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## The Next Generation of Transportation Policy

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## Abstract

Motor vehicle fuel-economy standards have long been a cornerstone of U.S. policy to reduce fuel consumption in the light-duty vehicle fleet. In 2011 and 2012 these standards were significantly expanded in an effort to achieve steep reductions in oil demand and greenhouse gas emissions through 2025, consistent with long-term U.S. policy goals. As a policy approach, however, standards that focus on efficiency alone, as opposed to lifetime consumption, impose unnecessarily high costs and do not deliver guaranteed petroleum savings. On the basis of a commitment to cost-benefit analysis, defining U.S. regulatory policy for more than 30 years, we propose a novel policy solution that would implement a cap-and-trade system in transportation. Acknowledging that the very idea of cap and trade has become controversial, we show that this approach would increase the certainty of reductions in fuel consumption in transportation and do so at a far lower cost per gallon avoided. Such an approach is consistent with the regulatory authority existing at key federal agencies.

## Acknowledgements

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## Chapter 1. Introduction

Originally crafted during the mid-1970s, motor vehicle efficiency standards remain a cornerstone of U.S. policy to improve energy security and environmental quality by limiting fuel consumption and greenhouse gas (GHG) emissions in transportation. Standards for passenger cars and light trucks were finalized by the Environmental Protection Agency (EPA) and the National Highway Traffic Safety Administration (NHTSA) in 2010 and 2012 under a harmonized National Program. The standards are cumulatively intended to reduce oil consumption by 11.6 billion barrels over the lifetime of vehicles sold between model years (MYs) 2012 and 2025 by doubling the efficiency of vehicles sold in 2025 compared to 2010 (EPA 2012a). In the agencies' analysis, the admittedly high costs of the standards were dwarfed by the monetized benefits.

Yet, despite the aggressiveness of these targets, current trends suggest that progress has been limited and that the net benefits will be lower than anticipated. Instead of continuously rising as expected, gains in fuel efficiency have abruptly slowed in recent years: after increasing by nearly 8.5 percent between MYs 2011 and 2013, the real-world, production-weighted fuel economy of new U.S. vehicles improved by just 2.1 percent between 2013 and 2015 (EPA 2016a). Meanwhile, U.S. gasoline demand reached an all-time high in 2016 due to record vehicle travel amid lower-than-expected fuel prices and a significant shift toward larger vehicles. Lower gains in fuel efficiency might not be disturbing in themselves, but they signal lower net benefits, including adverse health effects from standard sources of air pollution and greater exposure of the U.S. economy to the volatile global oil market.

Similarly, carbon dioxide (CO<sub>2</sub>) emissions in the transportation sector are on the rise after a brief decline following the 2007–09 financial crisis, and mobile sources are now America's largest emitter (Energy Information Administration [EIA] 2016a). The Department of Energy (DOE) expects this dynamic to remain in place going forward, even in the case where all policies are extended through 2040 (EIA 2016b). Cars and light trucks currently account for 60 percent of U.S. fuel consumption in transportation (Davis, Diegel, and Boundy 2016).

Could the current approach for regulating vehicle fuel consumption be improved to reduce costs, increase benefits, or both? We believe so. We note from the outset that, because they affect only new vehicles, automotive efficiency standards are limited in their reach compared to alternatives that would target the stock of *existing* vehicles. Only a fuel tax would achieve this outcome. This characteristic of the regulations limits the impact they can have on overall fuel consumption, and helps to explain why efficiency standards achieve reductions at a relatively high cost compared to alternative potential policies (Congressional Budget Office 2003).

### OUR POLICY PROPOSAL

We propose a novel, more cost-effective reform to vehicle efficiency regulation that is substantially more likely to achieve reductions in light-duty fuel consumption and GHG emissions—and at a lower cost per gallon—than the current system. There are three key features of our proposal:

1. Regulate expected fuel consumption/GHG emissions directly, without differentiation based on the source vehicle.
  - a. Remove the separate treatment of cars and light trucks.
  - b. Remove size categories.

Currently, the efficiency standards treat cars and light trucks differently, providing standards for light trucks that are more lax. The result is that the ability to achieve policy goals is highly dependent on the price of gasoline, which is determined globally, and consumer preference about vehicle type and size, which is not controlled by government.

*We recommend that vehicle efficiency standards treat fuel consumption/GHG emissions identically, regardless of whether they are emitted from a car or light truck and regardless of the vehicle's footprint.*

Such a reform would meet a fundamental economic principle that the best way to achieve a goal is to target it directly.

2. Use data to estimate a vehicle's lifetime fuel consumption/ GHG emissions.

Currently, the vehicle efficiency regulations are targeted at miles-per-gallon benchmarks, but ignore differences in miles that vehicles will be driven over their lifetime. As a matter of policy, this does not make sense. For example, the typical Honda Civic being retired today has been driven 169,000 miles over its lifetime, whereas the average Mitsubishi Mirage has been driven 92,000 miles. The models have nearly identical fuel efficiency, but vastly different lifetime fuel consumption. Efficiency is therefore more valuable in terms of fuel reductions with the Civic than with the Mirage.

*We recommend that each vehicle be assigned estimated lifetime fuel consumption and GHG emissions and this, rather than fuel economy, be the target of regulations.*

EPA and NHTSA already use estimates of car and light truck lifetime miles to estimate the benefits of the rules, but assume that the number is identical for all cars and trucks respectively. Yet, there are now several data sets that can be used to develop reliable estimates of lifetime vehicle miles traveled (VMT) by model. Furthermore, important new research demonstrates that regulating vehicles on the basis of a combination of efficiency and usage would be vastly superior to regulating efficiency alone, which captures only one-fourth to one-third of potential emissions reductions (Jacobsen et al. 2016).

### 3. Create a robust cap-and-trade market to reduce compliance costs.

With a regulatory system based on vehicles' lifetime fuel consumption and GHG emissions, it might be natural to set automaker-specific limits. However, this raises the possibility that some automakers would face high compliance costs simply because of their expertise in manufacturing particular types of vehicles.

A solution to this problem is to set a cap that applies across all manufacturers and then allow trading. Economic theory and decades of practical experience demonstrate that a robust cap- and-trade market would greatly reduce compliance costs while providing certainty on expected emissions. We acknowledge that the term "cap and trade" has become controversial in recent years. We hope that it will be less controversial here, where the goal is to take an existing program, with existing mandates, and make it far more flexible and far less costly.

*We recommend the establishment of a cap-and-trade market for expected GHG emissions across all car and light truck sales annually.*

Credit trading, banking, and borrowing are already legal and embedded in the existing EPA and NHTSA programs, providing the needed framework for establishing a cap-and-trade system. Each year's cap would be set consistent with U.S. policy goals. The sale of each vehicle would require holding permits for that car's projected lifetime fuel consumption. The permits could be distributed through some combination of allocations to automakers and auctions that could raise revenue for the U.S. Treasury or be used to ensure that the program does not have adverse distributional consequences. For example, the allocations could be used to compensate automakers that would otherwise be unfairly harmed by the program.

Importantly, such a regulatory approach would retain the technology-neutrality of efficiency standards. But because it would more directly target fuel use and emissions, it would not only reduce costs, but also provide an incentive for automakers to develop and sell low- or zero- emissions vehicles, including those powered by electricity or hydrogen. Over the long term, widespread adoption of these technologies will be essential if the United States is to achieve stated energy security and environmental policy goals. Our own commitment is to cost-benefit analysis and policy with the highest bang for the buck, not to any target. Therefore, we express no comment on national policy goals here.

This program would logically be implemented following the 2025 expiration of the current National Program. It would be best administered by EPA, whose statutory authority under Title II of the Clean Air Act (Clean Air Act Amendment Summary: Title II [CAA] 1990) most effectively allows for the development of a long-term program. Because this reform would effectively be a modification of the existing program and would be seated within the EPA, it would not require new authorizing legislation.

Because this program will result in the trading of fuel consumption, it would create additional opportunities to



allow the market to identify the greatest flexibility to identify the lowest-cost opportunities. One possibility would be to link the light-duty vehicle program with EPA's recently finalized program regulating fuel consumption from medium- and heavy-duty trucks through 2027; we will refer briefly to this possibility. In principle, it would also be advantageous to link the cap-and-trade program in transportation to future trading in the power sector. The goal of this link would be to reduce compliance costs still further. This would require that the permits be denoted in GHG emissions, rather than petroleum, but this is extraordinarily straightforward. If, for example, a power plant owner could reduce GHG emissions more cheaply than an automobile producer, there is every reason to allow that to happen, consistent with a general cap. For reasons discussed below, new legislation would almost certainly be necessary to produce such a link.

The rest of this paper has three main components. In chapter 2, we describe the current form and function of U.S. vehicle regulations, including the major shortfalls of the current approach. In chapter 3, we propose an alternative approach based on a cap-and-trade system in transportation, including its potential benefits. In chapter 4, we review the legal grounds for our approach.

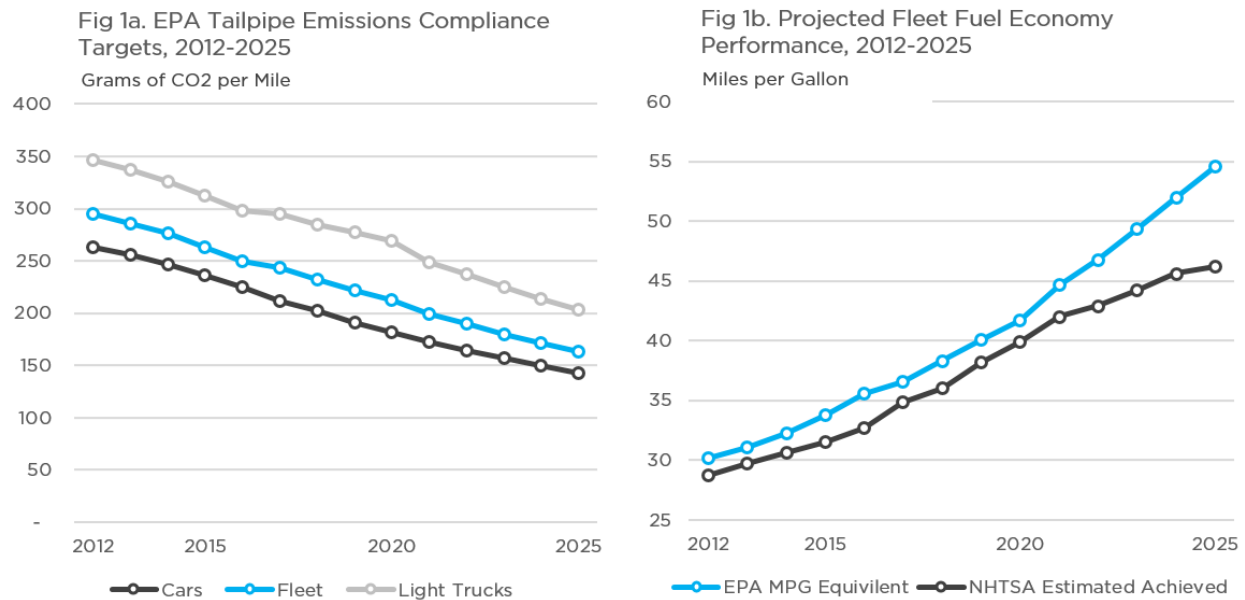
## Chapter 2. U.S. Motor Vehicle Efficiency Regulation: Form and Function

The current U.S. regulatory system governing automotive efficiency is known as the National Program. At its core, the National Program is intended to produce high net benefits by driving large improvements in the amount of fuel consumed and GHGs emitted per mile of travel for all new light-duty vehicles sold in a given model year in the United States. It does this by setting efficiency requirements for individual vehicle categories by size, which increase in stringency each year. Each automaker's compliance level is determined by the average requirement of the vehicles it produces for sale in a given year. The National Program was implemented in two rulemakings (one in 2010 and one in 2012), and now governs vehicle MYs 2012 through 2025.

