

ISSUE BRIEF

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Improving Fuel Economy in Heavy-Duty Vehicles

Winston Harrington and Alan Krupnick¹

In September 2011, the National Highway Traffic Safety Administration (NHTSA) and the U.S. Environmental Protection Agency (EPA) jointly promulgated the first-ever federal regulations mandating improvements in fuel economy among heavy-duty commercial vehicles (HDVs).² Although much more complex than the corporate average fuel economy (CAFE) standards for light-duty vehicles, the rules employ many of the same concepts and regulatory strategies. While regulatory familiarity can be advantageous for almost all interested parties, the approach also has weaknesses.

In this issue brief³, we describe fuel economy technologies for the trucking sector, its economic structure, the details of the new fuel economy regulations for heavy-duty trucks, and the controversies they sparked. We also cite problems with the underlying cost–benefit analysis of the regulation and highlight some flaws of this form of regulation. We conclude by suggesting a variety of alternative, more market-oriented approaches that might work better.

Fuel Economy Technologies for the Trucking Sector

The Federal Highway Administration categorizes trucks by gross vehicle weight, as shown in Table 1. HDVs range from class 2b large pickups and utility vans that weigh 2.5–3.2 tons when empty to class 8b large tractor trailers that weigh as much as 17 tons. When full, the smallest HDVs can about double their weight to 3.5–5 tons, while the largest can more than double their weight to 16.5–40 tons.

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² U.S. EPA and NHTSA. 2011. Final Rules: Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium and Heavy-Duty Engines and Vehicles. Federal Register 76 (2011): 57106.

³ A forthcoming RFF discussion paper contains a fuller discussion of the issues presented here.



Table 1. Vehicle Weight Classes Defined by U.S. Department of Transportation

Class	Description/examples	Empty weight range	Gross weight range	Typical fuel intensities	
		Tons	Tons	Gallons per thousand miles	Gallons per thousand ton-miles
1c	Passenger cars	1.2–2.5	<3	30–40	67
1t	Small light-duty trucks	1.6–2.2	<3	40–50	58
2a	Standard pickups, large SUVs	2.2–3	3–4.25	50	39
2b	Large pickups, utility vans	2.5–3.2	4.25–5	67–100	39
3	Utility vans, minibuses	3.8–4.4	5–7	77–125	33
4	Delivery vans	3.8–4.4	7–8	83–140	24
5	Large delivery vans, bucket trucks	9.2–10.4	8–9.75	83–166	26
6	School buses, large delivery vans	5.8–7.2	9.75–13	83–200	20
7	City bus, refrigerated truck, fire engine	5.8–7.2	13–16.5	125–250	18
8a	Dump/refuse trucks, city buses, fire engines	10–17	16.5–40	160–400	9
8b	Large tractor trailers, bulk tankers	11.6–17	16.5–40	133–250	7

The potential fuel economy savings available from current technologies are specific to a truck's design and how it is used. For a class 8 combination tractor, for example, the potential savings from better aerodynamics is far more important than for other trucks because so much energy is expended in highway driving. For HDVs primarily used in urban or off-road settings, aerodynamics will be much less important. But in all HDVs, the engine is the largest user of energy, and fuel-savings technologies for engines will be important.

According to a 2010 National Research Council report, current technologies are capable of reducing energy use in HDVs by around 45–50 percent in 2015–2020, although the estimated costs and cost-effectiveness of various technology options are highly variable.⁴

Complex Industry, Complex Products

Several features of the HDV manufacturing industry complicate regulation of fuel consumption rates.

⁴ National Research Council 2010. *Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles*. Washington, DC: National Academies Press.



DYNAMISM

Commercial vehicle manufacturing is a very dynamic industry, and its dynamism creates problems for setting fuel economy standards. Over the period 2004–2008, annual production of trucks and engines swung between 39 percent above and 35 percent below the five-year average. A likely reason that contributed to the 2005–2006 increase followed by the 2007 decline is that many buyers bought ahead of an anticipated major price increase in 2007—an “announcement effect.” Truck and engine prices increased primarily because in that year, costly new regulations to curb emissions of nitrogen oxides (NO_x) and fine particulate matter (PM_{2.5}) from heavy-duty engines began to take effect. At the same time, this pattern also was influenced by the “new source bias,” which refers to the decrease in vehicle turnover in response to rising new vehicle prices.⁵ To the extent the new fuel economy regulations raise new vehicle prices, similar effects can be expected.

