The Motor Fuel Tax:

A Critical System at Risk

Framing the Problem for America

A Policy White Paper

By Ed Regan, Senior Vice President, CDM Smith

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***Ed Regan** is a Senior Vice President with CDM Smith who has been involved in tolling and transportation finance policy for more than 40 years. He has been involved in hundreds of studies for toll agencies and state departments of transportation and has testified before two Congressional Commissions on transportation funding policy.*

Though the FAST Act has provided America with transportation funding assurance through 2020, the long-term security and sustainability of our transportation infrastructure is still in jeopardy. This white paper first examines why the motor fuel tax (and the funding it provides) is at risk. It then centers on the opportunities that a mileage-based user fee system alternative would bring to funding our future mobility.

The motor fuel tax has served as the primary source of transportation funding in the United States for close to 100 years. It has been a simple (almost invisible) form of an indirect user fee, based on the amount of fuel consumed. Simply stated, the more a vehicle is driven, the more fuel that is consumed and the more road usage tax that is paid. It is elegant in its efficiency, widely accepted by the public and probably doomed to fail in the future, at least in its current form.

How can such a steady and dependable funding source be at risk? As fuel efficiency increases, and we move toward alternative fuel vehicles, drivers will be using less fuel. That is great for reducing greenhouse gas emissions and our dependency on foreign oil supplies, but it is terrible for transportation funding , as long as we continue to primarily rely on the gas tax as our major funding source.

It is one of the most notable policy contradictions: Transportation funding in America is based on the taxation of a commodity that our nation is trying hard to discourage the use of. Increased fuel efficiency, led by dramatically higher Corporate Average Fuel Efficiency (CAFE) standards, is one of the biggest initiatives in the U.S. war on climate change. The federal government is offering significant tax incentives toward the purchase of all-electric vehicles and, in response, auto makers are rapidly developing plug-in hybrid electric vehicles (PHEV) and full battery electric vehicles (BEV).

According to the University of Michigan Transportation Research Institute[1], the average fuel efficiency of new passenger cars and other light vehicles sold in the United States increased almost 22 percent between 2008 and 2014. It has remained steady in 2015 and 2016 due to a significant drop in fuel prices, but will undoubtedly increase further as auto makers try to achieve an average new car fleet efficiency of more than 54 miles per gallon (mpg) by 2025 (just 9 years away). State and federal gas tax revenues have already shown a significant impact, and the Federal Highway Trust Fund has been largely on life support for about 5 years or more.

The problem is further compounded by a clear reluctance on the part of elected officials to increase tax rates, motor fuel or otherwise. The federal gas tax has been set at $0.184 per gallon (higher for diesel) for more than two decades. Some states have elected to index portions of the state gas tax to inflation. But that approach does not deal with the problem of dramatic future increases in fuel efficiency, or the resulting phenomena where vehicle miles of travel (VMT) and demand for transportation increases while fuel consumption (and tax revenue) decreases.

This white paper quantifies the problems with the gas tax, both in terms of magnitude and timing, and presents a long-term solution for agencies to consider in the form of mileage-based user fees It will take time to define, test and deploy alternative revenue systems, but the first step is to acknowledge and define the problem. Armed with information about the current deficits of the gas tax system and potential solutions, the industry can work toward realizing a more sustainable and secure funding future.

How Serious is the Problem?

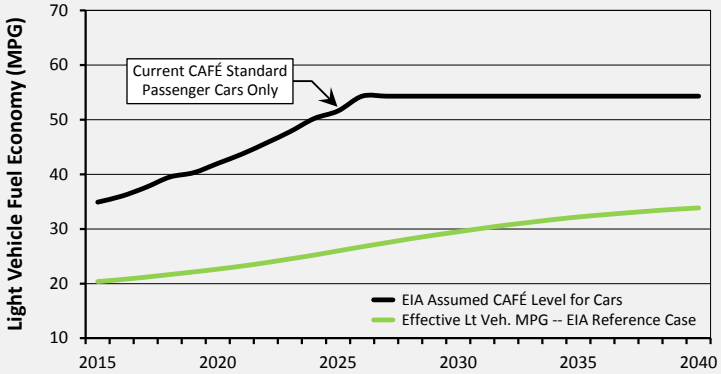
The recent downturn in gas tax revenue is just a small glimpse at the problems to come. Indeed, some of the downturn arose from a reduction in VMT spurred by increasing gas prices and the Great Recession after 2008. Nationally, VMT is rising again, but fuel consumption is rising more slowly.