The program is jointly administered by two separate federal agencies: the NHTSA within the Department of Transportation and the EPA. The agencies have worked to harmonize their requirements under the National Program, but they nonetheless operate under different statutory authorities with different mandates.

NHTSA is charged with improving vehicle efficiency in pursuit of reduced oil consumption. Its authority is derived from the Energy Policy and Conservation Act of 1975 (EPCA), which created America's first program for regulating vehicle efficiency, known as Corporate Average Fuel Economy (CAFE). EPCA's fuel economy provisions were amended in 2007 as part of the Energy Independence and Security Act (EISA) of 2007.

For its part, EPA regulates tailpipe emissions of GHGs in pursuit of U.S. climate policy goals. Its authority rests in Title II of the CAA as interpreted by a 2007 Supreme Court ruling that GHG emissions meet the definition of a pollutant under the title (*Massachusetts v. EPA* 2007). A subsequent 2009 endangerment finding by the EPA administrator initiated the agency's vehicle emissions program. Although there is substantial overlap between EPA's emissions rate requirement and NHTSA's focus on fuel consumption, fuel efficiency improvements are not the only means an automaker can use to reduce tailpipe emissions under EPA's program. Therefore, a direct conversion of EPA's standard into miles-per-gallon efficiency slightly overstates the estimated level of fuel efficiency expected by NHTSA.



Source: EPA 2012b.

Figure 1a presents EPA's 2012–25 standards for cars, light trucks, and the combined fleet in grams of CO<sub>2</sub> per mile. It is immediately apparent that the fleet standard depends on the share of vehicles that are light trucks rather than cars; a higher share of light trucks than the EPA predicted would mechanically lead to compliance within the car and truck categories but would fail to meet the fleet average.

Figure 1b presents the combined fleet figure in miles per gallon. Converting the EPA values directly produces the top line, which effectively assumes automakers meet their requirements fully through efficiency improvements and produces the headline-grabbing 54.5 mpg target in 2025. Removing the impacts of air conditioner credits, non-compliance, and other flexibilities produces the lower line. This is NHTSA's estimated achieved fleet-wide efficiency, which reaches 46.2 mpg in 2025.

It is important to note that the National Program is attribute-based, a feature introduced by EISA and a departure from the prior approach, which prescribed fleet-wide averages for cars and trucks. Under an attribute-based approach, a particular characteristic is used to sort vehicles into groups with differing requirements. In this case, the attribute is footprint, which is the rectangle formed by the four points where a vehicle's four tires touch the ground.

Under this approach, each automaker's target performance and compliance values are calculated at the close of the model year once the final production mix is determined. In other words, each automaker will necessarily have individually tailored compliance and performance levels based on the vehicles it produces and sells. There is no predetermined, fleet-wide average requirement. This feature was intended to provide flexibility to allow automakers to produce whichever vehicles are most profitable for them. That is, an automaker can choose to sell its preferred mix of small and large vehicles, as long as those vehicles become more efficient on average as required by the standards.

## A POLICY CRITIQUE OF THE NATIONAL PROGRAM

The National Program—and indeed, the decades of fuel economy regulation that began in 1975—has by any measure produced important economic, energy, and environmental benefits. Despite the significant cost, the net benefits are estimated to be in the billions of dollars. The efficiency of the entire, on-road U.S. passenger car fleet stood at just 14 mpg in 1977, the year before the first NHTSA standards came into effect. In 2014 it stood at 25.4 mpg. Light truck fleet efficiency increased from 11.2 mpg to 18.5 mpg over the same period (Davis, Diegel, and Boundy 2016). Market pressures and technological changes undoubtedly have contributed to these improvements. But no one doubts that vehicle efficiency is higher and GHG emissions are lower today than they would be in the absence of a policy designed to address the social costs of fossil fuel consumption in transportation.

However, the current approach is unlikely to be adequate in light of long-term U.S. energy security and environmental goals. It will produce far lower net benefits than it could with a suitable redesign. Furthermore, the current approach will not achieve reductions in fuel consumption and emissions that are consistent with the goals of the policy makers who originally designed the standards, either through EISA or through the CAA.

The following discussion is intended to highlight a number of key features of the current approach that ensure excessive costs and limit its potential impact. In short, the National Program (1) ignores large potential savings by regulating efficiency instead of consumption, (2) contains structural loopholes that undermine its ability to bind automakers to real improvements, and (3) raises costs and lacks enhanced flexibility that could be achieved through a well-functioning trading program. In a time of sensitivity to the costs of regulation, (3) is worth emphasizing.

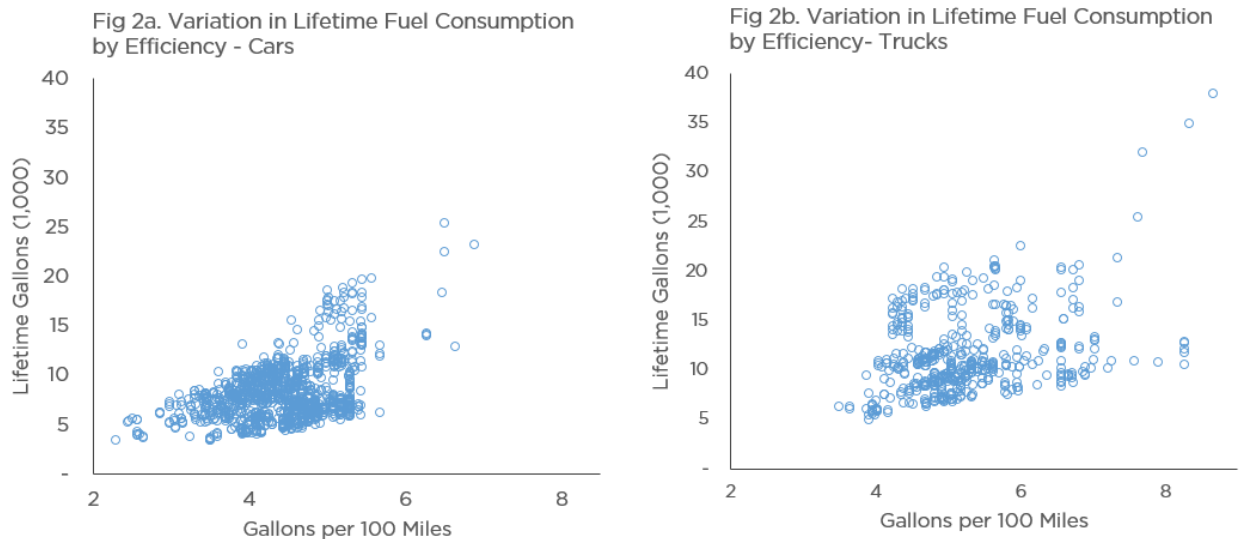
### ***1. The National Program regulates efficiency, not consumption or emissions.***

The regulated metric under the National Program is efficiency. The origin for this approach dates back to EPCA, which defined fuel economy in miles-per-gallon terms, specifying it as “the average number of miles traveled by an automobile per gallon of gasoline consumed” (Government Printing Office [GPO] 2001, Sec. 501 (6)). Harmonizing the NHTSA and EPA programs effectively dictated the continuation of this approach, given that EISA extended NHTSA authority and program structure through 2030.

Yet as a means for regulating gross fuel consumption and emissions, this approach has serious limitations. By

focusing strictly on efficiency, the National Program ignores the way vehicles are used once they are driven off the lot. If all vehicles of similar efficiency levels were driven identical lifetime miles, this would present less of a challenge. However, some vehicle models are driven substantially more miles over their lifetime than other similarly efficient vehicle models, thereby exacting a larger cost on society through fuel consumption and pollution emissions. An important paper by Jacobsen et al. (2016) uses two novel data sets to demonstrate that lifetime miles traveled vary significantly across equally efficient vehicle models.<sup>1</sup>

The results of the authors' analysis are presented in figures 2a and 2b. The horizontal axis in each figure is efficiency measured in gallons per 100 miles. The vertical axis displays lifetime fuel consumption, which is the product of efficiency and VMT. Each plot represents the average observation for an individual vehicle model type in the sample.



Source: Jacobsen et al. 2016.

These figures show that lifetime fuel consumption in fact varies widely across vehicle models with identical efficiency. This is visible by choosing a value of gallons per 100 miles (i.e., efficiency) and reading the figure vertically at that point; it is apparent that there is meaningful variation in total lifetime gallons (and mechanically lifetime VMT) at each value of efficiency. This is true in the case of both cars and light trucks. As one would expect, the magnitude of this variance increases for less-efficient vehicles, because even small differences in lifetime miles produce large differences in fuel consumption and emissions.

From an economic perspective, this is an inequitable outcome that also has adverse policy consequences. Consumers purchasing vehicle models with vastly different expected lifetime social impacts are paying approximately the same implicit tax on inefficiency. In some cases, consumers are overpaying for their damages. In others, they are underpaying. More importantly, this dynamic results in a large missed opportunity from a social and public policy perspective. Jacobsen et al. (2016) conclude that, by focusing strictly on efficiency, fuel economy standards like the National Program are able to recover only between one-fourth and one-third of the potential benefits compared to an approach that focuses on both efficiency and lifetime miles driven.

