FUEL ECONOMY 2.0

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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 2010 and 2012, these standards were significantly expanded in an effort to achieve steep reductions in oil demand and greenhouse gas ("GHG") emissions through 2025. In 2018, following a review of the standards, the Environmental Protection Agency and National Highway Traffic Safety Administration proposed instead to freeze the standards at 2020 levels, citing high program costs (and potential safety issues).

The current debate over the future of U.S. fuel economy standards provides an opportunity to consider whether the existing approach could be improved to achieve environmental and other goals at a lower cost. The current policy prescribes standards that focus on fuel economy alone, as opposed to lifetime consumption, and treats vehicle categories differentially, meaning that it imposes unnecessarily high costs and does not deliver guaranteed GHG savings.

On the basis of a commitment to cost-benefit analysis, which has defined U.S. regulatory policy for more than thirty years, we propose novel reforms with three main features: (1) the direct regulation of expected fuel consumption and GHG emissions without consideration of the type or size of the vehicle; (2) use of existing data to assign lifetime fuel consumption and GHG emissions to each model; and (3) creation of a robust cap-and-trade market for automakers to reduce compliance costs. We show that these reforms would reduce fuel consumption and GHG emissions in transportation with greater certainty and do so at a far lower cost per ton of GHG emissions avoided. We also show that the the Environmental Protection Agency and the Department of Transportation could implement such an approach within their existing statutory authority.

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Introduction

Our goal here is to propose a large-scale reform of the fuel economy program—a kind of Fuel Economy 2.0. Our reform has three main features. First, it would regulate expected fuel consumption and GHG emissions directly, without consideration of the type or size of the vehicle. Second, it would use existing data to assign lifetime fuel consumption and GHG emissions to each model. Third, it would create a robust cap-and-trade market for automakers to reduce compliance costs. We shall elaborate each of these ideas, and their legality under existing law, in some detail.

Originally enacted during the mid-1970s,[1] fuel economy standards are a cornerstone of U.S. policy to improve energy security and environmental quality

1. Energy Policy and Conservation Act of 1975 ("EPCA"), Pub. L. No. 94-163, 89 Stat. 871, §§ 501–512 (1975).

by limiting fuel consumption and GHG emissions in transportation.[2] The current standards for passenger cars and light trucks were finalized by EPA and the National Highway Traffic Safety Administration ("NHTSA") in 2010 and 2012 under a harmonized National Program.[3] These standards were 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.[4] In the agencies' analysis, the admittedly high costs of the standards were dwarfed by the monetized benefits.[5]

In 2018, EPA and NHTSA proposed to continue the National Program but to amend the standards and to freeze the levels for MYs 2021 through 2026 at the 2020 levels.[6] The agencies conducted a new and dramatically different analysis, suggesting that the post-2020 standards would produce relatively high costs and low benefits—and hence that freezing them would produce billions of dollars in net benefits.[7] While the details of the new analysis are beyond the scope of the present discussion, it is useful to note that the differences stem from identifiable changes in the underlying assumptions. These include: (1) a significantly lower social cost of carbon;[8] (2) reassessment of the consumer valuation of fuel savings, suggesting that those savings are significantly lower than

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2. *See Corporate Average Fuel Economy (CAFE) Standards*, DEP'T OF TRANSP., https://perma.cc/GAL8-A3HQ. For the most recent proposed emissions standards, see The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2026 Passenger Cars and Light Trucks, 83 Fed. Reg. 42,986 (Aug. 24, 2018) (to be codified at 40 C.F.R. pts. 85, 86, and 49 C.F.R. pts. 523, 531, 533, 536, 537) [hereinafter SAFE Vehicles Rule].
3. Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule, 75 Fed. Reg. 25,324 (May 7, 2010) (codified at 40 C.F.R. pts. 85, 86, 600, and 49 C.F.R. pts. 531, 533, 536–538) [hereinafter 2010 CAFE Rule]; 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, 77 Fed. Reg. 62,624 (Oct. 18, 2012) (codified at 40 C.F.R. pts. 85, 86, 600, and 49 C.F.R. pts. 523, 531, 533, 536, 537) [hereinafter 2012 CAFE Rule].
4. *See* EPA, REGULATORY IMPACT ANALYSIS: FINAL RULEMAKING FOR 2017–2025 LIGHT-DUTY VEHICLE GREENHOUSE GAS EMISSION STANDARDS AND CORPORATE AVERAGE FUEL ECONOMY STANDARDS, at 4-137, 7-32 (2012), https://perma.cc/7X6Z-B6DN.
5. *Id.* at ii.
6. *See* SAFE Vehicles Rule, *supra* note 2, 83 Fed. Reg. at 42,986, 42,990–91.
7. *See id.* at 42,995–96, 42,997–98.
8. *See id.* at 43,226. The social cost of carbon is a dollar figure that represents the monetary value of the various harms produced by a ton of GHG emissions. There is a vast amount of literature on the topic. For the Obama Administration's analysis, see INTERAGENCY WORKING GROUP ON SOCIAL COST OF GREENHOUSE GASES, TECHNICAL SUPPORT DOCUMENT: TECHNICAL UPDATE OF THE SOCIAL COST OF CARBON FOR REGULATORY IMPACT ANALYSIS UNDER EXECUTIVE ORDER 12866 (2016), https://perma.cc/BXB7-RUA9 [hereinafter INTERAGENCY WORKING GROUP 2016 TECHNICAL SUPPORT DOCUMENT].

had been previously estimated;[9] and (3) a judgment that the earlier rule would result in increased safety risks, producing significant costs.[10]

As of this writing, the proposal has not been finalized. It is facing serious objections in terms of both policy and law.[11] If it is finalized, it will almost certainly face immediate legal challenge. Because the proposal has not been finalized, and because of that inevitable challenge, we focus much of our analysis on the rule that was finalized in 2012, noting that with respect to our particular concerns here, the proposed rule is not fundamentally different from that one.

Even before the proposed changes, mounting evidence was beginning to suggest that the National Program had been less successful than expected. The net benefits, understood as social benefits minus social costs,[12] would be lower than anticipated. Instead of continuously rising as expected, gains in fuel efficiency abruptly slowed. After increasing by 8.5% between MYs 2011 and 2013, the real-world, production-weighted fuel economy of new U.S. vehicles improved by a total of just 2.9% between 2013 and 2017.[13] Meanwhile, U.S. gasoline demand has been at or near record highs since 2016 due to record vehicle travel amid lower-than-expected fuel prices and a significant shift toward larger vehicles.[14]

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9. *See* SAFE Vehicles Rule, *supra* note 2, 83 Fed. Reg. at 42,993. For discussion of some of the complexities here, see Hunt Allcott & Cass R. Sunstein, *Regulating Internalities*, 34 J. POL'Y ANALYSIS & MGMT. 698 (2015).

10. *See* SAFE Vehicles Rule, *supra* note 2, 83 Fed. Reg. at 43,226. For a discussion of the key factors driving the agencies' revised analysis, see EPA & NHTSA, PRELIMINARY REGULATORY IMPACT ANALYSIS: THE SAFER AFFORDABLE FUEL-EFFICIENT (SAFE) VEHICLES RULE FOR MODEL YEAR 2021–2026 PASSENGER CARS AND LIGHT TRUCKS (2018), https://perma.cc/HKS2-3BRA. For discussion of the social cost of carbon, see *id.* at 1061–65. For discussion of consumer valuation of fuel economy, see *id.* at 934–40. For discussion of safety impacts, see *id.* at 1328–1413.

11. *See, e.g.,* Dianne Feinstein et al., Comment Letter on Proposed 'SAFE' Rule (Nov. 7, 2018), https://perma.cc/5AGE-PE54 (challenging the policy and legal justifications of the proposed rule); American Academy of Physicians, Comment Letter on Proposed 'SAFE' Rule (Oct. 24, 2018), https://perma.cc/TL8M-6C4Z (objecting to the new rule on the ground that it jeopardizes the health of Americans, particularly vulnerable populations).

12. For both benefits and costs, we proceed in the standard fashion outlined in OFFICE OF MGMT. & BUDGET, CIRCULAR A-4, at 18 (2003), https://perma.cc/BU8P-EHQ8. Benefits include purely economic savings and the monetary equivalent of environmental benefits, such as mortality gains that result from decreased air pollution. Costs include the required expense in producing more fuel-efficient vehicles, and also any costs in terms of safety or the environment.

13. *See* EPA, THE 2018 EPA AUTOMOTIVE TRENDS REPORT: GREENHOUSE GAS EMISSIONS, FUEL ECONOMY, AND TECHNOLOGY SINCE 1975, at 11 (2019), https://perma.cc/Y8UY-X6JG.

14. *See Petroleum and Other Liquids – Product Supplied*, ENERGY INFO. ADMIN. ("EIA"), https://perma.cc/W6H9-PMXD.

Similarly, carbon dioxide ("CO_2") emissions in the transportation sector are on the rise after a brief decline following the 2007-2009 financial crisis, and mobile sources have been America's largest emitter since 2016.[15] The Department of Energy ("DOE") expects this dynamic to continue going forward, even in the case where all policies are extended through 2040.[16]

Whatever the fate of the 2018 proposal, and whatever the right level of stringency, could the current approach for regulating vehicle fuel consumption be improved to reduce costs, increase benefits, or both? We believe so. Our goal here is to suggest a fundamental transformation in the nature of the fuel economy standards, one that would focus on a new target: lifetime vehicle emissions.

