenues by the calendar year. Therefore, the 2010 numbers Motor Fuel revenues are actually 2011 fiscal year numbers, even though the majority (8 out of 12 months) were reported in the calendar year 2010, resulting in an imperfect comparison.

Table 5 – State Motor Fuel and Motor Vehicle Revenues (in millions of current dollars)

State Motor Vehicle Revenues (000's of current $)							
	Motor Fuel Taxes		Motor Vehicle Taxes/Fees				
Year	State Fuel Tax (Gasoline and Diesel - $.085)	PBT ($.17)	Highway Use Tax (Truck and Misc.)	Registration Fees	Drivers License Fees	Title Fees	Total State Revenues
1982	436,796	75,970	53,673	242,118	13,660	7,409	829,627
1983	422,232	358,933	57,632	311,645	34,228	8,348	1,193,019
1984	408,761	258,992	65,775	359,705	46,462	9,344	1,149,039
1985	468,946	236,957	68,172	339,990	50,091	10,397	1,174,553
1986	495,922	206,731	68,855	289,755	56,611	11,836	1,129,710
1987	500,180	227,281	77,020	306,199	55,077	11,464	1,177,221
1988	488,730	202,394	78,746	293,571	50,052	11,799	1,125,292
1989	543,548	216,580	80,016	362,815	64,159	18,107	1,285,225
1990	505,107	490,962	115,535	320,271	57,655	21,465	1,510,994
1991	492,444	928,812	138,949	328,485	64,801	20,315	1,973,806
1992	525,250	1,172,753	152,245	323,767	63,948	19,902	2,257,865
1993	490,283	1,145,845	174,244	347,378	72,725	16,370	2,246,845
1994	484,962	1,048,099	189,161	341,782	89,801	16,966	2,170,770
1995	501,483	1,007,739	170,004	347,113	80,897	16,791	2,124,027
1996	471,508	967,829	157,314	306,218	88,532	16,216	2,007,618
1997	491,713	978,623	164,810	311,666	80,094	16,424	2,043,330
1998	502,320	1,034,175	168,667	285,874	86,634	16,750	2,094,419
1999	518,773	1,004,931	150,225	251,424	82,095	16,989	2,024,437
2000	510,324	971,097	155,075	267,502	34,767	17,455	1,956,220
2001	489,396	1,002,481	148,298	290,203	69,936	18,122	2,018,436
2002	543,781	1,022,876	146,839	315,407	98,575	18,537	2,146,015
2003	515,530	1,052,379	146,622	311,744	120,005	27,068	2,173,348
2004	529,774	1,085,058	151,393	342,510	137,854	31,462	2,278,051
2005	530,697	1,145,700	160,170	417,946	89,168	52,873	2,396,554
2006	513,390	1,090,306	152,670	416,350	56,483	133,686	2,362,885
2007	524,934	1,155,337	147,956	472,529	52,032	133,752	2,486,540
2008	503,937	1,106,562	140,907	458,168	60,765	126,158	2,396,498
2009	506,911	1,103,546	137,247	539,302	147,153	118,324	2,552,482
2010	516,145	1,090,440	129,162	719,309	203,761	121,403	2,780,221

Source: New York State Department of Taxation and Finance (FY) and Federal Highway Statistics Series (CY)

a. Highways and Transit

As shown in Table 5, almost $2.8 billion was distributed in 2010 from state fuel and vehicle taxes to highway and transit needs. In 2009, the Highway Statistics series reported that 77 percent of these revenues are dedicated to highway purpose, almost 20 percent to transit and the remaining to administrative costs and other needs. This share has stayed relatively constant for highways over the past dozen or so years, but the disbursement for transit have declined in recent years. This was also evident in the MTA's most recent 2010-2014 Capital Plan funding amendment, which reduced federal formula contributions by $632 million.

b. The Taxes

The two motor fuel taxes are both excise taxes (fixed amount per gallon of fuel) that are imposed by the state at a wholesale level for those that distribute gasoline and diesel. The State fuel tax in 2011 for gasoline was 8.5 cents per gallon tax and the Petroleum Business Tax (PBT) was 17 cents per gallon fee, for a combined state motor fuel tax of 25.5 cents per gallon (the motor fuel diesel rate was 8 cents and the PBT was 15.25 cents). The PBT tax is also imposed on aviation fuel, non-automotive diesel fuel and residual petroleum products. Over 40 percent of the tax receipts are dedicated to the MTA for operating assistance (or debt service). The PBT was amended in 1990 by Article 13-A, which substantially increased the PBT tax on diesel and gasoline.

There are four categories of motor vehicle taxes/fees – Highway Use Tax, Registration Fee, Driver's License Fees, and Title Fees - most are complex and vary based on vehicle weight or type, age of driver or mileage driven. The rates are summarized in Table 6; a detailed explanation is provided as Appendix B to this report.

Table 6– Summary of State Motor Vehicle Taxes/Fees

Motor Vehicle Tax	Type	Tax/Fee Range
Highway Use Tax	per mile	$.0056 to $.0546
Fuel Tax	per gallon	$.39 to $.24
Drivers License Fee		
Standard	per issuance or renewal (varies)	$29 to $102.5
Commercial	per issuance or renewal (varies)	$100 and higher
Registration Fee		
Standard	by weight (lbs) + flat fees	$36 to $220
Commercial	by weight (lbs) + flat fees	$27 to $389
Certificate of Title	per issuance	$50

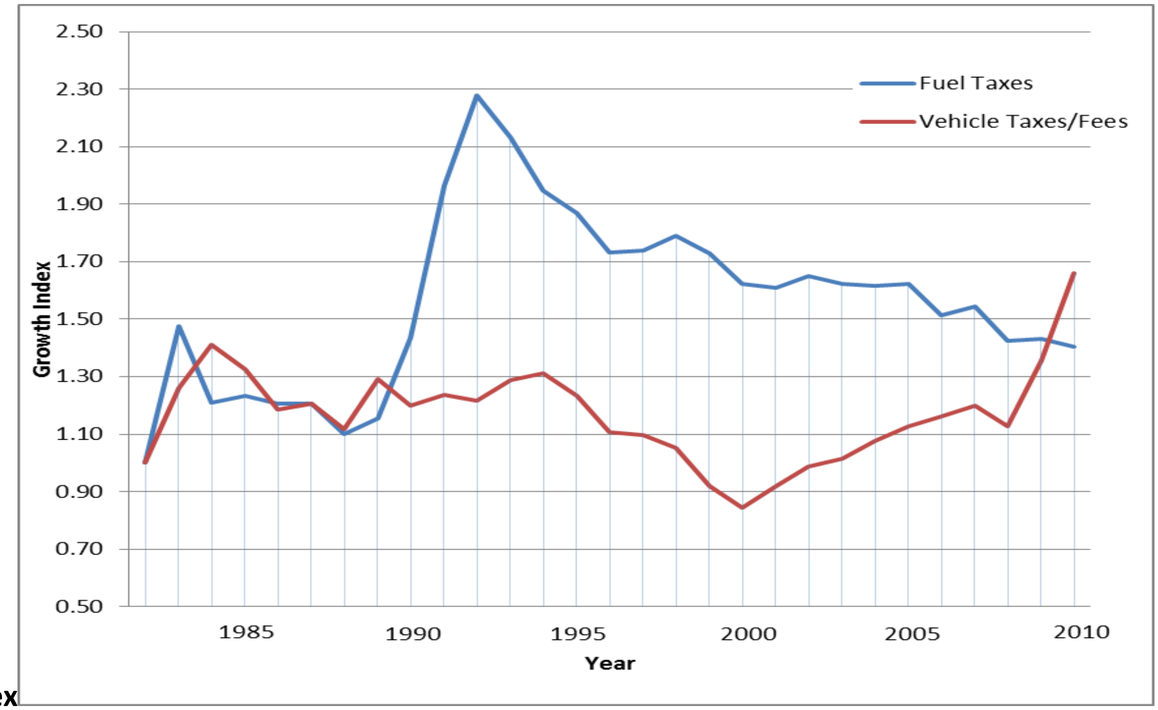
Sources: New York State Departments of Taxation and Finance, Transportation and Motor Vehicles

c. Motor Vehicle versus Motor Fuel

Motor fuel taxes contribute 58 percent of the state vehicle taxes, but have declined from a high of 76 percent just 10 years earlier, a combination of the erosion of the motor fuel tax yield and the rapid growth in motor vehicle revenues. The prior section and associated Appendix highlights the increasing number of surcharges that have been added to vehicle registration and license fees in direct response to transportation funding needs. Most recently, the State added a $50 registration surcharge for those who reside within the Metropolitan Commuter Transportation District[3] that goes directly to the MTA to subsidize its operating costs and debt service. Motor fuel rates have remained relatively unchanged since the PBT was increased in the early 1990's. Figure 4 clearly illustrates this point, using an index to compare the relative change in motor fuel taxes and motor vehicles fees. Figure 5 makes the same point in absolute constant dollar terms. Motor fuel revenues, when adjusted to constant dollars (2010) have been on a downward trend since 1998. This is mostly explained by the fixed excise tax rate, which is a rate per gallon rather than a sales tax, combined with the flattening of VMT that started to occur around this time and the increase in vehicle fuel efficiency. These trends are likely to continue, which will put even more pressure on motor vehicle taxes/fee to pick up the slack.

[3] New York City and Dutchess, Nassau, Orange, Putnam, Rockland, Suffolk, and Westchester Counties

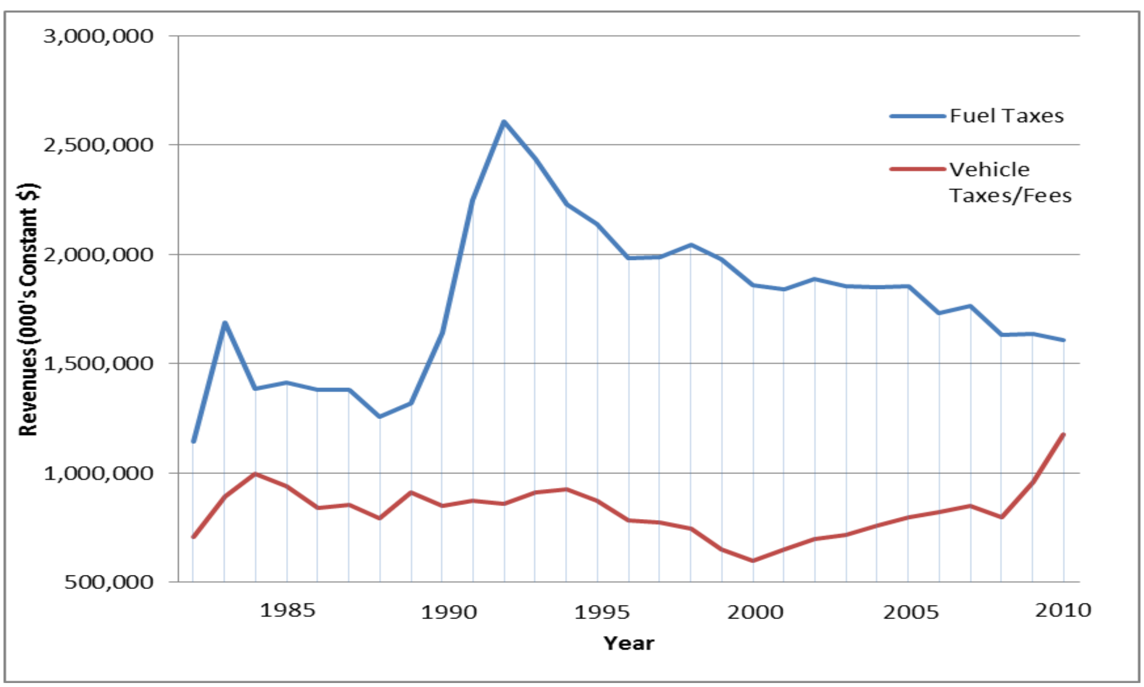
Figure 4 – Motor Fuel Taxes vs. Motor Vehicle Fees: 1982 to 2010



Index

Source: New York State Department of Taxation and Finance (FY) and Federal Highway Statistics Series (CY)

Figure 5 – Motor Fuel Taxes vs. Motor Vehicle Fees:
1982 to 2010 in Absolute Constant Dollars (2010)



Source: New York State Department of Taxation and Finance (FY) and Federal Highway Statistics Series (CY)

Section III – Capital Needs and Revenues

This section of the report explores the magnitude of the expected gap in revenues for transportation purposes in the New York State for three separate horizon years, 2015, 2020 and 2025. It begins by estimating the projected capital needs. This is followed by estimates of the revenue raised from all fuel and other motor vehicle taxes for transportation purposes, if no changes are forthcoming. The needs and the revenues are then compared to provide the projected gap in capital for transportation.

A. Capital Needs for New York State

The transportation capital needs for the State of New York are great and continue to grow. The State supports one of the largest public transit systems in the world, the New York City subway, bus and commuter rail system that carries over 8 million passengers a day, many other transit systems throughout the State, and an extensive surface transportation network, with 114,546 route miles of public roads and 17,378 highway bridges.

The two agencies responsible for the overwhelming majority of this infrastructure are the NYSDOTand the Metropolitan Transportation Authority (MTA); both rely on motor fuel and vehicle revenue collections to either directly fund their capital needs and/or cover debt service payments. The third major transportation provider, the New York State Thruway Authority (NYSTA) is self-sustaining through the issuance of toll-back bonds and federal aid. Regional Plan Association (RPA) reviewed the current Capital Plans and Twenty-Year Capital Needs Assessments compiled by each agency to determine the capital needs for NYS.

Table 7 - Current and Long-Term Needs of NYSDOT and the MTA

Agency	Unconstrained - 2010 to 2029 Capital Needs (in billions $)		Constrained - 20yr Capital Needs Based on Current/Historical Funding (in billions $)		Anticipated Unfunded Needs (in billions $)	
	For Period	*Annually*	*For Period*	*Annually*	*For Period*	*Annually*
NYSDOT	184.23	9.21	70.00	3.50	(114.23)	(5.71)
MTA	130.75	6.54	88.00	4.40	(42.75)	(2.14)
Total	**314.98**	**15.75**	**158.00**	**7.90**	**(156.98)**	**(7.85)**

Sources: MTA and NYSDOT

The Twenty-Year Needs Assessments are unconstrained[4] evaluations of capital needs that determine the funding levels required to complete capital expansion projects and to bring the systems up to a State of Good Repair (SGR) during this period. The MTA's five-year Capital Plans are typically spun-off from their Assessments and then adjusted to meet funding constraints. The MTA is currently in its fifth five-year plan, a process that started in 1982 and has resulted in an investment of tens of billions of dollars to restore and expand downstate transit systems. NYSDOT, on the other hand, has suffered from a more sporadic capital planning process. Most recently, the agency was forced to abandon its five-year planning process and draft a two-year plan instead due to budget constraints. Table 7 illustrates this impact; the NYSDOT assessed annual need was over $9 billion annually (assuming an equal distribution during the 20-year period), while their actual spending over the last two years has been closer to $3.5 billion annually or $5.7 billion less a year than planned. In reality, NYSDOT's constrained needs are likely somewhere in between, closer to an average of $6 billion annually based on a more realistic distribution of capital intensive projects.

In an unconstrained environment, as shown in Table 7, the annual capital needs for the agencies combined would be almost $16 billion, essentially doubling the current annual investment in the State's transportation system. A compromise might be $12 billion annually, assuming a more robust plan for NYSDOT or $8 billion at current levels. However, in the "real world" the agencies typically issue debt in the form of tax-exempt fare, toll or tax-backed bonds to fund a significant share of their capital needs. This allows them to generate greater amounts of capital to fund their programs now and then to pay off the debt over time, typically during a 20- to 30-year period.

Tables 8 and 9 detail the current Capital Plans for the MTA and NYSDOT, the proportion of each plan funded by bond proceeds is highlighted in red. NYSDOT currently funds 55 percent of its plan annually through debt financing, while the MTA is slightly higher at 57 percent. The MTA's 2000-2004 and 2005-2009 Capital Plans had debt financing levels of 57 and 48 percent, respectively. Little public data exists on NYSDOT's prior capital plans and funding sources to determine whether this is a typical debt financing level.

[4] The Assessments are only constrained insofar as the amount of work programmed does not cripple the system during commutation periods. This is the MTA's threshold, whereas the criterion used by NYSDOT is less clear.

Table 8 – NYSDOT 2010-2012 Capital Plan Funding Sources (in millions)

Source	Amount
Dedicated Highway and Bridge	$3,400
General Fund Transfer	$1,500
Federal Aid	$3,200
2005 Transportation Bond Act	$441
Debt/Bond Financing	$3,841 **55%**
Total	**$7,041**

Source: NYSDOT

Table 9 – MTA 2010-2014 Amended (Proposed) Capital Plan Funding Sources (in millions)

Source	Amount
Federal Formula	$5,783
Federal Security (DHS)	$225
Federal HSR	$295
Federal RRIF	$2,200
City Capital Funds	$762
MTA Bus Federal and City Match	$167
State Assistance	$770
MTA Bonds (Payroll Mobility Tax)	$10,503
Other	$1,490
Debt/Bond Financing	$12,703 **57%**
Total Pending CPRB Program	**$22,195**
Bridges & Tunnels Dedicated Funds	$2,079
Total Program	**$24,274**

Source: MTA

Assuming these debt financing shares are constant, it is possible to calculate the annual capital need for the agencies based on debt financing and direct capital infusion or PAYGO, which is typically in the form of federal aid and direct city and state grants. The assumptions to determine the annual debt service payments were an annual fixed-interest rate of 5 percent, which is slightly higher than the lowest rate available today and repayment period of 30 years. This analysis provides us with a more "realistic" estimate of the revenue needed to fully fund the State's capital needs; the results are shown below in Table 10. Assuming an annual capital need of almost $8 billion, the MTA and NYSDOT would need approximately $3.8 billion dollars in funding – almost $3.5 in direct support and over $280 in debt service (compounded annually[5]).

Table 10 – Annual Debt Service and Direct Funding Needs (in millions)

Agency	Bonds Issued	Annual Debt Service	Direct Capital Support	Total (Debt Service + Direct Support)
MTA	$2,508	$163	$1,892	$2,055
NYSDOT	$1,925	$125	$1,575	$1,700
Total	**$4,433**	**$288**	**$3,467**	**$3,755**

Source: RPA Analysis

This estimate could vary based on interest rates, which could go down or up or the bond rates themselves could be variable. The agencies will refinance and retire debt early over time as well. Additionally, the MTA currently has over $34 billion in outstanding debt and dedicates over $2.3 billion dollars annually to cover its debt service, which is almost 20 percent of its annual operating budget. Thus, the ability of the agency to bond in the future will be limited. At the same time, the Dedicated Highway and Bridge Trust Fund that NYSDOT relies on to issue debt, is approaching the point where its dedicated revenues streams will only cover the servicing of existing debt and will no longer be a funding source for the agency. Clearly, repeatedly issuing more debt alone is a financial dead-end. One obvious solution is to substantially reduce the amount of borrowing in future plans and use direct funding instead. This approach would require greater revenue streams than we have today and likely lead to the deferment of some of our less urgent capital needs.

1. Projected Fuel Tax Revenues

This sub-section projects the expected revenue that can be expected toward closing the capital gap. Because the revenue yield from the federal fuel tax is returned in part to the State of New York, it is necessary to estimate the projected revenue yield from both federal and New York State fuel taxes.

The steps involve the projection of VMT, application of the average fuel economy to the VMT to determine fuel consumption, and then application of the fuel tax rate to the number of gallons consumed, resulting in the revenue collected. In reality, the methodology is much more complex than

[5] This means that the debt service for the bonds issued that year would have to be funded annually until the bonds are retired, typically 30 years. For example, the first year debt service would be $280M, but the second year it would be $560 and the third $840 and so on, compounded to a point where available revenues might only be able to cover the debt service alone and not provide any additional direct funding.

that. Accordingly, this sub-section concentrates on briefly summarizing the methodology and presenting the results that emerged from the analysis. For a description of the detailed methodology, the reader is referred to Appendix C.

2. Projected Vehicle Registrations

Estimates of VMT in the nation and in New York State were based on vehicle registrations which were in turn based on registrations per capita. The actual 2009 and projected population and vehicle registration estimates are shown in Table 11.[6]

Table 11 - Projected Registered Vehicles in United States and New York State

	United States			New York State		
	Population	Vehicles	% Change	Population	Vehicles	% Change
2009	305,873,000	246,282,886		19,338,139	11,245,208	
2015	325,540,000	257,563,333	4.6	19,546,904	11,239,299	-0.05
2020	341,387,000	270,101,289	9.7	19,697,021	11,337,204	0.82
2025	357,452,000	282,811,724	14.8	19,786,848	11,424,272	1.59

Sources: Federal Highway Administration, Highway Statistics 2009; Regional Plan Association

As detailed in Appendix C, because the amount a vehicle is driven is a function of its age, vehicle registrations for passenger cars and light trucks were stratified by age of vehicle and by miles driven for vehicles by age to arrive at projected VMT. These are reported for passenger cars and light trucks in Table 12.

Table 12 - Projected Vehicle Miles of Travel for Passenger Cars and Light Trucks (millions of miles)

	United States	Percent Change from 2009	New York State	Percent Change from 2009
2009	2,655,276	NA	122,016	NA
2015	2,777,112	4.59	121,952	-0.05
2020	2,912,300	9.68	123,015	0.82
2025	3,049,347	14.84	123,959	1.59

Source: Regional Plan Association

[6] The vehicle registration projections were then stratified by vehicle type – passenger cars, light trucks, combination trucks, single unit trucks and buses to be used for the VMT estimates for each vehicle type.

3. Fuel Consumed by Cars and Light Trucks

In 2011 new CAFE standards were promulgated which can be expected to cause a significant jump in fuel efficiency between now and 2025. The fuel consumption rates are applied for each model year to determine the fuel consumption, shown for passenger cars and light trucks combined for the projection years in Table 13. The new standards are expected to produce an average fleet miles per gallon of 40.8 miles per gallon in New York State in 2025 and 40.0 miles per gallon in the United States. The light truck average would climb from 21.4 miles per gallon in 2009 to 30.4 miles per gallon in 2025 in the nation, and 31.4 miles per gallon in New York State. While reduction in foreign oil dependence is a worthwhile goal, the combination of more efficiency vehicles and dampening of VMT growth, in the absence of other changes, will result in substantial less revenue for transportation investment purposes.

The rise in electric powered vehicles, both hybrids and electric (either fully or partial) vehicles can also profoundly affect revenues, especially if the energy they use is not taxed and /or their revenues are not dedicated to transportation purposes. Today, hybrids and all electric vehicles represent only about 2 percent of the passenger cars sold in 2011, but that is expected to grow as more automakers enter the market, and as they introduce a broader variety of model types to meet the diverse needs of the driver. In the last year, both Chevrolet and Nissan have introduced all (or almost all) electric vehicles. As oil prices increase, it can be expected that the impetus to purchase these vehicles and the subsequent appearance of more makes and models will also increase.

Table 13 - Projected Fuel Efficiencies and Fuel Consumed by Passenger Cars and Light Trucks

	United States			New York State		
	Average MPG	Fuel Consumed (millions of gallons)	Percent Change from 2009	Average MPG	Fuel Consumed (millions of gallons)	Percent Change from 2009
2009	22.1	120,434	NA	24.2	5,048	NA
2015	23.9	116,352	-3.4	26.2	4,656	-7.8
2020	26.9	108,213	-10.1	29.8	4,122	-18.3
2025	31.7	96,390	-20.0	35.6	3,482	-31.0

Source: Regional Plan Association

The VMT results for trucks and buses that are detailed in Appendix C are combined with the results reported in Tables 12 to show the projected VMT for all vehicles in Table 14. VMT can be expected to grow by about 15 percent nationally from 2009 to 2025, or just about 0.9 percent per annum; New York State can expect growth of only 2 percent in the same 16 years, not reaching the high historically mark of 139,200 million miles of 2005.

Table 14 - Projected Vehicle Miles of Travel by Vehicle Class: United States and New York State (millions of miles)

United States		2009	2015	2020	2025
	Passenger Cars	1,321,701	1,382,337	1,449,628	1,517,844
	Light Trucks	1,333,575	1,394,776	1,462,672	1,531,503
	Single Unit Trucks	120,123	125,557	131,670	137,865
	Combination Trucks	167,841	175,100	183,623	192,264
	Buses	14,323	14,932	15,660	16,397
	TOTAL	2,957,563	3,092,702	3,243,253	3,395,873
New York State					
	Passenger Cars	90,980	90,332	91,724	92,439
	Light Trucks	31,036	31,019	31,290	31,530
	Single Unit Trucks	3,535	3,533	3,564	3,591
	Combination Trucks	5,371	5,603	5,876	6,152
	Buses	1,393	1,391	1,403	1,414
	TOTAL	132,315	131,878	133,857	135,126

Source: Regional Plan Association

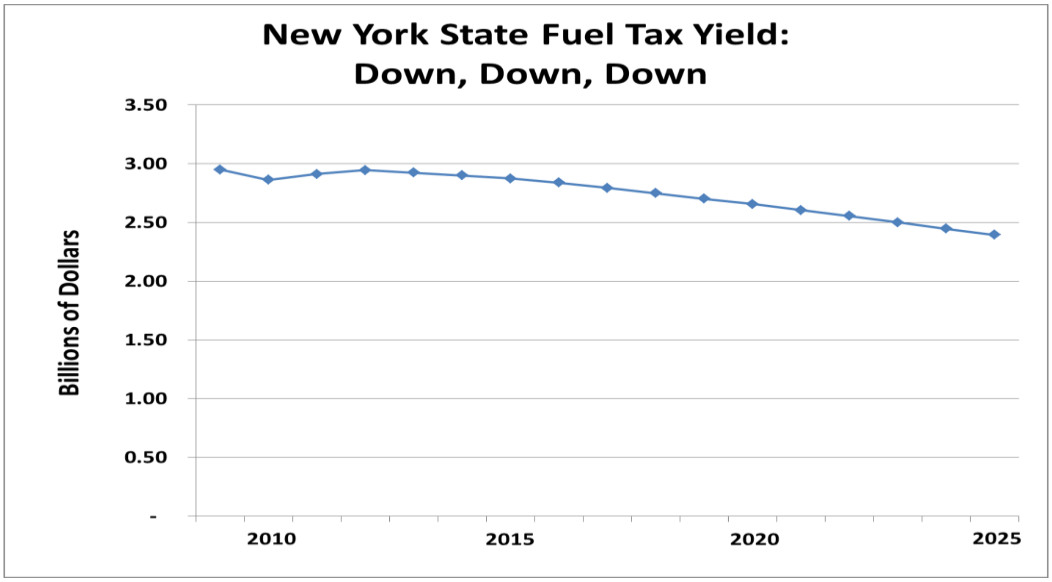
Estimates of the total fuel consumed for all vehicle types are detailed in Appendix C. These estimates are then converted to revenue yield estimates by applying today's tax rates and summarized in Table 15 and depicted on annual basis in Figure 6. As expected, the revenue yield from fuel taxes is projected to decline. The funds from the national fuel tax will drop by 15 percent and the New York State fuel tax yield will drop even more, 23.4 percent. Taken together, the two taxes will leave New York State with almost $600 million less each year, nearly a 20 percent drop.