Perhaps one of the best recent outlooks of what the future holds is the U.S. Energy Information Administration (EIA)'s 2016 official fuel consumption forecast "early release" reference case projection.[2] This report contains important outlooks on annual fuel efficiency for cars and trucks, updated national VMT forecasts and projected fuel demand by travel market segment.

The average fuel efficiency of new cars and other light vehicles sold in America increased 22% between 2008 and 2014.

In developing the estimate, EIA starts with the latest U.S. Environmental Protection Agency (EPA) CAFE passenger car fuel efficiency standards, shown in the black line in **Figure 1**. This line refers only to new sales of passenger cars, which make up only a portion of the total light vehicle fleet. It does not include SUVs or pickup trucks, which also comprise a significant portion. Note that EIA assumes the CAFE goal of 54.3 mpg will be reached by 2025, but then assumes no further increases beyond that point. (Note: The CAFE goal for 2025 was reduced slightly in 2016 to 52.5 mpg as a result of the recent downturn in fuel prices.)

The green line displays the overall EIA estimated light vehicle fuel efficiency used in the "reference case." It is lower than the CAFE standards because it includes all light vehicles, including SUVs and pickups. The CAFE standard of 54.3 MPG relates only to passenger cars, and the CAFE standards relate only to new car sales. The overall fuel efficiency includes that of the entire light vehicle fleet, and includes both new and old cars. The entire light vehicle fleet typically takes more than 15 years to turn over. EIA projects average light vehicle mileage (including pickups and SUVs) to increase from about 20 mpg in 2015 to nearly 35 mpg by 2040, an increase of about 70 percent over those 25 years.



Source: Adapted from Energy Information Agency 2016 "early" Forecast. Also, Bloomberg New Energy Finance.
Note: CAFÉ standards apply only to passenger cars. Light vehicles include cars, SUV's and pickup trucks.

ESTIMATED LIGHT VEHICLE FUEL EFFICIENCY (MPG)

FIGURE 1

Electric Vehicles

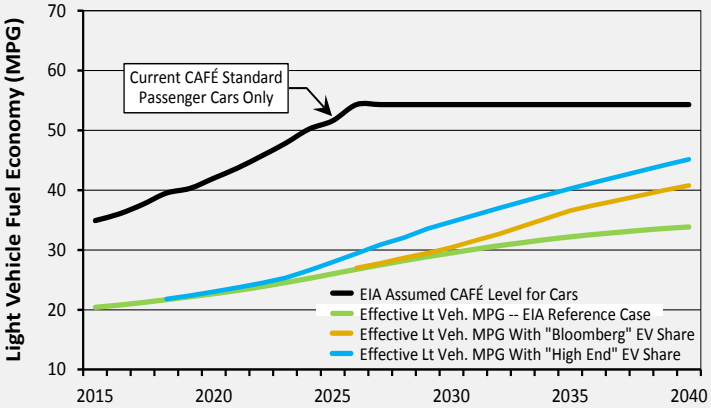
However, the EIA projection assumes no change in CAFE standards after 2025, right about the time electric vehicles are expected to begin taking off as a proportion of new car sales. *Bloomberg New Energy Finance* released a study in February 2016[3], which concluded that based on current trends in battery development and price declines, fully electric "plugin vehicles" will become more economical to buy and own than traditional internal combustion engine vehicles by the mid-2020s. They forecast that about 35 percent of all new cars sold will be gasless electric vehicles (EV) by 2040. Their estimate for EV sales in 2040 will be more than 90 times the number sold annually today.

