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Evaluation of Potential Impacts of Policy Responses to Climate Change on Transportation Revenue Mechanisms

Prepared by: Section 1909 Commission Staff
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Introduction

This paper is part of a series of briefing papers to be prepared for the National Surface Transportation Policy and Revenue Study Commission authorized in Section 1909 of SAFETEA-LU. The papers are intended to synthesize the state-of-the-practice consensus on the issues that are relevant to the Commission's charge outlined in Section 1909, and will serve as background material in developing the analyses to be presented in the final report of the Commission.

This paper presents information on the effect of potential policies for reducing emissions of greenhouse gasses (GHGs) on Highway Trust Fund (HTF) revenues.[i] In the transportation sector, policies to increase energy security and improve air quality have resulted in programs targeted at reducing petroleum consumption and increasing efficiency, such as the Corporate Average Fuel Economy (CAFE) program and use of renewable fuels. Many of these programs also reduce GHG emissions. The chief goal of policy responses to climate change would be to reduce carbon emissions. Since GHGs are emitted across all sectors of the economy, GHG reduction policies would potentially involve all sectors. This paper looks at the effect of potential policies that involve the transportation sector on the HTF. Generally, the details of policy design would determine the extent to which the HTF is affected.

Background and Key Findings

- Changes in existing transportation-specific policies (increases in CAFE or fuel taxes) are likely to affect the HTF, either positively or negatively, depending on their design. Fuel tax increases could create more revenue that could be directed to the HTF. CAFE increases could reduce revenue under existing mechanisms as greater fuel efficiency would likely reduce revenue per mile of travel.
- Economy-wide policies (cap-and-trade program across multiple sectors, national carbon tax) could have some impact on the HTF, as they would likely have a modest impact on fuel costs and thus HTF revenues.
- The size of any transportation specific policies to limit GHG emissions would depend on what policies were applied to other sectors such as electricity generation. For the same level of reduction, fuel taxes or CAFE increases would presumably have to be quite a bit larger if other sectors were not included.
- Policies designed to reduce carbon dioxide emissions from transportation would need to account for how changes in fuel prices could affect fuel consumption and driving habits.
- Several innovative transportation-specific policies (feebates, mileage-based user fees) could play a limited role in reducing GHGs, and could be established in a way that benefits the HTF.

This paper represents draft briefing material; any views expressed are those of the authors and do not represent the position of either the Section 1909 Commission or the U.S. Department of Transportation.

Introduction

Climate change is an issue that the US and many other countries have been grappling with for decades. A variety of measures will likely be needed to keep concentrations of greenhouse gases (GHGs) in the atmosphere from rising to critical levels. Many different policies could be implemented to address climate change. It is likely that the problem of GHGs will have to be addressed in multiple sectors, including transportation, over time. Transportation currently accounts for 28% of U.S. GHG emissions. This paper examines GHG mitigation policies, policies that could be applied at the national level to reduce emissions of carbon dioxide (CO_2), the primary GHG, and assesses their potential impact on HTF revenues. While the analysis focuses primarily on the near term or the next 15 years, it also gives consideration to the medium (30 years) and long term (50 years). Some of the policies are transportation focused, whereas others include transportation as part of an economy-wide effort. The policies considered include:

- Raising CAFE standards
- Establishing vehicle CO_2 emissions standards
- Increasing taxes on motor fuels
- Capping and trading CO_2 emissions (all sectors including transportation)
- Tax on carbon content of fuels
- Assessing mileage-based user fees
- Instituting Feebates
- Supporting development and use of renewable fuels

These policies would use different mechanisms to reduce GHG emissions. Tighter CAFE standards, feebates, and vehicle CO_2 limits push manufacturers to build vehicles that emit less CO_2 per mile traveled, and their effect is gradual as the vehicle fleet turns over. Fuel Taxes, Cap and trade, and Mileage fees use the market to raise the price of driving on a per mile basis and create an incentive for reduced vehicle travel. They have both short-term effects on how people use their existing vehicles and long term effects in future vehicle purchase decisions. Renewable fuel strategies reduce the amount of CO_2 emitted per vehicle mile traveled, and may have secondary effects on travel through changes in fuel prices. Increased support for research can encourage more rapid development of renewable fuels over the longer term such as ethanol, biodiesel and hydrogen, and support for renewable fuels infrastructure can encourage use of such fuels as well. The type of mechanism used by each policy will, to a large extent, determine how and whether the policy will affect the HTF.