The situation is made still worse by the likely decline in the buying power of the revenue raised. If the Construction Price Index were to behave in the sixteen year 2009 to 2025 period as it behaved in the most recent sixteen years from May 1996 to May 2012, there would be a further loss of buying power of 40 percent, or 60 percent in total when added to the loss from lower fuel tax yields.

One factor that might lessen the impact of fuel tax losses would be a loosening of the definition of a "light trucks," which could have the impact of increasing fuel consumption and fuel tax yields. This occurred when CAFE standards in the 1980s allowed passenger vehicles classified as sports utility vehicles to be defined as light trucks with its lower CAFE standard. However, given that experience, new loopholes are not very likely.

Figure 6

Yield from Fuel Taxes in New York State



Source: Regional Plan Association

Table 15 - Revenue to New York State from Fuel Taxes Assuming No Change in Tax Rates

United States	2009	2015	2020	2025
Total Fuel Consumed (gallons)	168,220	164,843	155,561	142,842
Gasoline Consumed (gallons)	132,927	130,259	122,924	112,874
Diesel Consumed (gallons)	35,293	34,584	32,637	29,968
Revenue from Gasoline ($)	24,459	23,968	22,618	20,769
Revenue from Diesel ($)	8,611	8,438	7,963	7,312
Total Revenue ($)	33,070	32,406	30,581	28,081
US Revenue Allocated to NYS ($)	1,320	1,293	1,221	1,121
Change in Revenue from Fuel Taxes, Percent	NA	-2.01	-7.53	-15.09
New York State	**2009**	**2015**	**2020**	**2025**
Total Fuel Consumed	6,578	6,173	5,585	4,899
Gasoline Consumed	5,220	4,899	4,432	3,888
Diesel Consumed	1,358	1,275	1,153	1,012
Revenue from Gasoline ($)	1,313	1,266	1,146	1,005
Revenue from Diesel ($)	317	307	278	244
Total Revenue ($)	1,630	1,573	1,423	1,249
Change in Revenue from Fuel Taxes, Percent	NA	-3.48	-12.68	-23.40
Total Fuel Tax Revenue to New York State ($)	2,950	2,867	2,644	2,369
Change in Revenue from Fuel Taxes, Percent	NA	-2.82	-10.37	-19.68

Source: Regional Plan Association

Section IV – How Big is the Capital Gap?

The projected decline in fuel tax revenues that accrue to New York State will put great pressure on the highway and transit capital programs. Assuming no increase in other motor vehicle related fees, the capital gap will grow substantially. These projected gaps for the three horizon years are shown in Table 16, based on the annual capital needs of $15.75 billion (full program) and the current spending levels of $7.9 billion discussed in the previous section. The table adds a third category – compromise program set at $12 billion, since programming the full need may be out of reach. After subtracting the fuel and motor vehicle revenues, the gap for the full program would rise from start at about $11.5 billion and grow to over $12 billion. Borrowing 30 percent of the capital program at five percent with 30-year bonds would substantially reduce the gap to only $6.8 billion initially the relief would not last long, rising to over $11 billion by 2025 to cover interest rising costs, and more thereafter. Borrowing at an even higher share of the need capital revenue – 55 percent for highways and 57 percent for the MTA, equivalent to current borrowing practices—would provide still more relief early, but higher payments in interest later. If the program were pared back to the compromise level, it would still produce a gap of $7 billion by 2025 with either borrowing scenario. If only the current spending levels were assumed, the magnitude of the gaps would be made more manageable early; borrowing 30 percent of the capital program would keep the gap in the $2 billion.

The benefits of borrowing, while lowering the gap in the early years evaporates in the later years, particular by and beyond 2025. This is illustrated in Table 17 which shows the annual interest payments for each spending level and borrowing scenario. For example, the full capital program – high borrowing scenario would require almost a half billion dollars of additional payments each year, rising to $7 billion in interest in 2025 when two-thirds of the funds spent would be used for interest, a clearly untenable situation. Other borrowing scenarios, whether assuming lower spending level or lower borrowing level are no better and sometimes worse. The use of borrowing to close the gap can only be a part of the future funding plan with a sustainable and reliable funding source beyond the current fuel and motor vehicle and license charges to prevent crushing interest payments in the long term.

Table 16 - Capital Funding Gaps in New York State With No Fuel Tax Rate Changes (in billions)

Full Program	2009	2015	2020	2025
No Borrowing	$ 11.55	$ 11.63	$ 11.83	$ 12.08
Borrow 30 % of Capital Program	$ 6.82	$ 8.32	$ 9.70	$ 11.14
Borrow 55 to 57% of Capital Program	$ 2.75	$ 5.48	$ 7.87	$ 10.32
Compromise Program				
No Borrowing	$ 7.80	$ 7.88	$ 8.08	$ 8.33
Borrow 30 % of Capital Program	$ 4.20	$ 5.36	$ 6.46	$ 7.61
Borrow 55 to 57% of Capital Program	$ 1.09	$ 3.18	$ 5.06	$ 6.99
Current Program				
No Borrowing	$ 3.70	$ 3.78	$ 3.99	$ 4.26
Borrow 30 % of Capital Program	$ 2.56	$ 2.12	$ 2.93	$ 3.78
Borrow 55 to 57% of Capital Program	$ (0.73)	$ 0.68	$ 2.00	$ 3.37

Source: Regional Plan Association

Table 17 - Impact of Interest Payments from Borrowing to Close Capital Cap

Full Program	Annual Interest Increment, $ millions	Spent on Interest in 2025, $ billions	Percent Spent on Interest in 2025
No Borrowing	$ -	$ -	$ -
Borrow 30 % of Capital Program	$ 236.25	$ 3.78	$ 33.93
Borrow 55 to 57% of Capital Program	$ 439.66	$ 7.03	$ 68.16
Compromise Program			
No Borrowing	$ -	$ -	$ -
Borrow 30 % of Capital Program	$ 180.00	$ 2.88	$ 37.84
Borrow 55 to 57% of Capital Program	$ 335.55	$ 5.37	$ 76.81
Current Program			
No Borrowing	$ -	$ -	$ -
Borrow 30 % of Capital Program	$ 118.50	$ 1.90	$ 50.16
Borrow 55 to 57% of Capital Program	$ 221.70	$ 3.55	$ 105.26

Source: Regional Plan Association

A. Scenarios to Close the Gap

The picture painted above is bleak. In the absence of a significant change in the trends or the manner in which we fund transportation, there will be less revenue available for transportation investments. Fewer miles traveled, more efficient vehicles, less reliance on petroleum, and no increase in fuel tax rates, computes to less revenue. Federal fuel taxes have not been raised in 17 years; state fuel taxes rates are no higher than they were 20 years ago. And there is limited political will to increase this tax rate[7].

[7] As a more politically palatable substitute to the gasoline tax, the US Congress is considering a bill that would attempt to raise funds for transportation purposes by charging petroleum companies exploration fees. The intent is for it to be a substitute for

The confluence of these trends indicates that changes in the way we fund transportation must be seriously considered.

1. Raise the Current Fuel Tax Rate

To close the projected gaps under any funding level or borrowing assumption, there are many reasons to consider higher fuel tax rates as the first place to look. Fuel taxes have many built-in advantages:

- They are an minor portion of the cost of fuel and becoming even less significant as prices rise and the fuel rate per gallon stays the same;
- Increasing the tax rate would not require any new administrative costs;
- Neither federal nor New York State are no higher than they were almost 20 years ago;
- New York State fuel taxes have been raised to a very minor degree in that time; and
- Fuel tax rates in the United States are among the lowest in the world.

Still, the idea of increasing fuel taxes has remained unpopular. Only 24 states have increased their rates since 1996 and one (Connecticut) has lowered them. The upper portion of Table 18 shows the required hike in the New York State fuel tax rates for all the capital gap scenarios. To fund the full program, future increases would have to be more than $2.00 per gallon in all cases, even with extensive borrowing. The compromise spending program would bring the fuel tax needed by 2025 down to about $1.50 per gallon. Even current spending levels would require $0.85 per gallon by 2025 if there were no borrowing, and still a hefty $0.68 with the highest level of borrowing. Put another way, even to meet current funding levels and borrowing, at least a tripling of the current New York State fuel tax rate would be required.

The New York State tax rate requirements improves substantially if the federal fuel tax is increased also, cutting the New York State rate hikes roughly in half, as the lower portion of Table 18 indicates. However, since New York State motorists would also be paying the federal fuel tax, the outlay would be the same. This assumes the allocations to New York State from the federal fuel tax remains as it is today. Even at current spending levels, the New York State and federal fuel tax would each have to increase by $0.31 per gallon 2025, with heavy borrowing still the case. Of course, this would require

---

the gasoline tax. However, this is estimated to raise only $5 billion over a ten year period, or $500 million per year, making it a pale substitute. Moreover, it has little chance of passing. Source: http://www.scribd.com/doc/75125313/2011-12-Senate-Republicans-Financing-Proposal.

agreement to increase the rate at the federal level as well as the state level, and there seems to be little appetite for that at this time.

Table 18 - Fuel Tax Increases Necessary to Close Funding Gap

If Only New York State Increased Fuel Tax				
	2009	2015	2020	2025
Meet All Capital Needs				
No Borrowing	$ 1.76	$ 1.88	$ 2.11	$ 2.44
Borrow 30%	$ 1.04	$ 1.34	$ 1.73	$ 2.25
Borrow 55 to 57%	$ 0.42	$ 0.88	$ 1.40	$ 2.08
Compromise Program				
No Borrowing	$ 1.19	$ 1.27	$ 1.44	$ 1.68
Borrow 30%	$ 0.64	$ 0.87	$ 1.15	$ 1.54
Borrow 55 to 57%	$ 0.17	$ 0.51	$ 0.90	$ 1.41
Current Spending Levels				
No Borrowing	$ 0.56	$ 0.61	$ 0.71	$ 0.85
Borrow 30%	$ 0.20	$ 0.34	$ 0.52	$ 0.76
Borrow 55 to 57%	$ (0.11)	$ 0.11	$ 0.35	$ 0.68
If New York State and US Each Increased Fuel Tax				
	2009	2015	2020	2025
Meet All Capital Needs				
No Borrowing	$ 0.87	$ 0.91	$ 1.00	$ 1.13
Borrow 30%	$ 0.51	$ 0.65	$ 0.82	$ 1.04
Borrow 55 to 57%	$ 0.21	$ 0.43	$ 0.66	$ 0.96
Compromise Program				
No Borrowing	$ 0.59	$ 0.62	$ 0.68	$ 0.98
Borrow 30%	$ 0.32	$ 0.42	$ 0.55	$ 0.71
Borrow 55 to 57%	$ 0.08	$ 0.25	$ 0.43	$ 0.65
Current Spending Levels				
No Borrowing	$ 0.28	$ 0.30	$ 0.34	$ 0.40
Borrow 30%	$ 0.10	$ 0.17	$ 0.25	$ 0.35
Borrow 55 to 57%	$ (0.06)	$ 0.05	$ 0.17	$ 0.31

Source: Regional Plan Association

2. Convert to a Sales Tax

Another approach would be to shift the New York State fuel tax from a per gallon tax to a sales tax, with the yield growing with higher prices. This would result in an increasing yield as the price of crude oil increased. In Table 19 the sales tax percent is estimated if the sales tax were to replace the current per gallon fuel tax in New York State. An increase of ten cents per year in the pre-tax price is assumed. These sales tax levels are well beyond any sales taxes levied in the US today. The full program would eventually require more than a 50 percent sales tax; the compromise program in the 42 to 48 percent range, and even funding the current program would require a sales tax rate in excess of 25 percent. These levels would be still higher if prices were not assumed to increase.

Table 19 - Percent Sales Tax on Fuel Required to Replace Per Gallon Tax in New York State and Close the Capital Program Gap

	2009	2015	2020	2025
Meet All Capital Needs				
No Borrowing	63.6	62.8	62.2	64.0
Borrow 30%	42.4	48.4	53.2	59.9
Borrow 55 to 57%	24.6	36.1	45.5	56.4
Compromise Program				
No Borrowing	47.0	46.5	46.4	47.9
Borrow 30%	31.0	35.6	39.6	44.9
Borrow 55 to 57%	17.2	26.1	33.7	42.2
Current Spending Levels				
No Borrowing	28.8	28.7	29.1	30.4
Borrow 30%	18.3	23.1	27.5	32.6
Borrow 55 to 57%	9.1	15.3	20.7	26.7

Source: Regional Plan Association

3. Charge by Miles Traveled

This brings the discussion back to the subject of this report – mileage based user fees. If fuel taxes, either as price per gallon or sales tax proves unpalatable, then what are the prospects for mileage based user fees? Two sets of calculations are shown here to open the discussion:

- The average mileage fee charge as an addition to the current fuel tax in New York to close the capital program gaps; and

- The average mileage fee to fully replace the fuel tax and close the capital program gaps.

As shown in Table 20, if implemented as an addition to the current fuel tax, the mileage fee would close the entire funding gap, without any borrowing if set at approximately nine cents per mile; 30 percent borrowing scenario could bring the rate down to five cents initially, but would climb to about eight cents by 2025, and more thereafter. Borrowing at the 55-57 level would require only about two cents initially, but climb to eight cents by 2025 and more after that. The compromise program would bring the per mile fee down to about six cents without borrowing, but by 2025 only about a penny less with borrowing. If only the current program was funded, a mileage base user fee could be as little as three cents per mile.

Table 20 - Required Per Mile Fee to Close the Funding Gap While Retaining Current New York State Fuel Tax

Needed Capital Program	2009	2015	2020	2025
No Borrowing	0.087	0.088	0.088	0.090
Borrow 30 % of Capital Program	0.052	0.063	0.074	0.083
Borrow 55 to 57% of Capital Program	0.021	0.042	0.059	0.077
Compromise Program				
No Borrowing	0.059	0.060	0.060	0.062
Borrow 30 % of Capital Program	0.036	0.041	0.048	0.056
Borrow 55 to 57% of Capital Program	0.008	0.024	0.038	0.052
Current Program				
No Borrowing	0.028	0.029	0.030	0.032
Borrow 30 % of Capital Program	0.019	0.016	0.022	0.028
Borrow 55 to 57% of Capital Program	(0.006)	0.005	0.015	0.025

Source: Regional Plan Association

To fully cover the funding gap and replace the New York State fuel tax, mileage based user fees would be about one to 1.3 cents more than the levels cited above.[8] These are shown in Table 21. A dime a mile would buy a fully funded program with no borrowing; seven cents would fund the compromise program and four cents, the current funding levels.

[8] In Oregon this same calculation produces an average of $1.56 cents per mile. Whitty, James M. "Oregon's Mileage Fee Concept and Road User Fee Pilot Program: Final Report." Oregon Department of Transportation (Nov 2007).

The rates cited here assume a flat rate independent of vehicle type, driving time or locations. These rates could vary in many ways:

- by class with passenger cars paying a lower rate and trucks paying at a higher rate;
- by fuel efficiency, with more efficient vehicles, including all-electric vehicles, paying at a lower rate and less efficient vehicles paying at a higher rate;
- by location, with the rates for driving in rural areas where there is little congestion set at a lower rate, and rates in congested urban areas set higher; and
- by time of travel, with rates lower at times of day or days of week when there is less congestion.

Table 21 - Required per Mile Fee to Close the Funding Gap if Substitute for New York State Fuel Tax (in dollars)

Needed Capital Program	2009	2015	2020	2025
No Borrowing	0.100	0.100	0.099	0.099
Borrow 30 % of Capital Program	0.064	0.075	0.085	0.092
Borrow 55 to 57% of Capital Program	0.034	0.054	0.070	0.086
Compromise Program				
No Borrowing	0.072	0.072	0.071	0.071
Borrow 30 % of Capital Program	0.048	0.053	0.059	0.066
Borrow 55 to 57% of Capital Program	0.021	0.036	0.048	0.061
Current Program				
No Borrowing	0.041	0.041	0.040	0.041
Borrow 30 % of Capital Program	0.032	0.028	0.033	0.037
Borrow 55 to 57% of Capital Program	0.007	0.017	0.026	0.034

Source: Regional Plan Association

The vehicle-based approach, with rates set by the characteristics of the vehicle would be relatively easy to implement since the rate would be set in advance. With the rate set according to the vehicle, there would be no need to record or monitor the time and location of the miles driven. This approach would retain and strengthen the incentive to buy and use more fuel efficient vehicles that is inherent in the price of fuel today. Another approach, which could be combined with the vehicle-based one, would vary the per mile rate based on where or when the vehicle was used, higher during more congested times and in more congested places.

Each of these pay-as-you-go pricing policies is intended to serve some larger public purpose beyond raising funds for transportation – less fuel use, or lower congestion, or higher transit use. But each complicates the monitoring, enforcing, and revenue collecting processes in some way. More importantly, each would depend on the public acceptance of the pricing policy from a perspective of fairness and simplicity. Within any group defined by vehicle class, vehicle efficiency, area driven in, and time of driving, there will be many individuals who fare poorly – they may have little choice but to use a large vehicle, or travel in urban areas, or do not have a transit options, or must travel at certain times. They will have legitimate grievances. Charging by where or when the miles are driven can raise privacy concerns, even if assurances are given and data retained only long enough to verify the charges. Where the line is drawn on a map or on a clock is necessarily arbitrary and will be challenged. And pricing policies that are complex reinforce the concerns about governmental intrusion.

Closing Comments

This discussion about what it will take to close the capital program gap for highways and transit in New York State is sobering. Higher fuel taxes, whether remaining as a per gallon levy or converted to sales taxes will require substantially more outlays to the consumer and taxpayer. Mileage based user fees, while having the potential to match the amount paid more closely to the use of the highway network, will still require much higher costs to users. Any of these options will require political leadership that recognizes the economic cost of not funding our massive and aging transportation infrastructure inaction, and is then willing to act and lead to solve the problem.

To better understand the possible incidence of impact within New York, better and more reliable data will need to be collected and disseminated for discussion. The use of either field-based or registration-based information each have their drawbacks, and which if either is used will depend on the method decided on to collect revenue from vehicle mileage fees. Over 30 years ago, RPA made an attempt through a household survey to better understand the forces that determine VMT levels. Such a study, if undertaken today would require enormous resources, and a more wary public is less likely to volunteer information regarding odometer readings as readily as they did in 1979. Still, methods should be explored to get at the heart of VMT generation, not just for the purposes of mileage based user fees consideration, but for other transportation planning applications.

A. Appendix A
Literature Review and Conference Notes

Approach & Organization

Regional Plan Association reviewed over forty journal articles, policy briefs and studies that were published since 2003. Pertinent information is summarized and organized by the following eleven topic areas:

- VMT Fees in NYS
- Implementation
- Jurisdictional Issues
- Collection Costs
- Elasticity of Vehicle Demand by Price
- Vehicle Technical Issues/Technology
- Transition from Gas Tax
- Fee Levels
- Privacy Safeguards
- Equity
- Gaining Public Support

Many of these categories are not mutually exclusive, for example implementation cuts through all of the topic areas. These interdependencies will be explained in each section.

The most compelling research has been completed more recently, specifically National Cooperative Highway Research Program 161: System Trials to Demonstration Mileage-Based Road Use Charges in 2010 and the recently published 2011 Congressional Budget Office report entitled Alternative Approaches to Funding Highways – these two studies concisely synthesized earlier research, articulated barriers to MBUF implementation and developed frameworks to guide pilot programs and VMT pricing schemes.

While the overall depth and breadth of the existing research is impressive, it is imbalanced. There are areas where considerable attention has been paid and others where the research is wanting. Significant work has been completed in the topic areas of MBUF implementation and in-vehicle technologies. Public perception, collection costs and fee levels have also been covered in some detail. However, jurisdictional issues, privacy, equity and transition from the gas tax have not been extensively studied. Additionally, very little New York State centric MBUF research exists – only one study and three journal articles were found.

RPA believes that this review is extensive, but not exhaustive or complete. As the field matures it can be expected that new information will emerge; this review represents a snapshot as of the time this report was written.

The following eleven sections summarize the available research for each topic area. Some background material on each topic is provided and then relevant information from the collected materials is referenced. A complete bibliography is provided at the end of the document.

VMT Fees in NYS

The goal of this study is to propose a program or framework for potentially implementing a MBUF system in New York State. One of the primary tasks of this literature review was to collect material that could be used to inform this research and the eventual plan, ideally some of this literature would be NYS specific. Not surprisingly, most state centric research involves places that are studying or implementing pilots – Oregon (Whitty, 2007) and Texas (Baker, 2008)– and since NYS has not undertaken this initiative there is very little available material with one exception, a recent study that examined a truck VMT fee pilot completed by the Delcan Corporation in April 2011. The study detailed the projected growth in truck VMT and their impacts on the road network, specifically freight bottlenecks and revenue loss. It tested several MBUF strategies and outlined a framework for a MBUF pilot for trucks.

- Truck VMT in New York State is projected to grow significantly over the next 20 to 30 years (Delcan, 2010) (Poole, 2007), which will impact the efficiency of segments of the interstate highway network (Delcan, 2010).
- Truck VMT in 2009 for New York State was estimated to be 10,139 million miles on Highways, 8,566 million miles of non-Thruway VMT. (Delcan, 2010).
- USDOT estimates that national highway freight will increase by 73% by 2020, from 11 billion tons annually to 19 billion (Poole, 2007).
- Freight tonnage is expected to grow by 1.6% per year reaching 27.1 billion tons by 2040, a 61% increase in tonnage between 2010-2040, with the trucking industry's share of the total tonnage increasing from 68% in 2009 to 70.7% by 2021 (Delcan, 2010).
- The Interstate I-90/I-290 interchange east of Buffalo was the worst freight bottleneck in the nation in 2008, with nearly 1.7 million hours of annual truck delay (Delcan, 2010).
- A MBUF system in NYS could address potential revenue shortfalls (Schuitema, 2007) (Delcan, 2010) and, in combination with PAYD, could help lower premiums for residents (Bordoff and Noel, 2008).
- Trucks have been paying a growing share of Highway Trust Fund revenues in recent years, 37% of the total versus 33% in 1997 (Delcan, 2010).
- A 6.6 cent per mile fee in New York State would result in 11.5%less mileage per average vehicle. This would lower accident rates, resulting in a PAYD rate of 9.2 cents per mile (Bordoff and Noel, 2008).
- There is a significant level of revenue loss in the current truck tax system. Setting VMT fees to equalize current truck fees would increase funds to New York by about $250 million a year. Another option would be to "split the difference" and decrease the official rate for trucks while still keeping it above what is currently collected by New York State. Another option is to raise overall fees but focus revenues on specific investments that focus on improving efficiency of freight movement (Delcan, 2010).

- Scenario 1: A Flat fee per mile, 10.6 cents per mile on non-NY State Thruway roads and 5.1 cents per mile on the NY State Thruway.
- Scenario 2: Fees that vary by class of roadway, 9 cents per mile for interstates and divided highways, 13 cents per mile for major arterials, 17 cents per mile for other arterials and local roads. Short trips on a lesser road as trucks exit the Thruway to a nearby facility could be missed, which could add up to thousands of miles. To avoid this, the Global Positioning Systems (GPS) data would have to be transmitted in very short intervals.
- Scenario 3: Fees offering incentive for off-peak travel, where fees are reduced by 50% for travel between 8PM and 5AM.

Implementation

Implementation is catchall term that includes jurisdictional, collection, privacy, fee and in-vehicle technical issues. For our purposes here it has been defined as the research that has been completed on MBUF pilots and the broader discussion of the barriers toward implementation. A limited number of international examples of truck VMT and congestion pricing systems are also included.

The implementation of MBUFs for passenger continues to be limited to pilot demonstrations, the most sophisticated of which have been carried out in Oregon and Washington. These programs have resulted from enabling State legislation, the creation of task forces, and research grants, but all have not led to implementation following their successful completion. Numerous studies have examined operational congestion pricing systems in Singapore, London and Stockholm as well as Heavy Goods Vehicle (HGV) tolling schemes in Switzerland, Austria and Germany.

While some studies put forward comprehensive phasing strategies to implement MBUFs, the majority of the literature reviewed looks at a specific subset of implementation – installation and management timeframes, political feasibility, targeting certain vehicles, toll rates, value added programs, etc.

- Many experts agree phasing must begin with the necessary legislative changes, task force creation, pilot demonstration, installation of infrastructure, system design to work concurrently with fuel tax followed by a full implementation (Baker 2009, Whitty 2007, Attard 2011, Puget Sound 2008, Kalauskas 2009).
- An incremental approach could be taken where fees change in phases, incorporating flat and dynamic tolls as well as parking rates and public transit fares (de Palma 2006, Proost 2006).
- Rely on vehicle replacements that come equipped with technology to facilitate MBUFs (Whitty 2007, Baker 2009) so that in twenty years 95% of national fleet with have the necessary On-Board Units (OBU) (Forkenbrock 2005) or require retrofitting of vehicles, which comes with higher costs (Sorenson, 2011).
- A volunteer-based implementation plan where drivers can opt-in to MBUFs and compare costs is advocated because it should help gain public acceptance (Baker 2009, Sorenson 2011).

