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# CAFE and ZEV Standards: Environmental Effects and Alternatives



by Julian Morris and Arthur R. Wardle

# Reason Foundation



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# **CAFE and ZEV Standards: Environmental Effects and Alternatives**

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# Introduction

Manufacturers and importers of vehicles sold in the U.S. are subject to federal fuel economy and greenhouse gas (GHG) emission standards. In addition, California and nine other states have imposed more-stringent standards and require a minimum proportion of vehicles to have “zero” emissions.

The stated objectives of Corporate Average Fuel Economy (CAFE) standards are: (1) to reduce fuel consumption and (2) to reduce greenhouse gas (GHG) emissions. This brief considers the extent to which the standards are likely to achieve these objectives, the relative importance of achieving such objectives compared with other possible environmental objectives, and more cost-effective alternative policies.

## Part 1

## CAFE and ZEV Standards

CAFE standards were first introduced in 1978 and new standards have been implemented at various intervals since then. In 2012, the National Highway Transportation and Safety Administration (NHTSA) and the Environmental Protection Agency (EPA) issued new CAFE and GHG emission rules for vehicles manufactured in years 2017–2025. Under these rules, fleetwide average fuel economy for passenger cars rises to 39.6 mpg in 2017 (from 38.2 mpg in 2016) and then incrementally to a minimum of 55.3 mpg in 2025.<sup>1</sup> For light trucks, minimum fuel economy rises to 29.1 mpg in 2017 (from 28.9 mpg in 2016) and then incrementally to 39.3 mpg in 2025. These minimum fuel economy standards are based on the maximum vehicle footprint in each category:<sup>2</sup> fleets with smaller average vehicle footprints are required to meet stricter standards.

Under the GHG emission rules in the 2017–2025 standards, manufacturers may offset other efficiency improvements, such as in air conditioning systems, thereby reducing the minimum effective fuel efficiency for passenger vehicles in 2025 to 49.6 mpg.<sup>3</sup> Moreover, manufacturers may count each electric and plug-in hybrid vehicle as more than one effective vehicle: for plug-in hybrids, this multiple starts at 1.6 in 2017 and declines to 1.3 in 2021; for electric vehicles, the multiple is 2 in 2017, falling incrementally to 1.5 in 2021.<sup>4</sup>

<sup>1</sup> “NHTSA and EPA Set Standards to Improve Fuel Economy and Reduce Greenhouse Gases for Passenger Cars and Light Trucks for Model Years 2017 and Beyond.” U.S. EPA, Office of Transportation and Air Quality. EPA-420-F-12-051. August 2012. [https://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/CAFE\\_2017-25\\_Fact\\_Sheet.pdf](https://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/CAFE_2017-25_Fact_Sheet.pdf)

<sup>2</sup> “Footprint is defined as the product of track width (measured in inches, calculated as the average of front and rear track widths, and rounded to the nearest tenth of an inch) times wheelbase (measured in inches and rounded to the nearest tenth of an inch), divided by 144 and then rounded to the nearest tenth of a square foot. For purposes of this definition, track width is the lateral distance between the centerlines of the base tires at ground, including the camber angle. For purposes of this definition, wheelbase is the longitudinal distance between front and rear wheel centerlines.” 49 CFR 523.2 see: <https://www.law.cornell.edu/cfr/text/49/523.2>

<sup>3</sup> Transportpolicy.net. *US: Light-duty: Fuel Economy and GHG*. [http://www.transportpolicy.net/index.php?title=US:\\_Light-duty:\\_Fuel\\_Economy\\_and\\_GHG](http://www.transportpolicy.net/index.php?title=US:_Light-duty:_Fuel_Economy_and_GHG)

<sup>4</sup> Center for Climate and Energy Solutions. *Federal Vehicle Standards*. <https://www.c2es.org/federal/executive/vehicle-standards>

Also in 2012, California’s Air Resources Board adopted the Advanced Clean Cars program, which created standards for new vehicles in California through 2025. A key provision of the program requires that, starting in 2018, major motor vehicle manufacturers sell a minimum proportion of “Zero Emission Vehicles” (ZEVs—i.e. electric cars) or combination of ZEVs and “Transitional Zero Emission Vehicles” (TZEVs—i.e. plug-in hybrids). For model year 2018, the minimum is 4.5%, including at least 2% ZEVs. This rises annually reaching 22% in 2025, of which at least 16% must be ZEVs.<sup>5</sup> California was permitted to implement these stricter standards under a waiver granted by the Environmental Protection Agency.<sup>6</sup> Other states have been permitted to adopt the same standards as California and so far nine additional states have done so, namely: Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, Oregon, Rhode Island and Vermont.<sup>7</sup>

<sup>5</sup> Air Resources Board. *Zero-Emission Vehicle Standards for 2018 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles*. [https://www.arb.ca.gov/msprog/zevprog/zevregs/1962.2\\_Clean.pdf](https://www.arb.ca.gov/msprog/zevprog/zevregs/1962.2_Clean.pdf)

<sup>6</sup> Government Printing Office. Federal Register. Vol. 76, No. 191. Oct. 3, 2011 Notices. 61095–61098. <https://www.gpo.gov/fdsys/pkg/FR-2011-10-03/pdf/2011-25399.pdf>

<sup>7</sup> Center for Climate and Energy Solutions. *ZEV Program*. <https://www.c2es.org/us-states-regions/policy-maps/zev-program>

Part 2

# The Effect of CAFE Standards on Fuel Efficiency, Fuel Consumption and GHG Emissions

CAFE standards have likely contributed to increases in the fuel efficiency of vehicles in the U.S. But the extent of this effect is difficult to determine because it is impossible to know precisely what would have happened in the absence of such standards. However, several studies have found that rising fuel prices during the 1970s and early 1980s resulted in increased demand for and supply of more efficient vehicles over and above the requirements of CAFE standards.<sup>8</sup>

However, the subsequent decline in fuel prices combined with rising incomes and changing tastes led to increased demand for larger, more powerful vehicles.<sup>9</sup> This effect was exaggerated by the lower fuel economy requirements imposed on vehicles classified as “light trucks.” Manufacturers developed numerous consumer-oriented vehicles, including SUVs, minivans and luxury pickups, that fell into this category. Because of the less onerous fuel economy requirements, these vehicles were relatively less expensive than lighter passenger cars.<sup>10</sup>

Though CAFE standards have likely reduced U.S. oil consumption and GHG emissions on net, it is worth noting two effects that have probably mitigated these savings: the rebound effect and the scrappage effect.

