Comments Concerning Corporate Average Fuel Economy Standards for Model Years 2024-2026 Passenger Cars and Light Trucks

Referencing docket ID number:
NHTSA-2021-0053

Prepared on behalf of:
Union of Concerned Scientists

by David W. Cooke , Ph.D.

The model year (MY) 2012-2016 and 2017-2025 fuel economy and greenhouse gas emissions standards for light-duty vehicles (LDVs) represent the largest single policy step towards reducing greenhouse gas emissions and oil usage in the United States. In 2012, the Environmental Protection Agency (EPA) committed to a mid-term evaluation of its 2022-2025 greenhouse gas emissions standards, reviewing their standards in light of the availability, cost, and effectiveness of technology; the economic impact on the industry and country as a whole; the impact of the standards on reduction of emissions and fuel savings to consumers; and the feasibility of the standards, among other relevant factors.[1] In January, 2017, this review was completed, with EPA finalizing its determination that the 2022-2025 standards are feasible. After careful review of the robust evidence collected by EPA and the National Highway Traffic Safety Administration (NHTSA) as well as the comments put in the docket during the comment period on the Draft Technical Assessment Report (TAR) and in response to the Proposed Determination (PD) and accompanying Technical Support Document (TSD), the Union of Concerned Scientists strongly supported this conclusion.

Since the Final Determination, new data has only strengthened the case for the feasibility of those 2022-2025 standards—new studies continue to show how the agency previously overstated costs for compliance with those standards; new technologies have been developed by suppliers and manufacturers that continue to show how more efficient gasoline-powered vehicles can achieve those standards; and studies have shown that these regulations have tremendous benefits for the economy as a whole and, in particular, the financial health of lower-income households.

Despite this overwhelming evidence, EPA and NHTSA finalized new fuel economy and greenhouse gas emissions standards for MY2021-2026 that fall well short of what the industry could achieve and fail to uphold the agencies mandates under the Clean Air Act (CAA) and Energy Policy and Conservation Act (EPCA). Those finalized rules are predicated not just on a misguided understanding of the agencies' Congressional mandates but are rooted in fundamentally flawed analysis, which we and other organizations detailed extensively in petitions for reconsideration to the agencies.

Given the deeply flawed justification for the LDV standards currently on the books, President Biden's Executive Order (EO) 13990 directing EPA to reconsider these standards was a welcome action.[2] We appreciate both the recognition of the inadequacy of these regulations and the speed with which the administration is moving forward to address these shortcomings—UCS strongly

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[1] This is an abbreviated list. The full list may be found at 40 CFR 86.1818-12(h)(1).

[2] 86 FR 7037, January 25,2021. "Executive Order 13990 of January 20, 2021: Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis."

supports protecting public health and the environment and agrees that policy must be based on the best available science to adequately address the climate crisis. Unfortunately, NHTSA's proposed replacement for MY2024-2026 falls short of this goal.

Many of the concerns raised below echo comments drafted in response to proposed greenhouse gas emissions standards for new LDVs that cover some of the same model years as this proposed rule;[3] however, we have detailed here comments specific to NHTSA's analysis and authority under EPCA.

We support the need to take action immediately, as NHTSA proposes, while providing data in support of going even further in order to better reduce fuel use from LDVs. Not only does this information support moving forward with Alternative 3, but it also supports reducing the scope of incentives proposed by EPA—such incentives are not necessary to support a short-term strengthening of the greenhouse gas program and risk an erosion of the benefits of the program that could jeopardize the long-term ability to adequately deal with climate change and support the administration's critical goal for half of all new LDVs sold in 2030 to be zero-emission vehicles (ZEVs).[4]

Summarized, our comments reflect these basic positions:

- NHTSA must finalize the strongest standards possible for MY2026, and the industry is well positioned to comply with those standards, as indicated via UCS analysis. Alternative 3 represents the maximum feasible standard considered by NHTSA and will best prepare the industry for further increases in stringency beyond MY2027 consistent with EISA.
- NHTSA should eliminate flexibilities in the proposal which will undermine the effectiveness of the CAFE program. These include reining in the off-cycle credit program, which has led to a significant overcrediting of fuel consumption reduction, and eliminating full-size pick-up incentives, which reward status quo compliance strategies.
- NHTSA's latest Volpe model is deeply flawed, both from a number of new, unexplainable errors related to changes made to the program as well as a history of recurring problems that continue to undermine its usefulness as a reasonable analytic tool supporting the CAFE program.

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[3] EPA-HQ-OAR-2021-0208-0277

[4] 86 FR 43583, Augusts 10, 2021. "Executive Order 14037 of August 5, 2021: Strengthening Leadership in Clean Cars and Trucks."