- Half of freight vehicles in New York already have the necessary technology installed (Delcan 2010). Freight could be targeted individually (Baker 2009, Balmer 2003, Nash 2003, Kalauskas 2009, Poole 2007, Schuitema 2007).
- The majority of road pricing has resulted from congestion problems and has often used public-private partnerships to help with implementation (Kalauskas 2009).
- PAYD insurance faces similar legislative barriers, requires compatible technology and provides large savings and travel impacts that offset and complement MBUFs (Bordoff 2008).
- Accompanying public transit improvements helped London congestion pricing to succeed (Kalauskas 2009).
- It is important that policy-makers clearly understand the capabilities of the various MBUF systems prior to implementation; as certain systems would allow for specific policy goals while others would negate them. For example, is the location, route of travel or time of travel required to meet certain end goals or is estimating miles of travel sufficient (Sorenson 2011)?
- Loosening weight restrictions along with Heavy Vehicle Fees (HVF) in Switzerland enabled goods movement industry to become far more efficient (Nash 2003).
- In Edinburgh, the lack of a pilot demonstration and its lack of a resident-friendly design prior to a referendum on MBUFs contributed to its rejection at the polls (Attard 2011).
- Puget Sound MBUF used a dual program: a main program requiring an on board unit (OBU) installation and an occasional program using a more expensive flat rate (Puget Sound 2008).

Jurisdictional Issues

Jurisdictional issues regarding MBUFs cannot be addressed in isolation since they are always in relation to technological concerns, toll collection issues, institutional barriers and questions surrounding implementation. Studies on freight MBUFs highlight jurisdictional issues that either provided the impetus for or are a barrier to implementation. Other research has attempted to identify agencies or bodies with the institutional capacity to operate and administer MBUFs over multiple jurisdictions. The division of control of parking rates and cordon pricing in certain areas also has implications for the effectiveness and welfare gains or losses of different pricing schemes.

One of the most critical, yet contentious issues, concerns the role the states, federal government and private sector (market based) will play in implementing MBUFs. This is issue is addressed by several authors, with overall consensus being that the federal government will have to coordinate the collection and system technical standards at the very least (Baker 2009, Rand 2010, Sorenson 2009, I-95 2011). While MBUF could be implemented by states and localities on the individual basis, there still needs to be a body to govern standards and to assist in multi-state jurisdictional issues. The same is true regarding the private sector, if the market was to take the lead a considerable effort would need to be made to coordinate standards to ensure interoperability and to police the system, which might be a federal role. The federal government might also need to provide incentives to induce drivers to opt-in to a voluntary program and pay the VMT fee, possibly be increasing existing taxes and fees (Sorenson 2011). Internationally, many of the VMT tax systems are coordinated on a national level. Germany, Belgium, the Netherlands and Luxemburg have effectively managed multi-jurisdictional issues as part of the heavy goods vehicle tolling initiative (Kalauskas 2009, Nash 2003).

- Three jurisdictional concepts for a transition are considered. In a state or group of states approach, the states would take the lead. This has the advantage of easier public acceptance (moves forward where there is more interest), but it does not address federal revenue shortfalls, and poses interoperability risks. The federal approach overcomes these disadvantages, but requires a national consensus and would require mandatory adoption, which is likely to be difficult. The market based approach, which could include value added services, would lower government costs and could circumvent public acceptance issues by a voluntary approach. However, the market is unproven and interoperability issues would likely arise. These three paths might not be mutually exclusive though, and could be a blend of approaches (Rand, 2010, Sorenson, 2009).
- To avoid jurisdictional problems, the federal government could ensure that state and local pricing decisions don't conflict with interstate commerce laws and objectives so that different state systems are compatible with one another (Baker 2009).
- Federal government could first codify system requirements for MBUFs to ensure vehicle manufacturers include certain technologies or as guarantors of user privacy (Baker, 2009).
- New York State is disadvantaged under current HGV system due to underreporting of ton-miles driven in New York State to the International Fuel Tax Association (IFTA) because of higher taxes by up to $170 million annually and $90 million in diesel taxes (Delcan 2010).
- The National Motor Vehicle Title and Information System (NMVTIS), the Dept. of Motor Vehicles (DMV), the International Registration Plan (IRP), the Interagency Group (IAG or E-ZPass) and the IFTA all are candidates for administrators for multi-jurisdictional MBUF systems (I-95 Corridor Coalition 2010).
- The U.S. DOT's Intelligent Transportation Systems Joint Program Office could also oversee development and demonstration of VMT fee technology as well as to address questions. (Puentes, 2010).
- Eurovignette HGV tolling system in Germany, Belgium, the Netherlands and Luxemburg coordinated freight charges to reduce preferential treatment of national operators and harmful competition, resulting in large efficiency gains (Nash 2003.)
- The Netherlands is currently proposing a national road pricing program to replace current transportation taxes and fees set to be implemented in 2012 using GPS systems (CURACAO 2009).
- For the Swiss HVF scheme, the Swiss Customs Authority collects and administers fees (Balmer 2003). Customs provides a chip as vehicles enter the country with the relevant information that is necessary to pay when the vehicle exits (Kalauskas 2009).
- Congestion pricing should be implemented regionally with revenues distributed to municipal governments with tolled freeways passing through them without restrictions on how to spend revenues (King 2007).
- Using the Oregon Model, information on mileage driven in the participating jurisdiction is stored until the vehicle reaches a compatible refueling station (Whitty 2007).

Collection Costs

A major concern that might affect the feasibility of MBUFs is their collection costs. These typically include the annual administrative and equipment/system maintenance costs. However, the initial capital investment required to setup the system can also impact collection costs since this is typically funded by issuing long-term debt (30-year bonds) backed and paid by system revenues.

The current motor fuel tax system requires less than 1 percent of gross revenues to go to administrative costs, largely because the tax is collected at 350 refineries rather than at the point of payment or retail level (CBO 2011, Sorenson 2011). Conventional tolling (fixed gantry or booth) consumes more than 33 percent of annual revenues and congestion pricing schemes have averaged around 40 percent (Balducci 2011). Acceptable administrative costs tend to be in the 5 to 10 percent range, which most operational VMT-based charging systems meet. Feasibility studies of proposed MBUFs vary in their administrative cost predictions but do demonstrate that operating below 10 percent is possible for VMT-based charging, particularly with Truck VMT-based charging. International experience has suggested that the administrative costs for VMT tolling might be as low as 6 percent or $75 per vehicle (Balducci 2011).

- Estimated collection costs for a New York Truck VMT fee system would be 2-5% or $40 per vehicle annually. However, this system would resolve current revenue losses of more than $200 million due to underpayment of the Ton Miles Tax and Diesel Tax (Delcan 2010).
- Swiss HVF average implementation costs were 8% of gross annual revenues in 2002, with net revenues approximately 525 million Euros (Nash 2003). Fee increases are expected to bring lower administration costs to 5-6% (Goodin 2009, Balmer 2003, Nash 2003).
- Operating costs for statewide implementation of Oregon MBUF pilot estimated at 3% of total mileage fee revenue (Whitty 2007).
- Trondheim toll operating costs totaled 10% of gross revenues in 2002 (Schuitema 2007).
- Implementation costs for the Puget Sound region MBUF pilot were $748 million in 2008 dollars, 89% of which came from OBU costs and installation. Annual operating costs are estimated at $288 million, mostly to cover data communications functions and no gross revenue figures are given, but the administrative costs would be far larger than current 1% (Puget Sound 2008).
- Collection costs for a hypothetical credit card-based congestion pricing scheme for an electronic toll collection system on all of Dallas-Fort Worth region highways would have administrative costs initially estimated at 40% of gross revenues (Gulipalli 2006).
- Lowest preliminary administrative costs for revenue neutral switch of entire country to VMT-based charging would be $30-40 (6-8%) per vehicle annually, requiring a total charge of $500 to each of the 240 million registered vehicles (I-95 Corridor Coalition 2010).
- Upfront per vehicle costs for switching to PAYD insurance are estimated to be between $50 and $170, but for two-thirds of households who would pay less for PAYD insurance than current insurance, average annual household savings would be $270 per vehicle. A government program to incentivize PAYD insurance using $100 tax credits for first 5 million vehicles would cost $515 million but have potential Medicare and Medicaid payment and productivity savings of $1.4 billion from fewer accidents and the resulting greater worker productivity (Bordoff 2008).

- Australia’s AustroRoads program costs participants with technology installed $30-50 per month, and non-equipped vehicles $110-190 per month (Baker 2009).
- OBUs for the Oregon DOT pilot each cost $209 for development, $338 for manufacturing and $55 for installation: $602 total, although these costs are expected to decline if mass produced (Baker 2009).
- Retrofitting vehicles with GPS or other technology is too expensive, better to simply wait for the natural replacement of the fleet, approximately 20 years (Forkenbrock 2005, Whitty 2007).
- The fuel tax system is the most cost-effective revenue stream when compared to VMT tolling, conventional tolls and cordon pricing schemes. It just requires 1% of tax revenue or $1.20 per vehicle. Violation rates are typically under 1% (Balducci, 2011).
- There are two types of conventional tolling systems, fixed barrier (bridge crossing) and open road tolling, which uses gantries with Electronic Toll Collection (ETC) and/or video to collect tolls at-speed (the NJ Parkway). There is also a hybrid variant that allows for greater flexibility in implementation and payment collection. System leakage rates have been estimated at between 5 to 10% (Balducci, 2011).
- The Netherlands is proposing to move to a comprehensive VMT-based charging system for all road use by 2016. Other existing systems are weight-based and there is little actual experience. The Dutch completed substantial work to determine the feasibility of a system, Balducci, et al used this as the foundation for their VMT revenue estimates (Balducci 2011).
- The cost data from pilots tend to be high due to developmental costs and small scale production, yet they do not include enforcement costs due to non-payment or evasion. This makes them an inaccurate “snap shot” of the true costs of operating the system. (Balducci 2011)
- The Dutch solicited proposals from four private companies (Siemens, DaimlerChrysler, T-Systems and Vodafone) to develop cost estimates for the design and production of the OBUs and operation of the system. These estimates also included initial start-up costs and annual depreciation. (Balducci 2011)
- The costs of the systems varied, Siemens was the cheapest and T-Systems the most expensive, partially due to the thick/thin client setup and funding of depreciation. On average the annual cost would be 6 to 7% of collected revenues. However, the revenues collected (rates) are on average $6.26 per 1,000 VMT, which is must higher than revenues collected in the US today per 1,000 VMT (if you were to convert the gas tax). Additionally, these estimates do not include the fixed costs of the OBU. The initial startup costs to equip vehicles with the OBU and setup the system would consume almost 22% of annual revenue for the first year or possibly two. There is the potential to defray some or most of these costs if the OBU was used for other value-added services. (Balducci 2011)

Elasticity of Vehicle Demand by Price

Elasticities of demand are used to estimate the sensitively of traffic volumes to different fee/tolling levels. Much of the research that was reviewed did not include the elasticities themselves, but did provide some statistics, survey data, and estimates of travel times and driver behavior. The literature covered how insurance cost might change if PAYD insurance programs were instituted, impacts on traffic and congestion levels, diversions to transit and some international examples MBUFs on truck fleets and congestion pricing.

- PAYD insurance could reduce VMT and emissions. If all motorists paid accident insurance per-mile rather than a lump sum, the study estimates driving would decline by 8% nationally, reducing carbon dioxide emissions by 2%, oil consumption by 4% and net social benefits worth $50-60b—or equivalent to a $1-per-gallon rise in gas taxes (p.2). However, higher fuel prices ($4/gallon) could reduce elasticities from the -.15 used to calculate an 8% reduction to -.2, which would produce a 7% reduction (Bordoff and Noel, 2008).
- MBUFs have been shown to impact traffic and congestion levels. Modeling of potential MBUF schemes and pilots in United States have shown that they result in a reduction in VMT (Gulipalli 2006, Puget Sound Regional Council 2008, Whitty 2007). However, toll elasticities tend to decrease over time as drivers adjust to the higher costs (Bordoff and Noel 2008). MBUFs could also increase speeds in CBDs if coupled with a congestion charge, increasing the efficiency of surface transit systems that could lead to higher ridership (King 2007).
- Vehicle elasticities are much higher in the short term following tolls than in the long term, likely because drivers are less aware of the rise in prices they are paying. This is similar to anecdotal findings for Hybrid Vehicles (Bordoff and Noel, 2008).
- Total system VMTs would be expected to fall by 7% in the Dallas Fort Worth region under a marginal cost pricing (MCP) scenario on freeways only. Under a MCP system on all roads scenario, total system VMT is predicted to drop by 6%. The average trip length for MCP-on-Freeways would fall 4% in short term but rise 2% in long term (p.4). Arterial VMT for MCP-on-all-roads is predicted to fall 2% in short run and 5% in longer run (p.4). Total travel time fell for Freeway VHT (vehicle-hour of travel) by 19% in short run, 21% in long run, with a higher difference for peak-period travel than off-peak period travel. Very small mode shifts for both scenarios regarding driving alone and shared ride trips are predicted, with travelers more likely to change their destinations or routes than travel mode (Gulipalli, 2006).
- Elasticities for households in the Seattle metropolitan area in relation to toll costs found for weekly tour distances were -0.12, or a 12% reduction in weekly vehicle travel distances. Similarly, there was a 7% average reduction in all vehicle tours, an 8% reduction in tour drive time/week, a 6% reduction in tour segments/week, and a 13% reduction in miles driven on tolled roads/week (Puget Sound Regional Council, 2008).
- Study participants who normally left for work within 15 minutes outside of a lower toll-cost period had a 40% chance of switching their trip to the low cost period. Within 60 minutes, the probability reduces to 20%, and within 180 minutes the probability is below 5% (Puget Sound Regional Council, 2008).
- The value of the commute tour travel time is close to 75% of the wage rate for the greater Seattle metropolitan area (Puget Sound Regional Council, 2008).
- Trips were reduced during the a.m. and p.m. peaks (2.4% and 2.7%) and increased during the evening/early morning by 5.5% (Puget Sound Regional Council, 2008).

- The May 2000 Port Authority of NYNJ pricing system, which is still in place in modified form, for the Hudson River Tunnels and Bridges saw a 4% drop in vehicles for the afternoon peak period but a corresponding 7% increase in the period after the afternoon peak period . The morning peak period also saw a 7% decline in vehicles (Schuitema, 2007).
- One author estimates congestion pricing will increase bus ridership in the typical US city by 30%, bus speeds will increase by 9% and bus fares could be possibly be reduced by 26% (King, 2007).
- Oregon's pilot completed in 2007 also resulted in decline in VMT. The greatest reduction took place predominantly during peak-hour travel, with some diverting to transit and other modifying their travel behavior or avoiding the congestion zone (Whitty, 2007).
  - Vehicles in the VMT group (paying the flat 1.2 cent/mile fee) showed a 12% reduction in driving, or 3 miles per day.
  - Vehicles in the rush hour group reduced driving by 5.5 miles per day on average or 14%. During peak periods, travel declined by 22% relative to the VMT group.
  - Households with transit access within 4 blocks reduced their rush hour miles by an additional 0.742 miles per day.
  - 12 of the 84 households in the rush hour group started using alternative transportation modes to save money. Twenty-six reported someone in the household changing either distance or time of travel to save money, with 23 of those mainly to avoid the congestion zone during rush hour.

- Congestion Pricing schemes, a form of VMT tolling, have resulted in significant traffic reductions (CURACAO 2009, Progress 2003, RAND 2009, Schuitema 2007, Sorenson and Taylor 2006). They have also driven efficiency improvements in truck fleets (Nash 2003).
- Cities that have implemented road user charging have experienced a 14-23% reduction in traffic in the charging zones. Stockholm is highlighted as an example of where predictions in travel responses were relatively accurate (CURACAO, 2009).
- One year prior to the new Swiss HVF, the sales of heavy goods vehicles increased by 45%. These new vehicles belonged to the lowest emission class, as well as the expanded range of truck sizes meant that fleets could be better matched to the actual needs of the market. The new HVF also led to a concentration of the truck industry, improving efficiency to minimize trip costs (Nash, 2003).
- Rome saw a 10% decrease in daily traffic and a 6% increase in public transport use in the first year of implementation. During Copenhagen's trail, 50% of participants changed their driving behavior, mostly for non-commuter trips. Models for Gothenburg's environmental charging scheme predict traffic drops of 13% by 2010. Particulate emissions in Bristol could be reduced by 24% in a decade if charging scheme was implemented (Progress, 2003).
- In London, 70% of low-income households made fewer trips to the cordoned area compared to 60% of all individuals surveyed (RAND, 2009).
- In Singapore, the 1975 implementation of manual cordon-style congestion pricing between 7:30-9:30am led to an immediate 73% reduction in private car use in the CBD, a 30% increase in carpooling (carpoolers were exempted from the fee), and a doubling of bus usage. Many people were also found to have shifted their travel time to around the restricted hours. In 1989, hours were expanded to include afternoon peak hours and all exemptions were eliminated except for

public transit vehicles. In 1994 times were again expanded, and in 1998 an electronic cash card system was implemented. Morning peak traffic remains 31% lower than pre-1975 levels.

- Trondheim, Norway has experienced a 10% drop in peak traffic and an 8% drop in off-peak traffic within the charging zone (Schuitema, 2007).
- London saw an immediate 20% decrease in traffic following the 2003 implementation of cordon-style congestion pricing and has potentially impacted the sales of hybrid vehicles, which are exempt from the charge (Schuitema, 2007).
- During the first 6 months following London's implementation of cordon congestion tolls, daily auto trips into the charging zone decreased by approximately 60,000, leading to a 14% reduction in journey times to and from the zone, a 30% reduction in traffic delays within charging zone and a 30% improvement in journey time reliability. Public transit delays dropped by about one third, transit ridership increased (Sorenson and Taylor, 2006).

Vehicle Technical Issues/Technology

MBUF vehicle technical issues have been extensively researched and tested in pilots in U.S. and abroad. It's not surprising then that many of the studies do not consider them a barrier to implementation (Baker 2009, Forkenbrock 2005, Puget Sound Regional Council 2008, I-95 2010, RAND 2010, Sorenson 2010, Sorenson and Taylor 2006, Whitty 2007). However, mileage discrepancies because of transmission gaps were noted between GPS systems and OBUs that plug into the on board diagnostics (ODB) II port during the Oregon pilot, as well as some ODB II compatibility issues, indicating that there are still some "bugs" to iron out (Balducci, 2011).

There are two primary technical issues that standout in the research: the various ways to track/record VMT and the transmission of the data for tax collection purposes. MBUF mileage tracking/recording systems range from manual odometer readings that require no in-vehicle technology to GPS and OBUs that are integrated with a vehicle's onboard electronics. The less sophisticated systems limit MBUF's to just a flat per mile fee, whereas the GPS and OBD units would allow a variable fee that could be based on a combination of location (roadway type or congestion zone), vehicle performance and time of day. Transmission of VMT data could also be manual, someone writing down the odometer reading, or automated, sent over a cellular network to a billing center or downloaded wirelessly at gas station or DMV inspection center. However, system redundancy and hardening to prevent tampering are still issues that appear to merit additional research (Baker, 2009).

- System redundancies will be important to technology-intensive software in case there is a technical failure. An example of such a redundancy is Oregon's system, which allows drivers to be charged the fuel tax as a default if their mileage-fee system isn't working. If the system is not operational at the pump then the gas tax will be applied to the purchase instead (Baker, 2009).
- Tampering with VMT-based pricing is much easier with technology that requires retrofitting older vehicles with units attached to an odometer rather than a pay-at-the-pump system such as the Oregon system where a fuel tax alternative serves as a backup to any malfunction (Baker, 2009).

- There are several international examples that have been tested of technologies that could be used for MBUF (Progress 2003, Nash 2003, Sorenson and Taylor 2006); most have been implemented as part of cordon pricing systems:
    - Rome, Italy tested out cordon pricing using electronic tags and automatic number plate recognition (ANPR).
    - Helsinki, Finland tested out cordon and zone pricing using electronic tags and a distance-based system using GPS.
    - Trondheim, Norway tested zone pricing using electronic tags and ANPR for enforcement.
    - Bristol, United Kingdom tested cordon pricing using ANPR and GPS and tried distance-based pricing through GPS.
    - Copenhagen, Denmark tested cordon pricing through GPS, zone charging through ANPR and distance-based through GPS.
    - Genoa, Italy tested cordon pricing using ANPR.
    - Gothenburg, Sweden tested distance-based using GPS.

- The technologies performed well, with high levels of accuracy. In Trondheim, Dedicated Short-range Communications (DSRC) had a 99.5% accuracy, but can be affected by metalized windscreens and have a relatively short battery life. Automatic number plate recognition (ANPR) accuracy was 74% in Rome, 85-95% in Bristol, but found that this largely depends on placement. GPS signals were found to be easily lost in urban areas due to 'street canyons,' with coordinate accuracy often not good enough to avoid needing further analysis. This is an issue that has been mostly addressed in more recent years (Progress, 2003).
- For German HGV charging, ETC Consortium was awarded the toll collection system contract in 2002to comprise a manual and an automatic collection system. The automatic system would use an OBU that is located by GPS signals and vehicle sensors against a digital map. When the OBU passes through 'virtual toll' plazas, the corresponding toll is deducted from a 'tariff table' that, once a certain credit threshold is reached, sends a bill through GSM to the ETC accounting center (p.10). For non-frequent users, a manual system will be in place where payment is made prior to the trip via Internet, point of sale or call center –all linked to a central computer. All information regarding trip route, vehicle identification, and possible future trip is stored in a database for checks at enforcement sites (Nash, 2003).
- Weight-Distance truck tolls include the Austrian GO program, which uses OBUs and DSRC which communicate with gantries through the highway system. The Swiss HVF system uses an on-board GPS with an OBU recording distance within Switzerland through the tachograph combined with a vehicle class to produce a fee. The German Toll Collect system uses GPS and GSM to calculate a fee that incorporates position, distance traveled, weight (by axels) and emissions class (Sorenson and Taylor, 2006).
- In Switzerland every domestic truck was required to have an OBU, the device was provided for free and the owner paid the installation costs. The OBU is fixed at the windscreen and connected with a tachygraph so that it begins when the engine starts and counts the electronic impulses it gets from the tachygraphy (registering the kilometers driver). The admissible weight and emission category

are stored in the OBU as well as in a backup system. The data is transmitted monthly to the Swiss Customs Authority either electronically or physically by chip card, which administers and collects HVF (Balmer, 2003).

- Several of the technologies that would be used for an MBUF system are in operation today in the U.S. for PAYD systems, fleet management, Original Equipment Manufacture (OEM) applications (GM's OnStar system) and MBUF pilots (Baker 2009, Bordoff and Noel 2008, Delcan 2010).
- All new GM vehicles are being equipped with On-Star which already uses GPS technology and Verizon cellular services (Baker, 2009).
- A problem with an Oregon Model/Pay-at-the-pump configuration is how electronic vehicles would be charged. There is also the question of enforcement for cellular-based models (Baker, 2009).
- PAYD insurance has also driven developments in technologies to track VMT. The TripSensor program in Michigan, Minnesota and Oregon records mileage, speed and time of day the vehicle is driven to calculate a rate that the customer would then be charged once they renew the insurance policy. OnStar, using its OEM technologies deployed in GM vehicles for over a decade, also offers discounts on insurance for drivers whose mileage is less than 15,000 miles (Bordoff and Noel, 2008)
- Truck VMT might be calculated using telemetry boxes already installed in many long-haul fleets, with new installation of a box costing $200. Other telemetry boxes are available in the market and there is sufficient competition to keep prices low (Delcan, 2010).
- Policy objectives are closely tied to the type of technical equipment needed, making prioritization of policy objectives critical from the start (Baker, 2009). These could include:
    - revenue generation – replacement of fuel tax/transportation funding
    - economic efficiency – user pays principle
    - charging fairness – accurately measures road use on taxable roadways
    - revenue reallocation – redistributes revenues by their source location
    - user privacy/data security
    - system reliability – ensuring redundancies
    - user audit ability – making it easy for drivers to check their bills
    - system flexibility – to accommodate future technologies, rate changes, network changes
    - operating reliability
    - enforcement
    - value-added options – using it as a platform for other services to offer users additional benefits (Baker, 2009)
- There are a variety of methods to record mileage, ranging from manual odometer readings to sophisticated GPS systems that combine real-time vehicle telemetry data. There has been substantial amount of research done in this area. (Baker 2009, Forkenbrock 2005, Puget Sound Regional Council 2008, I-95 2010, RAND 2010, Sorenson 2010, Sorenson and Taylor 2006, Whitty 2007).
- Baker and Gooden in their 2009 study identified four major technology categories.
    - Odometer distance measurements provide high accuracy of distance but not of roadway types or time of day.

- Vehicle speed-based distance measurements provides high distance accuracy and could also enable time-of-day pricing since it includes time stamps, however it doesn't provide locational information and so couldn't incorporate jurisdictional or revenue reallocation factors .
- Vehicle speed-based distance measurements with beacon-based location stamping, essentially the above system with the addition of beacons (potentially cellular phone towers) to locate vehicles.
- Detailed time and location-stamping would capture a complete record of miles driven and where and could incorporate GPS technology with map-matching done either through an OBU or at an external facility. This also offers high potential for value-added options (Baker, 2009).

- The RAND report assesses eight implementation options – three are based solely on odometer readings, two use radio frequency identification (RFID) tags, and three rely on more sophisticated OBU devices to determine the mileage, area, or route traveled. These options cover the spectrum of sophistication, with the most sophisticated (OBU with GPS) being able track mileage on a time of day and location and traffic congestion basis, and charge accordingly, to the least sophisticated that is simply annual total mileage reporting. The report assessed cost, institutional complexity and public acceptability of these alternatives (RAND, 2010).
  - During the test, OBDII and GPS were experimented with, OBDII using mileage information from the vehicle and GPS using information received from a satellite. GPS devices were used to differentiate zones, days of the week and time (Whitty, 2007).
  - "Smart Road" configurations work similarly to gantries using radio-based technology at intersections and roadsides to download information from passing vehicles at regular intervals. Retrofitting vehicles for this technology may not be cost effective, costing over $100 per vehicle, yet with new cars the technology is often already installed (RFID tags) (Baker, 2009).
  - OBUs would record distance, road types and time of day, transferring information to an Electronic Tolling Back Office using a mobile communications network (Puget Sound Regional Council, 2008)
  - For the occasional program, enforcement would be conducted using an Automated License Plate reader (Puget Sound Regional Council, 2008)
  - Sensing technologies include: GPS, Digital Cameras; Vehicle Detectors such as repeater loops embedded in the roads; weight sensors to measure the weight of a vehicle; and tachographs which are usually mounted in trucks to track speed, time, distance traveled, etc. (Sorenson and Taylor, 2006).
  - A MBUF system could involve a GPS receiver, a basic GIS data file, a file containing per-mile charge rates for different jurisdictions and input from the vehicle's odometer to cross-check mileage traveled. The system would record travel conducted in different zones and match those zones to the appropriate rate. Periodically, a center will update the data from vehicles either by digital wireless or hardwire and bill the owners, followed by reimbursing the respective jurisdiction. Alternatively, smart cards could be used to send information to the centers through readers placed in convenience stores, etc. (Forkenbrock, 2005).