But even that forecast may prove to be conservative, based on recent developments and consumer behavior. In 2016, Tesla announced that it will be mass producing an electric vehicle (Tesla 3), which will sell for about $35,000 and get about 225 miles between plug-in charges. It will begin delivery early in 2018, suggesting that the critical equivalent

"price point" assumed by Bloomberg may be reached 5 years earlier. More importantly, more than 400,000 U.S. drivers have already pre-ordered the Tesla 3—a clear indication of strong market appetite. The Bloomberg analysis assumed about 8 percent of new car sales in 2025 would be all electric; based on the consumer reaction to the Tesla initiative, it may be a lot higher.

As such, in preparing the paper, we developed two alternative fuel efficiency forecasts, one based on Bloomberg and one developed by CDM Smith assuming an even higher EV penetration. These alternatives are compared with the official EIA projection in **Figure 2**.

With the intermediate case, aligned with the Bloomberg electric vehicle forecast, depicted in orange, average fuel efficiency would reach about 41 mpg by 2040, as compared with about 34 mpg in the EIA reference case. The "Bloomberg" forecast begins to depart from the EIA projection in 2025, when they believe EV lifecycle cost will generally be in line with internal combustion engine vehicles.



Source: Adapted from Energy Information Agency 2016 "early" Forecast. Also, Bloomberg New Energy Finance.
Note: CAFÉ standards apply only to passenger cars. Light vehicles include cars, SUV's and pickup trucks.

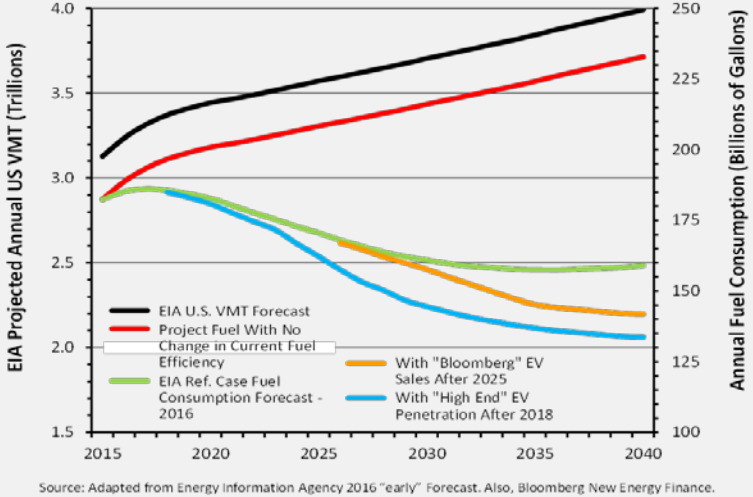
ESTIMATED LIGHT VEHICLE FUEL EFFICIENCY (MPG)

FIGURE 2

The “High End” electric vehicle penetration scenario assumes even more accelerated EV sales, as suggested by the early deployment and overwhelming advance sales of the Tesla 3. It begins to depart from the EIA case earlier (in 2018) and anticipates long-range light vehicle fuel efficiency may well reach 45 mpg. That is about 125 percent better than today’s average and more than 28 percent higher than the EIA estimate in 2040. Bottom line: all three “future scenarios” show dramatic increases in fuel efficiency which will, no doubt, reduce fuel sales in the future, even as travel increases.

What it Means for Fuel Consumption and Gas Tax Revenue

Needless to say, this is not good news for fuel sales and gas tax revenue. The black line in **Figure 3** is the EIA estimate of total VMT in the United States that was used to estimate fuel demand. Total national VMT is expected to increase from about 3.1 trillion in 2015 to about 4.0 trillion in 2040, an increase of almost 30 percent over 25 years. Certainly not excessive growth, but it does show ever-increasing demand on aging and sometimes clogged infrastructure already behind in funding and investment. The red line depicts what nationwide fuel sales would be if there was no



Source: Adapted from Energy Information Agency 2016 “early” Forecast. Also, Bloomberg New Energy Finance.

