MICHIGAN OHIO UNIVERSITY TRANSPORTATION CENTER

Alternate energy and system mobility to stimulate economic development.

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The Impact of Energy Efficient Vehicles on Gas Tax (Highway Trust Fund) and Alternative Funding for Infrastructure Construction, Upgrade, and Maintenance

FINAL REPORT

PROJECT TEAM

Utpal Dutta Ph.D. P.E
Nishita Patel
Civil, Architectural & Environmental Engineering
University of Detroit Mercy
4001 W. McNichols Road
Detroit, MI 48221

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Developed By:

Utpal Dutta
Principal Investigator, UDM
Phone (313)993-1040
duttau@udmercy.edu

Nishita Patel
Graduate Student, UDM

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DISCLAIMERS

The Impact of Energy Efficient Vehicles on Gas Tax (Highway Trust Fund) and Alternative Funding For Infrastructure Construction, Upgrade, and Maintenance

ABSTRACT

Road construction, upgrades, and maintenance have largely been financed by a gas tax since the first tax on fuel was instituted by the federal government in 1932. Monies from the gas tax and other sources are deposited in the Highway Trust Fund to handle the country's transportation infrastructure needs. States also tax fuel to varying degrees. As a result the average fuel tax paid by U.S. drivers is 48.8 cents per gallon. However, the taxes have failed to keep up with inflation and need. The country's crumbling transportation infrastructure is the result. Further, as the researchers have detailed, based on current conditions and forecasts the funding gap is likely to worsen significantly.

One alternative to the gasoline tax is a system based on miles travelled. The Mileage Based User Fee (MBUF) charges drivers based the actual amount of road use, not on fuel consumption. Research shows the implementation of a MBUF system offers significant potential benefits including:

- Fairness--all drivers pay for the true use and therefore the actual benefits derived from the use of the highway system.
- Stability of revenue--as gas prices increase there is a corresponding increase in the use of more fuel efficient cars and trucks, hybrids, and even electric vehicles. Less fuel is used resulting in lower gas tax collection even though the mileage travelled remains relatively constant. With an MBUF system revenue remains relatively constant.
- Flexibility--additional factors such as time of day, congestion, and vehicle weight can be built into the fees charged to road users.
- Higher revenue yield possible--value-added options, improved roads, and a direct correlation between benefit received and fee incurred will make the public more willing to accept higher user fees.

The project team has identified potential concerns and areas requiring additional research in order to implement MBUF. The project team also proposed a Mileage Based Vehicle Registration (MBVR) as a tool to implement MBUF. It is to be noted that MBVR is not the perfect mechanism to implement MBUF but it is a feasible and dependable means to add additional dollars to the state's highway fund without further delay.

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1. INTRODUCTION

1.1. Background

Every time drivers fill up at the pump they pay a fuel tax of 18.4 cents per gallon for gasoline and 24.4 cents a gallon for diesel fuel. This federal Highway-User fee is placed into the Highway Trust Fund, which primarily finances road projects across the country, enabling Americans to get to work and school each day and create a thriving interstate commerce system. This excise tax isn't a variable amount, and it's not tied to the cost of fuel. The more gasoline and diesel Americans buy the more revenue we have for roads. American energy consumption is largely driven by our ability to keep costs consistent and affordable. It's not a complicated scenario – when the price of gas goes up, fuel consumption drops off and, consequently, less money goes into the trust fund. By ensuring affordable energy for American consumers we not only solidify our standard of living we're also collecting a stable supply of user fees that fund America's highways. Fuel taxes, the single largest source of road funding have been declining at the same time annual distance traveled has increased significantly as shown in Figure 1.

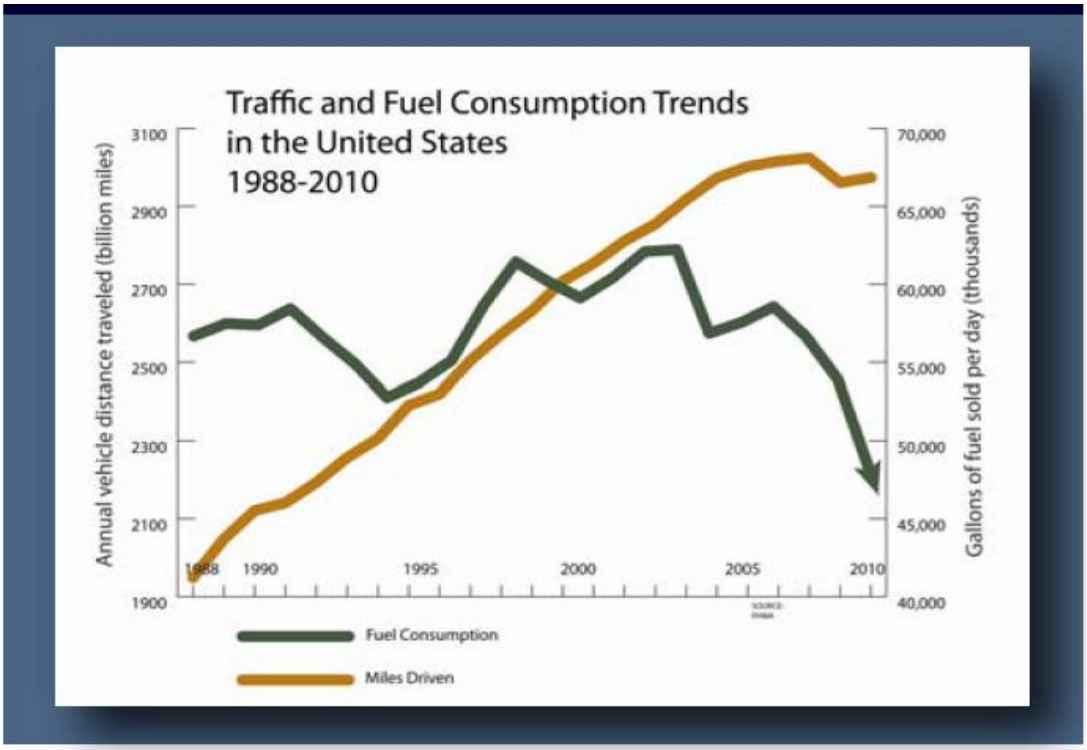


Figure 1. Distance Travelled and Fuel Consumption Trends 1988-2010 [1]

Michigan, funding for road agencies comes from the Michigan Transportation Fund (MTF): the pot of state–collected transportation funds, a mix of fuel tax and vehicle registration fees. The road agencies use these funds for road maintenance, operating expenses and to meet federal aid matching requirements.

Revenue generated by the fuel tax in Michigan has remained stagnant since 1994, when the gas tax was increased by 4 cents until 2004 when it started to decline (Figure 2). Due to the combination of declining revenues and drastically increasing costs associated with maintaining roads, road agencies have had to make service cuts, resulting in a reduction in road maintenance and quality. As vehicles become increasingly fuel efficient, their contribution toward the cost of maintaining the transportation infrastructure decreases. For example a GM Volt pays 0.104 cents per mile of travel, while a Hummer pays 1.85 cents per mile of travel as shown in Table 1.

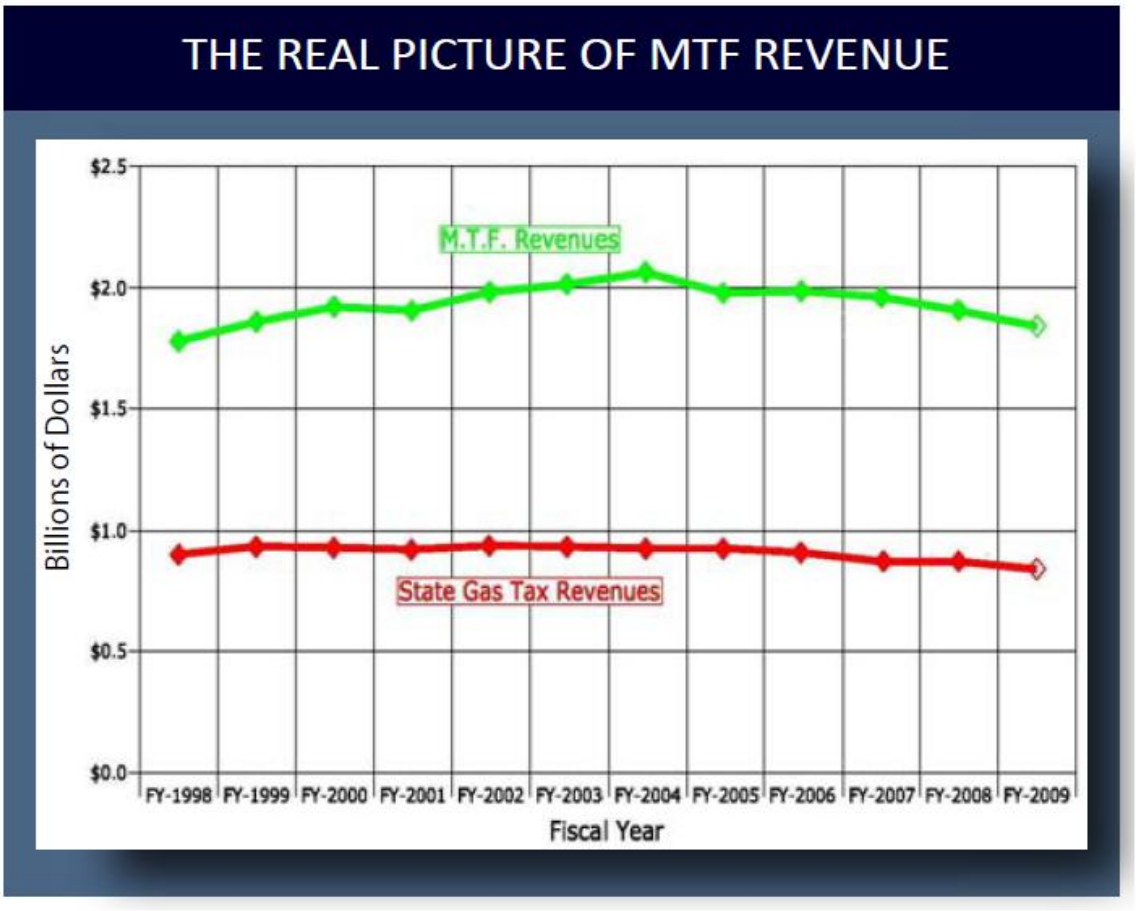


Figure 2. Real Picture of Michigan's Transportation Fund [2]

Table 1. Vehicle Fees for Same Transportation Services [2]

Car Type	Miles per Gallon (MPG)	Fuel tax per mile of travel
Hummer	13	1.85 Cents
Camry	21	1.142 cents
Prius	48	0.50cents
Volt	230	0.104 cents

Assuming each car is driven 15,000 miles per year, annual gas tax revenue by car type varies from $219 to as little as $12 (Figure 3). What this means, for the same transportation service, the Hummer is paying 20 times more towards gas tax revenue than the GM Volt. Another reality is that low income drivers typically drive older cars which yield lower mileage (15-20 miles) per gallon. High income driver groups generally drive newer cars, electric cars or hybrid cars which can yield 35 to 230 miles per gallon of gas. Due to this fact, low income drivers pay more tax per mile of travel than high income drivers. According to the Congressional Budget Office, rising fuel-efficiency standards will cut gas tax revenue by $57 billion through 2025 [3]. The reduction of $57 billion would mean $48 billion less for infrastructure repair/upkeep and $9 billion less for an already dying mass transit system. The new Corporate Average Fuel Economy (CAFÉ) standard will reduce the US gas tax revenue 21 percent per year by 2040. Therefore, we should look for avenues which are fair to all drivers but also provide adequate funds for infrastructure repair, maintenance and upgrading.

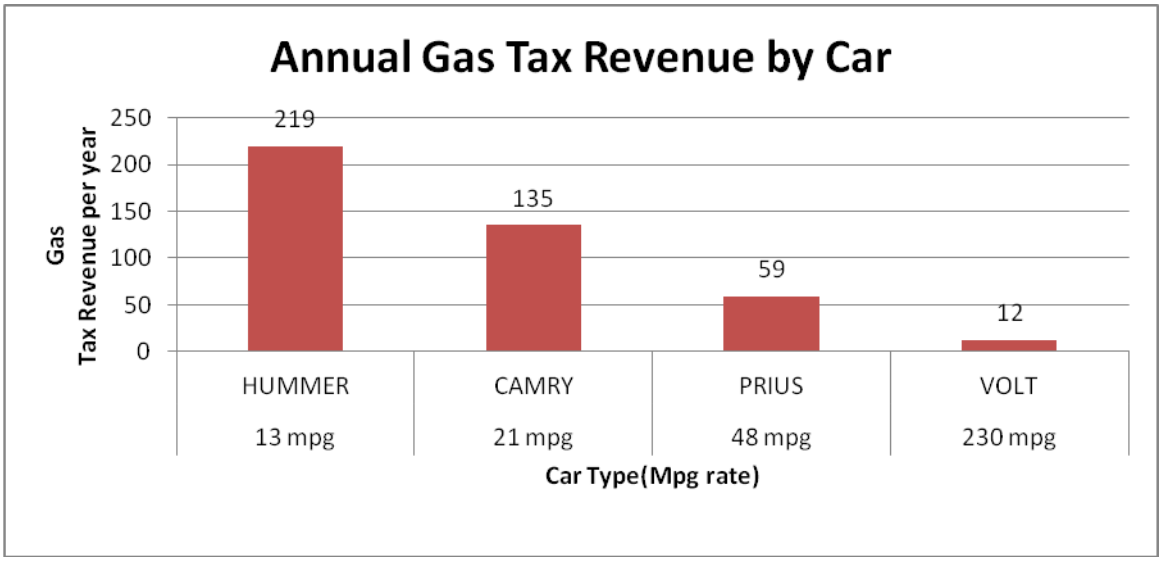


Figure 3. Annual Gas Revenue by Car [2]

1.2. An Alternative

Two congressional commissions studied the existing system of funding transportation infrastructure using fuel taxes and recommended it be replaced with a distance-based system of user fees. While there have been discussions among transportation agencies and their leaders about the viability of fuel taxes, the general public has little understanding of this issue.

Tax paying citizens strongly believe that the taxes they pay at the pump are adequate for infrastructure funding. They also think that if there is a funding problem, that it is due to waste and inefficiency. The rationale, technology, and transitional issues in switching funding of transportation from fuel taxes to mileage based user fees (MBUF) was studied extensively by a team of researchers from the University of Minnesota [4]. They examined existing fuel taxes, planned MBUF and the technology requirements to implement MBUF on the basis of transportation finance principles, namely: efficiency, equity, revenue adequacy and sustainability, environmental sustainability and feasibility. The study findings are summarized in Table 2.

Table 2. Assessment Scorecard

Subject	Finance Principles				
	Efficiency	Equity	Revenue Adequacy and sustainability	Environmental sustainability	Feasibility
Existing Fuel Tax	Weak	Moderate	Moderate	Moderate	Strong
MBUF	Strong	Strong	Strong	Moderate	Weak
Technology Option					
On-board diagnostic Units(OBD II)	Moderate	Moderate	Strong	Moderate	Strong
OBDII/Cellular	Strong	Strong	Strong	Moderate	Strong
Fine – resolution GPS	Very Strong	Very Strong	Strong	Moderate	Weak

This study concluded that MBUF would be the eventual replacement for fuel taxes as the primary means for funding transportation infrastructure. However, the proponents of MBUFs should understand the challenges of the MBUF implementation process and thus outreach/educational efforts should be planned to obtain support from the policy makers as well as public in this context.

1.3. Highway Trust Fund and Energy Efficient Vehicles: An Inverse Relationship

As stated before, revenue collection of the Highway Trust Fund and energy efficient vehicles are inversely related. Existing methods of fuel tax collection are penalizing low income drivers, since they are paying more tax per mile of travel. At present, electric vehicle driver are not only

getting more than $7500 in tax credits but they are also not contributing anything in fuel tax per miles travelled. Figure 4, displays the predicted demand for electric vehicles within the City of New York in 2015. The owner's of these 70, 000 vehicles will contribute the least amount of funds toward the improvement/maintenance of New York's road infrastructure.