- An OBD unit called OBU/cellular-based metering could attach to an OBD II port, which is available on all automobiles produced from 1996 onward. The ODU collects speed and time data through the ODB II port and then processes it to produce travel distance information. If the OBU was combined with a cellular transmitting device, it could transmit OBU data to a processing point for transactions (I-95, 2010) (Sorenson, 2011).
- The type of MBUF system would dictate the level of automation required in the back office and communications technologies deployed (Baker 2009, Bordoff and Noel 2008).

- Baker and Gooden in their 2009 study identified four approaches.
    - Manual Reading, which would work with an odometer-based assessment where drivers would take their vehicle to a charge reporting station to have their odometer recorded and charged, and computed to be sent to a billing office
    - Localized, Detection-Based Transmission using roadside readers that download data from vehicles and then forward that data to a back office for charging.
    - Wide-Area, Constantly Online Transmission where a network of readers continuously downloads data from vehicles over a wide area.
    - A hybrid Localized/Wide-Area Hybrid Transmission that relies on localized transmission but can fall back on wide-area transmission if data hasn't been downloaded within a specific timeframe (Baker, 2009).
- Taking manual readings of odometers during mandatory vehicle inspections is one way to record vehicle mileage. Another is electronic devices that record and transmit mileage. These include CarChipPro that costs approx. $119, a data-collection device that reads and stores data from a car's OBD. Also Intelligent Manufacturing Systems (IMS) and Sky-meter are similar devices and offer wireless data transmissions. Sky-meter is leased to the consumer for a $5 monthly fee (Bordoff and Noel, 2008).
- There are many ways to process the mileage data once it's recorded by an onboard automated system, the ODU can handle this task locally or the data can be uploaded to a data center. The private sector can also get involved as a third-party, assuming this task for government (Baker 2009, Sorenson 2010, Sorenson and Taylor 2006, Whitty 2007).

- Baker and Gooden in their 2009 study noted five options for processing mileage data.

• Thin-Client Data Transmission where OBUs only collect data and transmit them to a centralized location for processing and storage.

• Thick-Client Data Transmission where OBUs perform most data storage and processing and release a certain amount of information or charge to a charging facility or station where the charge could be paid. It would require OBUs have some type of on-board map.

• Third-Party Intermediary Data Transmission where information from an OBU is transmitted to a third party who acts as a privacy shield while processing the data before sending the billing information to a billing office. This system would facilitate private entity involvement and could reduce OBU technology requirements.

- Opt-In Third Party Intermediary Data Transmission would involve drivers opting into releasing their driving history to a third party in exchange for value-added services, such as increased privacy, audit ability, tracking, etc. before it is released to a billing office.

- Anonymous Loop-Back Proxy Data Transmission would entail OBUs which store travel information that can be sent to off-board calculators to ascertain the appropriate charge. The charge information is returned to the OBU and from the OBU the accrued charge is sent to a billing office (Baker, 2009)

- Processing and Analysis Technologies include: OBUs that can read GPS coordinates, determine the position on the road, track distance and compute user fees; GIS systems capable of determining position on the road using GPS coordinates and an accurate digital road map; Automated number plate recognition (ANPR) systems which is software that analyzes images of autos to detect license plate numbers (Sorenson and Taylor, 2006).
- Communications Technologies include: Electronic transponders which are mounted to the vehicle and transmit data to nearby sensors (overhead or on the road-side); Smart cards that are small and transportable so that they can transfer data from an OBU; Dedicated short-range communications (DSRC), using microwave frequency to broadcast and receive data over short ranges in real time between vehicles and roadside devices; Global system for mobile communications (GSM), or long-range cellular communications facilitated by low-orbit satellites (Sorenson and Taylor, 2006).
- Automatic vehicle identification (AVI) tag technology could be used for in-vehicle device connected to GPS, attached to the vehicle's USEPA emission rating so that a mileage fee can be calculated at a fuel pump (Whitty, 2007). In Oregon the OBU screen displays which zone the motorist is travelling in as well as the fee rates when fuel is purchased to see the price impacts of their travel behavior. Mileage is calculated using the vehicle's odometer and on-vehicle identification number, which is tracked using GPS. A central electronic reader at the pump station automatically detects whether a vehicle in the station has an OBU and then wirelessly matches an individual pump reader to the vehicle. The central reader extracts the mileage data and ID number and queries a central database using high-speed internet to gather the vehicle's last mileage reading for each zone. The last mileage reading for each zone is then matched with the current mileage reading to calculate the mileage fee, which is then passed to the point of sale system POS. The POS system then deducts the gas tax and adds the VMT fee, showing a breakdown of miles driven (Whitty, 2007).

Transition from Gas Tax

MBUFs could potentially replace the gas tax or be part of a dual system that requires all drivers to pay both taxes or target certain vehicle classes that do not pay their fair share under the existing gas tax – electric vehicles and/or trucks (Delcan 2010, Schuitema 2007, Whitty 2007). There is the danger that completely transitioning from a gas tax to MBUF might disincentivize the purchase of fuel efficient vehicles (Huang 2010). Some research suggests that voluntary, opt-in, approach might ease the transition: it can also help gain public acceptance of the program (CBO 2011, Sorenson 2011). Equipping vehicles for more sophisticated schemes might further complicate the transition. OEM installation is the preferred approach due to the lower per-unit costs, but it would be decades until the entire U.S fleet is equipped with the technology (Forkenbrock 2005, Sorenson 2011).

A pilot study of the VMT system could be implemented that operates alongside the current tax structure. This way, the carrier would continue to pay current motor fuel and other taxes but receive either a receipt with money returned or a bill to pay more based on the VMT-based system, making the VMT-based system the effective payment with the user aware of the changes it has on pricing (Delcan 2010).

If all new auto models in the US were equipped with OBUs necessary to implement MBUFs in 2005, by 2015 almost 63% of autos in operation would have OBUs and by 2025 nearly 95% of autos would have OBUs. Identifying vehicles with OBUs could be done with a sensor on the fuel nozzle or could work through giving MBUF credits based on how much fuel tax is paid (Forkenbrock, 2005).

Goodin, Baker and Taylor (2009) summarized lessons learned from the experience of the Real ID Act, passed by Congress in 2005 to create national standards for the issuance of state driver's licenses and other forms of identification. They found this the process took longer than anticipated and required the "grandfathering" of certain options, both are issues that could come up during the transition from the gas tax. Details of their findings were:

- Reprocessing current license holders would take far longer than expected as well as the passing of new legislation, federal funding and procurement processes to implement the program.
- There was a need for a "grandfathering" option to allow people who already have driver's licenses and IDs a set amount of time to ease the burden on Motor Vehicle offices.
- Better definitions of the purposes and parameters of the Real ID Act were needed.

Another example is the International Fuel Tax Agreement, which was more "from the ground up" than the Real ID Act since it was initiated by several states and then became incorporated into national legislation in ISTEA. First initiated by Arizona, Iowa and Washington in 1983 to help coordinate the collection of fuel taxes from commercial vehicle carriers, it had reached 16 states by 1990. The 1991 ISTEA legislation gave states flexibility in deciding how to coordinate fuel tax reporting so long as they met basic requirements (Goodin, Baker and Taylor, 2009).

VMT fees would reduce the incentive to buy more fuel efficient vehicles unless the mileage based fees rose with declining fuel efficiency. Proponents of status quo (gas taxes) believe that gas prices are a good proxy for impacts and can be indexed, and without gas taxes, the funding for transportation could be jeopardized. The caveat is that gasoline must remain as the predominant source of motor vehicle energy. They argue that retention of gas taxes can be sold as a deficit reduction measure, to lower reliance on foreign oil, and with a carbon tax, and would be an emission reduction incentive (Huang, 2010).

There was some disagreement as to how quickly VMT fees could be introduced, either as a replacement for gas taxes, or as a complementary revenue source introduced on a voluntary basis (Huang, 2010).

Some authors suggested that an American MBUF initially target trucks, since they constitute a disproportionate amount of air pollution, infrastructure damage and road congestion than their 14% of VMT otherwise would. The public could be more willing to accept this (Schuitema, 2007) (Delcan, 2010).

The Oregon pilot created a concept called Vehicle Miles Traveled Collected at Retail (VMTCAR), which treats part, or all, of the motorist's MBUF as pre-paid by the distributor in the form of the gas tax. The retailer instead uses the MBUF to reimburse the distributor for the gas tax, with any additional revenue from MBUF remitted to the ODOT. VTMCAR uses an electronic accounting mechanism to manage the differential between the MBUF and the gas tax through a periodic "truing up" between the ODOT and the service station retailer (Whitty, 2007).

- On the bill for gas, the driver sees a payment that includes both a mileage fee and a fuel purchase price with the state fuel tax subtracted. For motorists that aren't equipped for MBUF, they only pay the state fuel tax (Whitty, 2007).
- Mileage fees will only be applied to new fully equipped vehicles or newly registered vehicles entering Oregon that can have the capacity for either manufacture or post-manufacture application of the MBUF technology. This is due to current prohibitive costs of retrofitting vehicles with MBUF technology (Whitty, 2007).

Fee Levels

Fee levels can be set to modify behavior, to replicate the existing gas tax or to maximize revenues. Several studies have suggested that trucks should be targeted with higher fees to discourage their travel on certain segments of the network and to recapture their true infrastructure costs (Delcan 2010, Forkenbrock 2005). Some international truck pricing schemes, already in place have set fees to recover the external costs of trucks to the environment – impacts of pollution on respiratory health, noise and accidents (Balmer 2003, Nash 2003). A flat per-mile rate is problematic because it might limit incentives to purchase fuel efficient vehicles, some form of VMT discount should be considered (Huang 2010). Marginal cost pricing is a way to increase revenues. It has been demonstrated that the marginal per-mile cost that a driver is willing to pay is considerably higher than today's gas tax, converted to a comparable per-mile measure (CBO 2011, Gulipalli 2006). PAYD insurance is once again a "real world" application that would result in overall reduction in premiums, a savings that might be partially recaptured through marginal cost pricing (Bordoff and Noel 2008). Fee levels should be automatically indexed to prevent loss of buying power due to inflation (Sorenson and Taylor 2006).

Two examples of charging schemes in Switzerland and Germany are discussed (Balmer 2003, Nash 2003).

- The Swiss heavy vehicle fee (HVF) system set fee levels based on scientific studies commissioned by the Swiss Transport Department on the external costs of air pollution relating to residents' health, noise and accidents. Then the total transport performance was calculated as ton-kilometers. The rate was then set by dividing the uncovered external costs by the total transport performance, which was 1.6 cents per ton-kilometer. This fee would be phased in, beginning at 1.0 cents/ton-kilometer while increasing the weight limit from 28 to 34 tons. The second phase would raise the rate to 1.6 cents/ton-kilometer and the weight limit to 40 tons. The fee rate was 5 times higher in 2003 than it was in 1999 (Balmer, 2003).

- German HGV charges are to be based on distance traveled, number of axles, pollutant emission categories and possibly time and place. One author argues that the key to the new fee's success was that it simultaneously increased the weight limit while raising fees, making it possible for road transport to be more productive. Increases in productivity averaged 18%, almost equal to the increase in HVF of 19%. The paper argues that evidence shows that while charging HGVs congestion costs is much less efficient than charging all vehicles, flat rate charges for HGVs are actually more effective than if all traffic were charged (Nash, 2003).

PAYD schemes would result in savings to most customers and provide some insight as to how fee levels might be calculated (Bordoff and Noel, 2008).

- For PAYD insurance systems, certain premiums unrelated to mileage would remain fixed (comprehensive coverage for damage through fire, theft, vandalism, and weather) while others varying with mileage would become per-mile rates. These include liability coverage (bodily injury, property damage resulting from caused collisions), collision/accident coverage and uninsured motorist coverage. These per-mile rate characteristics make up 89% of typical premium (Bordoff and Noel, 2008).
- In 2007, to replace the percentage of a premium directly related to mileage would lead to an average of 6.6 cents per mile to replace the $809 that formerly comprised 89% of insurance fee (Bordoff and Noel, 2008).
- Based on a 6.6 cent per mile fee, New York State would see an 11.5% reduction in driving per average vehicle due to its higher premiums which is related to accident rates resulting in a PAYD rate of 9.2 cents per mile (Bordoff and Noel, 2008).

- Other observations and factors related to setting fee levels include:
  - Fee levels could be set based on the type of road traveled to discourage heavy vehicles from using residential streets as well as finance maintenance to specific streets (Forkenbrock, 2005).
  - An 80,000-pound combination truck imposes pavement costs 34 times greater than one weighing 33,000 pounds even though their fuel usage doesn't greatly differ. The weight and number of axles could all be calculated using different technologies and then imputed into the OBU (Forkenbrock, 2005) (Delcan, 2010).
  - Environmentally friendly vehicles could also be charged less per-mile (Forkenbrock, 2005).
  - MBUF should charge by distance traveled on specific road types and should account for multiple household vehicles and limited public transportation options (Goodin, 2008).
  - The issue of a flat per mile fee for all vehicles would limit incentives to purchase fuel efficient vehicles. The solution would be VMT fees that were sensitive to fuel efficiency (Huang, 2010).
  - Marginal social cost of freight transport depends on congestion, road damage (related to axle load and road quality), accidents and environmental costs (Nash, 2003).

- An MBUF study for the Dallas-Fort Worth region proposed a 45-mile trip to the CBD would cost $4.00 in short term and $3.00 in the longer term following workplace readjustments, or 10 cents/mile and 6 cents/mile, respectively. The MCP on freeways scenario would bring in $2.4 million in daily toll revenues in the short run and $1.6 million in the long run, with a monthly revenue of $52.8 million, assuming 3 million vehicles. (Gulipalli, 2006).
- Per-mile charges would need to be tied to an automated indexing scheme to prevent a loss in buying power due to inflation (Sorenson and Taylor, 2006).
- To match Oregon's 24 cents/gallon gas tax, ODOT's 'VMT' group was charged an MBUF flat mileage fee of 1.2 cents per mile. It mentions a possible energy consumption penalty rate which could be added to the bills of fuel efficient vehicles as an incentive to switch over to MBUF fees (Whitty, 2007).
- Rates for the 'rush hour' test group were 10 cents/mile for driving in the Portland Metropolitan Urban Growth Boundary on weekdays between 7-9 AM and 4-6 PM, and 0.43 cents/mile for all other in-state travel (Whitty, 2007).
- The CBO estimates imply that user charges that fully reflected marginal costs— would be much higher, on average, than are the taxes that currently fund highways and transit. In January 2011, combined federal and state fuel taxes were about 48 cents per gallon for gasoline and 53 cents per gallon for diesel fuel, on average. If converted, those tax rates work out to about 2 cents per mile for average passenger vehicles and less than 10 cents per mile for trucks. CBO estimated the MCP could be as high as 25 cent per mile for passenger vehicles (urban) almost 70 cents per mile for urban trucks (CBO, 2011).
- Full marginal pricing could potentially provide more than enough revenue to cover roadway capital costs and be used to supplement other programs or reduce other federal taxes (CBO, 2011).
- The efficient gas tax without per-mile charges was estimated to be several times higher than a tax with efficient per-mile charges— roughly $1.30 versus $0.20 (CBO, 2011).
- The costs related to VMT (pavement damage, congestion, accidents and emissions from passenger cars) are much higher than fuel-related costs (local air pollution from trucks, climate change and dependence on foreign oil) (CBO, 2011).

Privacy Safeguards

Privacy concerns are potential barriers to implementing a MBUF system; addressing them will be critical to gaining public acceptance. The type of system dictates whether privacy safeguards are required, a system that relies on manual odometer readings does not compromise an individual's privacy (Baker and Goodin 2009). Whereas, sophisticated systems that record driving behavior and vehicle location could be used by law enforcement to track a driver and punish certain behaviors (Baker and Goodin 2009, Schuitema 2007). The public is aware of these potential uses, particularly in areas where electronic tolling systems are in place. To address these concerns MBUF systems could be designed to process the data locally on the ODU and then transmit only aggregate data - the final computed fee for the designated period - to the government or third-party vendor (Baker 2009, Puget Sound Regional Council 2008, Sorenson and Taylor, 2006). The aggregate data could then be preserved for transportation planning purposes. There are also a variety of ways to throttle the geographic specificity of the system (cellular zones versus GPS) and make the geographic data anonymous, even though this could prove to be problematic if needed to dispute charges (Baker 2009, Forkenbrock 2005, I-95, 2010, Schuitema 2007). Studies of the truck VMT pricing indicated that truck drivers are less sensitive to being tracked, even though trucking companies do not want this data to be publically accessible for competitive reasons (Delcan 2010).

- Most devices (Sky-meter, IMS, CarChipPro) don't record or transmit location information and can be tailored for individual preferences relating to privacy concerns (Bordoff and Noel, 2008).
- For commercial vehicles, privacy is less of an issue since owners have the right to know the location of their trucks and employees. However, truck companies don't want information demonstrating that their vehicle operators are not acting in a safe manner. Three options are considered to deal with this: a) recording the odometer reading, which can still be audited through a review of the engine database record; b) a certified third party processing a vehicle's GPS data and calculating the associated taxes, but this requires a telemetry system and; and c) a certified system that calculates in real-time the mileage based tax, stores it and then forwards the information at a specific time (Delcan, 2010).
- The transfer of data to the center would be anonymous, with only the sum of all travel in certain jurisdictions passed on following the center's contact with the vehicle. To allow for auditability, data could remain on the vehicle's OBU, or a method uploading the odometer reading along with the user-charge data could be used to verify legitimate billing (Forkenbrock, 2005).
- Although the gantry model had the fewest privacy concerns associated with it, participants in the study preferred the Oregon model overall, mostly because of the pay-at-the-pump aspect rather than relying on a mailed bill or prepaid account (Goodin, 2008).
- Using a zone-based system rather than differentiating between highways, arterials and local roads would blur exactly where the road user is (Baker, 2009)
- Existing state privacy laws regarding sharing of information for non-governmental purposes appear to be strong enough to protect personal information, especially in combination with federal privacy laws (I-95, 2010).
- Applying the 'Thick-Client' model, where the level of detail retained by the central office is limited and the use of specific roads is obscured, could blunt privacy concerns. Also, clarifying the extent to which information can be used by other government entities is needed (Puget Sound Regional Council, 2008).
- The benefits for law enforcement could outweigh the costs of lost privacy. Alternatively, the use of cash cards as in Singapore could calm privacy concerns (Schuitema, 2007).
- OBUs can be set to report only aggregate data rather than individual, more detailed data (Sorenson and Taylor, 2006).
- Previous examples of privacy safeguards could be utilized: traffic cameras that don't save information so that law enforcement agencies don't often request this data; toll tag speed maps

where tolling agencies scramble data before transmitting it so that the unique vehicle tags are not tied to the speeds (Baker and Goodin, 2009).

- The issue of how law enforcement can use data collected from a VMT-based system likely needs to be resolved at the legislative level (Baker and Goodin, 2009).
- Another method to avoid all of this is to simply have an odometer inspected annually, which Rhode Island was considering doing, although jurisdictional problems arise since miles driven outside of the taxing area cannot be differentiated (Baker and Goodin, 2009).
- The European Union is moving towards keeping all MBUF information in OBUs in order to tackle privacy concerns. The debate centers on whether legislation or the private market should guide privacy protection (Baker, 2009).

Equity

Is MBUF a fee or tax? There is not yet consensus on this issue, even though several state legislatures and the federal government have determined that it is a tax. If MBUF replaces the gas tax then it will likely be considered a tax by the public as well. Most taxes are regressive, placing a greater burden on the poor than the rich. MBUF would likely be a regressive tax or fee, but it has the potential to be far less so than the gas tax is today (CBO, 2011, McMullen 2010, RAND 2009). PAYD insurance, a similar concept to MBUF, is already proving to be more equitable than conventional insurance. PAYD rates are based on VMT, resulting in higher income individuals being charged more since they typically drive more, which then lowers the average premium (Bordoff and Noel 2008).

Equity does not only refer to income, but also to spatial issues - rural vs. urban users, distribution of benefits and the polluter pays principle. MBUF would allow municipalities to recoup the cost of regional through traffic (RAND, 2009). Ideally, those revenues could then be used to fund local projects, generating even greater equity by distributing the benefits where the impacts are the greatest – in many cases major highways cut through low income areas (Baker 2008, King 2007, Schuitema 2007). Rural residents would benefit from MBUF because on average they operate older vehicles that are less fuel efficient, discounts could also be offered due to limited amount of infrastructure in rural areas (McMullen 2010, Whitty 2007). It is impossible to eliminate all inequities that transition of this nature, from one form of taxation to another will produce. For example, a VMT tax will not provide the same levels of incentives for conversions to clean truck technologies or more fuel efficient vehicles like the gas tax does today (CBO 2011).

There are concerns that MBUF could slow the conversion of the fleet to more fuel efficient and electric vehicles if their fees are not discounted in some way (Baker 2009, Whitty 2007).

- There are many different kinds of equity, including horizontal (within groups), vertical (between different groups), the number of alternative options, the location of income groups, and revenue redistribution (RAND, 2009).
- Characteristics used to measure equity include the efficiency and welfare impacts of policies (RAND, 2009).

- Other ways of measuring equity include the notion of regressive or progressive taxation, double taxation, the polluter pays principle, the benefit principle, spatial equity and intergenerational equity (RAND, 2009).
- MBUFs would still be considered a regressive tax, but one that is potentially far less regressive than the gas tax for lower income populations. Other forms of discounts or rebates might be considered as well.
  - A fixed distance-based toll system, including HOT lanes or tolls per mile within cordon areas, was found in several studies to produce a more equitable overall outcome for low-income drivers than conventional cordon systems (RAND, 2009).
  - The location of income groups relative to the charging areas is crucially important to the equity of a pricing system (RAND, 2009).
  - Reduced traffic congestion will have disproportionate benefits for low income people, who are more likely to be the victims of pedestrian deaths related to traffic levels and suffer health problems due to living near congested areas (Schuitema, 2007).
  - Providing rebates for commuters is an option for implementing targeted relief based on income (Schuitema, 2007).
  - Equity for MBUF might be handled by subsidies for lower income motorists (Huang, 2010).
  - VMT tax may be less regressive than a flat per mile emissions tax, because low income households tend to own vehicles that produce more emissions (McMullen, 2010).
  - In Oregon, on average those in the lowest income group (less than $15,000 annual income) would pay $7.82 more per year in fuel expenditures under the VMT tax, with the second lowest group ($15,000-$29,999) paying $5.19 per year (McMullen, 2010).
  - Changing from a gas tax of 24 cents/gallon to a VMT tax of 1.2 cents, while slightly regressive, is far less regressive for lower income groups than a general rise in gasoline prices over time, not taking into account travel elasticities (McMullen, 2010).
- Rural drivers would likely benefit from a transition to MBUF, government might also consider a lower per mile rate due to the lower roadway investment needs of these areas.
  - Rural households would actually benefit from changing from a gas tax to a VMT tax assuming fuel prices continue to increase because on average their cars have lower mpg despite driving more miles than urban households (McMullen, 2010).
  - Some question whether rural drivers should pay lower per mile rate due to the lower investments made in their facilities (Whitty, 2007).

- PAYD would be equitability spread the true costs of insurance in urban and suburban areas since low income households typically drive significantly less than higher income households. PAYD would not likely reduce the rates of rural households.
  - Low-mileage drivers subsidize high mileage drivers in the same risk class, and higher income households making over $100,000 annually drive their vehicles 25% more miles than households making $25,000 or less yet pay the same amount (Bordoff and Noel, 2008).
  - Low income households make up a disproportionately large fraction of low-mileage drivers within all risk classes. Based on 2001 National Household Travel Survey, every household in

income groups making less than $52,500 saves on average, while the losses for higher earners are insignificant in relation to overall income (Bordoff and Noel, 2008).
    - Only high mileage drivers will be guaranteed to pay more; rural households will not necessarily be adversely affected because insurance schemes are tailored to individual zip code accident rates, which would likely be lower on rural roads (Bordoff and Noel, 2008).

- A concern raised in several studies was the ability to charge through traffic for their impact to the infrastructure and redirect these revenues toward local improvements.
    - There is public consensus that out-of-region drivers should be charged to cover their impact on the roadway network, something that is not done equitably today (Baker, 2008).
    - One study uses a Los Angeles County model to argue for charging congestion tolls on all LA freeways and distributing revenue to cities that have freeways passing through them on a per capita basis. This would distribute funds to 66 of the county's 88 cities, or 97% of the population. In those cities with freeways, the average income is $20,100 a year. In those without, average income is $35,100 annually. Furthermore, because the highest income quintile owns 3.1 times more cars than the lowest quintile, this would redistribute funds from the richest to the poorest cities. If the freeway definition is stretched to include 4 poor cities with bordering freeways, and if congestion tolls yielded $5 billion annually net of collection costs, they would generate $550 per capita for recipient cities (King, 2007).
    - There is also public interest in a new system that might enable locally generated revenues to be invested on specific local projects (Baker, 2008).
    - The equitable nature of the charge largely depends on the way the revenues are distributed and which communities are benefitting (Schuitema, 2007).

- There would be less of an incentive to purchase fuel efficient and electric vehicles if fees did not reflect their environmental benefits in some way. This issue arises in many areas of MBUF implementation.
    - Flexible rates that involve a multiplier tied to fuel efficiency of the vehicle or another external factor (Baker, 2009).
    - Such a system is equitable if the burden placed on the road system is the focus, and not emissions since this would seem to penalize alternative fuel vehicles (Whitty, 2007).

Gaining Public Support

Privacy and equity concerns, along with the public's aversion to paying any new taxes or fees, will make gaining public support for MBUFs a challenge. Education is paramount. The benefits of MBUFs need to be clearly articulated to the public. These include value-added services that could save them money (PAYD) or assist them in their commutes (Baker 2009, Bordoff and Noel 2008, Kalauskas and Taylor 2009). Researchers found that the public was more receptive if the system was easy to use and understand – keep it simple (Baker and Goodin 2011, Delucci 2007, Dieringer 2007, Progress 2003).