ESTIMATED ANNUAL U.S. VMT AND FUEL CONSUMPTION

FIGURE 3

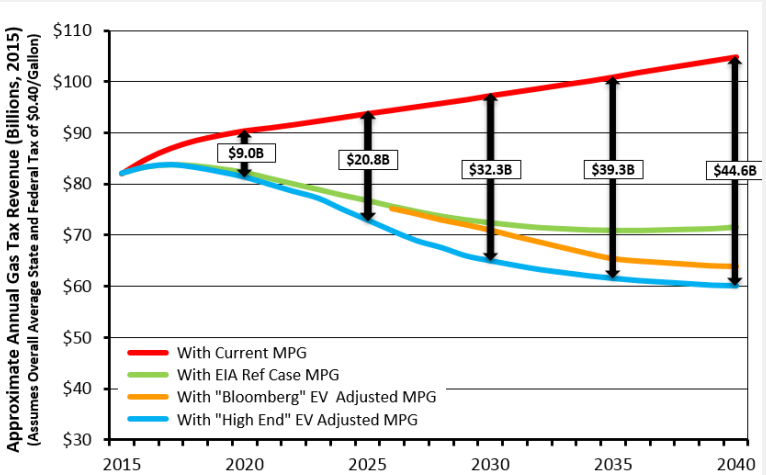
increase in fuel efficiency, increasing from about 185 billion gallons in 2015 to nearly 235 billion gallons in 2040. This scenario is completely hypothetical that will not occur if current EPA CAFE standards are met. We include it only for purposes of comparison with the three alternative "futures" to quantify potential impacts resulting directly from increasing fuel efficiency only.

With the projected increases in efficiency, and the shift to gasless electric vehicles, EIA projects (green line) that 2040 fuel sales will drop to around 155 billion gallons, a decrease of 34 percent in fuel as compared with the "No Change" in fuel efficiency case. With the higher EV penetration (blue line) fuel sales would decline further, dropping to just 130 billion gallons in 2040. That is a 45 percent reduction in 2040 fully attributable to increased fuel efficiency. Great for climate change but a disaster for transportation funding if we continue taxing gallons as opposed to miles.

By 2040, EIA projects 34% decrease in fuel sales. With higher EV penetration fuel sales would drop by 45%.

Figure 4 takes a look at what it would mean for national gas tax revenue over the next 25 years. All values are displayed in 2016 dollars, generally based on today's tax rates. The federal gas tax rate is $0.184 per gallon, while state gas tax rates vary. The overall average state rate is about $0.27 per gallon (including excise and some state additives), so a nominal overall $0.45 per gallon was used to calculate total fuel tax revenue.[4] In the absence of any further increase in fuel efficiency, as shown by the red line, national gas tax related revenue would increase from about $82 billion in 2015 to about $105 billion in 2040 (all 2016 dollars).

However, the EIA fuel forecast would drop the 2040 figure to about $71 billion, and the "High EV" case to about $60 billion. The chart shows that gas tax revenue (in 2016 dollars) would actually peak over the next 2 to 3 years and then decline, unless tax rates are increased to make up the difference. By 2025, just 8 years from the writing of this white paper, increasing fuel efficiency may cost state and federal coffers as much as $20.8 billion per year. The loss will rise to more than $33 billion by 2030 and almost $45 billion by 2040. It is a serious problem, especially when considering that current infrastructure funding levels are already well below needs even today.



APPROXIMATE STATE AND FEDERAL FUEL TAX REVENUE
2015 Dollars; Assumes Nominal
$0.45/Gal. Combined Average Tax

FIGURE 4

Compounding the problem is a very clear reluctance on the part of elected officials to approve increases in fuel tax rates. The federal gas tax, for example, has not been increased in more than 20 years, and senior congressional staff involved in negotiations on transportation funding have expressed that we may never see another increase in the federal motor fuel tax.