We note from the outset that, because they affect only new vehicles, fuel economy standards are limited in their reach compared to alternatives that would target the stock of *existing* vehicles. Only an increased national fuel tax would achieve that result. Because fuel economy regulations do not affect existing vehicles, they will have a limited impact on overall fuel consumption, and therefore achieve reductions at a relatively higher cost as compared to a fuel tax. However, since an increase in the fuel tax does not currently seem feasible in light of likely political opposition, there is a need for policy alternatives that can achieve similar results.[17]

We propose a novel, more cost-effective reform to fuel economy 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. Our proposal has three key features:

> *Feature 1: Fuel economy standards should treat fuel consumption and GHG emissions from different vehicle types identically, regardless of whether it is a car or a light truck and regardless of the vehicle's footprint.*[18]

Current fuel economy regulations treat cars and light trucks differently, with laxer standards for light trucks. The result is that the ability to achieve policy goals is highly dependent on the price of gasoline, which is determined globally, and consumer preferences about vehicle type and size, which are not controlled by government. Consistent with the fundamental economic principle that the

15. *See* EIA, June 2019 Monthly Energy Review 205–10 (2019), https://perma.cc/L327-DB7V.

16. *See* EIA, Annual Energy Outlook 2016, at A-35, D-10, D-16 (2016), https://perma.cc/LLS7-QMCP.

17. *See* Cong. Budget Office, The Economic Costs of Fuel Economy Standards Versus a Gasoline Tax, at iii–iv (2003), https://perma.cc/Y7Z4-W5HQ.

18. A vehicle's "footprint" is defined as the rectangle formed by the four points where a vehicle's four tires touch the ground. *See infra* Section II.A.2.c.

best way to achieve a goal is to target it directly, Feature 1 would eliminate the separate treatment of cars and light trucks and would eliminate size categories.

> *Feature 2: For each vehicle, the target of regulations should be the estimated lifetime fuel consumption and GHG emissions, rather than fuel economy.*

EPA and NHTSA already use estimates of car and light truck lifetime miles to estimate the benefits of the rules,[19] but assume that the number is identical for all cars and trucks respectively. Yet, there are now several datasets 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 fuel economy and usage would be vastly superior to regulating fuel economy alone, which captures only one-fourth to one-third of potential emissions reductions.[20] Feature 2 would be implemented by using this new data to estimate a vehicle's lifetime fuel consumption and GHG emissions.

In contrast, current fuel economy regulations are targeted at miles-per-gallon ("MPG") benchmarks, but ignore differences in the number of 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 economy, but vastly different lifetime fuel consumption. An increase in fuel economy for the Civic will therefore lead to greater reduction in lifetime fuel consumption than an equivalent increase in fuel economy for the Mirage.

> *Feature 3: To reduce compliance costs, federal agencies should establish a cap-and-trade market for GHG emissions, with a cap on the aggregate expected lifetime fuel use and GHG emissions arising from annual sales of cars and light trucks across all manufacturers.*

In a regulatory system based on vehicles' lifetime fuel consumption and GHG emissions, it might seem natural to set automaker-specific limits. However, this would impose disproportionately high compliance costs on some automakers simply because of their expertise in manufacturing particular types of vehicles. Economic theory predicts, and decades of practical experience demonstrate, that a robust cap-and-trade market solves this problem, greatly reducing compliance costs while also providing certainty on expected emissions.

This feature would implement the cap-and-trade market by setting an aggregate fuel use and emissions cap that applies across all manufacturers and

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19. *See, e.g.*, 2012 CAFE Rule, *supra* note 3, 77 Fed. Reg. at 62,890, 62,893.

20. *See* Mark R. Jacobsen et al., *The Use of Regression Statistics to Analyze Imperfect Pricing Policies*, J. Pol. Econ. (forthcoming 2020) (manuscript at 22–37).

then allowing trading between manufacturers. 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 or to distribute revenues to low-income households. The latter option is beyond the scope of the present discussion, but it is worth serious consideration. Any costly regulatory intervention is necessarily felt most by those with little income or wealth. Using proceeds to benefit them might well be justified on grounds of equity.

We acknowledge that the term "cap-and-trade" has become highly 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. It is worth noting that various cap-and-trade systems are already lawful and embedded in existing EPA and NHTSA programs in different forms, including credit trading, banking, and borrowing.[21]

Importantly, a reformed regulatory approach with these three features would retain the technology-neutrality of fuel economy 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. We emphasize that for purposes of this Article, our own commitment is to cost-benefit analysis and policy with the highest bang for the buck, not to any particular target. In the cap-and-trade market we propose, each year's cap would be set consistent with U.S. policy goals, *whatever they are*. Therefore, our proposal is not tied to any particular national policy goal.

This program would be best administered by EPA, whose statutory authority under Title II of the Clean Air Act ("CAA") most effectively allows for the development of a long-term program.[22] Because this reform would be a modification of the existing program and would be seated within EPA, it would not require new authorizing legislation. Because this program will result in the trading of lifetime emissions, it would create additional opportunities to allow markets to identify the greatest flexibility to produce the lowest-cost opportunities. A more ambitious possibility would be to link the light-duty vehi-

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21. *See generally* A. DENNY ELLERMAN ET AL., MARKETS FOR CLEAN AIR: THE U.S. ACID RAIN PROGRAM (2000); Robert W. Hahn & Gordon L. Hester, *Where Did All the Markets Go? An Analysis of EPA's Emissions Trading Program*, 6 YALE J. REG. 109 (1989).

22. 42 U.S.C. § 7521 (2018).

cle program with EPA's program regulating fuel consumption and emissions from medium- and heavy-duty trucks; 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 in order to reduce compliance costs still further. This would require that the permits be denoted in GHG emissions, rather than petroleum, but this conversion is extraordinarily straightforward. If, for example, a power plant owner could reduce GHG emissions more cheaply than an automobile producer, there is every economic 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 remainder of this Article consists of three parts. In Part I, we describe the current form and function of U.S. fuel economy regulations, including the major shortfalls of the current approach. In Part II, we propose an alternative approach based on a cap-and-trade system in transportation, including its potential benefits. In Part III, we review the legal foundations for our approach.

I. Fuel Economy Regulation: Form and Function

Started during the Obama Administration, the current U.S. regulatory system, designed to harmonize the statutory authorities of EPA and those of the Department of Transportation, is known as the National Program.[23] 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 MY in the United States.[24] It does this by setting fuel economy and emissions 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.[25] For present purposes, the key parts of the National Program were implemented in two rulemakings (one in 2010 and one in 2012),[26] and now govern vehicle MYs 2012 through 2025.[27] As noted, a pending proposal would freeze existing standards as of 2020.

Consistent with the goal of harmonization, the program is jointly administered by two separate federal agencies: NHTSA within the Department of Transportation, and EPA. The agencies have worked to link their requirements under the National Program, but they nonetheless operate under different stat-

23. 2012 CAFE Rule, *supra* note 3, 77 Fed. Reg. at 62,624; 2010 CAFE Rule, *supra* note 3, 75 Fed. Reg. at 25,323. For a general discussion, see Jim Rossi & Jody Freeman, *Agency Coordination in Shared Regulatory Space,* 125 Harv. L. Rev. 1331, 1169–72 (2012).

24. *See* 2010 CAFE Rule, *supra* note 3, 75 Fed. Reg. at 25,324.

25. *See id.* at 25,412 (codified at 40 C.F.R. pt. 86).

26. *See generally id.*; 2012 CAFE Rule, *supra* note 3.

27. *See* 2012 CAFE Rule, *supra* note 3, 77 Fed. Reg. at 62,624.

utory authorities with different mandates. (Harmonization would continue under the proposed freeze in levels of stringency.)

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"),[28] which created America's first program for regulating vehicle efficiency, known as Corporate Average Fuel Economy ("CAFE").[29] EPCA's fuel-economy provisions were amended as part of the Energy Independence and Security Act ("EISA") of 2007.[30]

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.[31] The subsequent 2009 endangerment finding by the EPA Administrator initiated the agency's vehicle emissions program.[32] Although there is substantial overlap between EPA's emissions rate requirement and NHTSA's focus on fuel consumption, fuel economy improvements are not the only means an automaker can use to reduce tailpipe emissions under EPA's program.[33] Therefore, a direct conversion of EPA's standard into MPG efficiency overstates the estimated level of fuel economy expected by NHTSA.

Figure 1a presents EPA's 2012–2025 standards for cars, light trucks, and the combined fleet in grams of CO_2 per mile.[34] 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.

28. Pub. L. No. 94-163, 89 Stat. 871 (1975) (codified as amended in scattered sections of 42 and 49 U.S.C.).
29. *Id.* at §§ 501–512; *see also* 42 U.S.C. § 6201(5) (2018).
30. Pub. L. No. 110-140, 112 Stat. 1492, §§ 101–113 (2007) (codified at 49 U.S.C.).
31. *See* Massachusetts v. EPA, 549 U.S. 497, 532 (2007).
32. Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66,496 (2009) (codified at 40 C.F.R. § 1).
33. *See* 2012 CAFE Rule, *supra* note 3, 77 Fed. Reg. at 62,624.
34. *See id.* at 62,641; *see also* 2010 CAFE Rule, *supra* note 3, 75 Fed. Reg. at 25,331.

Fig. 1a. EPA Tailpipe Emissions Compliance Targets, 2012–2025

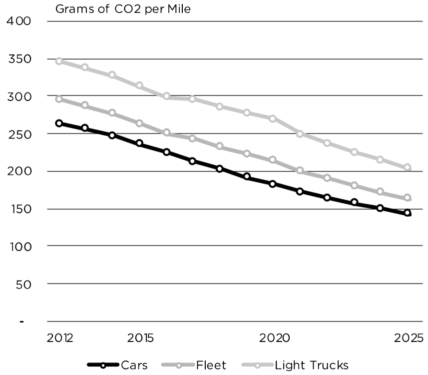

Fig. 1b. Projected Fleet Fuel Economy Performance, 2012–2025

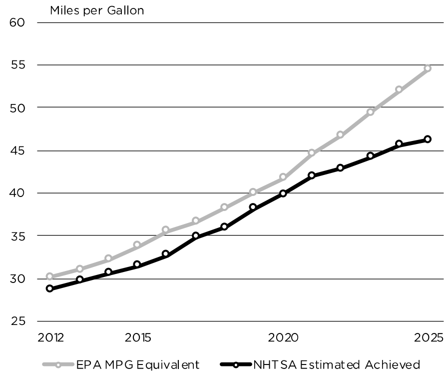

Figure 1b presents the combined fleet figure in MPG. Converting the EPA values directly produces the top line, which effectively assumes that automakers meet their requirements fully through fuel economy improvements and produces the headline-grabbing 54.5 MPG target in 2025.[35] The lower line reaching 46.2 MPG in 2025 is NHTSA's estimated achieved fleet-wide fuel economy, which the agency calculates by removing the impacts of air conditioner credits, non-compliance, and other flexibilities.