Congestion relief and environmental benefits must also be explained; how would MBUF reduce the amount of time they sit in traffic (Baker and Goodin 2011, Kalauskas and Taylor 2009)? The ability to raise revenues with MBUF received a mixed reception from the public, some studies show that this has not driven public acceptance in the past when used as a justification for conventional toll increases (Baker 2008, Baker 2009, Delucci 2007, Dieringer 2007, King, 2007). Internationally, the public has tended to support tolls to raise revenues if the proceeds were used to improve transit (CURACAO 2009, Farrell and Saleh 2005, Schuitema 2007). Earmarking MBUF transportation revenues beforehand, so the public knows where they will be spent or presenting transportation services as a public utility might help with public buy-in (Schuitema 2007, Baker and Goodin 2011). On a positive note, a survey conducted after the recent pilot in Oregon found that most participants (91%) would prefer to keep paying the VMT tax over the gas tax (Whitty 2007).

- Lessons learned included developing a long-term communication strategy involving how the scheme design mitigates exemptions and privacy concerns, building support, having a political champion, using it as part of a larger transport strategy with funds reinvested in transport especially before pricing begins. An emphasis on key stakeholders and a public information campaign regarding scheme's goals, operation and impacts (Progress, 2003).

- Value Added Services –PAYD and other system benefits:
  - PAYD insurance is a politically popular way of making inroads on capturing the externalities caused by driving by actually reducing the cost people pay to drive (Bordoff and Noel, 2008).
  - Value added services were seen by many as the incentive to gain acceptance (Huang, 2010).
  - Value-added services could include safety features by integrating VII/IntelliDrive software. Mobility devices like route directions, parking and traffic conditions could also be incorporated. Pay-as-you-drive insurance could also be incorporated into MBUF technology, significantly reducing the price of driving, with a Brookings Institute predicting potential average savings of $270 per car (Baker, 2009).
  - Road pricing initiatives in the US were more likely to be successful if they provided options, increasing travelers' choices rather than mandating fees. Political leaders acting as champions of road pricing have also been essential, along with a coalition of supporters including business, economic development and environmental groups (Kalauskas and Taylor, 2009).

- Keeping it simple:
  - All participating truckers were interested in VMT fee system as long as it was simple and that some or all of the funds generated went to highway investments. There is also significant support from truck companies for a VMT-based system for automobiles due to equity issues (Delucci, 2007).
  - The Point of Sale/Oregon model was the most preferred method of MBUF administration (Baker, 2008).
  - Simplicity improves support and understanding of schemes (Progress, 2003).
  - Public survey respondents expressed concern over high transaction costs, administrative and privacy challenges (Dieringer, 2007).

- Improving transportation funding levels and fairly distributing the dollars:
  - The present US fuel taxes fall 20 to 70 cents per gallon short of covering all expenditures (Delucci, 2007).
  - Few people perceive a decline in fuel taxes or understand the connection between transportation funding and fuel taxes. Most people did not know how much they were paying in taxes for gas. Many people believed the problem of transportation funding was political and saw the use of a VMT or MBUF fee as a supplement to the current motor fuel tax rather than a replacement (Dieringer, 2007).
  - An expert suggests that knowing the objectives for an MBUF/VMT tax is key. The objectives could include one or more of these: decreasing congestion, decreasing emissions or increasing transportation funding. The 'crisis' is a political problem of politicians unwilling to raise fuel taxes (Dieringer, 2007).
  - While initial reaction to replacing the fuel tax was mostly negative, as understanding of the current problems increased so too did public openness to a new system. Findings focused on how the fuel tax and transportation funding is not well understood and that gas prices drive the discussion on transportation-related issues. Commercial vehicles paying their "fair share" were also a concern as well as ensuring that a new system is simple (Baker, 2008).
  - The study highlights how MBUF acceptance depends on explaining the deficiency of fuel taxes and the reasons why it is important to switch (Baker, 2008).
  - Focus group data from Minnesota and Northeast Texas have shown that the general public may view responsible spending to be more of a problem than revenue base decline. Furthermore, MBUFs that appear costly could also hurt public acceptance of a VMT-based system (Baker, 2009).
  - King argues that there is little political advantage to dedicating a large stream of toll revenues to road improvements since it is unlikely to reduce drivers' opposition to tolling and will not create a vocal constituency in support of them. Having revenues go to cities, on the other hand, will be more successful in building a powerful constituency since they are already effective lobbyists and currently have highly constrained revenue-raising abilities (King, 2007).
  - In contrast, spending new toll revenues on regional purposes will not create as much support. In highly splintered regions, allowing local governments to decide how to spend revenues could build support for local projects (King, 2007).
  - In New York City, the paper puts forward a system where congestion toll revenues are returned to the boroughs in proportion to the share of the toll revenues paid by its residents. Toll revenues from drivers outside of New York City would be shared among the boroughs. Each borough could then decide how to spend its toll revenues (King, 2007).

- International lessons learned that might be applied to MBUF in the United States:
  - There is increasing evidence that public support levels are extremely dynamic and tend to decline as the proposal becomes more concrete and more imminent, advising against holding referenda on road pricing immediately before it's proposed implementation (CURACAO, 2009).

- In Europe, two research projects – TRANSPRICE and AFFORD — have indicated that there is a high level of agreement on spending revenue generated from Transportation Demand Management (TDM) on improving public transport. In the AFFORD project cities, 88% agreed revenues should be spent on improving public transport (Farrell and Saleh, 2005).
- In Edinburgh, UK, bus improvements were particularly popular as an expenditure for road pricing revenues, getting 90% support. Road improvements and maintenance also scored highly, second only to bus improvements. The third, fourth and fifth highest scoring expenditures were to provide new rail lines and stations, provide better linkages/facilities at rail stations, and increase frequency and capacity of existing rail lines. Less than half of the survey respondents agreed to use revenues to build new roads and or decrease general taxation (Farrell and Saleh, 2005).
- Using the results of the survey, revenue allocation for an Edinburgh road pricing scheme would be 60% on public transport, 15% on roads, 15% on taxes and non-transport related issues (health, education) and 10% on other transport improvements (cycling, city center beautification) (Farrell and Saleh, 2005).
- When Singapore first implemented congestion pricing, only 1 in 16 people had a car. In London, only 12% of commuters traveled into the cordoned area by car in 2003. Prior to Stockholm's congestion pricing trial, only 33% of travel into the toll zone was by car. This allowed toll revenues to move from the auto-using minority to transit-riding majority (King, 2007).
- A 1998 British survey found that 30% of adults supported road pricing as a stand alone measure, but support increased to 57% if the money raised was used for public transportation improvements, traffic safety measures and better facilities for pedestrians and cyclists (Schuitema, 2007).

- Researchers (Baker and Goodin, 2011) conducted listening sessions with the public and stakeholders to gather input on the concept. Researchers also prepared a decision matrix that can aid policy makers in evaluating the various trade-offs in policy that will be encountered in vehicle mileage fee system development. This study identified both challenges and opportunities for implementation of VM fees:
  - most study participants viewed the implementation of mileage fees as unworkable; privacy, cost of administration, and enforcement emerged as the most commonly cited concerns;
  - the rationale for transitioning to mileage fees has not been adequately established with the general public;
  - a new funding mechanism will inherently raise fairness concerns among rural and low-income drivers;
  - despite concerns, research shows that the vehicle mileage fees are a logical, sustainable, long-term option to supplement or replace the fuel tax;
  - if pursued, simple implementation solutions will engender the greatest public and stakeholder support;
  - field demonstrations that illustrate the full spectrum of implementation aspects, including payment will be necessary,

    - administration, and enforcement, can show how the concept might work in Texas; and
    - effective policy design can address any major public acceptance issues.

- For facility congestion-toll projects, a desire for public-private partnerships and the need for more highway capacity were the driving forces in implementation. Cordon-toll initiatives were generally related to transit funding needs, followed by congestion and economic development. The case for weight-distance tolling was motivated firstly by the desire to impose costs on outside users (foreign trucks) and the need to fund new capacity. Those who favored distance-based fees were motivated by the desire to charge users for facility and environmental costs imposed on society (Kalauskas and Taylor, 2009).
- Presenting transportation services to the public as a type of public utility like electricity or water might help a transition from a fuel tax to a VMT-based system (Baker and Goodin, 2009).
- Earmarking road pricing revenues beforehand could allay public fears that it becomes just another tax or a 'rainy day fund.' Another possibility is to have a private firm collect the tolls, operating as a buffer against government use for unrelated purposes, as is done with the SR-91 in Orange County (Schuitema, 2007).
- A survey found that 91% of the Oregon pilot program participants said they'd be interested in continuing paying the mileage fee instead of the gas tax if the program were extended (Whitty, 2007).

Bibliography

Attard, Maria and Marcus Enoch. "Policy transfer and the introduction of road pricing in Valletta, Malta." Transport Policy 18 (2011): 544-553. Web. 7 June 2011.

Baker, Richard et al. "Feasibility of Mileage-Based User Fees: Application in Rural/Small Urban Areas of Northeast Texas: Final Report." University Transportation Center for Mobility, Texas Transportation Institute, Texas A&M (Oct 2008): 1-60. Web 14 June 2011 <http://utcm.tamu.edu/mbuf/utcm_studies.stm>

Baker, Richard et al. "Mileage-Based User Fees: Defining a Path toward Implementation, Phase 2: An Assessment of Technology Issues." University Transportation Center for Mobility, Texas Transportation Institute, Texas A&M (Oct 2009): 1-44. Web. 14 June 2011 <http://utcm.tamu.edu/mbuf/utcm_studies.stm>

Baker, Richard et al. "Mileage-Based User Fees: Defining a Path toward Implementation, Phase 2: An Assessment of Institutional Issues." University Transportation Center for Mobility, Texas Transportation Institute, Texas A&M (Nov 2009): 1-69. Web. 14 June 2011 <http://utcm.tamu.edu/mbuf/utcm_studies.stm>

Baker, Richard and Ginger Goodin. "Mileage-Based User Fees: Defining a Path toward Implementation, Phase 1: Defining a Research Strategy." University Transportation Center for Mobility, Texas

Transportation Institute, Texas A&M (Nov 2009): 1-25. Web. 14 June 2011 <http://utcm.tamu.edu/mbuf/utcm_studies.stm>

Baker, Richard and Ginger Goodin. "Exploratory Study: Vehicle Mileage Fees in Texas." Texas Transportation Institute. (Jan 2011): 1-104. Web. 14 June 2011. <http://tti.tamu.edu/publications/catalog/record/?id=35581>

Balducci, Patrick et al. of Battelle. "Report 689: Costs of Alternative Revenue-Generation Systems." National Cooperative Highway Research Program. (2011): 1-139. Web. 7 June 2011. <http://www.trb.org/Main/Blurbs/Costs_of_Alternative_RevenueGeneration_Systems_165497.aspx>

Balmer, Ueli. "Practice and Experience with Implementing Transport Pricing Reform in heavy goods transport in Switzerland." IMPRINT-EUROPE (2003): 1-21. Web. 7 June 2011. <http://www.imprint-eu.org/public/Papers/IMPRINT4_balmer.pdf>

Bordoff, Jason E. and Pascal J. Noel. "Pay-As-You-Drive Auto Insurance: A Simple Way to Reduce Driving-Related Harms and Increase Equity." The Hamilton Project, Brookings Institution (July 2008): 1-58. Web. 14 June 2011. <http://www.brookings.edu/papers/2008/07_payd_bordoffnoel.aspx>

Cao, Xinyu and Patricia L. Mokhtarian. "How do individuals adapt their personal travel? A conceptual exploration of the consideration of travel-related strategies." Transport Policy 12 (2005): 199-206. Web. 14 June 2011.

Congressional Budget Office. "Alternative Approaches to Funding Highways." Congress of the United States (March 2011): 1-38. Web. 14 June 2011. <http://www.cbo.gov/doc.cfm?index=12101>

De Palma, Andre et al. "Policy insights from the urban road pricing case studies." Transport Policy 13 (2006): 149-161. Web. 14 June 2011.

Delcan Corporation. "A Practical Approach to Truck VMT Fees, Including Some Financial Implications and Possible Impacts on Traffic Congestion: Final Report." (April 2011): 1-85. Web. 14 June 2011 <http://www.google.com/url?sa=t&source=web&cd=2&ved=0CBsQFjAB&url=http%3A%2F%2Fonlinepubs.trb.org%2Fonlinepubs%2Fconferences%2F2010%2Ffinance%2Fmudge.pdf&rct=j&q=Delcan%20VMT%20Truck&ei=tQIfTuioHcT40gGu4ajcAw&usg=AFQjCNEp7oleyLDMcVTDSCu5rzHMrzxffA&cad=rja>

Delucci, Mark A. "Do motor-vehicle users in the US pay their way?" Transportation Research Part A 41 (2007): 982-1003. Web. 14 June 2011.

The Dieringer Research Group. "Mileage-Based User Fee Public Opinion Study: Summary Report Phase One (Qualitative)." The Value Pricing Program, Mn/DOT Market Research. (Aug, 2007): 1-54. Web. 7 June 2011. <http://www.lrrb.org/detail.aspx?productid=2141>

Farrell, Seona and Wafaa Saleh, "Road-user charging and the modeling of revenue allocation." Transport Policy 12 (2005): 431-442. Web. 7 June 2011.

Forkenbrock, David J. “Implementing a Mileage-Based Road User Charge.” Public Works Management Policy 10:87 (2005): 87-100. Web. 14 June 2011

Gulipalli, Pradeep and Kara M. Kockelman. “Credit-Based Congestion Pricing: A Dallas-Fort Worth Application.” Under consideration for Transport Policy (Jan 2006): 1-17. Web. 14 June 2011. <http://trid.trb.org/view.aspx?id=849878>

Huang, Edward et al. “Transportation Revenue Options: Infrastructure, Emissions, and Congestion.” Belfer Center, Harvard Kennedy School. (Sept. 2010): 1-26. Web. 14 June 2011. <http://belfercenter.ksg.harvard.edu/publication/20389/transportation_revenue_options.html>

I-95 Corridor Coalition. “Final Research Report: Administrative and Legal Issues Associated with a Multi-State VMT-Based Charge System.” (Nov 2010): 1-118. Web. 14 June 2011 <http://www.i95coalition.org/i95/Portals/0/Public_Files/pm/reports/I95%20CC%20VMT_Final_Report%202010.pdf>

Institute for Transport Studies, University of Leeds. “CURACAO Final Report.” (June 2009): 1-20. Web. 14 June 2011 <http://www.curacaoproject.eu/workfiles/files/deliverables/CURACAO%20D6%20Publishable%20Final%20Activity%20Report%20FINAL%20v1.0.pdf>

Institute for Transport Studies, University of Leeds. “CURACAO Deliverable D2: State of the Art Review (FINAL).” (April 2006): 1-268. Web. 14 June 2011 <http://www.google.com/url?sa=t&source=web&cd=1&ved=0CBgQFjAA&url=http%3A%2F%2Fwww.curacaoproject.eu%2Fpdf%2FCURACAO%2520D2%2520SoAR%2520FINAL%2520v1.0.pdf&rct=j&q=Deliverable%20D2%3A%20State%20of%20the%20Art%20Review%20(FINALDeliverable%20D2%3A%20State%20of%20the%20Art%20Review%20(FINAL)&ei=bfUeTuXBBaq30AHzkcW6Aw&usg=AFQjCNEa45jQboDQyLIOZPHGnDd6N0UTtg&cad=rja>

Kalauskas, Rebecca et al. “Task A-1: Motivations Behind Electronic Road Pricing. What is the Driving Force Behind the Worldwide Rise in Tolling? A Review of Innovative Road Pricing from Across the Globe.” Institute of Transportation Studies, University of California, Berkeley. (2009): 1-47. Web. 14 June 2011. <http://trid.trb.org/view.aspx?id=888885>

Kalauskas, Rebecca et al. “Task A-2: Implementation and Management of Electronic Roadway Tolling: Lessons from Successful Cases.” Institute of Transportation Studies, University of California, Berkeley. (2009): 1-47. Web. 14 June 2011. <http://www.its.ucla.edu/research/rpubs/pubdetails.cfm?ID=216>

King, David et al. “The political calculus of congestion pricing.” Transport Policy 14 (2007): 111-123. Web. 6 July 2011.

McMullen, B. Starr et al. “Distributional impacts of changing from a gasoline tax to a vehicle-mile tax for light vehicles: A case study of Oregon.” Transport Policy 17 (2010): 359-366. Web. 7 June 2011.

Nash, Chris et al. “Charges for Heavy goods vehicles: EU policy and key national developments.” Paper presented at IMPRINT-EU (Oct 2003): 1-17. Web. 7 June 2011. <www.imprint-eu.org/public/Papers/IMPRINTHGV_Nashetal.pdf>

Poole Jr., Robert W. “The Case for Truck-Only Toll Lanes.” Public Works Management & Policy 11 (2004): 224-249. Web. 7 June 2011.

PROGRESS Project 2000. “WP5 – Evaluation Initial Results.” European Commission (June 2003): 1-7. Web. 7 June 2011. <http://www.progress-project.org/Progress/pdf/Summary%20D6.pdf>

Proost, Stef and Ahksaya Sen. “Urban transport pricing reform with two levels of government: A case study of Brussels.” Transport Policy 13 (2006): 127-139. Web. 14 June 2011.

Puentes, Robert. “Moving Past Gridlock: A Proposal for a Two-Year Transportation Law.” Metropolitan Policy Program at Brookings (Dec 2010): 1-13. Web. 14 June 2011 <http://www.brookings.edu/papers/2010/1214_transportation_puentes.aspx>

Puget Sound Regional Council. “Traffic Choices Study – Summary Report.” Federal Highway Administration, U.S. DOT (April 2008): 1-40. Web. 7 June 2011. <http://psrc.org/transportation/traffic>

RAND Corporation. “Equity and Congestion Pricing: A Review of the Evidence.” RAND Transportation, Space, and Technology (2009): 1-63. Web. 7 June 2011. <http://www.rand.org/pubs/technical_reports/TR680.html>

RAND Corporation. “Research Brief: Moving Toward Vehicle Miles of Travel Fees to Replace Fuel Taxes, Assessing the Path Forward.” RAND Transportation, Space and Technology (2011): 1-5. Web. 14 June 2011 <http://www.rand.org/pubs/research_briefs/RB9576.html>

Schuitema, Michael H. “Road pricing as a solution to the harms of congestion pricing.” Transportation Law Journal 34:81 (2007): 81-112. Web. 14 June 2011

Small, Kenneth A. “Road Pricing and Public Transit: Unnoticed Lessons from London.” Forthcoming, Access 26 (Spring 2005): 1-8. Web. 7 June 2011.

Sorensen, Paul A. and Brian D. Taylor. “Innovations in Road Finance: Examining the Growth in Electronic Tolling.” Public Works Management & Policy 11:110 (2006): 110-125. Web. 7 June 2011.

Sorenson, Paul et al. of Rand Corporation. “Implementable Strategies for Shifting to Direct Usage-Based Charges for Transportation Funding.” National Cooperate Highway Research Program (June 2009): 1-150. Web 14 June 2011 <http://www.trb.org/Main/Blurbs/Implementable_Strategies_for_Shifting_to_Direct_Us_162252.aspx>

Sorenson, Paul A. of Rand Corporation. “System Trials to Demonstrate Mileage-Based Road Use Charges.” National Cooperative Highway Research Program (Oct 2010): 1-193. Web 14 June 2011 <http://www.trb.org/Main/Blurbs/System_Trials_to_Demonstrate_MileageBased_Road_Use_164521.aspx>

Verhoef, Erik T. “Second-best Congestion Pricing Schemes in the Monocentric City.” Tinbergen Institute Discussion Paper (Oct 2004): 1-24. Web. 7 June 2011. <http://ideas.repec.org/p/dgr/uvatin/20040110.html>

Whitty, James M. “Oregon’s Mileage Fee Concept and Road User Fee Pilot Program: Final Report.” Oregon Department of Transportation (Nov 2007): 1-101. Web. 14 June 2011 <http://www.oregon.gov/ODOT/HWY/RUFPP/>

Whitty, James M and John R. Svadlenak. “Discerning the Pathway to Implementation of a National Mileage-Based Charging System.” Special Report 299: Reducing Transportation Greenhouse Gas Emissions and Energy Consumption: for the Transportation Research Board. (Oct 2009): 1-125. Web. 14 June 2011 <http://pubsindex.trb.org/view.aspx?id=906637>

2011 Symposium on Mileage-Based User Fees
June 13 – 14 - Breckenridge, Colorado
Summary of Program: Major Themes and Issues

The theme of 2011 Symposium on Mileage-Based User Fees (MBUF) was implementation. Panels discussed political, public and technical barriers to implementing VMT tax, research and pilots underway and ongoing efforts to push MBUF over the threshold towards full implementation. The issues that stood out and are the most applicable to the RPA efforts include:

- Do We Need MBUF Now?
- The High Administrative Costs of MBUF
- The Political Climate
- Who Takes the Lead – Federal vs. State?
- Technology = Privacy: System Driven by Privacy Concerns & Costs
- Where Are We? A Need for more Studies?
- Targeted Implementation – Trucks and/or Electric Vehicles Go First?
- Leading with Value-Added Benefits

Do We Need MBUF Now?
The consensus was that MBUF is coming, if not in the near-term then in the long-term because of the eventual transition from fossil fuels to fully electrically powered vehicles. Most felt this transition was at least 10-15 years away. The gas tax still has legs since most of the gasoline and diesel fleet will not immediately turnover due to the depreciate costs of these assets. However, an increase in EV's and more fuel efficient hybrids might open the door for a phased implementation targeted at these vehicles which could take place sooner, since they will pay little or no gas tax. An additional complexity is the transition of the cashless/boothless ETC tolling infrastructure over to a VMT tolling system. It's anticipated that in five years the USA will have a national tolling system; Americans will only need one account and transponder to use all of the tolling facilities in the United States. This large infrastructure investment might not be compatible with the VMT tolling system, if GPS is used for example, which might prolong the transition or even dictate the technology that is deployed for the new system (ETC).

The High Administrative Costs of MBUF
High administrative costs are one of the major impediments in implementing MBUFs. Administrative overhead has been estimated at 15 percent or more of the gross revenues, compared to the less than one percent for the current gas tax. The current gas tax is only collected from 350 refineries in the US and there is very little infrastructure associated with the collections and no real operational costs. MBUF could conceivably be collected from every vehicle owner, requiring over 100,000 million transactions. Depending on the technology, the initial capital costs to roll-out the system might be high and debt service might need to be folded into the annual operating costs of the system. The customer service and system administration needs will be greater with this system than the existing gas tax. However,

private sector involvement could help defray the cost of the equipage, customer service and collections. There was consensus that administrative cost of 5 percent or less would be needed to make MBUF viable. If this costs are too high than the VMT charge would need to be greater than the existing gas tax to just cover the higher overhead, meaning drivers, on average, will be paying more but receiving no real additional benefits in return. This would not be political acceptable.

The Political Climate

The political winds are not blowing in favor of national or state MBUF plans. The Federal effort has been stalled due to partisan politics in Washington. In the past there has been bipartisan support of transportation funding, even today there are Republicans working with Democrats to craft a bill for a Federal MBUF system that would develop three national pilots to demonstrate the technology and generate national standards for MBUF. The federal government and both parties see this as a tax and replacement for the gas tax. This has fueled the opposition that is against any new tax for any reason, even if it is an "in-kind" replacement of an existing tax. At the state level there has been some success in getting studies and pilots approved, but little firm action at this time on implementation. Oregon has had the most success, yet has been unable to get its proposal through the state legislature to implement a VMT tax on electric vehicles. The consensus was that more education is needed to explain the need for the eventual transition to a VMT tax, with campaigns targeting to both elected officials and the public.

Who Takes the Lead – Federal vs. State?

The federal government strongly feels that it must take the lead since this is a replacement of the gas tax. The states, on the other hand, have been compelled to move ahead with their own pilots because of the lack of federal leadership in this area. The consensus was that MBUF will be implemented at the State and/or regional level, with many states forming compacts to work out multi-jurisdictional issues associated with metropolitan areas and major trade corridors that span multiple states. However, all agreed that the there is a federal role in developing standards for interoperability and to coordinate implementation nationwide.

Technology = Privacy: System Driven by Privacy Concerns & Costs

Technology to implement MBUF is already available. The University of Minnesota is starting a one year trial of a GPS-based MBUF system. Oregon has had a successful pilot that captured odometer readings at gas stations. Other countries have implemented GPS systems for trucks. And there are many other examples. There are two major barriers, institutions and privacy concerns. The institutions need time to develop the policies that will guide the state and national systems. Privacy concerns are directly related to the type of technology that would be used for MBUF. The more location and time specific the technology is the more it infringes on individual privacy. Even if government assures the public that their information would be kept confidential or anonymous, the lack of trust in government tends to result in the public seeing these as empty promises.

Where Are We? A Need for more Studies?

Only the FHWA (Federal government) and the American Trucking Association felt that more study was needed. The recurring theme was that we have studied this enough and we need to start moving forward with more pilots and that these pilots should lead towards implementation. Many attendees felt it was time for action and that MBUF should move ahead faster than the 10-15 year timeframe that has been discussed. The one major obstacle is political and public acceptance, education of both groups is essential before MBUF can really progress and this will take time.

Targeted Implementation – Trucks and/or Electric Vehicles Go First?

Oregon's approach is to implement a VMT tax on electric vehicles first, with the rational being that they will not pay any fuel tax. This equity issue has resonated with the public and elected officials; even the AAA is behind this approach. However, the downside of targeting EVs negates one of the benefits of purchasing them in the first place, which is lower operating costs that typically helps to offset (along with tax rebates) the higher price of the EV. If it costs as much or more to operate an EV then it will be less attractive to the consumer and conversion to the EV technology will be slowed. A balance between the environmental benefits of EVs and equity must be found before this type of approach can be fully endorsed.

Targeting trucks is another incremental approach to implementing MBUFs that might be taken. The heavier weight of trucks causes more damage than other vehicles on the road, while they do pay more at tolled facilities; they are not paying enough to cover their impact on the road network. MBUF would be an opportunity to make up the difference, which they could potentially pass on to the consumers, fostering even greater competition in the goods movement sector. Some state are already looking at this option, New York State recently completed a study on how it might implement a Truck VMT pilot. Advocates of this plan point to success in Germany, that resulted in 20 percent decrease in empty truck trips (through efficiency improvements, i.e. virtual container yards) and a 50 percent reduction in high emission vehicles. They also highlight the low evasion rate, only 1.7 percent and relatively reasonable administrative costs 10 to 15 percent. Also, truckers do not share the same privacy concerns as the public and in many cases their vehicles are already equipped with GPS devices that might be retrofitted for MBUF. However, the trucking industry is not in favor of this approach, arguing that they already pay enough and are concerned about the costs of the systems and abuse by local jurisdictions if implemented on a local or regional scale.