**The rebound effect** refers to the response by drivers to a reduction in the cost of driving as a result of higher fuel economy. Put simply: when driving costs less, people tend to drive

<sup>8</sup> Crandall, Robert W. “Policy Watch: Corporate Average Fuel Economy Standards.” *Journal of Economic Perspectives*, Vol. 6 (2). 171–180. Spring 1992.

<sup>9</sup> Congressional Budget Office. *The Economic Costs of Fuel Economy Standards Versus a Gasoline Tax*, U.S. Congress: Washington, DC, 2003.

<sup>10</sup> BenDor, Todd K. “The System Dynamics of U.S. Automobile Fuel Economy.” *Sustainability*, Vol. 4. 1013-42. 2012.



more—all other things being equal. This comes partly from people driving instead of using other modes of transport (bus, train, airplane), and partly from an increase in trips taken or trip length. A recent survey by economists at the OECD, evaluating 547 estimates from 64 studies, found that on average this rebound effect reduced total fuel savings by about 25% in the short term compared to what would have happened in the absence of such compensatory behavior by consumers.<sup>11</sup> In the longer term, the rebound effect reduced fuel savings by about 40%.

In addition to this direct rebound effect, fuel efficiency improvements may also result in other rebound effects, including:

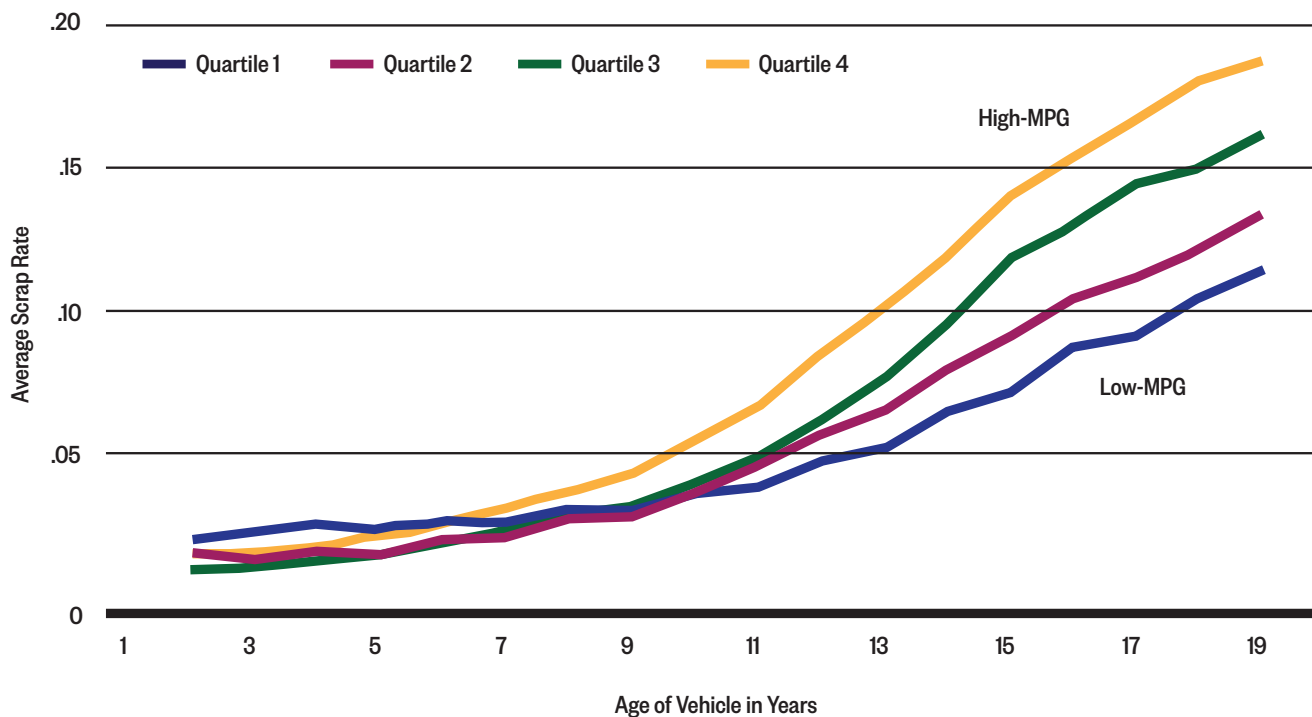
- When consumers spend less on fuel as a result of efficiency standards, they may spend more on other products, increasing associated emissions;
- By reducing demand for oil in the U.S., efficiency standards reduce world oil prices, with the result that people in other countries tend to increase oil consumption, with associated increases in emissions.

**The scrappage effect** occurs when vehicle owners respond to the higher price of new vehicles resulting from mandated fuel efficiency increases by keeping existing vehicles for longer, which in turn reduces the supply of used vehicles, raising their price and *reducing* the rate at which they are scrapped.<sup>12</sup> Moreover, because fleet-based fuel economy standards incentivize manufacturers to produce fewer gas guzzlers (e.g. vehicles with larger, more powerful engines), demand for used gas guzzlers rises disproportionately—and scrappage rates of such vehicles therefore falls disproportionately. This can be seen in Figure 1, which shows that vehicles with the lowest fuel economy are scrapped at a far lower rate than those with higher fuel economy.

<sup>11</sup> Dimitropoulos, Alexandros, Walid Oueslati, and Christina Sintek. *The Rebound Effect in Road Transport: A Meta-Analysis of Empirical Studies*. Environment Working Paper No. 113. Paris: OECD Publishing, 2016. 18-19.

<sup>12</sup> Jacobsen, Mark R. and Arthur van Benthem. "Vehicle Scrappage and Gasoline Policy." *American Economic Review*, Vol. 105, No. 3. 1312–1338. March 2015. The scrappage effect is also known as the Gruenspecht effect, after its originator economist Howard Gruenspecht. See: Howard K. Gruenspecht, "Differentiated Regulation: The Case of Auto Emissions Standards." *The American Economic Review*, Vol. 72, No. 2. Papers and Proceedings of the Ninety-Fourth Annual Meeting of the American Economic Association. May 1982. 328–331.