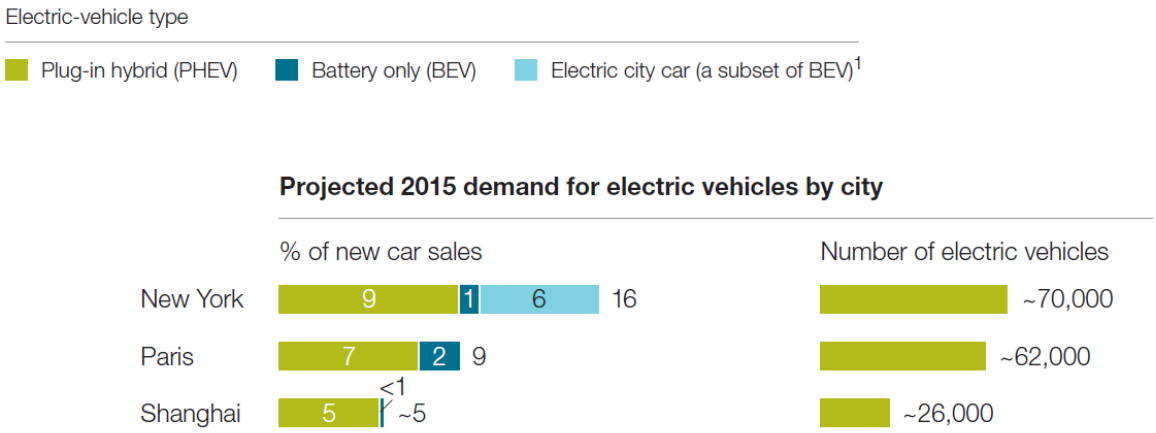


Figure 4. Demand of Electric Vehicle in 2015 [5]

Therefore, there is a need to identify the vehicle mix of the future and its impact on the Highway Trust Fund. Even now we are consuming less gas per year, which in turn is leading to a reduction in revenue for the Highway Trust Fund. Thus, research is needed to identify and recommend both short and long term approaches to raise sufficient revenues to address the needs of the transportation system and the economy. Mileage-Based User Fees (MBUF) may be an equitable way to solve the road improvement funding problem instead of the traditional fuel tax. MBUF charges drivers based on how much they use the roads, rather than how much fuel they consume. Potential benefits of MBUF include:

- Fairness because all users pay a true user fee
- More stable source of revenue than a gas tax
- Flexibility because road users can be charged based on factors such as time of day, weight of vehicle, etc.
- Ability to achieve higher revenue yield than the gas tax

Concerns related to MBUF include:

- Privacy protection
- Cost of implementation
- Multi-jurisdictional matters of collection, distribution and enforcement.

It should be noted that a number of insurance companies, namely Progressive have been using mileage based insurance for a number of years. As a part of this approach, drivers buy insurance for a specific number of miles of travel rather than for a specific period of time such as six months, one year, etc.

1.4. Research Objectives

The purpose of this research is to develop a means to ensure proper funding of infrastructure construction and maintenance.

The following are the objectives of this study:

- Quantify the extent of increased use of energy efficient vehicles and reasons for accelerated use where present.
- Develop/recommend means to ensure a solid level of funding is provided for transportation improvement in relationship to the use of the transportation system.
- Identify challenges for implementing the recommended means.
- Prepare a report presenting findings and recommendations for agency professionals and elected leaders.

2. Research Activities

2.1. Forecasting of Electric Vehicle Population

Over the last few years, interest in electric vehicles (EVs) by the auto manufacturers has surged significantly and has prompted the introduction of a number of EVs namely the Chevrolet Volt and the Nissan Leaf. Due to the increase in the Corporate Average Fuel Economy (CAFE) Standard, the auto industry is required to increase fuel economy through 2016 and beyond. The new requirements will encourage the speedy market entry of more electric vehicles. The table below displays the number of EVs expected to enter the U.S. Light-vehicle market by 2015. Since the U.S. is a major market for those manufacturers not included in the table such as Chrysler, Honda, etc., it is likely that additional production capacity of more than one hundred thousand EVs will enter into market in addition to those cited in below.

Table 3. Estimated Population of EVs by 2015 [1]

Estimated U.S. Supply of Electric Vehicles from 2011 through 2015						
Manufacturer and Model	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**
Fisker Karma PHEV	1,000	5,000	10,000	10,000	10,000	36,000
Fisker Nina PHEV		5,000	40,000	75,000	75,000	195,000
Ford Focus EV		10,000	20,000	20,000	20,000	70,000
Ford Transit Connect EV	400	800	1,000	1,000	1,000	4,200
GM Chevrolet Volt	15,000	120,000	120,000	120,000	120,000	505,000
Navistar eStar EV (truck)	200	800	1,000	1,000	1,000	4,000
Nissan LEAF EV	25,000	25,000	50,000	100,000	100,000	300,000
Smith Electric Vehicles Newton EV (truck)	1,000	1,000	1,000	1,000	1,000	5,000
Tesla Motors Model S EV		5,000	10,000	20,000	20,000	55,000
Tesla Motors Roadster EV	1,000					1,000
Think City EV	2,000	5,000	10,000	20,000	20,000	57,000
Cumulative Total						1,222,200

The price of oil will increase in the future due to 1) higher oil extraction costs for future oil supplies and 2) greater demand from developing countries like China and India. Two credible energy forecasting agencies namely, the Energy Information Agency (EIA) and the International Energy Agency (IEA), predict a rise in oil prices over the next two decades. EIA's energy forecasts for the next twenty years were developed by considering two scenarios: 1) a high oil price scenario due to a widening imbalance between the supply of cheap and accessible oil and a rising demand and 2) a baseline oil price scenario due to inflationary factors. Figure 5, displays those two cases. The price of gas per gallon will be between $4 and $5.50 depending on the scenarios with inflation [6].

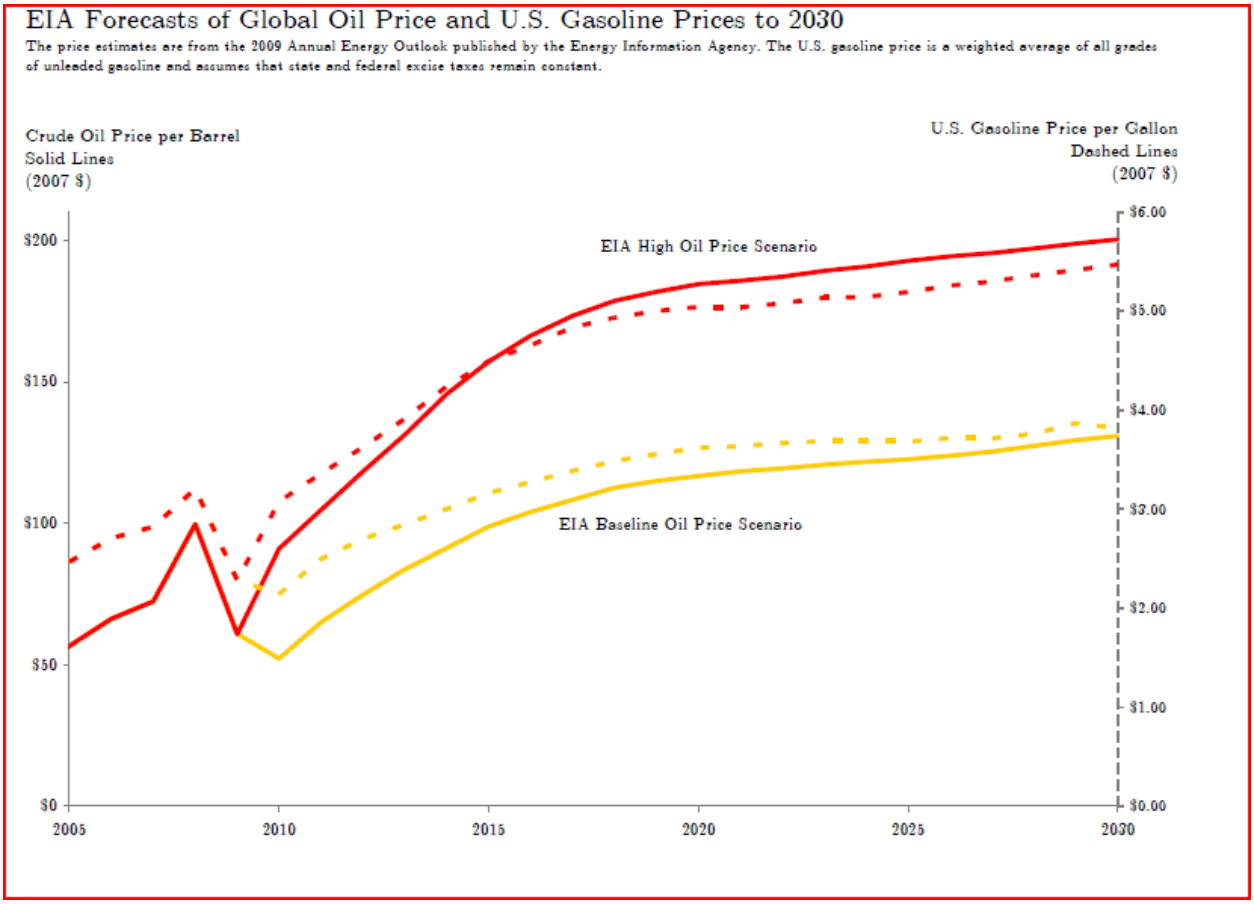


Figure 5. EIA 2030 Forecasts of Global Oil Price and Gasoline Prices [6]

The Center for Entrepreneurship and Technology (CET) at the University of California, Berkeley, predicted that under the high gas price scenario, electric vehicles will penetrate 90 percent of light vehicle sales by 2030 (Figure 6) [6]. This means close to 12 million cars will be sold by 2030. However, this is still a significantly lesser number of the total light vehicle mix of 2030 as shown in Figure 7.

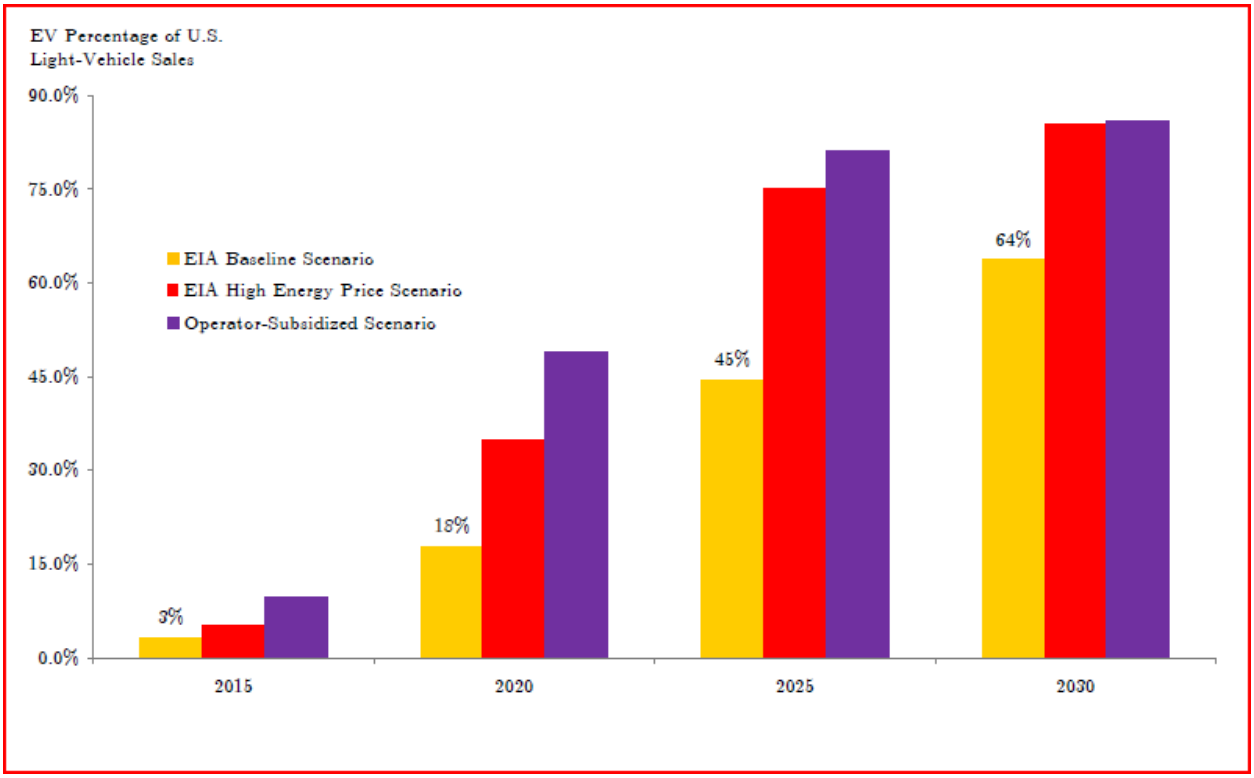
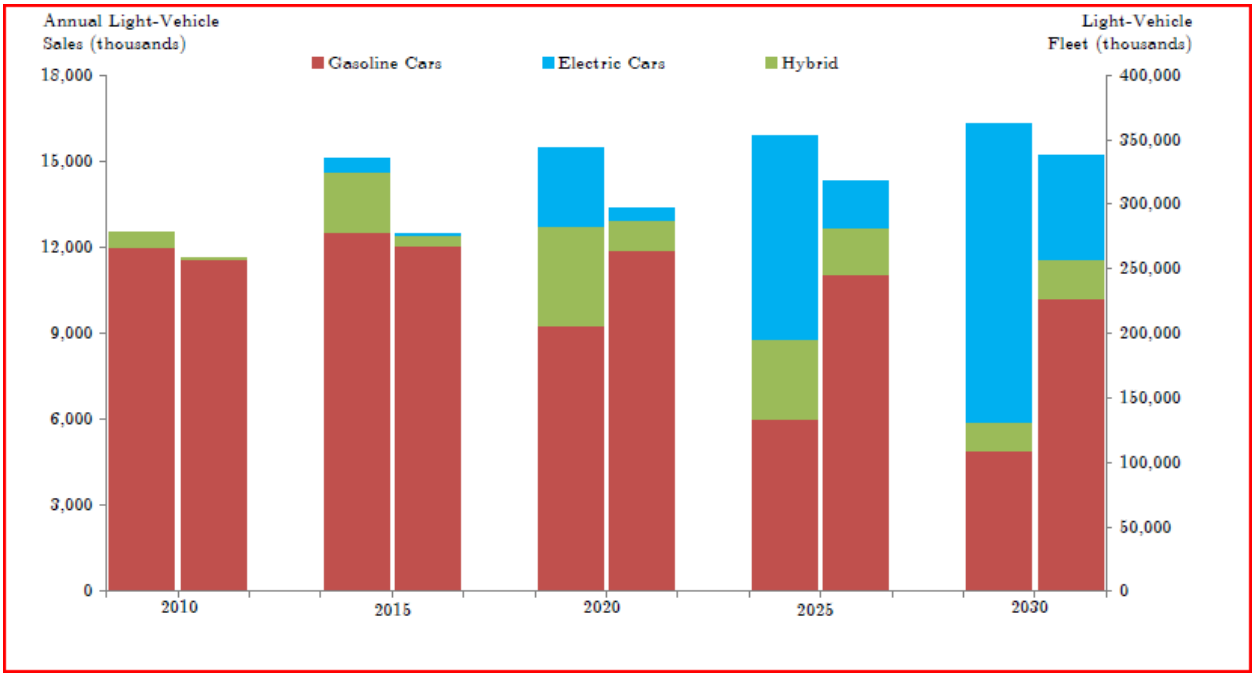


Figure 6. Three Scenarios of the US Market Share of Electric Vehicle from 2015-2030 [6]



Note*: The left column s represent forecasts for the composition of U.S. Light weight vehicle sales under baseline oil price scenario from the EIA. The right columns and axes represent the corresponding mix of vehicles in the U.S. light vehicle fleet.*

Figure 7. U.S. Light-Vehicle Sales and Fleet Composition Under Baseline Scenario [6]

The west coast will lead the adoption of electric vehicles. The governments of California, Oregon, Washington and Hawaii have adopted polices to encourage electric car purchases by providing various incentives along with the federal tax break. In a report titled "The State of U.S. Hybrid Sector", it was cited that California, Oregon and Washington were the states with the highest registration of hybrid vehicles in 2009 [6]. According to plug-in America, by 2020, 700,000 of 2.7 million electric cars sold in the U.S. are forecast to be sold in the four west coast states [7] as shown in Figure 8. Thus 26% of the EV's will be purchased in states representing 16% of the total population.