FRAGMENTATION

The trucking sector contains many manufacturers who design, manufacture, and service equipment for a wide variety of users and uses, from refuse collection to cement mixers to school buses. And unlike in the light-duty vehicle sector, manufacturers most often build specific components—from truck bodies to engines—rather than complete vehicles. The number of firms and the heterogeneity of products complicate the design of efficient and effective regulation in this sector. For instance, the typical manufacturer of truck bodies produces specialty items for special tasks, and the size of many of them places them in the category of “small businesses” even though they may have a substantial market share of their particular niche. Because of policy imperatives to protect small businesses, these specialty manufacturers may be subject to more lax regulations, giving the regulatory advantages over larger manufacturers producing a variety of products.

STRONG SECONDARY MARKET

Finally, tractors, diesel engines, and trailers and bodies are durable goods and have long useful lives. Therefore, there is a strong secondary market in trucks, engines and truck bodies. Regulation of products in these markets is much less extensive than in the new vehicle market; as a result, these markets may weaken or undo even successful implementation of new HDV standards over time.

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⁵ H.K. Gruenspecht. 1982. Differentiated Regulation: The Case of Auto Emission Standards. *American Economic Review* 72(2): 328–31.



The Regulations

The proposed HDV regulations are one of the most recent—and complicated—examples of a style of environmental policymaking called “technology-based standards.” These regulations share a number of common elements.

CATEGORIZATION

Targets of regulations are categorized (and frequently subcategorized), such that different products in the same subcategory must meet the same standard. In the case of the new HDV standards, at the top level of the categorization are three vehicle types: heavy-duty pickups and vans, combination tractors, and vocational vehicles.

Vehicles in the first category, heavy-duty pickups and vans, are manufactured as integrated vehicles and treated in the same manner as the CAFE standards for light-duty vehicles. Vehicles in the second category, combination trailers, are used in intercity freight hauling. These vehicles are estimated to account for 65 percent of fuel use and CO₂ emissions from the heavy-duty fleet, even though they make up only about 20 percent of the fleet. The third category, vocational vehicles, is defined as all vehicles that are not in the other two categories. This category is enormously varied by size, use, and body design, and includes fire trucks, cement mixers, dump trucks, and school buses, among others. These vehicles range in size from 8,500 to 80,000 pounds.

Tractor cabs are further classified by two weight classes and three roof heights. In addition, for class 8, there are both “day cabs” and “sleeper cabs” at each roof height, making a total of nine tractor categories. These nine categories differ by weight and aerodynamic qualities, both of which are adversely affected by height. In addition, two engines subcategories are defined: a “heavy heavy-duty” engine, which is primarily for class 8, and a “medium heavy-duty” engine for class 7.

PERFORMANCE METRICS

The principal performance metric for determining compliance with the NHTSA’s fuel consumption standards is the fuel consumption rate in gallons per 1,000 ton-miles (for vehicles) and gallons per horsepower-hour (for engines). For EPA’s carbon emissions standard, it is grams CO₂ per ton-mile (vehicles) or per horsepower-hour (engines). The performance standards in both metrics are chosen to be consistent so that achievement of the one implies the achievement of the other (with appropriate allowance made for alternative fuels).



Baselines. The baseline is defined as current or typical performance by the engines and vehicles in the industry to be regulated. The baseline can refer either to the designated performance level or the equipment capable of achieving it. The baseline engines for tractors use a sophisticated NO_x and PM_{2.5} after treatment system, and the three baseline engines for vocational vehicles use selective catalytic reduction (SCR), a treatment of exhaust gas that uses ammonia in the presence of a catalyst to chemically reduce oxides of nitrogen to harmless nitrogen gas. As discussed further below, this baseline is controversial.

THE FUEL ECONOMY STANDARDS

Tables 2a and 2b shows the range of standards and percentage improvements in the emissions rate over the baseline for the vehicle standards for 2018. The anticipated improvement in the rate of emissions from the baseline is 7–10 percent for all categories except class 8 sleeper cabs, which are to achieve up to a 24 percent improvement in 2018. Standards are more stringent in this last category because the ground has been prepared by EPA’s Smartway Program, a collaborative agency–industry program to improve the tires and aerodynamic characteristics of tractors and intercity trailers.