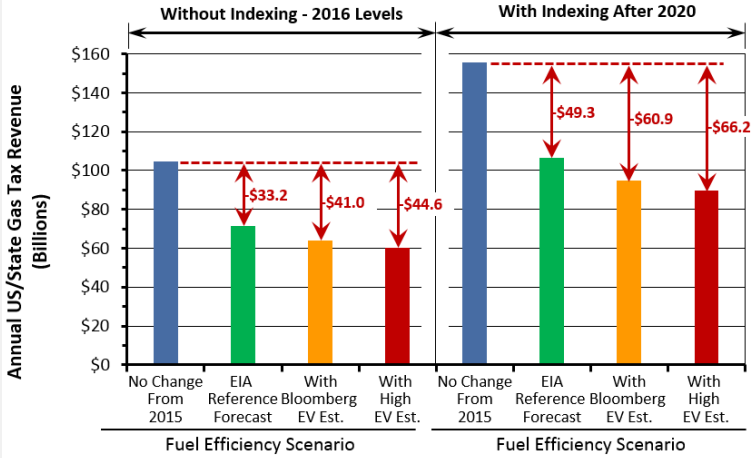
Some states have chosen to automatically adjust future fuel tax rates to keep pace with inflation. However, this indexing usually does not deal with the significant problem described above; that is, the reduction in fuel consumption due to increased fuel efficiency and the expected rapid future emergence of electric vehicles. Indexing helps by keeping pace with inflation, but is not a solution to this particular problem.

By 2025, just 8 years from now, increasing fuel efficiency may cost state and federal coffers as much as $20.8 billion per year in fuel tax revenues!

Looking at 2040

Perhaps the starkest comparison of the long-term impact in improving fuel efficiency can be seen in a comparison of national revenue potential at 2040 levels under each of the four scenarios considered in this analysis. **Figure 5** compares estimated 2040 total national gas tax related revenue under each fuel efficiency scenario, both with and without hypothetical inflationary indexing in the future.

The left side of the graph shows revenue potential without indexing; nominally assuming the same overall average combined federal and state tax rate of about $0.45 per gallon. The right side of the graph compares fuel-related revenue assuming annual indexing is hypothetically introduced to the rates from 2020 and beyond. This case assumes nominal annual inflation of 2.0 percent per year after 2020.



COMPARISON OF 2040 NATIONAL FUEL TAX REVENUES

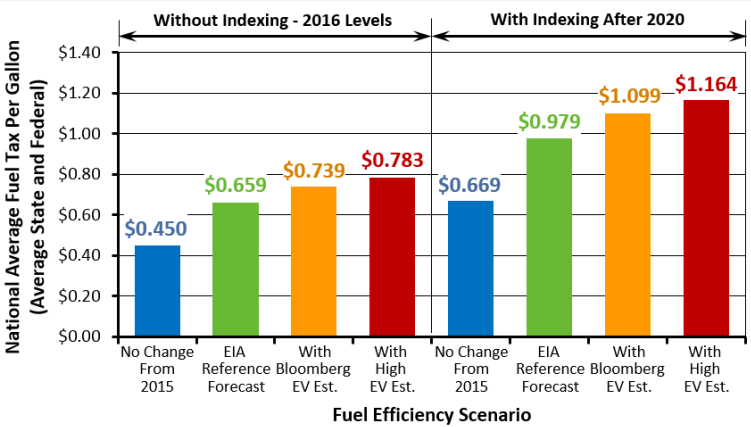
Note: Includes both federal and average state taxes.

FIGURE 5

At current tax rates, it is estimated that total national gas tax-related revenue would be around $104.8 billion in 2040. Using the EIA reference forecast, this drops to about $71.6 billion, a net decrease of more than $33 billion—entirely attributable to the increased fuel efficiency. Assuming the Bloomberg electric vehicle forecast scenario, the net impact is estimated at about $41 billion, and, with the high-end EV forecast, the reduction in 2040 annual revenue is estimated at $44.6 billion. That is nearly a 43 percent reduction in fuel tax revenue attributed exclusively to increased fuel efficiency. Not a pretty picture.

When we consider the impacts in future-year indexed dollars, even the EIA reference case forecast, which may well prove to be optimistic, shows a decline in future revenue of about $49.3 billion, even after indexing. This increases to as much as a $66.2 billion reduction for the other scenarios.

