Comparing Greenhouse Gas Reductions and Legal Implementation Possibilities for Pay-to-Save Transportation Price-shifting Strategies and EPA's Clean Power Plan[1]

Allen Greenberg[2]

Washington, DC
(202) 366-2425
Allen.Greenberg@dot.gov

John (Jay) Evans[2]

Cambridge Systematics, Inc.
3 Bethesda Metro Center, Suite 1200
Bethesda, Maryland 20814
(301) 347-9100
jevans@camsys.com

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[2] Although the first author is employed by the Federal Highway Administration (FHWA), the views expressed are not those of the FHWA or the U.S. Department of Transportation, and instead are solely those of that author. The views expressed are also not necessarily those of Cambridge Systematics, the employer of the second author, whose contributions were exclusive to the modeling and related analysis portions of this research.

ABSTRACT

This study models potential greenhouse gas (GHG) emissions reductions from public policy measures to bring about a set of innovative, revenue-neutral transportation pricing reforms including (a) pay-as-you-drive-and-you-save car insurance, (b) parking cash out, and (c) the conversion of fixed state and local vehicle sales taxes into distance-based taxes designed to raise equivalent revenue. By converting fixed costs into variable per-mile charges, and automobile-specific subsidies into modal-neutral subsidies (pedestrians, cyclists, carpoolers and public transit passengers receive benefits of equivalent value), these low-cost strategies give travelers significant financial incentives to curtail their driving and provide major co-benefits including reductions in traffic and parking congestion, automobile crashes, and local pollution. The study proposes using the U.S. Environmental Protection Agency's Clean Power Plan regulatory framework to bring about the transportation pricing reforms, and discusses Federal administrative authority to compel states to implement the reforms, or other measures yielding equivalent GHG emissions reductions, through a model State Implementation Plan and Federal Implementation Plan. Also modeled is an alternative Federal policy measure designed to appeal to a growing number of conservatives in Congress who favor non-regulatory approaches to reduce GHGs, such as tax incentives. Estimated reductions are 140 or 257 million metric tons of carbon dioxide equivalent annually, for the tax incentive and regulatory policy, respectively, which equates to 37 or 69% of the Clean Power Plan reductions, or 1.7 or 3.0 times the reductions of a nationwide transportation fuels cap-and-trade program with a permit price at the $50 per ton year-2030 social cost of carbon.

EXECUTIVE SUMMARY

Light duty passenger motor vehicles account for nearly 20% of total U.S. carbon emissions, but the U.S. Environmental Protection Agency (EPA) currently does not directly address these emissions from existing light duty vehicles (LDVs). It has, in its greenhouse gas (GHG) rulemakings affecting transportation, dealt only with such emissions as related to fuel economy for new vehicles. This is a significant potential missed opportunity.

Converting fixed driving costs to variable per-mile charges—and offering cash savings in lieu of parking that is bundled or otherwise provided for free—encourages voluntary curtailment of driving and related decreases in GHG emissions, traffic and parking congestion, crashes, and local pollution. These are revenue-neutral strategies; once implemented they impose no government costs and can provide significant government savings and efficiencies by reducing infrastructure costs to accommodate the growth of driving, and healthcare costs associated with crashes and air pollution. This paper explores possible regulatory approaches and the associated potential benefits to help achieve goals for the reduction of GHG emissions by setting transportation efficiency targets that are based on simultaneously deploying (a) pay-as-you-drive-and-you-save (PAYDAYS) car insurance, (b) parking cash out, and (c) the conversion of state and local sales taxes on newly purchased vehicles to mileage taxes designed to raise equivalent revenue. Through the use of a spreadsheet model, the authors estimate that a universal application of these measures could reduce GHG emissions by 257 million metric tons (MMT) of carbon dioxide equivalent (CO_2e) in year 2030 or 69% of the 375 MMT of CO_2e reduction projected to result from implementation of the Clean Power Plan rule, which has been called the most significant U.S. government action ever for reducing GHG emissions.

This study explores whether a transportation price-shifting policy bundle could be used to establish state-level carbon emissions reduction targets through Federal administrative action absent any additional Congressional authority. It examines related sections of the Clean Air Act (CAA) and Federal surface transportation law and investigates whether legislative authority exists to further bolster carbon reduction targets by limiting project selection authority to bring about investments that encourage vehicle-miles-traveled (VMT) reductions. The legal authority to price transportation fuels, such as through a cap-and-trade at the $50 per ton rate of the year-2030 social cost of carbon (SCC)—a much less effective carbon reduction strategy than the transportation price-shifting policy bundle (yielding reductions of 85 MMT CO_2e, or only 22% of those from the final Clean Power Plan rule) —is also contemplated as a second-best alternative.

Several options were explored for legal authority for implementation. CAA Sec. 115 was found to provide the broadest legal authority, including allowing EPA to set and enforce carbon targets through State Implementation Plans (SIP) based on the GHG

emissions reductions that would result from enacting a transportation price-shifting policy bundle, and possibly also basing such targets—but only in CAA nonattainment areas—on making infrastructure investments that encourage VMT reductions. In all areas, the burden of having to meet emissions targets tied to a transportation price-shifting policy bundle could be mitigated by allowing offset credits for funding of transportation infrastructure projects that reduce carbon emissions below an established baseline.

After reviewing constraints posed by the U.S. Constitution, statutes, and case law, this research proposes a model SIP and Federal Implementation Plan (FIP) under Sec. 115 authority which include, to the extent allowable, the elements of the transportation price-shifting policy bundle. The FIP is only deployed if a state fails to modify its SIP in response to EPA issuing an "endangerment finding" and setting related emissions limits; it must be implemented by the Federal government itself, which places practical constraints on its contents.

In the event of Federal administrative inaction, this research discusses two alternatives:

1. States with leadership that has shown particular interest in mitigating GHG emissions may enact the transportation price-shifting bundle on their own without Federal involvement. Using two different proxies for categorizing states as politically supportive of aggressive climate action, this would yield nationwide reductions in GHG emissions of 91 or 103 MMT CO_2e or 35 or 40% of the 257 MMT CO_2e reduction that would result in year 2030 if deployed in every state.

2. Targeted Federal legislation focused on price shifting. A number of prominent conservatives are on record as favoring legislatively enacted pricing measures over administrative regulations to reduce GHG emissions (although many conservatives do not like either, but may nonetheless accept the former in exchange for "environmentalist" votes in Congress for broader tax reform). Such legislation may include a Federal parking cash-out requirement coupled with a new Federal tax credit to reward companies for offering compliant PAYDAYS insurance products and states for shifting fixed vehicle sales taxes to mileage fees. Assuming that these tax credits impact 20% of insurance policies nationwide and in each state, and all car sales in states that are likely to respond by enacting tax shifting, the law would deliver nationwide reductions in GHG emissions of 140 MMT CO_2e or 55% of the 257 MMT CO_2e reduction if the transportation price-shifting bundle were applied universally.

These alternatives would bring about from 1.1 to 1.7 times the 85 MMT CO_2e emissions cut of a nationwide transportation fuels cap-and-trade program with a permit price at the SCC.

INTRODUCTION

A final rule by the U.S. Environmental Protection Agency (EPA), Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units (USEPA, Oct. 2015), also referred to as the Clean Power Plan, has garnered substantial praise within the environmental community, including being called by environmentalists the most important regulatory action the U.S. government has ever taken to reduce greenhouse gas (GHG) emissions and address climate change. (In terms of policy strategies enacted prior to the Clean Power Plan, the joint rule of EPA and the U.S. Department of Transportation (DOT), National Highway Traffic Safety Administration (NHTSA), to regulate carbon emissions and fuel economy from model year 2017-2025 light duty vehicles (LDVs) (USEPA & USDOT 2012) is widely credited with reducing GHG emissions more than any other U.S. government action.) This paper examines the possibility of meaningfully adding to the anticipated reductions in GHG emissions from the final Clean Power Plan rule by adopting an analogous rule to set and meet reduction targets associated with policies that encourage personal transport efficiency.

Passenger LDVs account for 19.9% of total U.S. carbon emissions (USEPA, April 2015). EPA regulations are already addressing sources of emissions that are both larger (e.g., power plant emissions responsible for 31% of total U.S. GHG emissions (USEPA, April 2015)) and smaller (e.g., EPA's Significant New Alternatives Policy program final rule, issued on July 2, 2015, under the authority of Clean Air Act (CAA) Sec. 612, banning certain hydrofluorocarbons (USEPA, April 2015)). The EPA Administrator also signed an endangerment finding for GHG emissions coming from aircraft emissions on July 25, 2016, beginning the process of establishing a regulatory response (USEPA 2016). The absence of addressing GHG emissions from existing LDVs becomes even more apparent as EPA addresses additional lesser sources of emissions.

This research explores the efficacy of a potential regulatory approach to achieving GHG reductions from the use of personal transportation and calculates the level of reductions in GHG emissions that would result from setting targets for transportation efficiency on the basis of deploying three strategies for transportation demand management (TDM) that have either been demonstrated or modeled to be particularly effective at encouraging voluntary reductions in vehicle-miles traveled (VMT) and related GHG emissions. These strategies, described in detail later, are (a) pay-as-you-drive-and-you-save (PAYDAYS) car insurance, (b) parking cash out as an option that employers choosing to subsidize commuter parking would be required to offer their employees, and (c) converting state and local sales taxes on newly purchased vehicles to mileage taxes—spread over the first three years of vehicle ownership—that are set at a rate to raise equivalent revenue.

As with the Clean Power Plan, the efficiency strategies examined here are used only to calculate statewide targets that a state in turn could meet by using these strategies or equivalently effective strategies of its choosing. The projected reductions in transportation emissions are compared, both nationally and state by state, against those anticipated from the prevailing 2030 target of a 32% nationwide average reduction included in the electric utility rule. The comparison, though, is between 2012 and 2030 instead of starting from 2005 (a peak year for power-sector carbon emissions and also a year of very high emissions from personal transport), the year that the electric utility rule uses as its baseline to derive the figure of a 32% reduction by 2030.

While EPA has pursued a comprehensive rulemaking approach to curtail power sector GHG emissions from both new and existing sources—including addressing plant-level efficiency through so-called "heat rate improvements," fuel switching in power generation, and expansion of low- and no-carbon power sources (USEPA, Oct. 2015)—it has, in its GHG rulemakings affecting transportation, dealt only with such emissions as related to fuel economy for new vehicles, ignoring the existing vehicle fleet and not engaging drivers in TDM.

Excessive reliance on driving alone in many metropolitan regions throughout the United States is causing overwhelming traffic congestion and air quality and safety problems, and is a major contributor to U.S. GHG emissions. These problems are exacerbated by the fact that, while the fixed costs of driving are quite high, the incremental costs for each mile of driving are low. Most of the costs of owning and operating a vehicle are fixed. Once a person has chosen to acquire and insure a vehicle, which is the case for the vast majority of Americans, little financial incentive exists not to use it for most trips. By contrast, the per-trip price for public transit is generally noticeably higher than the incremental cost of driving.

In exchange for reducing fixed driving costs and for revealing otherwise hidden parking costs (such as employer-provided parking), many drivers—especially lower-income ones—would readily accept new mileage charges and would relish cash-in-lieu-of-parking benefits that they control by modifying the amount they choose to drive and the decision on how to travel to work. Motorists, of course, will only reduce their driving when the savings offered by usage-based pricing exceeds the value of particular drive-alone trips to them. Driving reductions result from voluntary trip consolidation, carpooling, alternative transportation use, and forfeiting of low-value trips.

Various studies have shown transparent pricing of parking and vehicle travel to be tremendously beneficial in reducing VMT and related negative externalities. One modeling study, in particular, shows such strategies to be the most effective for reducing U.S. GHG emissions from the transportation sector while also saving most households substantial sums of money. Specifically, the report *Moving Cooler: An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions*, a joint effort of multiple Federal agencies, environmental organizations, and Shell Oil, shows the importance of implementing various packages of policy measures in reducing VMT and related GHG emissions. Significantly, when fully variable PAYDAYS insurance was added to a bundle of land use-transit-nonmotorized transportation measures (one of a number of policy bundles evaluated), the model showed a 44% greater reduction in transportation-related GHG emissions through 2050 than without the inclusion of such insurance (Cambridge Systematics 2009).

Focusing on TDM strategies that save money and do not impose additional costs on motorists can reduce political opposition, such as what resulted from the Employee Commute Options (ECO) mandate included in Section 182(d)(1) of the Clean Air Act Amendments of 1990. While a number of state and regional programs to encourage driving reductions were instituted in the 1970's and 1980's, and the Federal government offered encouragement to such programs during those decades, the 1990 Federal mandate caused a backlash that led to its rollback. The mandate applied beginning in 1994 only in nine severe ozone nonattainment areas and for employers with over 100 employees. Covered employers had to submit plans to reduce commute trips such that resulting average vehicle occupancies were supposed to be at least 25% above the regional average. While there was no sanction for failing to achieve the reductions, complaints about costs and lack of effectiveness associated with typical TDM measures led Congress to make ECO optional so long as whatever emissions reductions that were attributed to it in SIPs would instead be achieved through other means (Crimmins 1995). Shortly before the repeal, one libertarian organization, the Reason Foundation, called for gutting the ECO mandate and replacing it with less bureaucratic and costly requirements, including calling explicitly for parking cash out (Green 1995).

The legal path to requiring states to implement TDM actions to reduce GHG emissions appears, at first glance, to be less straight forward than to regulating power sector GHG emissions. In the case of the latter, CAA Sec. 111 provides EPA the same explicit authority to regulate pollutant emissions from existing stationary sources (Sec. 111(d)) as from new sources (Sec. 111(b)), and indeed requires regulations for both after making a so-called "endangerment finding" under Sec. 111(b) that a source "causes, or contributes significantly, to air pollution which may reasonably be anticipated to endanger public health or welfare." The "standard of performance" requirement for such regulation is defined within Sec. 111 to be "the application of the best system of emission reduction."

This research looks closely at what may and may not be legally allowable for a transportation efficiency rulemaking, exploring in detail various sections of the Clean Air Act. As a practical matter, though, the Federal political environment has changed with the election of President Donald Trump, who has stated strong opposition to EPA's past use of regulations including related to reducing GHG emissions. Regardless of what may be legally possible, it is the President's discretion whether or not to use EPA regulatory authority in the specific manner discussed in this research.

Adding further uncertainty, EPA's Clean Power Plan has generated significant policy and legal controversy. At the urging of 26 states, but against the objection of 18 states supporting EPA, a U.S. Supreme Court five-to-four majority issued a stay, without providing any rationale, of the final Clean Power Plan rule in *West Virginia, et al., versus EPA, et al.*, on Feb. 9, 2016. Justice Scalia was in the majority and then passed away days later on Feb. 13. The stay is pending disposition of review by the U.S. Court of Appeals for the District of Columbia, which held an en banc or full-panel hearing on September 27, 2016, and then by the U.S. Supreme Court, assuming it is sought and then granted. The U.S. Supreme Court's stay of a rulemaking before a lower court review and well before its requirements kick in is unprecedented. While predicting the ultimate outcome of any judicial review is by nature highly speculative, a host of media sources project that the liberal-leaning D.C. Circuit Court will be predisposed to rule in favor of EPA.

Regardless of whatever Federal role will emerge, it may be illuminating to contemplate, as this research does, states with leadership concerned about climate change taking aggressive transportation mitigation measures, and what their resulting CO_2e emissions reductions would be. A number of U.S. governors, led by California Governor Jerry Brown, have pledged aggressive state-level climate action even if the Federal government steps away.

It is also valuable to understand what Federal authority may exist to curtail GHG emissions, even if it is not used now, along with the related international commitments that the U.S. has made to date, even if it is contemplating backtracking from some of them. The Dec. 2015 Paris Agreement, which emerged from a 197-nation negotiation, demonstrates a consensus among the world's political leaders to aggressively tackle climate change. Stemming from the agreement, the combined intended nationally determined contribution (INDC) pledges to reduce GHG emissions, while moving toward meeting the agreement's primary objective to limit worldwide temperature increases to no more than 1.5 or 2 degrees Celsius, currently fall short and thus will need to be strengthened over time if the target is to be met. In the case of the U.S. meeting its INDC commitment (which the Trump administration is not supporting), multiple studies have projected failure even if the Clean Power Plan were to be fully implemented along with the new fuel economy standards and all other recently enacted GHG reduction measures (Greenblat & Wei 2016). In this context, consideration of policy approaches that would yield additional GHG emissions reductions in the U.S. is as important as ever.

Since transportation emissions have surpassed all other sources, including power sector emissions, in the U.S. (Plumer 2016), and is the only sector of the U.S. economy to have increased emissions in 2016, with "motor gasoline" emissions increasing by 1.8% as coal emissions decreased by 8.6% (U.S. Energy Information Administration 2017), focusing on curtailing transportation emissions—especially from neglected but nonetheless proven strategies for influencing travel demand—may be a good place to start. This realization that new and more aggressive strategies to curtail personal transport emissions are needed is beginning to be shared by some advocates at the forefront of addressing climate emissions, such as California's Next 10. The group notes an increase in statewide light-duty vehicle emissions of 4.4% from 2014 to 2015 (the most recent year in which it is confident in the statewide data) while total emissions decreased, and this trend continuing despite very sizable state government investments in clean transportation, including most recently a $369 million FY 2016-2017 appropriation to spur clean vehicle development and sales, plus other “clean” transportation investments, such as $93 million for high speed rail and $172 million for transit and intercity rail capital (California Green Innovation Index 2017).