**Figure 1: Scrappage Rates by MPG Quartile (Age of Vehicle in Years)**



Source: Mark R. Jacobsen: U.S. Fuel Economy Standards: Economics and Efficiency<sup>13</sup>

Marc Jacobsen and Arthur van Bentham, the authors of the recent study on which Figure 1 is based, show that the changes to fuel economy currently mandated by the EPA and NHTSA would likely result in a very substantial scrappage effect, with 13%–16% of the savings that would otherwise result from the mandated fuel efficiency increases likely to leak away as a result.<sup>14</sup>

There is one other potential perverse effect of the CAFE standards: manufacturers may have incentives to increase the average vehicle footprint by extending the wheelbase in order to minimize the required fleet fuel economy.<sup>15</sup> The midterm evaluation report dismissed this

<sup>13</sup> Stanford University Engineering Seminar. “Energy Seminar: Mark Jacobsen, U.S. Fuel Economy Standards: Economics and Efficiency.” November 17, 2014. Available at: [https://energy.stanford.edu/sites/default/files/jacobsen\\_energy\\_seminar.pdf](https://energy.stanford.edu/sites/default/files/jacobsen_energy_seminar.pdf)

<sup>14</sup> Jacobsen and Bentham. “Vehicle Scrappage and Gasoline Policy.”

<sup>15</sup> Whitefoot, Kate S. and Steven J. Skerlos. “Design incentives to increase vehicle size created from the U.S. footprint-based fuel economy standards.” *Energy Policy* 41 (2012). 402–411.

effect (arguing that footprint increases could be explained a number of ways).<sup>16</sup> But more recent scholarship supports the existence of such an effect.<sup>17</sup>

In combination, the rebound and scrappage effects could mean that the 2017–2025 CAFE standards would reduce fuel consumption and associated emissions by only about half to three-quarters the amount that would take place in the absence of such effects. In its mid-term evaluation of CAFE standards, the EPA and NHTSA assumed a rebound effect of 10%, and although it considered the scrappage effect, it dismissed it.<sup>18</sup> That mid-term evaluation found that between 2016 and 2028 total fuel consumption would be reduced by up to 1.6 billion barrels of oil, while carbon dioxide emissions would be reduced by up to 748 million metric tons.<sup>19</sup> Factoring in more realistic estimates of the rebound and scrappage effects of 25% to 50% (combined), oil use is unlikely to fall by more than 1.2 billion barrels (i.e. about 100 million barrels/year), while carbon dioxide emissions are unlikely to be reduced by more than 600 million metric tons (i.e. 50 million metric tons/year). Since the U.S. currently emits about 5,000 million metric tons of carbon dioxide, the CAFE standards would reduce those emissions by about 1%.

<sup>16</sup> EPA/CARB/NHTSA, *Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022-2025*, Section 6.2.2., Washington, DC: Environmental Protection Agency, California Air Resources Board, National Highway Transportation Safety Administration, EPA-420-D-16-900, July 2016. Available at: <https://nepis.epa.gov/Exe/ZyPDF.cgi/P100OXEO.PDF?Dockey=P100OXEO.PDF>

<sup>17</sup> Ullman, David F. “A difficult road ahead: Fleet fuel economy, footprint-based CAFE compliance, and manufacturer incentives.” *Energy Economics* 57 (June 2016). 94-105.

<sup>18</sup> The EPA’s justification was that the “results depend on the standards depressing new vehicle sales” and the evaluation drafters have “not identified ways to estimate the effects of the standards” on those sales.

<sup>19</sup> EPA/CARB/NHTSA, *Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022-2025*, ES-11, Table ES-5.

## The Effect of ZEV Standards

While electric cars do not consume oil or produce GHG emissions directly, they do consume fossil fuels and produce GHG emissions indirectly, both during the manufacturing of vehicles and during use. Car manufacturing is an energy-intensive process—and much of that energy comes from fossil fuels. Meanwhile, the vast majority of electricity in the U.S. comes from burning fossil fuels, predominantly coal and natural gas. So when an electric vehicle is charged using power from the electricity grid, it indirectly consumes fossil fuels and emits GHGs.

A 2013 study calculated emissions of carbon dioxide equivalent (a composite measure of GHGs emitted) during the manufacture and use of different kinds of automobiles.<sup>20</sup> The study found manufacturing electric cars involves higher levels of GHG emissions than manufacturing of gas and diesel cars, while emissions during use are lower. When averaged over the lifecycle of a typical vehicle, the study found that for the U.S., ZEVs emit the same amount of GHGs as gas and diesel cars (325 grams of carbon dioxide equivalent per mile travelled). One problem with this comparison between GHG emissions of electric, gas and diesel cars is that it uses GHG emissions data from 2009 but emissions from electricity generation have since fallen (see Figure 6). However, emissions from new gas and diesel vehicles have also been falling, so these effects may cancel out. In addition, emissions from ZEVs will vary from state to state, depending on the sources of electricity, as well as from car to car and driver to driver. In particular, GHG emissions from electric vehicles driven in California are likely somewhat smaller than average.<sup>21</sup> However, forcing manufacturers to

<sup>20</sup> Wilson, Lindsay. “Shades of Green: Electric Cars’ Carbon Emissions Around the Globe.” Shrink that Footprint. February 2013. Available at: <http://shrinkthatfootprint.com/wp-content/uploads/2013/02/Shades-of-Green-Full-Report.pdf>

<sup>21</sup> California has lower direct GHG emissions than average. But California is connected to the Western Grid and imports about one third of its electricity from generators in other states. (California Energy Commission. Almanac. “Total System Electric Generation.” [http://www.energy.ca.gov/almanac/electricity\\_data/total\\_system\\_power.html](http://www.energy.ca.gov/almanac/electricity_data/total_system_power.html)) Indeed, a 2015 report from SNL found that at times as much as 50% of Southern California’s electricity comes from coal-burning plants. (Christian, Molly. “UPDATE: California’s quiet market for coal.” SNL, Oct. 12, 2015. <https://www.snl.com/InteractiveX/Article.aspx?cdid=A-34113318-14128.>)

produce ZEVs is unlikely to reduce GHG emissions significantly—and it is certainly inappropriate to describe such vehicles as “zero emissions.”