It is important to note that the National Program is attribute-based. This feature, introduced by EISA,[36] was 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 the vehicle's footprint, which is the rectangle formed by the four points where the 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 MY once the final production mix is determined.[37] 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.

35. EPA uses a conversion factor of 8887 grams of CO_2 per gallon of gasoline. 2010 CAFE Rule, *supra* note 3, 75 Fed. Reg. at 25,330.

36. *See* Pub. L. No. 110-140, 121 Stat. 1492, § 102(b)(3)(a) (2007).

37. *See* 40 C.F.R. § 600 (2019).

A. A Critique of the National Program

In this Section, we mount a series of objections to the National Program. After explaining the goals and effects of fuel economy regulation, we explain, first, that the current approach suffers from its failure to attend to the question of petroleum consumption. It is important to emphasize fuel economy (or "efficiency," as we shall sometimes call it), but the current program neglects the fact that there would be significantly larger savings, both economic and environmental, if the program were focused not only on how much fuel motor vehicles consume per mile traveled but also on how many miles they travel. Second, we outline a series of structural loopholes in the current program that make it harder to achieve real improvements. Third, we show that the system is too rigid. A robust trading program based on lifetime emissions would have far more flexibility, potentially reducing costs, increasing benefits, or both.

Goals and effects. CAFE standards have a lengthy history.[38] Enacted in response to the oil crisis of 1973, their initial goal was largely to reduce national dependence on foreign oil.[39] As the standards have been debated, an assortment of issues have been raised, involving their effects on safety, cost, employment, and air pollution, including GHGs.[40] In light of the multiple effects of CAFE standards, the original goal—independence from foreign oil—has come to be seen, by many people, as secondary.[41] Today, environmental protection is certainly a primary goal.

Fuel economy regulation has, by any measure, produced important economic, energy, and environmental benefits. Indeed, the health, climate change, and other advantages are estimated to be exceedingly high.[42] The efficiency of

38. For a summary, see NATIONAL RESEARCH COUNCIL, EFFECTIVENESS AND IMPACT OF CORPORATE AVERAGE FUEL ECONOMY STANDARDS 1 (2002), https://perma.cc/C6W6-NEA9.

39. *Id.*

40. *See, e.g.*, *id.* at 63–65.

41. *Id.* at 86.

42. Kenneth Chay & Michael Greenstone, *The Impact of Air Pollution on Infant Mortality: Evidence from Geographic Variation in Pollution Shocks Induced by a Recession*, 118 Q.J. ECON. 1121, 1121 (2003) (suggesting that a reduction in total suspended particulates leads to a decrease in infant mortality); Yuyu Chen, Avraham Ebenstein, Michael Greenstone & Li Hongbin, *Evidence on the Impact of Sustained Exposure to Air Pollution on Life Expectancy from China's Huai River Policy*, 110 PROC. NAT'L ACAD. SCI. 1 (2013) (concluding that a Chinese policy that greatly increases total suspended particulates is causing 500 million Northern Chinese residents to lose 2.5 billion years of life expectancy); Francesca Dominici, Michael Greenstone & Cass Sunstein, *Particulate Matter Matters*, 344 SCI. & REG. 257, 257–59 (asserting that transparticulate matter in the air is linked to human health); Avraham Ebenstein, Maoyong Fang, Michael Greenstone, Guojun He & Maigeng Zhou, *New Evidence on the Impact of Sustained Exposure to Air Pollution on Life Expectancy from China's Huai River Policy*, 114 PROC. NAT'L ACAD. SCI. 10,384 (2017) ("[A] 10-Mg3/m3 increase in airborne particulate matter [particulate matter smaller than 10Mm (PM10)] reduces life ex-

the entire on-road U.S. passenger car fleet was just 15.1 MPG in 1977, the year before the first NHTSA standards came into effect. In 2016, it stood at 24.7 MPG.[43] Over the same period, the efficiency of the light-truck fleet increased from 13.3 MPG to 21.2 MPG.[44] Market pressures and technological changes undoubtedly contributed to these improvements, but there is little dispute that efficiency is far higher and GHG emissions far lower today than they would be in the absence of a policy designed to address the social costs of fossil fuel consumption in transportation.

At the same time, the current approach to vehicle regulation—attribute-based efficiency standards with separate schedules for cars and light trucks—is highly economically inefficient and therefore unnecessarily costly, and it is unlikely to be adequate as a means to achieve the substantial reductions in transportation-related GHG emissions needed to reduce the odds of disruptive climate change. This is true regardless of whether the regulations are ultimately frozen at 2020 levels or reverted to the original 2025 targets. As we will demonstrate, the current approach is unlikely to achieve reductions in fuel consumption and emissions that are consistent with the goals of the policymakers[45] who originally designed the standards, either through EISA or the CAA. It will also produce far lower net benefits than it could with a suitable redesign.

Problems and concerns. The following discussion is intended to highlight a number of key features of the current approach that create 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 acute sensitivity to the costs of national regulation, (3) is worth underscoring.

1. *The National Program Regulates Fuel Economy, Not Consumption or Emissions*

The regulated metric under the National Program is fuel economy (that is, efficiency). The origin for this approach dates back to EPCA, which defined

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pectancy by 0.64 years (95% confidence interval=0.21–1.07)."); Michael Greenstone, Elizabeth Kopits & Ann Wolverton, *Developing a Social Cost of Carbon for US Regulatory Analysis: A Methodology and Interpretation*, 7 Rev. Envtl. Econ. Pol'y 23, 23 (2013) [hereinafter Greenstone et al., *Social Cost of Carbon*]; (reporting that an interagency council's estimate that, by 2020, the social cost of carbon would be $26 per ton of CO_2).

43. *See* Stacy Davis & Robert Boundy, Transportation Energy Data Book 4–14 (37th ed. 2018).

44. *Id.*

45. *See* John M. Broder, *Bush Signs Broad Energy Bill*, N.Y. Times (Dec. 19, 2007), https://perma.cc/3DS6-P5L4; *see also* Massachusetts v. EPA, 549 U.S. 497, 533 (2007).

fuel economy in MPG terms, defined as "the average number of miles traveled by an automobile per gallon of gasoline consumed."[46] Since EISA extended NHTSA authority and program structure through 2030, any effort to harmonize the NHTSA and EPA programs was effectively required to be a continuation of this approach.[47]

As a means for regulating gross fuel consumption and emissions, the MPG approach has serious limitations. By focusing strictly on fuel economy, the National Program ignores how vehicles are used once they are driven off the lot. If all vehicle models were driven identical lifetime miles, the fuel economy approach would be acceptable. However, as an important recent paper that uses two novel datasets demonstrates, lifetime miles traveled vary significantly across equally efficient vehicle models.[48] Among similarly efficient vehicle models, those vehicle models that are driven substantially more miles over their lifetime exact a much larger cost on society through fuel consumption and pollution emissions.

The results of the authors' analysis are presented in Figures 2a and 2b.[49] 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.

Fig. 2a. Variation in Lifetime Fuel Consumption by Efficiency - Cars

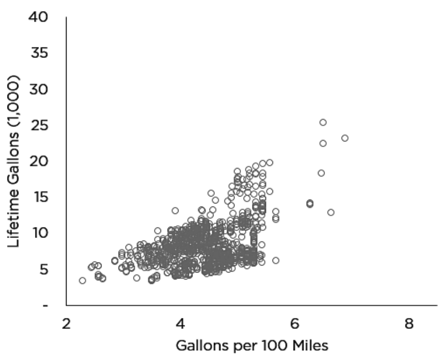
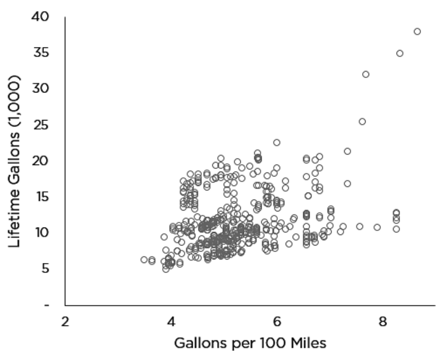


Fig. 2b. Variation in Lifetime Fuel Consumption by Efficiency - Trucks



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46. EPCA, Pub. L. No. 94-163, 89 Stat. 871, § 501(6) (1975).

47. *See* EISA, Pub. L. No. 110-140, 112 Stat. 1492, §102(b) (2007).

48. *See* Mark R. Jacobsen et al., *Sufficient Statistics for Imperfect Externality-Correcting Policies* 16 Nat'l Bureau of Econ. Research Working Paper No. 22,063 (2016). 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 1988–1992 vehicles that were retired in 2013. *See id.* at 16–17.

49. *Id.* at 17.