I. Support for strong CAFE standards through 2026

It has been more than a decade since NHTSA introduced the reformed CAFE program, including the first increase in fuel economy standards for passenger cars in 25 years.[5] Since then, manufacturers have responded with significant advancements in technology. At the same time, few of the internal combustion engine technologies identified to reduce fuel use in line with those standards have made their way into the majority of the new vehicle fleet, indicating substantial room for improvement with off-the-shelf technology.[6] Even newer combustion technologies continue to be developed and deployed, including high-energy ignition systems, electrically assisted turbochargers, and more.[7] And all this is happening as manufacturers continue to deploy an increasing number of electric vehicle models, indicating that the transition to electrification is fully underway now, and through the timeframe of the proposed rule.

All of these ongoing developments support finalizing a strong rule quickly, setting the stage for even further increases in fuel economy in the post-MY2026 period.

a. Alternative 3 is the maximum feasible standard considered by NHTSA

There are a number of apparent flaws in NHTSA's modeling detailed in § III. Because these flaws undermine the core questions around feasibility and benefits of *all* alternatives considered by the agency, UCS has conducted its own modeling using a modified version of the Volpe model.[8] The results of this modeling are clear: while all alternatives show significant net benefits beyond the current 2024-2026 standards, Alternative 3 is both feasible and maximizes those benefits and should be finalized by NHTSA rather than its preferred alternative.

Feasibility of higher fuel economy standards

All of the alternatives considered by NHTSA are achievable in our analysis. However, they have significant differences in the degree to which they will push industry to a trajectory consistent with what is needed to address climate change. Below, we detail the achieved levels of fuel economy, and the technology deployment scenarios modeled which can achieve them.

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[5] 70 FR 51414, August 30, 2005. "Average fuel economy standards for light trucks; model years 2008-2011." 74 FR 14196, March 30, 2009. "Average fuel economy standards passenger cars and light trucks model year 2011."

[6] 75 FR 25324, Figure 4.2.

[7] Roush. 2021. "CAELP Gasoline Engine Technologies for Improved Efficiency." (submitted to the docket)

[8] While some details can be found in § III, a full description of the model can be found in comments to EPA regarding its greenhouse gas program for MY2023-2026, at EPA-HQ-OAR-2021-0208-0277, Appendix A.

Given the clear statutory requirements of EPCA, NHTSA's determination of the appropriate standard is clearly predicated based on its determination of the maximum feasible standard. UCS' modeling below focuses on numerable considerations which will impact the agency's decision, including the technological feasibility of its various proposed standards and impacts related to energy conservation and the environmental and general public welfare impacts stemming from those reductions in energy usage.

NHTSA has provided three alternatives, along with a baseline scenario. While its own modeling of those scenarios is fundamentally flawed (§ III), UCS has independently modeled those scenarios in order to assess the relative value of these alternatives. To aid comparisons with NHTSA's own analysis, UCS has provided the various benefits calculations primarily in terms of aggregate model years, relative to the baseline. It is clear based on every metric considered that Alternative 3 represents the maximum feasible alternative considered by NHTSA.

Figure 1 indicates both the level of CAFE standards required under the given alternative scenarios, as well as the CAFE and CO_2 levels achieved.[9] Importantly, unlike the agencies' own analysis, UCS' analysis does not show unreasonably large levels of overcompliance with the scenarios.[10] This is even in spite of the fact that our CAFE modeling does not consider any trading between manufacturers, a significant compliance flexibility that enables the industry to more cost-effectively comply with the standards which will further reduce any modeled overcompliance.

The technology utilized by manufacturers to comply with these standards is discussed below.