## **2. The National Program has structural loopholes.**

The National Program contains at least three structural loopholes that undermine its effectiveness at achieving fuel and emissions reductions. Specifically, the National Program (a) includes various credits and bonuses that reduce compliance costs but do not reduce fuel consumption; (b) gives cars and light trucks differential treatment, with trucks benefitting from less-stringent regulation; and (c) regulates vehicles based on their footprint, which

encourages automakers to produce and sell larger vehicles. We briefly review each of these loopholes here.

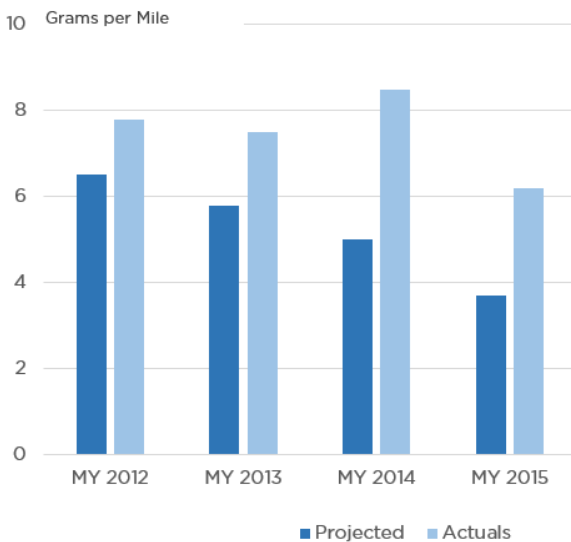
### a. Credits and Bonuses

The National Program contains numerous credits and bonuses that automakers can acquire by selling vehicles capable of operating on non-petroleum fuels. The most impactful of these from a regulatory standpoint are credits for dual-fueled vehicles known as flex-fuel vehicles (FFVs). Under the NHTSA program, the maximum allowable credit from 1992 to 2014 was 1.2 mpg, regardless of whether FFVs actually use alternative fuel. Starting in 2015 the credit gradually phases down by 0.2 mpg each model year through 2019, after which it is zero (EISA 2007, Sec. 109, (a)). In order to maintain a degree of regulatory harmonization, EPA allowed the same credit levels through 2015, after which the value is effectively zero, because the compliance value of FFVs will be determined by the fuel they actually use. It is worth pointing out the complexity that could arise from differing approaches through 2019.

The enhanced FFV credits were framed as a policy for promoting the deployment of alternative fuels such as ethanol, whose purported benefit included the fact that it was a domestically produced alternative to petroleum with a lower GHG footprint. But in practice the credits afforded automakers an extremely low-cost compliance loophole with little practical benefit. FFVs, which can be manufactured for as little as \$100 in additional costs compared to a conventional vehicle, rarely operate on high blends of ethanol and offer no improvement in real world efficiency (National Research Council 2015). According to DOE, FFVs account for 7 percent of the U.S. light-duty vehicle fleet today, yet high blends of ethanol account for just 0.4 percent of fuel consumed by light-duty vehicles (EIA 2016c).

As expected, automakers have made extensive use of these credits as a compliance tool. During the period for which they were available under the EPA rule, automakers' use of FFV credits exceeded the agency's projections by an annual average of nearly 50 percent, with the largest variance coming in later years, when the standards were more stringent (EPA 2016b). That is, as standards became more difficult to meet with efficiency gains alone, automakers relied more heavily on the loophole. Figure 3 displays actual credit consumption versus projected levels, as reported by EPA. Data from NHTSA show that the domestic automakers in particular claimed the maximum available credit of 1.2 mpg across both their car and light truck fleets for much of the period from 2004 to 2014 (NHTSA 2016). For some automakers, use of the credits was determinative in achieving compliance levels, especially in their light truck fleets.

Fig. 3. FFV Credit Use in EPA's Program



Source: EPA 2016b.

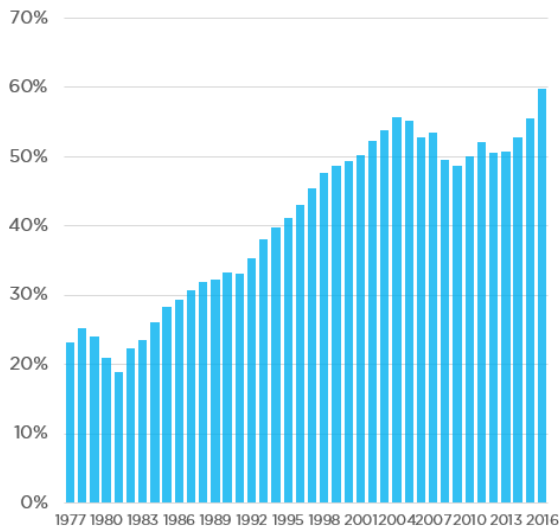
## b. Dual Treatment for Cars and Light Trucks

The National Program maintains a system of dual treatment for cars and light trucks, with regulations for trucks being substantially less stringent than for cars. Under this system, the heaviest polluters are regulated less stringently, and the potential savings of a more unified program are lost.

This system dates back to EPCA (1975), which identified two types of regulated automobiles: those rated at a gross vehicle weight of less than 6,000 pounds and those rated at a gross vehicle weight of more than 6,000 pounds but less than 10,000 pounds (EPCA 1975, sec. 501 (1)(A) and (1)(B)). EPCA also allowed for several important exemptions, most notably by setting standards only for passenger automobiles, a category that by definition excluded vehicles capable of off-highway operation and those that could carry more than 10 passengers. Sport-utility vehicles (SUVs), pick-up trucks, minivans, vehicles with four-wheel drive, and several other light trucks were ultimately exempted from statutory standards. Instead, EPCA gave substantial discretion to the secretary of transportation for these vehicles. When the final rules were promulgated in 1976, NHTSA defined two overarching categories of vehicles: passenger cars and light trucks. EISA (2007) subsequently preserved dual treatment in NHTSA's program.

This system of dual treatment has contributed to the surge in sales of many light trucks, particularly SUVs. By initially exempting some models, and requiring much lower levels of stringency for many others, NHTSA's fuel economy system has provided a strong incentive for automakers to market light trucks to U.S. consumers. These vehicles accounted for just 23 percent of U.S. auto sales in 1977, the year before the standards went into effect. However, their market share increased relentlessly through 2004, when it reached 56 percent. After briefly declining amid the high oil prices experienced from 2004 through 2013, light truck share is again on the rise, topping a record 60 percent in 2016 (BEA 2016). This trend is presented in figure 4.<sup>2</sup>

Fig 4. Light Truck Market Share, MY 1977-2016

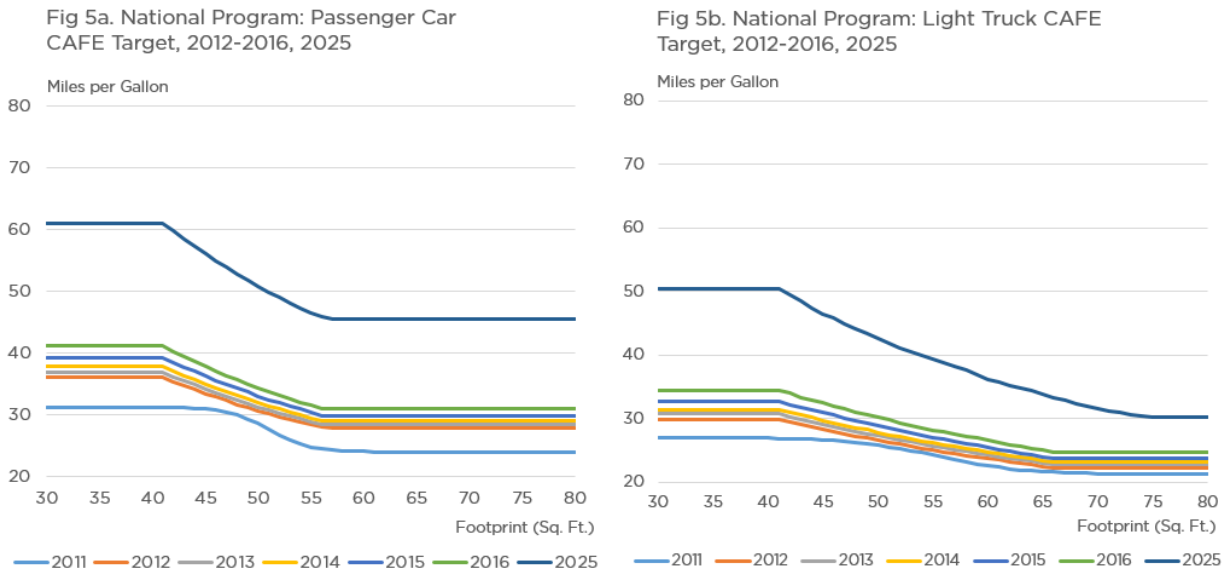


Source: BEA 2016

The broader point is that by regulating light trucks less stringently, the dual treatment worked to undermine its goals by causing a shift from cars to light trucks, which are on average less fuel efficient. Beyond its effect on fuel consumption and emissions, some research suggests that it might have increased traffic fatalities, because a higher share of light trucks is associated with higher rates of traffic fatalities (Gayer 2004).

### c. Footprint-based Standards

The National Program regulates automobiles based on vehicle footprint, defined as the area of the rectangle formed by the four points where a vehicle’s wheels touch the ground. This approach to regulation was introduced by EISA. Each motor vehicle footprint bin is required to achieve increasing levels of efficiency annually over the course of the National Program, with smaller vehicles facing steeper increases and larger vehicles facing more-modest requirements. As just discussed, passenger cars and light trucks are governed by different stringency requirements. An automaker’s annual compliance and performance values are the average fuel economy or GHG efficiency produced by the mix of vehicles it sells in a given year. Figures 5a and 5b present the National Program footprint curves for cars and light trucks from MYs 2011 through 2016, and 2025.



Source: EPA 2012b.

There is an active literature assessing the benefits and costs of some of the subtleties of an attribute-based approach relative to various alternative forms of efficiency standard (Ito and Sallee 2014; Whitefoot and Skerlos 2012). That literature underscores that whether footprints are socially desirable depends critically on the alternative policy. What is clear, however, is that the existing footprints tend to favor larger vehicles, and— like the dual treatment of cars and light trucks—this will, all else equal, create an incentive to produce larger vehicles. Thus, although the regulations aim to reduce fuel consumption and emissions, the footprint standard works against this goal by pushing manufacturers to produce larger cars and light trucks. We emphasize that this incentive operates even if we hold consumer preferences constant.