These figures show that lifetime fuel consumption in fact varies widely across vehicle models with identical fuel economy. This is visible by choosing a value of gallons per 100 miles (i.e., efficiency) on the x-axis and reading the figure vertically at that point; it is apparent that there is substantial variation in total lifetime gallons (and mechanically lifetime VMT) at each value of fuel economy. This is true in the case of both cars and light trucks. As one would expect, the magnitude of this variance is greater 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 who purchase vehicle models with vastly different expected lifetime social impacts are paying approximately the same implicit tax, with some overpaying and others underpaying for their shares of damages. More importantly, this dynamic results in a huge missed opportunity from a social and public policy perspective. The authors conclude that, as compared to an approach that focuses on both efficiency and lifetime miles driven, fuel economy standards like the National Program that focus solely on efficiency are able to recover only between one-fourth and one-third of the potential benefits.[50]

2. *The National Program Has Structural Loopholes*

The National Program contains three structural loopholes that undermine its effectiveness at achieving fuel and emissions reductions: (a) it includes various credits and bonuses that reduce compliance costs but do not reduce fuel consumption; (b) it gives cars and light trucks differential treatment, with trucks benefiting from less stringent regulation; and (c) it regulates vehicles based on their footprint, which encourages automakers to produce and sell larger vehicles. We briefly review each of these loopholes.

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 ("FFV").[51] Under the NHTSA program, the maximum allowable credit from 1992 to 2014 was 1.2 MPG, regardless of whether FFVs actually used alternative fuel.[52] Between

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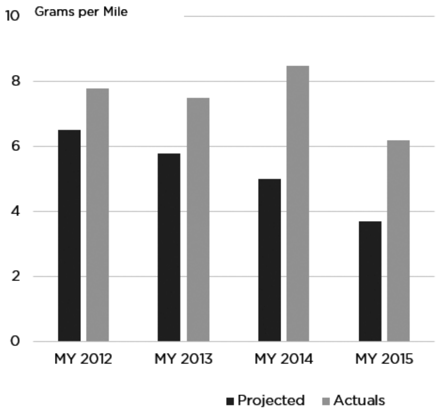
50. *See id.* at 4, 19.
51. Alternative Motor Fuels Act of 1988, Pub. L. No. 100-494, 102 Stat. 2441, § 513(b).
52. 42 U.S.C. § 32906 (2018); *see also* Gregory Powell, Nat'l Highway Traffic Safety Admin., Presentation: Alternative Fuels in CAFE Rulemaking (2015), https://perma.cc/ZZ57-7QPR.

2015 and 2019, the credit gradually phased down by 0.2 MPG each MY, after which it is zero.[53] Until 2015, in order to maintain a degree of harmony across regulations, EPA allowed the same credit levels. After 2015, the value effectively became zero because the compliance value of FFVs started being determined by the fuel they actually use.[54]

It is worth pointing out the complexity created by this difference in approaches. 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.[55] But in practice the credits afforded automakers an extremely low-cost compliance loophole with little practical benefit. FFVs, which can be manufactured for an additional cost of as little as $100 compared to a conventional vehicle, rarely operate on high blends of ethanol and offer no improvement in real-world efficiency.[56] According to DOE, FFVs accounted for 7% of the U.S. light-duty vehicle fleet as of 2016, yet high blends of ethanol accounted for just 0.4% of fuel consumed by vehicles and other equipment with gasoline-burning engines.[57]

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



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 regulations, the actual use of FFV credits by automakers exceeded the

53. *See* EISA, Pub. L. No. 110–140, 121 Stat. 1492, § 109(a) (2007).
54. See 2010 CAFE Rule, *supra* note 3, 75 Fed. Reg. at 25,340.
55. Dep't of Transp., Dep't of Energy & EPA, Report to Congress: Effects of the Alternatives Motor Fuels CAFE Incentives Policy 1 (2002).
56. *See* National Research Council, Cost, Effectiveness, and Deployment of Fuel Economy Technologies for Light-Duty Vehicles 2–53 (2015).
57. *See Almost All U.S. Gasoline Is Blended with 10% Ethanol*, Energy Info. Admin. (May 4, 2016), https://perma.cc/GK8L-FRQQ.

agency's projections by an annual average of nearly 50%, with the largest variance coming in later years, when the standards were more stringent.[58] 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.[59] Data from NHTSA show that domestic automakers in particular claimed the maximum available credit across both their car and light-truck fleets for much of the period from 2004 to 2016, the latest year for which such data is publicly available as of this writing.[60]

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 those 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, which identified two types of regulated automobiles: those rated at a gross vehicle weight of less than 6000 pounds, and those rated at a gross vehicle weight of more than 6000 pounds but less than 10,000 pounds.[61] 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 ten passengers.[62] Sport utility vehicles ("SUVs"), pickup trucks, minivans, vehicles with four-wheel drive, and several other light trucks were ultimately exempted from statutory standards, with EPCA giving 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.[63] EISA, enacted in 2007, subsequently preserved dual treatment in NHTSA's program.[64]

The precise reason for the dual treatment remains unclear; it might be a product of interest-group maneuvering, or it might be a product of a reasonable judgment that the costs and benefits of fuel economy rules would differ across

58. *See* EPA, Greenhouse Gas Emission Standards for Light-Duty Vehicles: Manufacturers' Performance Report for the 2016 Model Year 81 (2018), https://perma.cc/3UF9-88RN [hereinafter EPA MY 2016 Performance Report].

59. *Id.* at 81.

60. *See Cafe; Public Information Center,* NHTSA (2019), https://perma.cc/V2JQ-LRUN. The maximum FFV credit was 1.2 MPG in 2004–2014, 1.0 MPG in 2015, and 0.8 MPG in 2016. *Id.*

61. *See* EPCA, Pub. L. No. 94-163, 89 Stat. 871, §§ 501(2)–(3) (1975).

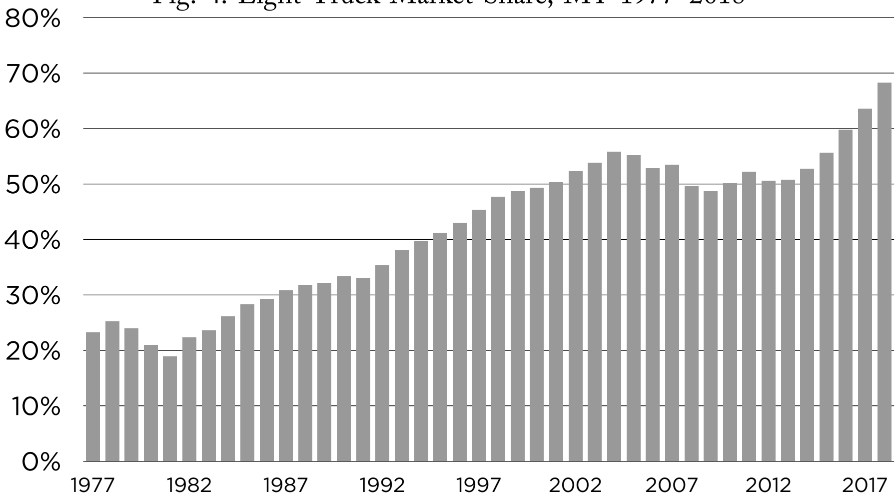
62. *Id.*

63. Fuel Economy of Motor Vehicles, 40 C.F.R. § 600 (2019).

64. EISA, Pub. L. No. 110-140, 112 Stat. 1492, § 102(b)(1) (2007).

the two categories. Whatever the reason, the system of dual treatment has contributed to a 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. Figure 4 illustrates the effects on the market share of light trucks in U.S. auto sales. In MY 1977, the year before the standards went into effect, these vehicles accounted for just 23% of U.S. auto sales. The share increased relentlessly from 1977 to 2004, when it reached 56%. And although there was a decline from 2004 to 2013 due to high oil prices, the market share of light trucks is once again on the rise, reaching a record 68% in MY 2018.[65]

Fig. 4. Light Truck Market Share, MY 1977–2018



Source: BEA 2019.[66]

It is important to note that the figures and sales numbers here use a commercial, not regulatory, definition of light truck. As part of the 2010 rulemaking, the agencies re-categorized certain light-truck models as cars for the purposes of regulation. As we discuss below, regardless of the definition used for light truck, shares of those vehicles have substantially exceeded the agencies' projections, thereby undermining fuel savings.

The broader point is that by regulating light trucks less stringently, the dual treatment worked to undermine its goals by contributing to the shift from cars to light trucks, which are on average less fuel efficient. Apart from its effect on fuel consumption and emissions, some research suggests that this shift

65. *See* Bureau of Econ. Analysis, Monthly Auto Sales Update, tbl.6 (2019).
66. *See id.*

might have also increased traffic fatalities, because a higher share of light trucks is associated with higher rates of traffic fatalities.[67]

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.[68] This approach to regulation was introduced by EISA. Motor vehicles in each footprint bin are required to achieve increasing levels of fuel economy annually over the course of the National Program, with smaller vehicles facing steeper increases and larger vehicles facing more modest requirements. As discussed above, passenger cars and light trucks are governed by different stringency requirements. An automaker's annual compliance and performance values are pegged to 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 for MYs 2011 through 2016, and 2025.[69]

Fig. 5a. National Program: Passenger Car CAFE Target, 2012–2016, 2025

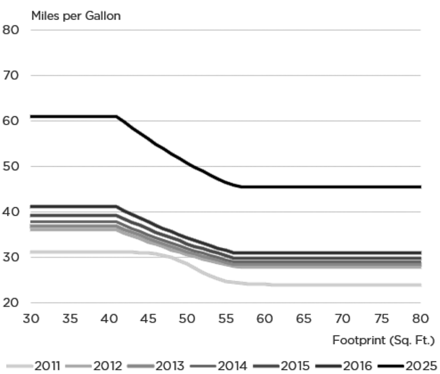
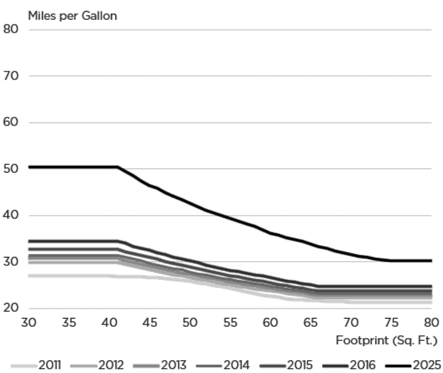


Fig. 5b. National Program: Light Truck CAFE Target, 2012–2016, 2025



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 fuel economy standard.[70] That literature demonstrates that whether indexing

67. *See* Ted Gayer, *The Fatality Risks of Sport-Utility Vehicles, Vans, and Pickups Relative to Cars*, 28 J. Risk & Uncertainty 103, 124–26 (2004).