Global Climate Change

Greenhouse gases insulate the planet and help it retain heat. Increasing levels of these gases have been linked to global climate change, resulting in higher global average temperatures, though with considerable regional variation. Carbon dioxide accounts for about 85% of all GHGs emitted, measured in terms of global warming potential.[ii] (CO_2 claims an even greater proportion of GHG emissions from transportation, though other emissions like nitrous oxide and methane play a small role.) Transportation emissions are substantial in the national context: more than one quarter (28%) of US GHGs and one third of CO_2 emissions come from transportation, second only to electricity generation.[iii]

In addition to a growing awareness that consumption of fossil fuel affects the climate by raising concentrations of CO_2 and other GHGs, it is becoming clearer that the level of reductions required is quite high. Since the beginning of the industrial revolution, CO_2 concentrations have increased by about a third, from about 280 parts per million (ppm) to 375 ppm in 2005, and concentrations continue to rise at a current rate of about 1.8 ppm annually.[iv]

There are several reasons why effectively addressing climate change is difficult. As economic growth spreads and more countries industrialize, global emissions of CO_2 and other GHGs are increasing, not decreasing. After they are emitted, greenhouse gases such as carbon dioxide remain in the atmosphere a long time. Unlike traditional air pollutants like hydrocarbons and nitrogen oxides, which generally break down in a matter of hours or days, carbon dioxide lasts on the order of 100 years. As a result, current *emissions* will affect global *concentrations* for years to come. In order to stabilize concentrations, the global rate of emissions growth needs to first fall to zero, and then decline steadily. Simply stabilizing global emissions is not enough. For example, an analysis conducted by Princeton University researchers notes that reducing emissions growth to zero over the next 50 years (a reduction of one third compared to emissions under "business as usual," given expected growth) and further reductions thereafter would be required to limit concentrations to about 500 ppm in 2125,[v] which is substantially higher than current concentrations.

This paper does not attempt to identify the level of a future domestic emission reduction policy. For illustrative purposes only, the table below shows the level of reductions needed in gasoline consumption under one scenario. The table estimates reductions necessary to reduce consumption of gasoline (and associated CO_2 emissions) compared to current levels by 5% in 2020, 10% in 2035, and 15% in 2055. When compared to likely consumption under the reference case used by the Energy Information Administration (EIA), that is, consumption under existing policy and rate of growth, the reductions would actually need to be quite large. For example, a 15% reduction in current gasoline consumption would in 2055 be closer to a 53% reduction, because of expected growth in consumption. (The reference case assumes a long term annual growth of 1.2% for both gasoline consumption and CO_2 emissions from energy consumption.)

Annual Gasoline consumption, quadrillion Btu, %

	2005	2020	2035	2055
Consumption, Reference Case [1]	17.00	19.95	24.31	30.87
Consumption, 2005 baseline, then reduced by 5, 10, 15%	17.00	16.15	15.30	14.45
Difference (necessary reduction from Reference Case) to meet caps		3.80	9.01	16.42
Reduction as percentage of Reference Case		19%	37%	53%

[1] Source: EIA, Annual Energy Outlook 2007, table A2, Reference Case (assumes continuation of current policies affecting the energy sector), 2005-2030. Values for 2035 and 2055 calculated assuming continued Reference Case annual growth of 1.2%.

On-road transportation VMT increases by about 2% to 2.5% per year. So, in order to keep emissions from this sector stable, average fleet fuel efficiency would have to increase by a similar rate, or other policies would be required to reduce VMT growth.

Policy options

The policies introduced above and their potential impact on the HTF are discussed below. Three policies in particular have received the most attention in recent debate and are dealt with first: increasing CAFE standards, raising fuel taxes, and cap and trade of carbon emissions rights. Two related policies, a national carbon tax and tailpipe emissions limits, are discussed briefly as they are similar to cap and trade schemes and to CAFE standards. Next, this paper continues with road use metering and feebates, two other fiscal measures that could play a role in reducing GHGs, and thus would affect HTF revenues. The paper concludes with a brief look at how alternative fuel policies might affect HTF revenues.

For a given GHG reduction goal, policies or combinations of policies that affect multiple sectors, instead of just transportation, should have less impact on transportation and HTF revenues.

Increasing CAFE Standards (and instituting tail pipe standards)

Raising CAFE standards could have a direct effect on fuel economy of the US light duty fleet and thus emissions of CO_2 from transportation.

A CAFE increase by itself would have two negative impacts on HTF revenue. First, as fuel efficiency increases, other things being equal, HTF revenues would decline with fuel consumption as tighter standards take effect, over 12-15 years as the vehicle fleet is replaced. Second, the relative reduction in fuel costs per mile could lead to a slight increase in travel (though the effects of congestion may reduce this effect), and thus put more demands on the HTF for construction and maintenance.