### 3. The National Program misses opportunities to reduce compliance costs

In order to provide manufacturers with maximum flexibility in meeting the potentially ambitious requirements of the National Program, the rules written in 2010 and 2012 introduced new credit-trading provisions. By exceeding their individual compliance level for a given model year, manufacturers can earn credits that can be traded, banked for future use, or applied to a prior year within certain constraints. Under NHTSA’s rules, one credit is generated for every one-tenth of a mile by which a manufacturer exceeds its requirement. The metric is one credit for every gram per mile of over-compliance in EPA’s system.<sup>3</sup>

Thus, a general point here is that trading is already legal under current vehicle regulations. In principle, the presence of such a system should allow for lower compliance costs and improved flexibility as automakers with the best ability to meet and exceed requirements (i.e., low marginal cost of reductions) generate credits and sell them to

automakers with more-costly compliance pathways (i.e., high marginal cost of reductions). In practice, however, the current systems have important drawbacks that have prevented them from improving flexibility thus far.

The fact that there are two separate, imperfectly harmonized trading regimes is itself suboptimal. In some cases, these differences are marginal or simply related to the differing authorities of the two agencies—EPA credits are based on GHG compliance, whereas NHTSA credits are based on miles per gallon compliance. But in other cases, the differences are more substantial, and this complexity likely undermines some of the possible benefits of trading. For example, NHTSA has a price cap on credits sold in its system, but EPA does not. EPA does not limit a manufacturer’s ability to transfer credits between its car and truck fleets, but NHTSA does. Under the EPA program, therefore, a manufacturer could generate excess credits from selling highly efficient (but low-mileage) passenger vehicles and use these to offset sales of less-efficient (and higher-mileage) light trucks.

Moreover, the market for credit trading is not well-developed thus far, with little price transparency. There is no centralized broker or exchange, so manufacturers deal with each other on an as-needed basis. Leard and McConnell (2015) have argued that this increases transaction costs, and could be one factor limiting trading between firms to date. Trade volume has typically been equal to less than 1 percent of earned credits in the EPA system, as shown in figure 6.

Fig 6. Traded versus Non-Traded Earned EPA Credits, 2010-2015

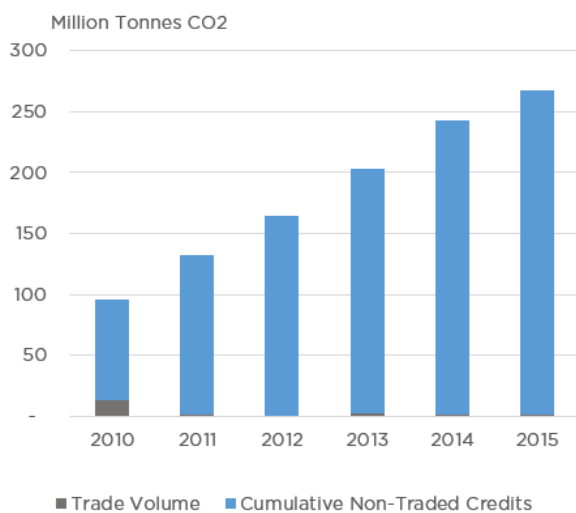
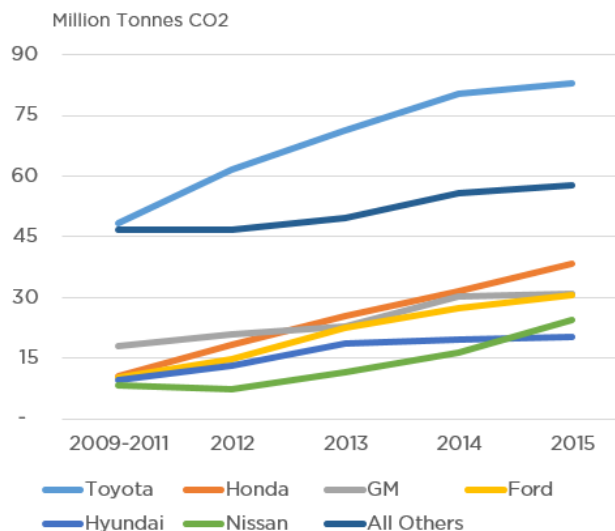


Fig 7. Cumulative Earned EPA Credits, Selected Manufacturers, 2009-15



Source: EPA 2016b.

Finally, the current trading system could be limited by the market power of a handful of firms. For example, Toyota held 30 percent of all cumulative EPA GHG credits after the 2015 model year. The top three credit holders had a combined 53 percent of all EPA credits, as shown in Figure 7 (EPA 2016b). These firms could choose to exercise market power by withholding credits to drive up costs for competitors. It is worth noting that a significant portion of these credits were generated using FFV credits and—at least in EPA’s case—under an early banking program that allowed automakers to generate credits under arguably “business-as-usual” conditions beginning in 2009.

None of these points undermines the rationale for a robust trading component of the efficiency regulations, but they do suggest that a handful of key improvements could produce sizeable benefits in terms of emissions reductions, reduced cost, and increased cost-effectiveness.

#### LACK OF GUARANTEED IMPROVEMENTS IN THE CURRENT SYSTEM

The current design of the National Program makes it hard to get guaranteed fuel savings. At the most fundamental level, this is because the regulations cover only efficiency instead of consumption, and because fuel savings are in



part determined by fleet mix. As we have discussed, a variety of factors, both exogenous and endogenous to the regulations themselves, suggest that the fleet will skew larger and less efficient than is optimal or expected by the regulations.

To test these arguments, we review data from the first five- year period of the National Program, with a particular focus on final data through MY 2015. The data confirm three important findings: (1) the fleet is significantly different from what NHTSA and EPA expected, (2) targeted performance has diverged substantially from the agencies' expectations, and as a result (3) reductions in fuel use could underperform expectations. We discuss these findings briefly here.

#### **a. The Fleet**

The fleet of cars and light trucks produced for sale in the United States has diverged in important ways from the projections EPA and NHTSA used to develop their estimates of efficiency. To understand why, note that at the time the National Program was finalized, global oil prices were averaging approximately \$100 per barrel, and the U.S. auto market was shifting toward lighter vehicles. Thus, prominent and mainstream market forecasts, such as those produced by private firms as well as the DOE, tended to suggest a continued shift toward lighter vehicles in the future.

The sales mix forecasts used as inputs in the agencies' fuel savings and emissions projections were consistent with this view, a factor that helped to produce high fleet-wide fuel efficiency performance estimates and fuel savings (EPA 2012c). Using a modified definition of cars and light trucks that reclassified a large portion of two-wheel drive SUVs as cars instead of trucks, these projections saw light truck market share falling from 38.9 percent in 2012 to 34.4 percent in 2016. Yet by 2015 the share had actually risen substantially to 42.6 percent of the market.<sup>4</sup>

In part as a result of this shift toward trucks and away from cars, vehicle footprint trends have also diverged from the agencies' expectations. Rather than declining from 48.6 square feet in 2012 to 48.2 square feet in 2015 as projected, fleet-wide average footprint increased over the course of the past several years, reaching 49.4 square feet in 2015 (EPA 2016b). It is worth noting that a meaningful portion of this increase was driven by an increase within the car category, which on its face appears to support the academic literature on footprint.

#### **b. Performance and Fuel Reductions**

Because the National Program is footprint-based, and because it maintains dual treatment of cars and light trucks, these shifting fleet characteristics have a direct impact on the efficiency of the overall fleet. To demonstrate this, we use recently released 2012–15 data from EPA (EPA 2016b) as well as 2016-2017 projections from NHTSA. Figure 8a compares the original, projected tailpipe performance target of the fleet with the actual target under the EPA program. (These data are directly converted to miles per gallon for ease of comparison.)

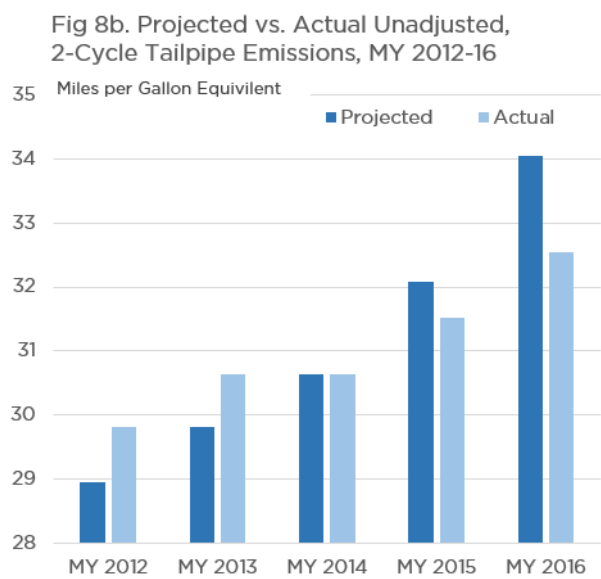
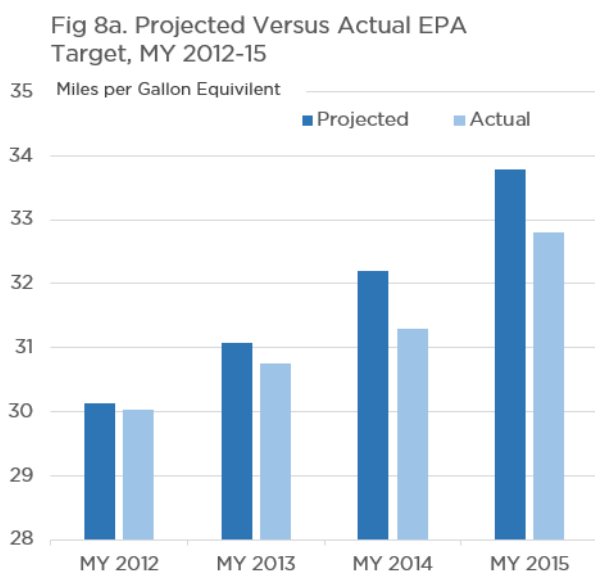
As can be seen, the actual target was on par with projections in 2012, but a gap opened in 2013 that broadened in 2014 and reached one full mile per gallon in 2015. Critically, this variance is not the result of technological barriers within any particular set of footprints. Rather, as EPA notes, it is due to the fact that “industry-wide footprint values and the truck fraction of the fleet are higher than projected in the rulemaking analyses” (EPA 2016b). Notably, EPA expects this gap to widen going forward. As detailed in its recently released mid-term review, EPA now sees its fleet-wide target in 2025 topping out at 50.8 mpg instead of 54.5 mpg, a projection that is itself somewhat reliant on oil prices being higher than they are today (EPA 2016d).