68. *See* Vehicle Classification Rule, 49 C.F.R. § 523.2 (2019).

69. *See* SAFE Vehicles Rule, *supra* note 2, 77 Fed. Reg. at 62,624.

70. *See* Kate Whitefoot & Steven Skerlos, *Design Incentives to Increase Vehicle Size Created from the U.S. Footprint-Based Fuel Economy Standards*, 41 Energy Pol'y 402, 402–11 (2011); *see*

standards to footprints is 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 consumer preferences with respect to size remain constant over time.

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.[71] Subject to certain constraints, manufacturers who exceed their individual compliance level for a given MY can earn credits that can be traded, banked for future use, or applied to a prior year. 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.[72]

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 significantly 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 MPG compliance. But in other cases, the differences are more substantial, and likely undermine some of the possible benefits of trading. For example, NHTSA has a

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also Koichiro Ito & James M. Sallee, *The Economics of Attribute-Based Regulation: Theory and Evidence from Fuel-Economy Standard*, (Nat'l Bureau of Econ. Res. Working Paper No. 20,500, 2014).

71. *See* 2012 CAFE Rule, *supra* note 3, 77 Fed. Reg. at 62,628; 2010 CAFE Rule, supra note 3, 75 Fed. Reg. at 25,338.

72. For an exhaustive discussion of the two systems, their history, characteristics, and differences, see Benjamin Leard & Virginia McConnell, *New Markets for Credit Trading Under U.S. Automobile Greenhouse Gas and Fuel Economy Standards*, 11 REV. OF ENVTL. ECON. & POL'Y 207, 210–11 (2017).

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 have argued that this increases transaction costs, and could be one factor limiting trading between firms to date.[73] Figure 6 shows that although trade volume in the EPA system has steadily risen in recent years, it stood at just 6% of cumulative earned credits in 2017.

Fig. 6. Cumulative Traded versus Non-Traded Earned EPA Credits, 2009–2017

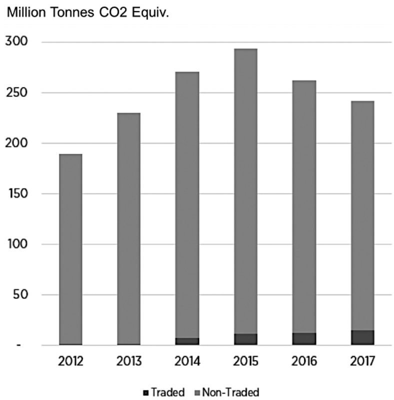
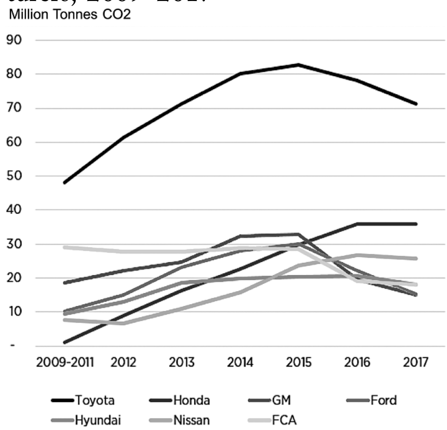


Fig. 7. Cumulative Net EPA Fuel Economy Credits, Selected Manufacturers, 2009–2017



Source: EPA.[74]

Alternatively, the low trade volume in the current system may be a function of the market power of a handful of firms. For example, as shown in Figure 7, Toyota held 30%—and the top three credits holders held 51%—of all EPA GHG credits at the end of MY 2017.[75] These firms could withhold 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

73. *See id.* at 221–22.

74. For 2009 through 2016 data, see EPA MY 2016 Performance Report, *supra* note 58, at 73. For 2017 data, see EPA, EPA Automotive Trends Report: Greenhouse Gas Emissions, Fuel Economy, and Technology since 1975, at 117 (2019) [hereinafter 2018 EPA Automotive Trends Report].

75. *See* 2018 EPA Automotive Trends Report, *supra* note 74.

case—under an early banking program that allowed automakers to generate credits under arguably "business-as-usual" conditions beginning in 2009.

The loopholes identified above do not undermine the rationale for a robust trading component of the fuel economy regulations, but they do suggest that a handful of key improvements could produce sizeable benefits by reducing emissions and costs, and increasing cost-effectiveness.

B. Lack of Guaranteed Improvements

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 is skewing larger and less efficient than is optimal or expected by the regulations. A final point that, though self-evident, has not received much attention is that the variable nature of total sales volumes also makes it effectively impossible to achieve a guaranteed level of fuel and GHG savings through fuel economy standards.

To test these arguments, we review data from the first six-year period of the National Program, with a particular focus on final data through MY 2017, the last year for which regulatory data is available from the agencies as of the date of this writing. The data confirm that the fleet is significantly different from what was recently projected in terms of cars versus trucks and the total number of vehicles. The result is that the National Program is failing to achieve its goals for reductions in fuel use and GHG emissions. We discuss these findings briefly here.

1. 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 averaged roughly $100 per barrel,[76] and the U.S. auto market was shifting toward lighter vehicles. 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.

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76. *See Petroleum and Other Liquids – U.S. Crude Oil First Purchase Price,* ENERGY INFO. ADMIN., 2012 CAFE Rule, *supra* note 3, 77 Fed. Reg. at 62,962; https://perma.cc/GY7X-C3Z5.

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.[77] 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 showed that light-truck market share fell from 38.9% in 2012 to 34.5% in 2016 before rebounding slightly to 36.8% in 2017.[78] In reality, the truck share rose substantially to 44.7% of the market in 2016 and to 47.5% in 2017.[79]

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 48.0 square feet in 2017 as projected, fleet-wide average footprint increased over the course of the past several years, reaching 49.8 square feet in 2017.[80] It is worth noting that a 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 standards.

Finally, we note that, given the complex set of unpredictable factors that determine demand for motor vehicles in any given year, it is effectively impossible for a policy like fuel economy standards to deliver guaranteed emissions savings or fuel reductions. For example, for MY 2017, EPA reported that total sales exceeded the agencies' predictions by approximately 1.2 million vehicles. At any given level of fleet efficiency, therefore, total emissions will also be

77. *See* EPA & NHTSA, EPA-420-R-12-901, Joint Technical Support Document: Final Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, at 2-13 to 2-31 (2012), https://perma.cc/B339-LHQL [hereinafter 2012 CAFE Rule Joint Technical Support Document].

78. Note that here we are using the agencies' revised definition of cars and light trucks and corresponding sales shares provided in the 2012 CAFE Rule Joint Technical Support Document, *supra* note 77, at 1, as the projected values. We then compare production-weighted values obtained from EPA's most recent automotive trends report. *See* EPA & NHTSA, EPA-420-R-10-901, Final Rulemaking to Establish Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards: Joint Technical Support Document at 1-14 (2010); https://perma.cc/TQJ9-Q39P [hereinafter 2010 CAFE Rule Joint Technical Support Document] (noting 2012 data); *id.* (noting 2016 data); 2012 CAFE Rule Joint Technical Support Document, *supra* note 77 at 1-26 (noting 2017 data). 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 fuel consumption by model year. 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.

79. *See* 2018 EPA Automotive Trends Report, *supra* note 74, at 32; *see also* 2012 CAFE Rule Joint Technical Support Document, *supra* note 77, at 1-30.

80. *See* 2018 EPA Automotive Trends Report, *supra* note 74.

higher than originally projected. Of course, a contraction in sales would have the opposite effect and lead to greater emissions savings or fuel reduction than desired.

To be sure, one might argue that the additional vehicles sold were more efficient than they would have been in the absence of the National Program. But this misses a key point: the critical input to climate change is not the rate of emissions per mile traveled; it is total emissions that matter. The same problems undermine efforts to achieve petroleum goals, because here too the relevant statistic is total petroleum consumption, not petroleum consumption per mile traveled. Whether it is due to unexpected changes in sales, sales mix, or footprint size, the current policy is not structured to deliver certain reductions in petroleum consumption or GHG emissions.

2. *Performance and Fuel Reductions*

Because the National Program is footprint-based, and because it maintains dual treatment of cars and light trucks, shifting fleet characteristics have a direct impact on the efficiency of the overall fleet. Specifically, as the share of trucks rises, deviating from the agencies' original expectations, fleet efficiency declines and a portion of fuel savings are lost. To demonstrate this, we compare projected data from the agencies' original rulemakings to real-world performance data released in two separate EPA reports: the annual Fuel Economy Trends report and the annual Manufacturers' Compliance Report. In 2019, these reports were combined into a single report, EPA's Automotive Trends Report. All data are converted to MPG for ease of comparison.[81]

First, we compare the annual targets set by EPA—that is, the level of standard set each year based on manufacturers' sales-mix estimates. Figure 8a compares the original, projected target for the fleet with the actual, sales-based targets eventually set under the EPA program.[82] As can be seen, the gap between the projected and actual target was small in the early years of the program, but it has widened over time, with the sales-based targets trailing projections by a considerable 2.1 MPG equivalent in MY 2017. Critically, this variance is not the result of technological barriers. Rather, as EPA noted in its MY 2016 report, it was due to the fact that "the industry-wide truck fraction of the fleet is higher than projected in the rulemaking analyses."[83]

Further, not only is the National Program vulnerable to market realities, real-world performance values—and therefore fuel and emissions savings—have also diverged from projections. Figure 8b compares projected performance

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81. In order to convert from grams per mile to MPG, we use the agencies' stated conversion factor of 8887 grams of CO_2 per gallon of gasoline. *See, e.g.*, 2012 CAFE Rule, *supra* note 3, 77 Fed. Reg. at 62,632 n.20.