Leading with Value-Added Benefits

NYCDOT's Smart Drive RFEI was presented at the conference. It was articulated as a strategy to promote value-added services to drivers first and then later introduce an MBUF pricing scheme. Many agreed that the public needed to see some benefit first before buying into to any new system. This approach also creates opportunities for the private sector to collaborate or lead in this area, in developing the device and services that could be offered to the public for a fee. Not all agreed with this tactic, some felt it was misleading and that the public would see through the "window dressing" for what this really is, i.e. a backdoor to MBUF. They strongly articulated that transparency with the public is critical in earning their trust and this this approach jeopardizes that.

Detailed Program Notes
Day One: 6/13/11

<u>Opening Statements</u>

- It's an exciting time for MBUF. Minnesota, Oregon and Colorado (MOVE coalition) all have studies and/or programs (pilots) underway now
- The FHWA has a major road user alternatives study underway that will look at MBUFs
- The RAND Corporation, under the supervision of Paul Sorenson (RAND), recently completed a ground breaking study that looked at implementation issues.
- The recently formed MBUF Alliance will be a group to advocate for policy change (membership is open and costs $5,000 annually)

<u>Table Discussion</u> (we were asked to spend 10 minutes discussing the following question, What is the most likely implementation pathway?)

- We could start with trucks, could be regional and state.
- Voluntary program or maybe dual program (autos=voluntary and trucks=mandated), weight of vehicles might not be the best idea (politically).
- Should start on Federal level, need advocacy to push people like Congressman Mica. Ideally, there should be national coordination of a MBUF program.
- The German truck VMT toll experience was really a success (at least initially). The collection costs were high and the original system failed (wanted to have the equivalent of a Mercedes). The system must be simple and the equipage cost low. The system was bi-directional, too much technology and communication than what was really needed, overkill.
- What about the private sector involvement, beyond OEM… new services like Google?

Session 1: Implementation Pathways

<u>Paul Sorenson, RAND Corporation</u> (Intro and overview of recent work)

- What is the sequence of steps that takes us to MBUF, how do we address cost concerns and public acceptance.
- Premise of recent RAND study, while MBUF is attractive there are still many hurdles to implementation. The study team spoke to variety of stakeholders, was hoping to find a consensus in how trials should be planned. What they found was that most agreed that the next round of trials should be final (meaning that they system should go live next) and be multijurisdictional. However, there were differing opinions on the size of trials, which ranged dramatically, and different visions of the pathway to implementation. Three frameworks were generated to illustrate what the trials might look like (how they can be modified) – they were the federal, state and market frameworks.

The Federal framework would impose a national system (top down); State framework would encourage experiments in states that would eventually lead to national system. The Market framework would consist of a set of trials that evolves into full implementation in partnership with the private sector to develop devices that provide value-added services, which could help to spread out the costs of equipage.

- Do you start with different groups of vehicles? Electric vehicles (EVs) or trucks?
- Three main questions for framing, national or state system first:
- Mandatory or opt-in?
- Do we target specific vehicle classes or cover all vehicles in system?
- This could be a mix and match (mandatory national system for trucks or voluntary state system for autos).

James Whitty, Oregon Department of Transportation - EV Implementation

- OR has determined that MBUF is a tax (legal determination).
- OR proposed a system that did not get public acceptance (underlying reason for objections)
- People would not accept a government mandated box in their car. They did not want government to force them to have a black box. Also, they worried about the cost of managing the system and that the technology would be outdated quickly. Felt it was a huge task to transition nation to this new system from gas tax.
- What's our new vision in Oregon?
    - No mandate for onboard GPS. Provide drivers with a discount if they allow GPS reporting, if not they pay full cost of driving… with GPS the tax would vary based on location and time.
    - Open technology system; try to future-proof the technology.
    - Have the private sector take on operational tasks.
    - Start with EV with onboard integrated system. However, there are concerns that this approach will discourage the purchase and slow the transition to EVs)
    - The VMT charged would be phased over time, with a lower initial charge that would be raised over a three year period. July 1, 2015 at .85 cents per mile, $1.56 per mile July 1, 2018 (the regular fee, there will be transition).
    - The bill to implement a VMT tax on EV's passed both house committees, still sitting on floor and has not passed.
    - Seems to be support for VMT tax for EV and fuel efficient vehicles.
    - Fairness issue worked better than low funding issue.
    - Some rural representatives were against any form of MBUF
    - The fact that MBUFs were determined to be a tax did complicate passage. Some elected officials were ideologically opposed to this type of action.
    - An independent task force generated legislation, education of representatives was key, was supporters (champions) in government (6 reps were part of the task force).
    - Automakers will challenge, as they will see this action as adding costs to their product and potentially undermining sales.
    - AAA was a supporter based on equity.

- ODOTs technical competency gained during the trials/pilots provided the state legislature with confidence that the agency could get the job done.
- As EV market grows the issue will get more complex. There will likely be an even greater overall consensus the tax is needed to be fair, but the larger driver base will likely oppose such a bill and pressure reps. This is probably the best time to move this forward.
- When legislature is involved in the process from the outset (with input) they tend to support the initiative.

<u>Dick Mudge, Delcan Corporation</u> – New York State Truck Vehicle Miles Traveled (VMT) Fee Pilot (Presentation was about Implementation of MBUF – Not the NYS VMT Truck Study)

- Dependence on the fuel tax is leading to bankruptcy, for one of the first times in history highway funding levels is going down.
- MBUF will take a long time to implement, likely 10-15 years.
- There have been [in his opinion] too many trials and pilots, we need to start focusing on implementation.
- In the past we have tended to articulate complex MBUF systems with great benefits (GPS and planning used) MBUF that were well meaning, but makes it harder to get MBUF implemented.
- Seven Steps Towards MBUF
    - Raise money, state the goals of the tax/fee. MBUF's will be used to raise additional highway revenues.
    - Trial for a reason, one that can be implemented.
    - Keep it simple. The NYS project on VMT examined varying the price based on the type of road (high price for local roads and a lower price for expressways). Three trucking companies provided detailed data using their existing GPS dispatch systems. The data showed that all three companies would pay less with the tiered pricing, but companies wanted to keep is simple and requested instead one flat per mile rate for all roads.
    - Real money involved, actual revenue (generate cash, to show it works)
    - Scalable, so it can be expanded to include different type of vehicles or to handle multijurisdictional issues – regions, states and federal.
    - Control administrative costs. Less than one percent of the cost of collecting gas/diesel tax rates goes toward administrative overhead). Most other transport fees are between 10 to 15 percent for tolls and registrations. MBUFs need to show costs of less than 10 percent, probably closer to 5 percent.
    - There should be tangible benefits for users, logistics/admin savings for truck companies.
    - Types of system?
    - Dual tax system for a trial could be higher or less than current tax. We need several hundred trucking companies for this to work, but would allow us to test the system.
    - Low tech and low cost, how many miles truck drive in each state each month, charge them a flat rate.
    - Can we do something with Mexican trucks? Require them to pay a VMT tax; they will already have this tech onboard.

- We should be looking at 2-5 year timeframe for MBUF implementation, not 10-15.

Bruce Schaller, New York City Department of Transportation – Voluntary Adoption Approach

- NYC's Drive Smart Program
  - Credible and compelling statement of benefits then you can deal with privacy, technology and costs (cost is the most concern).
  - Need to be responsive to how public views issues, which are that:
    - Government has enough money,
    - Don't trust government,
    - Taxes and fees are last resort,
    - Focus on economy
  - Need to show benefits of the new system before imposing the tax or fee.
  - If possible agencies should take a path that avoids the need to get legislative approval.
  - Developing software applications that are opt-in that improves motorist mobility.
  - RFEI for Park Smart led to recent RFEI for Drive Smart, which requests a solution that will result in money and time saving benefits for drivers. We want pilot and test some of these technologies in the short-term. City DOT can do this without special permission.
  - In vehicle device would provide service that could be used to test MBUF.
  - Much of this is location specific, pay as you drive… time and place sensitive MBUF… targeting of charges to specific improvements.

Panel Discussion:

- Canadian trucks are paying a charge already, they are likely underpaying.
- Important Federal role at minimum to foster standards to allow these state systems to talk to each other.
- MBUF has several indirect benefits, but all rely on trust with the public.
- What are direct benefits that public can derive from MBUF? Dedicate charge to specific improvements. The German government backed out and double-crossed truckers. Direct benefit from congestion pricing (but latter benefit)… other value-added services.
- Four reasons, funding, congestion, environmental/equity, national security…what is our starting part… what problem do we want to solve? What are we really trying to solve? We should pick one? What is the evaluation of application?
- Starting with a value proposition and then bring in MBUF later…easier to put together state/local value proposition… harder to be able to do that on the Federal side.

Session 2: Public and Political Acceptance

Alex Hergott, U.S. Senator Inhofe's Office – Congressional Perspectives

- Only 2 to 3 percent of national fleet is hybrid and EVs are just emerging.
- Many in the Congress see this as a federally mandated, state support system; this is the goal of bill.
- Office of Alternative Funding Solutions - VMT fees were one of the elements.

- Most people don't realize they are paying gas tax, that it's a regressive tax and how VMT tax would replace this tax with a more progressive/equitable tax.
- Major pushback on Capitol Hill on MBU, it has been dramatic
- The average fuel efficiency by state, cost per mile (2002 UDOT study) In Vermont the average 23.54 miles per gallon… 17 cents per mile… costs are 0.78 cents per mile… (Shows that rural states would actually benefit from tax, pay less)… try 13.69 MPG in Wyoming … average cost 1.34 cents… equity issue. .
- Senators Boxer, Bidder and Baucus are supporters of MBUF bill.
- However, there is significant opposition to well-funded MBUF pilot, how do you stick in the bill to give them authority?
- The consensus from the advocates on the hill is that federal leadership is required, 3 to 4 trials would be funded and standards in system architecture, the states would submit proposals that would have minimum standards.
- Not sure if we are doing 2 to 6 year bill for transportation, a lot is uncertain.

<u>JayEtta Hecker, Bipartisan Policy Center</u> (25 years at the GAO)

- Our current system is underpriced, fundamental flaw in structure of program.
- Three issues, positive steps/factor, observe distinct elements of state of play, personal view of prospect and call to action.
- Positives steps
  - House - Mica and T&I committee is committed to some type of VMT toll and many members of the committee are open to this, there is a real sense that this approach has value and is more equitable.
  - Senate – Inhofe, Carper and Boxer – these people get it… the need is there.
  - Administration, it was in the budget… not calling for tax, but was defensible.
- Where do we stand?
  - Most anti-tax or revenue enhancement and will not take risk.
  - Merits or personal position no longer matter, it's about party ideology.
  - VMT toll is viewed as a tax; there is little debate about this.
  - We are heading towards more extensions, not full reauthorization.
- Additional presenter thoughts:
  - We could be setback for decades or more at this rate, partisan politics are destructive and will have real consequences.
  - User fund base eroding. There are many examples of this, general fund bailout of federal trust funds.
  - Local taxes are more the primary source for revenue.
  - Get other people to pay for their roads, state tactic to get out of state drivers to cover cost, another step backwards.
  - At this moment the leadership is in THIS room, action will need to happen at the grassroots level.

Karen White, Federal Highway Administration, Office of Policy – USDOT Transportation Technology Scan

- We need more research, are not ready for implementation. We need to understand behavior better and economic impacts of charging, the USDOT must get smarter on this issue (Congressional expectation).
- What are the goals of our study and what will it cover?
  - Framework of existing information, since of operational definition of user fees, current future technology and institutional issues.
  - Location, distance, time of day, engine performance
  - We will exclude registration fee, fuel taxes and surcharges…
  - Two primary objectives, revenue generation which could be a hard sell because it may not add capacity, or demand management which also may be well received. American public used to premium pay for premium service.
  - Interoperability, charging reliability, privacy, equipment failures… how do you retrofit, how do you do security, how does it incorporate with Intelli-drive?
  - Concept of operations, very limited trials to test technology?
- Again we are NOT ready for roll-out, only more studies now.

Nick Farber, National Conference of State Legislatures – State Legislative Perspectives

- He is seeing lot of interest in MBUF, states are looking at this as an option but there has been limited success with trials thus far.
- States will be leading the implementation on this, examples below:
- Alabama, looked at MBUF, but will increase gas tax instead
- California, two studies, a 1996 study that stated MBUF would raise revenues and reduce pollution, and a 2006 study that MBUF would help finance transportation options.
- Colorado, 32 revenue options… endorsed VMT pilot for state.
- Connecticut, 2009 VMT tolling survey… too much time and costly to implement
- Florida, two options … road user fee, impact fee, adaptive transportation utility fee (assessing property in transport district)…
- Hawaii, introduced bill that is similar to OR… but it failed… trying to gain ground for VMT pilot project.
- Idaho, there is a governor's task force studying the transition from gas tax to other revenue techs
- Indiana, 1996 a plan to VMT fee (2.9 cents per mile) cover all expenditures for state… 2004 (1.04) and 2005 (1.29) instead of GPS and odometer… per cents to per gallon.
- Massachusetts, house bill 2660… would create a pilot project for VMT tax
- Missouri, two bills introduced in 2009 and 2011, but have not passed would prohibit the use of GPS or other technology to record persons position to charge a fee.
- Texas- senate bill to study feasibility of VMT, did not pass
- Washington State 2009 study on what would VMT in the state look like, converting insurance premiums and special charges of environmental costs.

Paul Hanley, Public Policy Center, University of Iowa – Public Opinion and Policy Research

- Older people have more negative attitudes towards the VMT tax.
- As the number of miles a person drove annually increased, so did their opposition or negative option of VMT taxes.
- A more positive reaction and greater acceptance if equipment performance is good and is proven.
- Reaction to privacy issue was significant, but polling showed it was surmountable.
- Most felt no matter what "guarantees" are given that the government will use this technology to track us anyway (again lack of trust).
- The number of respondents that would accept the system increased to 70 percent of the sample IF the system was reliable, accurate and fair…they then were not as opposed to government intruding in privacy. Takeaway -- we need to get users to experience the system.
- Respondents felt that government will spend too much money on system and were concerned about billing frequency.
- The most insensitive population to privacy was the elder population (as age increased less sensitive to travel patterns, whereas younger population was).
- 66 percent of respondents favored summary of VMT by jurisdiction, but indifferent as to whether it was daily or monthly summary. They wanted the ability to audit the system (transaction disputation) but do not require a lot of detail.

Panel Discussion

- Federal approach would not have private sector leadership, would be led by the government. The private section could partner, but we need to something grounded to replace the gas tax.

Session 3: Policy Issues

Adrian Moore, Reason Foundation – Mileage Fees as Revenue Replacement vs. Supplement/New Revenue Source.

- Transparency and trust… show that we are tightening our belts.
- We need to prove to public that we can solve privacy issue.
- MBUF needs to replace the gas tax.
- Presenter covered many of the same topics that were in the prior panel, it was more a singular viewpoint on MBUF.

Mark Muriello, Port Authority of New York and New Jersey – Multi-Jurisdictional Charging - I-95 Corridor Coalition

- Administrative costs summary
- Alliance of transportation agencies, toll authorities, MPOs, public safety and related organizations from Maine to Florida

- Vehicle Miles Traveled (VMT) are expected to grow at a significantly faster pace than fuel usage (the current primary source of highway revenue)
- VMT: 49.9 percent (avg. annual growth: 1.51 percent) vs. Fuel Used: 15.4 percent (avg. annual growth: 0.53 percent) - US Department of Energy projections (2008-35):
- A switch to VMT charges at currently equivalent rates would yield about 30 percent more revenue per year by 2035.
- I-95 Corridor Coalition to advance two projects to address administrative elements of multi-state VMT charge
- Conducted extensive interviews, investigate institutional models and evaluate costs
- Used NCHRP #69 three broad options, as framework to guide study
- Phase I of study found that data processing and customer relations will be a major driver of costs
- Administrative costs are estimated to be considerably higher for MBUFs:
    - Motor Vehicle Fuel Tax = $1.20 per vehicle
    - Motor Vehicle Registration = $13.00 per vehicle
    - VMT-Based Charges = $30.00 -$40.00 per vehicle
- Administrative costs as a percentage of revenue collected:
    - Motor Vehicle Fuel Tax = 0.82 percent of revenue
    - VMT-Based Charges (All highway expenditures) = 6 percent -8 percent of revenue
    - Motor Vehicle Registration = 11 percent of revenue
    - VMT-Based Charges = (Federal & State Fuel Tax Only) 15 percent -20 percent of revenue
- There are numerous legal hurdles to address with authorizing legislation to enable states to enforce tolls and safeguard user privacy.
- Phase II will be to create concept of operations for three states – Delaware, Maryland and Pennsylvania, which will lay foundation for potential multi-state field trial.
- Traditional to all electronic toll collection, laying foundation for MBUF
- Concept of operations and transition strategy by December 2011.
- Miller Center report (collect)

<u>Mark Burris, Texas A&M University</u> - Geographic and Income Equity

- Equity issue – rural vs. urban travelers and income issues…
- Four VMT scenarios in respect to equity
    - Flat VMT Fee
    - Flat VMS Fee for Added Revenue
    - Three-Tier VMT fee to Encourage "Green Vehicles"
    - Urban and Rural VMR Fee
- Assume no change in behavior and then scenario assume some change in behavior
- Verizon 2.1 2009 national highway travel survey
- Key variables – ANNMILES, EIADMPG (miles per gallon), FUELTYPE
- 21,000 to 14,000 households, weighted data to reflect Texas 7.9 million vehicle owning households

- Price elasticities have been calculated (Wadud, Grahm and Noland 200) for urban and rural households and stratified by household income.
- Price elasticities

Household Income Level ($1,000s)	**Urban**	**Rural**
<20	-0.447	-0.254
20-40	-0.280	-0.159
40-60	-0.259	-0.147
60-100	-0.335	-0.191
100+	-0.373	-0.212

- Flat Fee – Scenario 1
    - System costs are 42 percent greater than current system
    - .01426 per mile or dynamic .01442 per mile
- Flat VMT for Added Revenue
    - Designed to generate $14.3B
    - .1156 per mile and .15 per mile
- Three Tier
    - .15 to .07 cents and .19 to .09 cents (dynamic)
- Urban and Rural Needs
    - Urban roadway .13 to .17 (80/20 assumptions)
    - Rural roadway .08 to .10
- Not very sensitive to income, scenario one is 40percent lower versus 43percent higher income
- GINI Coefficient (G)… shows that we progressive… not changing all that much from state gas tax, scenario three is most progressive.
- Scenario 4 - Horizontal equitable, this is the most fair for urban and rural areas…as you move away from this rural residents will pay more… they will pay less under VMT than today with gas tax.
- Abstract on the study can be found here: http://swutc.tamu.edu/projectdescriptions/161105.htm

<u>Teri Binder, Club 20 - Rural Issues</u>

- Why? Gas tax is declining, decreased buying power of the dollar, higher mileage more efficient engines, higher maintenance construction and materials cost, hybrid, electric and natural gas fleet vehicles, fund state police in Colorado and we now also fund transit with trust fund revenues.
- Direct disconnect to what we have and we need, huge public lack of knowledge of how we fund roads
- Rural drivers average of 44 miles a day and urban drivers are 11 miles a day (CDOT)
- Rural incomes are lower than urban incomes, yet spend more of their income on transportation.
- No access to transit alternatives in rural areas.
- Drive further distance for their jobs, goods and services.
- Own and drive older and heavier vehicles.

- Possible impact to tourism (CO #1 industry, what would MBUF do for industry… would it discourage discretionary travel?)
- What are other solutions?
  - Charge less in rural areas (agricultural fee, for farms or large land holders)
  - Only in urban area where there is alternate transportation
  - Raise and index the gas tax to inflation
  - Cut government and programs and take money and put towards transportation
  - Fees on car/truck weight…

Session 4 – States of the Practice: Demonstration Projects

<u>Ben Pierce, Battelle Institute, Minnesota Department of Transportation Technology Demonstration</u>

- Passed legislation in 2007 to fund a pilot project to test alternative to gas tax.
- Developed software and hardware…
  - Utilize commercial off the shelf
  - 500 in vehicle devices
  - Will be deployed for 1 year
  - Odometer reading to compare high and low technology options
- Discounting System
  - Everyone pays flat fee per mile, based on odometer reading… if you use technology and prove you are off-peak or on rural roads… you have option to receive a discount. You will have option to stop being tracked anytime… but will lose discount.
  - Three odometer reading… first two months are free they remaining one is charged.
  - Samsung smart-phone, mobile odometer… once every 24 hours… it reports the miles in the buckets up to back-office.
  - "Real" money will change hands; they will use PayPal for transactions. All program participants will receive $200 at the outset that they can use to pay for their VMT fees- this should cover 4 months of tolls.
  - Only three components
    - Smart Phone (cannot use phone/voice function during trial), Samsung Galaxy S
    - ODBII module with blue-tooth, to transmit onboard vehicle operational data to phone. The phone will be keyed to work with a specific car and will know it is in the car it's supposed to be paired with.
    - Mounting hardware.
  - It will take about a minute and half to install – total time for first customer visit should be about 5 to 6 minutes.
  - The device will automatically sense a power up… view reports on mileage… navigation software… Google maps… and settings… it will tell you current fee and where you are. Can be keep it in glove compartment or mounted on dash to use it as a tool.

- User can get feedback on trip and how much it costs them (customer feedback, wanted feedback before they made the trip)
- Microsoft cloud services are being used as the backend… allows the system to be a scalable solution – 500 to 500,000 users.
- Can manage account online or you can get your bill in the mail.
- Administrators can remotely send commands to the device, it can be bricked (disabled) and receive and display administrative messages.
- August 1st is the start of the one year trial-period
- If participants complete the entire study they get to keep the smart phone and other incentives are provided if they complete surveys.
- People associated with miles, but user O/D data is anonymous.
- Total estimated cost of pilot is $18,000.
- They will save navigation points for bill disputes, but will need phone to link with customer.

<u>Alauddin Kahn, Nevada Department of Transportation</u>

- Study on VMT program pilot.
  - Tax as a portion of overall cost of fuel per gallon has dropped from 50 percent of total cost to now just under 17 percent.
  - 18 percent of new vehicles per year will be EV's in the near future, making up 13 percent of the total fleet by 2016 along with more fuel efficient vehicles.
  - It is critical to educate people to correct existing misconceptions.
  - Purpose of this study was not to have MBUF raise additional revenue.
  - Privacy will be protected.
  - Payment through private vendor at pump. Range of administrative options.
  - Collaboration of states, not overlap studies and pilots… use settings like this to attempt to coordinate research.
  - Education and public buy-in are key
  - Wireless device at gas station will read odometer device at the pump… there is no tracking after that, flat VMT fee… very simple ODBII unit.
  - There will be a screen at pump that will show the VMT and the fee. Idea is to see how much they would pay under current gas tax system versus VMT.
  - $140 to $240 tax a year, educate them to understand that the tax is not high.
  - Complete frequency analysis for variety of options…
  - Mini-field test right now… 20 to 30 vehicles to test out at gas station… cost would be 100,000's of dollars.
  - Issue with approach is high costs of infrastructure, will require onboard device and devices at every gas station to read and display information and transmit the data to the government.

<u>John Sabala, Texas Department of Transportation</u>

- Study looking at the feasibility of a VMT tax in Texas and whether a pilot should be undertaken.

- Focus groups, stakeholder interviews, technology panel, state DOT peer groups. Wanted to get public feedback before pilot. Encountered push back due to other large Texas projects that were less than successful.
- Older population had typical response, against as well. Rural users were not open to the idea. Government monitoring was a concern as well. Overall they did not see funding crisis.
- Enforcement and system costs were a concern; simple is better and would be preferred.
- Public lacks understanding of transportation financing or needs…
- Simple odometer would be the best, target EVs first, how do you enforce this?
- How technology stakeholder responds to public… they felt concern could be addressed through tech and policy.
- The phrase “Field Tests” had a better acceptance than “pilots”
- Fix current system first
- What gas tax?
- What funding problem?
- VMT fees will not work
- Public distrust of government (presenter noted that are many examples of government not trusting government, a major problem)
- Privacy concerns were noted again.
- Finding of the study was to recommend that there be no Texas VMT tax or pilot as this time, however…
- A pilot program was introduced in the legislature and later modified during April 2011; however, it never left the committee.
- Consensus was that they should develop odometer model.
- Keep it simple, does not have to mean a non-complex solution, but it must be easy/simple for the customer

Day 2: 6/14/2011
Session 5: User Perspectives

<u>Ken Buckeye , Minnesota Department of Transportation</u>

- Industry did not see how MBUF would benefit truckers , research targeted to answer the question (preliminary work)
- Preliminary work of University of Minnesota study, will be conducting interviews with agencies this summer. The report will be completed in fall of 2011 and publicly distributed early next year.
- Will mileage based pricing produce benefits for the trucking industry?
- Transportation accounts for 40 percent of logistics costs
- Could be a stand-in for charges by weight…
- We are 10-15 years away from implementation of MBUF
- Cost of maintaining highway related to VMT and weight. The truth is that trucks cause more damages than private automobiles.

- Truckers say they already pay too much in transportation taxes
- Studies show (2010 Gupta, Federal CAS 1997 and 2000) that trucks pay less than the costs they impose on the system.
- Truckers concerns – We already paid for Interstate ($129B– $1.3 to $2.5 trillion for the reconstruction of Interstate Highway network). Fuel efficiency standards should apply to autos and not trucks, would not support weight and distance tax.
- Fuel taxes work well and more efficient to collect, administer and enforce than VMT. Recent study by University of Minnesota shows that VMT tax would compare favorably to current gas tax. Cost is important, but not only factor and might be able to be managed.
- Most trucks are equipped with GPS and other fleet management technology that might be able to be leveraged for VMT tax.
- Privacy is more of a concern for autos (SOV) than truckers (worried about competition)
- Germany system in 2005… all domestic and international pass-thru traffic required to pay tax
- 20 percent decrease in empty truck trips, a 50 percent decrease in high emission trucks (they consist of only 35 percent of the fleet today).
- 99 percent collection rate… 1.7 percent evasion
- Administrative costs ranged from 25-35 percent total collected revenue; however, today this has been reduced to 10-15 percent.
- Companies have successfully passed on the costs to customers
- Congestion cost savings for shippers has amounted to $7B and $33B for truckers [euros or dollars?]
- Congestion pricing in London, Stockholm and significantly reduced congestion by 20 percent
- Reduced congestion can lead to lower operating, inventory and logistic costs

<u>Darrin Roth, American Trucking Association (ATA)</u>

- What it will it take to get the trucking industry onboard with MBUF?
    - Politically viable
    - Cost Effective?
    - Evasion and enforcement
    - Local jurisdictions
    - What is the mission?
- Does the fuel tax need to be replaced? It will take a decade or two for EV and Hybrid vehicles to become a significant share of the market…what's the rush?
- JD Power – Drive Green by 2020 (lookup) – forecasts of EVs and projections of fuel use by 2020.
- The ATA's position is that the fuel tax is viable in medium-term
- Over the road trucks are slower to convert to hybrid and EV will continue to run on diesel.
- Is this politically viable? – will public distinguish the difference between this and fuel tax, revenue neutral VMT requires an increase to cover higher admin costs, privacy is an issue, bipartisan opposition to MBUF.
- Cost effective? ATA says the answer is no, very high collection costs, will they be saddled with multiple accounts, will carriers be able to recover costs, trucks do have GPS tech – but this is a small

part of fleet and technology is typically proprietary and might not be able to be used for MBUF purpose.