While these data demonstrate that the National Program is vulnerable to market realities, EPA has noted that manufacturers' compliance performance was in fact better than projected through MY 2015, and that although a gap between projected and actual performance did appear in 2015, the gap was extremely small. However, this ignores two important factors. First, larger-than-projected use of FFV credits played a key role in keeping the gap narrow in MY 2015. Without the credits, the gap would have been 0.4 mpg instead of 0.1 mpg. Perhaps if the credits were unavailable, automakers would have made up the difference through other means, but then costs would have presumably been higher.

Second, direct improvements in efficiency—which are the key mechanism for achieving reductions in fuel use—

have thus far been smaller than EPA projected. Figure 8b presents unadjusted, tailpipe emissions projections and performance, expressed in miles per gallon. After initially slightly exceeding expectations, actual unadjusted efficiency fell behind EPA's projections by 0.6 mpg in 2015. Based on data submitted by manufacturers, EPA expects performance to lag expectations by an even larger 1.4 mpg in 2016. In this case, reductions in fuel use from engine efficiency alone in MY 2016 would be about 25 percent less than expected in the absence of the rule, resulting in an increase in fuel consumption equal to roughly 150 million to 200 million barrels of oil over the lifetime of MY 2016 vehicles.<sup>5</sup>

Finally, we note that data released in early 2017 by NHTSA shows projected fleet-wide CAFE performance in both MY 2016 and 2017 diverging substantially from the originally projected levels in the agencies' rules (NHTSA 2017). The difference in MY 2016 was 1.6 miles per gallon, a gap that NHTSA projects widened to 3.3 mpg in MY 2017 as actual performance declined year-over-year at a time when it expected to rise significantly. If confirmed by final data, the realization of such a gap would imply that actual fuel savings over the lifetime of MY 2017 vehicles will be considerably smaller than originally anticipated.



Source: EPA 2016b.

## REDUCTIONS ARE ACHIEVED AT A HIGH COST

The ultimate assessment of fuel economy standards boils down to estimates of the overall costs per ton of CO<sub>2</sub> abated, which gives an overall measure of the costs. One recent paper finds that fuel efficiency standards have a total societal cost about 2.5 times larger than the cost per gallon from a gasoline tax that reduces gasoline consumption by an equal amount (Jacobsen 2010). This finding is not surprising, given the rigidities in the current system that this section has outlined.

This review of the evidence suggests that there are opportunities for improving the efficiency of existing efforts in order to obtain the same reductions in fuel consumption and CO<sub>2</sub> emissions at a much lower cost than the current policy or to obtain much larger reductions in fuel consumption and CO<sub>2</sub> at the same cost. The principle that emerges from this analysis is that policies that more directly target fuel consumption, rather than fuel economy, are less expensive and motivate the approach we outline in this proposal.

## Chapter 3. Reforming Efficiency Regulation to Include Lifetime Vehicle Emissions

In order to address the challenges outlined, and to increase the certainty of achieving large emissions reductions in transportation, we are proposing the establishment of a cap-and-trade program for expected fuel consumption and GHG emissions in light-duty vehicles. Our starting point is to assume that a gasoline or carbon tax is politically infeasible. We therefore seek to design a system capable of most comprehensively covering lifetime fuel consumption for new vehicles. We then ask whether existing legislative authorities allow for a policy that can produce more bang for the buck. We argue that on both economic and legal grounds such a reform is desirable and feasible.

The core of this proposal is a national cap on lifetime fuel consumption and CO<sub>2</sub> emissions from each year's new vehicle sales. This cap can be adjusted up or down for each model year, depending on policy goals. The great advantage of such a policy approach is that it directly targets fuel consumption by regulating the product of efficiency and usage instead of efficiency alone. It accomplishes this by assigning each car model an expected number of lifetime miles driven based on that model (or a comparable model's) historical average and then using its fuel economy to determine expected lifetime gallons of gasoline consumed and total GHG emissions.

### THE THEORY: WHY CAP AND TRADE?

Properly designed, a cap-and-trade policy offers a high level of certainty in, for example, emissions reductions at the lowest possible cost. The certainty of the cap is fairly straightforward: policy makers place an industry-wide limit on consumption or production of an externality, such as the volume of pollution emitted by covered entities. Permits are allocated in an amount that equals the cap. No entity can pollute without a permit. The cap then evolves in line with policy makers' goals. As long as the cap is below the level of emissions that would prevail with no effort to reduce emissions, the permits will have a positive price. Firms must then make decisions about whether to purchase or sell credits and whether to invest in a given amount of technology or other means for reducing pollution.

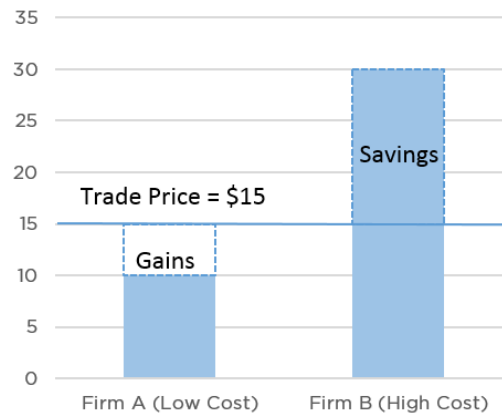
The cost minimization aspect of cap and trade derives from its recognition that each firm in the market faces a different cost to reduce its emissions. From a policy perspective, this type of cost minimization is nearly impossible to implement using a command-and-control type of regulatory regime. Governments almost always lack complete knowledge about each firm's cost of lowering emissions, especially when there are many firms under regulation offering differentiated products. It is widely acknowledged that the cost of emissions reduction varies greatly between firms, and that one-size-fits-all, command-and-control policies result in much higher costs than necessary (Schmalensee and Stavins 2015).

Cap and trade is a decentralized, market-based approach to solving this cost-minimization problem. It limits government involvement and discretion and also compensates those firms that have the lowest cost of reducing emissions. In such a system, the government issues tradable emissions credits that allow the firm to emit a certain amount of pollution. Firms will trade these credits among themselves to meet their respective caps until all gains from trade are exhausted, resulting in an efficient, cost-minimizing outcome.

To illustrate this in practice, consider a simplified example. Suppose that the government imposes an emissions cap on two manufacturers, Firm A and Firm B. In order for each firm to meet its cap, it can either reduce its emissions or purchase credits from another firm. Firms can earn credits by emitting less than their cap. Suppose that both Firm A and B are currently one unit above their cap. Firm A can reduce its emissions at a cost of \$10, and Firm B can reduce its emissions at a cost of \$30. This is represented graphically by the solid blue bars in figure 9. Suppose Firm A reduces its emissions to meet its cap. Firm B, instead of reducing its emissions, offers to pay Firm A \$15 to reduce its emissions by another unit and transfer the generated credit to Firm B. In this situation, both firms are better off than if each had met its cap individually. Firm A receives \$15 dollars for a credit that cost it \$10 to produce. Firm B paid \$15 for a credit instead of \$30 to reduce its emissions (see dashed boxes in figure 9). And most importantly, the required reduction in emissions of two units has been met.

The power of the cap-and-trade system should be clear from this simplified example. By making a market for tradable emissions credits, the government did not need any information about each firm's private costs of reduction to reach its target level of emissions in the least costly way possible. Rather, firms self-identified as having low or high costs of compliance by selling or buying credits. Furthermore, the government's role was limited once the initial cap for each firm was established, reducing the regulatory burden for itself and the manufacturers.

Figure 9: Example of Gains from Trade

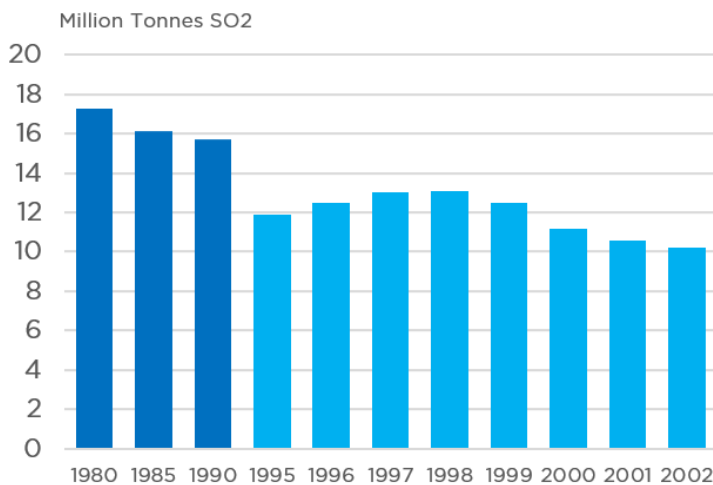


### THREE PRINCIPLES FOR A WELL-FUNCTIONING CAP-AND-TRADE MARKET

Despite the controversial character of the term, cap and trade is hardly a new policy design. A number of countries and governing bodies globally have experience implementing cap-and-trade programs in recent years. Probably the most prominent example in the United States was the Acid Rain Program administered by EPA beginning in the mid-1990s to address sulfur dioxide (SO<sub>2</sub>) emissions from power plants. Since 2009 nine northeastern U.S. states have participated in the Regional Greenhouse Gas Initiative, a CO<sub>2</sub> emissions trading program. The state of California has operated the California Carbon Market since 2012. Globally, the European Union (EU) has operated the Emissions Trading System since 2005.

Some of these programs have worked well, and others have not. The EPA Acid Rain Program is widely credited with achieving sharp reductions in sulfur dioxide, its covered pollutant. By 2002 U.S. power plant emissions of SO<sub>2</sub> were 41 percent less than 1980 levels, and wet sulfate deposition, the major component of acid rain, was 25 to 50 percent lower than 1990 levels in most areas of the U.S. Midwest and Northeast (EPA 2004). A 2003 program review found that the Acid Rain Program accounted for the largest human health benefits of any federal program implemented between 1993 and 2003, with benefits exceeding costs by 40 to 1.

Fig 10. Total Emissions in the US Acid Rain Program, 1980 - 2002



Source: EPA 2004

Throughout all this, the EPA's role was limited to monitoring emissions and tracking ownership of allowances by recording initial allocations and trades. Large reductions were achieved because the cap-and-trade system incentivized emitters to find new ways to reduce emissions and take advantage of low-cost options as soon as they were available. Notably, trading on the SO<sub>2</sub> market was active, with about 20.3 million tons of allowances bought or sold by March 1998. Subsequent studies have suggested cost savings were between 15 and 90 percent compared to counterfactual policies that did not allow trading (Carlson et al. 2000; Ellerman et al. 2000; Keohane 2003; Stavins 2005).