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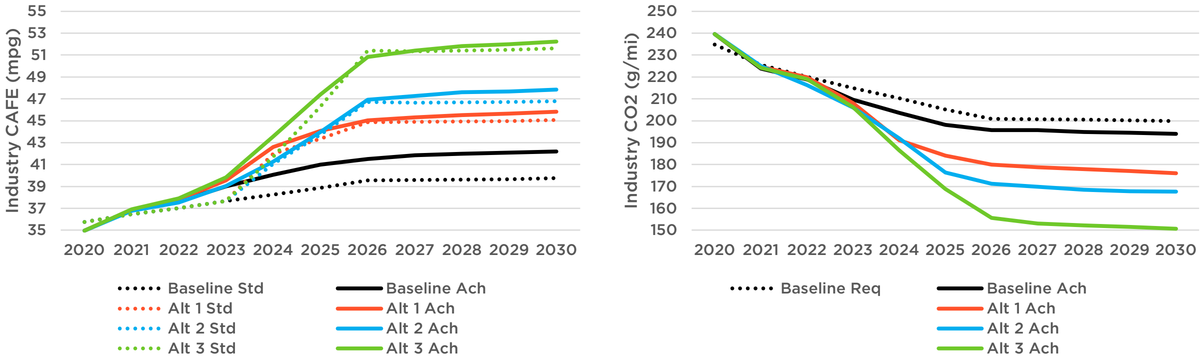
[9] Because CO_2 emissions reductions are a significant co-benefit from reductions in fossil fuel usage, and because EPA is pursuing a separate rule on greenhouse gas emissions (86 FR 43726), in many instances we have provided comparisons of our results in terms of average CO_2 emissions. Our analysis does not simultaneously track compliance with EPA's own program under its separate and distinct authority under the Clean Air Act-however, it is worth noting that the range of CAFE alternatives considered matches the range of alternatives modeled by UCS in response to EPA's proposals, with NHTSA's CAFE Alternative #3 yielding similar trajectories in emissions to UCS' recommendation to EPA of finalizing EPA Alternative #2 in MY2023-2025, plus an additional 10 g/mi stringency on top of EPA Alternative #2 in MY2026 (EPA-HQ-OAR-2021-0208-0277, Figure 5).

[10] While there is significant levels of CAFE overcompliance in the baseline, this is largely the result of overcompliance with CAFE resulting from improvements made by automakers who've voluntarily signed agreements with the state of California that will yield overcompliance with the SAFE program in MY2021-2026, as evidenced by the reduced overcompliance seen in Figure 5, where the baseline requirements include the California agreements.

FIGURE 1 CAFE standards and achieved fleetwide average fuel economy and emissions for the regulatory scenarios modeled



Nearly 12 mpg separates the emissions levels in 2026 for the scenarios considered, with a 6-mpg difference for the three action alternatives. It is clear that there is a significant opportunity to improve fuel economy through strong CAFE regulation. The resulting fleets regulated under CAFE will yield significant improvements as measured under EPA's own greenhouse gas emissions program as well.

TECHNOLOGICAL FEASIBILITY OF THE STANDARDS

Given automaker investments and future product plans,[11] it is likely that manufacturers' compliance strategies will include increased electrification. However, there are significant opportunities for improvements to internal combustion engine vehicles as well. The importance of both strategies is evident in our own modeling.

Internal combustion engine vehicles will continue to improve in the timeframe considered under this rule and show no sign of exhausting their potential. While our modeling suggests that manufacturers will deploy a significant number of EVs due to the improvement they can make in a fleet's performance, this is by no means the only path available, as indicated by the relatively low levels of vehicle technology modeled as being deployed in the remaining gasoline-powered fleet, which leave many other options open (Figure 2).

The strongest gains come in the adoption of high compression ratio (HCR) engines, and especially an advanced HCR engine with a cooled exhaust gas recirculation and dynamic cylinder deactivation (HCR2). As has been highlighted previously, HCR2 remains a cost-effective technology.[12] However, our modeling also shows an increase in advanced cylinder deactivation, as well as an increasing use of cylinder deactivation with turbocharged engines. We see with increasing stringency an increasing level of adoption of more advanced versions of a given engine platform, though there continues even in Alternative 3 to remain further room for improvement.