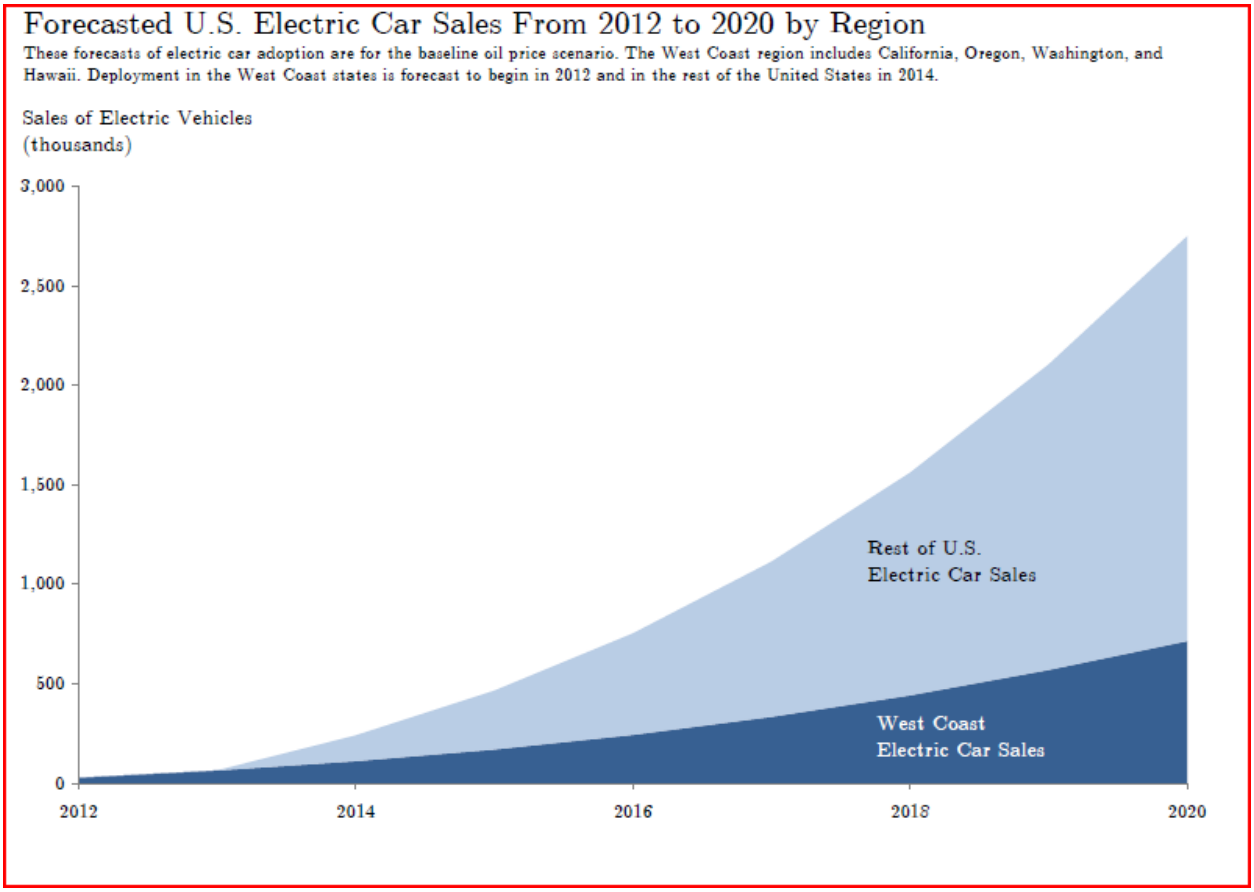


Figure 8. Forecasted Electric Car Sales from 2012-2020 by Region (US) [6]

2.2. The Status of Gas Tax

Federal Gas Tax

The federal gas tax has been increasing in small amounts over the years. The chart below indicates the rise of the federal gasoline tax from 1932 to 2011. The federal gasoline tax was originally set at 1 cent per gallon (cpg) and was set to expire at the end of June 1933.

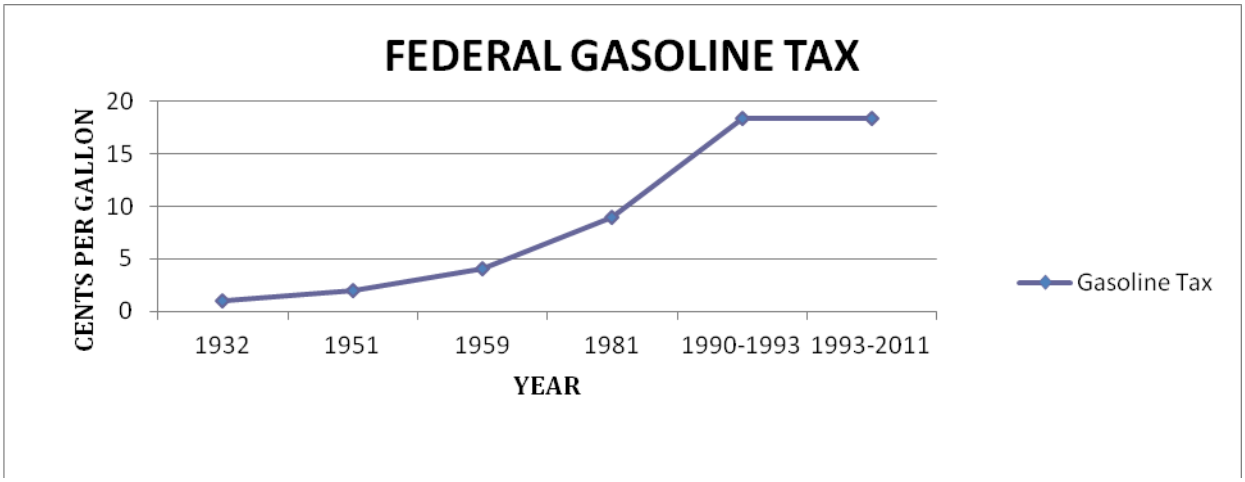


Figure 9. Federal Gasoline Tax [9]

The American Petroleum Institute and the American Automobile Association were among those who supported expiration of tax. With enactment of the National Industrial Recovery Act of 1933, the tax was extended and the Revenue Act of 1934 increased the gas tax to 1.5 cent per gallon, although each tax was temporary until the 1941 Revenue Act made the gas tax permanent [9]. To raise additional funds for the Korean War the government raised the gasoline tax to 2 cents per gallon. In 1959 the gasoline tax was raised to 4 cpg to aid in funding the construction of the new interstate highway system. The next increase was in 1981 to 9 cents per gallon. Subsequent increases in 1990 and 1993 resulted in an 18.4 cent per gallon federal gasoline tax, which is the current level of the tax [8] (Figure 9).

The gas tax is one among many sources for the Highway Trust Fund. Tax revenue from the federal government is distributed among the Highway Trust Fund, the Leaking Underground Storage Tank Trust Fund and the General Fund. The Highway Trust Fund further allocates the revenue to the Highway Account and the Mass Transit Account. The major share of the tax rate per gallon is assigned to the Highway Trust Fund and a much smaller percentage is allocated to the Leaking Underground Storage Tank Trust Fund, with almost zero to the General Fund. The fuel taxes collected from highway users and the percentage distributed to the Highway Account and the Mass Transit Account by the Federal government are listed below (Table 4). Gasoline has a tax rate of 18.4 cents per gallon, 83.91% of which is allocated to the Highway Account with 15.54% going to the Mass Transit Account. The diesel tax rate is 24.4 cpg, 87.86% of which is assigned for the Highway Account while 11.72% goes to the Mass Transit Account. Out of the 18.3 cpg tax on liquefied petroleum gas (LPG), 88.36% is set for the Highway Account and 11.63% for the Mass Transit Account [8].

Table 4. Federal Highway-User Tax Rates [8]

Fuel	Tax Rate	Distribution of Tax			
		Highway Trust Fund		Leaking Underground Storage Tank Trust Fund	General Fund
		Highway Account	Mass Transit Account		
Gasoline	18.4	15.44	2.86	0.1	0
Gasohol	18.4	15.44	2.86	0.1	0
Diesel Fuel	24.4	21.44	2.86	0.1	0
Liquefied Petroleum Gas	18.3	16.17	2.13	0	0
Liquefied Natural Gas	24.3	22.44	1.86	0	0
M85 (85% methanol)	9.25	7.72	1.43	0.1	0
Compressesd Natural Gas (Cents per thousand cubic feet)	TBD	TBD	9.71	0	0

(Source: U.S. Department of Transportation, Federal Highway Administration, Highway history)

The Federal government also imposes nonfuel taxes like a tax on tires, truck and trailer sales and heavy vehicle use. For tires with a maximum rated load capacity of over 3,500 pounds, the tax rate is set be to 9.45 cents per each 10 pounds in excess of 3,500, for trucks and trailers the sales tax is set at 12% of retailer's sales price for tractors and trucks over 33,000 pounds gross vehicle weight (GVW), and the trailers over 26,000 GVW and for heavy vehicles the annual tax on trucks of 55,000-75,000 pounds GVW is $100 plus $22 for each 1,000 pounds in excess of 55,000 pounds and for trucks over 75,000 pounds GVW, $550. The fines and penalties imposed for violation of motor safety requirements are deposited in the Highway Account of the Highway Trust Fund since October 30, 1984, as an additional revenue source [8]. A large percentage of the amount from federal highway user tax is assigned to the Highway Trust Fund.

The State Gas Tax

When any driver buys a gallon of gasoline or diesel, she/he pays 18.4 cents federal tax and also a fixed amount of state tax. The first state to introduce the gas tax as revenue for roadway projects was Oregon in February 1919 at 1 cpg. The amount of state tax is different for different states. State and local governments impose various taxes on road users based on the retail price of the fuel. The American Petroleum Institute (API) has designed a method to calculate the average tax rate on a gallon of fuel. These tax rates may include environment fees, general sales tax, excise taxes, storage tank fees and other fees [10]. These taxes are converted to cents per gallon and imposed on the road users.

A combined federal, state and local tax in cents per gallon of gasoline or diesel is displayed in Figures 10 and 11. The tax between the states may vary extensively: New York drivers pay the highest amount of combined tax (67.4 Cents/gallon), and Alaskans pay the least amount of gas tax (26.4 cents/gallon). The average tax paid by U.S. road users is 48.8 cents per gallon. In the case of diesel tax, consumers in California pay 79.5 cents per gallon for diesel in comparison to 32.4 cents by Alaskan's drivers, the lowest of all the states. The U.S. average diesel tax is 54.0 cents per gallon.

The U.S. average of state excise tax, other taxes and federal tax for all the 50 states are displayed in the Table 5. The rates are updated every quarter year. The table above indicates gasoline and diesel weighted average for each state taking in to consideration the typical percentages of premium, midgrade and regular fuel purchased in each state, meaning that tax which can vary across a state's jurisdiction has been averaged according to the population of the area in relation to each particular tax rate. In the states where the motor fuel tax varies because the tax rate is set as percentage of sales rather than cent per gallon, the price listed in the above table is as on the date chart was prepared.

2.3. Michigan

Michigan is known for its automotive industry in U.S. In state of Michigan highway and road projects are funded by Highway Trust Fund. The major revenue source for Highway Trust Fund is motor fuel tax. The State of Michigan also pays both state and federal fuel taxes like most of the other states. Michigan drivers pay 19 cents in state tax and 18.4 cents in federal tax per gallon of gasoline. The tax on diesel is set to be 15 cents per gallon. The price of gasoline and diesel per gallon includes cost of crude oil import, refining, marketing and distribution, profit for each of the production and supply chain levels and taxes. Rack price is the price retail station pay.

The federal taxes paid by Michigan drivers, is 18.4cents per gallon including 10% ethanol blends that account for a 4.5cent tax credit. Michigan sale tax is 6% on all products and motor fuel is no exemption. The gasoline sales state tax is complicated to determine. The retail price would have included the state sales tax, unlike other products. The sales tax paid by retail station owners is not included in 19 cents paid for road tax but it is paid on the federal tax of 18.4 cents. The calculation of state sales tax per gallon of gasoline is complex.

The other charges include delivery and distribution charges, credit card fee, evaporation credit and Michigan Underground Storage Tank Financial Assurance (MUSTFA) fee, and operating expenses. Delivery and distribution charges are the charge for transportation and distribution of gasoline from wholesale centers to retail stations. Delivery charge is 2.5 cents per gallon and distribution charge is 2 cents per gallon. Gasoline tends to evaporate at a very fast rate and wholesalers receive evaporation credit. It depends on the wholesalers to pass all, part or even none of the credit received to retail gas stations. The evaporation credit received by wholesalers is 0.005 cents per gallon. MUSTFA is a Michigan-specific environmental regulation fee for refined petroleum fund and is set to 0.00875 cents per gallon [11].

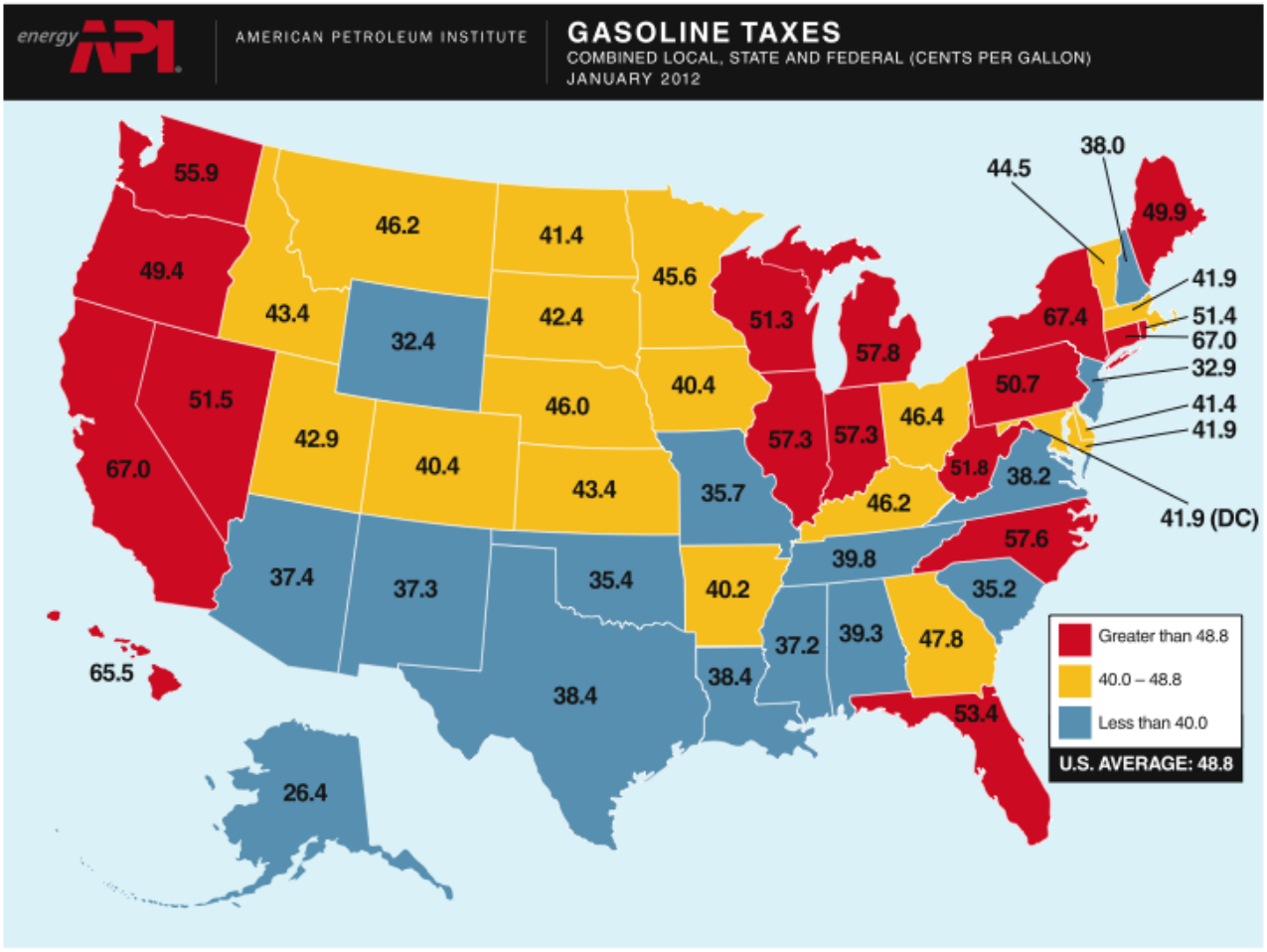


Figure 10. Combined Local, State and Federal Gasoline Taxes in Cents per Gallon [10]