Other programs have not been as successful on some dimensions. The EU Emissions Trading System, for example, has been held up as an example of a weakly designed cap and trade, evidenced by periods of exceptionally low prices for CO<sub>2</sub> credits (Schmalensee and Stavins 2015). The same could be said of both the California Carbon Market and the Regional Greenhouse Gas Initiative. In some of these instances, the markets have not delivered the expected cost savings.

With these experiences in mind, we identify three principles for a well-functioning cap-and-trade market, which we incorporate into our proposed structure for CO<sub>2</sub> emissions in U.S. transportation.

### ***1. The cap must be both optimal and enforceable.***

A cap-and-trade program is only as good as the cap that determines it. Caps that are too low could force firms to engage in costly abatement, inflating the price of credits beyond the environmental benefit they deliver. Ultimately, for example, the efficient price of a petroleum or CO<sub>2</sub> credit is equal to the social damage of one unit of fuel or CO<sub>2</sub>. Otherwise, firms might be paying more than or less than the negative externalities caused by pollution. Caps should reflect both the cost of reducing pollution for firms and the cost of pollution to society.

When the Regional Greenhouse Gas Initiative instituted a cap-and-trade program on electricity generators in 2009, it chose caps that would not be reconsidered in light of economic changes. The fall of natural gas prices in 2009 made it less costly for firms to meet cap requirements (i.e., natural gas-fired electricity plants could more cheaply reduce electricity output and reduce emissions). As a result, caps were too easy to meet and the price of credits plummeted to \$1.86/ton of CO<sub>2</sub> in 2010. As a benchmark, the current social cost of CO<sub>2</sub> is approximately \$40/ton of CO<sub>2</sub>, so there was a clear disparity between how much firms were paying to pollute and how damaging the pollution was for society. Thus, there was an efficiency case for increasing the stringency of the cap.

### ***2. Liquid, transparent trading is critical.***

In order for firms to transfer pollution abatement to the source of the least-cost method, there must be liquidity and stability in trading markets to facilitate transactions. In part, this requires the presence of a well-populated market and a formal structure for clearing trades. In many instances, these markets function better when financial traders are allowed to participate (Mercadal 2016). Furthermore, it is important for there to be safeguards against the exercise of market power among participants.

### ***3. The system must be simple and not hampered by duplicative or conflicting regulations.***

The success of a cap-and-trade scheme is contingent on the market determining the least-cost method of pollution abatement. The California Carbon Market is an example of restricting regulation that undermines the optimality of a cap-and-trade system. California's Assembly Bill 32 (AB-32), passed in 2006, instituted energy efficient standards for vehicles, buildings, and appliances; renewable portfolio standards that increased the required share of renewable electricity; and a low carbon fuel standard that requires oil refineries to reduce carbon content for motor fuels. In 2013 AB-32 added a cap-and-trade system for GHG emissions for regulated entities.

This created a fundamental clash between the 2006 regulations, which mandated specific ways of reducing pollution, and the 2013 cap-and-trade program, which allowed entities to trade credits. Although firms could trade credits with each other to abate in the cheapest way, they could do so only after meeting all of the requirements in the 2006 regulations. That is, the market was restricted in how it could optimize abating pollution. Ultimately, this raises the compliance costs for participants.

## A CAP-AND-TRADE PROGRAM FOR TRANSPORTATION

These principals inform our design of a cap-and-trade program for transportation. Our target is a binding, optimal cap-and-trade program that achieves verifiable reductions in expected fuel consumption in the light-duty vehicle fleet. This program would benefit from liquid, transparent trading, reducing compliance costs for the auto industry as a whole. Our approach would also eliminate several weaknesses of the current system, including dual treatment for cars and trucks, attribute-based standards, and credit loopholes. Thus, our proposed approach represents a dramatic improvement from the current approach to regulation, which is both leaky and inefficient and in its best form would be capable of capturing only one-quarter to one-third of potential welfare gains, since it regulates efficiency only.

Under our proposal, the National Program would remain in place through 2025 as designed by EPA and NHTSA. (We acknowledge that it might make sense to revisit that idea and we bracket it for current purposes.) EISA mandates that NHTSA promulgate fuel economy rules in increments of at least one year and not more than five years through 2030. However, from 2020 to 2030 significant flexibility is given to the secretary of transportation, who is required only to promulgate rules that are the maximum feasible, subject to a handful of constraints, such as economic and technical feasibility.

Our proposal would see EPA implement a cap-and-trade program beginning in 2026 and become the binding constraint for fuel consumption and emissions compliance. NHTSA's rules could remain at the 2025 levels through 2030, after which its authority effectively expires. In other words, this program would be housed at EPA, which has far more durable and flexible authority under the CAA (see chapter 4 for further discussion).

In the sections that follow, we discuss the key features of a cap-and-trade program for light-duty vehicles administered by EPA beginning in 2026. Specifically, these are (1) setting the cap; (2) calculating lifetime VMT by model; (3) allocating permits; (4) incorporating advanced technology; and (5) creating a functioning trading system.

### ***1. Setting the cap***

The core of this proposal is an industry-wide cap on expected lifetime fuel consumption (and in turn GHG emissions) from new light-duty vehicles sold in the United States. The cap would evolve over time consistent with U.S. policy goals, whatever they might be. EPA and NHTSA have established a bottom-up process for determining technological feasibility. This is an artifact of both NHTSA's EPCA/EISA authority and EPA's CAA authority. Specifically, in the case of EPA, its authority to regulate mobile source emissions under the CAA is not intended to be technology forcing in the same way that its other authorities are. Therefore, to some degree the establishment of the cap would have to follow a similar bottom-up pathway. This has the advantage of building on existing processes within industry and EPA. However, it will be critical that EPA set an optimal cap, which will also need to be informed by broader, top-down U.S. policy goals.

### ***2. Calculating lifetime VMT by model***

Any automaker selling a light-duty vehicle would be required to hold permits for its expected lifetime fuel consumption (or GHG emissions). Crucially, there is no separate system for cars or light trucks, or vehicles of various sizes. Vehicles are regulated solely based on their expected lifetime fuel consumption. This regulates the gas guzzlers *most* stringently, as opposed to the current system, which regulates them *least* stringently.

Expected lifetime fuel consumption would be calculated at the vehicle model level, and would be the product of that model's efficiency in miles per gallon and its expected lifetime VMT. The projected lifetime VMT of a given model would be based on its historical average, which EPA could obtain from a variety of sources. Vehicle retirement data are available by vehicle identification number through a number of sources, including private data firms like R. L. Polk (IHS Markit). The lifetime VMT of a new model would be determined by the nearest existing model. Furthermore, it is possible to build a more-complex and more-accurate model that in principle could account for oil prices, which certainly affect VMT.

Here, an obvious challenge is that vehicles being retired in any given year were manufactured 20 years prior.

Expected longevity could theoretically change for any number of reasons. To address this, we propose that EPA use historical data to develop longevity curves by model, and that the value used to calculate lifetime VMT in a given year be the fitted value for that model extended on the curve. Each year, new data will allow recalibration of the curves.

Ostensibly, the automakers could also provide expected lifetime VMT data. One could argue that the automakers would have an incentive to understate expected lifetime VMT to lower compliance costs, but there are at least two problems with this argument. First, there is a brand and sales cost to automakers perceived as selling vehicles that “do not last.” Second, the data provided by automakers could be compared to historical data, and variance could be limited to a tight range.

### ***3. Allocating permits***

In principle, there are roughly three ways to manage allocation of permits in a cap-and-trade system. One option is for credits to be auctioned at the outset of each period, which has the benefit of raising revenue, ultimately benefiting taxpayers and initially, in this case, the federal government. Alternatively, credits can simply be given away to each regulated entity based on some formula, which is often based on historical activity in the regulated market. A third option, of course, is some combination of these.

It is important to remember that the impact of any of these approaches on expected fuel consumption is identical. All that matters in terms of limiting pollution is the total number of permits available—that is, the cap. The allocation of those permits is strictly a distributional issue that determines how the costs are shared. For example, automakers with fleets heavily weighted toward light trucks will face relatively larger adjustment costs. Therefore, our recommendation is that a portion of the permits in this system be distributed at no cost, and that these be allocated to each automaker in proportion to the share of fuel-inefficient vehicles currently in their fleet mix. We would recommend that the rest of the permits be auctioned, with proceeds turned over to the U.S. Treasury.

### ***4. Incorporating advanced technology***

The National Program supports advanced technology vehicles through two specific mechanisms. First, vehicles powered by electricity and hydrogen have a compliance value of 0 grams per mile in EPA’s program, with no limit on the number of vehicles sold between MY 2017 and MY 2021. From MYs 2022 to 2025, there is a limit on the number of vehicles that can be sold at the 0 g per mile level, after which EPA has indicated it plans to use a formula for accounting for the upstream emissions for these vehicles (e.g., the GHGs emitted during electricity production). Vehicles powered by natural gas benefit from a generous calculation of fuel economy under both the NHTSA and EPA rules.

Second, vehicles powered by these fuels count as more than one vehicle in a manufacturer’s compliance calculation. Electric and fuel-cell vehicles start with a multiplier value of 2.0 in MY 2017 and phase down to a value of 1.5 in MY 2021. Plug-in hybrid electric vehicles and natural gas vehicles start with a multiplier value of 1.6 in MY 2017 and phase down to a value of 1.3 in MY 2021.

These incentives reflect a commitment, which might well wax or wane over time, to foster the development and deployment of advanced transportation technologies. It is important to note that the substantial emissions reductions achieved in the power sector in recent years are largely the result of fuel competition and substitution, a possibility that does not yet exist in transportation at scale. Therefore, maintaining a commitment to fuel diversity is critical to achieving deep reductions in fuel use in transportation. The opportunity presented by electric vehicles is particularly noteworthy in the context of economy-wide emissions reductions: in a fully electrified transport sector, emissions reduction in the power sector cascade throughout the energy economy.

With this in mind, we recommend that vehicles powered by electricity continue to be treated as zero emissions vehicles under a cap-and-trade program, a program element that could be revisited over time based on shifts in power generation or technological maturity.

## **5. Creating a functioning trading system**

The lessons learned from past cap-and-trade systems can be used to evaluate and improve on the NHTSA and EPA credit trading programs. First, as demonstrated by the EU Emissions Trading System scheme, creating a centralized exchange for NHTSA and EPA credits would lower transaction costs, promote price stability and transparency, and increase trade volume. Currently, the EPA and NHTSA do not even report credit prices of trades, and trades between manufacturers are reported by the EPA, but not by NHTSA. Even small steps toward promoting a central trading platform or data repository of past trades could result in large gains in efficiency.