SELECTED POLICIES AND POLICY PARAMETERS FOR CALCULATING GHG REDUCTIONS

For this paper, the authors have developed a spreadsheet model (presented in Appendix 1) to permit the evaluation of three transportation price-shifting policy strategies that are bundled together. For each of the three policy strategies, the “Policy Background” subsection provides a brief research summary and explanatory context about the strategy and a “Scenario Description” subsection provides the associated policy parameters used in arriving at the potential GHG emission reductions.

PAYDAYS Insurance

Policy Background

PAYDAYS insurance—commonly known as usage-based insurance—converts all or some portion of fixed insurance costs to per-mile or per-minute-of-driving charges. Traditional rating factors (e.g., residential location, gender, age, and driving record) are directly incorporated into usage-based rates (including applying lower per-mile rates in rural areas than in urban areas), with such rates also reflecting the specific coverage a driver chooses. PAYDAYS insurance is likely to result in charges that more accurately reflect crash risk, as they are, based on usage. By contrast, traditional insurance rates vary little, if at all on the basis of mileage, even though few claims are made for damages such as theft that may happen when a vehicle is not being driven.

Studies estimate that converting fixed costs into mileage-based variable costs could reduce VMT between 8% and 20% (Litman 1997 and 2004, Barrett 1999, Parry 2005Bordoff & Noel 2008, and Ferreira & Minikel 2010 and 2012). The Brookings Institution estimated that fully variable PAYDAYS insurance pricing would provide between $50 billion and $60 billion in net benefits in the United States from reduced driving-related externalities, such as related to congestion costs, infrastructure costs to accommodate the growth of driving, and healthcare costs associated with crashes and air pollution (Bordoff & Pascal 2008).

While the risk of an insurance claim is directly related to driving exposure, the appropriateness of converting all fixed insurance costs to mileage charges is being debated. Since benefits are principally a result of consumers reducing their mileage because of higher variable costs of driving, benefits will be reduced if not all insurance costs are made variable. Researchers at the Massachusetts Institute of Technology

(MIT) matched claims data that insurance companies are required to report to the State of Massachusetts with mileage data from annual vehicle inspections. The data included $502 million in reported claims corresponding to almost three million cars driven about 3.4 billion miles. The period recorded for insurance claims and mileage tended to match fairly closely (within months) but not precisely. The study concluded that—when also accounting for territory and class (reflective of years of driving experience)—the best fit premium pricing model included a fixed fee that covered the first 2,000 miles of driving, plus a fee for additional miles (with both the fixed and per-mile prices varying by individual risk factors). The projected result for Massachusetts, a high-cost insurance state, was that applying the best-fit model to premium pricing—for which on average 53% of the premium would be made variable—would yield a 5.0% reduction in driving versus a 9.5% reduction with a fully variable pricing model (Ferreira & Minikel 2010 and 2012).

Because, for a variety of reasons, higher-mileage drivers tend to present a lower per-mile risk than lower-mileage drivers, and vice versa, a PAYDAYS pricing model that fails to differentiate customers on the basis of a multitude of demographic factors will invariably overestimate the fixed risk and underestimate the per-mile driving risk of an individual driver. If a pricing model were sophisticated enough to differentiate the risk of every driver, it could then reflect the likelihood that, if an individual curtails his or her driving by a certain percentage, the driver's probability of getting into a crash should be cut by the same percentage, if one assumes that the nature of his or her driving (mixture of time and place plus the condition of the driver) remains similar despite reduced mileage (Litman 2011). Thus, a more sophisticated best-fit model would almost certainly yield a lower fixed premium and higher variable premium than that developed through the research by MIT.

Among the costs unrelated to claims that car insurance companies incur on a household’s insured vehicles, some are linked to having an additional policyholder (e.g., transmitting bills, accepting some number of unprofitable high-risk or nonstandard insureds on the basis of a company’s total number of insureds, and automatically providing policyholders insurance on rental cars), some relate to the price of the insurance premiums (e.g., percentage-based taxes and commissions), and some are just general administrative and overhead costs (e.g., building leases, company personnel and legal departments). Costs in the first category are appropriately apportioned evenly among policyholders; costs in the second category should be mileage based, at least to the degree that the premiums from which they are derived are mileage based; and costs in the third category could legitimately be apportioned either on a per-policyholder or premium-dollar basis, with the latter being preferable, as it would lead to premiums that vary more by mileage and thus further reduce GHG emissions.

Scenario Description

For the sake of this scenario, the authors assumed that, on average, premiums in 2030 will be 70% usage-based. This number falls between that previously offered in the marketplace (the fully variable premium structure of start-up Milemeter, Inc.—although 2,000 miles of premium had to be purchased every six months to keep the policy active—when it offered insurance in Texas until a few years ago) and the current most-variable products available in at least some states (ranging in variability from about 50% to 60%) from State Farm's Drive Safe & Save product, National General (formerly GMAC) Insurance's Low-Mileage Discount program, and the only product offering of start-up MetroMile, Inc. These available products offer premiums that are probably less variable than would result if, instead of individual insurance companies owning data collected for PAYDAYS pricing, the consumer would. Such a change would propel the market to respond to consumers shopping their data for better prices by offering PAYDAYS premiums that are more variable and competitive. The 70% figure for 2030 used in this analysis matches the level of premium variability required to be eligible for State of Oregon PAYDAYS insurance tax credits [Oregon Code, Chapter 317 (Corporate Excise Tax), Sec. 317.122], a state public policy best practice. State insurance commissions could also require PAYDAYS pricing as a condition to approve a product offering, if it is consistent with state law, either current or amended.

Insurance premiums could be higher or lower in 2030 than they are today for a variety of reasons. This analysis assumes that if premiums are 30% fixed and 70% variable in 2030, then the fixed cost and variable per-mile rate would be the same as they are today (if today's premiums were kept at the same level, but restructured to be 70% variable) but that the total average premium cost for the 2030 base case would be lower, commensurate with the Energy Information Administration's estimate for reduced per-capita VMT.

Parking Cash Out

Policy Background

Approximately 95% of employers provide employees free parking at work, while only 5% of private-sector employers offer other transportation commute benefits, and even when such alternative benefits are offered, they are generally capped at a far lower value than the parking subsidy that is provided (Bureau of Labor Statistics 2010). For these and other reasons, most employees choose to drive alone to work.

Parking cash out modifies existing employer-provided parking-only commute benefits to reward employees for using alternative modes while allowing employees who choose to continue to drive to and park at work to do so without penalty. Both employers and employees benefit from parking cash out since employees who accept the cash-out offer experience increased incomes funded by savings from employers reduced business expenses (because of not having to lease or otherwise subsidize as much parking). This helps employers in recruiting and retaining good employees.

Among 1,700 employees in eight case study firms in Southern California, implementation of parking cash out led to an 11% reduction in drive-alone commute trips and a 12% reduction in commute VMT (Shoup 1997). Studies of parking cash out in Seattle, Washington, and the Minneapolis-St. Paul, Minnesota, metropolitan area yielded similar results, with a 10% reduction in employee parking demand in Seattle (Glascock, Cooper & Keller 2003) and an 11% shift to alternative transportation modes in Minneapolis-St. Paul (Van Hattum, Zimmer & Carlson 2000). Parking cash out is revenue positive to governments because a portion of employees who drive alone to work and are provided a tax-exempt car-parking benefit from their employers would, if offered, choose to accept an alternative commute benefit that could likely include some taxable cash in exchange for using other transportation.

The U.S. Internal Revenue Service already has procedures for establishing the value of parking benefits, which are needed to determine the appropriate cash-out value. Specifically, 26 CFR 1.132-9 bases such value on the costs that an individual would incur in an arm's-length transaction for a space in a comparable lot in the same general location under the same or similar circumstances.

A small effort on the part of companies is required to establish internal systems to accommodate parking cash out, just as for setting up any new system. Companies could also incur some benefit-related costs, including costs for employees accepting newly available cash after not having used parking that had been offered and employer payroll taxes for employee cash benefits. Employers, however, have the option of defraying such costs by reducing very slightly subsidies to those who park or by charging a very small amount to park if it is now free. Because not a single recorded case was found of an employer rescinding a cash-out offer once it has been made, the evidence is clear that the employers offering cash out do not see it as burdensome or costly—or at least not so burdensome or costly as to exceed the value it provides in employer-employee relations. Nothing being contemplated here would alter the discretion otherwise available to employers to make choices about the parking benefits they offer to their employees or to make changes to such benefits at any time.

Ideally, the average statewide value of commuter parking could be discerned for the purpose of this modeling exercise. In reality, though, such data are only readily available at the city level, and even then they are imperfect. Another challenge is that local zoning codes within the United States almost always require more parking be built than is used, even if offered for free (or bundled with other costs), let alone if cost-recovery pricing were applied. For those owning, leasing, or otherwise in control of multiple parking spaces, most would rather make the parking available below cost (or as a freebie for employees or bundled with rent) than leave it unused and get no revenue or other benefit for it.

Scenario Description

The policy being considered here would have states prohibit employers from discriminating against nondrivers in the commuter benefits they offer. It would require that, when a parking subsidy is provided, an equivalently valued subsidy for those not driving to and parking at work also be offered; otherwise the parking subsidy loses its tax-exempt status at the state level. The state-level requirement to offer parking cash out could be scheduled to give employers abundant time to shed unneeded parking (through a new lease with less parking, subletting unused parking spaces, or selling spaces) and thus to recoup costs for spaces no longer needed by employees who accept the cash-out benefits in lieu of parking. The authors envision that, well before 2030, a state-level parking cash-out requirement would apply in all cases with an employee parking subsidy.

One reasonable policy approach for 2030 would be to require that commuter parking charges or cash-out values be set at a minimum of cost-recovery levels. This would allow plenty of time between now and then to change parking codes to eliminate the perverse incentive to oversupply and then to subsidize commuter and other parking heavily and for excess preexisting parking to be sublet or sold, such as to occupants of new buildings constructed with too little parking, or otherwise repurposed, such as for building storage space. King County, Washington, as part of the development of its Right-size Parking Calculator, recently went through an exercise with its development consultant, Kidder Mathews, to determine values (in part on the basis of land costs and the type of parking that is built) for cost-recovery parking charges in multifamily residential developments. The specific objective was to find the minimum parking charges that would be needed to generate returns sufficiently high to justify the provision of the parking by using the same approach as that used for calculating the minimum rents required to justify building the housing units. (While the scenario examined for this paper is for workplace parking instead of residential parking, the approach to discerning cost-recovery parking charges should be nearly identical.)

King County's cost-recovery structured parking charges, derived in detail in an August 15, 2014, memorandum from Kidder Mathews to King County, range from a minimum of $242 per space per month for a suburban above-ground two-story parking structure to $344 per space for underground garage parking in Seattle's central business district (Howe & George 2014). For a state to require parking cash-out benefits (when parking is subsidized) of at least the lowest cost recovery level calculated here ($242 per space per month) would be very reasonable but, because this cost is so much above the amount that some state political leaders at this point might perceive as reasonable, a much lower average $121/month ($1,452/year), or half the $242 cost, cash-out value is modeled. (To reach this $121 average cost in states with abundant low-market-value commuter parking, a minimum cash-out amount might have to be established, perhaps at $100/month or pegged to the average cost of a local monthly transit pass.) The analysis assumes that the current ratio of commute-related VMT to overall VMT (27.77%) will remain the same in 2030. Current statewide per-vehicle VMT was multiplied by the nationwide 27.77% figure and then reduced to reflect Energy Information Administration 2030 nationwide VMT projections for a per-capita reduction in driving from today's levels. For commuters driving to work (whether alone or in a carpool), 95% of whom are receiving a parking subsidy today (as noted earlier), the annual cash-out value ($1,452) was divided by state-level per-vehicle commute VMT, adjusted for 2030, to determine the per-mile opportunity cost of the cash-out offer.

One factor not considered in the analysis is that because cash taken (instead of or in combination with a tax-free transit benefit) is taxed, the opportunity cost of the parking would be reduced by whatever tax the commuter would need to pay. Because consumers may not fully consider this, and also because the average cash-out value assumed for this analysis is very conservative, an adjustment to this value was not made.

Converting Fixed-percentage Sales Taxes to Mileage-based Taxes

Policy Background

As with other measures to convert fixed driving costs to usage-based charges, replacing fixed vehicle sales taxes with mileage-based taxes for newly purchased vehicles would result in reduced VMT, especially in states with the highest sales taxes. This change would also spur new vehicle sales (generally with lower carbon emissions than vehicles that are replaced), as it would reduce, by the amount of the sales tax, the money that a buyer would need to have or to borrow to make a purchase. The literature converges upon a price elasticity of about -1.0 for new vehicle sales and EPA and NHTSA have used this figure in their fuel economy rule (USEPA & USDOT 2012). Thus, in the State of Michigan, with a 6% sales tax, for example, new vehicle sales are estimated to increase by about 6% if this tax is eliminated and replaced with a mileage-based tax on newly purchased vehicles. This would provide a huge cobenefit in the form of a healthier U.S. auto industry.

Scenario Description

The specific scenario modeled takes the population-weighted combined state-local sales taxes charged on newly purchased vehicles and converts them to mileage-based taxes designed to raise the same amount of revenue. Forty-five states collect statewide sales taxes and 38 collect local sales taxes (Tax Foundation 2014). Table 1058, Retail Sales and Leases of New and Used Vehicles, from the Statistical Abstract of the United States, indicates that 51,434,000 vehicles were sold in 2010 for an average new and used car combined price of $13,105 (U.S. Census Bureau 2012). The scenario here assumes that the same portion of the vehicle fleet newly purchased in 2011 would also be newly purchased in 2030 and then applies the population-weighted combined average applicable state-local sales tax to the average-priced newly purchased vehicles as a mileage fee spread over a three-year period (using statewide average per-vehicle VMT in 2011, but lowering it proportionately on the basis of the Energy Information Administration's 2030 nationwide VMT projections compared with 2011).

This scenario is a simplification. Local sales taxes would be converted to mileage fees only where they exist instead of being averaged across all new vehicle purchases in a state, and states are likely to adjust per-mile fees downwards for rural drivers and upward for urban drivers, reflective of rural drivers driving more miles than urban drivers. New vehicles are driven slightly more than the fleet as a whole, a fact suggesting that per-mile sales taxes should be set a little lower for cost recovery (although this policy would apply to sales taxes on used vehicle purchases, too). On the other hand, mileage fees are calculated by assuming no change in VMT when in reality VMT will go down because of such fees, thus requiring higher per-mile fees. If a state implements this policy in 2027 or earlier, mileage fees in 2030 would apply to all vehicles purchased within the previous three years.

Not included in the calculations, but nevertheless appropriate to convert to mileage-based fees for states striving to meet the emissions targets of this proposal, would be: (a) a host of sources for state general tax revenue for transportation-related expenditures and (b) fixed annual vehicle registration fees.

ALTERING MODELED STRATEGIES AND STILL MEETING CARBON REDUCTION TARGETS

Same Strategies, but with a Behavioral Economics Twist

Another issue to consider when projecting the benefits of vehicle-use and parking price shifting is the degree to which behavioral economics strategies are deployed in concert with the new pricing to encourage reductions in driving beyond what would be realized without the use of such strategies. Behavioral economics, a discipline combining economics and psychology to explain consumer decision making, offers important insights to maximize consumer acceptance and benefits. Research focused specifically on PAYDAYS insurance, but which could also be applied to other vehicle-use price-shifting strategies, identified the following product features and related communications protocols as most likely to increase consumer response (i.e., lead to greater reductions in driving) at all levels of premium:

- Direct and transparent per-mile charges (no rebates or requirements to purchase miles in large use-or-lose bundles);
- Frequent billing emphasizing tangible (check or even cash) as opposed to less tangible (credit card) payment forms;
- Reinforce pricing through e-mail reminders and taxi-like in-vehicle meters;

- Negotiate transit pass discounts and matching funds to buy down prices of alternative transportation modes;
- Provide individualized assistance to customers to reduce driving by identifying alternative transportation, trip consolidation, and trip elimination (e.g., through Internet shopping) options; and
- Establish reasonable driving-reduction goals for participants and provide, contingent upon achieving such goals, frequent-flyer-program-like status-related designations and rewards and "regret lottery" rewards, where participants would regret it if they had to forfeit a lottery award for failing to meet a goal (Greenberg 2010).

The benefits discussed in this research presumed that PAYDAYS insurance and vehicle sales taxes converted to mileage fees would be presented to drivers as a pure per-mile charge without the "bells-and-whistles" suggested immediately above that would likely enhance driver responsiveness to the price shifting.