Instituting tail pipe regulations to limit GHG emissions per mile would have the same effect as raising CAFE standards, since consumption of a unit of gasoline requires the emission of a corresponding quantity of carbon dioxide into the atmosphere.[vi] Thus, the effect on the HTF would be essentially the same, depending on the design of such regulations.

The CAFE program, administered by DOT/NHTSA, has set fleet mileage standards since the oil crises of the 1970s. Standards for automobiles rose from 18 mpg in 1978 to 27.5 mpg in 1990, and have remained constant ever since. From 1994 to 2002, NHTSA was prohibited from raising CAFE standards by Congressional action. In 2003, shortly after the freeze was lifted, NHTSA raised standards for light trucks from 20.5 mpg to 22.2 mpg for the 2005-2007 years. Under a 2006 rule, CAFE standards for light trucks will rise beginning in 2008 to an average of 24 mpg in 2011.

NHTSA's decision to raise light truck standards for 7 consecutive model years (2005-2011) will contribute to reducing fuel consumption and CO_2 emissions. In addition to the 14.3 billion gallons of fuel saved over the lifetime of the vehicles affected by the standards, NHTSA also completed and instituted a size-based CAFE reform structure that will save more fuel than the unreformed CAFE structure (without negatively affecting safety and jobs). There still will be more reductions in fuel consumption by light trucks once NHTSA sets standards for model years 2012-2014 and beyond. In addition, the regulation of the large sport utility vehicles, beginning in model year 2011, will produce further increases in fuel savings in 2012 and beyond.

Further reductions in fuel consumption and CO_2 emissions could also be achieved by 2010 and beyond if Congress were to give NHTSA the authority it needs to reform the passenger car CAFE program and set CAFE standards accordingly. In May 2006, Secretary Mineta wrote to Congress, asking for legal authority to institute size-based standards for passenger cars as part of a new rulemaking to increase fuel economy standards for passenger cars. Congress has not acted on this request. While the agency cannot precisely quantify the potential reduction of fuel consumed by passenger cars at this time due to unavailability of passenger car data and product plan information, the agency believes that significant fuel economy improvements could be made through raising passenger car standards within a reformed structure. A well-designed, attribute-based system for passenger cars would generally result in more fuel savings than the unreformed flat average CAFE system because it requires all manufacturers, not just a few, to apply additional fuel-saving technologies. It would also address the safety and economic concerns with the unreformed system.

Increasing CAFE standards for passenger cars and light trucks in an effort to reduce CO_2 emissions is of great interest to Congress and to the public, as evident in the various bills that were put forth last year by members of the House and the Senate: Boelhert-Markey (H.R. 3762); Barton (H.R. 5359); Obama-Lugar (S. 3694); Feinstein-Snowe (S. 3543); Sens. Lott and Pryor (S. 2830). While these bills varied substantially, they all focused on raising CAFE standards under a reformed structure.

Raising CAFE standards, however, is potentially costly. NHTSA conducts rulemakings using cost/benefit analysis and sets stringency based on the balancing of 4 statutory requirements, including evaluations of technical feasibility and economic practicability. In the 2006 light truck rulemaking, NHTSA set the stringency at a level that maximizes net economic benefits. Further increases in stringency either by NHTSA or through a legislative mandate of a CAFE goal or an explicit assertion of a very high value for avoided carbon dioxide emissions, depending on the size of the increase, would thus require manufacturers to use more fuel efficient technologies and to develop new technologies to further increase efficiency. This could potentially increase the cost to manufacture and purchase vehicles. In recent years, technology improvements have generally led to increases in horsepower and vehicle size rather than fuel economy. This outcome reflects consumer preferences, which would be costly to overcome—in effect to persuade consumers to buy smaller or lower horsepower vehicles than they currently want.

An increase in CAFE could also cause an indirect or rebound effect of slightly more travel (about 20% of the change in fuel costs induced by CAFE, according to the Congressional Budget Office and studies reviewed by CBO) because the fuel costs of travel become cheaper.[vii] So, if CAFE standards increased such that fuel costs fell by 10%, it would likely cause an increase in VMT of about 2%. However, for urban commuting decisions, the travel cost effects of even large changes in CAFE may be dominated in congested areas by travel time and convenience considerations.

If CAFE standards were raised gradually over the next 50 years, it seems likely that the negative effect on HTF revenues would increase with vehicle efficiency. Other policies such as increased fuel taxes that produced revenue might be necessary to offset these effects.