- Fuel costs have been recovered by trucker in past, tolls have been harder to recover through increasing contracted rates with customers
- There are 27 million commercial trucks today (90 percent are companies with 6 or less trucks)
- Concerned that enforcement will target largest trucks and that technology can be defeated, can order GPS scrambler for $100 online.
- Will every jurisdiction charge a fee, concerns about a “1,000 hits to the pocketbook” since truckers tend to pass through many jurisdictions on every trip
- Trucks generally don’t react at all to pricing… the possibility of congestion pricing can kill the possibly of MBUF all together…trucking industry feels it will be obvious to the public what intent is if congestion pricing is end game.
- Will it be used to promote fuel efficiency?
- Regulate truck routing and commodities… concerned about abuse. Who will control and maintain public access?
- Not opposed to research, but concerned about impact on industry… see it as changing trucking industry [for the worse] in fundamental ways.

<u>Jill Ingrassia, American Automobile Association</u>

- 52 million AAA members, the organization was founded 110 years ago to advocate for better and safer roads.
- AAA supports a gas tax increase in near-term to meet current transportation funding needs…
- Takes a cautious approach to MBUF, does see needs for fee as fleet converts more to hybrids and EV. AAA does support trials, but there are concerns about privacy.
- Significant challenge to making public understand need for system (they don’t understand current system)… they do understand transport is important for economy to function and quality of life… just don’t want to pay more (trust and value concerns need to be addressed).
- Need a clear program on the Federal level, where money is being spent, performance based system, reliability…
- Motorist Bill of Rights – AAA (http://www.aaamakingamericastronger.com/billofrights.html)
- There are two separate conversations, discussion with public to explain the replacement of the fuel tax and then a more complex discussion if goal increase revenues and policy based (environmental and congestion). Discussion needs to be frank and honest… (all costs, including opportunity costs need to be articulated)
- AAA assumes that revenues from a MBUF would be used in part for transit, sensitive but not opposed to this. (redistributing revenues from toll roads is a concern and something that AAA has opposed in the past)

<u>Dave Huber, GMAC Insurance</u>

- Usage-Based Insurance is gaining prominence in the marketplace

- The goal of these new services is to gain a better understanding about how, when and where vehicle is driven to more accurately price insurance. In a nutshell, it's all about segmentation in pricing. The industry is always trying to figure out who is a higher risk? Used to address risk… can use information on how vehicles are operate, can more accurately price the risk and policy.
- Framework to develop pricing (four pillars)
    - Technical Feasibility – need a way to collect data (telematics), some are using aftermarket data products that plug into ODBII port (1996 and newer model cars sold in US have ODBII port, about 80 percent of all cars insured in US) and include a digital clock (time of day) or GPS systems (industry has avoided this due to big brother issue), accelerometer (direct line acceleration)… they are all about collecting data, but not in hardware business… there is no ready repository of driving data (need to collect data to build model)… OEM data. OnSTAR subscribers are covered by GMAC… if they partner together the can capture enough data to create a model (ISO)… another approach might be personal telematics (iPhone), create own driving footprint and give to insurance to generate a rate (which you can shop). Insurers in CA have to use mileage to determine pricing, but self-reporting is flawed. Data is critical to usage based programs.
    - Consumer Acceptance – needs to appeal to consumer, must be iPhone simple…easy to use. Making it easy is a critical part of usage based insurance; transparency is important (kinds of data being collected, how it might affect their rate. The data is theirs… will not share with other companies/marketing firms). Notion of tracking is one of the reasons industry has not moved to GPS. Agents are uncomfortable talking about that product right now. Another major issue is that it's voluntary; customers still have access conventional products if they are uncomfortable.
    - Economic viability – Four cents on a dollar is successful profit, margins are thin…How can I reduce costs so that this works. Initially it is acquisition strategy (new customers), reduce turnover, fewer crashes (reduced payouts)… this can pay for increase admin costs in system.
    - Validating Model/Rates – using data to explain how your rate was calculated. Prove they deserve a better rate, less of a risk than neighbors.
- The model also needs driver's crash history to determine risk.

Session 6: Roles of the Public and Private Sectors

<u>Ed Regan, Wilbur Smith Associates</u>

- Tie in existing and future tolling systems with VMT tax
- Nationwide toll interoperability by 2016 (IBTTA)
- One account everywhere in North America (US and Canada), included ETC and video tolling
- National toll pricing system, VMT then replaces gas tax to create National Driving Pricing system.
- New toll systems in urban area, all electronic tolling and integrated with managed used lane treatments (e.g. HOT lanes).
- Interstate tolling is inevitable, the system will probably mandated to be all-electronic, congestion charging… all applications will likely be linked into national toll pricing system.

- Why? When the Interstate system was constructed the federal government covered 90 percent of the capital costs ($130B), but today owns almost none of it - the state DOTs own most of it and responsible for rebuilding.
- Interstates consume over 30 percent of state's transportation funding even though they typically account for on average just 6 percent of their total road network
- Today, the federal government will only fund 30 to 34 percent of the capital costs of rebuilding the Interstate, placing the majority of the burden on the states.
- Cost projections to reconstruct the national interstate system (2.5 percent inflation assumption) are over $800 billion dollars by 2060, most will be State contribution as federal match declines.
- The presenter foresees that the first interstate tolling pilots could happen as soon as 2015
- He also predicts that by 2020-2025 toll plazas will disappear and MULs will be in decline and that after 2025 VMT become standard.
- Today, 38 million (15 percent of all vehicles in US) vehicles are ETC equipped and by2025 it is forecasted that this will increase to 125 million vehicles (40 percent of all vehicles)

Jack Opiola, D'Artagnan Consulting LLP

(He also recently spoke in NYC at the http://www.nyas.org/events/Detail.aspx?cid=6f031d9b-663e-4df8-adc9-71a1d90ad0ae – his presentation focuses on a private sector scheme to manage all of the MBUF tolling facilities using "trust" third party vendors).

- Urban growth, internationally urban areas are growing
- Energy, lack refining capacity (98 percent)… causes jumps in fuel price in response to events that slow down production.
- Transportation DNA, 350MPG vehicles (Volvo… experimental car).
- Convergence, smartphone… digital tech on smart phones… payment systems.
- Integrated traffic management solutions, transit and vehicle operations that are under one roof.
- Open system architecture will lead to more partnerships and alliances.
- 1 and 6 users will have Near Field Communication (NFC) cell phone by 2014 (Juniper Research and Frost and Sullivan (forecasts of NFC and smartphones)
- New Zealand Case Study (Truck and Auto VMT… since 1977, paper based)
- 2005 market open to third parties, 80 percent have shifted.
- Light RUC, pre-buy blocks of miles (1,000 mile blocks)… same police force that monitors it. Reduced admin costs to 3 percent (check).

Bern Grush, Bern Grush Associates

- There will be two billion cars on the planet by 2025; we cannot "wish away" the automobile it is here to stay.
- Voluntary is only path to acceptance, platform that is stuffed with services…add MBUF later.
- Parking is the on-ramp for road-use metering
- Make safety driving message for consumers, hard to say no to
- Start with TDM first and funding sustainability later; if system is designed for funding there is less of a chance to do TDM later.

- Design for Congestion first; adjust for funding, scale for funding
- Government mandates, industry operates… 14 barriers in our way – we don't agree on what a road user is?
- Services first, tolling later… 2.5x more value over status quo
- Mega-region focused, not state or national… most SOV traffic takes place in region.
- Focus on equity, we must deal with perception of unfairness
- If there are sufficient services to absorb costs than costs might be under 2 percent.

Session 7: Perspectives from Taxation and Revenue Agencies

<u>Richard Prisinzano, U.S. Department of Treasury and Mark Muriello, Port Authority of New York and New Jersey</u>

- Gas taxes are cheap and easy to collect
- Do not require enrollment, unlike VMT tolling
- Lack of toll operator, banking, finance people are missing…conversation should be broadened.
- Toll agency has a major role to play, private companies that provide the tech and services and public agencies to inform and influence discussion.
- Where are the tolling agencies today -- a key stakeholder?
- All electronic and video tolling, legislative underpinnings for settlement of balances and transactions across state lines. Enforcement is critical.
- VMT's will require adjustments to inflation just like gas tax, indexed to CPI.
- IRS collects the gas tax, treasury office oversees the final collection and admin (audit the tax collection, audit). Federal tax is on the refiner level (350 people), less fraud this way so drop the retail level. To move to something where 100 million people are directly sending payments to federal government is a huge administrative increase.
- IRS is behind the technology curve (file your taxes on internet, they print it out and enter it into another system).
- Tax credit to alternative fuel cars, what happens? Will the market for EVs decline?
- Demand elasticity for gasoline increase has been calculated.
- Alternative Fuel Vehicles:
- Policy and Infrastructure Requirements

Rudin Center for Transportation Policy and Management
NYU Wagner, New York City
June 14th 2011

Summary

- Electric Vehicles (EVs), Compressed Natural Gas, Hybrids, Biofuels competing for market share
- Studies predict expansion of EV; Obama goal of 1 million vehicles by 2015 on target
- Volt entered commercial production in November 2010, following Leaf and Tesla
- Compressed Natural Gas (CNG) vehicles offer alternative, with 13.2 million world-wide today
- Hybrids seem stuck at 3% of annual total vehicle sales
- EVs limited in range to 10-100 miles and can take 4-7 hours to charge on average
- CNG less polluting than petroleum on wheels-to-wheels basis and more practical for trucks due to space and weight constraints
- Renewable CNG presents opportunities in Landfills, Wastewater treatment, Agro waste
- CNG has large up-front cost but operational savings ($1.50-$2.00/gallon), particularly for larger fleets
- Ethanol fuels also pose opportunities but have caps when derived from corn that are already almost reached; also distributional challenges to due harming infrastructure or other fuels
- Alternative fuels becoming increasingly attractive to municipal fleets due to stable prices and quick payback periods from operational savings
- City of NY actively acquiring alternative fuel vehicles (EVs, CNGs, Biofuels)
- Silence of EVs still a safety problem (no audible warming for pedestrians), with several models requiring retrofitting
- EV and CNG stations need to meet the needs of different users in terms of time/space constraints (trucks, retail shoppers, overnight commuters, etc.) and vary by cost/location
- Managing future electricity demand at specific locations/times to prevent overloads and provide energy security for facilities will be more challenging than meeting overall energy demand
- Policy Questions: Should CNG be subsidized, should the government continue to focus on EVs by continuing subsidies for purchases or should States/Feds use purchasing power to spur further innovation?

Detailed Notes

Keynote Speaker: Craig Ivey, President, ConEd Company of New York

- Obama's target: 1 million Electric Vehicles (EVs) by 2015. So far, we are on target
- Studies predict 150,000 EVs in region by 2020 [What share is this of entire market? How does NYS look?]
- Challenge is installing charging at residence during the evening vs. at work
- Infrastructure requirements aren't predicted to be huge in the next few years in NYC
- Charging rates will reflect: location, mileage/kW hour, charging time of day, type of vehicle

Panel 1: Alternative Fuel Vehicle Technologies

Speaker: John Zamurs, NYS DOT

- 60% of NYSDOT uses partly alternate fuel vehicle
- Executive Order 24: NYS Climate Action Plan to reach 80% of 1990 Greenhouse Gas (GHG) levels by 2050
- Large part of this to be achieved through electrification of transportation sector

Speaker: Ann Schlenker, Argonne National Laboratory

- Goals are to decrease petroleum dependency and decrease vehicle emissions
- Currently, 240 million light-duty vehicles on the road in the US
- 11.5 million new cars and light trucks sold in 2010
- Hybrid vehicles remain at 3% of vehicles sold
- Volt entered market in November 2010, followed by Leaf, Tessla
- EVs have a range of 10-100miles
- Average energy use of a Volt about the same as a washer: 2,500kW, 4 hours to charge
- Leaf, 99mi/g, 7 hours to charge
- More intense uses reduce battery life: Air conditioners can use up 70% of energy; aggressive driving can use up 20-30%

Speaker: Rich Kolodziej, Natural Gas Vehicles Association

- 13.2 million natural gas (NG) vehicles existing today, with lots of different models
- Freight remains a problem for using batteries; NG fills gap
- 120,000 NG vehicles in the USA out of a total 250 million
- NG vehicles produce 22% less GHG than diesel, 29% less than gasoline (on a wheels-to-wheels basis, not tailpipe-to-tailpipe)
- Renewable NG includes Biomethane can be derived from landfills, sewage, animal waste, crop waste
- Studies estimate enough NG to last 100+ years (this includes use of fracking)
- Large up-front cost for vehicles, but operational savings (currently $1.50-$2.00/gallon vs. $4/g for gasoline)

Speaker: Bruce Bunting, Oak Ridge National Laboratory

- Federal goal of producing 36 billion gallons of renewable fuels by 2020
- 13 billion a year produces of ethanol already, mostly from corn
- Ethanol produced from corn has a cap of 15b annually
- Challenges of distribution and end uses: Fungible fuels (fuels that can be substituted for one another) vs. compatible fuels (that can work with existing infrastructure and end uses)
- Many biofuels aren’t allowed in common carrier infrastructure due to risks of damaging other fuel, damaging environment, damaging systems
- Current demand for biofuels hasn’t been met by blending with conventional fuels

Speaker: Steve Weir, NYC Office of Fleet Administration, DCAS

- Budget issues tied to fluctuations in gas prices, making alternative fuels attractive
- NYS Local Law 38 requires Cities to buy vehicles with highest California Air Resources Board ratings
- Local Law 55, PlaNYC requirement for GHG emissions: 30% reduction by 2017 from government sources
- 4,300 alternative fuel vehicles in use by city already
- Believes Compressed NG (CNG) is "the fuel of the future"
- Plug-in hybrid vehicles still limited by lack of charging stations

Questions

- Audible noise a real problem. Tesla and Leaf moving forward with audible design, others require retrofitting
- Marketplace will have to deal with parking/plug-in charging stations in terms of prices (i.e. parking space rate + plug-in fee + electric rate)

Panel 2: Required Infrastructure Investments

Speaker: Caley Johnson, Market Transformation Center; National Renewable Energy Laboratory

- Created an alternative fuel station locator online (http://www.afdc.energy.gov/afdc/locator/stations/)
- E85 stations (for ethanol blends) showing consistent growth
- EV stations showing recent exponential growth from 2010 to 2011
- CNG stations decreased from 1998 to2006, but CNG volume sold has grown
- CNG prices much less volatile than diesel/gas, making it attractive for business planning
- If you compress NG yourself, cheaper than buying CNG
- Payback period for upfront costs for outfitting municipal fleets (buses, garbage trucks) declines quickly with economies of scale
- For 18-wheelers, liquefied natural gas (the most compressed) is best for refilling (fastest refill, smallest tank size)
- The more you compress NG, the more expensive the station (anywhere from $7,000 to $4.5m)
- Conversion costs to turn vehicles into CNG vehicles range from $7,000 (small sedan) to $50k (bus) or $60k (18-Wheeler)
- Under current diesel prices ($4/g), payback period for converting 50-100 buses is 3-4 years
- Currently, less than half of existing CNG stations is open to the public (operated by private fleets)
- 98% of NG comes from Canada and the USA
- Renewable NG (i.e. biomethane or biogas) currently being utilized from national waste:
  - Landfill Gas (50%)
  - Livestock Operations (2% due to transportation challenges)
  - Wastewater treatment (10%)

- Potential for using Renewable NG to fuel garbage trucks/municipal/private vehicles used by operations for these waste industries

Speaker: Stephen Schey, ECOtality – North America

- Different kinds of chargers, some that produce AC and some that produce DC for use in car
- All EVs have converter to turn AC to DC
  - AC Level 1 and 2 take anywhere from 13 hours to 2.5 hours for 20 miles (cost: Approx. $7k)
  - DC Fast Charger takes 16-24 minutes for 50 miles+ (cost: $15-20k)
- National travel survey shows average commuter drives 40miles/day, including trip chaining, showing potential for recharging during the day or when doing errands at retail
- Target is to bring charging time down to 1-3 hours needed for 50 miles
- The EV Project, funded by US DOE, is installing 14,775 Level 2 AC charging units across West Coast, Texas, Tennessee, also a few hundred DC Fast chargers
- Studies for traffic corridors/employment guide location for installation

Speaker: Brian Asparro, Green Charge Networks

- Challenge of managing new energy demand forecasted by EVs
- Company is currently working with 7-11, Avis, Wholefoods, parking garages in NYC to test power network usage
- Owners of charging facility and utility providers (ConEd) don't want electrical congestion problems i.e. too many people charging from one place or at one time
- *First gas stations in US were at pharmacies*
- Currently, there are 150,000 gas stations in the US, with 250 million vehicles
- In EV Market, there are more stations than cars: a problem
- Researching places where charging overload is a problem
- Only 49% of Americans have a garage. Of the early adopters of EVs, that number is 20%
- Retail stations must fill the gap since office/work garages can't handle future electrical loads of many cars charging at once
- Energy storage and distribution must increase to meet expected demand
- Speaker: John Shipman, Engineering & Planning, Con Edison
- Alternative fuels must be one item in diversified portfolio of fuels
- Because of high fixed costs, CNG vehicles great for fleets, but consumers still fringe
- NYISO estimates 225,000 EVs in NYS by 2020; 200-300 EVs expected in State by end of 2011
- Growth of EVs by 2015 will still only be 0.1% of total ConEd load
- Charging rates are easy for residential and monthly parking garages, more challenging for transient parking spots and for fleets more similar to building load management systems for setting rates
- 38 parking garages in Manhattan have AC level 2 chargers

Panel 3: Moving Towards Implementation

Speakers: Richard Kassel, Clean Vehicles Project, NRDC; Christina Ficicchia, NYC LHV Clean Cities Coalition; Ari Kahn, Electric Vehicles Program for the Mayor's Office of Long-Term Planning & Sustainability; Rich Kolodziej, Natural Gas Vehicles Association

- Fleets are diversifying types of fuel they are using rather than just trying one
- 20% of MTA buses, all Long Island buses are CNG
- If EVs can only go 40-50 miles, they are predominantly commuter vehicles and might just be displacing hybrid vehicles
- Poor people will still be using traditional fuel vehicles
- Question: will efficiency of petroleum vehicles outpace CNG/EV operational economies?
- EV batteries still incredibly expensive, but this may change with industrial production of them through Volt/Leaf/Tesla
- To increase buying EVs, greater education about EVs needed, and barriers to entry (i.e. charging stations, high fixed costs) need to be reduced
- Low interest loan structures for smaller fleets could help expand market for EVs/CNGs
- Currently, $7,500 tax credit for EVs from Feds, with an additional rebate for installing charger
- VALE program funds airports to buy alternative fuel vehicles
- Feds cover 80% cost of buses, so they could mandate shares to EVs/CNGs
- Container taxes in L.A./Long Beach also subsidizing purchasing of cleaner trucks to help local environment
- "Golden Carrot" idea where massive purchaser (i.e. federal government) establishes research competition and buys out winner, shaping the market by actions (i.e. story of refrigerators)
- Dependence on foreign oil a national economic liability
- In NYC and Lower Hudson Valley, there is a CNG infrastructure shortage
- LNG pays slightly more to highway trust fund than traditional gas

Connected Vehicle Research/IntelliDrive

- Connected Vehicle Research is the centerpiece of the U.S. Department of Transportation's Research and Development Agency's 'Intelligent Transportation Systems' Strategic Research Plan for 2010 to 2014. Known formerly as IntelliDrive, Connected Vehicle Research involves the use of wireless technology in vehicles to sense other vehicles and the surrounding environment to better help drivers move from one destination to another.
- The research program has three focuses. The first concentrates on safety and 'value-added' applications such as GPS systems or mobile phone applications to make driving safer, more efficient and enjoyable. The second aspect centers on making the technology secure and flexible to meet future growth and technological needs. The third part addresses public policy concerns over privacy, necessary legislation and funding issues to ensure the program is sustainable in the long term.
- Current Connected Vehicle Research is building off of previous developments using 'dedicated short-range communications' (DSRC) installed in vehicles to detect other nearby vehicles and roadway

features, known as 'Vehicle-to-Vehicle' (V2V) and 'Vehicle-to-Infrastructure' (V2I) systems. These short-range communications provide information to on-board computers to help drivers in a wide variety of ways: from automatically avoiding swerving cars and roadway hazards to avoiding potholes, congested routes and inclement weather.

- 'Proof-of-Concept' testing using DSRC technology was successfully conducted in 2008 and 2009 and the Federal Communications Commission has allocated 5.9GHz as the radio frequency dedicated to transportation safety applications. Still outstanding is whether new vehicles will be required to install V2V or V2I technology or whether governments will first need to install equipment along roadways. This question will be resolved by National Highway Traffic Safety Administration in 2013.
- The Intelligent Transportation System has an annual budget of $100 million for 2010 to 2014, $49 million of which will go to Connected Vehicle Research in 2010. While the main thrust of the program is towards safety applications, there is significant overlap with other transportation demand management technology and value-added research. The strategic plan highlights the potential for this technology to use collected information to help mitigate traffic congestion, find parking or better inform drivers as to alternative transit options and schedules. Fostering private sector entrepreneurs to develop their own applications, similar to iPhone apps, is highlighted as a measure of success.
- Unrelated to traffic managements is the IntelliDrive Human Factors Research, which focuses on identifying and counteracting distractions that could result from the new technology and impair the driver. An IntelliDrive certification that ensures technology developed addresses the risks identified by the Human Factors research is also part of the strategic research plan.
- By the end of 2014, the strategic research plan intends to have connected vehicle technology ready to be deployed into the market, with accompanying governance and regulatory structures and investment models to make it sustainable and successful.

Sources:

- ITS Strategic Research Plan, 2010-2014, Executive Summary
http://www.its.dot.gov/strategic_plan2010_2014/index.htm#two-b
- ITS Strategic Research Plan, 2010-2014, Fact Sheet
http://www.its.dot.gov/strategic_plan2010_2014/2010_factsheet.htm
- "Connected Vehicle Research," US DOT RITA Website
http://www.its.dot.gov/connected_vehicle/connected_vehicle.htm
- ITS Strategic Plan Overview, US DOT RITA Website
http://www.its.dot.gov/research_planning.htm
- US DOT RITA White Paper, "Achieving the Vision: From VII to IntelliDrive," April 30, 2010
http://www.its.dot.gov/press/2010/vii2intellidrive.htm
- Mobile Synergetics Blog, "US-DOT ditches 'IntelliDrive' program name," March 26, 2011
http://mobilesynergetics.com/us-dot-ditches-intellidrive-program-name/#more-2796
- Mobile Synergetics Blog, "U.S. DOT engaged in 5-year ITS plan," June 22, 2010
http://mobilesynergetics.com/us-dot-engaged-in-5-year-its-plan/
- Siemens Summary of Intellidrive, September 1st 2010
http://www.itssiemens.com/en/t_nav141.html

B. Appendix B

Motor Vehicle Taxes/Fees

This appendix details the various motor vehicle taxes/fees imposed by the State of New York, as of 2011.

The Highway Use Tax (HUT) is imposed on any truck/tractor/other self-propelled vehicle with a gross weight of over 18,000 pounds or any truck with an unloaded weight over 8,000 pounds or any tractor with an unloaded weight over 4,000 pounds that drives on NYS public highways (excluding toll-paid portions of the Thruway). Truck operators (carriers) can choose which method they prefer if both apply; however, the same method must be used constantly across their fleet[9]. The owner/operator of the vehicle is responsible for tracking and verifying all miles traveled (including which portions were on toll-paid parts of the Thruway).

The HUT tax is a variable rate based on the weight of the truck and whether the carrier choose to use the gross weight or unloaded weight measure. For example, using the gross weight method the average rate for trucks only is $.02635/mile (min $.0084 to max $.0546) and using the unloaded weight method the average rate is $.0153/mile (min $.0056 to max $.0308). Another part of the HUT is the Fuel tax imposed on the fuel that carrier's purchase outside of the state but who then operate vehicles predominately on public highway in NYS, including the tolled paid portions of the Thruway fuel purchased in NYS is not subject to the tax. Qualified vehicles for the tax meet any of the following conditions: have two axles and a gross weight of over 26,000 pounds, have three or more axles (whatever the weight), or are used in combination and the combined gross weight exceeds 26,000 pounds.[10]

The fuel tax is collected through the International Fuel Tax Agreement (IFTA) which allows a carrier to record all taxes on a single form and submit it in their base jurisdiction. The current IFTA fuel use rates for NYS are $.3925/g for diesel, $.41/g for gas and ethanol, and .24/g for LPG.

There are several types of licenses, each with its own fee. There is also a supplemental Metropolitan Commuter Transportation District fee for residents of NYC, Dutchess, Nassau, Orange, Putnam, Rockland, Suffolk, and Westchester. The standard "passenger vehicle" class D license fee varies based on the applicant's age The fees range from $29.5 to $65.25 outside of the MCTD and from $73.25 to $102.5 within. Motorcycle license fees are the same plus five dollars. The DMV calculates CDL fees on a per applicant basis. The fee is determined by expiration date and class of current license along with the date the applicant receives the CDL. Class E (taxis) licenses range from $100.25 to $120.

[9] Exempted vehicles include buses, power shovels, road-building machines, road rollers, road sweepers, sand spreaders, snow plows, tractor cranes, truck cranes, and well drillers. Also exempt are vehicles used to deliver mail under contract with the USPS, any vehicle owned by state/local/fed governments, vehicles operated by a fire company, vehicles operated by a farmer to transport his own goods, recreational vehicles used solely for personal pleasure, vehicles with transporter/dealer plates.