82. *See* EPA MY 2016 PERFORMANCE REPORT, *supra* note 58, at 81.

83. *See id.* at 80.

values with actual values through 2017.[84] While real-world performance values actually exceeded projections in the early years of the EPA program, this began to shift in 2015, when actual performance fell 0.5 MPG short of originally projected levels. By 2017, fleet performance was a full 2.8 MPG-equivalent short of projections, a difference driven almost entirely by underperformance in average tailpipe efficiency (that is, the shortfall was not principally driven by credits).

In its original analyses, EPA had projected that the National Program would reduce downstream CO_2 emissions by 960 million metric tonnes over the lifetime of vehicles sold in MYs 2012 to 2016.[85]

Fig. 8a. Projected Versus Actual Target Level, MY 2012–2017

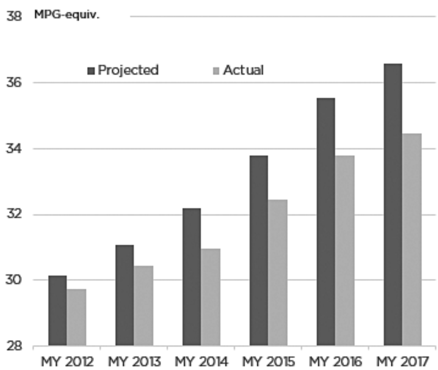
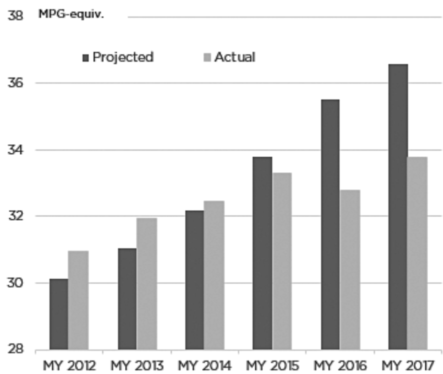


Fig. 8b. Projected Versus Actual Compliance Level, MY 2012–2017



In order to assess the impact of the shifting fleet mix on GHG benefits, we compare the actual fleet performance levels discussed above with the reference and policy scenarios contained in the original regulatory impact analysis, accounting for the on-road efficiency gap and rebound effect. Holding total vehicle sales constant at the agencies' original projected volumes, we ask a narrow question: how much of the originally projected savings have been eroded by the shortfall in achieved efficiency. We estimate that cumulative CO_2 savings between MYs 2012 and 2017 fell short of EPA projections by nearly 150 million metric tonnes, and that the foregone savings were equal to roughly 30% of expected savings in 2016 and 2017 each.

84. *See id.* at 81.

85. *See* EPA, EPA-420-R-10-009 Final Rulemaking to Establish Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards: Regulatory Impact Analysis, at ES-1 (2010), https://perma.cc/P67W-DK4M.

C. 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_2 abated. One recent paper finds that the total societal cost of using fuel efficiency standards to reduce gasoline consumption is about 2.5 times larger than the cost of using a gasoline tax to reduce gasoline consumption by an equal amount.[86] This finding is not surprising, given the rigidities in the current system outlined in this Part.

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_2 emissions at a much lower cost than the current policy or to obtain much larger reductions in fuel consumption and CO_2 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. We emphasize that the principle holds regardless of the desired level of stringency. The principle favoring fuel consumption, rather than fuel economy, would continue to hold regardless of whether fuel economy standards are frozen as of 2020 (as proposed) or 2021 or 2022, or revised to more ambitious levels than they were as of 2017 (and unless and until the currently final regulations are actually revised).

II. 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 the agencies have existing legal authority to adopt a policy that can produce more bang for the buck. We conclude that, on policy grounds, such a reform is desirable and feasible, and that, as a matter of law, there are no serious obstacles.

The core of this proposal is a national cap on lifetime fuel consumption and CO_2 emissions from each year's new vehicle sales. This cap can be adjusted up or down for each MY, 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 us-

86. *See* Mark Jacobsen, *Evaluating U.S. Fuel Economy Standards in a Model with Producer and Household Heterogeneity*, 5 Am. Econ. J.: Econ. Pol'y 148 (2013).

ing its fuel economy to determine expected lifetime gallons of gasoline consumed and total GHG emissions.

A. Why Cap-and-Trade?

The principal argument for a cap-and-trade system is that if it is properly designed, it can produce emissions reductions at the lowest possible cost. For a given level of pollution reduction, it can ensure lower costs, and because it lowers costs, it makes higher levels of pollution reduction both more feasible and more desirable.

But the idea of cap-and-trade is not, of course, met with universal enthusiasm. A familiar objection is that cap-and-trade is inferior to no regulation at all. That objection is plausible if the environmental problem is modest or nonexistent, or if the costs of addressing it, even through a cap-and-trade system, exceed the benefits. A more technical objection is that an environmental tax or fee is preferable to a cap-and-trade system. On plausible assumptions, the claim is right, in part because a tax or fee might impose lower administrative burdens or because the price certainty that a tax offers is more socially desirable than the emissions certainty that a cap-and-trade delivers.[87] A different kind of objection is moral in character; it is that a cap-and-trade system does not impose the proper moral opprobrium on pollution.[88] In our view, that objection is unconvincing, because the proper level of pollution is not zero; the moral concern analogizes pollution to activities that should be abolished, such as murder and assault.[89]

For any cap-and-trade program, there are several key details. Specification of the cap is of course critical: policymakers place an industry-wide limit on consumption or production of an externality, such as the volume of pollution emitted by covered entities. To be sure, the choice of the cap can be informationally demanding.[90] Permits are issued in an amount that equals the cap through some combination of free distribution and auctions. Each entity must hold a permit for each unit of pollution they emit. 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

87. *See* William Nordhaus, The Climate Casino 239–41 (2013).

88. Michael J. Sandel, Opinion *It's Immoral to Buy the Right to Pollute*, N.Y. Times (Dec. 15, 1997), https://perma.cc/UT4F-4T3E.

89. Cass R. Sunstein, *Moral Heuristics*, 28 Behav. & Brain Sci. 531, 537 (2005).

90. Jonathan B. Wiener, *Global Environmental Regulation: Instrument Choice in Legal Context*, 108 Yale L.J. 677, 732 (1999). We bracket here the question of the right cap, consistent with our effort to suggest a reform that will improve on the status quo, whatever the preferred level of stringency.

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 across firms, and that one-size-fits-all, command-and-control policies result in much higher costs than necessary.[91]

Cap-and-trade is a decentralized, market-based approach to solving this cost-minimization problem, while ensuring a given level of fuel consumption and GHG emissions. It limits government involvement and discretion and also gives an economic benefit to those firms that have the lowest cost of reducing emissions (and thus incentivizes environmental innovation).[92] In such a system, the government issues tradable emissions allowances 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 where the government imposes emissions limits on two manufacturers, Firm A and Firm B, but does not allow for trading through a cap-and-trade system. Suppose that both Firm A and B are currently one unit above their government set limit. Firm A can reduce its emissions at a cost of $10, and Firm B can reduce its emissions at a cost of $30. Since each firm must cut its emissions by one unit, the total costs of abatement are $40. This is represented graphically by the solid blue bars in Figure 9.

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91. *See* Richard Schmalensee & Robert N. Stavins, *Lessons Learned from Three Decades of Experience with Cap-and-Trade* (Resources for the Future ed., Discussion Paper No. 15-51, 2015).

92. Bruce A. Ackerman & Richard B. Stewart, *Reforming Environmental Law*, 37 STAN. L. REV. 1333, 1341–42 (1985).

Figure 9. Example of Gains from Trade

Now to illustrate the benefits of trading, suppose that the government keeps each firm's emissions limit as it was before, but allows them to meet their respective limits by reducing their emissions or purchasing reductions (that is, credits) from the other firm. Firms can therefore earn money by emitting less than their statutory limit. 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 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, firms spent $20 on abatement, which is only half of the total abatement costs without trading, while meeting the required reduction in emissions.

The power of the cap-and-trade system is evident 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.

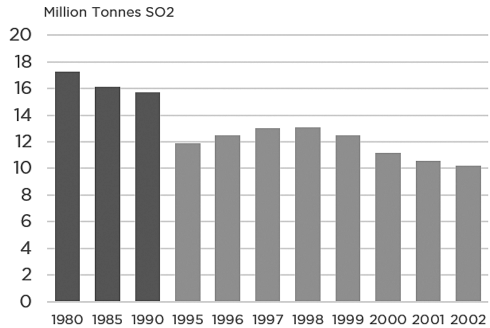
B. Three Principles

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.[93] The European Union ("EU") has operated the Emis-

93. *See* World Bank Group, State and Trends of Carbon Pricing 2019, (2019), https://perma.cc/8UZX-UH28.

sions Trading System since 2005.[94] Since 2009, nine northeastern U.S. states have participated in the Regional Greenhouse Gas Initiative ("RGGI"), a CO_2 emissions trading program.[95] California has operated the California Carbon Market since 2012.[96]

Fig. 10. Total Emissions in the U.S. Acid Rain Program, 1980–2002



The first nationwide cap-and-trade program in the United States was the Acid Rain Program, which targeted sulfur dioxide ("SO_2") emissions from power plants.[97] Administered by EPA beginning in the mid-1990s, the program is widely credited with achieving sharp reductions in emissions. By 2002, SO_2 emissions from U.S. power plants were 41% lower than 1980 levels, and by around 2003 wet sulfate deposition, the major component of acid rain, was 24 to 36% lower than 1990 levels in most areas of the U.S. Mid-Atlantic and Northeast.[98] 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 a ratio of forty to one.[99]

Throughout all this, EPA's role was limited to monitoring emissions and tracking ownership of allowances by recording initial allocations and trades.