There are alternative demand and supply side policies aimed broadly at reducing fuel consumption that could complement CAFE regulatory programs and further reduce fuel consumption. In its study, the NAS committee cited some of these policies, which include tradable fuel economy credits, feebates, and higher gasoline taxes and found that these other policies could accomplish the same end as raising CAFE standards at lower cost.[viii] While NHTSA cannot pursue and implement these policies under its existing authority, the agency is working with other Federal agencies, including the U.S. Department of Energy (DOE) the U.S.

EPA (EPA), the U.S. Department of Commerce, and the U.S. Department of the Treasury on a study to evaluate the feasibility of some of these alternative approaches. This study is expected to be completed by the end of the year.

Raising Fuel Taxes

Raising Federal fuel taxes is another option for reducing carbon emissions. Federal fuel taxes on motor fuels are the main source of HTF revenues, and the current Federal tax is 18.4 cents per gallon of gasoline. If taxes were increased, all, none or a portion of the new revenue could be directed to the HTF.

If all or even a significant portion of the revenue from a fuel tax increase was directed to the HTF, it could benefit the HTF greatly. Otherwise, HTF revenues would likely decline. This is because as taxes rise so to would the incentive to reduce fuel consumption by reducing VMT and/or buying a more efficient vehicle. Over time, the fuel tax rate would need to increase with the pace of fuel efficiency increases for HTF revenues to remain stable, other things being equal. A tax increase could also be paired with increases in CAFE standards to offset reductions in HTF revenues caused by CAFE increases.

A fuel tax increase would likely reduce fuel consumption in two ways. First, it would influence driving habits, as drivers of existing cars would have a new incentive to reduce travel immediately by driving less, switching to transit, carpooling, etc. Second, because purchasers would have a greater incentive to buy vehicles with higher fuel economy if taxes and thus fuel prices increased, manufacturers would have a greater incentive to focus on efficiency, and would likely use existing technology and develop new technology to raise fuel economy levels. Any new technologies developed as a result of increased fuel taxes could influence new transit technology over time, just as hybrid technology has. New efficiencies could be expected to lower operating costs of transit vehicles. A fuel tax increase would have an immediate effect on GHG emissions, and according to one analysis could cost less overall than a CAFE increase.[ix]

Taxes, as well as many of the other policy options—cap and trade, VMT fees, feebates—put a price on emissions of carbon dioxide and/or travel, either directly or indirectly. A policy designed to reduce CO_2 emissions would need to account for how changes in fuel prices may affect consumption of fuel and driving habits, which is discussed below.

The price elasticity of demand for gasoline is made up of the (short-term) price elasticity of demand for driving or VMT, and the longer term price elasticity of demand for fuel economy.[x] Elasticity of demand for gasoline varies due to many factors including the current cost of gas, incomes, cost of developing more fuel efficient technologies, alternatives such as public transit, suburbanization, and personal preferences. It also varies over time as these and related factors change.

Economists do not generally agree on the price elasticity of demand for gasoline, but generally it is thought to have become less elastic (that is, consumption is affected less by a change in price) over the last few decades. The evidence of recent years and prior oil shocks suggest that small changes in gasoline prices have nearly imperceptible effects on travel behavior. However, if gasoline prices rise enough so that gasoline expenditures start to significantly affect household budgets, they may stimulate a more robust reaction than can be inferred from data during "normal" periods. Indeed, data from the last few years suggest that a threshold might have been reached beyond which increases in gas prices could have a larger effect on driving and consumption.[xi] In 2005, for example, the rate of increase in VMT was less than 1 percent, due in large part to gasoline prices being more than 25 percent higher than in 2004.

However, if we assume that demand for gasoline is quite inelastic, a very large tax might be necessary before any significant emission reductions are realized. A goal of reducing gasoline consumption, and CO_2 emissions from its use, by 25% for example could mean a very large tax increase. If gas costs $2.00 per gallon today, then it would take a fuel tax increase of $1.28 to reduce consumption by 25%, assuming an elasticity of demand for gasoline of -0.39.[xii] If the elasticity of demand for gasoline is actually lower (or higher), then a greater (or lesser) tax increase would be required to reach the same level of reduction in gasoline consumption.