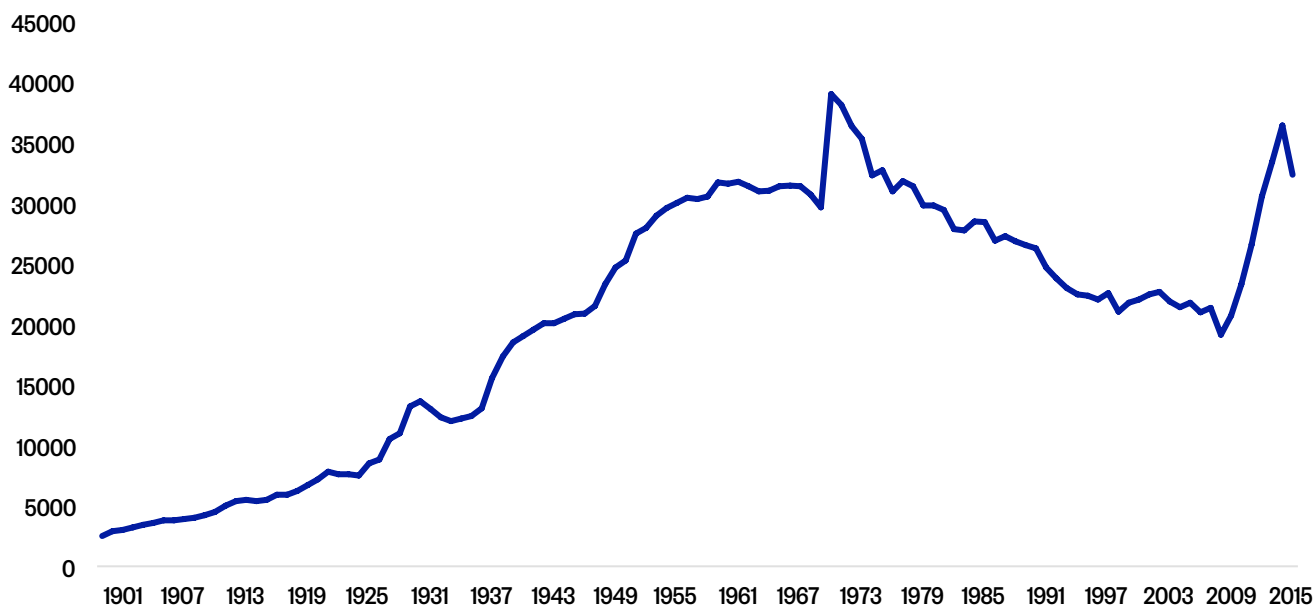
Meanwhile, the assumption in the federal GHG emission rule that counts each hybrid or electric vehicle as multiple vehicles (having already taken into account their actual emissions) may have the effect of encouraging manufacturers to sell large numbers of hybrids or electric cars; this would reduce their notional average fleet emissions according to the regulations but might, perversely, cause the release of more net GHG emissions.

## Part 4

## The Relative Importance of Reducing Fuel Consumption and GHGs as Environmental Priorities

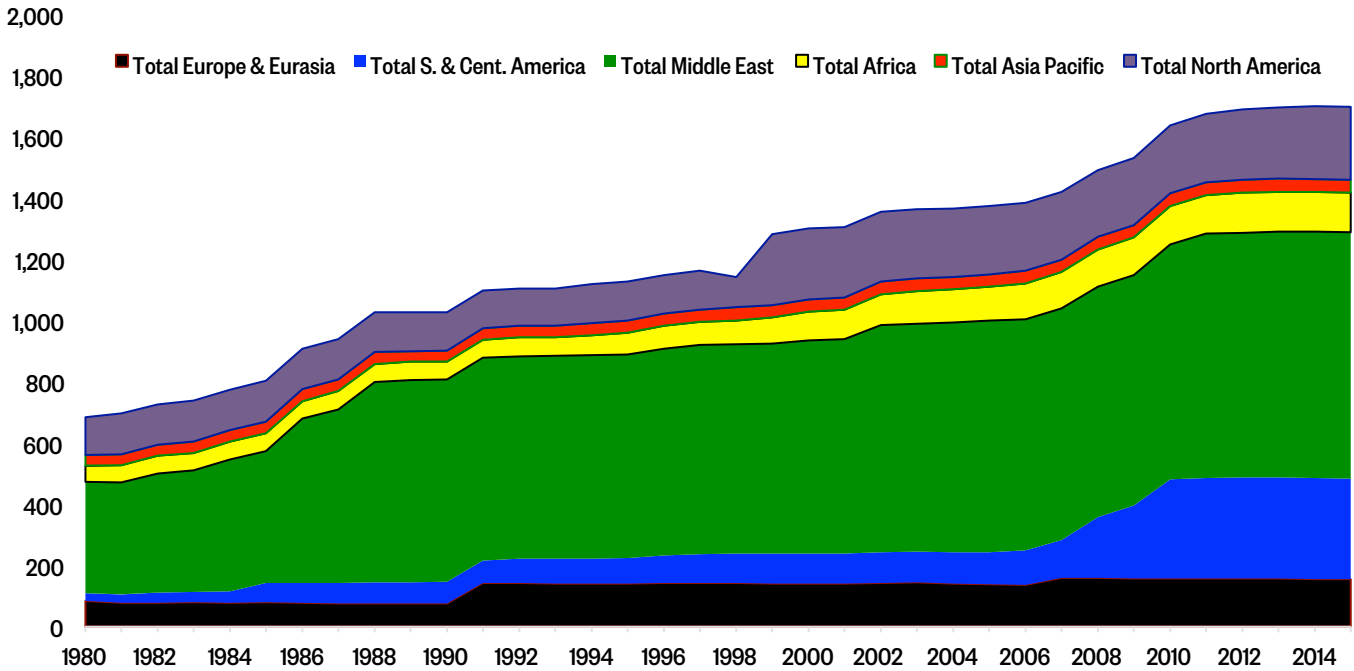
The original justification of CAFE standards was that the world was running out of oil and that America was overly reliant upon supplies of oil from OPEC. The intention was to conserve oil, thereby reducing America's reliance on (imported) oil. But this premise was at best faulty and at worst simply wrong. As Figure 2 shows, proved reserves of oil in the U.S. fell and then rose—and are now about the same as they were when CAFE standards were first implemented. Meanwhile, as Figure 3 shows, global proved reserves of oil have *increased* dramatically.