[10] The same vehicles exempt from the HUT are also exempt from the fuel tax with the exception of buses engaged in interstate or foreign transportation of passengers.

Passenger vehicle registration fees vary based on vehicle weight. The lowest fee, for vehicles between 0-1659 pounds is $26 and the highest fee is, for vehicles 6,951 pounds and over is $140.[11] The registration fee is paid when a vehicle is purchased and every two years thereafter or every time the vehicle is re-registered. In addition, vehicles registered in NYC and other counties must pay a vehicle use fee. For NYC this fee is $30 for each two year registration. The fee for other counties is $10 for vehicles under 3500 pounds and $20 for vehicles over 2500 pounds.[12] Counties subject to the MCTD tax must also pay an additional MCTD registration fee of $50. Orange and Rockland have no vehicle use fee but pay the MCTD fee.

Commercial vehicle registration fees also vary by weight. The lowest fee is for 0-500 pound and is $7, the highest is for vehicles 17501-18000 pounds at $259. In addition, vehicles registered in NYC and other counties must pay a vehicle use fee. For NYC this fee is $80 for each two year registration. The fee for other counties is $20[13] Counties subject to the MCTD tax must also pay an additional MCTD registration fee of $50.

The final category is the certificate of title, which is a flat fee that applies to all vehicles registered in NYS - this fee is currently set at $50.

[11] For example, a 2012 Accord weighs 3216 pounds and would pay a fee of $52, a 2012 Audi A4 Avant (station wagon) weighs 3814 pounds and would pay a fee of $64, and a Ford Explorer weighs 4731 pounds and would pay a fee of $85.50.
[12] Except for Nassau County which is $30 and $50, Westchester which is 30 and $60, and Wyoming which is only $10
[13] Except for Nassau which is $80, Westchester which is $60, and Wyoming County which is $10.

C. Appendix C

Methodology for Estimating VMT, Fuel Consumed and Revenues

The estimate of projected fuel revenues is complex for a number of reasons:

- The fuel economy of vehicles is changing rapidly in the coming years as a result of new fuel economy standards, indicating the need for an approach that accounts for vehicle age;
- The fuel economy standards differ for passenger cars and light trucks, requiring separate treatment of each vehicle type;
- The fuel economy standards are likely to differ from the actual fuel efficiency achieved on the road;
- Trucks have different future fuel standards;
- There are different classes of trucks with different characteristics;
- Buses have different future fuel standards; and
- There are four types of buses with differing characteristics.

Given these factors, the methodology adopted to project the revenue yields from the fuel tax for both the United States and for New York State is outlined below. The base year used for these projections was 2009, the latest year with all the necessary data in hand. Because fuel efficiency will be closely tied to the age of vehicles as new efficiency standards are set, and vehicle miles traveled per vehicle is also tied to vehicle age, a method was devised that is tied to the age distribution of future vehicles. These steps are consolidated and then discussed in greater detail.

- Project the number of vehicles registered based on the trends in vehicles per capita;
- Stratify the registered vehicles into the categories of passenger cars, light trucks, single unit trucks, combination trucks and buses;
- Apply the age distribution of passenger cars and light trucks to the projected registered vehicles to determine the number of passenger cars and light trucks in each age group;
- Apply the average miles driven by each age group to determine the total vehicle miles driven for passenger cars and for light trucks by each age group;
- Based on the national CAFE standards, develop two matrices of miles per gallon by year of new car sales for passenger cars and for light trucks;
- Apply the miles per gallon to the vehicle miles of travel for each age group for each projection year to determine the total fuel consumed for passenger cars and for light trucks for each of three projection years;
- Using the data for 2009, determine the difference between the average fuel standard and the actual miles per gallon to adjust the fuel consumption to account for the difference;
- Project the number of single unit and combination trucks;
- Apply the average vehicle miles of travel for each of these truck types for projection years;
- Apply the future fuel economy in each year, accounting for truck age turnover;
- Calculate the fuel consumed for the two types of truck;

- For each category of buses – local transit, long haul transit school, and other -- determine the number of registered vehicles, the miles per vehicle, the miles per gallon the fuel consumed, and the revenue collected for the United State and for New York State for each projection year;
- Adjust the fuel consumed for the CAFE versus actual fuel efficiencies;
- Calculate the fuel consumed by all classes of vehicles, splitting between gasoline and diesel and apply their fuel tax rates for each for the United States and for New York State to determine the revenue yields;
- Add the fuel revenue collected by New York State for all vehicle categories for each projection year;
- Add the fuel revenue collected from the federal fuel tax by the United States and determine the portion returned to New York State;
- For each projection year, sum the state and federal fuel tax yields and the projected yields from other motor vehicle fees to arrive at estimates of the New York revenues from fuel and motor vehicle fees.

Projection of Vehicle Registrations

Vehicle registrations were projected by examining per capita and per licensed driver trends. The vehicles per capita trends were preferred since they avoid first calculating the number of licensed drivers, which are also related to the size of the population. The ratio of registered vehicles to the population for both New York State and for the United States have been stable, with the former hovering around 0.58 for the last 15 years, and the latter at about 0.80 for the last ten years. Projected population estimates were used to calculate vehicle registrations. For New York State population projections were based on projections of Cornell University Program of Applied Demographics (http://pad.human.cornell.edu/counties/projections.cfm) and the United States estimates are from the United States Census.[14] The actual 2009 and projected vehicle registration estimates are shown in Table C-1.

Table C-1
Projected Registered Vehicles in United States and New York State

	United States			New York State		
	Population	Vehicles	% Change	Population	Vehicles	% Change
2009	305,873,000	246,282,886		19,338,139	11,245,208	
2015	325,540,000	257,563,333	4.6	19,546,904	11,239,299	-0.05
2020	341,387,000	270,101,289	9.7	19,697,021	11,337,204	0.82
2025	357,452,000	282,811,724	14.8	19,786,848	11,424,272	1.59

Sources: Federal Highway Administration, Highway Statistics 2009; Regional Plan Association

[14] Table1: Projection of the Population and Components of Change for the United States: 2010 to 2050

Vehicles by Type

Data from the Federal Highway Administration's Highway Statistics series was used to determine the number of passenger cars, single-unit trucks, combination trucks (tractor trailers/18-wheelers) and buses.[15] In the United States in 2009, the last year of available data, the vehicle classification distribution was:

- Passenger cars, 54.77 percent;
- Light trucks, 40.44 percent;
- Single unit trucks, 3.39 percent;
- Combination trucks, 1.06 percent; and
- Buses, 0.34 percent.

For the purposes of estimating the miles driven, fuel consumption and the revenues derived from it, the inclusion of combination trucks in the New York state vehicle fleet would be misleading, since combination trucks typically travel long distances outside of the state in which they are registered. For this reason the combination truck VMT within New York State was determined separately by using Table VM4 from the 2009 Highway Statistics. This table reports the percent of VMT by vehicle type by state. It is from these data that the VMT generated by combination trucks traveling *within* New York State is calculated, and subsequently the fuel consumption and revenue was derived.

In the absence of any data to the contrary, the distribution by vehicle type for the United States and for New York State were assumed to remain the same for the projection years.

Vehicle Age Distribution

The annual miles driven is closely tied to the age of vehicles, and the age of the vehicle will be highly relevant when estimating fuel consumption as fuel efficiency rises rapidly to meet CAFE standards. It is for these reasons that the age distribution of vehicles estimated. National data for age distribution of passenger cars and trucks are reported in the Oak Ridge National Laboratory's Transportation Energy Handbook – 30 Edition. Tables 3.7 and 3.8 of that handbook provide the distribution by age of passenger cars and trucks in the United States in 2001 and the average miles driven for each age level. In Table 3.9 the average age history is shown for 1993 to 2009. Passenger cars' average age increased from 9.3 years to 10.6 from 2001 to 2009, and trucks' average also increased, from 8.4 to 9.6 years. These increases are likely a result of a combination of economic distress and improved vehicle quality.

Based on these data it was possible to construct an age distribution for passenger cars and trucks for 2009 for the United States by modifying the age distribution reported in 2001 to match the average ages of vehicles in 2009. However, average age of vehicle vary by state. To determine the average vehicle age (and subsequently the age distribution) data from the National Household Travel Survey for 2009 was used by the Oak Ridge National Laboratory to estimate the average ages for US vehicles and for

[15] Table MV1 and MV9 were used in combination to make these estimates. Table MV1 does not differentiate among types of trucks, combining light trucks (SUVs, pick-up trucks) with other types of trucks. Table MV9 shows the truck categories, which then makes it possible to back into the light truck estimates.

each of the states, reporting and average of 9.4 years for the US and 7.8 years for New York State. Accordingly, the age distribution synthesized for passenger cars and trucks was constructed to account for the younger average age in New York. Table C-2 shows the age distributions for 2009. These distributions were assumed to remain the same for the projection years.

Table C-2 Age Distribution of United States and New York State Vehicles: 2009

	United States		New York	
Percent	**Passenger Cars**	**Light Trucks**	**Passenger Cars**	**Light Trucks**
<1	4.5	5.5	4.8	6.6
1	6	7.2	6.9	8.6
2	5.8	6.1	6.3	8.1
3	5.7	5.9	5.9	6.9
4	5.6	5.8	6.1	6.8
5	5.5	5.7	5.7	5.5
6	5.4	5.6	6.6	5.9
7	5.3	5.5	5.8	5.5
8	5.2	5.4	5.8	4.2
9	5.1	5.1	5.3	3.5
10	5	4.8	5.3	3.5
11	4.7	4.5	5.2	3.5
12	4.6	4.3	5.2	3.7
13	4.5	4	4.8	3.4
14	4	3.7	4.2	3.2
15+	23.1	20.9	16.1	21.1
Average	10.6	9.6	9.3	7.8

Source: *Transportation Energy Handbook, 30th Edition* – Oak Ridge National Laboratory – Tables 3.7, 3.8 and 3.9; Regional Plan Association

These percentages were applied to the total number of passenger cars and light trucks projected to determine the number of vehicles in each age group.

Miles Driven by Age Group

The Transportation Energy Handbook reported the average number of miles driven by vehicles by age for passenger cars and for trucks (Tables 3.7 and 3.8). These were applied to the number of vehicles by age for each projection year to determine the total number of miles driven in each age group by both passenger cars and by light trucks for the projection years.[16]   The miles driven used in this step are shown in Table C-3.

[16] The Oak Ridge data reported the age distributions for all trucks; in the absence of data for light trucks only, it was assumed that these applied to light trucks as well.

Table C-3

Miles Driven By Age of Vehicle

Age	Passenger Cars	Trucks
<1	15,000	17,500
1	14,300	19,200
2	13,700	19,800
3	12,900	17,900
4	12,400	17,500
5	12,000	17,000
6	11,700	15,600
7	11,400	15,400
8	11,100	15,100
9	10,700	13,200
10	9,900	9,200
11	9,000	9,200
12	9,400	9,200
13	8,200	9,200
14	7,200	9,200
15+	5,300	9,200

Source: *Transportation Energy Handbook, 30th Edition* – Oak Ridge National Laboratory – Tables 3.7 and 3.8

The average miles driven by each age group were used to determine the total vehicle miles driven for passenger cars and for light trucks by each age group, which were summed to arrive at the annual VMT for the projection years for both the United States and for New York State. The projected estimates assumed the average miles driven in each age group would not change for the projection years and are shown in Table C-4. Most relevant is the sluggish growth expected in New York State VMT, which will increase by only 1.59 percent or less than 0.1 percent annually over the 16 year period.[17]

Table C-4

Projected Vehicle Miles of Travel for Passenger Cars and Light Trucks (millions of miles)

	United States	Percent Change from 2009	New York State	Percent Change from 2009
2009	2,655,276	NA	122,016	NA
2015	2,777,112	4.59	121,952	-0.05
2020	2,912,300	9.68	123,015	0.82
2025	3,049,347	14.84	123,959	1.59

Source: Regional Plan Association

[17] Reinforcing this point, the 2010 VMT volume has just been reported by the FHWA and is down from by 1.7 percent from 2009.

Fuel Economy

In 2011 new CAFE standards were promulgated which can be expected to cause a significant jump in fuel efficiency. The fuel economy target has been raised from 24 mpg to 37.8 mpg for passenger cars sold in 2016 and to 54.5 mpg by 2025. Unlike the earlier CAFE standards, the light vehicle loophole has been closed with light trucks, which are now are required to meet a standard, albeit a lower one than passenger cars. As will be demonstrated later in this report, the average fuel economy on the road can be expected to climb substantially between now and 2025.

The standards for passenger cars and light trucks are shown in Table C-5 by year of sale to 2025.

Table C-5
Corporate Average Fuel Economy by Year and Vehicle Type (miles per gallon)

	Passenger Cars	Light Trucks		Passenger Cars	Light Trucks
2010	27.5	23.5	**2018**	41.4	30.0
2011	30.2	24.2	**2019**	43.0	30.6
2012	33.3	25.4	**2020**	44.7	31.2
2013	34.2	26.0	**2021**	46.6	33.3
2014	34.9	26.6	**2022**	48.8	34.9
2015	36.2	27.5	**2023**	51.0	36.6
2016	37.8	28.8	**2024**	53.5	38.5
2017	40.0	29.4	**2025**	56.0	40.3

Source: 2017-25_CAFE_NPRM_Factsheet.pdf, Table 1

These standards will result in a substantial increase in the average fuel efficiency for the car fleet in the coming years. Each year the share of vehicles meeting the higher standards will increase, driven by turnover and higher fuel standards. In 2009 applying the older CAFE standards consistent with the age of the fleet produced an average of 27.5 miles per gallon for passenger cars. The new standards will produce an average fleet miles per gallon of 40.8 miles per gallon in New York State in 2025 and 40.0 miles per gallon in the United States. (The higher New York State is a result of the younger fleet for New York vehicles). The light truck average would climb from 21.4 miles per gallon in 2009 to 30.4 miles per gallon in 2025 in the nation, and 31.4 miles per gallon in New York State.

Fuel Consumed by Passenger Cars and Light Trucks

The fuel that would be consumed in the projection years is estimated by applying the average fuel efficiency in each model year fleet to the vehicle miles driven by that model year cohort for passenger cars and light trucks separately. This was done for the United States and for New York State for passenger cars and for light trucks. However, these nominal fuel efficiency levels are not reached on the road. The 2009 data was used to compare the fuel consumed based on the expected fuel efficiency with the actually fuel consumed. This produced an adjustment factor for the United States of 1.092 and for New York State of 1.063, which were applied to the projection years. Table C-6 shows the US and New York State actual expected fuel efficiencies and the estimated amount of fuel that passenger cars and light trucks combined for the projection years. The United States fuel consumption will not decline nearly as much as New York State for many reasons:

- New York State has proportionally fewer light trucks which have lower CAFE targets;
- New York State vehicles are turned over quicker, producing newer vehicles with higher CAFE standards; and
- New York State VMT is growing much more slowly than the nation's, a combination of slower population growth and lower ratio of vehicle registrations to population.

As passenger cars and light trucks increase their fuel efficiency, the loss in fuel tax revenue collected from these vehicles will be substantially, with 20 percent less collected from the federal fuel tax and over 30 percent less by New York State from its fuel taxes.

Table C-6

Projected Fuel Efficiencies and Fuel Consumed by Passenger Cars and Light Trucks

	United States			New York State		
	Average MPG	Fuel Consumed (millions of gallons)	Percent Change from 2009	Average MPG	Fuel Consumed (millions of gallons)	Percent Change from 2009
2009	22.1	120,434	NA	24.2	5,048	NA
2015	23.9	116,352	-3.4	26.2	4,656	-7.8
2020	26.9	108,213	-10.1	29.8	4,122	-18.3
2025	31.7	96,390	-20.0	35.6	3,482	-31.0

Source: Regional Plan Association

Trucks

Single-Unit Trucks. These commercial trucks account for 3.4 percent of all vehicles registered in the United States. The number of registered vehicles, the miles driven and their fuel consumption and fuel efficiency for the base year, 2009 are report by the Highway Statistics 2009 (Table VM1). The projected estimates for future fuel use is determined by assuming that registration of this class of vehicles increases at the same rate as the total vehicle projections and that the annual miles per vehicle of 14,380 for 2009 remains the same through 2025. The fuel efficiency is assumed to approve beginning with 2016 vehicles in accordance with CAFE standards, growing from 7.4 miles per gallon in 2009 to 8.4 miles per gallon in 2025. The New York State estimates use the same annual miles per vehicle and miles per gallon, and projects their values in the same way. The number of registered vehicles is based on data of sub-classes of trucks reported in Table MV9 *in Highway Statistics* 2009.

Combination Trucks. For the national estimates, fuel consumption for this class of trucks was made in the same manner as for single unit trucks. Combination vehicles averaged 64,132 miles per year in 2009 and consumed fuel at 6.0 miles per gallon, parameters taken from Highway Statistics 2009, Table VM1. The miles traveled per vehicle are used for the projections and the miles per gallon are assumed to increase to 7.04 by 2025 as CAFE standards kick in. However, to estimate the fuel purchased in New York State, a different approach was necessary since vehicle registrations by state do not necessarily reflect where these vehicles are driven or where their fuel is purchased. Therefore, Table VM2 from Highway statistics 2009 was used, which stratifies vehicle miles of travel use by state and class of vehicles. These data indicate that New York State's roads carry an estimated 3.2 percent of combination trucks' annual vehicle miles traveled. One added modification was made for combination trucks. Since these vehicles travel long distances they have an opportunity to choose where to buy fuel, and thereby avoid the higher cost of fuel in New York State. A 25 percent reduction was assumed.

Table C-7 shows the key features of current and projected vehicle registrations, fuel efficiency and fuel consumption for each of the truck classes. In the United States it is projected that truck fuel consumption will grow slightly until the CAFE standards starts to take hold, but eventually small drops will be seen. For New York State the declines in consumption will be seen early since the growth in vehicle registrations and VMT will be quite small. By 2025 New York State fuel consumption by single unit trucks will fall by 10 percent over 2009 levels; fuel consumption by combination trucks, whose use is more tied to the national economy will fall by only a little more than two percent.

Table C-7

Projected Truck Registrations, Vehicle Miles Travel, Fuel Efficiency and Consumption (millions of miles)

	Vehicles (000's)	Vehicle Miles of Travel (millions of miles)	Fuel Efficiency (miles per gallon)	Fuel Consumed (millions of gallons)	Percent Change from 2009
United States					
Single Unit Trucks					
2009	8,356	120,163	7.40	16,238	NA
2015	8,731	125,557	7.65	16,911	4.14
2020	9,156	131,670	7.86	16,750	3.15
2025	9,587	137,866	8.35	16,503	1.63
Combination Trucks					
2009	2,617	167,841	6.00	27,974	NA
2015	2,730	175,100	6.21	28,187	0.76
2020	2,863	183,623	6.72	27,315	-2.36
2025	2,977	192,264	7.04	27,307	-2.38
New York State					
Single Unit Trucks					
2009	246	3,535	7.40	477.7	NA
2015	247	3,533	7.43	475.8	-0.40
2020	248	3,564	7.86	453.3	-5.11
2025	250	3,591	8.35	429.9	-10.01
Combination Trucks					
2009	NA	5,371	6.00	671.4	NA
2015	NA	5,603	6.21	676.5	0.76
2020	NA	5,876	6.72	655.6	-2.35
2025	NA	6,152	7.01	655.4	-2.38

Note: For New York State combination trucks, VMT based on share of national VMT.

Source: Regional Plan Association

Buses

Analysis of buses is made more complex by the various uses to which they are put. The analysis stratifies the data by four categories: transit buses, long distance buses, school buses and "other." In Table C-8 the assumed 2009 values are shown for the United States and for New York for these four categories.

Table C-8

Bus Data – 2009

United States	Vehicles	Miles per Vehicle	VMT (millions)	MPG	Gallons (millions)
School buses	480,000	9,167	4,400	6.00	733
Transit buses	111,304	35,313	3,930	3.59	1,095
Long haul buses	49,605	60,000	2,976	3.00	992
Other	201,084	15,000	3,016	4.00	754
TOTAL	841,993	17,011	14,323	4.01	3,574
New York	**Vehicles**	**Miles per Vehicle**	**VMT (millions)**	**MPG**	**Gallons (millions)**
School buses	38,168	9,167	350	6.00	58.3
Transit buses	17,411	35,313	507	3.08	164.5
Long haul buses	NA	60,000	298	3.00	99.2
Other	15,860	15,000	238	4.00	59.5
TOTAL	71,439	19,485	1392	3.65	381.5

Source: The data in this table was developed using a variety of sources including Highway Statistics 2009, National Transit Database (Table 19), and the American School Bus Association.

Projections of bus registrations, VMT, fuel efficiencies and consumption are given in Table C-9. Fuel consumption is expected to rise modestly in the absence of CAFE standards that apply to buses. Again, fuel consumption in New York State will rise more slowly than in the United States.

Table C-9
Projected Bus Registrations, VMT, Fuel Efficiency and Consumption

United States	Vehicles (000's)	Vehicle Miles of Travel (millions of miles)	Fuel Efficiency (miles per gallon)	Fuel Consumed (millions of gallons)	Percent Change from 2009
2009	842	14,323	4.01	3574.00	NA
2015	876	14,932	4.01	3727.00	4.28
2020	918	15,660	4.01	3908.00	9.35
2025	962	16,397	4.01	4091.00	14.47
New York State	**Vehicles (000's)**	**Vehicle Miles of Travel (millions of miles)**	**Fuel Efficiency (miles per gallon)**	**Fuel Consumed (millions of gallons)**	**Percent Change from 2009**
2009	71	1,393	3.65	381.50	NA
2015	71	1,391	3.65	381.30	-0.05
2020	72	1,403	3.65	384.60	0.81
2025	73	1,414	3.65	387.50	1.57

Source: Regional Plan Association

Vehicle Miles of Travel Projections

The projected vehicle miles traveled for the United States and for New York State are determined by adding the passenger car, light truck, single unit truck, combination truck and bus components. This is shown in Table C-10. The projections indicated that over the 160-year period US VMT will grow by a little over 14 percent, about 0.8 percent per annum. The New York State VMT will grow much more slowly, only about 2.1 percent in that period, or about 0.13 percent annually.

Projected Total Fuel Consumption and New York State Fuel Tax Revenues

To determine the revenue that would be expected from expected fuel consumption, the following calculations were performed:

1. Add the projected fuel consumption for the United States and for New York State for all classes of vehicles: passenger cars, light trucks, single unit trucks, combination trucks and buses;
2. Determine the expected split between gasoline and diesel consumption and apply to the total fuel consumed to determine the projected gasoline and diesel consumption;
3. Apply the current New York State gasoline and diesel tax rates to the New York State fuel consumption projections to determine the projected revenue from New York State fuel taxes;
4. Apply the current US gasoline and diesel tax rates to the projected US fuel consumption to determine the national revenues from fuel taxes;
5. Determine the share of US fuel taxes that is allocated to New York State and apply that share to the determine the federal fuel tax revenue that New York State receives; and
6. Add the fuel tax revenue that New York State accrues from New York State fuel taxes and from US fuel tax revenues.

Table C-10
Projected Vehicle Miles of Travel by Vehicle Class: United States and New York State (millions of miles)

United States		2009	2015	2020	2025
	Passenger Cars	1,321,701	1,382,337	1,449,628	1,517,844
	Light Trucks	1,333,575	1,394,776	1,462,672	1,531,503
	Single Unit Trucks	120,123	125,557	131,670	137,865
	Combination Trucks	167,841	175,100	183,623	192,264
	Buses	14,323	14,932	15,660	16,397
	TOTAL	2,957,563	3,092,702	3,243,253	3,395,873
New York State					
	Passenger Cars	90,980	90,332	91,724	92,439
	Light Trucks	31,036	31,019	31,290	31,530
	Single Unit Trucks	3,535	3,533	3,564	3,591
	Combination Trucks	5,371	5,603	5,876	6,152
	Buses	1,393	1,391	1,403	1,414
	TOTAL	132,315	131,878	133,857	135,126

Source: Regional Plan Association

These steps resulted in Table C-11. The table is based on assuming that the 2009 split (Step 2 above) between gasoline and diesel in the United States of 79.02 / 20.98 and for New York State of 79.65/20.65 will each remain constant.[18] The table also assumes that the share of US fuel taxes allocated to New York State of 3.991 percent (Step 5 above) will also remain constant.[19]

As expected the revenue yield from fuel taxes is projected to decline. The funds from the national fuel tax will drop by 15 percent from $1.32 billion in 2009 to $1.12 billion by 2025. The New York State fuel tax yield will drop even more, from $1.63 billion to $1.25 billion, or some 23.4 percent. Taken together, the two taxes will leave New York State with almost $600 million less each year, nearly a 20 percent drop.

[18] Based on Table MF2 in FHWA *Highway Statistics 2009*
[19] Based on Table HDF in FHWA *Highway Statistics 2009*

Table C-11

Revenue to New York State from Fuel Taxes Assuming No Change in Tax Rates

United States	2009	2015	2020	2025
Total Fuel Consumed (gallons)	168,220	164,843	155,561	142,842
Gasoline Consumed (gallons)	132,927	130,259	122,924	112,874
Diesel Consumed (gallons)	35,293	34,584	32,637	29,968
Revenue from Gasoline ($)	24,459	23,968	22,618	20,769
Revenue from Diesel ($)	8,611	8,438	7,963	7,312
Total Revenue ($)	33,070	32,406	30,581	28,081
US Revenue Allocated to NYS ($)	1,320	1,293	1,221	1,121
Change in Revenue from Fuel Taxes, Percent	NA	-2.01	-7.53	-15.09
New York State	2009	2015	2020	2025
Total Fuel Consumed	6,578	6,173	5,585	4,899
Gasoline Consumed	5,220	4,899	4,432	3,888
Diesel Consumed	1,358	1,275	1,153	1,012
Revenue from Gasoline ($)	1,313	1,266	1,146	1,005
Revenue from Diesel ($)	317	307	278	244
Total Revenue ($)	1,630	1,573	1,423	1,249
Change in Revenue from Fuel Taxes, Percent	NA	-3.48	-12.68	-23.40
Total Fuel Tax Revenue to New York State ($)	2,950	2,867	2,644	2,369
Change in Revenue from Fuel Taxes, Percent	NA	-2.82	-10.37	-19.68

Source: Regional Plan Association