Cap and Trade (and national carbon tax)

A cap and trade policy or a national carbon tax involves limiting CO_2 emissions across multiple sectors. The effect of such policies on CO_2 emissions depends on how low the cap or how high the tax is set. In isolation, these options would likely have a greater impact on coal consumption than motor fuel consumption, because mitigation costs are higher for transportation than electricity generation and as a result the power generation sector would likely feel the greatest effects.[xiii] Nonetheless, motor fuel costs would likely increase somewhat as costs associated with permits or taxes are passed on to consumers, but given the inelasticity of fuel consumption, impacts on HTF revenue may be limited.

By themselves transportation-focused policies would have a limited effect on reducing US GHG emissions, as transportation is only a part of the problem. For a given CO_2 reduction target, economy-wide measures like cap and trade or a carbon tax that involve all sources could reduce emissions more efficiently because they use the market to generate reductions at the lowest cost.

Both a cap and trade[xiv] policy and a tax on the carbon content of fossil fuels would encourage affected entities (producers and consumers) to reduce emissions at the least cost, and could perhaps be varied over time as the understanding of climate change improved. In both cases, regulated sources would have an incentive to reduce emissions if they can do so at a cost below either the market price of the permits or the tax rate.

Cap and trade involves setting a cap on carbon emissions, allocating CO_2 emissions permits to affected parties, and requiring that all emissions be tied to a permit. The value of the permits is ultimately set by the market, based on supply and demand for the permits. Caps could either be set upstream on producers/importers of fossil fuels, or downstream on the consumers of fossil fuels, including power plants and transportation sources.

A national carbon tax, on the other hand, would add a tax to fossil fuels based on their carbon content. Under either policy, the cost of fuels would rise based on the carbon content, and these costs would spread throughout the economy. Producers and consumers would have an incentive to develop or switch to fuels with a lower carbon content such as renewable fuels (e.g., ethanol, biodiesel), natural gas, or nuclear at the expense of higher carbon fuels such as petroleum and particularly coal.[xv]

In the initial allocation, permits could either be sold at their expected market value, sold at a reduced rate, or given to affected entities based on historical use.[xvi] The total value of all the permits would depend on the level of expected reductions, but is likely to be quite large; issues of fairness and varied economic effect on different groups would require consideration. With a carbon tax, a portion of tax receipts could be used to more fairly distribute its effect on different economic groups by offsetting other taxes, but such issues are not the focus of this paper.

Various cap and trade proposals have been raised in Congress, including S.139, The McCain-Lieberman Climate Stewardship Act of 2003.[xvii] As initially drafted, this proposal would have capped emissions from commercial, industrial, electric power, and transportation sources; it excludes emissions from smaller sources as well as direct emissions from the residential and agricultural sectors. The transportation sector is covered by capping allowances at oil refineries; while the initial draft included provisions specific to transportation sources, they were later dropped to avoid double counting. The bill caps emissions of the covered sectors at 2000 levels in 2000-2015, and reduce the cap to 1990 levels beginning in 2016; emissions allowances would be allocated annually. The bill includes a variety of flexibilities, including banking (allows emissions allowance to be saved and used in the second phase, when allowances are likely to be more valuable) and offsets (reductions by non-covered sources that are registered and then sold to entities covered by the bill).

The EIA analyzed the effects of the bill on the reference case (that is, continuation of current policy) that forms the basis of its *Annual Energy Outlook (2003)*, and found that by 2025 US carbon emissions would fall to 2000 levels. According to the EIA analysis, which is based on assumptions about how trading and technology would develop, the majority of CO_2 reductions, 88% of the energy-related reductions in 2025 compared to the reference case, would come from the electricity generation sector and largely from reductions in coal use. While petroleum and particularly coal use would decline, the analysis found that the use of renewable fuels, natural gas and nuclear power would increase.

Furthermore, it found a smaller effect on transportation (-10% emissions of CO_2) than the commercial (-60%), residential (-55%) and industrial (-34%) sectors compared to the reference case in 2025. The EIA analysis projected that the bill would cause light duty vehicle VMT to fall by 8% and fuel efficiency of light duty vehicles to increase by 1.3 mpg (5%) for a net reduction in gasoline consumption of 13%, compared to the reference case in 2025. Gasoline prices would rise by 19 cents in 2010 and 40 cents/gallon (27% increase) in 2025, while electricity prices would rise at almost twice the rate, 46%.

The impact of a cap and trade program (or a national carbon tax) on the HTF depends in part on the design of the system including how permits are allocated across the economy. Under a cap and trade system like S.139, fuel consumption would decrease, and other things being equal, this would have a negative effect on HTF revenue.

The EIA analysis of S.139 sees gasoline consumption falling steadily, which means that HTF revenues would decline steadily, at least over the short and medium term. One mitigating factor is that the analysis also shows a decline in light duty vehicle travel of 8%, thereby reducing demand on the HTF.