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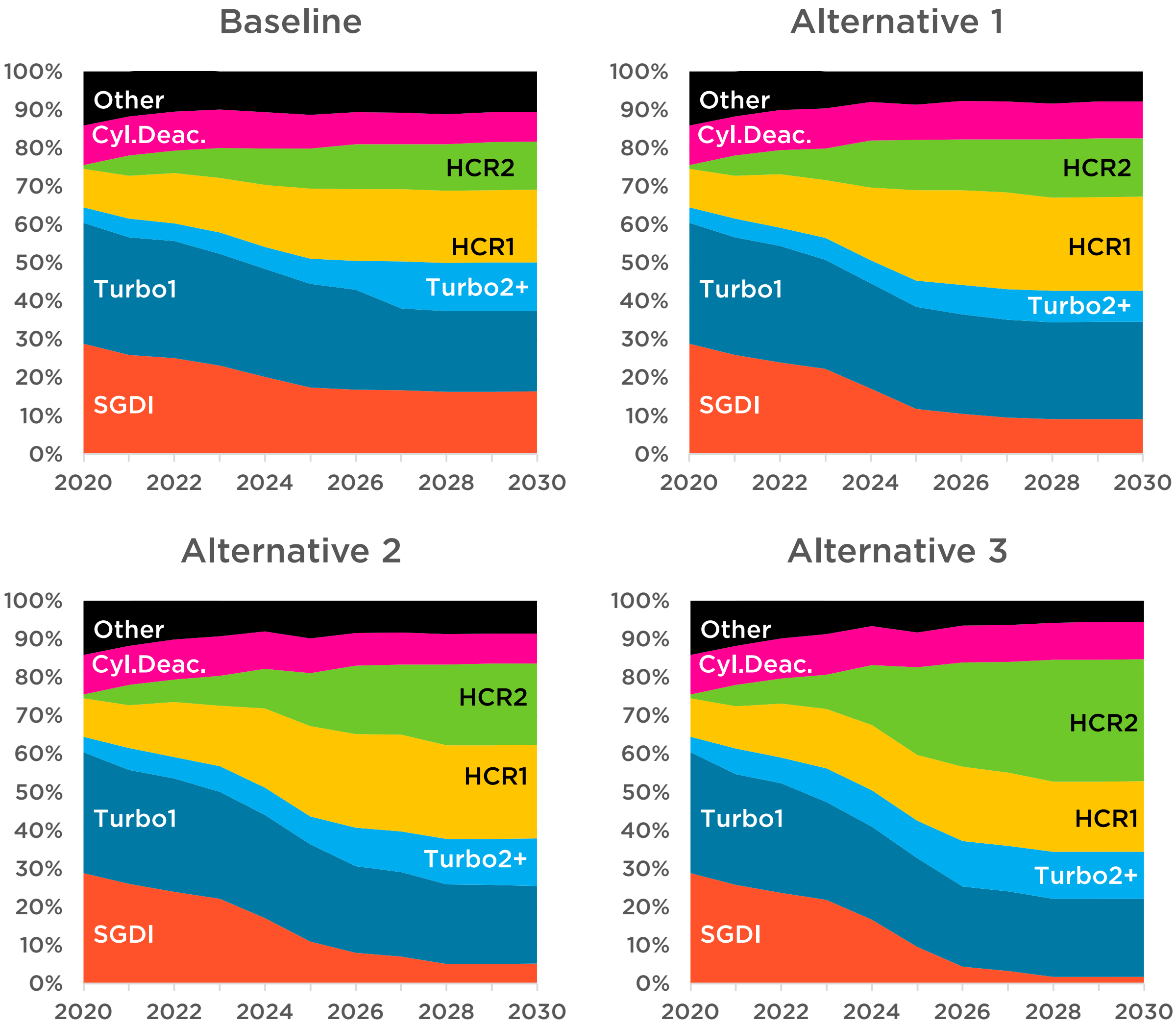
[11] Murphy, John. 2021. "US Automotive Product Pipeline: Car Wars 2022-2025 (Electric Vehicles shock the product pipeline)." Media briefing, June 10, 2021, on behalf of Bank of America Securities. https://s3-prod.autonews.com/2021-06/BofA%20Global%20Research%20Car%20Wars.pdf.
[12] EPA-420-R-17-002, pp. 52-53.

FIGURE 2 **Share of different technologies found in modeled internal combustion engine vehicles**



Incremental improvements to internal combustion engines occur under all scenarios, though the technology shifts are largely similar under all scenarios. Stoichiometric gasoline direct injected (SGDI) engines shift largely to high-compression ratio engines, particularly the more advanced HCR2. Turbocharged engines improve somewhat as well, particularly with the adoption of cylinder deactivation.

NOTE: Percentages refer to the share of internal combustion engine vehicles only—shifts to battery-electric or fuel cell vehicles are instead captured in Figure 3, while Figure 2 details the technology on the remaining engines.

While not shown, we saw across all scenarios a significant shift to more advanced transmissions, both for continuously variable transmissions (CVTs) moving to more advanced variants, and for a marked shift to more 10-speed automatic transmissions. Both of these are consistent with ongoing trends in the industry.[13]