Second, we argue for careful consideration of inclusion of financial traders as allowable participants in the program we have outlined. In many programs, only regulated entities are allowable participants in the market. But in cases where the number of regulated entities is not sufficiently large and diverse, this inhibits market function. It is possible that the light-duty vehicle market represents such a market. Moreover, a growing body of research suggests that allowing third-party participants increases liquidity and reduces costs (Li et al. 2015; Mercadal 2016).

We note finally that although our proposal is focused on light duty vehicles, it would be best to combine the program with the existing regulations for medium- and heavy-duty trucks as well. In principle, the same arguments that justify the forms of trading for which we have argued justify a more-expansive program, including all categories of vehicles.

## **Chapter 4. Legal Justification and Framework for this Proposal**

Does the federal government have legal authority to adopt the approach for which we have argued? We believe that it does. Our focus throughout is on fuel consumption, not GHG emissions. But of course the goals of reducing fuel consumption and reducing GHG emissions are promoted simultaneously through the National Program. We focus here on the EPA's authority on the ground that the legal analysis is relatively straightforward, but our principal focus remains fuel consumption. We note as well that for present purposes we paint with a relatively broad brush and avoid a full treatment of the legal technicalities.

As discussed in chapter 2 of this paper, Title II of the CAA provides for regulation of air pollution from mobile sources. In particular, the statute requires the EPA administrator to establish "standards applicable to the emission of any air pollutant from any class or classes of new motor vehicles or new motor vehicle engines, which in his judgment cause, or contribute to, air pollution which may reasonably be anticipated to endanger public health or welfare. Such standards shall be applicable to such vehicles and engines for their useful life" (CAA 1990, sec. 202 §7521 (a)(1)).

This grant of authority establishes two conditions for EPA action: (1) The substance in question must qualify as an air pollutant, and (2) the administrator must make a finding that the air pollutant could endanger public health or welfare. With the Supreme Court's 2007 decision that GHGs meet the statutory definition of an air pollutant, and EPA's subsequent finding that GHGs endanger public health or welfare, EPA appears to be legally obligated to set standards for the emissions of GHGs from motor vehicles.

Although the CAA establishes clear conditions on when regulation is necessary, the statute leaves considerable discretion to the agency to determine the nature and degree of regulation. EPA is required by statute to set standards that "reflect the greatest degree of emission reduction achievable," considering technological feasibility, costs of compliance, and necessary lead-time of such a standard (CAA 1990, sec. 202 §7521 (a)(3)(A)). EPA also has the discretion to weigh other relevant factors, including safety, impacts on consumers, and energy impacts related to the use of the technology. Because the statute does not specify how much weight to attribute to each of these factors, courts have interpreted section 202 of CAA (1990) as giving EPA significant discretion in its balancing analysis. EPA is not strictly required to choose the approach that requires "the greatest degree of emission reduction achievable," because it is entitled to give consideration to (for example) cost and safety. If the agency seeks to engage in some form of cost-benefit analysis and to maximize net benefits, subject to the constraints of feasibility, it appears that it is entitled to do that.



At the same time, as discussed in chapter 3, emissions standards under Title II are technology-based, rather than harm-based; the major constraint on the administrator's determination is that the standard be technologically feasible. Title II emissions standards are not technology-forcing to the same extent as regulations under other sections of the CAA.

EPA has broad discretion to decide how to categorize vehicles for the purposes of emission regulation. The CAA provides, "in establishing classes or categories of vehicles or engines for purposes of regulations... the Administrator may base such classes or categories on gross vehicle weight, horsepower, type of fuel used, or other appropriate factors" (CAA 1990, sec. 202 §7521 (a)(3)(A)(ii)). There is no evident barrier to combining cars and light trucks, and indeed there is no evident barrier to combining light-duty vehicles and heavy-duty vehicles, as long as EPA respects to statutory enumeration of relevant pollutants.

#### THE LEGALITY OF A CAP-AND-TRADE SYSTEM FOR VEHICLE EMISSIONS

It is true that, as a matter of practice, EPA has not used section 202 of the CAA (1990) to create a cap-and-trade system, which, by definition, allows regulated entities to meet a regulatory mandate despite failing to meet average performance metrics. In the context of GHG-emissions regulation, an auto manufacturer would be able to manufacture and sell vehicles that did not meet average emission standards, as long as that manufacturer purchased credits from another automaker that exceeded those standards. This flexibility is one of the primary virtues of cap and trade: it enables market-based compliance mechanisms that command-and-control regulation does not.

Under section 202 (CAA 1990), EPA is not required to adopt average performance metrics. Section 202 calls for EPA to establish emissions standards that "reflect the greatest degree of emission reduction" that is technologically feasible. Our proposal is consistent with this standard. Nothing in section 202 forbids EPA from issuing standards that are based on an industry-wide cap. (We note in addition that under this section it would likely be possible to harmonize the programs of light-duty and heavy-duty vehicles. Such harmonization would present a range of questions, practical and legal, but the statute appears to authorize it.)

It is true that building a cap-and-trade system from this mandate would require EPA to construe the relevant provisions to authorize market-based regulatory structures. It is also true that the cap would need to be ultimately derived from a judgement about the technological feasibility of implementing the average emissions standard. But this approach would be a perfectly legitimate interpretation of the broad language of the CAA, and it is also consistent with EPA's approach in other recent rules, including the Clean Power Plan (CPP). Insofar as the agency's use of a cap would be based, in part, on consideration of costs of compliance and impacts on consumers, it would be drawn directly from the statutory language.

We agree that under that same language the national emissions cap must be based on a calculation of the aggregate emissions from new mobile sources, based on what reductions are technologically feasible. As technology improves, EPA can continue to lower the overall cap if it wishes, but the cap must reflect what manufacturers can feasibly achieve.

#### LIFETIME VEHICLE EMISSIONS ARE APPROPRIATE CONSIDERATIONS IN THE REGULATION OF MOTOR VEHICLE EMISSIONS

To create a cap-and-trade system, the EPA administrator must issue regulations that set standards for motor vehicles. The relevant statutory authorities place limits on how these standards can be applied. The CAA restricts the administrator's consideration to "gross vehicle weight, horsepower, type of fuel used, or other appropriate factors" (CAA 1990, sec. 202 §7521 (a)(3)(A)(ii)). The cap-and-trade system proposes to reflect the actual expected GHG emitted by each vehicle during its lifetime by assigning a cost to each vehicle based on three factors: lifetime VMT, mpg, and CO<sub>2</sub> emitted per gallon. The use of these factors raises additional issues, but it is statutorily permissible.

Specifically, we believe that the phrase "other appropriate factors" includes factors such as lifetime VMT. After all, lifetime VMT is a function of the vehicle's physical characteristics and the quality of its engineering, making it similar to statutory factors such as weight and horsepower. It is true that, unlike the other factors deemed relevant by EPA, lifetime mileage is also *to some degree* a product of external influences that might include the consumer's preferences, employment, family size, geographic location, and so forth. By contrast, vehicle weight, horsepower,

and fuel used are physical attributes known by the manufacturer at the time of the vehicle's sale. When projected mileage depends in some part on consumer behavior, it is arguably not an "appropriate factor."

The statutory language is expansive, however, and it delegates to EPA the authority to decide what factors are appropriate in determining emissions standards. It would be perfectly reasonable for EPA to interpret "other appropriate factors" to include lifetime vehicle emissions, since lifetime vehicle emissions are primarily grounded in the physical characteristics of the vehicle. Furthermore, a reviewing court would likely give substantial deference to EPA's interpretation of such an ambiguous term within its regulatory sphere.

#### LIFETIME VEHICLE EMISSIONS TRAVELED IS AN APPROPRIATE CONSIDERATION OF THE VEHICLE'S USEFUL LIFE

The CAA restricts the EPA administrator's application of standards by limiting the standard to the vehicle's "useful life." The statute requires the administrator to define this term by regulation while offering baseline definitions. The statutorily defined useful life for light-duty vehicles has increased from 5 years or 50,000 miles, whichever comes first, for all pollutants to the current regulatory definition of 10 years or 120,000 miles, whichever comes first, for GHG pollutants.

EPA's consideration of lifetime emissions, as we propose, poses no statutory conflict, because the EPA has the express authority to revise the definition of useful life. In order to reflect the actual emissions, the cap-and-trade system must include emissions from the time of sale until the vehicle's retirement, and this could very well be longer than both 10 years and 120,000 miles. To be sure, manufacturers might object to a regulation that holds them to high standards during the final years of a vehicle's life. But previous regulations have set different definitions of useful life according to the pollutant being limited, and section 202 of CAA (1990) itself allows for alternative definitions of useful life for determining in-use compliance. Thus, the EPA will be able to craft a definition of useful life that avoids both statutory and policy concerns.

#### LINKING MOBILE AND STATIONARY SOURCES

For the reasons that we have given, there would be substantial benefits of linking a mobile source cap-and-trade system to the CPP. Unfortunately, any such link would run into formidable legal obstacles.

Section 111(d) of the CAA provides the statutory authority for the CPP; it expressly calls for state implementation of performance standards issued by EPA.<sup>6</sup> That program is independent of the mobile source program, which is implemented by the national government. Interpreting section 111(d), EPA set state-level standards of performance, but designed the CPP to give states full authority to decide how the electric generating units (EGUs) within its jurisdiction should meet that standard. Controversially, credit trading within a state (or between states) is a compliance option that EPA suggests that states could adopt. But the CPP does not establish any kind of national market for CO<sub>2</sub> credit trading. Indeed, one of the primary lines of attack pending litigation is whether EPA can legally base its standards of performance on intrastate credit trading ("generation shifting," in the parlance of the CPP) at all. Even if the CPP survives the existing challenge, there is no clear path to establishing a national credit trading scheme within the CPP's regulatory framework that could link to a mobile source cap-and-trade program.

Notwithstanding these arguments, EPA might yet be able to allow some credit trading between motor vehicle manufacturers and EGUs. Section 111(d) and the CPP might not allow for a national market for EGU CO<sub>2</sub> credit trading, but a market established under section 202 would be able to connect with a market established by states pursuant to the CPP. As noted previously, 111(d) gives the states the authority to craft a plan that takes into account the particular energy and economic needs of its localities. A state could include intra-state or regional cap and trade in its state implementation plan, and if that trading market was compatible with the market design of the section 202 mobile source cap-and-trade program, EGUs in that state could trade CO<sub>2</sub> credits with automakers both within and beyond that state's borders. While falling short of the goal of a single comprehensive regulatory scheme for GHG emissions, this arrangement would enable for some cross-sector trading, and would expand the market-based incentives beyond the confines of the traditional mobile/ stationary dichotomy.