Extensions or More Aggressive Forms of the Modeled Policies

As noted earlier, more aggressive versions of the modeled policies, or logical extensions of such policies, could be deployed by states to exceed the emissions reductions of the modeled policies. While government officials in some states may choose to exceed the overall targets, others may not want to pursue all three modeled policies, or in some cases may not want to pursue them in a form as aggressive as what was modeled. Such states would then need to pursue some other strategies more aggressively than modeled to compensate for the emissions reduction shortfall.

Many examples are possible. A state could encourage or require insurance policies that are 90% or more variable, instead of 70%; could apply a much higher minimum parking cash-out value (e.g., $242/month, instead of the $121 modeled); or convert to mileage fees all vehicle-related taxes and fees instead of just sales taxes.

Even with a monthly parking cash-out offer (which is what was modeled), employees who decline the offer but are able to forgo driving their cars and parking at work on any particular day are not incentivized to do so. A daily-in-lieu-of-monthly parking cash-out offer, which a state could also encourage or require, would create such an incentive. The PayGo Flex-pass tested this idea in Minneapolis, where employees received a $7 rebate on days they did not use parking and a $2 rebate on days they used transit instead of parking (reflective of the prorated daily cost of both parking and transit); the result was that recipients cut their driving days from 78.5% to 59.8% of workdays at the end of the pilot period (Lari et al., 2014).

As noted earlier, a host of fixed transportation-related fees besides sales taxes on newly purchased vehicles, and general-revenue taxes supporting transportation infrastructure and services, could be converted by a state to mileage-based fees. Similarly, states could incentivize, through tax credits or other policies, car leases (which accounted for 27% of new-vehicle acquisitions in 2012) to include direct mileage charges. (While vehicles depreciate on the basis of age and mileage, vehicle leases are generally structured such that only a flat monthly fee is charged, regardless of mileage, with end-of-lease overages for excess mileage rarely being assessed and collected.)

MODELED RESULTS OF GHG EMISSIONS REDUCTIONS

As noted, converting fixed or hidden driving costs to variable and transparent charges or cash-out benefits would result in reduced VMT. The levels of reductions are projected using observed results from previous before-after studies in which consumers experienced a change in their driving costs and adjusted their driving habits in response. Many studies have been conducted on the effects of fuel price on fuel demand, and a small subset of these studies has obtained VMT data for a corresponding time frame to discern the effects of fuel price changes on VMT (Litman 2013). These studies derive a price elasticity that expresses the change in fuel use or mileage as a function of the change in price of fuel. Consumers could respond somewhat differently to equal price changes from distinct sources (e.g., new PAYDAYS premiums versus increased VMT costs from fuel price increases), but there is no economic reason to expect this. The overall benefits of price-shifting strategies are very sensitive to the price elasticity that is selected. In addition, price elasticity changes with time, with short-term elasticity being lower than long-term elasticity (where drivers have more time to arrange for alternatives, like carpooling and teleworking).

Major studies on PAYDAYS insurance have converged on a lower-bound elasticity figure of -0.15, which is based on finding a conservative average of results from previous elasticity studies of fuel prices (Bordoff & Noel 2008, Edlin & Mandic 2006, and Ferreira & Minikel 2010 and 2012). That is, if the per-mile cost of driving (including fuel costs and insurance premiums that are tied directly to mileage but generally excluding vehicle wear and tear because drivers may not consider it) doubles, drivers are expected to cut their VMT by 15%. Our analysis uses -0.15 as the lower-bound price elasticity and also considers only fuel costs as the starting point for a driver's per-mile price.

The literature seems to support an elasticity value higher than -0.15. Two studies in particular are noteworthy. One study derives a medium-run elasticity of VMT with respect to gasoline price for new vehicles in California by using "a unique and extremely rich vehicle-level data set of all new vehicles registered in California from 2001 to 2003 and then subsequently given a smog check [with an odometer reading] from 2005 to 2009, a period of steady economic growth but rapidly increasing gasoline prices after 2005" (Gillingham 2013). A second major study relied on aggregate state-level data from 1966 to 2008 on gasoline consumption, VMT, and vehicle purchase decisions adjusted for employment, driving population size, and other demographic factors (Li et al., 2011). The elasticity values for VMT with respect to fuel price derived from these data-rich studies, -0.22 and -0.238, respectively, are very close. (The Li et al. study also included a household- level analysis that used data from the 1995 and 2001 National

Household Travel Surveys and derived from this "study within a study" a -0.34 VMT elasticity with respect to fuel price (Li et al., 2011).) Our second scenario builds off of the more conservative result, a -0.22 elasticity.

The elasticity value of -0.22 (or -0.238) is also likely too conservative when the effect of a direct mileage or parking charge on VMT is being projected. Because part of the response to higher fuel prices is mileage shifting to more efficient vehicles (within multiple-vehicle households in the short term and through vehicle retirement and purchase decisions in the long term) plus somewhat more fuel-efficient driving, such as by lowering freeway driving speeds, the per-mile price of driving *experienced* by drivers rises, on average, by a lower percentage than the fuel price. The limited number of studies that have attempted to discern and apportion the causes of fuel savings have usually concluded that, to varying degrees, more fuel savings result from vehicle-driving efficiency measures unrelated to VMT than from VMT reductions (Litman 2013). Here we conservatively assume that both causes contribute equally to savings. Then the elasticity of demand for VMT with respect to fuel price is converted to an elasticity of VMT with respect to the per-mile price of driving by using Equation 14; this conversion yields, in the case of a -0.22 (or -0.238) elasticity, a revised elasticity of -0.28 (or -0.31).

Three major studies use a -0.30 elasticity of demand for VMT with respect to per-mile price (USEPA 2011, USEPA 2014, and Kay et al., 2014). Given the analysis above, the data support using this elasticity for our best-estimate scenario. An upper-bound -0.45 elasticity is used for the fourth scenario. This choice is based in part on the use of this elasticity in another study (Cambridge Systematics 2009). Conversion of the -0.34 elasticity of household-level VMT demand with respect to fuel price from the Li et al. "study within a study" to an elasticity of VMT demand with respect to the per-mile price of driving would yield an even higher elasticity (exceeding -0.5) (Li et al., 2011).

The model uses an arc elasticity approach (see Equation 8) (Pratt 2013). Table 1 shows the analysis results for all four scenarios. For the best-estimate Scenario 3 price elasticity of −0.30, highlighted, the analysis shows that enacting a regulatory scheme to achieve the policy-based transportation efficiency targets discussed in this paper would yield nationwide carbon emissions reductions of 68.6% of those of the Clean Power Plan (on top of the reductions of that rule), or 257 MMT versus 375 MMT reduction in CO_2e. The transportation efficiency measures would bring about GHG reductions greater than those calculated for the Clean Power Plan in 24 states plus the District of Columbia.

Table 1 – Model Application Summary

Scenario	Assumed Price Elasticity	Total Nationwide MMT of CO_2e Reduction	Percentage of Nationwide Power Rule MMT of CO_2e Reduction	Number of States (including the District of Columbia) Where Transportation Reductions Exceed Power Plant Reductions
1	-0.15	138.3	36.9%	23
2	-0.22	196.0	52.3%	25
3	-0.30	257.2	68.6%	25
4	-0.45	359.7	95.9%	29

This table shows model results under different elasticity values.

Had NHTSA and EPA not set such aggressive fuel economy standards, the vehicle fleet in 2030 would be far less efficient, and the impact of mileage reductions on carbon emissions resulting from the transportation efficiency policy outlined in this research would be much greater. Similarly, if implementation were to be required earlier than 2030, the reductions would also be greater, as the fuel economy standards require year-over-year improvements in vehicle efficiency, meaning that earlier-year reductions in VMT would yield greater fuel savings than later-year reductions.

Table 2 provides a summary of the results of the analysis by state for the best-estimate scenario (price elasticity of -0.30). Total nationwide GHG emissions reductions of 257 MMT of CO_2e or 68.6% of those of the Clean Power Plan is shown from the transportation price-shifting policy bundle. For Vermont and the District of Columbia, EPA's final rule did not establish emissions reductions goals because of a lack of eligible power plants. The EPA's Integrated Planning Model (IPM), used by EPA to illustrate the power rule reductions at the state level, does not include Alaska and Hawaii, although these states are covered by the rule. In the case of some additional states, the IPM actually indicated increases in emissions over the base case. This increase is not an irrational result if interstate emissions trading schemes are deployed as a compliance mechanism, where utilities in states with cleaner power sources are incentivized to produce more power and related emissions than they otherwise would in order to enable reduced power production in states with dirtier power sources.

Table 2 – Summary of Analysis by State for Selected Scenario

State	CO_2E Reduction in Million Metric Tons (MMT): Estimated EPA Final Power Rule	CO_2E Reduction in Million Metric Tons (MMT): Estimated Transportation Policy Strategy	State	CO_2E Reduction in Million Metric Tons (MMT): Estimated EPA Final Power Rule	CO_2E Reduction in Million Metric Tons (MMT): Estimated Transportation Policy Strategy
Alabama	1.1	4.5	Montana	8.4	1.0
Alaska	N/A*	0.5	Nebraska	13.9	1.4
Arizona	11.9	6.7	Nevada	(0.5)	2.8
Arkansas	6.8	2.4	New Hampshire	0.1	1.1
California	5.9	33.8	New Jersey	2.7	5.8
Colorado	9.1	4.1	New Mexico	5.7	1.8
Connecticut	0.2	2.6	New York	3.6	9.1
Delaware	(0.2)	0.8	North Carolina	(3.7)	7.4
District of Columb	(0.0)	0.2	North Dakota	10.3	0.5
Florida	14.5	22.2	Ohio	25.0	9.0
Georgia	19.0	10.2	Oklahoma	3.6	2.7
Hawaii	N/A*	0.9	Oregon	(1.1)	3.0
Idaho	(0.1)	1.3	Pennsylvania	10.8	7.8
Illinois	9.1	8.5	Rhode Island	0.4	0.8
Indiana	25.5	5.1	South Carolina	10.4	4.3
Iowa	3.9	2.2	South Dakota	1.0	0.7
Kansas	17.4	2.1	Tennessee	15.7	5.8
Kentucky	0.1	3.4	Texas	53.1	22.3
Louisiana	(4.3)	4.1	Utah	11.9	2.3
Maine	1.4	0.9	Vermont	0.0	0.5
Maryland	(3.0)	4.9	Virginia	(3.6)	6.6
Massachusetts	1.1	4.9	Washington	(0.1)	5.4
Michigan	3.8	9.8	West Virginia	28.7	1.2
Minnesota	6.5	4.8	Wisconsin	17.7	5.4
Mississippi	(0.3)	2.2	Wyoming	6.2	0.5
Missouri	25.4	4.7			
			TOTAL	**375.1**	**257.2**
			As % of EPA Power Rule		**68.6%**

Notes: Using price elasticity of -0.3

Green indicates states where reductions from transportation strategies exceed power rule.

Power rule reductions are based on EPA Integrate Planning Model (IPM) Base Case 5.15 versus Mass-Based Case. Negative reductions are estimated by IPM for some states.

* IPM does not address Alaska or Hawaii.

This table shows a comparison between state-level emissions reductions from the Clean Power Plan versus from the transportation price-shifting bundle.

MODELED RESULTS OF GHG EMISSIONS REDUCTIONS FROM ALTERNATIVE SCENARIOS

Results from a Federal Emissions Permit Price at the Social Cost of Carbon

As discussed later in this paper, there is likely a legal mechanism available, though CAA Sec. 211, to enact a nationwide cap-and-trade permitting scheme on transportation fuels, with permit prices limited to the social cost of carbon (SCC). The SCC is a technical term referring to the full range of societal costs associated with the impacts of carbon emissions and related global climate change.

While different sources in the literature estimate different SCC values, the generally accepted values are pretty low. On July 2, 2015, the Office of Management and Budget announced a $36 per ton revised Obama Administration SCC value for 2015—derived by a comprehensive and complex analysis process that was guided by the Interagency Working Group on the Social Cost of Carbon—that it then applied to benefit-cost analysis associated with carbon-reduction-related rulemakings (OMB 2015). The Technical Support Document accompanying this announcement derived a $50 per metric ton SCC (in year 2007 dollars) in 2030 (the target year for most emissions reductions from the Paris Agreement), garnered by applying the 3% discount rate as "the central value," although other discount rates were also tested. Regarding the rising SCC in out-years, the Technical Support Document explains: "[T]he SCC increases over time because future emissions are expected to produce larger incremental damages as physical and economic systems become more stressed in response to greater climatic change. The approach taken by the interagency group is to compute the cost of a marginal ton emitted in the future by running the models for a set of perturbation years out to 2050." (Interagency Working Group on Social Cost of Carbon 2015)

If EPA were to regulate transportation emissions from existing vehicles by setting carbon targets reflective of states applying the bundle of transportation price-shifting policies, the incentive to reduce such emissions would be much higher than would result from instead just pricing carbon emissions (through requiring the purchase of emissions permits) at its year-2030 SCC value of $50 per ton. The GHG reductions would also be substantially greater.

Based on the spreadsheet model developed for this research (shown in Appendix 1), an additional calculation was performed (shown in Appendix 2) to enable a comparison with converting a $50 per ton year-2030 SCC to a per-mile additional cost of driving in year 2030 (applying the Energy Information Administration's projected 2030 LDV fleetwide average fuel economy of 32.6 mpg (U.S. Energy Information Administration 2014), yielding a per-mile price increase of about 1.4 cents). For this analysis, a best-estimate price elasticity of -0.30 was used. A nationwide reduction of 42.3 MMT CO_2e resulted because of reduced VMT due to the 1.4 cent increase in the per-mile cost of driving. As discussed in the previous section when attempting to discern a price elasticity of demand for VMT with respect to mileage pricing from data showing the price elasticity of demand for VMT with respect to fuel price, the literature supports a presumption that about half of fuel savings from increased fuel costs comes from more efficient driving (such as by choosing to shift driving mileage to the most fuel-efficient vehicle in a household and driving at lower freeway speeds) and the other half comes from reduced driving mileage. Thus the total emissions reductions from this strategy should be about double those from reduced VMT, or about 84.6 MMT CO_2e, which is only 22.6% of the final Clean Power Plan rule reductions.

Another source in the literature, using an entirely different analytical approach, finds a result within the same range, thus supporting that it is reasonable. Resources for the Future (RFF) conducted an analysis of the American Opportunity Carbon Fee Act of 2017 using a computable general equilibrium or CGE economy-wide model of the U.S. This bill, authored by Senators Whitehouse and Schatz, was designed to meet the U.S. climate emissions reduction commitment that President Obama made after signing the Paris Accord. It has a slightly higher carbon tax in year 2030 than we modeled ($52.20 per metric ton vs. $50, both in year-2007 dollars) and yielded a bit lower reduction from light duty vehicle emissions (66 versus 85 MMT CO_2e) (Hafstead, July 2017 & Hafstead, Oct. 2017).

The RFF analysis shows how effective an economy-wide carbon tax would be to reduce emissions, but also how ineffective it would be, at least relative to the price-shifting strategies modeled in this research, to reduce personal transport emissions. While, as noted earlier, such emissions are responsible for 19.9% of total U.S. emissions, carbon emissions reductions from personal transport would account for only 3.7% of the 1.78 billion metric ton total year-2030 reduction from this legislation (Hafstead, Oct. 2017). This suggests that gasoline could be exempted from a carbon tax (thus placating political opposition to broad carbon pricing that stems from particular opposition to increasing the gas tax) in exchange for instead including the likely more politically acceptable and better performing transportation price-shifting policy bundle provisions (even in the “conservative” form outlined in the section below) in legislation such as proposed by Senators Whitehouse and Schatz.

The 85 MMT CO_2e personal transport emissions cut from a carbon tax contrasts with the nationwide reductions from the specified transportation price-shifting policy bundle which, as noted earlier, yielded a reduction of 257.2 MMT CO_2e, or 68.6% of the final rule reductions. That is, the transportation price-shifting policy bundle would yield over three times the GHG emissions reductions that charging drivers the $50 per ton SCC would yield. Thus, if accepting the constraint, discussed later, to minimize legal risk by only charging motorists the SCC and limiting cap-and-trade permit prices for the fuel sold to the SCC, the GHG reduction possibility would be substantially limited and would result in only about 33% of the CO_2e emissions reductions that would be realized by deploying the modeled transportation price-shifting policy bundle.

A special "reverse" model run was also performed to determine the required CO_2e permit price that would yield the same 257.2 MMT CO_2e reduction as the transportation price-shifting policy bundle. The result was $183 per ton, or 3.7 times the SCC.

Documentation of the calculations performed is provided in Appendices 1 and 2.