Table 2a. Fuel Consumption Standards for Class 7–8 Combination Vehicles

	Engine standards (expressed as percentage emission rate reduction from baseline), by model year (MY) ^a					
	Proposed			Final		
	Baseline (gallons per Kbhp-hr) ^a	2014 MY standard ^b	2017 MY standard	Baseline (gallons per Kbhp-hr) ^a	2014 MY standard ^b	2018 MY standard
Medium-heavy duty engines (Class 7)	5.09	4.93 (3%) ^b	4.78 (6%)	5.09	4.93 (3%)	4.78 (6%)
Heavy-heavy duty engines (Class 8)	4.81	4.67 (3%) ^b	4.52 (6%)	4.81	4.67 (3%)	4.52 (6%)
Vehicle standards (expressed as percentage emission rate reduction from baseline) ^c						
	Baseline (gallons per Kton-mi)	2014 MY Standard	2017 MY Standard	Baseline (gallons per Kton-mi)	2014 MY Standard	2018 MY Standard
Class 7 day cab						
Low roof	11	10.3 (6.4%)	10.1 (8.2%)	11.4	10.5 (7.9%)	10.2 (10.5%)
Mid roof	11	10.3 (6.4%)	10.1 (8.2%)	12.6	11.7 (7.1%)	11.3 (10.3%)
High roof	12.8	11.6 (9.4%)	11.4 (10.9%)	13.6	12.2 (10.3%)	11.8 (13.2%)
Class 8 day cab						
Low roof	8.3	7.8 (6%)	7.7 (7.2%)	8.7	8.0 (8.0%)	7.8 (10.3%)
Mid roof	8.3	7.8 (6%)	7.7 (7.2%)	9.4	8.7 (7.4%)	8.4 (10.6%)
High roof	9.4	8.6 (8.5%)	8.5 (9.6%)	10.1	9.0 (10.9%)	8.7 (13.9%)
Class 8 sleeper cab						
Low roof	7.4	6.3 (14.9%)	6.3 (14.9%)	7.8	6.7 (14.1%)	6.5 (16.7%)
Mid roof	8.0	6.9 (13.8%)	6.8 (15%)	8.7	7.4 (14.9%)	7.2 (17.2%)
High roof	8.7	7.1 (18.4%)	7.0 (19.5%)	9.3	7.3 (21.5%)	7.1 (23.7%)
Notes: ^a Carbon dioxide (CO ₂) emission standards are proportionate and expressed in grams CO ₂ per (Kbhp-hr; thousands of brake horsepower-hour) or (Kton-mi; thousands of tons-mile). Numerically, the conversion factor from gallons of fuel to grams CO ₂ is about 10,000. ^b The fuel consumption standard for engines is voluntary for 2014. Not so the CO ₂ standard. ^c Vehicle standards reflect engine improvements.						

Table 2b. Fuel consumption standards for Class 2b–8 Vocational Vehicles

Engine standards (expressed as percentage emission rate reduction from baseline)						
	Baseline (gallons per Kbhp-hr)	2014 MY standard	2017 MY standard	Baseline (gallons per Kbhp-hr)	2014 MY standard	2017 MY standard
Light heavy-duty engines	6.19	5.89 (5%)	5.57 (9%)	6.19	5.89 (5%)	5.57 (9%)
Medium-heavy duty engines	6.19	5.89 (5%)	5.57 (9%)	6.19	5.89 (5%)	5.57 (9%)
Heavy-heavy duty engines	5.74	5.57 (3%)	5.45 (5%)	5.74	5.57 (3%)	5.45 (5%)
Vehicle standards						
	Baseline (gallons per Kton-mi)	2014 MY standard	2017 MY standard	Baseline (gallons per Kton-mi)	2014 MY Standard	2017 MY Standard
Light heavy-duty class 2b–5	37.6	35.2 (6.3%)	33.8 (10%)	40.0	38.1 (4.8%)	36.7 (8.2%)
Medium heavy-duty class 6–7	22.3	20.8 (6.6%)	20 (10.3%)	24.3	23.0 (5.3%)	22.1 (9%)
Heavy heavy-duty class 8	11.3	10.7 (5.2%)	10.5 (7%)	23.2	22.2 (4.3%)	21.8 (6%)
<p>Notes:</p> <p>^a Carbon dioxide (CO₂) emission standards are proportionate and expressed in grams CO₂ per (Kbhp-hr; thousands of brake horsepower-hour) or (Kton-mi; thousands of tons-mile). Numerically, the conversion factor from gallons of fuel to grams CO₂ is about 10,000.</p> <p>^bThe fuel consumption standard for engines is voluntary for 2014 and only becomes mandatory in 2016. Not so the CO₂ standard.</p> <p>^cVehicle standards reflect engine improvements.</p>						