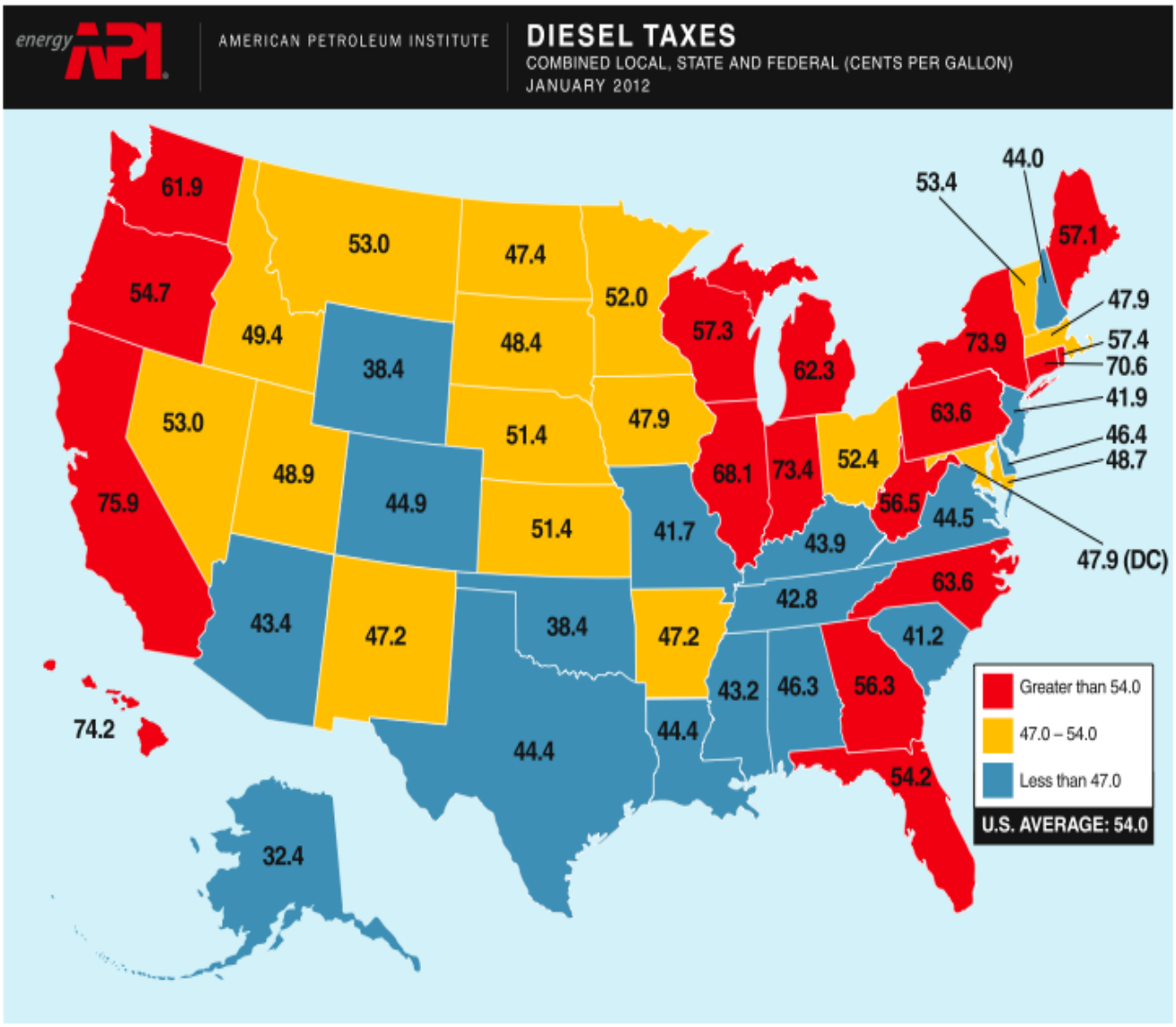


Figure 11. Combined Local, State and Federal Diesel Taxes in Cents per Gallon [10]

Table 5. State Motor Fuel Excise and Other Tax [10]

State	Gasoline				Diesel			
	State Excise Tax	Other State Taxes/ Fees	Total State Taxes/ Fees	Total State plus Federal Excise Taxes (@ 18.4 cpg)	State Excise Tax	Other State Taxes/ Fees	Total State Taxes/ Fees	Total State plus Federal Excise Tax (@ 24.4 cpg)
Alabama	16.0	4.9	20.9	39.3	19.0	2.9	21.9	46.3
Alaska	8.0	0.0	8.0	26.4	8.0	0.0	8.0	32.4
Arizona	18.0	1.0	19.0	37.4	18.0	1.0	19.0	43.4
Arkansas	21.5	0.3	21.8	40.2	22.5	0.3	22.8	47.2
California	35.7	12.9	48.6	67.0	13.0	38.5	51.5	75.9
Colorado	22.0	0.0	22.0	40.4	20.5	0.0	20.5	44.9
Connecticut	25.0	23.6	48.6	67.0	46.2	0.0	46.2	70.6
Delaware	23.0	0.0	23.0	41.4	22.0	0.0	22.0	46.4
District of Columbia	23.5	0.0	23.5	41.9	23.5	0.0	23.5	47.9
Florida	4.0	31.0	35.0	53.4	4.0	26.5	30.5	54.9
Georgia	7.5	21.9	29.4	47.8	7.5	24.4	31.9	56.3
Hawaii	17.0	30.1	47.1	65.5	17.0	32.8	49.8	74.2
Idaho	25.0	0.0	25.0	43.4	25.0	0.0	25.0	49.4
Illinois	19.0	19.9	38.9	57.3	21.5	22.2	43.7	68.1
Indiana	18.0	20.9	38.9	57.3	16.0	33.0	49.0	73.4
Iowa	21.0	1.0	22.0	40.4	22.5	1.0	23.5	47.9

Table 5. State Motor Fuel Excise and Other Tax (Continued)

	Gasoline				Diesel			
State	State Excise Tax	Other State Taxes/ Fees	Total State Taxes/ Fees	Total State plus Federal Excise Taxes (@ 18.4 cpg)	State Excise Tax	Other State Taxes/ Fees	Total State Taxes/ Fees	Total State plus Federal Excise Tax (@ 24.4 cpg)
Kansas	24.0	1.0	25.0	43.4	26.0	1.0	27.0	51.4
Kentucky	26.4	1.4	27.8	46.2	18.1	1.4	19.5	43.9
Louisiana	20.0	0.0	20.0	38.4	20.0	0.0	20.0	44.4
Maine	30.0	1.5	31.5	49.9	31.2	1.5	32.7	57.1
Maryland	23.5	0.0	23.5	41.9	24.3	0.0	24.3	48.7
Massachusetts	21.0	2.5	23.5	41.9	21.0	2.5	23.5	47.9
Michigan	19.0	20.4	39.4	57.8	15.0	22.9	37.9	62.3
Minnesota	28.0	0.1	28.1	46.5	27.5	0.1	27.6	52.0
Mississippi	18.0	0.8	18.8	37.2	18.0	0.8	18.8	43.2
Missouri	17.0	0.3	17.3	35.7	17.0	0.3	17.3	41.7
Montana	27.0	0.8	27.8	46.2	27.8	0.8	28.6	53.0
Nebraska	26.7	0.9	27.6	46.0	26.7	0.3	27.0	51.4
Nevada	23.0	10.1	33.1	51.5	27.0	1.6	28.6	53.0
New Hampshire	18.0	1.6	19.6	38.0	18.0	1.6	19.6	44.0
New Jersey	10.5	4.0	14.5	32.9	13.5	4.0	17.5	41.9
New Mexico	17.0	1.9	18.9	37.3	21.0	1.8	22.8	47.2
New York	8.1	40.9	49.0	67.4	8.0	41.5	49.5	73.9
North Carolina	38.9	0.3	39.2	57.6	38.9	0.3	39.2	63.6
North Dakota	23.0	0.0	23.0	41.4	23.0	0.0	23.0	47.4
Ohio	28.0	0.0	28.0	46.4	28.0	0.0	28.0	52.4

Table 5. State Motor Fuel Excise and Other Tax (Continued)

	Gasoline				Diesel			
State	State Excise Tax	Other State Taxes/ Fees	Total State Taxes/ Fees	Total State plus Federal Excise Taxes (@ 18.4 cpg)	State Excise Tax	Other State Taxes/ Fees	Total State Taxes/ Fees	Total State plus Federal Excise Tax (@ 24.4 cpg)
Oklahoma	16.0	1.0	17.0	35.4	13.0	1.0	14.0	38.4
Oregon	30.0	1.0	31.0	49.4	30.0	0.3	30.3	54.7
Pennsylvania	12.0	20.3	32.3	50.7	12.0	27.2	39.2	63.6
Rhode Island	32.0	1.0	33.0	51.4	32.0	1.0	33.0	57.4
South Carolina	16.0	0.8	16.8	35.2	16.0	0.8	16.8	41.2
South Dakota	22.0	2.0	24.0	42.4	22.0	2.0	24.0	48.4
Tennessee	20.0	1.4	21.4	39.8	18.0	0.4	18.4	42.8
Texas	20.0	0.0	20.0	38.4	20.0	0.0	20.0	44.4
Utah	24.5	0.0	24.5	42.9	24.5	0.0	24.5	48.9
Vermont	19.0	7.1	26.1	44.5	25.0	4.0	29.0	53.4
Virginia	17.5	2.3	19.8	38.2	17.5	2.6	20.1	44.5
Washington	37.5	0.0	37.5	55.9	37.5	0.0	37.5	61.9
West Virginia	20.5	12.9	33.4	51.8	20.4	11.7	32.1	56.5
Wisconsin	30.9	2.0	32.9	51.3	30.9	2.0	32.9	57.3
Wyoming	13.0	1.0	14.0	32.4	13.0	1.0	14.0	38.4
US Average	**20.9**	**9.5**	**30.4**	**48.8**	**19.0**	**10.6**	**29.6**	**54.0**

Note: For states with sales tax on fuel, price per gallon calculated based on AAA average prices for 1/1/12
Tax rates changed since 10/11 report: FL, MN, NC, NE, NY, VT, and WV

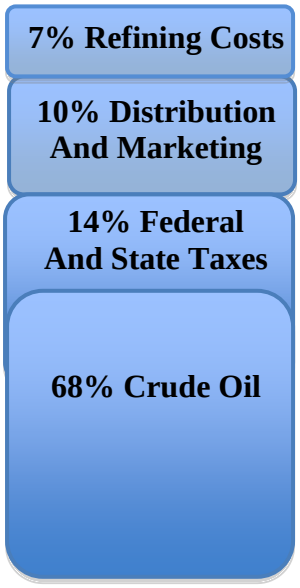
3. WHY GASOLINE PRICE DIFFERS FROM STATE TO STATE?

Gasoline and diesel are made out of crude oil. It is important to know the price of crude oil to determine the price of gasoline. The price of crude oil depends on the demand and supply in the global market. In 2008, when the demand for gasoline and diesel fuel suddenly spiked, the suppliers could not adequately meet supply and the price rose. By the end of 2008, due to the global economy and decrease in the demand the price dropped [12]. The chart above indicates that the gasoline and diesel fuel price varies from region to region, mainly because of the type of gasoline that region requires and because the taxes that local governments charge vary.

According to U.S. Energy Information Administration (EIA), the factors affecting the price of gasoline are:

- Cost of Crude oil
- Federal and state taxes
- Refining cost and profits
- Distribution and marketing cost

Every time we refill our tanks with gasoline and diesel at the gas station, the price we pay per gallon is determined by:



Source: U.S. Energy Information Administration, 2010 Average Retail Price: $2.78 [12]

3.1. Crude Oil

Crude oil price is the major factor in the price of gasoline. Crude oil is the raw material for gasoline production. The demand and supply in the global market is another factor on which fuel prices depend. If the demand goes up and supply is limited the price automatically rises. The demand for motor fuel depends on the consumption across the world and supply depends on the countries producing crude oil. The Organization of the Petroleum Exporting Countries (OPEC) has significant impact on setting the price of crude oil. In 2010 OPEC produced 43% of the world's crude oil. The OPEC countries have all the resources and technologies to produce crude oil and have two-thirds of the world's estimated crude oil reserves [12].

3.2. Federal and State Taxes

After crude oil cost the next factor affecting gasoline retail price is taxes. Federal and state government each sets many taxes on gasoline and other motor fuels like excise tax, environmental taxes, oil inspection charges, sales tax and underground storage fees. In some states there are government regulations to charge no less than certain percentage on the

wholesale gasoline price to help small and individual gas stations to survive. As of today federal government has fixed 18.4 cpg tax and state government taxes vary from region to region.
The average U.S gasoline tax is 48.8 cpg. It is not certain how much gas stations add to the gasoline price; depending on the margin of profit every gas station has different prices.

3.3. Distribution and Marketing

Some crude oil is imported from other counties and then sent to refineries, after oil is refined gasoline and diesel is transported to distribution centers and then to individual gas stations. All the expenses for these processes are converted to a per gallon cost and the end user is charged. Some companies buy gasoline from refiners and transport it to different regions. The transportation charges, insurance, lease of the business (station) place, equipments, salaries, local taxes and many other charges are added to gasoline price. The marketing of individual brands also adds a small amount to the fuel price. Competition between local markets may help to drop the price of gasoline and diesel.

3.4. Refining Cost

Gasoline is mixture of many components including additives to improve stability, octane level, and control deposit formation in engines, oxygenates like methyl tertiary-butyl ether [MTBE] / RFG and ethanol to provide the required octane level [12]. There are three main grades of gasoline regular, midgrade and premium that are available at most gas stations. These grades are based on octane levels; octane level is measure of the anti-knock property of motor fuel. Fuel with a higher-octane level has higher fuel economy. Premium grade gasoline gives the highest fuel economy and hence the price is higher. The composition of gasoline also changes with the season.

The technology used by refiners to produce cleaner burning gasoline has undergone several changes over years. Many states have adopted environment protection systems and set regulations on formulations of gasoline used. As a result of state regulation to reduce air pollution, there are around 17 different kinds of gasoline that are sold in United States [6]. The cost associated with producing different types of gasoline is also included in the gasoline prices sold at gas stations in respective states. Gasoline sold in San Francisco is different from gasoline sold in New York.

A barrel of crude oil contains 42 gallons of oil. All the charges to produce, distribute, market, and refine the gasoline as well as the federal and state taxes are divided, distributed and converted to per gallon cost and sold at individual gas stations across the country.

The two states that pay high gasoline tax are New York and California. Alaska has the lowest gasoline and diesel prices.

3.5. New York

The New York gasoline tax as of January 2012 was 67.4 cpg (combined local, state and federal taxes), which is the highest price in United States. The average gasoline tax in U.S is 48.8 cpg. New Yorkers pay 38.11% more than the U.S. average. New York is one of the most populated areas with a population estimated at 19.4 million people.

If every person took a vehicle to work there would be no space for vehicle parking. Most of the population takes public transportation to work. New Yorkers drive substantially less miles annually than drivers in other states. If New Yorkers drive 15 miles less than the average American that translates to approximately 291 million miles less per day. This means billions of dollars less revenue for the state and federal governments but highway maintenance and development costs are not reduced because of the lower gasoline consumption.

Governments have to compensate for the difference in many ways and one of them is to charge high taxes on the motor fuel.

In addition, some states have a pollution reduction policy that adds to the gasoline price as specific formulations are required to reduce carbon dioxide emissions into the environment.

3.6. California

California has the second highest combined local, state and federal taxes. The combined tax is 37.3% more than the U.S. average of combined taxes. As of January 2012, the average U.S. of combined taxes was 48.8 cpg.

California pays both excise and sales tax on gasoline. California has one of the most demanding environmental fuel policies in the world, requiring the most environmental friendly gasoline. It pays around 5 to 15 cents per gallon extra for gasoline due to specific formulations required by the state [13]. These specific formulations cannot be supplied by all the refineries and thus limits the supply of gasoline to the state to only a few suppliers. It is expensive to produce specific formulations of gasoline with limited suppliers.

California is a fuel island, there are no pipelines linking it to crude oil supplies. It is far from other supply centers and requires approximate 14 days travel time by tanker from the Gulf Coast [13]. The transportation of crude oil is slow as it has been transported only by road and the possibilities of accident are higher and very expensive. Even a few hours or days of a closed refinery due to maintenance, cleaning or any other reason can drive the fuel price higher. In addition, other fuel taxes are charged for oil spill prevention and administration fee, underground storage tank maintenance fee, liquid petroleum gas use fuel tax and annual flat rate tax [13].

3.7. Alaska Pays the Lowest Gasoline Price

The geographical location of Alaska is advantageous for fuel prices. The most important revenue source for the state is the oil and natural gas industry. Prudhoe Bay, on the northern Alaska coast is North American's largest oil field. The trans-Alaska pipeline moves up to 88,000 barrels of oil per hour. Alaska accounts for 25% of the oil produced in the U.S. Hence there is no transportation fee, high insurance fee and other charges are very minimal. This state has an advantage on indirect taxes unlike other states in U.S.

The Alaskan government has not set any state taxes other than a state excise tax. The only taxes paid by drivers are the state excise tax and federal taxes. The state excise tax is also low compared to other states like Delaware and the District of Columbia. These states also do not charge state taxes on fuel but the state excise tax is a little higher compared to Alaska.