Results from Targeted Federal Legislation

A second alternative to Federal administrative action is targeted Federal legislation focused on price shifting, especially since a number of conservative thinkers are on record favoring legislatively enacted pricing measures over regulations to reduce GHG emissions (although many do not like either). Of all the possible strategies to reduce GHG emissions, conservatives who desire some government action tend to favor a direct carbon tax, with a consumer rebate of all the revenues raised (sometimes referred to as a "dividend"), to other alternatives (Bailey & Bookbinder 2017). Even some Republican members of the U.S. of Representatives have begun to step forward with 17 such members introducing a resolution on March 15, 2017 calling for legislative action (without specifying details) on climate change (Henry 2017). Further, 26 Congressional Republicans have joined with the same number of Democrats to constitute the bipartisan House Climate Solutions Caucus (Siders 2017).

While proponents of this tax-and-dividend strategy cite public support through polling, such as one poll showing 67% support for a GHG emissions tax on companies coupled with an income tax rebate to individual taxpayers (Resources for the Future, et al., 2015), other polls indicate that even the smallest consumer price increases to mitigate GHG emissions will beget opposition. For example, 42% of Americans are unwilling to pay even $1 more on their monthly electric bill to combat climate change, and only 29% would be willing to pay $20, an amount according to the pollsters that is "roughly equivalent to what the Federal government estimates the damages from climate change are per household" (Energy Policy Institute 2016).

It does seem that, given the public sensitivity to paying more, it may be relatively easy for opponents of a tax-and-dividend approach to foster doubts as to whether the dividend will actually materialize. (Of course, proponents would respond, but which side would win the public opinion battle is not clear.)

An advantage of the transportation price-shifting bundle, in contrast, is that the "dividend" from such a policy materializes instantly in the form of a significantly reduced fixed insurance premium, an immediate rebate on cashed-out parking, and an up-front cost reduction on newly bought vehicles (with sales taxes not having to be paid upon purchase, and mileage taxes being incurred at a slightly later time). Possible legislation, the impacts of which we model here, may include a Federal parking cash-out requirement (which, as noted earlier, the libertarian Reason Foundation previously endorsed), coupled with a new Federal tax credit to reward companies for offering compliant PAYDAYS insurance products and states for shifting fixed vehicle sales taxes to mileage fees. (Also as noted earlier, parking cash out is revenue positive to the Federal Treasury, which would offset the costs of tax credits, perhaps making conservatives more amenable to supporting this sort of legislation.)

In addition to full implementation of parking cash out, we assume for this scenario that the tax credits would impact 20% of insurance policies. We also assume that the credits would cause all of the states predisposed toward GHG reduction actions, identified in the subsection immediately below (and using the shorter, more conservative list of states from the two approaches contemplated to identify such states), to replace their state vehicle sales taxes with mileage fees, as the tax-credit incentive, combined with their policy objective to reduce GHG emissions, would spur such states to do this. We also assume that the three states that, according to the Alliance of Automobile Manufacturers, have over 100,000 in-state automotive manufacturing jobs—Michigan (394,984 jobs), Indiana (159,972 jobs), and Ohio (109,826 jobs) (Alliance of Automobile Manufacturers 2017)—would do the same thing but for a different reason. Namely, and as was discussed earlier, the increase in vehicle sales that would result because of the lower purchase costs from the elimination of sales taxes would be expected to be particularly popular in these states.

This targeted Federal legislation is modeled to deliver nationwide reductions in GHG emissions of 140 MMT CO_2e or 54.5% of the 257 MMT CO_2e reduction if the transportation price-shifting bundle were applied universally. Interestingly, even this more modest approach than relying on a CAA Sec. 115 regulatory strategy brings about greater CO_2e emissions reductions than the Clean Power Plan in 24 states (including the District of Columbia). Only in Florida does the Sec. 115 regulatory approach, but not this more modest legislative approach, yield greater reductions than the Clean Power Plan.

A second special reverse model run was performed to determine the required CO_2e permit price that would yield the same 140 MMT CO_2e reduction as the transportation price-shifting policy bundle. The result was $89 per ton, or about 1.8 times the SCC.

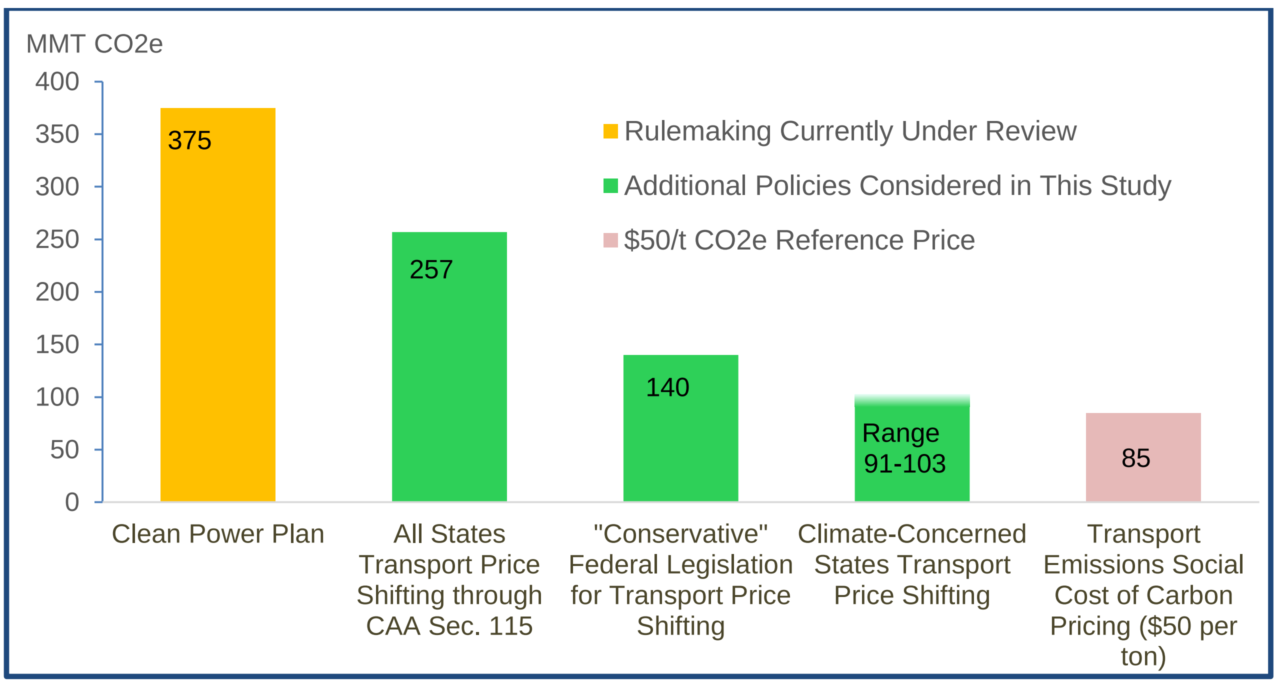
Results if Relying Solely on State-level Initiative

If the transportation price-shifting bundle is only implemented in the 19 states (and the District of Columbia) that voted for Hillary Clinton in the last U.S. presidential election, a possible proxy for state-level political support for aggressive climate action, this would yield nationwide reductions in GHG emissions of 103 MMT CO_2e (using a price elasticity of -0.30) or 40% of the 257 MMT CO_2e reduction if deployed in every state. (The result is garnered from adding up the state-level results from Table 2 from CA, CO, CT, DE, DC, HI, IL, ME, MD, MA MN, NV, NH, NJ, NM, NY, OR, VT, VA, and WA.)

An alternative method of ascertaining likely state-level interest would be to focus on states that have already taken very significant climate action, such as California and the nine member Northeast and Mid-Atlantic states of the Regional Greenhouse Gas Initiative (RGGI)—CT, DE, ME, MD, MA, NH, NY, RI, and VT—that was formed to set a regional cap on power sector CO_2 emissions and facilitate emissions trading—and/or have signed onto a legal filing to the DC Circuit Court supporting the Clean Power Plan (DC, CA, CT, DE, HI, IL, IO, MD, ME, MA, NM, NY, OR, RI, VT, VA and WA). Adding up the results from Table 2 for these states (but not double counting RGGI states that have also weighed in to favor the Clean Power Plan) would yield a slightly lower 91 MMT CO_2e reduction or 35% of the 257 MMT CO_2e reduction that would result if deployed in every state. (The second approach adds the state of IO, but takes away CO, MN, and NJ.)

Using either approach would still yield total CO_2e emissions reductions that are substanially greater than the 85 MMT CO_2e reductions that would result from pricing transportation fuels nationally through a cap-and-trade at the SCC rate. Emissions reduction results from all the policy scenarios, and their comparison reductions to the Clean Power Plan, are shown in Figure 1 immediately below.

Figure 1. Estimated CO2 Equivalent Reductions in Year 2030



This graph compares results from the three policy packages considered in this study (green bars) with Clean Power Plan Rule currently under review and pricing transport emissions at the social cost of carbon ($50 per ton of CO2 equivalent).

TRANSPORTATION PRICE-SHIFTING BENEFITS BEYOND GHG CUTS

While the focus of this research is on climate change emissions, some of the other benefits of implementing a transportation price-shifting bundle are at least worth noting. The literature has reported a range of such benefits, especially for PAYDAYS insurance. A few are highlighted here.

Federal Highway Administration models estimate typical infrastructure improvements savings of 3 to 5¢ for every mile not driven. Government incentives to promote price shifting would be very cost competitive with alternative transportation related expenditures for reducing air pollution and saving lives (Greenberg 2002).

PAYDAYS insurance is better than gasoline taxes for providing public benefits. PAYDAYS pricing that achieves the same level of fuel reduction as a comparable gas tax does so solely through voluntary reductions in driving, rather than partially through vehicle switching, and driving reductions directly benefit the public through reducing congestion and crash externalities (Parry 2005).

Congestion reduction has been shown in many instances to be disproportionately greater than the reduction in traffic. For example, one report concluded that fuel price spikes of 2008 led to a 26% reduction of peak-hour congestion, resulting from a much smaller reduction (i.e., around 3%) in VMT (INRIX 2008).

University of California Professor of Law and Professor of Economics, Aaron Edlin, has researched the insurance-costs-to-others externality of driving in traffic-dense states. His research concluded that in California, an additional insured driver causes between a $1,725 and $3,239 increase in total statewide insurance costs to other drivers (equivalent to $2,122 and $3,984 in 2017 dollars) by increasing overall traffic density compared to only $10 in North Dakota (Edlin & Mandic 2006).

For driving reductions resulting from a transportation price-shifting bundle, crash reductions, and likely claims' reductions (even resulting from measures unrelated to insurance pricing), would be about 1.4 times the reduced VMT accounting for multiple-vehicle crashes that would not have occurred had one of the vehicles involved been off the road (Greenberg 2002). By providing affordable insurance to low-income motorists who are willing to limit their mileage, PAYDAYS could reduce the number of uninsured motorists (Litman, 2004). It has been projected that 63.5% of households with insured vehicles (63.7% of urban households, 62.9% of rural households, and approaching 80% for the poorest of households) would save an average of 28% on their total premiums, or about $496 annually for households that do save from fully variable PAYDAYS premiums (Bordoff & Noel, 2008).

Finally, converting a parking-only employer-provided commute subsidy benefit to an all-modes parking cash-out offer would be especially advantageous to low-income workers who do not own a car or who share a car with others. While the highest-income quintile of households own 0.9 cars per capita, the lowest-income quintile possess only 0.5 cars (Bureau of Labor Statistics 2015).

ARE THE PROJECTED GHG EMISSIONS REDUCTION RESULTS REAL?

Starting Considerations: EPA's Clean Power Plan

A number of states, especially California and members of the multi-state RGGI consortium, are already taking aggressive actions to curtail greenhouse emissions and have committed to more aggressive implementation going forward. EPA's emissions targets generally reflect best practices, including projecting the effects of already-enacted policies. It can be argued that EPA's Clean Power Plan would "lock in" best practices for states that are deploying them, which is itself a benefit. The same could be said about this proposal for transportation emissions reductions, although current practices in the three policy areas that were explored in this research are somewhat weak.

The Energy Information Administration's (EIA's) 2030 VMT Projections

EIA developed a "Reference Case" scenario for VMT growth through 2040, plus a Low VMT and a High VMT case. All of its scenarios are anchored on assumptions related to the fuel cost of driving, disposable personal income, employment, vehicles per licensed driver and past VMT trends. In none of the scenarios, at least as can be discerned from EIA's documentation, are the policies that are modeled in this research paper included, meaning that such policies are presumed not to be implemented in 2040 (or 2030) (USEIA, April 2014, and USEIA, July 2014).

While projecting whether state governments might, absent a Federal rulemaking, mandate parking cash out (which California alone currently does, but only under narrow and limited circumstances) or convert vehicle sales taxes to mileage-based fees is challenging (although it was attempted earlier in this paper when contemplating a scenario where there is complete Federal inaction), more could be said about possible market deployment of PAYDAYS insurance.

Insurance companies today have compelling reasons to use telematics for market segmentation and do offer consumers some incentives to gain their cooperation (e.g., "PAYDAYS insurance lite" policies where some minor discounts are offered in exchange for drivers sharing telematics data). These firms experience little market pressure, however, to use the data to offer genuine PAYDAYS premiums.

Companies that fail to use telematics for segmentation face fairly extreme adverse selection risk. For example, one firm that facilitates insurance companies in offering usage-based insurance asserted the following benefits of its driver evaluation scoring at a recent industry conference: when insurance companies with sophisticated, but not telematics-informed, premium-setting models use its usage-based score to recalculate premiums, 10% of drivers had an expected loss ratio (meaning the ratio of claims paid to premium dollars collected) of 30% or less of the average-driver loss ratio and another 10% of drivers, at the other extreme, had an expected loss ratio that was 250% greater than the average (Harbage 2013). Clearly, adverse selection will occur if some companies have this data, and price accordingly, while others do not, and the latter will likely be unable to price in a way that will both retain market share and enable continued profitability.

The benefits of having consumers appreciate how their driving affects their rates and then being provided an opportunity to change behavior to save on premiums may be lost if “black box” pricing becomes the norm. (“Black box” pricing refers to where an insurance company gathers and applies usage-based data in premium setting primarily for improved market segmentation—to offer the most attractive rates to the lowest-risk drivers within any rate class—but without the consumer having any detailed knowledge as to how their usage characteristics affect their rates.) This concern is not just theoretical since the majority of the over two million people who have signed up for telematics-enabled insurance products are not provided by their insurance carriers significant personalized guidance about reducing their crash exposure and earning premium savings as a result.

The key unknown, though, is whether the PAYDAYS insurance products that are to become prevalent in the marketplace will provide transparent and variable pricing that encourages motorists to reduce their risk exposure in order to secure a lower rate, or instead whether the products will improve driver segmentation without offering such incentives (and, thus, without yielding benefits). The question remains whether, absent policy intervention (which could be a mandate, but may, as noted earlier, instead be targeted tax credits), drivers will be afforded this opportunity. Similar questions also apply to the policy interventions modeled by EPA for its Clean Power Plan.

TRANSPORTATION EFFICIENCY RULEMAKING AUTHORITY OPTIONS

This section examines the authority under different sections of the Clean Air Act to implement a transportation price-shifting bundle. CAA Section 115 is found to provide the broadest authority, although much is learned from a section-by-section exploration. Results are summarized in Table 3 below (including a separate table entry related to the possibility of listing carbon as a criteria pollutant under CAA Sections 108 and 109, which is discussed in the body of the paper but not in its own separate subsection).