What might this do to gas tax rates in 2040? This is addressed in **Figure 6**. Overall average state and federal gas tax rate levels are shown with and without nominal indexing after 2020. With the 2 percent per year overall indexing, if there is no change in current fuel efficiency, the current rate per gallon would nominally increase to about $0.67 per gallon, including both federal and state levies.



ESTIMATED 2040 NATIONAL AVERAGE COMBINED FUEL TAX RATES

Note: Includes both federal and average state fuel taxes.

FIGURE 6

However, if the states and federal government wished to generate revenue in the year 2040, commensurate with the amount of estimated travel, fuel tax rates would have to be increased above current levels. Using the EIA reference forecast, the least aggressive mpg impact scenario, this would mean the effective gas tax rate would need to be increased to about $0.66 per gallon without indexing and $0.98 per gallon with indexing. With the higher EV forecast, combined gas tax rates would be increased to over $0.78 per gallon without indexing and more than $1.16 per gallon with indexing. That is about 2.5 times the current rate per gallon.

If governments want to still generate equivalent revenue to keep up with future travel levels, gas tax rates will need to be increased to as much at $1.16 per gallon to overcome the effect of increasing fuel efficiency.

So What is the Solution?

The motor fuel tax as we know it today is unsustainable as the primary source of transportation funding in the future. It is true that fuel tax rates per gallon can continue to be increased in the future to offset changes in fuel efficiency, especially in the short term.

But in the longer term, is that the best course of action? There are a couple of major problems with this approach:

- As shown above, gas tax rates will need to increase to very high levels in the not-too-distant future to compensate for high fuel efficiency and usage of electric vehicles; and,
- An increasing proportion of drivers (those who use electric vehicles) will wind up paying no gas tax at all, possibly reaching 30 to 40 percent of total travelers in the 2040-2050 timeframe.

One option might be to assess annual fees for electric vehicles and other alternative fuel cars and trucks. The disadvantage of this approach is that it further erodes the relationship between consumption of transportation capacity versus payment for road use. A 2016 publication by the Congressional Budget Office suggested transportation funding needs to move toward user fees. One of three recommendations to Congress to make highway spending more productive would be to “have the federal government–or allow states … to charge drivers directly for their use of roads more often.”[5]

Over the longer term, the ultimate solution to the declining sustainability of the gas tax may be some gradual transition to more direct user fees. Some states have begun discussing adding all-electronic tolling to interstate highways, should

Congress eventually remove federal prohibitions against tolling those roads. There is also a great deal of national interest in moving to a mileage-based user fee (MBUF) system. More than half the states have contemplated or actually conducted some type of pilot demonstrations, and Congress recently appropriated about $95 million in the FAST Act to help fund state-operated pilots of alternative revenue sources, primarily VMT fees of some type.

Most experts believe that over the long term, the states and our nation will shift from a “per gallon” to a “per mile” basis of taxation for transportation use. There are a number of methods that can be used to achieve this shift, but there is no shortage of technical and public acceptability challenges associated therewith. In fact, polling suggests that there is considerable public concern about moving to MBUFs, particularly related to privacy issues. There are technology solutions to privacy and other issues, but significant research, development and testing must be undertaken to solve these problems. A strong program of public information and outreach will also be needed.

Mileage fees would be a replacement for, not an addition to, the current gas tax. They may actually enable governments to avoid increasing gas tax rates simply to make up for losses due to fuel efficiency

Another common public misconception is that potential VMT fees would be *in addition to,* the current gas tax, suggesting an increase in taxes. Over the long term it will be a replacement for the gas tax, and will enable governments to avoid increasing tax rates simply to make up for the decline in fuel sales in the face of increasing travel demands (as shown in Figure 6 above).

The MBUF Concept

MBUFs, sometimes referred to as VMT fees or simply road user charging , represents a potential long-term solution to the future unsustainability of the gas tax. Depending on how they are implemented in the future, MBUFs may become a new paradigm in both transportation funding and demand management and optimization. They may also become one of the many "disruptive" technology changes in transportation that are on the horizon, such as connected and autonomous vehicles and the emergence of fully electric vehicles.