Figure 2: Proved Oil Reserves, U.S. (in millions of barrels)



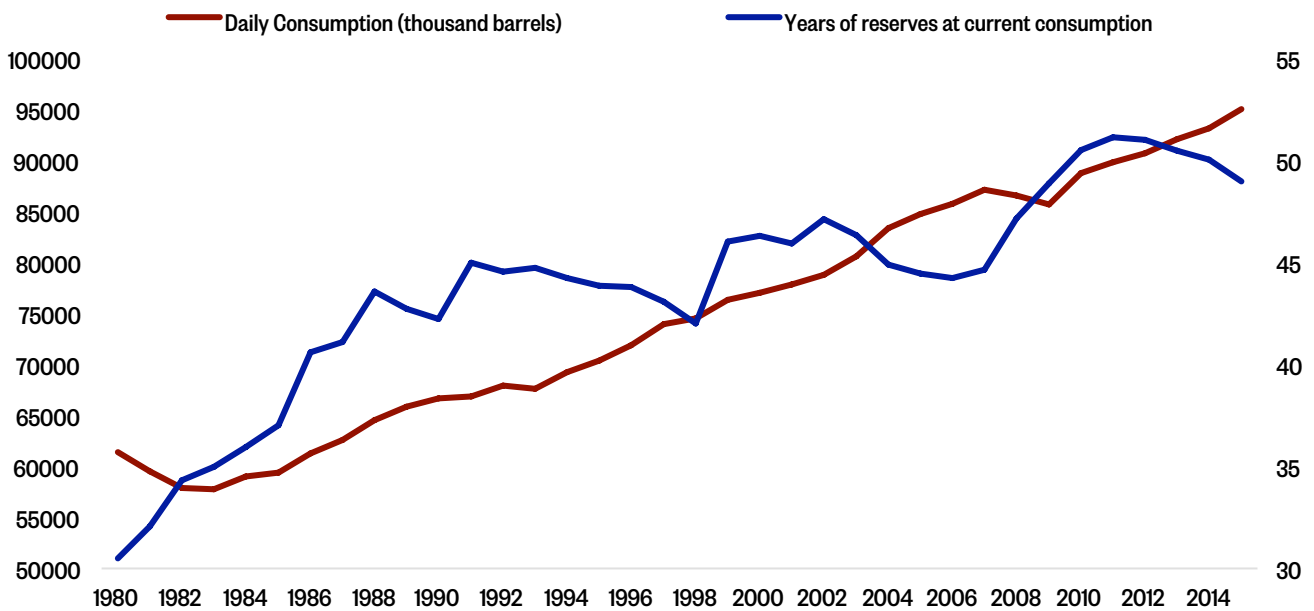
Source: U.S. Energy Information Administration. Petroleum and Other Liquids. "U.S. Crude Oil Proved Reserves."  
[https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RCCR01NUS\\_1&f=A](https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RCCR01NUS_1&f=A)

Figure 3: Proved Oil Reserves, Global (in billions of barrels)



Source: BP Statistical Review of World Energy 2016

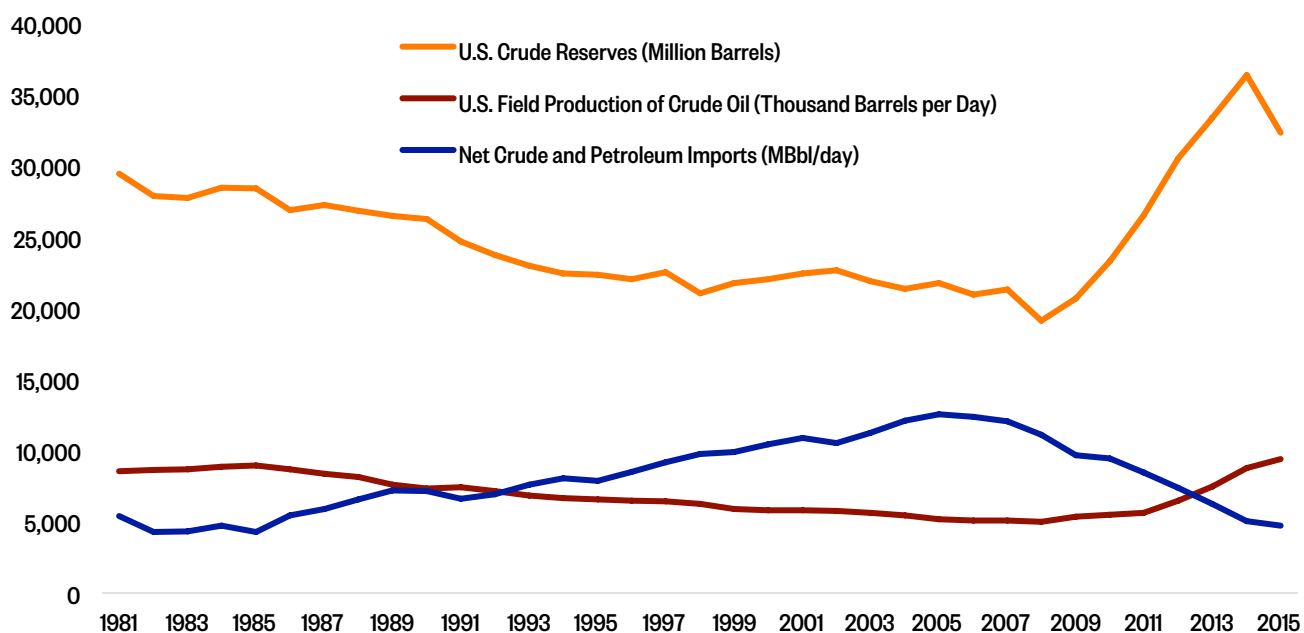
Figure 4: Global Oil Consumption and Years of Proved Reserves



Source: BP Statistical Review of World Energy 2016

Although global consumption of oil has also increased, the number of years of proved reserves has increased more rapidly, from about 30 to about 50 years—as shown in Figure 4. The evidence thus suggests that there simply was no need to force consumers to purchase more-fuel-efficient vehicles in order to conserve oil. Meanwhile, as Figure 5 shows, increases in domestic production have done far more to reduce imports than CAFE standards.