Table 3 – Summary of Legislative Authority from Different Sections of the Clean Air Act

Clean Air Act section	General authority to curtail transportation carbon emissions	Limitations on authority of this section	Extent to which existing motor vehicle use could be affected by regulation	Legal risk of relying on this section
Emission standards for new motor vehicles (Section 202)	Regulates fuel economy. "Off cycle" credits for measures to influence driver behavior and decisions, including efficient routing assistance, are strongly implied to be legal within the preamble of a final rulemaking.	Applies only to new vehicles. Core standards are set based on vehicle technology with off cycle credits serving only to loosen the core standards instead of to secure additional carbon emissions reductions.	Not allowed.	The more novel off cycle credit strategies to influence driver behavior have yet to be allowed, and thus their legality has also not been tested in court.
Regulation of fuels (Section 211)	With an "endangerment finding" for this source due to its GHG emissions, which EPA has already issued for other GHG-emitting sources under the CAA and the U.S. Supreme Court has upheld, EPA could establish a national carbon regulation for motor vehicle fuel emissions.	States may not deviate from the national standard unless necessary to meet NAAQS for ozone, particulate matter, or carbon monoxide, and approved by EPA, thus severely curtailing state-level policy innovation.	This would only enable the enactment of a single national strategy, such as a cap-and-trade system for fuel sales.	Very little, except that there could be some legal vulnerability if costs of a regulation exceed its benefits; permit prices in excess of the social cost of carbon could trigger a legal challenge.
International air pollution (Section 115)	This section is triggered because U.S. carbon emissions are endangering public health or welfare in another country, and the affected country gives the U.S. reciprocal rights to weigh in about foreign sources of pollution. Section 115 coverage "shall be deemed to be a finding" under Sec. 110 "which requires a…[SIP] revision…to prevent or	The broad legal authority otherwise enabled by this section does not trump the limitation prescribed by 23 USC Sec. 145 which says that the Federal government "shall in no way infringe on the sovereign rights of the States to determine which projects shall be federally financed" (except where 23 USC Sec.	EPA has broad authority to pursue a state-level regulatory approach to control carbon emissions, including setting SIP targets based on the expected statewide emissions reductions from a transportation pricing policy bundle and allowing substantial state-level policy innovation to meet such targets. In areas of	While the authority provided under this section seems straight forward, no regulations have ever been promulgated under it, and thus its scope has never been tested in court. There are compelling legal arguments on both sides of the issue of whether state or metropolitan transportation

Clean Air Act section	General authority to curtail transportation carbon emissions	Limitations on authority of this section	Extent to which existing motor vehicle use could be affected by regulation	Legal risk of relying on this section
	eliminate the endangerment." There is no limitation within this section on the sectors to be regulated and strategies to be deployed.	135(g)(4)(D)(iii) requires project conformance with SIPs in nonattainment areas for ozone, particulate matter, and carbon monoxide).	nonattainment for ozone, particulate matter, or carbon monoxide, EPA may (or may not) be allowed to compel SIP carbon targets to be tightened further by presuming the selection of transportation infrastructure projects that reduce carbon emissions below a baseline level.	infrastructure project selection authority could ever be constrained to compel carbon standards within SIPs to be met.
Air quality criteria and control techniques (Section 108) and National primary and secondary ambient air quality standards (Section 109)	Identical to what occurs when Sec. 115 applies, listing carbon as a criteria pollutant under these sections would trigger EPA authority under CAA Sec. 110, including allowing EPA to order states to revise their SIPs (which EPA enforces) to bring about compliance with nationwide carbon standards.	A listing under these sections would not impact EPA's authority under CAA Sec. 115 (which provides the same legal authority as under Sections 108/109), and it would also not trigger conformity requirements related to project selection under 23 USC Sec. 135(g)(5)(D)(iii).	Same as for Sec. 115.	The plain language of these sections seems clear in providing EPA broad legal authority. It is deemed within the literature as impractical to place the whole country into nonattainment for carbon, however, and courts may view doing this, because of its impracticality, as statutory overreach.

This table summarizes the authority provided by various Clean Air Act sections to implement the transportation price-shifting strategies proposed in this report, along with other transportation strategies, and also summarizes their impacts and risk.

Emission Standards for New Motor Vehicles (CAA Section 202)

A similar Federal statutory and regulatory structure exists for, and has been applied to, controlling GHG emissions from new vehicles as from new power plants, but there is no statutory provision comparable to Sec. 111(d) to pave the way to regulate GHG emissions from existing vehicles as Sec. 111(d) does for GHG emissions from existing power plants. For new vehicles, CAA Sec. 202(a) contains identical language to Sec. 111(b) regarding endangerment, and endangerment effects of GHG emissions are clearly unrelated to their source, thus equally compelling EPA to regulate GHG emissions from power plants and new vehicles. (The U.S. Supreme Court, deciding *Massachusetts et al. versus Environmental Protection Agency* in April 2007*,* concluded: "Under the Act's clear terms, EPA can avoid promulgating regulations only if it determines that greenhouse gases do not contribute to climate change" (U.S. Supreme Court 2007); EPA, on multiple occasions, has concluded the opposite.) Sec. 202 compels EPA to set emissions standards to address the endangerment from new motor vehicles and engines covering their "useful life," but it does not allow EPA to go back and address the existing vehicles that were not subjected to GHG or other regulations when they were new.

Sec. 202 does not appear to limit EPA to only considering vehicle technology when developing GHG standards for new vehicles, and indeed EPA and DOT/NHTSA, had seriously considered ideas that would apply results from driver engagement in setting such standards and determining compliance. For example, Daimler and Garmin, responding to a joint notice from EPA and DOT/NHTSA of proposed rulemaking, urged that fuel efficiency requirements be eased by granting "off-cycle emissions credits" (for emissions reductions that would not by captured by the vehicle test procedures) for technologies that would help drivers avoid crashing or getting lost, thus reducing VMT. The preamble of the final rulemaking discussed this request, but it was ultimately rejected on the technical grounds that it would be too difficult to accurately measure benefits. Nowhere was it asserted in the final rule that the Federal government lacked the legal authority to grant this request if its technical concerns could be overcome (USEPA & USDOT 2012). While driver engagement approaches were contemplated for new vehicles, they could, of course, equally be applied to preexisting vehicles if GHG emissions could be regulated from them (and, while not allowed under Sec. 202, as noted here, it may, as discussed below, be allowed under other CAA authority).

Regulation of Fuels (CAA Section 211)

The next place worthy of examination for regulating emissions from existing vehicles is under the CAA authority that applies to curtailing motor fuel emissions. This is because it is through the burning of motor fuels that existing vehicles contribute to GHG emissions, and if the use of such fuels could be regulated, then perhaps regulations could apply to existing vehicles, and drivers of such vehicles, and not just to new vehicles.

CAA Sec. 211 provides EPA the authority to address “offending fuels and fuel additives” including “by regulation, control or prohibit[ing] the manufacture, introduction into commerce, offering for sale, or sale of any fuel or fuel additive for use in a motor vehicle…if, in the judgment of the Administrator, any fuel or fuel additive…causes, or contributes, to air pollution…that may reasonably be anticipated to endanger the public health or welfare.” EPA has, as noted above, made a so-called endangerment finding for different sources because of their GHG emissions under other provisions of the CAA. The Institute for Policy Integrity, a non-governmental organization affiliated with the New York University School of Law, argues that a reasonable and allowable mechanism to control GHG emissions from fuels is a cap-and-trade policy applied to such fuels (Institute for Policy Integrity 2009).

The regulated entity under Sec. 211 is the fuel producer, and states may not deviate from related Federal regulations under this section except if the EPA Administrator “finds that the State control or prohibition is necessary to achieve the national primary or secondary ambient air quality standard which the plan implements.” EPA, though, has never even proposed to list carbon as a criteria air pollutant under CAA Sec. 108, a prerequisite to setting National Ambient Air Quality Standards (NAAQS) for it under CAA Sec. 109. Absent EPA first going through the Sec. 108 listing process, the statutory restriction on exceptions would preclude EPA from implementing a regulatory structure under Sec. 211. In fact, absent a Sec. 108 listing, Sec. 211 could be interpreted to require EPA to block any voluntarily pursued state-level carbon-reduction fuel regulations applied to fuel producers.

(EPA’s lack of action to list carbon as a criteria pollutant under Sec. 108 has been a matter of some discussion in the literature. One Columbia Journal of Environmental Law article provided this succinct explanation: “Because atmospheric GHG concentrations are uniform, establishing NAAQS for GHGs would place the entire country either in attainment status, which would have little effect on controlling emissions, or in nonattainment status, which would require states to implement onerous requirements and is consequently viewed as an excessively burdensome approach to GHG mitigation.” (Chang 2010))

If EPA were to choose to pursue a Sec. 211 regulatory approach to curtailing fuel production and use, it would appear to be limited to deploying a single national policy strategy, such as applying a price through a cap-and-trade mechanism imposed directly on fuel producers. (As the U.S. Constitution allows new Federal taxes to be initiated only in the House of Representatives and then passed into law, an administratively imposed direct tax, absent tax legislation, would be unconstitutional.)

Statutory provisions of the CAA, especially as related to explicitly enabling the use of financial instruments as a compliance tool, along with case law, support a legal interpretation of a cap-and-trade not being considered a tax. As a recent case law example, the California Third District Court of Appeal upheld the state's Air Resources Board cap-and-trade program, ruling that permit purchases were voluntary and a thing of value, distinguishing this from a tax which is neither (Cadelago 2017).

With a cap-and-trade, a legally defensible permit price may be constrained by the social cost of carbon. Such a constraint may be implied by the U.S. Supreme Court June 29, 2015, *Michigan, et al., versus Environmental Protection Agency, et al.*, ruling that said that consideration of whether a "regulation is appropriate and necessary" under CAA Sec. 112, which applies to the regulation of hazardous air pollutants, requires a benefit-cost analysis prior to the decision to regulate a pollutant (U.S. Supreme Court 2015).

Despite the absence of a statutory prohibition on regulatory costs exceeding benefits (the *Michigan* decision did not weigh in as to what, if anything, the benefit-cost analysis results would need to show for a regulation to be "appropriate and necessary"), a regulation that fails this test could offer a lower court a justification for overturning it (perhaps ruling that the *Michigan* decision would only make sense if costs exceeding benefits were disallowed). While a rulemaking that leads to emissions permit costs exceeding the SCC may still be found to be cost effective overall, because of revenue reuse and the like, there may nonetheless still be some legal vulnerability in imposing a carbon emissions charge that exceeds public benefits.

Benefit-cost analysis would also seem to be required using authority to regulate carbon and other emissions from other sections of the CAA, but fortunately the set of transportation price-shifting policies modeled in this paper almost certainly would net positive in a benefit-cost analysis, in large part because converting fixed driving costs to variable usage-based charges would, through voluntary reductions in driving, save consumers a substantial amount of money, and such savings would be a benefit on top of the benefits from carbon emissions reductions reflected by the SCC. Enacting those policies, though, would require legislative authority beyond what is provided by Sec. 211 and that is somewhat analogous to that offered by CAA Sec. 111(d), which provides the legal underpinning to regulate emissions of existing sources under the Clean Power Plan rule.

International Air Pollution (CAA Section 115)

Various sources in the literature that have examined possible regulatory approaches to reducing carbon emissions that do not require legislative authority beyond that provided by existing law have concluded that CAA Sec. 115 provides the broadest authority for such regulation.

A Petition for Rulemaking under Sec. 115 to regulate GHGs, sent by the Institute for Policy Integrity to EPA, asserts: "Sec. 115 creates a mandatory duty for EPA to respond to U.S. emissions that endanger public health and welfare in foreign countries. All the prerequisites for action under Sec. 115 have been satisfied for greenhouse gases: EPA has already acknowledged—based in part on reports from an international body (the multiple, voluminous reports from the United Nations established Intergovernmental Panel on Climate Change being the most prominent among these)—that greenhouse gases from the United States endanger foreign countries; and other countries, such as Canada, have given the United States reciprocal rights." (Institute for Policy Integrity 2013)

An identical conclusion about the broad authority to regulate GHG under Sec. 115 had been drawn earlier in a Columbia Journal of Environmental Law article. Specifically, it says: "Upon a finding that pollution in the U.S. is causing or contributing to air pollution 'which may reasonably be anticipated to endanger public health or welfare in a foreign country' and a reciprocity finding that the affected foreign country gives the U.S. 'essentially the same rights with respect to the prevention or control of air pollution occurring in that country as is given that country'…, Section 115 authorizes EPA to order the states in which emissions are occurring to revise their …SIPs…to address the foreign endangerment" (Chang 2010).

More recently, a group of five legal scholars authored a comprehensive assessment of the authority provided by Sec. 115. These scholars, along with six others characterized as "endorsing reviewers," noted the significance of the December 2015 Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) (United Nations 2015) in meeting the critical Sec. 115 reciprocity requirement that endangered foreign countries give the U.S. "essentially the same rights with respect to the prevention or control" of their own air pollution as Sec. 115 provides to foreign countries. About 190 countries have made pledges about their Intended Nationally Determined Contributions (INDC), with these countries accounting for over 93% of global GHG emissions. The Paris Agreement meets the reciprocity requirement under Sec. 115 by requiring all its signatories to regularly update their emissions reduction pledges, which UNFCCC will "communicate and maintain." For "Annex I" developed countries, including the U.S., regular and reciprocal opportunities to review and question INDC commitments from other nations are provided. Sec. 115 does not require the U.S. to have obtained the authority to enforce foreign national targets, especially since no foreign countries are given the authority to enforce U.S. targets. The U.S. INDC pledge could be used as the obvious Sec. 115 target for aggregate GHG emissions (Burger et al., 2016).

Unlike how, as discussed earlier, failure to list carbon as a criteria pollutant under Sec. 108 precludes EPA from pursuing all but a single national regulatory approach under Sec. 211 (Regulation of Fuels), such as pricing emissions through a cap-and-trade at the SCC rate, a non-listing would not constrain EPA's broad authority to pursue a state-level regulatory approach to control carbon emissions under Sec. 115, such as one based on the expected emissions reductions from the transportation price-shifting policy bundle modeled in this research. Both the plain language of Sec. 115 and three independent sources in the literature conclude that a Sec. 108 NAAQS listing is not a prerequisite for EPA possessing the full regulatory authority otherwise provided by Sec. 115 (Chang 2010, Institute for Policy Integrity 2013, and Burger et al., 2016).

According to one of these sources: "The eventual incorporation of international pollution in the SIP framework was *not* accompanied by dictates that air quality standards be established for international pollution, but was instead accompanied by amendments requiring SIPs to address Clean Air Act requirements unrelated to NAAQS." The reference in Sec. 115(a) to "*any* pollutant…emitted in the United States" does not limit coverage under this section to criteria pollutants, according to this source. Further, "just as a SIP is required to regulate *any air pollutant* that would interfere with another state's attainment or maintenance of NAAQS, it is required to comply with Sec. 115's requirement to avoid causing endangerment in another country." Finally, among the two circumstances that "provide for revision" of SIPs under Sec. 110(a)(2)(ii) is "whenever the Administrator finds…that the plan is substantially inadequate to attain the NAAQS which it implements *or to otherwise comply with any additional requirements established under this Act*" (Chang 2010).

Regarding a specific remedy, and as pointed out by this source, Sec. 115(b) notes that a determination that a pollutant is covered under Sec. 115 "shall be deemed to be a finding" under Sec. 110 "which requires a plan revision with respect to so much of the applicable implementation plan as is inadequate to prevent or eliminate the endangerment" (Chang 2010). Another source went further: "Based on statutory text, context, and legislative history, Sec. 115 should be interpreted to require…reasonable progress toward abatement. EPA can use its discretion to determine what level of greenhouse gas reductions is required to eliminate the global dangers that U.S. emissions contribute to" (Institute for Policy Integrity 2013).

As noted above, the U.S. INDC Paris Agreement commitment could serve as the appropriate national emissions target. Regarding the setting of state-level targets, EPA has broad discretion in apportioning GHG emissions allowances to the states, may implement a Federal Implementation Plan in recalcitrant states, could integrate a Sec. 115 rulemaking with existing and future stationary source rulemakings and transportation fuel regulations (such as by reducing Sec. 115 targets to reflect emissions reductions resulting from regulations under other sections of the CAA), and may permit the use of offsets as part of an economy-wide cross-sectoral trading program designed for efficient Sec. 115 compliance (Burger et al., 2016).

U.S. Supreme Court precedent supports EPA having broad discretion to set and enforce individual state-level emissions targets. In *U.S. Environmental Protection Agency versus EME Homer City Generation, L.P., et al.*, the Court upheld EPA's Cross-

State Air Pollution Rule, or Transport Rule, which was designed to curb emissions in 27 upwind states to achieve downwind-state attainment of NAAQS for three criteria pollutants. The Court affirmed EPA's ability to apportion SIP requirements to states based on EPA's determination of the most appropriate approach to meet the Clean Air Act Good Neighbor Provision requirements. The Court also affirmed EPA's authority to establish and enforce a FIP, even without giving states an opportunity to modify their own non-compliant SIPs, where such SIPs failed to achieve EPA's newly-issued state-level emissions standards. Part of EPA's approach in setting standards was to consider the relative cost effectiveness of remedies available to different states, and then to place the greatest emissions reduction burden on the states where the incremental costs of such reductions would be lowest, rather than requiring all states to reduce emissions proportionately (U.S. Supreme Court, April 2014).

In a similar vein, EPA could choose to base some of the Sec.115 burdens it apportions to states on the presumption of states implementing the modeled transportation price-shifting policy bundle, which on its face does not seem burdensome to implement and would save consumers significant amounts of money, rather than requiring proportionate personal transport emissions reductions, where some such emissions reductions could be burdensome and costly to implement.

Members of Congress opposed to the regulation of GHG emissions are attempting to amend the CAA to explicitly prohibit its application to GHG, suggesting that even they foresee at least the possibility that court challenges to such regulation would fail, especially given the aforementioned U.S. Supreme Court rulings and others showing significant deference to EPA and other agency rulemaking. One Congressman opposed to GHG regulations, Rep. Scott Perry (R-PA), is sufficiently concerned with the authority available to the President under Sec. 115 that he introduced a bill, H.R. 4544, to repeal this section. More broadly, House Speaker Paul Ryan's "A Better Way: Our vision for a Confident America" policy document, issued on June 14, 2016, endorses H.R. 3880, introduced by Rep. Gary Palmer (R-AL), which would repeal all Federal climate change regulations and prohibit any such future regulations.

AUTHORITY FOR AND RESTRICTIONS ON TRANSPORTATION PRICE-SHIFTING AND OTHER TRANSPORTATION MEASURES IN SIPS AND FIPS

Outside of the transportation arena, and as detailed in the subsection immediately below, the U.S. Supreme Court upheld a Federal agency's regulation to apply a price-shifting approach to meeting a broader statutory objective where the underlying statute was silent about price shifting, a situation analogous to the one contemplated in this research.