Each of these future developments, which seem increasingly likely to occur, will involve placing a higher degree of "intelligence" and automated communications capability in our vehicles, cars and trucks alike. Providing technology to accumulate mileage driven, by jurisdiction, route or time of travel would be a minimal technological challenge, especially compared with automated vehicle control and various safety improvements.

The most sophisticated technology options considered thus far would involve the installation of GPS "on-board units" (OBU). There is a common perception, reinforced by frequent mischaracterizations in the media, that these devices would allow government "tracking" of private vehicles by satellites. In reality, the GPS component of the devices would function exactly as commercially available dashboard route mapping devices. They simply use satellite triangulation to determine where a vehicle is at any moment; the satellites do not actually track anything. Most cell phones have the same technology, which is used with countless apps people use every day.

The devices used in testing thus far also are designed to simply plug into a vehicle's "OBD-II" port, which connects to the vehicle's technology systems and is typically used for computerized vehicle diagnostics. Every new vehicle sold in America in the last 20 years comes with the OBD-II port, which also enables linkage to electronic odometer readings and other data useful to MBUFs. This port is also used by various driver performance monitoring devices that have been offered by auto insurance companies in recent years. The in-vehicle OBU can be designed to accumulate miles driven, by jurisdiction or agency, with no action required by the driver. Accumulated data can then be automatically downloaded via a cellular-type connection at periodic intervals, such as each time the vehicle is started. It is not necessary to provide actual travel histories for government revenue collection, rather just accumulated totals with aggregated charge allocations by jurisdiction.

While it is more complicated than the current gas tax system, it is really quite simple and not as costly as it sounds. Preliminary estimates of the one-time cost for each vehicle range from $100 to $200. This estimate is likely to fall considerably as states begin to move off the gas tax. That is not likely to occur for at least another decade, but first there are many challenges to solve and trials to be proven, so pilot testing and research is already underway.

New Opportunities with MBUF

If a program is implemented that includes some type of "on-board unit" in all vehicles, designed to fully protect driver's privacy, MBUF offers a number of new opportunities, which simply do not exist with the motor fuel tax. Some of these include:

- It would establish a more direct linkage between road usage and road user charges. As discussed in the CBO report referenced earlier, this will help prioritize investments and assure high performance of the system and also better allocate the cost of transportation investments to those who benefit from them (and not to those who do not).
- Rates per mile could be varied by time of day to help manage demand and to directly support potential integrated urban mobility solutions.
- Rates could also be varied by jurisdiction, with a state fee per mile that might be supplemented by local option additives, which would apply only to miles driven in a certain jurisdiction not based on where you buy gas or register your vehicle. An example might be a small additive to support transit alternatives, which might be assessed only where viable transit alternatives really exist (and not where they do not).
- The same MBUF OBU technology and account systems can be used to collect tolls, without the need for expensive roadside equipment and electronic toll gantries. In Germany, trucks from all over Europe are assessed tolls on the Autobahn system. More than $8 billion per year is collected with only GPS-based units on the vehicles.
- Revenue collected on certain routes, or in certain regions, can be directly allocated to those routes or regions. This may open up new opportunities to support public/private partnerships for major reconstruction and long term maintenance agreements.
- MBUF assesses vehicles based on where they drive, rather than where their car is registered or where they buy gas.

MBUF Issues and Challenges

There are many challenges and issues with MBUF that will need to be addressed—particularly, significant concerns about "Big Brother" and privacy preservation. Unfortunately, because of perceived public and political anxiety about privacy, and a generally skeptical attitude among the public on road user charging, most of the pilots performed to date have focused on overcoming the reluctance of the public and not necessarily identifying technology solutions. Recent pilots have offered participants a choice of various "non-technology" options, such as paying a flat annual fee or simply reporting annual odometer readings, in addition to some on board unit technology choices. These non-technology choices represent potential options only for replacing the gas tax; they will not permit the many new opportunities that could be enabled by moving to a tech-based road user charging system.