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94. *See EU Emissions Trading System*, EUROPEAN COMM'N (Oct. 9, 2019), https://perma.cc/GXH8-DCE4.

95. *See* THE REGIONAL GREENHOUSE GAS INITIATIVE, https://perma.cc/ACN9-KSDT.

96. *Overview of ARB Emissions Trading Program*, CAL. ENVTL. PROT. AGENCY AIR RES. BD. (Feb. 9, 2015), https://perma.cc/4S9C-LJQA.

97. 42 U.S.C. § 7651 (2018) (establishing the Acid Rain Program); 40 C.F.R. §§ 72–78 (2019) (regulations enforcing and implementing the Acid Rain Program); Clean Air Markets: Acid Rain Program, EPA (Apr. 3, 2018), https://perma.cc/4RSZ-HRT9.

98. *See* EPA, ACID RAIN PROGRAM 2003 PROGRESS REPORT 4 (2004), https://perma.cc/B92D-FFAL [hereinafter 2003 ACID RAIN PROGRESS REPORT]; EPA, ACID RAIN PROGRAM 2004 PROGRESS REPORT: 10 YEARS OF PROGRESS 5 fig.2 (2005), https://perma.cc/5C5G-ZCKG [hereinafter 2004 ACID RAIN PROGRESS REPORT].

99. 2003 ACID RAIN PROGRESS REPORT, *supra* note 98, at 17.

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_2 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% compared to counterfactual policies that did not allow trading.[100]

Other programs have the reputation of not having 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 low prices for CO_2 credits.[101] The same has been said of RGGI. We believe these criticisms are not merited in that the programs delivered the ex-ante desired emissions levels and incentivized firms to find least cost ways to abate emissions. Furthermore, these example do not point to any inherent defect in cap-and-trade markets: if regulations have an additional goal of maintaining the price for permits at a certain level, it is possible to achieve that by setting a price floor within the cap-and-trade system. The decisions on the cap, price floors, and price ceilings reflect political judgments about relative desirability of emissions certainty versus price certainty, and cap-and-trade markets can accommodate any combination of these goals.

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_2 emissions in U.S. transportation.

1. The Cap Should Be Set to Reflect Social Damages of Emissions

The stringency of a cap-and-trade program is determined by the cap. Caps that are too low could force firms to engage in costly abatement, inflating the price of credits beyond the environmental benefit they deliver. The economically efficient price of a petroleum or CO_2 credit is equal to the social damage of one unit of fuel or CO_2. If the actual price of the credit does not equal the efficient price, firms might be paying more or less than their contribution to the negative externalities caused by pollution. Caps should reflect both the cost of reducing pollution for firms and the cost of pollution to society.

Under RGGI, which instituted a cap-and-trade program on electricity generators in 2009, regulators opted to impose fixed caps that would not be reconsidered in light of economic changes. As a result, after the fall of natural

100. *See* DENNY ELLERMAN ET AL., MARKETS FOR CLEAN AIR: THE U.S. ACID RAIN PROGRAM (2000); Curtis Carlson et al., *Sulfur Dioxide Control by Electric Utilities: What Are the Gains from Trade?*, 108 J. POL. ECON. 1292, 1313 (2000); Robert N Stavins, *Lessons Learned from SO_2 Allowance Trading*, 20 CHOICES 53, 53 (2005); Nathaniel O. Keohane, *What Did the Market Buy? Cost Savings Under the U.S. Tradeable Permits Program for Sulfur Dioxide* 2 (Yale Ctr. for Envtl. L. & Pol'y Working Paper No. 01-11-2003, 2003).

101. *See* Schmalensee & Stavins, *supra* note 91, at 15.

gas prices in 2009, which made it cheaper for natural gas-fired electricity plants to reduce electricity output and emissions, firms found it less costly to meet cap requirements. Because the caps were easier to meet, the price of credits plummeted to $1.86 per ton of CO_2 in 2010. As a benchmark, the Obama Administration's estimate of the social cost of CO_2 was approximately $38.39 per ton of CO_2 in current dollars. Due to the marked disparity between how much firms were paying to pollute and how damaging the pollution was for society,[102] there was a strong efficiency case for a more stringent cap. Some cap-and-trade markets have tried to address this issue by including a price ceiling and price floor that guarantee that the cost of a permit stays within a specified range. Note, however, that this guarantee creates uncertainty about total CO_2 emissions.

2. *Liquid, Transparent Trading is Critical*

The objective of the cap-and-trade system is to allow firms to transfer their pollution abatement obligation to the firm that can fulfill that obligation at the lowest cost. To achieve this objective, there must be liquidity and stability in trading markets to facilitate transactions between firms. This requires, among other things, 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.[103] Furthermore, it is important for there to be safeguards against the exercise of market power among participants through, for example, limits on individual firm's holdings or alternative rules.

3. *The System Will Deliver Least-Cost Pollution Reduction Only If It Is Simple and Unhampered 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"), enacted in 2006, instituted: energy efficiency 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.

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102. *See* INTERAGENCY WORKING GROUP 2016 TECHNICAL SUPPORT DOCUMENT, *supra* note 8. On how this number was calculated, see Greenstone et al., *Social Cost of Carbon*, *supra* note 42.

103. *See generally* Ignacia Mercadal, *Dynamic Competition and Arbitrage in Electricity Markets: The Role of Financial Players* (Colum. Univ. Working Paper, 2019).

This addition 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.

C. A Cap-and-Trade Program for Transportation

The principles outlined above inform our proposed 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 allow for liquid, transparent trading, thus 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 even at its best is capable of capturing only one-quarter to one-third of potential welfare gains, since it regulates efficiency only.[104]

In our analysis, we have assumed that the current National Program would remain in place through 2025 as designed by EPA and NHTSA. We make that assumption solely for expository and heuristic purposes. We acknowledge that it might make sense to revisit that idea; we bracket it for current purposes. The central ingredients of our proposal could be adopted with different decisions about what to do with the current program.

EISA mandates that NHTSA promulgate fuel economy standards in increments of at least one year and not more than five years through 2030.[105] However, from 2020 to 2030, significant flexibility is given to the Secretary of Transportation, who is required only to promulgate standards that are the maximum feasible, subject to a handful of constraints, such as economic and technical feasibility.[106]

Our proposal would see EPA implement a cap-and-trade program beginning in 2026 that would 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.

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104. *See* Jacobsen et al., *supra* note 20.

105. *See* EISA § 102(b)(2), 49 U.S.C. § 32902(b)(2) (2018).

106. *See id.*

In the remainder of this Section, we discuss the key features of our proposed cap-and-trade program for light-duty vehicles. This program would be administered by EPA beginning in 2026.

1. *Setting the Cap*

The core of this proposal is an industry-wide cap on expected lifetime fuel consumption of (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 and EISA authority and EPA's CAA authority. EPA's 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. 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 is critical that EPA set a cap that reflects the social cost of CO_2 emissions, the estimation of 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. Our approach would regulate 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 MPG 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 such as R.L. Polk (IHS Markit). The lifetime VMT of a new model would be determined by the "nearest" existing model. Furthermore, it would be possible to build a more complex and more accurate model that, in principle, could account for oil prices, which certainly affect VMT.

An obvious challenge is that vehicles being retired in any given year were manufactured roughly twenty years earlier. Expected longevity could theoretically change for any number of reasons. To address this challenge, 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 for recalibration of the curves.

In practice, the automakers could also provide expected lifetime VMT data, and regulators might be expected to rely on their projections. Although it is reasonable to fear that the automakers would have an incentive to understate expected lifetime VMT to lower compliance costs, there are some indications that the fear might be overstated. First, there is a potentially serious brand and sales cost to automakers perceived as selling vehicles that "do not last." Second, EPA could potentially detect and reduce irregularities in automakers' projections by comparing the data provided by automakers to historical data and limiting the variance 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. First, credits could be auctioned at the beginning of each period. The auction approach has the advantage of raising revenue, which would initially benefit, in this case, the federal government and ultimately benefit taxpayers. Alternatively, credits can simply be given away to each regulated entity based on some formula, which might be based on historical activity in the regulated market before the cap-and-trade program was instituted. A third option is to adopt some combination of the first two options.

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. With this point in mind, 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, but this is a judgment of both policy and politics, for which multiple considerations may be relevant.

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 zero grams per mile in EPA's program, with no limit on the number of vehicles sold from MYs 2017 to 2021.[107] From MYs

107. *See* 2012 CAFE Rule, *supra* note 3, 77 Fed. Reg. at 62,651.

2022 to 2025, there is a limit on the number of vehicles that can be sold at the zero grams per mile level, after which EPA has indicated it plans to use a formula for accounting for the upstream emissions for these vehicles (such as the GHG emissions during electricity production).[108] 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.[109] 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.[110]

These incentives reflect a commitment, which will inevitably 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 at scale in transportation. 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, technological maturity, or other considerations. It is important to underscore that such a treatment is justified because it aims to improve the efficiency of these vehicles in the future (for example, through learning by doing) and not by consideration of current emissions.

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, EPA and NHTSA do not even report credit prices of trades, and trades be-

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108. *See id.*

109. EPA, Regulatory Announcement: EPA and NHTSA Set Standards to Reduce Greenhouse Gases and Improve Fuel Economy for Model Years 2017–2025 Cars and Light Trucks (2012), https://perma.cc/39H4-4DWF.

110. *See id.*

tween manufacturers are reported by EPA but not by NHTSA. Even small steps toward promoting a central trading platform or data repository of past trades could result in large efficiency gains.

Second, we argue for careful consideration of inclusion of financial traders as allowable participants in the proposed cap-and-trade program. In many existing programs, only regulated entities are allowable participants in the market. This inhibits market function whenever the number of regulated entities is not sufficiently large and diverse. 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.[111]

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 that includes vehicles in all categories.