A carbon tax similarly would discourage fuel consumption, so, unless a portion of a carbon tax generated from motor fuel sales were directed to the HTF, HTF revenues would decline.

Mileage-based User Fees

Also known as VMT fees or road use metering, mileage-based user fees are related to tolling as they set a price based on vehicle use (VMT). A mileage-based fee measure would charge a fee based on use, not fuel consumption, and thus is more closely tied to the effects of vehicle use (road construction and maintenance, congestion) than fuel taxes.

Mileage-based user fees could have a beneficial effect on HTF revenues as long as a portion of the revenue was directed toward the HTF. Second, road use metering would create an incentive to reduce travel, thus reducing HTF outlays in the long run as road construction and maintenance costs declined compared to baseline growth, other things being equal. Such a policy would be likely to encourage some drivers to switch to transit where available, and the magnitude of this effect would depend on how high the fees were set.

In its simplest form, this measure would apply to all VMT, while tolls generally apply only to limited access networks.[xviii] If feasible, such a policy could replace traditional highway funding that comes largely from fuel sales. Depending on the level of the fees, road use metering could also be a useful policy to address climate change, similar to increases in fuel taxes, though road use metering likely would not by itself encourage increased fuel efficiency.

In both the US and Europe, efforts are under way to develop a system of road use metering.[xix] In the US, a year-long pilot begun in 2006 in Oregon examines ways to collect mileage fees (as well as congestion pricing and tolling).[xx] Both GPS and odometer reading equipment are options for recording VMT traveled at each trip to the gas station, and the Oregon study is evaluating the two technologies as well as paying fees either at the gas station with the fuel bill or later. The Oregon pilot sets a rate of 1.2 cents per mile.[xxi]

The program could be phased in gradually as new vehicles included the technology to record VMT.[xxii] Also, different rates could be set to encourage purchase of more fuel-efficient vehicles. For road use metering to be a significant tool for reducing emissions of CO_2, the fees would have to be high enough to encourage drivers to focus on the amount of travel in their current vehicle. The elasticity of demand for driving with respect to operating costs would need to be considered in setting specific rates.

Mileage-based user fees could be considerably more effective if paired in congested urban areas with congestion pricing. Such a combined policy could use existing road capacity more effectively, limit peak travel demand, and increase in-service fuel economy of existing vehicles through reduced acceleration/deceleration cycles and idling. Most of the gains would come from time savings by the traveling public.

Feebates

The concept of feebates is a program designed to encourage people to consider fuel economy when they purchase a vehicle. An initial fuel economy target is set (perhaps based on current average fuel economy), and purchasers are charged an extra fee (or given a rebate) based on how much less (or more) efficient their new vehicle is. Vehicles that exceed the target are given a rebate at the time of purchase proportional to how much more fuel efficient their vehicle is than the target.

Depending on the goal, this measure could be designed to be revenue neutral, so that the payments made to drivers of more efficient vehicle are completely balanced by revenue from fees assessed on less efficient vehicles. In this case, HTF revenues would be expected to decline with fuel sales as the fuel efficiency of new vehicles increased and the fleet turned over. In this respect, the policy is similar to CAFE. However, a feebate policy could be designed to direct a portion of the fees to the HTF to offset declining fuel tax receipts.

Under this policy, buyers would have an incentive to purchase more efficient cars, which would encourage manufacturers to meet this demand by selling more high-mileage vehicles and thus raise their fleet's fuel economy.[xxiii] Over time, the average efficiency of the fleet would rise, and thus the policy would push average fuel economy upwards. This type of policy could be implemented gradually in order to give manufacturers time to respond, by slowly raising the fee/rebate assessed per mile difference from the target. Alternatively, mileage targets could be set for different types or sizes of vehicles,[xxiv] though this could reduce the incentive to switch away from heavier/less efficient vehicles. As with CAFE increases, there would likely be a slight rebound effect of slightly increased travel as the relative per mile cost of driving fell.

The speed with which average fuel efficiency rises under this policy would be greatly affected by the level of the fees. Some reports have noted that consumers are only willing to pay more for fuel savings in the first 3 years or 50,000 miles of use.[xxv] So, a fee/rebate that reflects the value of the fuel wasted/saved over the life of the vehicle could help buyers make purchasing decisions that affected the true costs of inefficient vehicles. While raising vehicle costs would be expected to encourage use of transit, increased fuel efficiency could dampen this result due to the rebound effect.