4. WHY IS IT CRITICAL TO IMPLEMENT AN ALTERNATIVE TAX SYSTEM TO GENERATE FUNDS FOR HIGHWAY WORKS?

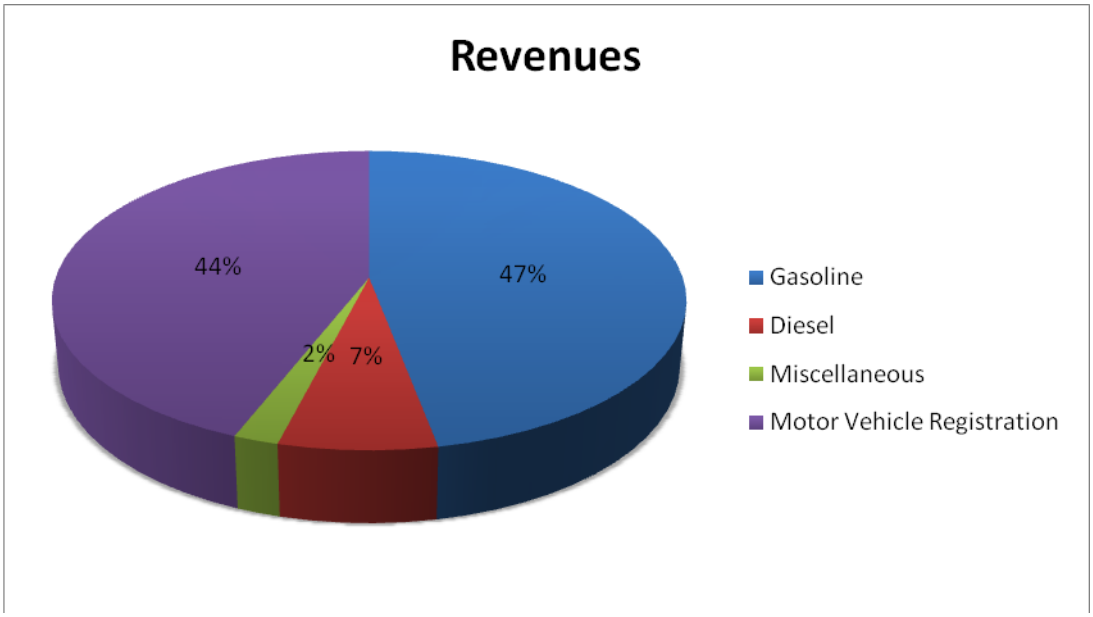


Figure 12. FY 2005 Michigan Trust Fund (MTF) Revenues [11]

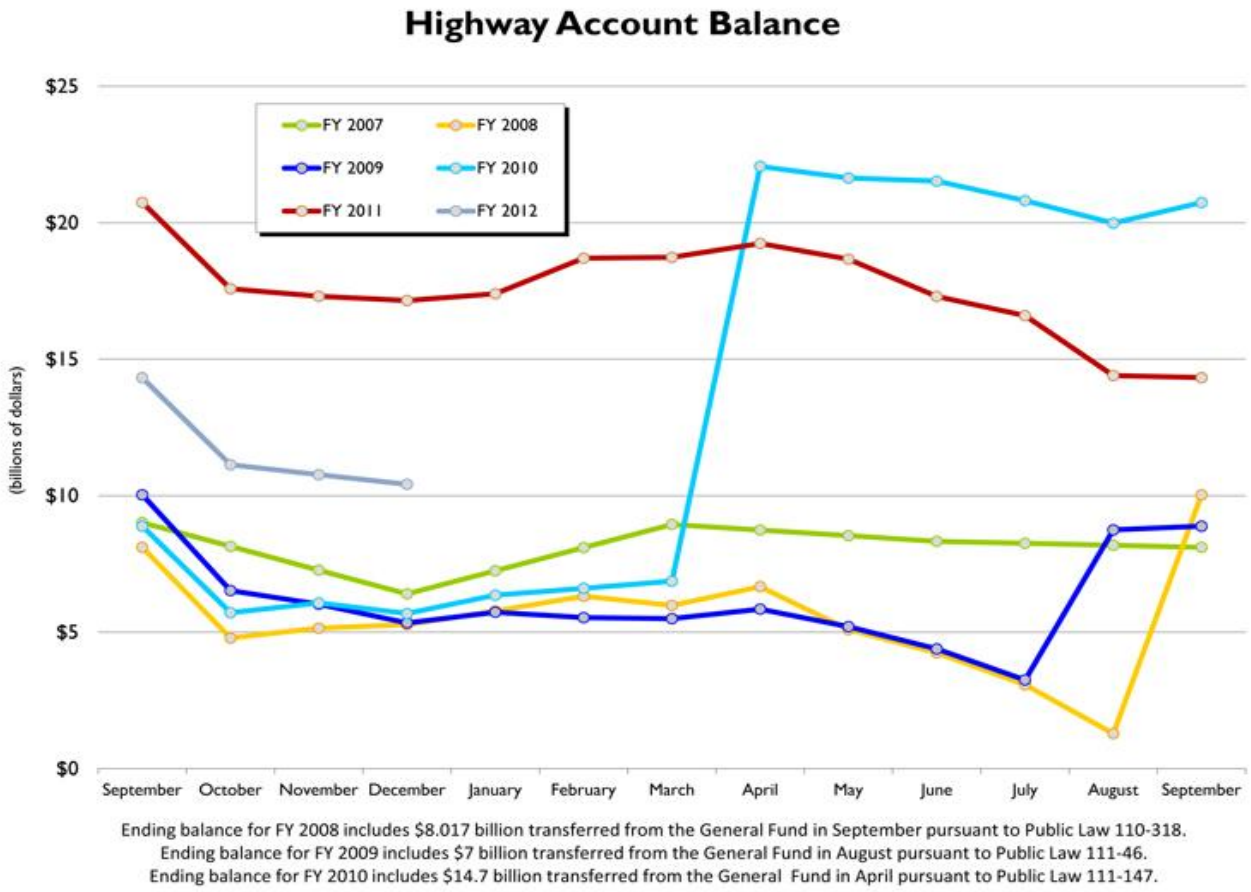
4.1. Status of Highway Trust Fund

Most of the states have four major funds sources that they rely on to develop and maintain their highway infrastructure. First is the motor fuel tax, second is the motor vehicle registration, third is the motor vehicle sales tax and fourth is the revenue from the federal gas tax. The major source of revenue for the Highway Trust Fund is from the gasoline tax. Motor vehicle registration, diesel and miscellaneous add up to a very minor percentage of the total fund (Figure 12). Apart from the four major revenue sources, the Highway Trust Fund also generates revenue from special motor fuels, heavy vehicle use tax and truck/trailer sales taxes. These funds are distributed among the Highway Account and the Mass Transit Account.

Due to inflation in the construction industry and the increasing growth of fuel-efficient vehicles sales, the current taxation system is becoming inadequate to satisfy the growing needs of highway infrastructure projects. The account balance summary of the Highway Trust Fund, month-by-month from 2007 to 2012, is indicated in the figure 13. Until 2010, the Highway Trust Fund account balance was below 10 billion dollars, but in 2010 the balance has suddenly jumped to more than 20 billion dollars. Congress authorized transfers of $8 billion in general revenue in FY 2008, $7 billion in FY 2009, and $19.5 billion in FY 2010 to ensure Highway Trust Fund solvency [14].

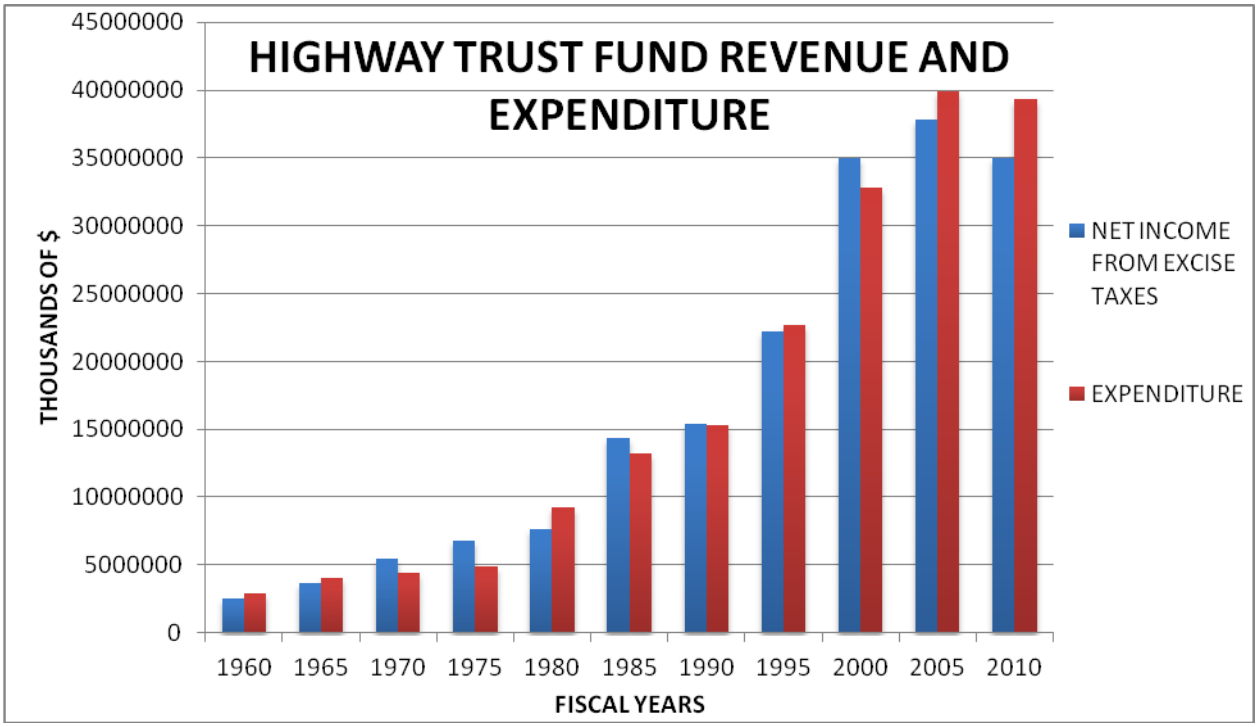
It can be inferred from the chart below that available funds in the Highway Trust Fund account are declining, while the construction and maintenance costs are increasing due to inflation. The available fund is inadequate to respond to demanding U.S. mobility needs. At the end of the 2011 financial year, the Highway Trust Fund account balance was below 15 billion dollars.

In 2012, the opening balance was $14,322,538,907 and the percent loss from the prior fiscal year was 31.0% [8]. Between 2008 and 2010, a total amount of $34.5 billion was transferred to the Highway Trust Fund from general revenue to meet the expenditure of the highway trust fund [14].



Source: U.S. Department of Transportation, Federal Highway Administration [15]

Figure 13. Highway Account Balance



Source: U.S. Department of Transportation, Federal Highway Administration [8]

Figure 14. Highway Trust Fund Revenue and Expenditure

The total excise taxes collected by the Highway Trust Fund from all the sources, including motor fuel, parts and accessories, lubrication oil, trucks, buses, trailers, and miscellaneous, together with the total expenditures and the closing balance are indicated in the chart above. It can be observed from Figure 14 that from 1970 until 2005 the expenditure of the Highway Trust Fund was less than the net income from excise taxes but from 2005 the expenditure is more than net income. It is critical to increase net income in the Highway Trust Funds account to adequately fund highway projects in the competitive global market.

4.2. Gasoline Consumption Forecast of United States

The major source of energy used for transportation is motor fuel. Of all the motor fuels, gasoline is the major fuel consumed in the United States. Gasoline accounts for about 66% of all the energy used for transportation [12]. There were approximately 249 million vehicles in United States that used gasoline as of 2011. In 2010, Americans used about 138 billion gallons of gasoline a year, an average of about 379 million gallons a day [12], and a major percentage of gasoline is consumed by cars and light trucks.

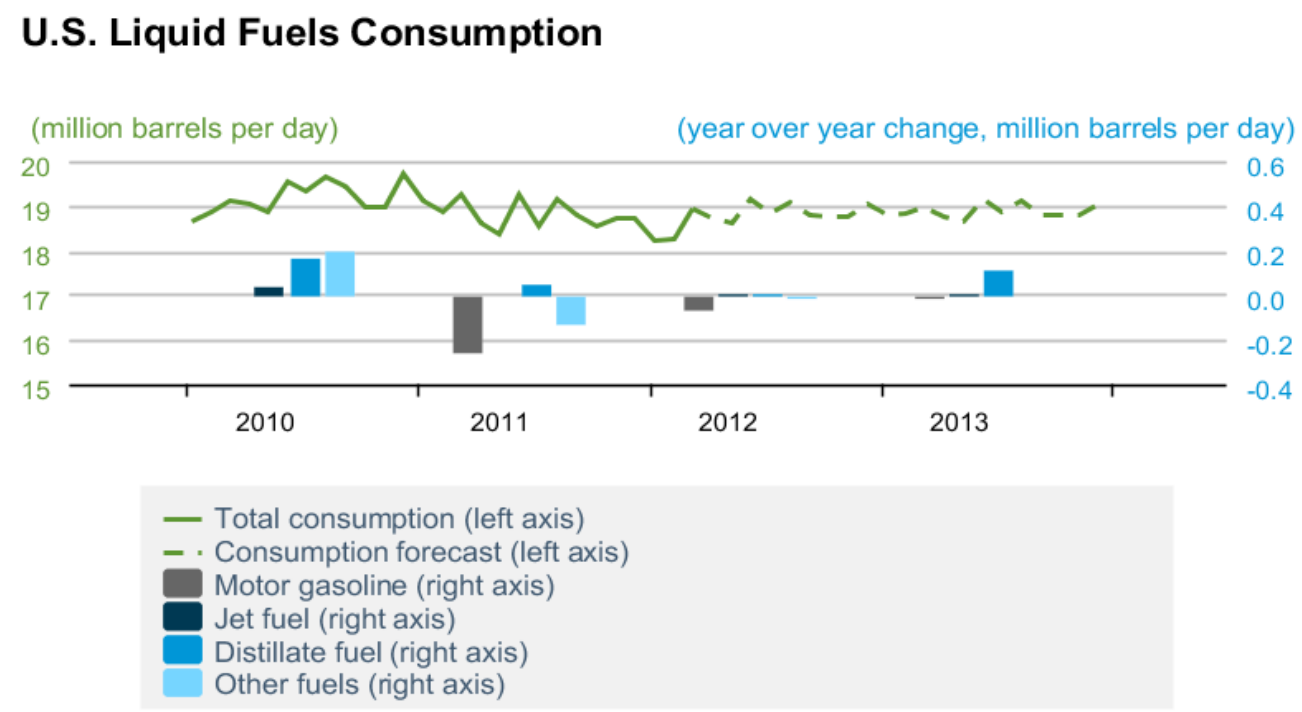


Figure 15. U.S. Liquid Fuel Consumption [12]

Figure 15 indicates that in 2011, the total liquid consumption declined by 340 thousand bbl/d from the 2010 average level. Motor fuel accounted for the largest percentage of the decline, 260 thousand bbl/d (76.47 percent) of the total 340 thousand bbl/day. In 2011, the total average motor gasoline consumption was 8.74 million bbl/day. In 2012 and 2013 the total average consumption has been forecasted to be 8.67 and 8.66 million bbl/day respectively [11]. According to the EIA forecast, there is no major change expected in motor gasoline consumption in 2012 and 2013. Also, according to the EIA, due to slow growth in the driving-age population and the improving fuel economy of new vehicles, it is forecasted to fall by 60 thousand bbl/d in 2012 and decline by 10 thousand bbl/d in 2013 [6].

The chart below indicates U.S. gasoline consumption forecast until 2020 (Figure 16). The gasoline consumption forecast indicates that until 2015 the annual consumption of gasoline may be above 17 quadrillion and that there may be significant decline in the consumption of gasoline after 2016. This decline in the consumption of gasoline projected could be mainly because of increasing number of fuel-efficient vehicles, electrical vehicles, and supply and demand of crude oil in the international market.

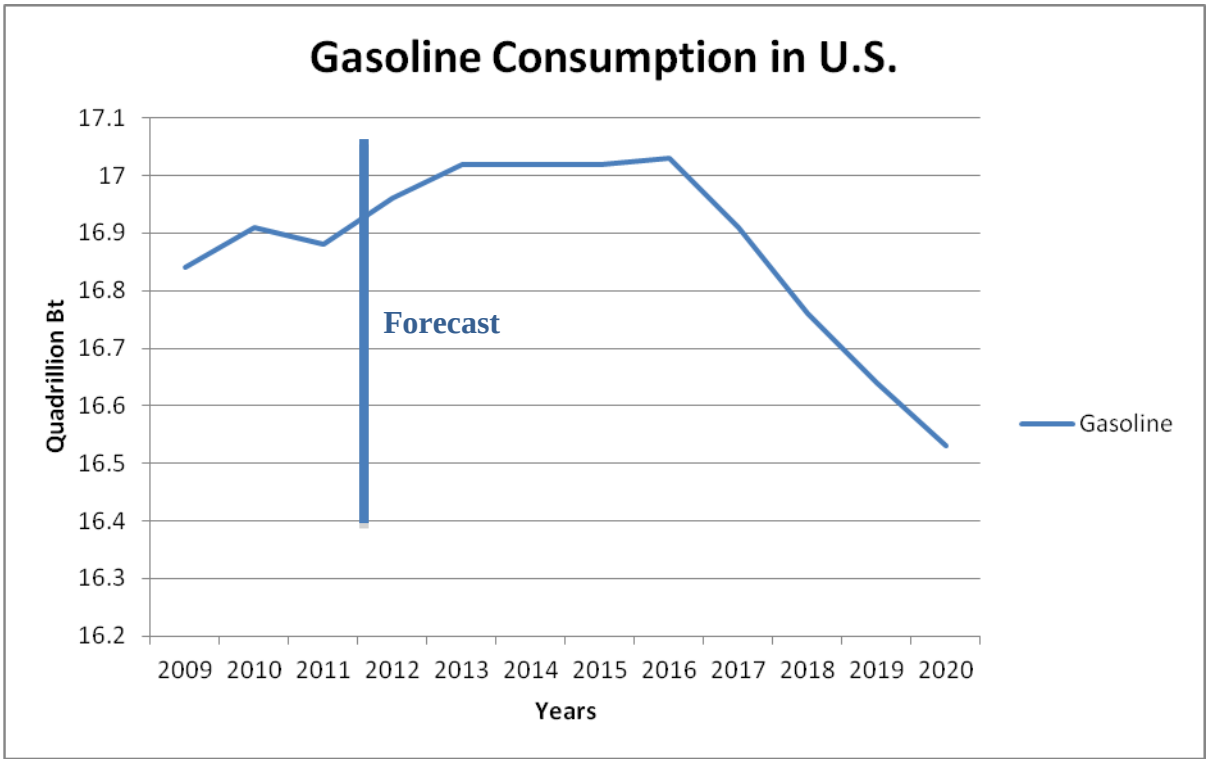


Figure 16. Gasoline Consumption
Source: EIA, Annual Energy Outlook 2012 Early Release [16]

With a significant drop in the consumption of the gasoline as forecast in the above chart, the gas tax collected would be alarmingly inadequate to raise fund for the Highway Trust Fund, due to increasing inclination towards fuel efficient and electrical vehicles. Hence it is important to implement alternative revenue sources that would be sustainable and adequately fund highway infrastructure.