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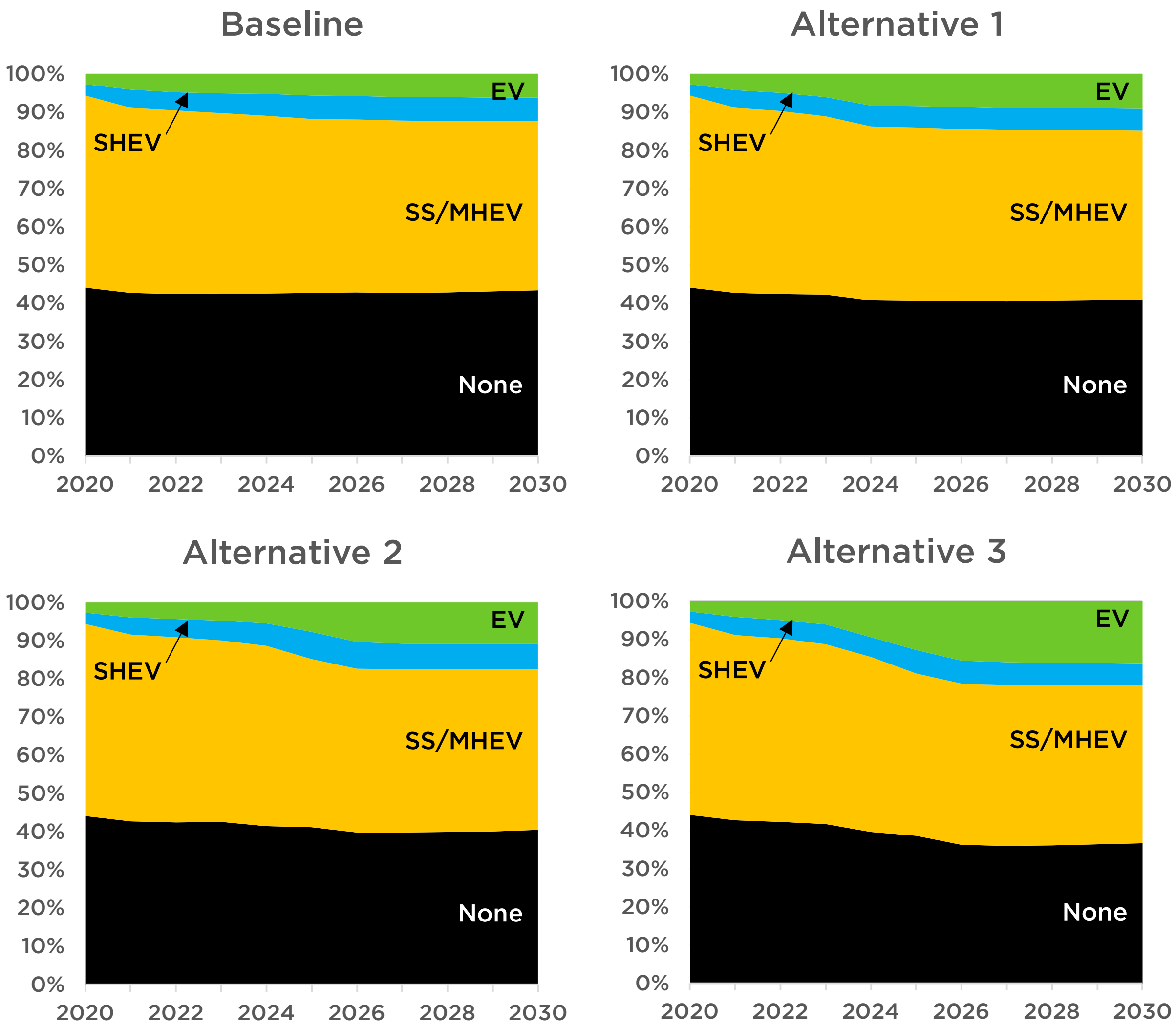
[13] National Academy of Sciences. 2021. Assessment of Technologies for Improving Light-duty Vehicle Fuel Economy 2025-2035, pp. 4—54-56 and Finding 4.4.

FIGURE 3 **Share of conventional, hybrid-electric, and plug-in electric vehicles, by model year**



Baseline

Alternative 1

Alternative 2

Alternative 3

Despite increasing stringency in the four different modeled scenarios, the share of start-stop (SS), mild hybrid-electric (MHEV), and strong hybrid-electric vehicles (SHEV) does not change dramatically. Mostly our modeling indicates a shift of a small share of vehicles away from a conventional platform (not even start-stop deployed, largely) to mostly battery-electric vehicles.

Interestingly, apart from the differences in plug-in electric vehicles, there is little difference between the four modeled scenarios when it comes to hybridization of conventional vehicles. Shares of stop-start/mild hybrids, as well as strong hybrids, only see marginal changes in all scenarios (Figure 3).