But even when relying on the very broad authority of CAA Sec. 115 to regulate GHG emissions, Federal power is not boundless to require or limit state- and metropolitan-level level transportation policy measures to reduce VMT. It is constrained by laws covering, among other things, the Federal role in influencing both parking pricing and the selection process for transportation projects funded by the Federal government through so-called formula funds provided to state departments of transportation and metropolitan planning organizations (MPOs) under Title 23 of the U.S. Code. On the other hand, CAA Sec. 110 requires SIPs to include transportation measures to meet NAAQS and other CAA requirements, which would include curtailing "foreign endangerment" under CAA Sec. 115, so inaction is not an option either.

Regulations Rewarding Consumer Energy Savings Upheld

The U.S. Supreme Court has, for utility pricing regulations, accepted policy remedies entailing providing direct financial awards to consumers who forego energy use, which is precisely what the transportation price-shifting policy bundle would accomplish. In *Federal Energy Regulatory Commission (FERC) versus Electric Power Supply Association (EPSA), et al.*, the U.S. Supreme Court allowed FERC very wide discretion in exercising its authority granted by the Federal Power Act (FPA) to regulate "the sale of electric energy at wholesale in interstate commerce," including activities "affecting" such rates, which the Court defines as "directly affecting the wholesale rate." The Court noted that the FPA left to states alone the power to regulate "any other sale" or, in practical terms, "any retail sale" of electricity. The Court upheld FERC's authority to encourage the creation of nonprofit entities to manage electricity by regions within the national grid, for such entities to stage competitive auctions to secure electric power and set wholesale prices, and to require that demand response program bids—except when prohibited by state regulations—be allowed in auctions (i.e., "to pay the same price to demand response providers for conserving energy as to generators for making more of it") (U.S. Supreme Court 2016).

With demand response programs, willing consumers are organized and compensated by aggregating entities that the consumers permit to remotely power down their high-wattage home appliances when systemwide electricity demand peaks. Large commercial power users, such as manufacturing facilities, could also participate by agreeing to be shut down during peak-power demand in exchange for compensation. The Court allowed this because "whatever the effects at the retail level, every aspect of the regulatory plan happens exclusively on the wholesale market and governs exclusively that market's rules."

Regarding the level of scrutiny the Court deemed appropriate for its judicial review of the design of FERC's rulemaking, the Court reiterated its 1983 *Motor Vehicle Manufacturers Association of the United States, Inc., versus State Farm Mutual Automobile Insurance Company* decision that the "scope of review under the 'arbitrary and capricious' standard is narrow. A court is not to ask whether a regulatory decision is the best one possible or even whether it is better than the alternative. Rather, the court must uphold a rule if the agency has 'examine[d] the relevant [considerations] and articulate[d] a satisfactory explanation for its action'…" (U.S. Supreme Court 2016).

Interestingly in the Motor Vehicle Manufactures case, the Court upheld a Court of Appeals ruling that the 1982 repeal of a 1977 requirement for passive restraints (automatic seat belts and air bags) was arbitrary and capricious, the legal standard of review under the Administrative Procedure Act. The Court concluded that the rationale offered by NHTSA that the earlier-proposed standard may not provide any safety benefit was unsupported and the lack of even minimal consideration to alternatives to a complete repeal was arbitrary and capricious (U.S. Supreme Court 1983).

Limitations on Requiring Parking Pricing in the Transportation Policy Bundle

In terms of specific measures from the transportation price-shifting policy bundle that we modeled that may be included in a "model SIP" (discussed in the next section), Sec. 110(c)(2)(B) may appear to limit EPA's authority to include the parking cash-out element that was modeled in this research, but upon closer look does not. It says: "No parking surcharge regulation may be required by the Administrator…as part of an applicable implementation plan…This subparagraph shall not prevent the Administrator from approving parking surcharges if they are adopted and submitted by a State as part of an applicable implementation plan. The Administrator may not condition approval of any implementation plan submitted by a State on such plan's including a parking surcharge regulation."

Parking cash out does not surcharge parking, but instead rebates employees who are offered but decline a workplace parking subsidy the value of the forgone parking. Interestingly, in *FERC versus EPSA, et al.*, discussed in the subsection immediately above, the U.S. Supreme Court dismissed the argument that creating a retail opportunity cost for avoiding peak-load energy use was tantamount to imposing a retail price on energy, which would be outside of FERC's authority. "To set a retail electricity rate is…to establish the amount of money a consumer will hand over in exchange for power. Nothing in…the Federal Power Act suggests a more expansive notion, in which FERC sets a rate for electricity merely by altering consumers' incentives to purchase that product…Consider a familiar scenario to see what is odd about EPSA's theory. Imagine that a flight is overbooked. The airline offers passengers $300 to move to a later plane that has extra seats…[W]ould any passenger getting off the plane say he had paid $700 to fly? That is highly unlikely." By this same logic, parking cash out would not be considered a prohibited "parking surcharge" (U.S. Supreme Court 2016).

Sec. 110(c)(2)(B) makes clear, though, that if EPA wanted to require a parking surcharge instead of just parking cash out, it could not. It is less clear, however, if EPA could base a transportation-related carbon emissions reduction target in part on a state imposing a parking surcharge if a state were allowed to meet the target through a different policy measure. Thus, if the model SIP stays away from using parking surcharges in any fashion and instead sticks only to parking cash out, it could be seen as taking a legally conservative approach.

Statutory Constraints on Federal Influence on Transportation Project Selection

While, as discussed earlier, the modeled bundle of transportation price-shifting policy measures would make a huge contribution to reducing U.S. GHG emissions, an even larger contribution could be made if Federally-funded transportation infrastructure projects were also required to be selected based at least in part upon their anticipated future GHG emissions impacts. The *Moving Cooler* study showed that a national strategy focused on transit and nonmotorized investments combined with land use controls would be very effective at reducing U.S. GHG emissions from the transportation sector, and even more so when combined with price-shifting strategies such as PAYDAYS insurance (Cambridge Systematics 2009).

While the Federal government has some ability to influence the selection of Federally-funded transportation projects, its authority is limited. Sections 134 and 135 of 23 U.S. Code provide the transportation planning rules that both MPOs and states must follow in order to be allowed to expend related Federal funds. The rules cover topics such as public involvement, "consideration of projects and implementation of projects" that, among other things, "protect and enhance the environment [and] promote energy conservation," environmental mitigation, consistency between metropolitan and state plans, and conformity with the CAA and, specifically, SIPs. Transportation Improvement Programs, which specify projects to be funded, must be consistent with Sec. 134 and 135 long-range transportation plans.

The consequences of failure to meet these requirements may be severe. For example, if an MPO representing an area with a population in excess of 200,000 fails to secure a planning certification from the U.S. DOT, 23 USC Sec. 134(k)(5)(C) says that "the Secretary may withhold up to 20 percent of the funds attributable to the metropolitan planning area of the MPO for projects funded under this title." In terms of project selection for the Statewide Transportation Improvement Program, 23 USC Sec. 135(g)(5)(D)(iii) provides that "[e]ach project shall be…in conformance with the applicable State air quality implementation plan developed under the Clean Air Act if the project is carried out in an area designated as nonattainment for ozone, particulate matter, or carbon monoxide." Thus, even if there were to be a CAA Sec. 108 listing of carbon as a criteria pollutant, it would not trigger a conformity requirement that is applied to project selection, as that requirement is only triggered due to nonattainment for ozone, particulate matter, or carbon monoxide.

Such nonattainment would trigger the conformity requirement and legal precedent suggests that after such a requirement is triggered, the selection of transportation projects could be compelled by the Federal government to conform to a SIP, including to transportation-related carbon reduction measures brought into the SIP as a result of CAA Sec. 115 (in addition, of course, to whatever is required to advance ozone, particulate matter, and/or carbon monoxide attainment).

In *Utility Air Regulatory Group versus Environmental Protection Agency*, the U.S. Supreme Court was asked to decide a case about whether EPA could apply its so-called "Tailoring Rule" to limit the facilities to be covered under its best available control technology (BACT) regulations or Title V permitting requirements for carbon emissions from stationary sources. This rule limited such regulations only to facilities that are fairly large sources instead of to all sources with carbon emissions exceeding 250 tons per year of "any air pollutant" (which is a very low level of carbon pollution), established by the CAA as the pollutant-agnostic quantity trigger for determining which facilities are subject to EPA regulation. The court decided that EPA did not have the authority to change the quantity trigger, which EPA had changed in a rulemaking to 100,000 tons per year of carbon emissions for a facility to be covered, and instead ruled that EPA could only apply carbon standards to facilities otherwise regulated by EPA because of their emissions of other pollutants. Referring to otherwise regulated sources, the court ruled: "Our narrow holding is that nothing in the statute categorically prohibits EPA from interpreting the BACT provision to apply to greenhouse gases emitted by 'anyway' sources. However, EPA may require an 'anyway' source to comply with greenhouse-gas BACT only if the source emits more than a *de minimus* amount of greenhouse gases." The court did not object to EPA layering on a reasonable quantity threshold of its choosing after first limiting the scope of facilities covered under its carbon regulations to ones already subjected to regulation due to their emissions of one or more NAAQS-covered pollutants (U.S. Supreme Court, June 2014).

This Supreme Court ruling would support the conclusion that, while carbon emissions would not themselves trigger project selection limitations that require conformity under the CAA, projects selected in areas in nonattainment for ozone, particulate matter, or carbon monoxide would still need to conform to all elements of an approved SIP, including transportation-sector carbon emissions provisions (in addition to having to make sufficient progress in reducing transportation emissions of ozone, particulate matter, and/or carbon monoxide). This significant leverage on the part of the Federal government to influence the selection of transportation projects can only be exercised in areas in nonattainment for ozone, particulate matter, or carbon monoxide.

One provision in Federal transportation law, 23 USC Sec. 145, Federal-State Relationship, appears to substantially limit the Federal government's ability to influence project selection, however. The relevant provision is: "(a) Protection of State Sovereignty. – The authorization of the appropriation of Federal funds or their availability for expenditure under this chapter shall in no way infringe on the sovereign rights of the States to determine which projects shall be federally financed. The provisions of this chapter provide for a federally assisted State program."

While it is uncertain how a court may weigh the limitation of this authority against the authority provided in statute to control project selection in areas in nonattainment for ozone, particulate matter, or carbon monoxide, the application of one legal principle suggests that the 23 USC Sec. 145 restriction on Federal interference with project selection authority would not apply to the more specific circumstance of areas in nonattainment for ozone, particulate matter, or carbon monoxide, but would apply elsewhere. Title 23 USC 135, which was discussed above, was not repealed and when a specific and more general provision of law are in conflict, the specific provision usually wins out (Eig 2011). Put differently, the law could be read as establishing a general provision (i.e., no Federal interference with project selection) and a specific exception (i.e., project selection in areas in nonattainment for ozone, particulate matter, or carbon monoxide must conform with SIPs that are designed to lead such areas into attainment).

But a counter argument could be made against allowing the reach of the conformity process to be extended to cover GHG emissions from transportation project selection in areas that are in attainment. The limitation on the Federal government to influence project selection could be interpreted by courts to also limit Federal authority to condition compliance under CAA Sec. 115 on the selection of a grouping of transportation infrastructure projects designed to constrain transportation sector carbon emissions. Even if, ultimately, the Federal government is not choosing the specific projects, but instead is developing a Sec. 115 standard that assumes certain specific projects are chosen (and even then there would likely be other paths available to states and MPOs to meet conformity requirements without having to select these specific transportation infrastructure projects), the “in no way infringe on the sovereign rights of the States” language is very strong, and could be interpreted by courts as a severe limitation on new project selection barriers erected by the Federal government that are not specifically tied to bringing areas into attainment for ozone, particulate matter, or carbon monoxide (such as by weighing the scales in favor of certain projects by presuming their carbon emissions reductions benefits within SIPs).

Even for areas in attainment for ozone, particulate matter, and carbon monoxide, however, it would be inaccurate to conclude that there could not be any Federal influence on project selection, although there cannot be Federal coercion. While especially in such areas it might be legally problematic for EPA to insist that SIP targets be established with the presumption that at least some transportation projects will be selected for the purpose of meeting carbon emissions reduction targets, there are no legal obstacles to allowing offset credits—pursued at the discretion of states—for selecting of transportation projects that perform especially well in terms of the expected resulting carbon emissions (typically due to their curtailing of area VMT).

To avoid providing offset credits for projects otherwise required to meet conformity targets for ozone, particulate matter, or carbon monoxide, credits could be made available only to projects that are not also needed to, where applicable, make the required progress toward conformity. Assuming no double counting of benefits for projects required for conformity and to meet carbon targets, if EPA chooses to require SIP modifications under Sec. 115 reflective of state adoption of the transportation price-shifting policy bundle, and state officials choose not to adopt an element of the policy bundle (or to adopt an element in a form that is less aggressive than modeled), offset credits from transportation projects could be used to still enable SIP compliance with a carbon goal that was set based on the modeled transportation policy bundle.

CONTEMPLATING AND DESIGNING A CAA SEC. 115 MODEL SIP AND FIP

Overview and Proposed General Approach

One source suggests a particular implementation approach: "In issuing a call for SIP revisions under Sec. 115, EPA could effectively establish a cap on GHG emissions and encourage interstate trading by identifying GHG emissions 'budgets' for each state and presenting a model budget trading rule, much like it did in the 1998…SIP call for NOx emissions. Although EPA cannot force states to implement particular measures in SIPs, the existence of a cap on GHG emissions in a state would incentivize participation in trading as a cost-effective means of emissions reduction" (Chang 2010).

But, since EPA has been legally compelled or has otherwise elected to control carbon emissions from a myriad of sources besides existing motor vehicles using sector-specific authority provided under different provisions of the CAA, a prudent strategy to further reduce carbon emissions may be to apply Sec. 115 authority only to otherwise uncovered sources, starting first with LDV emissions for vehicles already on the road, the largest of such sources. Nowhere in Sec. 115 or other sections of the CAA is EPA's authority under Sec. 115 diminished by authority also granted elsewhere in the act and used by EPA to regulate carbon emissions. To allow for the most cost effective reductions in carbon emissions, trading among all sectors that are ultimately brought under the regulatory fold of Sec. 115 could be allowed and even encouraged (Institute for Policy Integrity 2013).

Existing motor vehicles clearly present the largest unregulated source of carbon emissions in the U.S., as discussed earlier, and indeed even emissions from new motor vehicles are only partially covered (i.e., through fuel economy regulations, but not otherwise). For both new and existing vehicles, EPA is not regulating, nor has it proposed to regulate, carbon unrelated to fuel economy, such as by continuously engaging drivers to reduce VMT through TDM.

While designing a narrow solution to address the gap in regulating light duty vehicle GHG emissions—and specifically bringing in consumer-side engagement in vehicle-use efficiency on top of preexisting fuel economy standards—may be justified, it may nonetheless still be the case that a more general remedy, such as capping (and enabling trading for) all economy-wide GHG emissions or even just automotive-fuel GHG emissions, would be a better approach. After all, Sec. 115 would allow the broadest approach, and even Sec. 211 would—as noted earlier and also in Table 3—allow the somewhat narrower approach of capping only motor-fuel GHG emissions. But a counter argument is that other reasonable and workable remedies are already in place, or nearly in place (assuming existing court challenges fail or rules are not reversed administratively), to address other GHG sources, and a more targeted remedy would be less disruptive than a broad remedy. Further, and as discussed earlier, the transportation price-shifting policy bundle would provide huge GHG reduction benefits on a scale with the Clean Power Plan with very minimal cost and burden while providing substantial consumer savings.

One means to accommodate both points of view and thus to serve both objectives would be to use Sec. 115 authority to separately establish (1) a targeted rulemaking focusing on the transportation price-shifting policy bundle and (2) the broadest regulatory approach covering other yet-to-be-regulated sources. A broad Sec. 115 approach could be integrated with preexisting and even other future GHG regulations by quantifying and then crediting the reductions from such regulations within the broader Sec. 115 scheme (reducing the Sec. 115 baseline emissions forecast from the otherwise regulated source), essentially exempting otherwise-regulated sources from additional Sec. 115 regulations. This would apply in instances, such as with the proposed transportation price-shifting policy bundle, where a specifically-tailored approach provides some advantages over relying entirely on a broader Sec. 115 scheme. It would offer the advantage of allowing additional emissions reductions from those otherwise-regulated sources to be incentivized by and credited within the broader Sec. 115 framework (Burger et al., 2016). For sources where a layered regulatory structure would not offer an advantage over a simpler broad Sec. 115 framework, it may be possible to rescind previous rulemakings and allow the broader Sec. 115 regulatory framework to govern such sources.