If a single scheme is to be created, it would have to be a result of a legislative change. Notably, the change would be

comparatively modest; it would not require Congress to produce some large-scale program, nor would it add a new part to the CAA. All that would be required would be a short section granting EPA authority to link the mobile source and stationary source programs, perhaps on the basis of a demonstration of substantial cost savings.

## Chapter 5. Conclusion

Motor vehicle fuel-economy standards have long been a cornerstone of U.S. policy to reduce fuel consumption in the light-duty vehicle fleet. As a matter of public policy, however, standards that focus on efficiency alone, as opposed to lifetime consumption, miss out on large potential economic savings, and the savings they do achieve come at an unnecessarily high cost. On the basis of a foundational commitment to cost-benefit analysis, established under presidents of both political parties, we have outlined the case for a cap-and-trade system in transportation. Acknowledging that the very idea of cap and trade has become controversial, we show that this approach would increase the certainty of reductions in fuel consumption in transportation and do so at a far lower cost per gallon avoided. Such an approach is consistent with the regulatory authority existing at key federal agencies and could be implemented without new legislation.

## Endnotes

1. The authors use odometer data from the California Smog Check Program and propriety registration and retirement data from IHS Markit to obtain lifetime VMT over a large sample of MYs 1988–92 vehicles that were retired in 2013.
2. Note that the data presented here use the traditional definition of car and light truck, which is different from the definition used under the National Program. These data are not intended to present a view on compliance, but rather simply illustrate the broader shift in the U.S. vehicle mix since 1975.
3. For an exhaustive discussion of the two systems, their history, characteristics, and differences, see Leard and McConnell 2015.
4. Note that here we are using the agencies’ revised definition of cars and light trucks and corresponding sales shares provided in the “Joint Technical Support Document” as the projected values (National Service Center for Environmental Publications [NSCEP] 2009). We then compare production- weighted values obtained from EPA’s most-recent fuel economy trends report (EPA 2016a). For this discussion, we have specifically avoided using the more common sales-weighted data. Although sales-weighted data provide a very useful estimate of real-time market trends, they are not useful for calculating lifetime model year fuel. The agencies use production- weighted data for compliance. Although production and sales should roughly be equal over a period of years, there can be important differences from year to year as consumer preferences shift in real time.
5. We have notably omitted air conditioner credits from this discussion. Under EPA’s program, automakers can earn air conditioner credits through two means—reduction in leakage of hydrofluorocarbons and efficiency improvements through reductions in the amount of energy consumed by air conditioner units. Although the latter can directly impact fuel use, the former is strictly an emissions benefit. To date, EPA reports that the majority of credits consumed by automakers have been attributed to leakage reduction.
6. “Each State may develop and submit to the Administrator a procedure for implementing and enforcing standards of performance for new sources located in such State. If the Administrator finds the State procedure is adequate, he shall delegate to such State any authority he has under this chapter to implement and enforce such standards” (GPO 2011, (c)(1)).

## References

- Bureau of Economic Analysis (BEA). 2016. “Monthly Auto Sales Update.” Bureau of Economic Analysis, U.S. Department of Commerce, Washington, DC.
- Busse, Meghan, Christopher Knittel, and Florian Zettelmeyer. 2013. “Are Consumers Myopic? Evidence from New and Used Car Purchases.” *American Economic Review* 103 (1): 220–56.
- Carlson, Curtis, Dallas Burtraw, Maureen L. Cropper, and Karen Palmer. 2000. “Sulfur Dioxide Control by Electric Utilities: What Are the Gains from Trade?” *Journal of Political Economy* 108 (6): 1292–1326.
- Clean Air Act (CAA) of 1963. Pub. L. 88-206, 77 Stat. 392 (1963).
- Clean Air Act Amendment Summary: Title II (CAA) (1990). CAA § 201–219; USC § 7521–7554.
- Congressional Budget Office (CBO). 2003, December. “The Economic Costs of Fuel Economy Standards Versus a Gasoline Tax.” Congressional Budget Office, Washington, DC.
- Davis, Stacy C., Susan W. Diegel, and Robert G. Boundy. 2016. Oak Ridge National Laboratory (ORNL). 2016. *Transportation Energy Data Book*, ed. 35. Oak Ridge, TN: Oak Ridge National Laboratory.
- Ellerman, A. Denny, Paul L. Joskow, Richard Schmalensee, Juan- Pablo Montero, and Elizabeth M. Bailey. 2000. “Markets for Clean Air: The U.S. Acid Rain Program.” Cambridge, UK: Cambridge University Press.
- Energy Independence and Security Act (EISA) of 2007. Pub. L. 110-140.
- Energy Information Administration (EIA). 2016a. “October Monthly Energy Review.” Energy Information Administration, U.S. Department of Energy, Washington, DC.
- . 2016b. “Annual Energy Outlook 2016.” Energy Information Administration, U.S. Department of Energy, Washington, DC.
- . 2016c, May 4. “Almost All U.S. Gasoline Is Blended with 10% Ethanol.” Today in Energy. U.S. Energy Information Administration, U.S. Department of Energy, Washington, DC.
- Energy Policy and Conservation Act (EPCA) of 1975, Pub. L. 94- 163, 89 Stat. 871.
- Gayer, Ted. 2004. “The Fatality Risks of Sport-Utility Vehicles, Vans, and Pickups Relative to Cars.” *Journal of Risk and Uncertainty* 28 (2): 103–33.
- Government Printing Office (GPO). 2001. “Code of Federal Regulations of the United States of America: Title 15— Commerce and Trade.” Government Printing Office, Washington, DC.

- . 2011. “42 U.S.C. 7411 - Standards of Performance for New Stationary Sources.” Government Printing Office, Washington, DC.
- Ito, Koichiro, and James M. Sallee. 2014, September. “The Economics of Attribute-Based Regulation: Theory and Evidence from Fuel-Economy Standards.” Working Paper 20500, National Bureau of Economic Research, Cambridge, MA.
- Jacobsen, Mark. 2010. “Evaluating U.S. Fuel Economy Standards in a Model with Producer and Household Heterogeneity.” Working Paper, University of California at San Diego.
- Jacobsen, Mark, Christopher Knittel, James Sallee, and Arthur van Bentham. 2016, February. “Sufficient Statistic for Imperfect Externality-Correcting Policies.” Working Paper 22063, National Bureau of Economic Research, Cambridge, MA.
- Keohane, Nathaniel O. 2003. “What Did the Market Buy? Cost Savings under the U.S. Tradeable Permits Program for Sulfur Dioxide.” Working Paper 01-11-2003, Yale Center for Environmental Law and Policy, New Haven, CT.
- Leard, Benjamin, and Virginia McConnell. 2015. “New Markets for Pollution and Energy Efficiency Credit Trading under Automobile Greenhouse Gas and Fuel Economy Standards.” Discussion Paper 15-16, Resources for the Future, Washington, DC.
- Li, Ruoyang, Alva J. Svoboda, and Shmuel S. Oren. 2015. “Efficiency Impact of Convergence Bidding on the California Electricity Market.” *Journal of Regulatory Economics* 48 (3): 245–84.
- Massachusetts, et al., *Petitioners v. Environmental Protection Agency, et al.*, 549 U.S. 497 (2007).
- Mercadal, Ignacia. 2016, January. “Dynamic Competition and Arbitrage in Electricity Markets: The Role of Financial Players.” Working Paper, University of Chicago, Chicago, IL.
- National Highway Traffic Safety Administration (NHTSA). 2010, March. “Final Regulatory Impact Analysis: Corporate Average Fuel Economy for MY 2012–MY 2016 Passenger Cars and Light Trucks.” National Highway Traffic Safety Administration, U.S. Department of Transportation, Washington, DC.
- . 2016. “Public Information Center.” National Highway Traffic Safety Administration, U.S. Department of Transportation, Washington, DC.
- . 2017. “Model Year 2016 and 2017 Projected Fuel Economy Performance Report.” National Highway Traffic Safety Administration, U.S. Department of Transportation, Washington, DC.
- National Research Council. 2015. *Cost, Effectiveness, and Deployment of Fuel Economy Technologies for Light-Duty Vehicles*. Washington, DC: National Academies Press.
- National Service Center for Environmental Publications (NSCEP).  
2009. “Draft Joint Technical Support Document: Proposed Rulemaking to Establish Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards.” National Service Center for Environmental Publications, U.S. Environmental Protection Agency, Washington, DC.
- Schmalensee, Richard, and Robert N. Stavins. 2015, November. “Lessons Learned from Three Decades of Experience with Cap-and-Trade.” Discussion Paper 15-51, Resources for the Future, Washington, DC.
- Stavins, Robert N. 2005. “Lessons Learned from SO<sub>2</sub> Allowance Trading.” *Choices* 20 (1): 53–57.
- U.S. Environmental Protection Agency (EPA). 2004. “Acid Rain Program 2004 Progress Report: 10 Years of Progress.” U.S. Environmental Protection Agency, Washington, DC.
- . 2012a. “Regulatory Impact Analysis: Final Rulemaking for 2017–2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards.” U.S. Environmental Protection Agency, Washington, DC.
- . 2012b. “Final Rulemaking to Establish Light-Duty Vehicle Greenhouse Gas Emissions Standards and Corporate Average Fuel Economy Standards for Model Years 2012– 2016.” 40 CFR Parts 85, 86, and 600. U.S. Environmental Protection Agency, Washington, DC.
- . 2012c. “Final Rulemaking to Establish Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards: Joint Technical Support Document.” U.S. Environmental Protection Agency, Washington, DC.
- . 2016a. “Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2016.” U.S. Environmental Protection Agency, Washington, DC.
- . 2016b. “Greenhouse Gas Emission Standards for Light- Duty Vehicles: Manufacturers’ Performance Report for the 2015 Model Year.” U.S. Environmental Protection Agency, Washington, DC.

- . 2016c. “EPA and NHTSA Adopt Standards to Reduce Greenhouse Gas Emissions and Improve Fuel Efficiency of Medium- and Heavy-Duty Vehicles for Model Year 2018 and Beyond.” U.S. Environmental Protection Agency, Washington, DC.
- . 2016d, July. “Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022–2025.” U.S. Environmental Protection Agency, Washington, DC.
- Whitefoot, Kate, and Steven Skerlos. 2012, February. “Design Incentives to Increase Vehicle Size Created from the U.S. Footprint-Based Fuel Economy Standards.” *Energy Policy* 41: 402–11.