The relatively small changes in marketshare across different compliance scenarios illustrates one of the challenges with a model like the Volpe model—it can get stuck in particular pathways that act as a local minimum and may not necessarily fully reflect all of the compliance pathways utilized by manufacturers. There will always be examples of a model such as Volpe not quite accurately reflecting reality—for example, Figure 3 shows little change in strong hybridization, and our

modeling observed no strong hybrid pick-up trucks, yet both Ford and Toyota are moving forward with full-size hybrid pick-up trucks (§ II.b.). NHTSA's own modeling exhibits a similar level of stability in overall technology deployment across all regulatory scenarios and sensitivity cases.[14]

At the same time, while our model may not perfectly replicate the industry's eventual path forward, it indicates that there are many viable pathways for compliance, since large numbers of vehicles remaining in relatively low-technology configurations like a lack of start-stop or large remaining share of 18-bar BMEP turbocharged engines (Turbo1).

Benefits of higher fuel economy standards

The above analysis makes clear that all regulatory alternatives considered by NHTSA are achievable. However, the benefits of these standards vary widely. By every metric below, our analysis makes clear that Alternative 3 is the most beneficial alternative.

TOTAL SOCIAL BENEFITS

Table 1 indicates the overall social costs, benefits, and net benefits of the three regulatory alternatives. While the costs of Alternative 3 are nearly double that of Alternative 2, primarily related to the increased technology costs of greater battery electric vehicle sales, these increases costs are far outweighed by the social benefits. Net social benefits of Alternative 3 are nearly 50 percent greater than Alternative 2, at a 3 percent discount rate.

TABLE 1 Summary of benefits for MY1978-2029 vehicles

Scenario	Total Social Costs ($B)		Total Social Benefits ($B)		Total Net Social Benefits ($B)	
	3%	7%	3%	7%	3%	7%
Alternative 1	$56.6	$43.3	$87.1	$61.1	**$30.5**	**$17.8**
Alternative 2	$62.0	$45.4	$111.5	$76.8	**$49.5**	**$31.4**
Alternative 3	$126.5	$95.6	$199.3	$139.1	**$72.8**	**$43.5**

The climate, consumers, and the country overall are better off with more stringent alternatives. The most stringent alternative (Alternative 3) yields nearly 50 percent more benefits through the 2029 model year than the agency's preferred alternative (Alternative 2), at a 3 percent discount rate.

ECONOMIC BENEFITS

The economic benefits from increasing the stringency of CAFE regulations are substantial (Table 2). Consumers stand to gain up to $530 per vehicle in benefits, on net, over vehicles sold through MY2029, thanks largely to the substantial fuel savings resulting from stronger standards.

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[14] See Volpe output files, Central Analysis\output\M000000_P00000_S000000_T000000_2\reports-csv\technology_utilization_report.csv. For example, in MY2029, SS/MHEV penetration ranges from 41.0-43.7 percent over the three regulatory scenarios; HCR1/1D varies from just 24.8-26.0 percent; TURBO2+ spans just 24.8-29.6 percent; 10-speed Ats from just 44.4-46.4 percent; while EVs ranged from 8.8-18.3 percent.

TABLE 2 **Summary of economic benefits for MY1978-2029 vehicles**

	Est. Average Increase in Jobs (2021-2029)			Consumer Impacts		
Scenario	Auto sector	Macro (low)	Macro (high)	Costs ($B)	Benefits ($B)	Net $ / veh
Alternative 1	4,700	22,600	31,400	$50.1	$86.2	**$250**
Alternative 2	6,400	24,800	33,600	$58.6	$113.6	**$380**
Alternative 3	13,200	47,900	67,100	$121.8	$198.4	**$530**

The climate, consumers, and the country overall are better off with more stringent alternatives. The most stringent alternative would cut greenhouse emissions by 50 percent more through 2050 than the proposal and put us on a more sustainable trajectory. Even looking at just the model years EPA is proposing to alter shows that consumers will net up to $11 billion back in their pockets over the lifetime of these new vehicles.

NOTE: For normalizing the consumer impacts, only new vehicle sales were considered in the denominator.

Those additional fuel savings come from substantial technology improvements, which mean increased jobs for the auto sector in particular, with greater investments offsetting any potential decreases in sales volume. However, it is the economywide impact of those fuel savings that spawn greater job growth overall. While UCS did not conduct new economywide analysis for this rulemaking, previous macroeconomic analysis over a similar time period indicated substantial job growth as household income that would have been wasted on gas expenditures is reinvested into the broader economy.[15] Assuming a similar level of economic effect resulting from the net re-spending seen in UCS' analysis of NHTSA's proposals, we estimate that strong standards could achieve an average economywide increase of up to 67,100 jobs annually over the 2021-2029 period.[16]

PETROLEUM REDUCTIONS

TABLE 3 **Summary of reductions in petroleum and petroleum impacts from MY1978-2029 vehicles**