DEMONSTRATION OF FEASIBILITY

For each product, the agencies identify a suite of technologies available within the time frame that, if applied to a vehicle, will allow the relevant performance standard to be met. For example, domestic tractor manufacturers already offer products with some of the aerodynamic features identified and developed as part of the Smartway Program. A more controversial issue involves the use of post-combustion technologies in the baseline engine, as discussed below

CERTIFICATION

To demonstrate compliance of vehicles, engines, and other components with the standards, vehicles and engines must be tested and their performance quantified.

FLEXIBILITY

An array of flexibility measures are available to manufacturers to make it easier to comply with the regulation. Probably the most important of these are provisions allowing averaging, banking, and trading of emissions credits within vehicle or engine subcategories. For example, in the subcategory of medium heavy-duty engines for class 2b–8 vocational vehicles, credits can be traded with other engines in the subcategory, even across manufacturers, but they cannot be traded with other tractor, chassis, or engine categories.

Credit also can be received for early adoption/demonstration of improvements before they become requirements, and use of “advanced” or “innovative” technology. Four technologies are available for advanced technology credits, which can then be used in other subcategories if desired. This is the only category where credits can be traded across subcategories.

ALTERNATIVE-FUELED VEHICLES

The regulations provide credits for alternative-fueled vehicles according to the carbon content of their fuel relative to diesel. Thus, a natural gas vehicle, with 30 percent less CO₂ emissions per gallon equivalent than the identical vehicle fueled by diesel, would be presumed to be 30 percent more efficient. For some alternative-fueled vehicle types, this degree of improvement would be enough to meet the standards or, if more than enough, would generate credits to offset necessary fuel economy improvements in conventional diesel vehicles.

Controversies

EPA and NHTSA received many comments on the proposed HDV fuel economy regulation from a variety of sources: engine manufacturers, chassis and body manufacturers, tire makers, nongovernmental organizations, state and local air quality authorities and private citizens. The agencies’ responses took up more than 1,000 pages of text. As is usually the case, the most



extensive comments came from those most directly and significantly affected—the manufacturers. We briefly describe some of these comments, grouped around what we think are a few significant decisions that generated controversy and some degree of pushback.

BASELINES

In early 2001, EPA promulgated the 2007 Heavy-Duty Highway Rule, which stringently regulates NO_x, hydrocarbons, and particulate emissions from heavy-duty vehicles manufactured in 2007 and beyond. To meet the new NO_x standards, most manufacturers opted to use SCR, but at least one manufacturer—Navistar—took a different approach to meeting the new NO_x and PM standards: a major redesign of heavy-duty engines. Yet as mentioned above, the baseline engine requirements for vocational vehicles under the heavy-duty fuel economy standards include the use of SCR.

In the company's comments on the proposed regulation, Navistar argued against the incorporation of SCR in the baseline technology, saying that the SCR-equipped engines used to construct the baseline do not meet the NO_x standard and therefore do not in fact comply with the 2007 Heavy-Duty Highway Rule. Thus, it argued, the standards built on this baseline technology are infeasible.⁶

In its reply, EPA noted that the feasibility requirement did not mean that all designated technologies had to be now available, only that they had to be available before the effective date of the regulations. It was also pointed out that Navistar and other manufacturers could resort to the alternative standards for an engine, which required a 3 percent improvement over the engine's performance by the effective date. Generally the agencies' view was that the lead times gave all manufacturers time to achieve compliance.

TECHNOLOGIES IN VOCATIONAL VEHICLES

The proposed class 2b–7 vocational vehicle standards only reflect two things: the improvements in engine fuel intensity and an anticipated improvement in rolling resistance. As numerous commenters pointed out, fuel-saving technologies potentially could apply to other vehicle components, including transmissions, advanced drive trains, weight reduction and improved auxiliary systems. Many of those commenters urged the agencies to set the standards so as to force adoption of these technologies for new vehicles. The agencies declined, because to do so would be tantamount to picking technological winners.