A feebate policy differs from CAFE in that CAFE produces definite fuel economy results, though the compliance cost is uncertain. A feebate policy, by contrast, imposes a set of definite costs and rebates on consumers, though the fuel economy results of the feebate are uncertain.

Alternative Fuels Development

There are several policies that could be adopted to encourage development and use of alternative fuels.[xxvi] As a national GHG policy, a biofuel strategy would be effective to the extent that reduced GHG emissions in the transportation sector are not offset by higher GHG emissions in the agricultural sector. These policies include alternative fuel vehicle (AFV) mandates, support for research and development of fuels and refueling infrastructure, and increasing the existing renewable fuel standard. There is also an existing subsidy of $0.51 per gallon for fuel ethanol and $1.00 per gallon for virgin biodiesel. Future policies might be combined with these subsidies or replace them. Since 2005, ethanol tax credits are no longer drawn from the HTF.

Mandates or incentives for purchase or sale of alternative fuel vehicles can help generate demand for alternative fuels. Under existing law, manufacturers can obtain a 'CAFE credit' for building alternative fuel or flexible fuel vehicles. This law has stimulated the manufacture for several hundred thousand flexible fuel vehicles each year. Future policies might be combined with this program or replace it.

Support for R&D, either through direct funding or indirect methods such as tax credits, aims to stimulate research so that alt fuel development advances more quickly. R&D incentives are likely to have a greater effect over the medium and long term. The effect on the HTF would depend on the extent to which these policies promote use of alternative fuels and the extent to which alternative fuels are taxed.

Increasing the renewable fuel standard would require that a certain fraction of gasoline or gasoline and diesel consumption be provided from renewable sources, probably ethanol and biodiesel. The Energy Policy Act of 2005 requires that the gasoline pool contain 7.5 billion gallons of renewable fuel in 2015, or about 5 percent of the national gasoline pool.

A renewable fuel standard creates, in effect, a cross-subsidy between gasoline and diesel on the one hand, and the applicable renewable fuels, since gasoline blenders would be willing to pay extra to get renewable fuels in order to earn the right to sell gasoline. It thus functions as a tax on gasoline/diesel and a subsidy to renewable fuel producers. The magnitude of the tax/subsidy depends on the volume of renewable fuels required under the standard and the actual cost of producing renewable fuels in the necessary volume.

If renewable fuels are available in sufficient volume at the prevailing price, the tax/subsidy element is negligible, and the price paid by consumers would increase at most marginally. In fact, there could be a neutral to a slight positive impact on the HTF, since the addition of ethanol slightly increases the volumetric quantity of fuel subject to tax. On the other hand, if renewable fuel production costs force automotive fuel suppliers to raise prices to cover the costs of the renewable portion, then prices paid at the pump could increase such that total fuel sales would fall enough to lower HTF revenues.

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[i] Impacts on other funding mechanisms such as toll roads or congestion pricing are not considered in this paper because they are too speculative or too site specific to address here.

[ii] EPA, 2006. *Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2004*, p. ES-4. http://www.epa.gov/climatechange/emissions/downloads06/06_Complete_Report.pdf

iii EPA, 2006 , p. ES-13 (for GHGs) and EIA, Annual Energy Outlook 2007, table A18, http://www.eia.doe.gov/oiaf/aeo/pdf/appa.pdf.

[iv] http://www.epa.gov/climatechange/science/recentac.html, as of Dec 2006. Cites NOAA *State of the Climate Report*, 2005.

[v] Pacala, S., R. Socolow, August 13, 2004. "Stabilization Wedges: Solving the Climate Problem for the Next 50 years with Current Technologies," *Science*, p. 968-69.

[vi] California passed AB 1493 four years ago, a bill to reduce GHG emissions from passenger vehicles. The law charges the California Air Resources Board to develop and adopt regulations to reduce GHG emissions from vehicles. (The law was challenged in court by the Alliance of Automobile Manufacturers in 2004.)

[vii] Congressional Budget Office, *Reducing Gasoline Consumption: Three Policy Options*, November 2002, pp. 14-15, 17. Points to a probable range of 0.1 to 0.3

[viii] NRC, 2002. Effectiveness and Impact of Corporate Average Fuel Economy (CAFE) Standards. Washington D.C.: National Academy Press.

[ix] Congressional Budget Office, *The Economic Costs of Fuel Economy Standards versus a Gasoline Tax*, December 2003. This study compares the costs of reducing gasoline consumption by 10%, by either increasing CAFE (by 3.8 mpg) or increasing gas taxes (by $0.46, assuming an elasticity of demand of -0.39). CBO found that during the phase in period, the tax option would save 42% more gasoline and cost producers and consumers combined 27% less. A similar comparison conducted today would need to account for changes in fuel prices, incomes, and the elasticity of demand for fuel.