Scenario	Oil Reductions (B bbl)	Net fuel savings ($B)		Reduction in Oil Externalities ($B)	
		3%	7%	3%	7%
Alternative 1	**0.98**	45.3	$28.4	$1.17	$0.73
Alternative 2	**1.22**	58.3	$35.6	$1.44	$0.87
Alternative 3	**2.35**	104.8	$64.8	$2.80	$1.73

Reductions in petroleum resulting from strong standards translates not just into significant net fuel savings for consumers but significantly reduces externalities associated with the petroleum-based transportation sector. The oil-related benefits of Alternative 3 are nearly double that of the agency's preferred alternative (Alternative 2).

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[15] Allison, A., J. Hall, and F. Ackerman. 2018. "Giving back half the gains." Report by Synapse Energy Economics prepared for Union of Concerned Scientists, September 25, 2018. https://www.synapse-energy.com/sites/default/files/Giving-Back-Half-the-Gains-17-072.pdf.

[16] *Ibid.,* Table 1. To estimate a range, we consider the fuel savings with and without fuel taxes. Given the design of IMPLAN, it is likely that the high estimate is more accurate with respect to the modeled outputs; however, the range of values was indicated owing to the large amount of uncertainty in changes to the economy since the analysis was originally undertaken, and these values should be seen primarily as qualitatively representative of the magnitudes of macroeconomic job impacts.

As we've noted previously, the most important of the four statutorily required factors for NHTSA to consider in setting the maximum feasible standard is "the need for the United States to conserve energy."[17] According to this metric, the savings are nearly twice as great under Alternative 3 than the agency's preferred alternative (Table 3), reducing lifetime oil usage by 2.35 billion barrels at net fuel benefits of $104.8 billion, at a 3 percent discount rate. The externalities of this oil usage result in an additional $2.80 billion in benefits, at a 3 percent discount rate.[18]

ENVIRONMENTAL AND PUBLIC HEALTH BENEFITS

As a result of the substantial reductions in petroleum usage, there are clear public health outcomes from strengthening the standards for MY2024-2026 (Table 4). Additionally, the tailpipe and upstream emissions affected by this rule have the potential to disproportionately affect vulnerable communities, as communities who live in close proximity to roads and refineries are more likely to be of a racial minority, Hispanic ethnicity, and/or low socioeconomic status.[19]

The spatial extent of these pollution impacts are a critical component of understanding the environmental justice element of this rule, particularly if the agency moves forward with finalizing a rule much stronger than the one it proposed, which will inevitably drive greater EV adoption and could yield even more complex variations between local pollution from tailpipe and upstream sources. At the same time, previous air quality analysis of the MY2017-2025 rules found only a

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[17] Center for Biological Diversity v. NHTSA, 538 F.3d 1172, 1194 (9th Circ. 2008); Center for Auto Safety v. NHTSA, 793 F.2d 1322, 1340 (D.C. Circ. 1986). Cited in the comment to NHTSA and EPA regarding the SAFE MY2021-2026 NPRM, at EPA-HQ-OAR-2018-0283-5840.

[18] Recent evidence from Oak Ridge National Laboratory, as analyzed by EPA, suggests greater valuation of petroleum-based externalities and would yield impacts more than twice as great (see EPA-420-R-21-018, Section 3.2).

[19] Mohai, P., D. Pellow, and J. Roberts Timmons. 2009. *Env. justice. Ann. Rev.* 34: 405–430. https://doi.org/10.1146/annurev-environ-082508-094348; Rowangould, G.M. 2013. "A census of the near-roadway population: public health and environmental justice considerations." *Trans Res D* 25: 59–67.http://dx.doi.org/10.1016/j.trd.2013.08.003; Marshall, J.D., K.R. Swor, and N.P. Nguyen. 2014. "Prioritizing environmental justice and equality: diesel emissions in Southern California." *Environ. Sci. Technol.* 48: 4063–4068. https://doi.org/10.1021/es405167f; Marshall, J.D. 2000. "Environmental inequality: air pollution exposures in California's South Coast Air Basin." *Atmos. Environ.* 21: 5499–5503. https://doi.org/10.1016/j.atmosenv.2008.02.005; C.W. Tessum, D.A. Paolella, et al. 2021. "PM2.5 polluters disproportionately and systemically affect people of color in the United States." *Sci. Adv.* 7. DOI: 10.1126/sciadv.abf4491; U.S. EPA. 2014. Risk and Technology Review—Analysis of Socio-Economic Factors for Populations Living Near Petroleum Refineries. Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina. January; Tian, N., J. Xue, and T.M. Barzyk. 2013. "Evaluating socioeconomic and racial differences in traffic-related metrics in the United States using a GIS approach." *J. Exposure Sci. Environ. Epidemiol.* 23: 215–222; Boehmer, T.K., S.L. Foster, et al. 2013. "Residential proximity to major highways—United States, 2010. Morbidity and Mortality Weekly Report 62(3): 46–50.