Designing a State Implementation Plan “Model Rule”

Designing a SIP model rule (or more descriptively, model provisions to be added to a preexisting SIP), whereby states that adopt it could be assumed to be in compliance regardless of whatever level of emissions reductions actually result, is a relatively straightforward exercise. The model rule could be adopted as part of a SIP by simple reference, or by adding tailored language to a SIP reflecting a unique state context, assuming it is done in a way whereby the model provisions are substantively left intact (Burger et al., 2016). The model would rely on states securing the needed authority, through whatever combination of state legislation and regulations is required, to implement the transportation price-shifting policy bundle. Two versions of a SIP model rule were developed by EPA for the Clean Power Plan (one for states choosing a rate-based emissions target and the other for a mass-based target), but only one should be needed in this instance.

The model SIP must first clearly articulate the specific policies that would form the basis of the emissions reductions. The policies in the transportation price-shifting bundle would be the same ones as specified in detail earlier in this research, with their essential features highlighted in the next two paragraphs below. Recall that the policies were designed to provide benefits in the same timeframe as the Clean Power Plan to meet the U.S. Paris Agreement commitments, most of which begin in 2030, and thus there would be substantial lead in time for states to adopt and implement the policies, including whatever related changes in laws and regulations are required (which would vary be state), and for markets to adjust accordingly.

For PAYDAYS car insurance, the SIP would need to demonstrate that premiums will on average be at least 70% usage-based. For parking cash out, the SIP would require that, when a parking subsidy is provided, an equivalently-valued subsidy for those who do not drive to and park at work also be offered or the parking subsidy loses its tax-exempt status at the state level. States would be required to demonstrate to EPA that the design of their cash-out requirements would lead to average cash-out values of at least $121 per space per month, or one-half the $242 required to recover the costs of providing and maintaining a space within a suburban above-ground two-story parking structure (Howe & George 2014).

For VMT fees replacing sales taxes on newly purchased vehicles (the third component of the transportation price-shifting policy bundle), the model SIP would require that state law be amended to take the population-weighted combined state/local sales taxes that are charged on newly purchased vehicles and convert them to mileage-based taxes charged over a three-year period, set at a level designed to raise the same amount of revenue. (Many states already collect and rebate local sales taxes for vehicle purchases.)

States that implement all three of these transportation price-shifting policies as specified would be presumed by EPA to be in compliance. States that adopt only one or two could rely on EPA's emissions projections related to those component parts of the policy bundle, with additional state remedies required only to make up the difference.

Designing a Federal Implementation Plan

To address the possibility of a state failing to revise its SIP to include the measures contained in the transportation price-shifting policy bundle or other measures that yield comparable GHG emissions reductions—and to make whatever changes are needed in state law or regulation to implement the SIP, a Federal plan or FIP could be promulgated.

In "Federal Implementation Plans for Controlling Carbon Emissions from Existing Power Plants: A Primer Exploring the Issues," one researcher cites CAA Sec. 110 as making FIP promulgation mandatory for states refusing or otherwise failing to submit SIP revisions that meet new standards. It further notes that case law under the Tenth Amendment of the U.S. Constitution "precludes the federal government from 'commandeering' states to enforce a federal program." The Tenth Amendment says:

"The powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to States respectively, or to the people." (Selmi 2015)

One particularly germane case cited by this same researcher was the 1975 Court of Appeals for the D.C. Circuit decision in *District of Columbia versus Train*, where EPA's FIP had required the District "to purchase buses, adopt…an inspection and maintenance program for vehicles, and retrofit…certain classes of vehicles with pollution control devises." The court ruled: "[A]n analysis of the language of the [Clean Air] Act, and particularly its enforcement provisions does not appear to…authorize…requiring the states to enact statutes and to administer and enforce the programs contained in the EPA plan." The U.S. Supreme Court has supported this general limitation, with this researcher citing the 1992 *New York versus United States* opinion (Congress "may not simply 'commandee[r] the legislative process of the States by directly compelling them to enact and enforce a federal regulatory program'…") as one good example (Selmi 2015).

As a result, practical considerations need to govern FIP content – "Tenth Amendment limitation would prevent [EPA] from relying on the state to carry out any of the regulations; it would have to implement all regulation on its own" (Selmi 2015). Legal issues could also arise in attempting to include all elements of the model SIP, even in modified form, in the FIP.

Designing a FIP, relying on the Federal government's ability to actually implement it in recalcitrant states, would be more challenging than designing the model SIP. Along with finalizing the Clean Power Plan, EPA proposed a FIP with the goal of ensuring Clean Power Plan rule GHG target compliance in every state. Similar to that proposed FIP, the Federal plan for transportation GHG emissions compliance could be structured differently and/or more simply than the model SIP (and the state plans that follow it).

In states that would otherwise be noncompliant, the FIP could, as its central component or as a backstop, cap allowable transportation fuel use at an amount that would result if a state were to choose to implement the model SIP in its entirety and then limit the sale of permits to that quantity. If this were the central component of the FIP, and as modeled and discussed earlier, a permit price of $509 per ton CO_2e, or over 10 times the $50 SCC in 2030 (Interagency Working Group on Social Cost of Carbon 2015), would be expected to be required to reduce the same 257.2 MMT CO_2e in 2030 as the transportation price-shifting policy bundle would reduce. This hardly seems to be the best alternative. As just a backstop mechanism, though, the price would be at least somewhat lower, such as if some but not all of the model SIP measures were adopted either by a state or implemented in a state through a FIP. Such measures would curtail fuel demand prior to requiring emissions permits and thus allow a lower permit price to close the gap in achieving the total emissions reductions desired.

A more complex FIP would have the advantage of bringing about implementation of the transportation price-shifting policy bundle components—along with their public benefits and consumer savings—even in states that are not cooperating. While the policies included in the model SIP do not readily translate into one or more programs that the Federal government could easily implement without state government involvement, imposing some clever design modifications to such policies could, in some instances, enable Federal enforcement. Nevertheless, a backstop such as the aforementioned is required in instances, such as some discussed below, where a practical alternative Federal remedy is not available and also if a court strikes down part of the FIP for whatever reason.

For the PAYDAYS insurance component of the transportation price-shifting policy bundle, it may be reasonably practical for the Federal government to require insurance companies to act as its agent. Insurance companies could be required to prove to the Federal government that they are offering a compliant product (where premiums are, on average, at least 70% variable), and where they are not, they could be compelled to collect a per-mile fee from motorists who they insure that is comparable to the variable portion of a compliant PAYDAYS policy. (As a practical matter, the additional fees required of customers of noncompliant insurance policies would make such policies cost prohibitive and likely quickly lead to their demise in the marketplace.)

This would raise two legal questions. First, since insurance is not the source of the pollution, could insurance companies be compelled to serve this role? Second, are there legal limitations to the dispensation of the collected revenues?

CAA Sec. 110, which guides SIP and FIP content, says that plans need to “include enforceable emission limitations and other control measures, means, or techniques (including economic incentives such as fees, marketable permits, and auctions of emissions rights)…” Imposing a fee on insurance premiums that acts as an economic incentive to reduce driving would seem to be an allowable control measure under this provision. While insurance companies are not responsible for their customers’ driving, they have at their disposal a means directly related to their product offerings to influence it, and indeed, some companies are already using it to at least some degree.

While fees are explicitly allowable under CAA Sec. 110, the U.S. Constitution requires that taxes be initiated by Congress. The Constitution suggests how the two could be distinguished. Most often, such as in Article I, Section 7, the Constitution is concerned with revenue raising: “All bills for raising revenue shall originate in the House of Representatives…” Section 8 adds: “The Congress shall have power to lay and collect taxes, duties, imposts, and excises to pay the debts and provide for the common defense and general welfare of the United States…” Thus, it seems that so long as revenues raised do not stay with the Federal government, imposing fees should be acceptable. That then begets the question: where should the money go?

One possibility, as proposed in previous research, is to dedicate all the fee revenues raised from noncompliant insurance companies to reward compliant insurance companies (Greenberg 2009). This pay-or-be-paid approach has the advantage of raising the opportunity cost of noncompliance. All the revenue collected in noncompliant states could be proportionately redistributed to insurers in such states based upon the number of compliant insurance policies that they sell there. Given the limited number of U.S. auto insurance companies, this solution does appear reasonably practical for Federal implementation.

Unfortunately, there does not appear to be a practical mechanism for the Federal government to compel and enforce parking cash out in noncompliant states as part of a FIP. While one can conceive of a system first involving mandatory reporting by employers, and then employers collecting fees and the Federal government distributing the revenues, it would not be practical given the very large number of employers that exist. (As imagined, all employers would be required to indicate on some Federal form whether they are offering subsidized parking and, if so, whether they are also offering cash out. Then, if they are subsidizing parking but not offering cash out, they would be required to collect a fee from parkers equivalent to the cash-out value. Revenues from the fee would be distributed by the Federal government among employers proportional to the number of their employees in the state who either are not offered subsidized parking or are offered it, but with a cash-out option.) Unless a more practical scheme is conceived, utilizing the backstop measure, discussed earlier, would be required.

The third element of the model SIP, VMT fees replacing sales taxes on newly purchased vehicles, would be relatively easy for the Federal government to implement within a FIP and would face little legal vulnerability. Automakers—of which there are very few—and used car dealers—which are limited in number—would be required to collect a mileage fee for three years on newly purchased vehicles. The money could be kept by these entities (and hence should not be considered a Federal tax) which in turn would likely lead them to lower sales prices reflective of the VMT fees they expect to collect. Use of a vehicle is clearly the source of emissions thus making this approach particularly robust legally.

Laws and regulations frequently include severability clauses, which state that all provisions not explicitly struck down as a result of a court challenge remain in force (National Conference of State Legislatures 2011). Such clauses could also specify replacement provisions for those that might be struck down. Such provisions would not be as desirable from a policy standpoint (or they would have been adopted in the first place), but they would be less vulnerable legally.

In the case of this FIP, a court could, as an example, strike down requiring any insurance company involvement because insurance companies are not a “source” of carbon pollution. This is possible since the term “source” is used in multiple places in the CAA, which may imply a statutory intent to limit agency authority to regulating sources even when not stated explicitly. But it is also somewhat unlikely since Sec. 115 discusses only eliminating endangerment from a pollutant and then requires a Sec. 110 plan revision to accomplish this. Sec. 110 does mention the term "source," but only in the context of nonattainment, and its cross reference to Sec. 115 only notes the need to ensure compliance with the requirements of that section, which the proposed transportation price-shifting policy bundle would unequivocally aid.

In any case, the backstop measure of requiring permits for selling transportation fuel would be needed anyway because of the lack of a practical Federal remedy for states refusing to implement cash out, and this backstop would ensure the desired outcome in terms of limiting emissions from using transportation fuels even if a court decides to relieve insurance companies and their customers from FIP-related obligations.

CONCLUSIONS

This research examined the vehicle travel and carbon emissions reduction impacts that could be achieved by deploying a bundle of revenue-neutral transportation pricing reforms that convert fixed driving and parking costs to variable, usage-based charges, specifically through (1) PAYDAYS car insurance, (2) parking cash out, and (3) conversion of state and local sales taxes applying to newly purchased vehicles to mileage taxes designed to raise equivalent revenue. This bundle, combined with previously implemented fuel economy standards, is somewhat analogous to EPA's Clean Power Plan rule, which bases state-level carbon emissions reduction targets on deploying a series of power sector emissions reduction strategies.

Results of the transportation price-shifting policy bundle were modeled (as shown in Tables 1 and 2), yielding nationwide GHG emissions reductions of 257 MMT of CO_2e emissions or 68.6% of those of the final Clean Power Plan rule (on top of the reductions of that rule), and reductions greater than those calculated for the Clean Power Plan rule in 24 states plus the District of Columbia. Other policy options, discussed below, were also modeled based upon what was considered legally and politically possible.

This research explored whether the transportation policy bundle could be used to establish state-level carbon emissions reduction targets through Federal administrative action absent any additional Congressional authority. Specific sections of the CAA and Federal surface transportation law were examined. Also researched was whether legislative authority exists to further bolster carbon reduction targets by limiting project selection authority to bring about investments that encourage VMT reductions and transit and nonmotorized travel. The legal authority to price transportation fuels through a cap-and-trade at the rate of the SCC was also explored as a second-best alternative. The results of this legal research are summarized in Table 3.

CAA Sec. 115 was found to provide the broadest Federal legal authority to bring about transportation sector carbon emissions reductions, including by allowing EPA to set and enforce carbon targets through SIPs based on the presumption of state enactment of a transportation price-shifting policy bundle. There is some legal ambiguity as to whether or not the Federal government could compel such targets to be further tightened within SIPs by EPA also presuming the selection of transportation infrastructure projects that reduce VMT beyond some baseline in setting such targets. Nonattainment for ozone, particulate matter, or carbon monoxide triggers a Federal conformity requirement constraining project selection options available to states for transportation infrastructure projects such that funding decisions must lead toward compliance with standards for these criteria air pollutants. U.S. Supreme Court precedent suggests that, after an environmental regulatory requirement like conformity is triggered, the selection of transportation projects could be compelled by the Federal government to adhere to a SIP, including to transportation-related carbon-reduction measures brought into the SIP as a result of CAA Sec. 115.

One provision in Federal transportation law, 23 USC Sec. 145, Federal-State Relationship, was shown to likely substantially limit the Federal government's ability to influence project selection. It is uncertain, however, how a court may weigh the limitation of this authority against the authority provided in statute to control project selection in areas in nonattainment for ozone, particulate matter, or carbon monoxide. In all areas, though, offset credits to help meet emissions targets reflective of the modeled transportation price-shifting policy bundle could legally be provided for funding of transportation infrastructure projects that are anticipated to reduce carbon emissions below some pre-established baseline.

A model SIP to bring about the transportation price-shifting policy at the state level was proposed. Then, a design for a practical and most-likely-legal FIP to mimic as closely as possible the measures included in the model SIP was presented. In the event that any element of the FIP may be struck down in court, a severability clause was recommended to preserve the remaining FIP provisions.

To make up for any lost emissions reductions that could result from a successful court challenge, a backstop measure was proposed within the FIP entailing capping allowable transportation fuel use at an amount that would result if a state were to choose to implement the model SIP in its entirety and then limit the sale of permits to that quantity. A special "reverse" model run was performed to ascertain the permit price required in the backstop FIP measure (assuming, in the extreme case, that all the specific FIP measures of the transportation price-shifting policy bundle were struck) to reduce the same 257 MMT CO_2e as the policy bundle would reduce. It was determined that the price would have to be $183 per ton CO_2e, or 3.7 times the SCC, if no other incentives from the model SIP were brought into the FIP. Thus, it was shown that by having the FIP mimic, to the extent possible, the model SIP, a much lower cost could be imposed on fuel permits (and, of course, no permits, or related costs would be required in states that adopt the model SIP, or measures with equivalent emissions reduction benefits).

It would be advantageous for residents if their states choose adoption of the model SIP which provides them money-savings opportunities, or something similar to it, over a less generous FIP, and certainly over a carbon price at the level required to achieve the same emissions reductions as the model SIP.

The changing political climate in the U.S. was noted, suggesting for at least a few years a less dominant Federal role in climate policy being replaced, in part, by state-level leadership. If states that have already demonstrated some form of climate policy leadership or interest follow through by enacting the modeled transportation price-shifting policy bundle on their own, it is estimated that, depending upon which of two approaches more accurately predicts state participation, this would yield nationwide reductions in GHG emissions of 91 or 103 MMT CO_2e or 35 or 40% of the 257 MMT CO_2e reduction that would result in year 2030 if deployed in every state. This is still more than the 85 MMT CO_2e emissions cut of a nationwide transportation fuels cap-and-trade program with a permit price at the SCC.

Additionally, conservatives seem significantly more amenable to pricing strategies that are legislatively enacted to reduce carbon emissions over regulatory strategies that they consider an overreach of authority, although neither approach seems especially popular (but the former could become popular if its inclusion in broader tax legislation yields votes from environmentally oriented members of Congress for a comprehensive tax reform package otherwise having broad conservative support). Price-shifting legislation may include a Federal parking cash-out requirement coupled with a new Federal tax credit to reward companies for offering compliant PAYDAYS insurance products and states for shifting fixed vehicle sales taxes to mileage fees.

After making some assumptions about the impacts of the tax credits on the adoption rates of the price-shifting policies for which the credits are offered, the targeted Federal legislation was modeled to deliver nationwide reductions in GHG emissions of 140 MMT CO_2e or 54.5% of the 257 MMT CO_2e reduction if the transportation price-shifting bundle were applied universally. This would bring about 1.7 times the 85 MMT CO_2e emissions cut of a nationwide transportation fuels cap-and-trade program with a permit price at the SCC and could easily be combined with emissions taxes applying to other sectors of the economy. For example, the American Opportunity Carbon Fee Act of 2017 that was introduced in the U.S. Senate applies an economy-wide carbon tax of $52.20 (in year-2007 dollars) in year 2030. While transportation price-shifting could be enacted concurrently with a carbon tax, the proposed tax bill could instead be amended to include the transportation price-shifting bundle while exempting personal transportation emissions from taxation (since fuel tax increases may be especially unpopular and could hinder the chances of successfully enacting a carbon tax on non-transportation emissions). As noted earlier, the legislative enactment of a “conservative” transportation price-shifting bundle would yield CO_2e emissions reductions equivalent to those resulting from imposing an $89 per metric ton carbon tax on transportation fuels, or instituting a tax rate that is 1.8 times higher than the SCC or 1.7 times higher than the year-2030 rate from the American Opportunity Carbon Fee Act of 2017. This is a rare instance where the policy yielding a greater emissions reduction would likely be easier to enact than the alternative policy.