At the same time, the agencies received a great many comments on the decision to base vocational vehicle performance in 2017 on improved rolling resistance. Vehicle and tire

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⁶ Navistar, Inc. 2011. Comments To EPA and DOT/NHTSA Proposed Greenhouse Gas Emissions Standards and Fuel Efficiency Standards For Medium- and Heavy-Duty Engines and Vehicles, January 31. (Lisle, IL.).



manufacturers argued that the industry would need more than six years to develop new tire designs and prove they were safe and effective on the wide range of vocational vehicle types. In response, the agencies granted that the market for vocational vehicle tires faced some obstacles but concluded that a sufficient range of products was available to lead to significant reductions in rolling resistance. The requirements were left unchanged in the final regulation.

CATEGORIZATION

In the Notice of Proposed Rulemaking, the agencies classified all vocational vehicles with sleeper cabs as “tractors.” The argument for doing so was to prevent vocational vehicles from being modified to serve as intercity combination trailers. Numerous commentators objected, arguing that the agencies had underestimated the cost and difficulty of making vocational sleeper cabs suitable for intercity use. Those costs, dissenters said, were at least as great as the savings available from access to the less stringent regulation. In response to the new information, the agencies removed the tractor designation from all vocational vehicles.

ALTERNATIVE-FUELED VEHICLES

The rule giving credit equal to the difference in CO₂ emissions between an alternative-fueled vehicle and its diesel counterpart generated many comments from producers of alternative-fueled trucks and exposed a fault line between NHTSA and EPA’s responsibilities.

EPA’s mandate is to focus on reducing CO₂ emissions, and the rule on alternative-fueled vehicles fully reflects the appropriate incentive for these types of vehicles according to that metric.

However, under NHTSA’s mandate to reduce oil consumption and energy dependence, credits for some alternative-fueled vehicles, such as all-electrics or natural gas vehicles, should be much larger because they use no petroleum. Indeed, with U.S. shale gas resources so large and prices so low, substitution of oil by natural gas in transportation could enhance our energy security. The agencies say that they will revisit this issue in the future.

The Regulatory Impact Analysis

Because the fuel economy standards are a “major” rule, the agencies are required by Executive Order to complete a cost–benefit analysis of their proposed rule and alternatives, called a regulatory impact analysis (RIA). The RIA estimates that with technology costs of \$1.62 billion per model year and benefits of \$10.48 billion, net benefits are \$9.86 billion, implying that the regulations pass a benefit–cost test.

A number of issues underlie these estimates. The main issue concerns the “energy-efficiency paradox”: although there appears to be large cost savings available from making energy-efficient



investments at prevailing energy prices, few such investments are actually made. This paradox can be resolved by citing market failures, hidden costs, or both.

In their cost–benefit analysis, EPA and NHTSA assumed that market failures explain the energy-efficiency paradox. If, alternatively, they had accepted a hidden-cost argument, the estimated benefits of the regulation would have been smaller.

The concern over these calculations doesn’t end there. The calculations assume a certain amount of new truck sales in each category and penetration into the fleet over time. But these assumptions may be wrong. If truck buyers balk at the higher prices required for better fuel economy, they may hold onto their existing trucks longer than usual or shift to less heavily regulated vehicles in a different regulatory class. There is precedent in the light-duty fleet: buyers shifted toward light-duty trucks from light-duty autos when the former were less regulated than the latter, especially as manufacturers began to design and market SUVs, vehicles that were defined as trucks for regulatory purposes but had great appeal as household vehicles.

Calculations for some of the other categories are worth discussing as well because their benefits come close to offsetting technology costs without even counting fuel savings. Of particular note are the estimates of climate change damage avoided from CO₂ reductions, which offset 52 percent of the costs. These calculations use an estimate of \$22/ton in 2010, taken from an Interagency study led by the USEPA that uses aggregative models that necessarily rely on sweeping and controversial assumptions. Nevertheless, we note that this number is now the standard number for use in U.S. government cost-benefit analyses.⁷ Likewise, the agencies’ estimates of energy security benefits, which net out about 22 percent of the costs, are controversial in the economics literature.

A final issue concerns the externalities associated with the “rebound effect”—the additional vehicle miles driven in response to the lower price of driving from the mandated efficiency improvements. This effect means that some of the fuel use and both CO₂ and conventional pollution emissions reductions from the standards may be offset by this price response. On top of this, if manufacturers believe that conventional pollution emissions standards on diesel vehicles are binding, when faced with the prospect of lower emissions per mile because of the new fuel economy standards, they may relax their controls on these conventional air pollutants, saving on costs to themselves and consumers, or adding other desirable features. In this case, emissions would be unchanged following the imposition of the new fuel economy standards.