**Figure 5: U.S. Crude Oil Reserves, Production, and Net Imports**

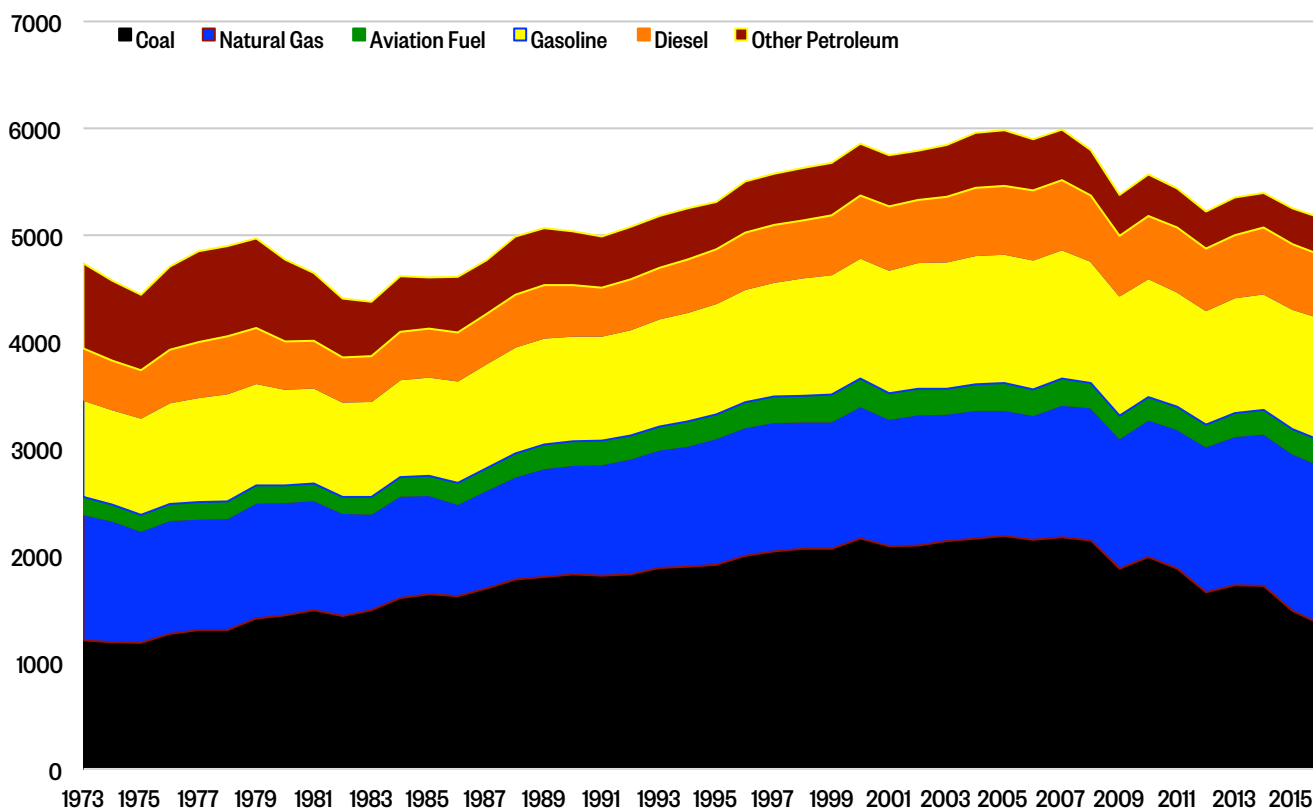


Source: Data from: Energy Information Administration. “U.S. Crude Oil and Natural Gas Proved Reserves, Year-end 2015,” Figure 4 (available at: <https://www.eia.gov/naturalgas/crudeoilreserves/>) and “U.S. Crude Oil Proved Reserves” (available at: [https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RORR01NUS\\_1&f=A](https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=RORR01NUS_1&f=A))

With the introduction of GHG emission standards, the premise of fuel economy standards has shifted. Indeed, now the central premise is not that the world is running out of oil but that it has “too much”—and as a result oil is cheaper than other forms of transportation fuel, encouraging its use and thereby causing harmful global warming. But that premise is also highly questionable. First, while U.S. emissions of GHGs from automobiles are rising, total U.S. emissions of GHGs have been falling for a decade, as shown in Figure 6. This is primarily due to a switch in primary energy use from coal to natural gas (which results in fewer emissions of GHGs per unit of energy produced).



Figure 6: Annual U.S. Emissions of Carbon Dioxide (in million metric tons) by Fuel Type

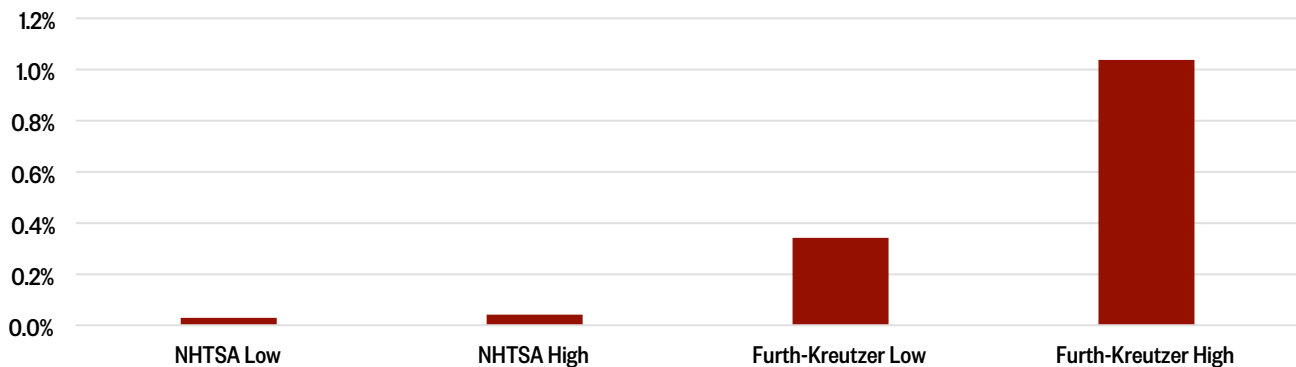


Source: Data from U.S. Energy Information Administration

Second, CAFE standards are an expensive way of reducing carbon dioxide emissions. In its regulatory impact assessment of CAFE standards for model years 2011–2025, NHTSA estimated the annualized cost of implementation at between \$5.4 billion and \$7.6 billion.<sup>22</sup> Other studies estimated much higher costs: in a review and extension of several estimates, Salim Furth and David Kreutzer of the Heritage Foundation found that the costs of meeting the new standards could range from \$61.2 billion to \$186.1 billion per year.<sup>23</sup> The higher figure would put the cost of meeting the new CAFE standards at approximately 1% of U.S. GDP—as shown in Figure 7.