APPENDIX 1 - MODEL DOCUMENTATION

Main Model

The parameters and equations used in applying the scenarios in the model are detailed below. The nomenclature for the parameters is as follows: (a) for the first letter, "S" indicates that each state has a different value for this parameter, while "F" indicates a single Federal figure for the parameter; (b) for the second letter, "E" is for a parameter used mostly or exclusively for calculations of power rule emissions, and "T" is for a parameter used mostly or exclusively for calculations of transportation emissions; and (c) for parameters consisting of four characters and ending in "F", "F" indicates a Federal sum of all the state-level figures. Table A1 summarizes the data sources used.

Equation 1 – Power Rule Reduction

$$Power\ Rule\ Reduction = SE1$$

Where:

SE1 = CO_2 emissions reduction [MMT in 2030 based on difference reported from U.S. EPA IPM 5.15 Base Case versus the Mass-Base Case (Based on USEPA, August 3, 2015)] (USEPA, Oct. 2015)

Note:

Through consultation with EPA, the authors have determined that CO_2 and CO_2e power plant emissions are virtually equivalent.

Equation 2 – Estimated 2030 VMT by State

$$SI1 = FT4 \times \frac{\frac{ST2}{ST3}}{\frac{ST2F}{ST3F}} \times \left(\frac{ST4}{ST4F}\right)$$

Where:

ST1 = State-registered light duty vehicles (LDVs) (2011)
ST2 = Vehicle miles of travel (VMT) in 2011 for state
ST2F = Total VMT in 2011 (U.S. total)
ST3 = Estimated population in 2011 for state
ST3F = Population of all states in 2011 (U.S. total)
ST4 = Projected population in 2030 for state
ST4F = Projected population of all states in 2030 (U.S. total)
FT4 = Projected VMT in 2030 for U.S.

Equation 3 – Estimated 2030 Cost per Mile for Pay-As-You-Drive Insurance by State[3]

$$SCSA = \frac{ST5 \times FT9}{\frac{ST2}{ST1}}$$

Where:
ST1 = Registered LDVs in 2011 for state
ST2 = VMT in 2011 for state
ST5 = Average car insurance premium from January 2014 for state
FT9 = Percentage of insurance premium that is assumed variable (U.S. average)

Equation 4 – Estimated 2030 Cost per Mile for Parking Cash Out

$$SCSB = \frac{FT10}{\frac{ST2 \times FT5}{(ST7 \times ST8) + \frac{(ST7 \times ST9)}{FT2}} \times \frac{FT4}{ST2F}} \times \frac{ST4F}{ST3F}$$

Where:
FT2 = Average vehicle occupancy of carpool/vanpool
FT4= Projected VMT in 2030 for U.S.
FT5 = U.S. percentage of commute VMT of total VMT in 2009
FT10 = Average parking cash-out value modeled
ST2 = VMT in 2011 for state
ST7 = Number of workers in 2011 for state
ST8 = Percent drive alone to work in 2011 for state
ST9 = Percent carpooling to work in 2011 for state
ST2F = Total VMT in 2011 (U.S. total)
ST3F = Population of all states in 2011 (U.S. total)
ST4F = Projected population of all states in 2030 (U.S. total)

Equation 5 – Estimated 2030 Cost per Mile for Sales Tax Converted to VMT Tax[4]

$$SCSC = \frac{FT13 \times \frac{ST6}{FT11}}{\frac{ST2}{ST1} \times \frac{FT4}{ST2F}} \times \frac{ST4F}{ST3F}$$

Where:
FT4 = U.S. projected VMT in 2030
FT11 = Number of years over which sales tax charges for newly purchased vehicles is distributed
FT13 = Average U.S. vehicle sales price (new and used) in 2010

[3] A 20% factor is applied to *SCSA* to calculate results for the limited-penetration alternative scenario that is discussed in the paper.

[4] A 1/0 dummy variable is multiplied to *SCSC* to calculate results for the limited-penetration alternative scenario that is discussed in the paper.

ST1 = Registered LDV in 2011 for state
ST2 = VMT in 2011 for state
ST2F = Total VMT in 2011 (U.S. total)
ST3F = Population of all states in 2011 (U.S. total)
ST4F = Projected population of all states in 2030 (U.S. total)
ST6 = Combined population-weighted state/local sales tax rates in 2014

Equation 6 – U.S. Percentage of Commuter VMT with Free Parking

$$SI2 = FT5 \times FT8$$

Where:
FT5 = U.S. percentage of commute VMT of total VMT in 2009
FT8 = Percentage of workers with free parking

Equation 7 – U.S. Percentage of New Vehicles in LDV Fleet within Past Three Years

$$SI3 = \frac{FT12}{ST1F} \times FT11$$

Where:
FT11 = Number of years over which sales tax charges for newly purchased vehicles is distributed
FT12 = U.S. LDV sales and leases (new and used) in 2010
ST1F = Registered LDVs (U.S. total)

Equation 8 – Generalized LDV Fleet Reduction Price Elasticity Equation

$$LDVR = Q_1 \times \left(\left(\frac{P_2}{P_1}\right)^{\eta} - 1\right)$$

Where:
Q_1 = Original LDV miles to which potential strategy applies
P_1 = Cost per mile of gasoline
P_2 = Cost per mile of gasoline plus cost per mile of applicable strategies
η = Price elasticity

Equation 9 – LDV Fleet Reduction in Driving due to Factors A+B+C

$$LDVR_{A+B+C} = SI1 \times SI2 \times SI3 \times \left(\left(\frac{SCSA + SCSB + SCSC + \frac{FT7}{FT6}}{\frac{FT7}{FT6}}\right)^{FT1} - 1\right)$$

Where:
SI1 = Estimated 2030 VMT by state (see Equation 2)

SI2 = U.S. percentage of commuter VMT with free parking (see Equation 6)
SI3 = U.S. percentage of new vehicles in fleet within past three years (see Equation 7)
SCSA = Estimated 2030 cost per mile for PAYDAYS insurance (100% penetration) by state (see Equation 3)
SCSB = Estimated 2030 cost per mile for parking cash out (see Equation 4)
SCSC = Estimated 2030 cost per mile for sales tax converted to VMT tax (see Equation 5)
FT1 = Price elasticity
FT6 = U.S. LDV average fuel economy in 2030
FT7 = U.S projected fuel price in 2030

Equation 10 – LDV Fleet Reduction in VMT due to Factors A+B

$$LDVR_{A+B} = SI2 \times (1 - SI3) \times \left(\left(\frac{SCSA + SCSB + \frac{FT7}{FT6}}{\frac{FT7}{FT6}} \right)^{FT1} - 1 \right)$$

Where:
SI1 = Estimated 2030 VMT by state (see Equation 2)
SI2 = U.S. percentage of commuter VMT with free parking (see Equation 6)
SI3 = U.S. percentage of new vehicles in fleet within past three years (see Equation 7)
SCSA = Estimated 2030 cost per mile for PAYDAYS insurance (100% penetration) by state (see Equation 3)
SCSB = Estimated 2030 cost per mile for parking cash out (see Equation 4)
FT1 = Price elasticity
FT6 = U.S. LDV average fuel economy in 2030
FT7 = U.S projected fuel price in 2030

Equation 11 – LDV Fleet Reduction in VMT due to Factors A+C

$$LDVR_{A+C} = SI1 \times SI3 \times (1 - SI2) \times \left(\left(\frac{SCSA + SCSC + \frac{FT7}{FT6}}{\frac{FT7}{FT6}} \right)^{FT1} - 1 \right)$$

Where:
SI1 = Estimated 2030 VMT by state (see Equation 2)
SI2 = U.S. percentage of commuter VMT with free parking (see Equation 6)
SI3 = U.S. percentage of new vehicles in fleet within past three years (see Equation 7)
SCSA = Estimated 2030 cost per mile for PAYDAYS insurance (100% penetration) by state (see Equation 3)
SCSC = Estimated 2030 cost per mile for sales tax converted to VMT tax (see Equation 5)
FT1 = Price elasticity
FT6 = U.S. LDV average fuel economy in 2030
FT7 = U.S projected fuel price in 2030

Equation 12 – LDV Fleet Reduction in VMT due to Factor A

$$LDVR_A = SI1 \times \Big(1 - \big((SI2 \times SI3) + (SI2 \times (1 - SI3)) + (SI3 \times (1 - SI2))\big)\Big) \times \left(\left(\frac{SCSA + \frac{FT7}{FT6}}{\frac{FT7}{FT6}}\right)^{FT1} - 1\right)$$

Where:
SI1 = Estimated 2030 VMT by state (see Equation 2)
SI2 = U.S. percentage of commuter VMT with free parking (see Equation 6)
SI3 = U.S. percentage of new vehicles in fleet within past three years (see Equation 7)
SCSA = Estimated 2030 cost per mile for PAYDAYS insurance by state (see Equation 3)
FT1 = Price elasticity
FT6 = U.S. LDV average fuel economy in 2030
FT7 = U.S projected fuel price in 2030

Equation 13 – Reduction in CO_2E due to Application of Strategies

$$CO_2e\ Reduction = (LDVR_{A+B+C} + LDVR_{A+B} + LDVR_{A+C} + LDVR_A) \times \frac{FT3}{FT4}$$

Where:
$LDVR_x$ = LDV reduction in VMT due to strategy *x* (see Equations 9-12, above)
FT3 = LDV CO_2 equivalent emissions in 2030 in U.S.
FT4 = Projected VMT in 2030 in U.S.

Equation 14 – Derived Elasticity of Demand for VMT with Respect to VMT Price

$$e^*_{vmt} = e_{vmt} \times \frac{1}{1 + e_{gpm}}$$

Where:
e^*_{vmt} = price elasticity of demand for VMT with respect to the price of VMT
e_{gpm} = price elasticity of demand for gallons per mile with respect to the price of fuel
e_{vmt} = price elasticity of demand for VMT with respect to the price of fuel

Table A1 – Model Parameter Summary

Description		Value	Source
State-Level Parameters and Inputs			
Energy/Power			
SE1	CO_2 emissions reduction in 2030 in million metric tons (MMT)	State specific	Uses Difference between EPA Integrated Planning Model (IPM) Base Case and Mass-Based Case
Transportation			
ST1a	Registered cars in 2011	State specific	From BTS STS Table 5-1
ST1b	Registered pickups in 2011	State specific	From BTS STS Table 5-1
ST1c	Registered vans in 2011	State specific	From BTS STS Table 5-1
ST1d	Registered sport utility vehicles in 2011	State specific	From BTS STS Table 5-1
ST1	Registered light duty vehicles (LDV) in 2011	State specific	Sum of ST1a through ST1d
ST2	Total vehicle miles of travel (VMT) in 2011	State specific	From BTS STS Table 5-3
ST3	Estimated population in 2011	State specific	From BTS STS Table 5-3
ST4	Projected population in 2030	State specific	Census, 2005 Interim State Population Projection, Table 1
ST5	Average car insurance premium from January 2014	State specific	Insure.com
ST6	Combined state/local sales tax rates from January 2014, population weighted	State specific	Tax Foundation
ST7	Number of workers in 2011	State specific	From BTS STS Table 4-1
ST8	Percentage drive alone to work in 2011	State specific	From BTS STS Table 4-1
ST9	Percentage carpooling to work in 2011	State specific	From BTS STS Table 4-1
Federal-Level Parameters and Inputs			
Transportation			
FT1	Price elasticity	-0.3	Author review of multiple sources
FT2	Average vehicle occupancy of carpool or vanpool	2.4	Based on 2010 CTPP (Table A102106)
FT3	LDV CO2 equivalent emissions in 2030 (MMT)	1,108 MMT	U.S. EIA VISION 2014 AEO Base Case
FT4	U.S. projected VMT in 2030	3,228,085	U.S. EIA VISION 2014 AEO Base Case
FT5	Percentage commute VMT of total VMT in 2009	27.77%	Based on 2009 National Household Travel Survey (NHTS)
FT6	LDV average fuel economy in 2030 (mpg)	32.6 mpg	U.S. EIA, Annual Energy Outlook 2014, Table A7
FT7	U.S. projected fuel price in 2030 (per gallon)	$3.21/gal	U.S. EIA VISION 2014 AEO Base Case
FT8	Percentage of workers with free parking	95%	Bureau of Labor Statistics
FT9	Percentage of insurance premium that is variable	70%	Author modeled policy
FT10	Average parking cash-out value (per year)	$1,452/year	See paper
FT11	Number of years over which sales tax charges for newly purchased vehicles is distributed (years)	3 years	See paper
FT12	U.S. LDV sales and leases (new and used) in 2010	51,434,000	U.S. BTS, National Transportation Statistics, Table 1-17 (January 2012)
FT13	Average U.S. vehicle sales price (new and used) in 2010	$13,105	U.S. BTS, National Transportation Statistics, Table 1-17 (January 2012)
ST1F	U.S. registered LDV (sum of state-level figures)	229,259,112	U.S. BTS, State Transportation Statistics 2013, Table 5-1
ST2F	U.S. total VMT in 2011 (sum of state-level figures)	2,946,132	U.S. BTS, State Transportation Statistics 2013, Table 5-3
ST3F	U.S. population (sum of state-level figures)	311,587,816	U.S. BTS, State Transportation Statistics 2013, Table 5-3
ST4F	Projected U.S. population in 2030 (sum of state-level figures)	363,584,435	U.S. Census Bureau, Population Division, Interim State Population Projections, Table 1, 2005.

APPENDIX 2 - SOCIAL COST OF CARBON ANALYSIS

As discussed in the paper, a supplemental analysis was performed using the same elasticity framework to consider the potential benefits of a Federal emissions permit price at the social cost of carbon (SCC) as was used to calculate the comparative benefits of the transportation price-shifting policy bundle. Equations 15-17 present the calculations employed. Table A2 summarizes the base inputs used. Also as discussed in the paper, the equations were used to determine a value for the SCC that would yield the equivalent CO_2e reduction offered through the transportation policy bundle (i.e., $509 per metric ton to yield a 257.2 MMT CO_2e reduction).

Equation 15 – Elasticity-Based LDV VMT Reduction Factor

$$reduction\ factor\ = \left(\left(\frac{P1 + SSCM}{P1}\right)^{FT1}\right) - 1$$

Where:
P1 = Gasoline price per mile;
FT1 = Price elasticity; and
SSCM = Social cost of carbon per mile.

Equation 16 – LDV VMT Reduction

$$LDV\ VMT\ reduction = FT4\ \times reduction\ factor$$

Where:
FT4 = Projected VMT in 2030 in U.S.; and
Reduction factor = See Equation 15.

Equation 17 – LDV CO_2 Reduction from VMT Reduction

$$LDV\ CO_2\ emissions\ reduction = FT3 * \left(\frac{LDV\ VMT\ reduction}{FT4}\right)$$

Where:
FT3 = LDV CO_2 equivalent emissions in 2030 in U.S.;
FT4 = Projected VMT in 2030 in U.S.; and
LDV VMT reduction = See Equation 16.

Table A2 – Social Cost of Carbon Calculation Parameter Summary

Description		Value		Source
Federal-Level Parameters and Inputs				
Transportation				
FT1	Price elasticity	-0.3		Author review of multiple sources
FT3	LDV CO2 equivalent emissions in 2030	1,108	MMT	U.S. EIA VISION 2014 AEO Base Case
FT4	U.S. projected VMT in 2030	3,228,085	in millions	U.S. EIA VISION 2014 AEO Base Case
FT6	LDV average fuel economy in 2030	32.6	MPG	U.S. EIA, Annual Energy Outlook 2014, Table A7
FT7	U.S. projected fuel price in 2030	$ 3.21	per gallon	U.S. EIA VISION 2014 AEO Base Case
P1	Gasoline cost	$ 0.10	per mile	
Social Cost of Carbon				
SSC	Social cost of carbon (SC-CO2) in 2030	$ 50	in 2007 dollars per metric ton	Interagency Working Group on Social Cost of Carbon, 2015
CPG	CO2 per gallon of gasoline	8.9	kg per gallon	Carbon Dioxide Emissions Coefficients by Fuel, U.S. Energy Information Administration, February 14, 2013 Release http://www.eia.gov/environment/emissions/co2_vol_mass.cfm accessed September 25, 2014
SSCG	Social cost of carbon per gallon in 2030	$ 0.45	in 2007 dollars per gallon	Calculated as SSC [in kg]/CPG
SSCM	Social cost of carbon per mile in 2030	$ 0.014	in 2007 dollars per mile	Calculated as SSCG/FT7
Note: 1 metric ton = 1,000 kg				

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