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⁷ Interagency Working Group on the Social Cost of Carbon. 2010. Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866. Washington, DC.



Because of technical and resource limitations, EPA and NHTSA did not estimate the model-year effects of the standards on conventional air pollutants. Instead, they estimated the effects and benefits of the standards on these pollutants in 2030 and extrapolated those to all years of the analysis, for an added benefit of \$25.3 billion. Including this benefit adds more than 50 percent to the overall net benefits of the program over all five model years. This benefit estimate should be viewed as a possible overestimate, depending on market choices about emissions controls.

Some Economic Issues with Fuel Consumption Standards

The work done by the agencies in developing these standards with so little data available is admirable. Yet a basic problem arises: like the CAFE standards for light-duty vehicles, the new standards regulate the design and initial performance of vehicles rather than their use. Once they leave the showroom floor, the regulations have no further influence on the vehicles themselves. As a result, the standards affect fuel use only by improving fuel intensity in new vehicles and, with appropriate design, the availability of fuels and engines that use fossil fuels less intensively. The current standards do nothing for fuel consumption rates in existing vehicles, vehicle miles traveled, fleet mix, or fleet turnover rates. Worse, they can affect these other margins perversely.

THE REBOUND EFFECT

Better fuel use will lower cost per mile or ton-mile, potentially increasing the demand for transport and attracting traffic from more energy-efficient modes, such as barges and railroads. This is a mixed blessing; cheaper transport increases wealth, but more transport is counterproductive with respect to the policy goal.

FLEET TURNOVER EFFECT

While the price per mile traveled is decreasing, the initial price of the vehicle is going up. But the effects do not stop with the increase in new vehicle prices. Potential buyers will have second thoughts and may decide to postpone new vehicle purchases, delaying fuel intensity improvements. This effect could be stronger in HDVs than in light-duty vehicles simply because their expected lifetimes are longer.

CLASS SHIFTING

Because costs per vehicle can vary considerably, buyers have an incentive to substitute a vehicle in another category for their first choice. Use of vehicles in other categories may produce cost savings for users but could raise CO₂ emissions substantially. And manufacturers may respond by designing and building vehicles that do not now exist but that could, with relatively minor alterations, have multiple uses.



Alternative Approaches

To help avoid these distortions and perverse outcomes, regulations should target vehicle use either through a carbon tax or a fossil fuel rationing scheme, such as what would be part of an upstream cap-and-trade system.⁸ These policies have several important advantages over fuel intensity standards:

- They attack all the margins of fuel use discussed in the previous section.
- They are cost-effective—that is, they encourage reductions in fuel use up to the point where the marginal cost equals the price of carbon.
- They can be efficient if the carbon price is set at the marginal social cost.
- They avoid the perverse outcomes that fuel intensity standards are prone to.

Not only can these policies substitute for fuel intensity standards, they also can supplement them, as a way of mitigating the disadvantages of each. This is especially true of a carbon tax. As argued above, the incentives for perverse behavior in response to fuel intensity standards depend on the price of fuel: the lower the price, the greater the incentives. Raising the price of fuel will therefore reduce the likelihood that significant distortions occur. The combination of fuel intensity standards and a carbon tax to raise the price will be just as effective as fuel intensity standards alone at improving fuel intensity, and it will reduce the rebound effect, stagnant fleet turnover, and class shifting.

Unfortunately, the likelihood is low that such measures will get a fair hearing in Congress for the foreseeable future. Cap and trade is moribund now, and few public policy ideas have been less popular with the general public or their legislators than fuel or carbon taxes.⁹ Yet it should be remembered that the percentage improvement in CO₂ emissions reductions is modest compared to the 50 percent thought to be technologically possible by 2020. This suggests we are now at the very beginning of a long regulatory process. It makes sense to try to keep all options on the table, including emissions fees and fuel taxes.

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⁸ This is not the place to expand on the virtues and design issues of such policies; the interested reader should see the following studies: I.W.H. Parry and K.A. Small. 2007. Does Britain or The United States Have the Right Gasoline Tax? *American Economic Review* 95(4): 1276–89; and I.W.H. Parry, M. Walls, and W. Harrington. 2007. Automobile Externalities and Policies. *Journal of Economic Literature* 45(2): 374–400.

⁹ A nascent interest is budding in carbon taxes; see <http://www.rff.org/Events/Pages/Fiscal-Reform-and-Climate-Protection-Considering-a-US-Carbon-Tax.aspx>.