4.3. U.S. Petroleum Dependency of Other Countries

The U.S. depends on other countries for crude oil and petroleum products. Approximately half of petroleum is imported to the U.S. from Canada, Saudi Arabia, Mexico and other countries. During 2010, U.S. consumed 19.1 million barrels per day of petroleum product, making it one of the largest petroleum consumers in the world [16]. In 2010 U.S. imported approximately 11.8 million barrels per day of petroleum and accounted for 49% of the petroleum consumed in the United States (petroleum includes crude oil and petroleum products) [17]. An average of 2.4 million barrels per day of crude oil and petroleum products were also exported. In 2011, U.S imported an average of 11.4 million barrels per day and exported 3.0 million barrels per day of crude oil and petroleum products per day (Figure 17) [17].

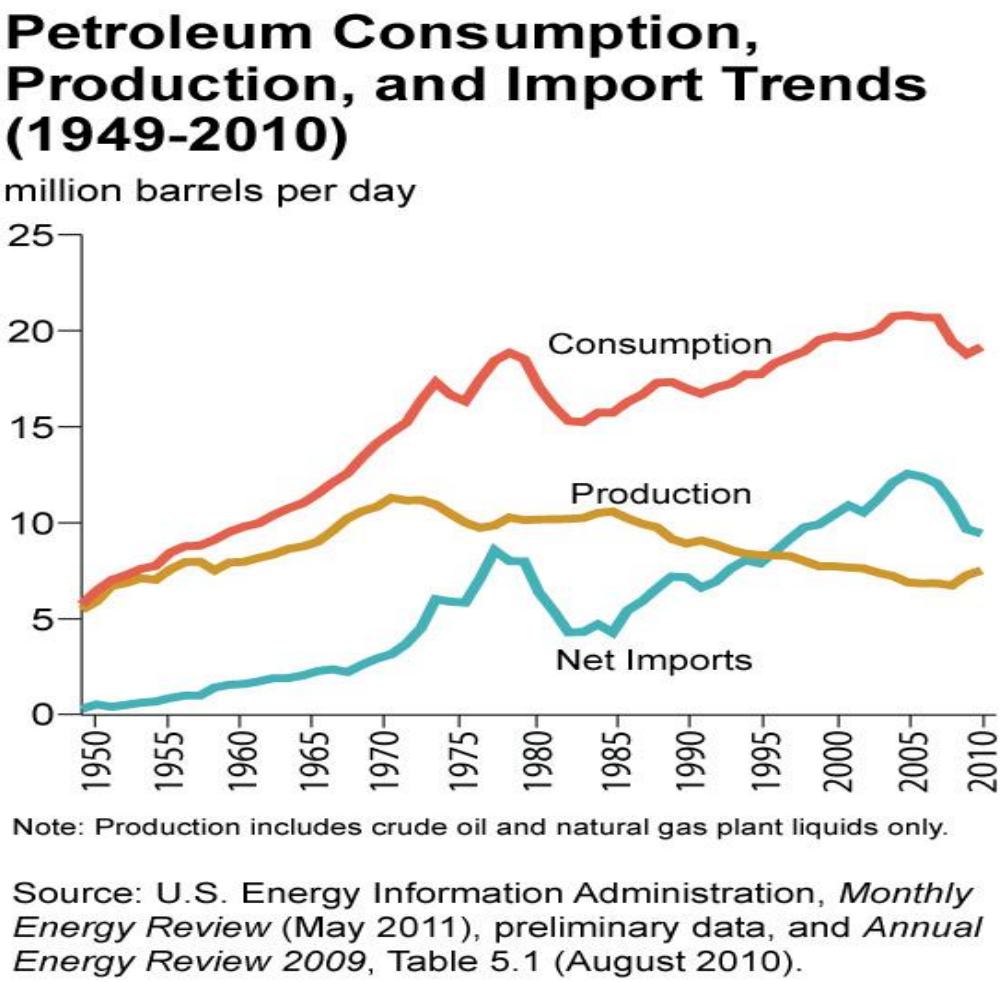


Figure 17. Petroleum Consumption, Production, and Import Trend [17]

It can be observed that the consumption volume of petroleum products is higher than the production and import volumes. Since 2005, U.S. dependency on imported oil has dramatically declined; this could be a result of various factors, including but not limited to the decline in the consumption of petroleum products, patterns of economic growth and a very small percentage increase in domestic production expanded the domestic supply and reduced the need for imports. Today, about half of the oil we use is imported, and our dependence will increase as we use up domestic resources.

4.4. 2025 Proposal to Boost Fuel Efficiency

In 2011, the Obama administration proposed to nearly double the required miles per gallon for passenger cars and light trucks by 2025. The formal proposal follows President Obama's agreement with 13 major automakers, announced in July 2011, to gradually boost these vehicles' fuel economy to the equivalent of 54.5 miles per gallon – up from current standard of 27.3 mpg. Last year, the administration finalized rules to hike the standard to 35.5 mpg by 2016 [18].

The U.S. Transportation Secretary, Ray LaHood, said in a joint announcement with the U.S. Environmental Protection Agency, that they would reduce U.S. dependence on oil and protect the climate [18].

He also said that they expect this program will not only save consumers money, it will ensure that automakers have the regulatory certainty they need to make key decisions that create jobs and invest in the future. The president of the Natural Resources Defense Council Frances Beinecke said that these standards are just what consumers want and the country needs, by delaying a decision on the Keystone XL pipeline and moving toward curbing carbon dioxide pollution from new power plants, the president's initiatives will help wean America from its oil addiction and begin to slow, stop and reverse climate change, and protect our health [18]. More than 100 members of the congress, including Rep. John Dingell, D-Mich., welcomed the tougher standards. In a letter, they said the new requirements will increase our national and economic security in an unprecedented way by dramatically decreasing our dependence on foreign sources of petroleum. U.S. officials say cars, minivans, SUVs and pickup trucks account for nearly 60% of U.S. transportation-related petroleum use and greenhouse gas emissions.

Some people on the board, including Darrell Issa, R-Calif, have criticized the new standards and more than 60 House Republicans have said that they want to stop their finalization. They argued the new rules would hike vehicle prices. The National Automobile Dealers Association said in a statement that they are concerned that adding about $3,000 to the average cost of a car will price millions of Americans out of the market, which could reduce fleet turnover and delay environmental gains.

The Obama administration has estimated that new technologies for a 2025 vehicle will add about $2,200 in costs. However, it says lifetime fuel savings could average up to $6,600, leaving consumers with a net savings of about $4,400. The costlier technologies, mostly limited now to high-end vehicles, include turbo-charging, direct fuel injection, electric drive and up to 10-speed automatic transmissions.

The EPA proposes that vehicles emit fewer than 163 grams of carbon dioxide per mile. Without any changes to the air conditioning refrigerant, a vehicle could meet that CO2 standard if it got 54.5 mpg by 2025. If the refrigerant were upgraded, it could do so at 49.6 mpg, which is the official CAFÉ standard. The proposed rules say that more than 80% of passenger vehicles meeting the 2025 standard will still have gasoline engines but many will be turbocharged and 15% will be hybrids and 3% will be powered by batteries.

5. ALTERNATIVE GAS TAX SOURCE

Many factors in the current gas tax system are responsible for the need for alternative sources of revenue to supplement or replace the gas tax. The following are the possible potential alternative sources for revenue generation:

- Increasing the gasoline tax
- Mileage based user fee

5.1. Is Increasing the Federal Gasoline Tax a Solution For Highway Financing Problems?

A proposal exists that promises a decrease in carbon emissions, reduces U.S. energy dependency on foreign countries, and decreases highway financing problems currently faced by the government. Some people believe that all of these outcomes would be possible by increasing the federal gasoline tax by some percentage.

In 1932, the first federal gasoline tax was set at 1 cpg, and subsequent increases from 1939 to 1951 have set the current federal gas tax. Even though over the years road and bridge construction costs have increased significantly the federal gas tax has not been increased to compensate for inflation since 1939. This imbalance could be one of the causes for insufficient revenue generation by the gas tax. Before increasing the federal gas tax it is important to study the impact of increasing the federal gasoline tax:

Potential Benefits of Increasing the Federal Gasoline Tax

1. Increases revenue
2. Reduces U.S. oil dependency on foreign countries
3. Reduces carbon emission into the environment
4. Motivation for innovative technology

Increases Revenue

Increasing the federal gas tax would generate enough revenue to cover the economic crisis the Transportation Department is now facing, but only if the funds collected by raising the gas tax are spent efficiently.

Reduces U.S. Oil Dependency on Foreign Countries

The United States imports approximately half of the oil required for transportation from other countries. An increase in the federal gas tax may decrease the rate of fuel consumption and, hence, reduce U.S. oil dependency and gas prices in a perfectly competitive global market [19]. However, the global market is not perfectly competitive and the fuel production rate and oil price are set by the Organization of the Petroleum Exporting Countries (OPEC).

Reduces Environmental Pollution

Every state is becoming aware of the need to protect the environment and hence is implementing various policies regarding petroleum products. Many states have specified formulation requirements on petroleum products such as gasoline to prevent environmental pollution.

Motivation for Innovative Technology

Increasing the federal gas tax could increase the demand for more fuel-efficient vehicles as well as vehicles with alternative sources of energy. This motivation could lead to innovation in the field of automobile technology and energy.

5.2. Reasons Not to Increase the Federal Gas Tax

There are many reasons that prevent increasing the federal gas tax:

- Burden on some segment of society
- Demand for gasoline may not fall as expected
- Price of other goods may increase
- Political issues

Burden on Some Segment of the Society

Increasing the federal gas tax would act as an additional burden on the lower income population and would be unfair to individuals in rural and remote areas with no access to public transportation. In a 2004 study West confirms the overall regressive nature by calculating the Suit's index for gasoline taxes [19]. The Suit's index is similar to the Gini coefficient in that -1 and 1 bound it, with a positive value indicating a progressive tax and a negative value indicating a regressive tax. West also finds that gasoline taxes tend to be regressive over the top half of the income distribution and progressive over the bottom half of the income distribution [19]. This occurs because the poorest households do not own vehicles and the poor households that own vehicles are more price-responsive than upper-income households [19].

Demand for Gasoline may not Fall as Expected

The fuel consumption rate should fall significantly by increasing the federal gas tax for any proposal to be successful. Many studies have shown that the gasoline consumption is inelastic to price, and the middle and higher income percentage of society would continue to use vehicles for transportation at the same rate. The lower income household cannot afford vehicles and hence an increase in the federal gas tax does not affect them. A study by H.A. Kayser, using data from Panel Study of Income Dynamics concludes that price elasticity of demand for gasoline is -0.23 in the short run [19].

As concluded by much research, if the price of the gasoline is inelastic, many of the benefits of the gasoline tax will be diminished. However, many economists and studies believe that increasing the federal gas tax by a significant amount would change driving habits and, hence, fuel consumption would be reduced.

Price of other Goods may Increase

There are many indirect effects of increasing the federal gas tax. There may be increases in the price of other commodities due to increased shipping costs caused by the higher federal gas tax. Refiners would have to increase their price to cover the increased cost of shipping. Transportation costs would increase, which would increase the prices of all the other commodities including public transportation costs. Consumers would pay a large share of the price increases resulting from the increased gasoline tax.

Political Issues

Political issues are the most important concern regarding the increase in the federal gas tax. It is evident from the past that every increase in tax has met significant political opposition. Congress would be reluctant to pass any increase in the federal gas tax.

5.3. Conclusion on Increasing the Federal Gas Tax

Much research needs to be undertaken on the impact of gasoline tax on the elasticity of the demand for gasoline, public outreach, and the impact of a gasoline tax increase on other goods to take this proposal of increasing the federal gas tax to next level [19]. The decision makers will also have to consider the collective response to an increase in the federal gas tax. An increase in the federal gas tax will amplify the state gas tax and the consumers will have to carry the burden of paying additional gasoline tax. In order for an increased federal gas tax to become reality political leaders will need to be influential in explaining the benefits that increase gas tax would accomplish to the public and earn public confidence.

5.4. Mileage Based Users Fees: Review

A transportation system is one of the most important channels for the progress of a nation. In the United States the major percentage of funds to maintain and develop highway projects is from motor fuel taxes. The motor fuel tax collected by state and federal governments to maintain and develop highway work is becoming inadequate to fund highway projects due to fuel-efficient and electrical vehicles. There are many options to significantly increase revenue that can adequately fund highway projects. It is important to evaluate all the options to design a sustainable system to increase revenue to maintain and develop transportation infrastructure.

A significant amount of research, development and testing have been carried out in the U.S. to evaluate the feasibility of alternative revenue sources for transportation financing. Several options have been studied in order to aid in understanding the concerns and advantages of implementing a new tax system as a potential revenue source for highway projects. Among many options for potential revenue, mileage-based user fees have gained the confidence of many transportation professionals and academic scholars as a way to increase funding.

Introducing alternative revenue sources invites new administrative and operational implementation requirements. These concerns and requirements should be addressed to ensure that the new system would work. The transportation departments of many U.S. states have made efforts to evaluate options to finance transportation systems. Significant efforts made by a few states are documented below:

Oregon State

In 2001, the Oregon legislature established a task force to explore alternative revenue models for transportation financing that would replace the gas tax. After evaluating 28 different options for potential alternative revenue sources, The Task Force considered three potential strategies to increase fund collection [20]. These three strategies are:

- Mileage Fees
- Congestion Pricing
- Tolling New Capacity

Mileage Fees and Congestion Pricing

A mileage fee system charges road users on the basis of amount of road usage by vehicles. Congestion pricing charges peak hour usage of certain roads. The task force recommended the Oregon Department of Transportation conduct a pilot program to evaluate the following two strategies

- Feasibility study of mileage-based fees as an alternative to the gas tax in Oregon and to collect fees at the fuel station
- Feasibility study of using a mileage-based fee system to collect congestion charges

In April 2006, the Oregon Department of Transportation commenced a 12 month pilot program to test the technical and administrative feasibility of a mileage-based- fee system. This was the first field test of the Oregon Mileage Fees Concept: 285 volunteer vehicles, 299 motorists and two service stations were involved in this program [20]. The concept of this program was to collect the mileage data and fees at gas stations. An on-vehicle device was set in vehicles that could identify zones, for allocation of mileage fees. The data of miles travelled at pre-identified zones were stored in the on-vehicle device. At the gas station, data stored in the device was transferred to the station's point-of-sale unit (POS) to apply mileage fees rates. The mileage fees were then calculated and included in the gasoline bill.

To examine the concept of identifying zones and calculating miles driven by vehicles, the Oregon Department of Transportation (ODOT) signed a contract with Oregon State University (OSU) to develop new applications. The OSU developed applications to electronically assign mileage within pre-determined zones and to establish wireless transfer of mileage data to POS at gas stations. By utilizing signals from satellites, GPS could identify zones and odometers could record miles [20].

5.5. Findings from the Pilot Program: The Concept is Feasible and can be Integrated with the Current System

The pilot program demonstrated that using an existing system with some technological upgrades, mileage fees could be successfully implemented and the gas tax could be replaced gradually by the mileage-based user fee system.