<sup>22</sup> NHTSA: *Final Regulatory Impact Analysis: Corporate Average Fuel Economy for MY 2017-MY 2025; Passenger Cars and Light Trucks*, National Highway and Transportation Safety Administration, Office of Regulatory Analysis and Evaluation, National Center for Statistics and Analysis, August 2012, at p. 10. (Total discounted costs were estimated to be \$146.8 billion to \$155.7 billion.)

<sup>23</sup> Furth, Salim and David W. Kreutzer. *Fuel Economy Standards are a Costly Mistake*. Heritage Foundation Backgrounder No. 3096. March 4, 2016.

**Figure 7: Annualized Cost of New CAFE Standards (%GDP)**

Source: Authors' calculations based on: NHTSA, *Final Regulatory Impact Analysis: Corporate Average Fuel Economy for MY 2017-MY 2025 Passenger Cars and Light Trucks*, Office of Regulatory Analysis and Evaluation National Center for Statistics and Analysis, 2012, Table 1, p. 10.; Furth, Salim and David W. Kreutzer. *Fuel Economy Standards are a Costly Mistake*. Heritage Foundation Backgrounder No. 3096. March 4, 2016.

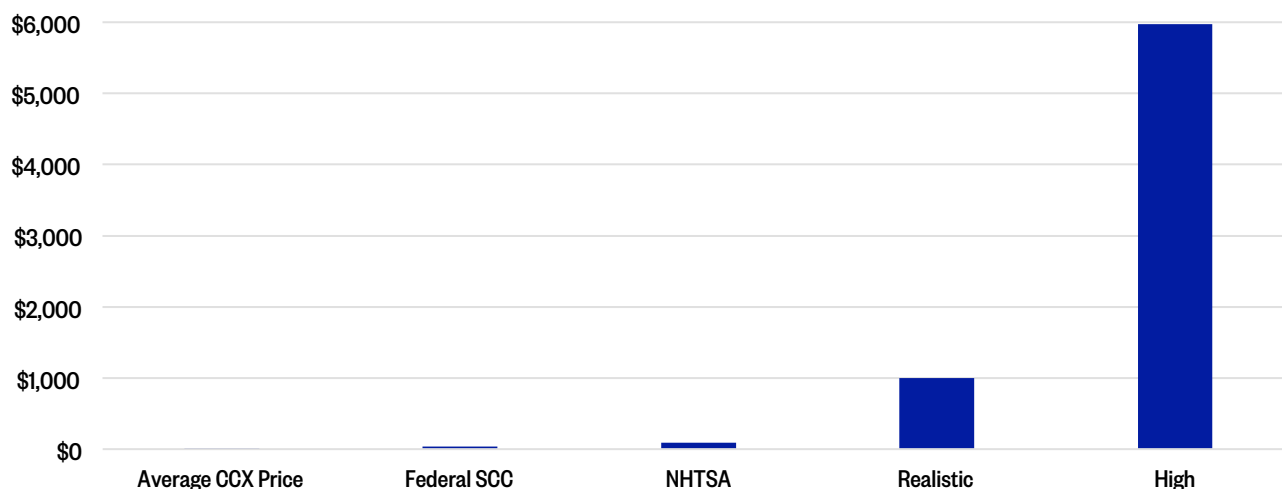
Using NHTSA's lowest estimate for the annual cost of implementing the 2017–2025 standards, \$5.4 billion, and NHTSA's maximum estimate for reductions in carbon dioxide emissions over the period 2016–2028, 62 million metric tons/year,<sup>24</sup> CAFE represents an implicit cost of \$87 per ton of carbon reduced. That is higher than most estimates of the “social cost of carbon” (SCC) and more than twice the SCC developed by the EPA for the federal government (but since rescinded by President Trump).<sup>25</sup> It is also more than 100 times the average price of a ton of carbon dioxide traded on the Chicago Climate Exchange (CCX).<sup>26</sup> Using a higher—and more realistic—estimate of annual cost of \$50 billion/year, and lower—but more realistic—estimate of emissions reduction of 50 million metric tons/year, CAFE represents an implicit cost of \$1,000/ton. At the highest cost (186.1 billion/year) and lowest reduction (31.2 million metric tons/year), the implicit cost is about \$6,000/ton. These estimates are shown in Figure 8.

<sup>24</sup> EPA/CARB/NHTSA, *Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022-2025*, Section ES-11, Table ES-5, Washington, DC: Environmental Protection Agency, California Air Resources Board, National Highway Transportation Safety Administration, EPA-420-D-16-900, July 2016. Available at: <https://nepis.epa.gov/Exe/ZyPDF.cgi/P100OXEO.PDF?Dockey=P100OXEO.PDF>. Total reductions of 748 million metric tons reduced over the 12-year period 2016–2028.

<sup>25</sup> For a review of estimates of the social cost of carbon, see: Julian Morris, *Assessing the Social Costs and Benefits of Regulating Carbon Emissions*, Los Angeles: Reason Foundation, 2015 (<http://reason.org/studies/show/social-cost-of-carbon>). See also: Julian Morris, *Climate Change, Catastrophe, Regulation and the Social Cost of Carbon*, Los Angeles: Reason Foundation, Forthcoming.

<sup>26</sup> The Chicago Climate Exchange provided a means of enabling companies voluntarily to reduce emissions through the purchase of “offsets”. Data on exchange prices are available here: <https://www.theice.com/ccx> (The average price per metric ton of carbon dioxide was \$0.64).

**Figure 8: Estimates of Cost of Reducing CO<sub>2</sub> Emissions by One Metric Ton under CAFE/GHG Emission Standards Compared to Alternatives and the Federal Social Cost of Carbon, US\$**



Authors' calculations based on: Price data from Chicago Climate Exchange (available at: <https://www.theice.com/ccx>); 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*. United States Government. August 2016. 4. (available at: [https://www.epa.gov/sites/production/files/2016-12/documents/sc\\_co2\\_tsd\\_august\\_2016.pdf](https://www.epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf)); NHTSA, *Final Regulatory Impact Analysis: Corporate Average Fuel Economy for MY 2017-MY 2025 Passenger Cars and Light Trucks*. Office of Regulatory Analysis and Evaluation National Center for Statistics and Analysis. 2012. Table 1. 10.; Furth, Salim and David W. Kreutzer. *Fuel Economy Standards are a Costly Mistake*. Heritage Foundation Backgrounder No. 3096. March 4, 2016.