[x] CBO, December 2003, p. 12.

[xi] One DOE study pointed to a long-run price elasticity of demand for gasoline of -0.38 in the mid 1990s, and noted that this had declined over time from -0.81. [-0.38 means that if the price increases 10%, gas sales would fall by 3.8%.] Research at UC Davis points to lower elasticities since 2000, though recent data suggests that there may be a threshold beyond which demand elasticity for fuel increases greatly, that is, a change in price has a higher impact on consumption than at lower prices; in the last few years, when gas prices increased precipitously, the growth rate in VMT declined, and VMT per licensed driver fell slightly. See Congressional Budget Office, *Reducing Gasoline Consumption: Three Policy Options*, November 2002, p. 17 citing DOE, *Policies and Measures for Reducing*

Energy Related Greenhouse Gas emissions: Lessons from the Literature, 1996. Also, David R. Baker, Dec 1, 2006.Gas Prices Hardly Affect Demand, *San Francisco Chronicle*, on more recent elasticities.

[xii] CBO, December 2003, p. 12. Also, "inelastic" means that a change in fuel costs leads to a comparatively small change in fuel consumption.

[xiii] EIA, "Analysis of S.139, the Climate Stewardship Act of 2003: Highlights and Summary," June 2003, p.3.

[xiv] For more on Cap and Trade, see two studies by CBO: *An Evaluation of Cap-and Trade Programs for Reducing U.S. Carbon Emissions*, June, 2001 and *Shifting the Cost Burden of a Carbon Cap-and-Trade Program*, July 2003.

[xv]In the US, coal contains about 75% more carbon per Btu than natural gas, while motor gasoline contains about 30% more carbon than natural gas. See EIA, *Documentation for Emissions of GHGs in the United States 2003*, May 2005 http://www.eia.doe.gov/oiaf/1605/ggrpt/documentation/pdf/0638(2003).pdf

[xvi] In the sulfur dioxide program implemented in the 1990s, sulfur dioxide emissions permits were largely allocated to existing sources (electricity generators and industrial facilities) based on past emissions. Some credits were reserved and auctioned to new entrants.

[xvii] For more on this, see: EIA, "Analysis of S.139, the Climate Stewardship Act of 2003: Highlights and Summary," June 2003, particularly pp. 1-4, 14, 17, 19.

[xviii] *The Fuel Tax and Alternatives for Transportation Funding: Special Report 285*, p.123-24. http://onlinepubs.trb.org/onlinepubs/sr/sr285.pdf

[xix] Sorensen, Paul A., Brian D. Taylor, 2005. *Review and Synthesis of Road-Use Metering and Charging Systems*, p. 82. Available online at: http://onlinepubs.trb.org/onlinepubs/news/university/SRFuelTaxRoad-MeterPaper.pdf

[xx] "Usage-based Vehicle Charges," accessed Dec 13, 2006. http://ops.fhwa.dot.gov/tolling_pricing/value_pricing/projtypes/usagebasedvehchgs.htm

[xxi] Westover, Craig, April 5, 2005. Oregon to Test Taxing Motorists by the Mile. *Govpro.com* http://www.govpro.com/News/Article/31456/

[xxii]Transportation Research Board, 2006. *The Fuel Tax and Alternatives for Transportation Funding: Special Report 285*, p.141-43. Available at http://onlinepubs.trb.org/onlinepubs/sr/sr285.pdf and Katherine Pickavet, December 2004. The Road Too Traveled. *Government Technology*. Available at *http://www.govtech.net/magazine/sup_story.php?id=92348&magid=17&issue=12:2004*

[xxiii] *Greenhouse Gas Reduction Strategies in Utah: En Economic and Policy Analysis*, http://yosemite.epa.gov/OAR/globalwarming.nsf/UniqueKeyLookup/RAMR5ECRCK/$File/UtahActionPlan.pdf

[xxiv] *Transportation and Global Climate Change: a Review and Analysis of the Literature*, 1998, p. 76.

[xxv] Greene, David L., Andreas Schafer, May 2003. *Reducing Greenhouse Gas Emissions from US Transportation*, 15.

[xxvi] Alternative fuels include renewable fuels, also known as biofuels (ethanol and biodiesel), fossil fuels with lower carbon emissions (compressed natural gas and liquefied petroleum gas), and other sources whose carbon content depends on how they are generated (hydrogen and electricity).