Paying at the Gas Station

The pilot program showed that mileage fees could be paid at the pumps. Mileage fees could be implanted in the day-to-day transactions at the pump with minimal changes to the existing process. The idea is to collect a bulk amount of pre-paid mileage fees from the distributors. The distributor at gas station would collect charges by including mileage fees in the gas bill. However, many of the elements used in the pilot program did not meet the standards of commercial products, so the next stage is to develop technology that would take care of commercial feasibility. The new system would place a minimum burden on distributors and gas stations; administration is automated and can be integrated easily with a current transaction process.

Progressive Implementation of Mileage Fees

Once the mileage fees system is enforced, the vehicle mix (vehicles with on-vehicle device and without on-vehicle device) would be expected. Upgrading all existing vehicles to a mileage on-vehicle device would be a burden on vehicle owners. Enforcement should be gradual without becoming a burden on vehicle owners and the government. The approach by the Task Force to efficiently integrate with the current gas tax collection system gives flexibility to collect mileage fees from vehicles that have an on-vehicle device and gas tax from vehicles without an on-vehicle device. Mileage fees can be implemented alongside and integrated with the gas tax system [20]. The Mileage Based User Fee (MBUF) can be specifically integrated with current gas station operating systems and tax collection from fuel distributors by state government. This approach gives a platform to gradually implement the MBUF system.

Congestion and other Pricing Options are Viable

The study showed that mileage fees could be zoned charging varying mileage fees for travelling in certain geographical areas during high congestion periods. There are many potential strategies to implement area pricing, like entry fees to certain geographical zones and tolling certain highways. The Task Force recommended area pricing because of the configuration of road systems, as well as, the geography and technological ease of integrating with the current gas tax system. In an area pricing system, different zones could be assigned different charges, and electronic pricing for driving in different zones could be generated. This showed that mileage fee systems were viable for not only congestion pricing but also area pricing strategy. Further, the study concluded that area pricing could reduce driving during peak periods by 22 percent [20].

Privacy is Protected

The privacy of vehicles with an on-vehicle device can be protected. The system used in the pilot program was developed by ODOT, and is a feasible way to generate mileage charges while using engineering that maintains as much privacy as possible. All the technology design choices and administrative systems would be designed to protect privacy. Key privacy requirements considered were [20]:

- Specific point location and trip data could not be stored
- Communication of data from on-vehicle devices would be short range
- Only vehicle identification, zone mileage travelled data and fuel purchased data would be generated to assign mileage fees

Secure short distance data transfer would occur only at the time of fueling, preventing data documentation. The on-vehicle device would be designed such that no one other than the vehicle owner would know the vehicle's movement. The on-vehicle device would be private property, the same as any other part of the vehicle. The maintenance and safety of the device would be the owner's responsibility and the DOT would have no authority over the on-vehicle device other than to protect it from evasion of mileage fees.

The on-vehicle device would be designed to prohibit generating any other data not required to calculate mileage fees.

Evasion would be Minimal

The device and data transmission system could be designed to prevent evasion. If a vehicle has not paid mileage fees, it could be possible to electronically identify those vehicles during the mileage fees charging process at the gas station. Since mileage fees would be paid with the gas price at the time of refilling at gas station, avoiding the mileage fees could be minimal. The difference between the gas tax and mileage fees would be very small, providing less motivation to avoid mileage fees. Ultimately, any evasion of mileage fees would be minimal through advance payment of the mileage fees in bulk by the distributor to the government.

Low Cost of Implementation and Administration

The implementation cost includes installing electrical and wireless devices across the state of Oregon at gas stations and administration costs include expenses to transfer data from an on-vehicle device to a central data center, calculation of the mileage fees based on area pricing, communicating to station's point-of-sales, and prevention of evasion.

The capital cost of the on-vehicle device would be calculated by manufacturers, who will perform the installation. The total on-vehicle device cost would be included with the vehicle cost. State DOT's would incur the cost of auditing and providing technical support to service stations. It was estimated that auditing the system in Oregon could cost $1.0 million annually, which would be a small percentage of the revenue generated by mileage fees. Economists estimated a capital cost of $33 million in 2003 to implement a mileage fee system statewide, and this would result in less than a two percent increase in the mileage fees rate compared to the current system fuel tax rate [20]. Development costs of the on-vehicle devices used in the pilot program are estimated to be $209 per unit, manufacturing costs were $338 per unit, installation of the device cost $55 per unit, a prototype station device cost $186 per unit, and manufacturing cost $286 each. Other service station infrastructure development costs, contingencies and miscellaneous costs would sum to $33 million [20].

5.6. Action Required

To ensure successful implementation, additional testing and development is required [20]:

- Further improvement of on-vehicle device technology and insure ease of mileage fees transactions at the gas station
- Estimation of cost of implementation, operation and administration
- Establishing concept of multi-state coordination

Cost

The mass production and installation of devices to implement the mileage fees system would cost less compared to the pilot program. In the pilot program, the original company contracted to manufacture equipment failed to deliver the product. A new contract was signed with another company and due to a very tight deadline this increased the cost per unit from what was initially expected. The mass production of the device would cost less than the pilot program. During the discussion, it was suggested that in the near future the price per unit of GPS, the chip used as the core of the device, would be $100.

Further, during the pilot program, one of the selected stations was incompatible with pilot program requirements because its pump could not accept credit cards. The cost incurred to replace this pump was $78,000. To implement the mileage fee system statewide, stations would have to comply with the Point-of-Sales (POS) system requirement. It was recommended that the state DOT could issue the POS system requirement and stations could figure how to meet the requirements. The cost incurred by stations to comply with the POS requirements would be calculated, and the state DOT would then decide what percentage of the cost would be absorbed by the station and what percentage would be transferred to the state DOT.

Further refinements in estimation of cost of the implementation, operation and administration are required.

Texas

There are many research works ongoing; however, a few have been concluded in Texas. The first significant effort to test the feasibility of a MBUF (mileage based user fees) system as a potential revenue source and to identify the issues related to implementation was carried out in 2008. Later, in 2009, a second effort to study a MBUF system implementation pathway was made by Texas. The Texas Transportation Institute (TTI) has made considerable effort to identify potential revenue sources for transportation financing.

The objective of the research work conducted and written in 2008 was to explore the feasibility of MBUF system as an alternative to a fuel tax system and identify the issues related to implementation of a new transportation financing system [21].

Researchers conducted a strategic assessment of the gas tax to emphasize potential institutional issues that the MBUF system will have to address in the near future. Another very critical study made by Texas was on public acceptance of the new road tax system. The reaction of the public to a new road tax system needs to be studied before implementing mileage fees system. Texas conducted public outreach activities, including stakeholder interviews, formation of a community advisory committee, and a focus group in order to examine public reaction to transportation financing. The Texas Transportation institute (TTI) focused implementation issues in small urban and rural areas, specifically northern Texas.

To study implementation issues of mileage user fees, assuming mileage based user fees to be the most practically feasible potential alternative revenue source, technological issues to implement mileage fees were discussed. Many potential models to be used for implementing mileage fees were discussed, and three were considered to be most practical models to implement in large scale:

- The Oregon Model
- The Cellular Model
- The Gantry Model

In the Oregon model, the on-board unit (OBU), affixed to the interior of the car, uses GPS signals and computerized maps to record the location of the car. The OBU computes miles driven on certain roads. At the refueling station, a wireless device at the pump receives information about miles driven from the OBU.

Point-of-sale (POS) software communicates this information to a central data center through a digital subscriber to determine charges. The pump device then sends a signal to the car that the fees have been applied to the fuel bill and all data are erased from OBU [21].

In the Cellular model, a car's OBU uses GPS signals and computerized maps to record the location of car. OBU computes miles driven on certain roads. OBU intermittently communicates with the billing center, via cellular technology, and relays mileage information [21]. The driver will receive a bill in the mail for miles driven, or if they opt for a prepaid account, the bill will indicate fees deducted from a prepaid account.

In the Gantry model, the car's OBU uses GPS signals and computerized maps to record locations of car. The OBU computes miles driven on certain roads. Mileage travelled data is collected when a vehicle passes under tolling gantries that are placed throughout the area road network. Information gathered by gantries is forwarded to the billing center. The driver will receive a bill in the mail for miles driven, or if they opt for a prepaid account, the bill will indicate fees deducted from pre paid account [21].

Public Outreach

Public outreach activities were conducted, and interaction with many members of the community to understand public reaction towards transportation financing issues, general concerns, and mileage fees concerns were noted. A community advisory committee was formed to study public perspective towards MBUF system. Nine stakeholders were interviewed and two focus groups were conducted in northeast Texas.

Result of Interviews with Stakeholders

The interviews with stakeholders were conducted to study the public viewpoint towards a MBUF system. It was noted that many had very vague knowledge about transportation financing and administration and need to be educated. The public is already under the impression that the government is overcharging them for road usage, and mileage fees would be a duplication of the gas tax or appear as a completely new tax as a fuel tax acting as proxy to road usage. It was also noted that many thought that the mileage fees system was complicated compared to the gas tax system and the complexity may lead to mischarging the public.

Privacy was a concern to many; however, some percentage of the participants did not have a concern about the device collecting the travel information. Some expressed approval, as it appeared to them that only mileage travel data is required to charge mileage fees and the location of the vehicle will not be tracked.

Mileage fees would be of concern to farmers and ranchers, as they live in the countryside and will have to travel long distance very frequently. Fuel distributor's opinions were neutral about the idea of mileage fees. When mileage fees models were presented to participants, it was noted that many preferred the Oregon model out of three models.

Focus Group

The objective of the Focus Group was to examine the conclusions drawn from interactions with community members and stakeholders, discuss transportation issues, and mileage base user fees issues with a group of area citizens. Two groups conducted meetings in Tyler and Henderson, Texas. The first meeting was held on July 29, 2008, in Tyler with five participants attended the meeting. The second meeting was held in Henderson on July 30, 2008, with nine participants attended [21].

The general concern expressed by both groups' participants regarded the rising fuel prices. After educating on transportation financing and the role of government and local bodies in transportation infrastructure funding and the need to increase funds for the highway projects due to fuel-efficient vehicles, participants of both the groups were presented with three models of mileage fees systems. The first group liked the Oregon model, as only mileage data of the vehicle would be transferred from vehicle to information center and not the location details of the vehicle. The first group expressed concern that the system is very complicated to implement, as hacking the on-vehicle devices by some road users would be possible. The Cellular model was also believed to be very difficult to implement and group participants did not like the concept of billing through mail. The Gantry model seemed to be very expensive, as it needs additional infrastructure and can be easily evaded.

The second group was also presented with three models of mileage fee systems and participants expressed concern with the lack of privacy in the Oregon model. As in the first group, the second group also expressed concern about implementation difficulties and did not like the billing through the mail concept with the Cellular model. Only one person liked the Gantry model, as he thought that privacy was well taken care of compared to the other two models [21].

5.7. Findings from the Public Outreach Activity and the Focus Group

- Public has a very vague idea about transportation financing, the gas tax, and funding process.
- Rising fuel price will be the biggest concern to public.
- Privacy concerns are an issue, but also individualized.
- New system should fairly consider mixed vehicle usage, mileage of all types of vehicles, higher mileage in remote areas and limited public transportation options.
- The cost of implementing and administrating a new mileage fees system is a concern and needs further research.
- Reliability on the technology in concern.

It was recommended that further research is required to recognize what level of the government should be involved in administration and operation of the new system, what are the available new technologies for implementing MBUF system, and ways to gradually switch to a new system from the current system with minimum implementation cost.

In 2009, research to further evaluate institutional issues concerned with the implementation of mileage based user fees was performed by the Texas Transportation Institute, the Texas A & M University and University Transportation Center for Mobility [22].

There are many institutional issues associated with the mileage user fees system which need to be addressed before implementing MBUF system as an alternative revenue source for transportation financing.

Direction

Direction regarding whether the state government or the federal government should initiate design and development to implement alternative sources of revenue should be determined. If nation-wide implementation of mileage system is envisaged then the federal government involvement is required at the design and development stage or if the state government administers the MBUF system without any involvement from the federal government, guidelines on technical and operational elements of the system are required to standardize the process. The implementation process requires a well-organized coalition of the state government and the federal government personnel to further examine, design, and develop a mileage fee system.

Legislation

Many commercial and domestic vehicles travel between states. Calculating the mileage fees by area pricing would require interstate cooperation. It is yet to be determined that if revenue collected by mileage fees could be completely dedicated to the Transportation Department or if some percentage would be dedicated to the general fund. Once it is determined that revenue generated from MBUF system would be dedicated to a transportation department, a constitutional amendment is required so that these funds are not diverted.

Structure

The program to implement a MBUF system needs well-defined structure. There are many areas of concern such as, if the mileage fees should be made voluntary participation or if it should be made mandatory participation for road users. Another concern is that once direction is set, whether implementation should be immediate or gradual [22]. To determine answers to these issues further research and development is required. The involvement of the federal government is required for facilitating research and development.

Administration

The fuel tax system collects tax at a higher level than in supply chain. The distributors pay tax at the time of purchasing fuel from a wholesale center and hence, no direct interaction with an individual vehicle owner is involved. The tax inflow sources are minimal and hence administration cost is less. The mileage based user fees system has to determine miles driven by each vehicle and apply area pricing to determine mileage fees per vehicle every time the vehicle refills fuels at a gas station. The administration cost associated with mileage fees is high compared with the gas tax.

The vehicles will be equipped with on-vehicle devices to determine miles driven. These devices would be responsibility of the vehicle owners, hacking the device to avoid mileage fees would be possible. It would be necessary to examine vehicles for any violation of the rules.

The cost of preventing violation will be incurred in the administration system and should be determined before implementing the mileage fees. The potential MBUF system should be designed such that hacking or another interference with data stored in on-vehicle device should be impossible.

5.8. Guidelines

After studying the many aspects of institutional concerns to implementing a mileage based user fee system, the following guidelines were given:

- Many commercial and domestic vehicles travel interstate and on-vehicle device records mileage travelled in different locations that include different zones of many states. To calculate mileage fees for these vehicles, coordination between states is required and a standard framework has to be established to avoid confusion. If a standard framework is not followed by all the states it would be very complicated to compute mileage fees of individual vehicles. To make it easy to compute fees for miles driven by these vehicles the federal government is required to design a framework to standardize the process.

- Implementation of a mileage based user fees system on a large scale requires various processes at the state and federal levels. These processes require legislative approvals and amendments before implementing mileage based user fees system. Gradual implementation of the MBUF system allows sufficient time for state legislation to make appropriate adjustments.

- The fuel tax system administration requires processing only a few tax invoices and evasion of paying fuel tax would be low and hence the cost of administration would be low. The mileage based user fees will have to determine mileage traveled data from several vehicles and needs additional administration processes and infrastructure and hence, the administration cost is expected to be higher, compared to the gas tax system. And also gradual implementation of the mileage fees system requires development of a mass database for maintaining user accounts. State governments may require the federal government to provide support to develop the infrastructure.

Minnesota

The Minnesota Department of Transportation appointed a task force to identify and evaluate issues related to potential future implementation of an MBUF system in Minnesota. The Task Force consisted of 25 Minnesotans from a broad range of backgrounds [22]. Members were from the public and private sectors, experts from the transportation industry, economic development community, and a privacy expert. The Task Force was invited to submit a minority opinion. The minority group members submitted their opinions on the task force report. The Task Force also identified concern on certain issues of implementation, as well as, administration that require further evaluation.

Task Force Issues

- Fairness
- Flexibility
- Sustainability

Multiple Potential Applications

The MBUF system would be an answer to many transportation problems other than serving as an alternative revenue source. The area pricing policy of MBUF system could be used for traffic congestion charging [22].

- Excessive road wear
- Traffic congestion
- Pollution

Services: Value added services would be possibly offered to drivers depending on the tax collection system.

System Management: For more efficient management of the peak period demands, real-time data would be available depending on implementation of MBUF system.

Task Force Identifies the following Concerns MBUF System may Face

- Cost
- Jurisdiction Issue
- Feasibility
- Acceptance
- Use of revenues

Potential Design Options for MBUF System

The Task Force provided many design options for each of the elements of mileage based user fees system, as these options would help to address some of the issues.

Collecting Vehicle Miles Travelled Data

It is possible to collect miles travelled data from vehicles by various ways:

- Odometer inspections.
- Mileage estimates, based on vehicle fuel economy and fuel consumption.
- GPS-based electronic metering device.
- Cell phone tower-based electronic mileage-metering device.

Collecting Fees from Road Users

Mileage traveled fees could be collected by the following methods:

- Payment at refueling stations.
- Automatic transmission of invoices via electric mileage metering device.
- Payment with vehicle registration fees.
- Pre-paid debit cards.