Likewise, if we take the EPA's estimates, CAFE would reduce oil consumption by an annual average of 133 million barrels at a cost of \$5.4 billion—equivalent to \$40.5/barrel. But if we take the more realistic estimate of oil savings of 100 million barrels/year and a more realistic cost of even \$50 billion/year, the cost per barrel of oil saved rises to \$500/barrel. That's more than ten times the current price, five times the prevailing price in 2012, and more than three times the highest price oil has ever reached (\$156.34 in June 2008).

Even if it were considered desirable to increase vehicle fuel efficiency and/or reduce GHG emissions at a rate higher than would be achieved through innovation in a competitive market, fuel economy standards are a very inefficient way to achieve those goals. Numerous researchers have compared the efficiency of CAFE standards with alternatives such as higher gasoline and diesel taxes and find that taxes are far more efficient.<sup>27</sup> Fuel taxes incentivize

<sup>27</sup> See e.g.: Congressional Budget Office: *The Economic Costs of Fuel Economy Standards Versus a Gasoline Tax*, U.S. Congress: Washington, DC, 2003; Austin, David and Terry Dinan, "Clearing the Air: The Costs and Consequences of Higher CAFE Standards and Increases in Gasoline Taxes," *Journal of Environmental Economics and Management*, Vol. 50 (3), pp. 562-582, 2005; Jacobsen, Mark R., "Evaluating U.S. Fuel Economy Standards in a Model with Producer and Household Heterogeneity," *American Economic Journal*:

consumers to buy more-efficient vehicles and thereby incentivize manufacturers to produce more-efficient vehicles in ways that match consumer preferences rather than by seeking to comply with footprint-based fuel economy standards. By increasing the effective cost per mile travelled, fuel taxes reduce any rebound effect resulting from the purchase of more-fuel-efficient vehicles. Fuel taxes also result in higher scrappage rates for less-efficient vehicles—in other words, they reverse the negative effect created by fuel economy standards. In total, fuel economy standards like CAFE cost three to four times as much to achieve similar gains in fuel economy and emissions reduction as a fuel tax.<sup>28</sup>

Arguably, an even better alternative to fuel economy standards would be to charge drivers per mile travelled.<sup>29</sup> Such mileage-based user fees (MBUFs) have the advantage that prices could be varied according to the number of vehicles on the road, or at least according to the time of day—with higher prices during peak periods. This would reduce congestion, which results in additional unnecessary fuel use and emissions. MBUFs could also vary according to the weight of vehicle, thereby more accurately accounting for the damage the vehicle causes to the road. And they could vary according to the emissions released by the vehicle, thereby more effectively incentivizing users to reduce emissions. Moreover, unlike a manufacturer-side fuel efficiency standard, MBUFs could be changed according to local conditions, allowing cities with bad bouts of pollution to hike prices and lower them during periods of adequately clean air. While no research has quantified the political palatability of this exact proposal, survey results from California found that a similar scheme which charged variable vehicle registration fees based on fuel efficiency and vehicle miles travelled to be the most preferred highway revenue collection solution from a slate of policy options.<sup>30</sup>

Resources expended on improving fuel economy and reducing GHG emissions from vehicles through fuel standards—rather than more cost-effective alternatives such as fuel taxes or MBUFs—are not available for investment elsewhere. If these resources were not wasted on

*Economic Policy*, Vol. 5 (2), pp. 148-87, 2013; and Anderson, Soren T. and James M. Sallee, *Designing Policies to Make Cars Greener: A Review of the Literature*, NBER Working Paper No. 22242, Washington, D.C.: National Bureau of Economic Research, May 2016.

<sup>28</sup> Jacobsen, Mark R., Christopher R. Knittel, James M. Sallee, and Arthur A. van Benthem, *Sufficient Statistics for Imperfect Externality-Correcting Policies*, Manuscript: University of California at Berkeley.

<sup>29</sup> Poole, Robert W., Jr. and Adrian T. Moore. *Ten Reasons Why Per-Mile Tolling Is a Better Highway User Fee than Fuel Taxes*. Policy Brief 114. Los Angeles: Reason Foundation. February 2014. [http://reason.org/files/why\\_tolling\\_is\\_better\\_than\\_fuel\\_taxes.pdf](http://reason.org/files/why_tolling_is_better_than_fuel_taxes.pdf); Fleming, D. S. *Dispelling the Myths: Toll and Fuel Tax Collection Costs in the 21st Century*. Policy Study 409. Los Angeles: Reason Foundation, Nov. 2012. [http://reason.org/files/dispelling\\_toll\\_and\\_gas\\_tax\\_collection\\_myths.pdf](http://reason.org/files/dispelling_toll_and_gas_tax_collection_myths.pdf); DeGood, Kevin and Michael Madowitz. *Switching from a Gas Tax to a Mileage-Based User Fee: How Embracing New Technology Will Reduce Roadway Congestion, Provide Long-Term Funding, and Advance Transportation Equity*. Washington, DC: Center for American Progress, July 2014.

<sup>30</sup> Dill, Jennifer and Asha Weinstein. "How to pay for transportation? A survey of public preferences for California." *Transportation Policy* 14 (2007). 354.

compliance with inefficient fuel economy standards, there would be more resources available to spend on other environmental amenities, such as improvements in local air or water quality or conservation of species. Thus, requiring manufacturers to comply with fuel economy standards, rather than using a more cost-effective alternative policy tool to achieve the same goals, likely harms the environment.

## Conclusions

While the CAFE and GHG emission standards for model years 2017–2025 likely would reduce fuel consumption and GHG emissions, they would do so at extremely high cost. It is very unlikely that the benefits of such reductions come anywhere close to those costs. Moreover, the imposition of such costs on automobile manufacturers and ultimately consumers reduces the availability of resources to spend on environmental amenities that would have greater benefits. If society values reductions in fuel use and GHG emissions, there are other, far more effective and efficient means of achieving those goals, including fuel taxes or mileage based user fees. Policymakers should consider eliminating CAFE standards and switching to one of these more cost-effective alternatives.

## About the Authors

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