III. Law

Does the federal government have the 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 EPA's authority rather than NHTSA's authority on the grounds 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 an excessively technical treatment of all relevant legal questions. To the extent that there is room for reasonable doubts, there is of course a strong argument for new legislation, removing that doubt. As we shall see, such doubts unquestionably exist here. But a background doctrine is helpful to EPA: in the face of statutory ambiguity, it will be entitled to deference—as the Supreme Court established in a famous case that happened to involve an innovative form of cap-and-trade.[112]

As discussed in Part I, 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,

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111. *See* Ruoyang Li, *Efficiency Impact of Convergence Bidding on the California Electricity Market*, 48 J. Reg. Econ. 245, 275–76 (2015); Mercadal, *supra* note 103.

112. *See* Chevron v. NRDC, 467 U.S. 837 (1984). We recognize that the *Chevron* doctrine is now under challenge. *See, e.g.*, Cass R. Sunstein, *Chevron as Law*, 107 Geo. L.J. 1613 (2019).

> 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.[113]

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. In the aftermath of the Supreme Court's 2007 decision that GHGs meet the statutory definition of an air pollutant[114] 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 limits on EPA's authority, the statute also leaves the agency with considerable discretion. EPA is required under Section 202 of the 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.[115] It follows that the agency can and even must depart from the greatest achievable emission reduction if, for example, that reduction is extremely costly in comparison to a lower level of stringency. At the same time, the agency evidently has discretion to decide exactly how much weight it should give to cost considerations.

EPA also has the discretion to consider other relevant factors, including safety, impacts on consumers, and energy impacts related to the use of the technology. But how much weight is it entitled to give? Because the statute does not answer that question, EPA has considerable room to maneuver in its balancing. As noted, it is clear that 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. But if the agency seeks to engage in some form of cost-benefit analysis and to maximize net benefits, subject to the constraints of feasibility, there is a reasonable argument that it is entitled to do so.[116] At the same time, as discussed in Part II, emissions standards under Title II are technology-based; a firm constraint on the Administrator's determination is that the standard be technologically feasible.

Congress gave EPA 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

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113. 42 U.S.C. § 7521(a)(1) (2018).

114. *See* Massachusetts v. EPA, 549 U.S. 497, 532 (2007).

115. *See* 42 U.S.C. § 7521(a)(3)(A)(i).

116. *See* Entergy Corp. v. Riverkeeper, Inc., 556 U.S. 208, 226 (2009). Even if strict cost-benefit analysis is forbidden, the agency is explicitly authorized to give weight to cost, which means, as noted, that it has some discretion in deciding exactly how much weight to give.

Administrator may base such classes or categories on gross vehicle weight, horsepower, type of fuel used, or other appropriate factors."[117] 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 the statutory enumeration of relevant pollutants, and other constraints on its discretion.

A. The Lawfulness 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 to create a cap-and-trade system, which, by definition, allows regulated entities to meet a regulatory mandate despite failing to meet average performance standards. Under our proposal, an auto manufacturer would be able to manufacture and sell vehicles that did not meet such 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. But is it lawful?

The initial point is that under Section 202, EPA is *not* required to adopt average performance standards. Section 202 broadly calls for EPA to establish emissions standards that "reflect the greatest degree of emission reduction" that is technologically feasible.[118] Our proposal is consistent with this standard. Nothing in the statutory text forbids EPA from issuing standards that are based on an industry-wide cap. (In addition, we note 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. More specifically, it would require the agency to treat such a system as an emission "standard." Could it lawfully make that judgment? On one view, it could not. Perhaps a "standard" is simply a limit of some kind—as in, no more than X or Y or Z, with such variations as the statute plainly allows—rather than a cap-and-trade system. This argument might be fortified by reference to the acid depositions provisions of the CAA, which plainly authorize such a system.[119] The argument has force. The best response is that the term

117. 42 U.S.C. § 7521(a)(3)(A)(ii).
118. *Id.* § 7521(a)(3)(A)(i).
119. *Id.* § 7651.

"standard" is no more unambiguous, in this context,[120] than was the word "source" in another context.[121]

It is also true that the cap would need to be derived on the basis of a judgment about the technological feasibility of implementing the relevant cap and also in light of the other factors identified in Section 202. But it would not be difficult to make such a judgment. 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.

It is important to emphasize that under the statutory 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.

B. Lifetime Vehicle Emissions as Appropriate Considerations

To create a cap-and-trade system, the EPA Administrator must issue regulations that set standards for motor vehicles. The text of the CAA places limits on how these standards can be applied, restricting the Administrator's consideration to "gross vehicle weight, horsepower, type of fuel used, or other appropriate factors."[122] In the cap-and-trade system we propose, a vehicle's expected lifetime GHG emissions would be constructed by assigning a cost to each vehicle based on three factors: lifetime VMT, MPG, and CO_2 emitted per gallon. The use of these factors may raise additional issues, but in our view, it is statutorily permissible.

Specifically, we believe that the phrase "other appropriate factors" legitimately 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, including, for example, the consumer's preferences, employment, family size, geographic location, and so forth. By contrast, vehicle weight, horsepower, and fuel used are purely 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 might be argued that it is not an "appropriate factor."

The statutory language is expansive, however, and it seems to delegate to EPA the authority to decide what factors are appropriate in determining emis-

120. In ordinary language, a cap-and-trade system can be a standard. We acknowledge that the issue is not free from doubt, but in our view, a cap-and-trade system should be able to count as such.

121. Chevron v. NRDC, 467 U.S. 837 (1984).

122. *See* 42 U.S.C. § 7521(a)(3)(A)(ii).

sions standards. In our view, 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. As noted, a reviewing court would likely give substantial deference to EPA's interpretation of such an ambiguous term within its regulatory sphere.[123]

C. 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."[124] 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.[125]

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,[126] and Section 202 of the CAA itself allows for alternative definitions of useful life for determining in-use compliance. Thus, the EPA should be able to craft a definition of useful life that avoids both statutory and policy concerns.

D. 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 regulation of stationary sources. However, it appears that the CAA does not give EPA the authority to create such a link. Section 111(d) of the CAA, which provides the statutory authority for regulation of stationary sources, expressly calls for state implemen-

123. The standard reference, with particular relevance to the claim we are making, is *Chevron*, 467 U.S. 837, which specifically upheld a kind of cap-and-trade program under an ambiguous statute; to be sure, the program was intrafirm.

124. 42 U.S.C. § 7521(a)(1).

125. *See* 2010 CAFE Rule, *supra* note 3, 75 Fed. Reg. at 25,685 (codified at 40 C.F.R. §§ 86.1805–1812).

126. *Id.*

tation of performance standards issued by EPA.[127] That program is independent of the mobile source program, which is implemented by the national government. Under the Section 111(d) program, the Obama Administration finalized the Clean Power Plan, designed to regulate GHG emissions by stationary sources.[128] The Trump Administration repealed the plan for reasons of both policy and law.[129] Whatever the ultimate fate of the program, or of coming regulations applicable to stationary sources, there is no clear path to establishing a national credit trading scheme within the statutory program for stationary sources that could link to a mobile source cap-and-trade program. The statutory program for stationary sources is clearly meant to be independent of that for mobile sources.

If a single scheme is to be created, it seems that it would have to be a result of a legislative change. Note, however, that a comparatively modest change would suffice. Congress would not need to create a new large-scale program, nor would it need to 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. The section might specify that EPA may allow trading between mobile sources and stationary sources so long as it can show that the effect of the allowance would be to reduce costs by a specified amount for a given level of benefits.

E. A Note on Political Realities

No one should ignore the obstacles to any large-scale rethinking of fuel economy regulation, whether the proposal involves legislative or administrative action. In Congress, it is of course necessary to obtain some kind of bipartisan approval, especially in a period in which each party has an incentive and often the means to make things difficult for those who seek to move legislation forward. The notice-and-comment process does not pose as formidable an obstacle, but it is nonetheless time-consuming and reforms of the magnitude suggested here would undoubtedly meet with both internal and external objections (whatever the political party of the president). The controversies during

127. *See* 42 U.S.C. § 7411(d); *see also id.* § 7411(c)(1) ("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.").

128. *See* Carbon Pollution Emission Guidelines for Existing Stationary Sources: Electric Utility Generating Units, 80 Fed. Reg. 64,662, 64,664 (Oct. 23, 2015) (*repealed by* Repeal of the Clean Power Plan; Emission Guidelines for Greenhouse Gas Emissions From Existing Electric Utility Generating Units; Revisions to Emission Guidelines Implementing Regulations, 84 Fed. Reg. 32,520 (July 8, 2019) (codified at 40 C.F.R. § 60)).

129. *See* Repeal of the Clean Power Plan; 84 Fed. Reg. 32,520.

the first term of the Trump Administration, in the particular area of fuel economy, attest to this reality.

Our primary goal here is to make a substantive recommendation, not to explore the issue of feasibility. Nonetheless, we hope that by its very nature, the recommendation might be able to command something like a consensus. Whether one favors highly stringent fuel economy standards or less aggressive ones, the recommendations should be able to do better than the status quo along every relevant dimension. An administration that wants to use such standards as a central part of an effort to reduce GHGs could do so more easily under the approach we have outlined, because it would be less costly and more effective. An administration that wants to reduce regulatory costs could endorse our proposal for exactly the same reasons. In this sense, the proposal is independent of any judgment about whether the fuel economy standards should be extremely aggressive, quite modest, or somewhere in between.

Conclusion

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. In these circumstances, there is a strong argument for a cap-and-trade system in transportation. 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 probably consistent with the regulatory authority existing at key federal agencies and could likely be implemented without new legislation. At the same time, there is a strong argument on behalf of such legislation, removing legal doubts and broadening the EPA's authority to produce the largest gains at the lowest costs.