Preventing Evasion

It is possible to prevent evasion by several ways:

- Odometer inspection
- Electronic equipment inspection
- Roadside electronic monitoring to verify the functioning of electronic mileage metering devices

Data Protection

Privacy can to protected by many ways:

- Only odometer reading
- Only fees charged is transmitted and data will be in vehicle
- Anonymous user account that does not disclose vehicle ID
- After mileage fees is determined, immediate deletion of data
- Use of pre-paid debit card

Revenue Usage

Revenue generated from the mileage based user fee system can be utilized for many objectives:

- Roadway usage only
- Roadway and transit use
- Transportation system use

Value Added Services

The mileage-based user fees system would offer many value added services in addition to mileage metering:

- Pay-as-you-drive vehicle and liability insurance
- Electronic payment of parking, ramps meters
- Traffic alerts and safety information
- Navigation assistance

Cost

The Cost of implementing, operating and administrating MBUF system are critical and should be low

- Mass production and factory installation of devices
- Proven technology to be used
- Additional cost for non-essential feature to be restrained
- Distribution of the revenue generated by mileage based user fees system should be sanctioned by legislation

6. MBUF SYMPOSIUM [23]

The third national symposium on Mileage-Based User Fees systems was held on June 13 and 14, 2011 in Breckenridge, Colorado. The Texas Transportation Institute and the Hubert H. Humphrey School of Public Affairs at the University of Minnesota hosted the conference.
In addition, support from the University Transportation Center for Mobility of the Texas, A&M University, and from the Transportation Research Board was extended. Transportation professionals, agencies, academics, consultants from various backgrounds, and experts, provided their views during the session. The main objective of the symposium was to discuss mileage based user fees as a potential revenue generation source to finance the transportation system and to discuss implementation pathway.

Originally 13 questions were presented to all the participants at the beginning of the conference. Participants were given facility to vote for three questions, which are considered to be critical and then the three critical questions were discussed [23].

- What is the most effective way to increase public acceptance and awareness?
- What are the effective ways to coordinate research, develop and implementation activities at state level?
- What is the most effective implementation pathway?

After discussion and interaction sessions, members provided answers to the critical questions.

6.1. Public Acceptance

The objective of the alternative revenue source for the transportation system is to assist government to provide better services to public. Before making any changes or adjustments to the current fuel tax system, public opinion should be taken. Many states have conducted surveys to evaluate public reaction to the new road tax system and it was noted that the public could oppose any new tax system because they have little understanding of the transportation financing and have a disapproving mind set on the current government administration capabilities.

Some percentage of the public may approve MBUF system due to its value added services to users. Voluntary adoption of mileage based user fees system was recommended as most practical approach.

State Level Coordination

For a mileage based user fees system, it will be very complicated to charge mileage fees to road users without a coalition between states. If all contiguous states coordinate with each other during planning, design and development stages, implementation could be less complex and duplication of effort could be avoided. But considering that some research could be restricted to a particular state and may not be able to be applied in general, policy makers at the state level may require examining certain issues before implementation. The pool fund was recommended as a method to coordinate research and development at state levels. It was suggested, that a national framework to standardize mileage based user fees implementation and administration practices would be required [23].

Implementation Path

Implementation of mileage based user fees system is believed to be complex and expensive, as new infrastructure should be provided and also due to large-scale implementation. The state level implementation was considered as the most feasible method for mileage base user fees system.

The federal government was considered to be more politically resistant for the initial implementation of MBUF system. It is believed that successful implementation of MBUF system would be flexible, cost effective and would concentrate public confidence in system. Open system designs were recommended to encourage multiple third-party applications and provide value added services.

7. I-95 CORRIDOR COALITION [24]

A workshop was arranged in May 2009, to discuss and address legal and regulatory issues and institutional and administrative requirements for a multi-state vehicle miles-travelled (VMT) based system. A mileage travelled fee system demands very closely coordinated infrastructure, such as administration, institutional and legal functionalities that support successful implementation of a mileage-travelled fee system.

In order to provide more flexibility in the design and implementation of a multistate VMT-based system, the I-95 Coalition workshop formed three broad functionality options to study administrative, institutional and legal requirements [24]. Depending on whether a state wants to utilize all the functionalities, which would achieve a variety of policy goals of a multistate VMT-based system, or if the state decides to deal only with mileage-travelled data collection to generate mileage-travelled fees, three options were framed. Simple option – Calculating mileage fees based on fuel consumption data of the vehicle. This system offers the ability to achieve basic functionality of charging road users per mile travelled. Vehicles must be equipped with automatic vehicle identification devices. Electronic readers and communications systems installed at service stations would read the vehicle IDs and transmit the ID data to a processing point. Moderate option – In this system it is possible to estimate the cost of vehicle travel by time and by jurisdiction. This system requires equipping vehicles with an on-board unit (OBU) connected to the on-board diagnostic port (OBD II) available on vehicles. The vehicle speed and time data collected by OBD II is processed by the OBU to produce travel distance information. The integration of cellular communications technology with the OBU enables the estimation of travel location and transmitting OBU data to a processing point. Complex option – this option achieves all the optional functionalities associated with time and with general or specific location variability. It is possible to estimate the cost of travel by jurisdiction, by specific route or facility, or by time-of-day by use of GPS technology. Wireless communications would be used to transmit data to the processing point.

The board identified the following process administrative requirements for VMT charges [24]:

- Enrolling user participants: Enrolling user participation could be voluntary or mandatory, but voluntary enrollment would not make much of an impact unless incentives are established for enrollment. Mandatory enrollment could be possible based on the current vehicle registration data. Enrollment should be linked to an already existing system for effective administration and implementation.

- Accumulated mileages and charges due to state and state approved agency
- Calculating and reconciling mileage charges
- Distributing revenues among the states and other agencies
- Calculating and billing the charges to users and utilizing credit and debit card-based payment procedures
- Maintaining user interface and communication
- Auditing, security and enforcement to assure collection of charges from users and to assure the equitable distribution of the charges among agencies
- Identifying specific state and multi-state administrative units and their respective responsibilities
- Governance procedures for resolving issues between states and for defining multi-state agreements versus state responsibilities
- State and other agency membership rules and requirements

The administrative cost for operating all the functionalities of a VMT-based system has to be estimated. The motor fuel tax administrative cost on average is 0.82 percent of tax receipts collected. For the I-95 corridor motor vehicle fees and vehicle registration administration cost an average of 0.82% and 11.04%, respectively [24]. The motor fuel taxation system is very simple compared to the VMT-based system and hence requires low administration expenses. If the VMT-based administration system were designed to utilize the existing system, administrative costs would be low.

The Department of Motor Vehicles (DMV) was identified as the best-positioned government institute to administer a VMT-based charge program. State DMV's have basic information, operational knowledge, customer identification and interface, billing and collection, and infrastructure for multi-state coordination. I-95 coalition member's observations after interviewing state DMV officials on the status of the current processes and those existing state DMV systems adaptability to add VMT-based charges are [24]:

- States' current registration processes are highly automated; the addition of any other system to the existing system may impact the operational ability of the current system. Current vehicle registration fee collection can be easily operated and can be easily understood by officials and customers, but the VMT-based system may not be simple to operate.

- States' transportation administrative systems are moving to paperless systems, encouraging electronic transaction processes and Internet transactions to reduce administration costs and improve efficiency, so a VMT-based system also needs to be as highly electronic as possible to accommodate interfacing with an existing state system while not creating any additional burden on a state DMV.

- In some states, registration processes are handled by agencies and not by a state DVM. These agencies receive a percentage on each transaction or flat fees from the state. Incorporating a VMT-based system to existing systems in these states may be complicated. A VMT-based system may have to accommodate the agency's structure,

and the agency may oppose incorporation of any additional system without compensations.

- The VMT-based system charges vehicle owners based on vehicle travel by time and by jurisdiction. Vehicle ownership changes on a regular basis so the mileage travel fee should be updated to new vehicle owners by the DMV or other administrative agency as in some states. The DMV administrative system should be incorporated to allow for de-registration, in-sale and re-registration phases and updating the system and charging the new owner. It was observed that not all state DMV technology is updated to facilitate VMT-based system vehicle ownership transfer and charging new vehicle owner based on miles travelled.

- It is difficult to identify the percentage of unregistered vehicles in many states. VMT-based system should be designed to avoid evasion of charges, fines will need to be substantial and fees should be paid upfront, leaving less possibility for evasion.

- Even though administration of DMVs in most of the states is becoming electronic, there may be concern about collecting VMT charges through credit cards. Collectively credit card charges would be high, as the charges would be paid by DMV as a percentage of the total fees. The VMT-based system should be simple and should not burden the DMV. Customers might prefer the monthly VMT charges, so they can be aware of how much it is costing them to drive each month.

To implement a VMT-based system, many legal concerns have to be addressed, like setting tax rates by state legislation, use of revenue, and transition from fuel tax to VMT-based charges. Issues of multi-state VMT-based charge collection and redistribution need to be addressed. When a VMT-based system has to be implemented on a large scale, state legislation must address all the issues of VMT-based charges.

7.1. Workshop Conclusions

After analyzing various efforts to increase revenue in the Highway Trust Fund account to fund highway projects, it can be concluded that the optimum approach is to charge road users on the basis of miles travelled by vehicles. Charging a mileage-based user fee has several advantages; the most significant of these benefits would be that the Highway Trust Fund would then have sufficient funds to address all the issues of transportation financing.

The mileage-based user fee system charges all road users operating different types of vehicles powered by different types of energy sources fairly. The MBUF system does not charge the road user based on motor fuel consumption; taxes are based on usage of the highway infrastructure facilities provided by the government to road users.

It can be concluded that the MBUF system provides various benefits to the Highway Trust Fund.

- The current gas tax system charges road users based on fuel consumption, if the vehicle fuel efficiency were low, drivers would be paying more tax compared to vehicle drivers with very efficient vehicles. It is unfair to charge more for using the same amount of the

highway infrastructure. The MBUF system charges all the vehicles drivers equally, irrespective of the type of energy source and different fuel efficiencies of the vehicles.

- The MBUF system would be sustainable; that is, the revenue inflow would not fluctuate with respect to the fuel consumption level; the tax does not depend on motor fuel consumption. Instead, it depends on the usage of highway infrastructure.

- The technological design options allow the MBUF system to be integrated with the current motor fuel taxation system and hence would make operation and administration easy for the taxpayers and for the administrative authority (government or private).

- The MBUF operating system would be designed for gradual implementation. The MBUF system is flexible enough to integrate with the current gas tax system; hence the time required to gradually implement the system would be reasonable.

- The costs of implementation and administration are expected to be reduced since the MBUF system can be integrated with the current gas tax operations.

- The system also offers answers to many highway problems, such as viability of congestion and other pricing options. Also, the technology of the MBUF system could be designed to offer value-added services.

During the analysis of the current and previous work on MBUF systems as an alternative to the gas tax system, some concerns were observed regarding implementation, administration, and operation of the MBUF system. These concerns need to be addressed for successful implementation of the vehicle mileage travelled system.

- Acceptance by the public of new taxation on road usage could be a concern. The public has very vague ideas on transportation financing and due to the recent economical downturn public trust in the financial administration of the government has been undermined. The public could oppose any increase in the current taxation system.

- The technical interface between the on-vehicle device and the point-of-sale at the gas station needs to be improved for large-scale implementation to ensure ease of mileage fee transaction at the gas station.

- The capital cost, research and development, implementation, administration and operation, calculated estimates of these elements are required for the decision makers. It is very difficult to estimate the costs, since any history of a similar taxation system does not exist.

- The MBUF system collects mileage travelled by the vehicle to calculate charges from the on-vehicle device, but some percentage of the public may not agree to install or buy a vehicle with an on-vehicle device as they may consider it as governments trick to track their vehicle’s location.

- The jurisdiction issues are of concern and need to be addressed before implementation of any mileage travelled system. Many vehicles travel interstate, and calculation of mileage fees would be complex without standard framework for administration and operation.

- Once mileage-travelled fees from vehicle owners are collected, the distribution system of revenue from MBUF has to be determined. It should be decided if the revenue generated by the MBUF system would be reserved only for the highway infrastructure development and maintenance or distributed among various disciplines of the Transportation Department, or should be distributed among various other departments to reduce taxes on other elements.

8. A TO DO LIST FOR MBUF

Among transportation professionals, MBUF is the most promising means of funding the nation's infrastructure. However, a number of issues are raised regarding implementation, public acceptance, economics, equity, public policy, technology and pricing and land use.

The summary below reflects research needs and other critical topics identified: during the 2009 MBUF symposium held in Austin, Texas, the 2010 MBUF Symposium held in Minneapolis, Minnesota, the 2011 MBUF Symposium held in Breckenridge, CO, the MBUF sub-committee meeting at the 2012 Transportation Research Board (TRB) annual meeting at the Washington D.C.[25] and various literatures reviewed by the project team.

- *Implementation*
  - Participation of road users in this process should be mandatory or voluntary
  - MBUF should replace or in addition to traditional fuel tax
  - Traditional fuel tax should continue along with the mileage based registration fees
  - Mechanisms to distribute collected funds among federal, state and local entities

- *Public Acceptance*
  - To what extent is the public willing to accept mileage-based user fees as a mechanism for addressing policy issues outside of revenue generation such as congestion relief and air quality
  - What sort of market research and other attitudinal data collection efforts can federal, state and local entities undertake to better understand public attitudes with regards to transportation funding and financing and mileage fees
  - Outside of the general public, what other transportation system stakeholders should entities pursuing mileage fees approach for input? Are there groups outside of the transportation industry, such as financial and legal professionals, that should be involved
  - What is the level of acceptance for various rate structuring scenarios? How can discounts be applied be applied to increase public acceptance

- *Economics, Equity, and Public Policy*
    - What sort of objectives can a mileage fee system achieve outside of revenue generation and how effective are the various implementation configurations under consideration at achieving those objectives
    - Develop a framework for decision-makers about the allocation of net revenues from user fees. The framework should integrate economic theory, potential transportation solutions, and political reality into the decision-making process

- *Pricing and Land Use*
    - Conduct an assessment of potential cross-jurisdictional effects on traffic and land use so as to determine the appropriate role of various governmental actors at the federal, state and local level. This assessment should account for the fact that jurisdictions adjacent to an implementing entity may not opt to deploy a mileage-based fee system. The assessment should also account for differences in pricing policies and administrative structures between adjacent jurisdictions that do implement mileage fee systems.

- *Technology*
    - Many implementation pathways envision the use of multiple technology platforms that provide road users options in metering technologies. How robust are some of these "off-the-shelf" technologies, such as smart phones, in terms of their ability to reliably and accurately assess road usage
    - Conduct pilot projects to test multiple technology platforms with possibilities for bundled or value-added services. Pilot projects should seek to involve private entities, such as automobile manufactures and various technology vendors, as well as the tolling industry.
    - Conduct an assessment of the security of various technology applications in terms of protecting driver information and providing security from threats external to the system
    - Determine appropriate charging system for motorcycles, trailers and boats, and light commercial vehicles.

9. RECOMMENDATIONS

Mileage-Based User Fee (MBUF) is the way to provide Transportation Infrastructure Funding.

- ***Ideal System to Implement MBUF: (Collection)***
  1. GPS based
  2. GPS will track time and zone of travel
  3. Mail invoice to owner based on the time and zone of travel at the end of each month similar to telephone, gas and electricity bill

- ***Issues***
  1. GPS is not ready for this challenge ?
  2. Privacy
  3. Distribution of funds among state/county/city and federal governments

- ***Mileage-Based Vehicle Registration (MBVR)***
  1. Vehicle Registration is good for 12,000 miles and not for 12 months
  2. Any vehicle travels more than 12,000 miles between registrations (date of birth) must pay extra fees for additional miles.
  3. Existing technology will be able to handle this feature
  4. When any ticket is issued to a driver, mileage will be included as a part of information.
  5. UD-10 form should be modified to include mileage
  6. MBVR is in addition existing fuel tax

- ***Limitations***
  1. Only good at state level
  2. Federal revenue will not be impacted by this approach
  3. Newer cars pay higher registration fees than older, similar models
  4. Odometer manipulation may be a new business however by adding mileage as part of UD-10 and ticket, this can be minimized or eliminated.

Note: Our proposed approach has been reviewed by Allen Greenberg of USDOT, who is an authority on MBUF and Joshua L. Schank, President of Eno Center for Transportation. Both of them think this an acceptable/doable approach.

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11. ACRONYMS

API	American Petroleum Institute
CAFE	Corporate Average Fuel Economy
CET	Center of Entrepreneurship and Technology
CPG	Cent per Gallon
DOE	Department of Energy
EIA	Energy Information Agency
EV	Electric Vehicles
GPS	Global Positioning System
GVW	Gross Vehicle Weight
LPG	Liquefied Petroleum Gas
MBUF	Mileage -Based User Fees
MBVR	Mileage-Based Vehicle Registration
MPG	Miles per Gallon
MTF	Michigan Transportation Fund
MUSTFA	Michigan Underground Storage Tank Financial Assurance
OBD	On-Board Diagnostic
OBU	On-Board Unit
ODOT	Oregon Department of Transportation
OPEC	Organization of the Petroleum Exporting Countries
OSU	Oregon State University
POS	Point of Sale
TRB	Transportation Research Board
TTI	Texas Transportation Institute
VMT	Vehicle Miles Travelled