The public is skeptical, to say the least, about MBUF. There are several reasons for this:

- As noted above, there is a real fear among a portion of the population about invasion of privacy and "Big Brother" getting inside our private vehicles.
- There is relatively little awareness of the pending problems with the gas tax. In fact, most people have no idea how little then current pay in gas taxes. It is almost invisible to the public.
- There is great simplicity with the gas tax. Since the public does not see the problem with it, they also see no reason to change it. Anything else would be more complex and costly.

But the big issue is perceived privacy concerns, amplified in recent years with revelations about National Security Agency and other government monitoring programs. Growing public distrust of government also contributes to this issue. It may never be possible to convince everyone that there are no real privacy concerns. But the first step is to challenge the technology industry to develop (and prove) that there are ways to easily collect road use data (in aggregate), while ensuring that the government is not tracking us or otherwise invading our privacy. This should be, without a doubt, the highest priority in RUC pilots of the future. Unfortunately, it has been largely avoided in pilots to date

Other issues and challenges to be overcome include:

- Enforcement: How do we make sure each vehicle is equipped and each system is "on" to ensure mileage based revenue is actually collected?
- Can one state implement MBUF without the establishment of a national framework and technology protocol? If so, how will we handle out of state vehicles?
- The cost of administering an MBUF system is likely to be higher that the gas tax. How can this increase in cost be minimized, and might this be at least partially offset through new value added services for drivers such as dynamic route guidance, parking payments, etc., which might be enabled through new on board technologies?

So What Should States Be Doing Now?

The first step is recognizing the flaws with the current system. While some states (particularly in the West) have begun to identify increased fuel efficiency in their long-term forecasts of fuel sales and gas tax revenue, most have not. A majority of states still project fuel sales based on projected VMT growth alone despite current federal policy, which requires doubling fleet fuel efficiency on new car sales over the next 9 years. As shown above, fuel sales will likely decline about 25 percent by 2025, and by as much as 60 percent by 2040 because of increased fuel efficiency.

Next, policymakers need to consider short-term solutions, such as temporarily raising gas tax rates (beyond inflation) or coming up with potential new revenue sources to supplement the declining motor fuel tax. This approach may preserve our current funding levels through, maybe, 2025. Of course, we also need to recognize that in most cases "current funding levels" are woefully inadequate to meet transportation infrastructure investment needs.

Ultimately, states will need to plan on a whole new paradigm for transportation funding—most likely road user charging. There are a lot of challenges to overcome, and trials and testing to be performed. Now is the time to start, before the gas tax craters entirely. The FAST Act (Section

1020) includes special funding for planning and testing possible new alternatives to the gas tax. Up to $95 million in federal matching funds are available over the 5 years of the act. Nearly $15 million of that total was distributed to early enactors in the first fiscal year. That still leaves $80 million in funding for pilots and testing over the coming 4 years that state agencies can leverage.

Summary

The unsustainability of the gas tax is almost a certainty—not so much a question of "if" but "when." MBUF can provide a solution that creates a new paradigm in revenue generation and transportation management and operation. But there are many challenges to be solved, and it will take some time to develop, demonstrate and prove those solutions. That is why new federal funding opportunities to test new options are so timely and important.

It is not about adding new taxes. **It may actually be more about coming up with new solutions to avoid raising tax rates.**

It is not about moving off the gas tax tomorrow. **It is about designing and testing new solutions so we will be ready to make a change in the future when the time comes.**

Appendix:

1. Michael Sivak and Brandon Schoettle, University of Michigan Transportation Research Institute, *Monthly Monitoring of Vehicle Fuel Economy and Emissions,* June 2016.
2. U.S. Energy Information Administration, *Annual Energy Outlook 2016,* Reference case, May, 2016.
3. *Electric Vehicles to be 35% of Global New Car Sales by 2040,* Jennifer MacDonald, Bloomberg New Energy Finance, February, 2016
4. *State Fuel Tax Rates*, U.S. Energy Information Administration, August 2016.
5. *Approaches to Making Federal Highway Spending More Productive* , Congressional Budget Office, February, 2016.

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