TABLE 4 Summary of environmental and public health benefits from MY1978-2029 vehicles

Scenario	Greenhouse Gases		Reductions in non-GHG Emissions			Reduced Premature Mortality (deaths)	
	Reductions ($MMTCO_2e$)	($B, at 3% SCC)	Reduced $PM_{2.5}$ (tons)	Monetary Benefits ($B)			
				3%	7%	Low est.	High est.
Alternative 1	409	$18.0	4,390	$5.0	$2.7	460	1065
Alternative 2	517	$22.5	5,563	$6.6	$3.6	608	1403
Alternative 3	967	$42.3	9,951	$10.3	$5.5	969	2245

The climate, consumers, and the country overall are better off with more stringent alternatives. The most stringent alternative would cut greenhouse emissions by 50 percent more through 2050 than the proposal and put us on a more sustainable trajectory. Even looking at just the model years EPA is proposing to alter shows that consumers will net up to $11 billion back in their pockets over the lifetime of these new vehicles.

handful of areas that would experience a negative shift in PM or ozone levels,[20] and coal-fired power plants continue to be retired,[21] helping to clean up some of the dirtiest local sources of upstream emissions. Moreover, the public health impacts of these rules extend well beyond immediate proximity as a result of the complex atmospheric chemistry involving these pollutants, and the estimated public health impacts based on average emissions shows in general a small but positive trend (Table 4). While we support an effort to better assess local exposure impacts, such efforts are more appropriate for a future rule and not a critical component of assessing the benefits of the proposal.

II. Proposed flexibilities undermine the CAFE program

While NHTSA is more limited in what flexibilities it may consider under EPCA, there are three significant changes that serve to undermine the CAFE program. Each of these changes results in increases in fuel usage and result in a direct erosion of the consumer, energy, and climate benefits of the rule.

Given the relatively weak stringency of its proposal, NHTSA should not move forward finalizing *any* of the proposed changes in flexibilities under its Preferred Alternative. As we seek to reduce the adverse impacts of our fossil-fuel dependent transportation sector, we need *certainty* from the CAFE program. These proposed flexibilities could significantly erode the projected benefits of the rule at a time when every drop of oil reduction is needed.

a. Off-cycle credits

The off-cycle credit program was introduced to capture reductions in fuel use that were not captured in the standard two-cycle test procedures. While this program has prompted some

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[20] EPA-454-R-12-004, Figures III—1-3.

[21] S&P Global Platts Analytics. 2021. "US coal-fired power output decline continues with last PSEG coal plant retirement." June 1, 2021. https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/060121-us-coal-fired-power-output-decline-continues-with-last-pseg-coal-plant-retirement.

innovation, including active aerodynamic improvements and high efficiency alternators, real-world data on the benefits of many of these technologies continues to be scant, even as they become a larger and larger share of the purported reductions of the fleet.

Despite this lack of evidence, NHTSA is proposing to *increase* the amount of reliance on off-cycle credits for reductions from the rule by increasing the cap on technologies from the off-cycle menu. UCS strongly opposes the increase of this cap—if anything, the latest evidence indicates that NHTSA should be reining in the impacts of the off-cycle program, not expanding it.

Evidence of real-world improvement?

In the design of the off-cycle program, and in particular the off-cycle menu, uncertainty was cited as a major factor in the design of the program.[22] Despite some fleets approaching the limit of the off-cycle credit menu, indicating a widespread use of these off-cycle technologies, there has been no systematic study of the impacts of these technologies. What little additional data is available suggests that the program has likely been substantially overcrediting manufacturer improvements.

TABLE 5 Comparison of off-cycle menu credits to NREL data[23]

Technology	Percent Reduction	Equivalent Credit (g/mi)		Menu Credit (g/mi)	
		Car	Truck	Car	Truck
Active seat ventilation	17.0%	2.0	2.9	1.5	2.0
Active cabin ventilation	0.4%	0.1	0.1	2.1	2.8
Passive cabin ventilation	0.9%	0.1	0.1	1.7	2.3
Solar control glass	8.5%	1.0	1.5	Up to 2.9	Up to 3.9
Solar reflective paint	3.4%	0.4	0.6	0.4	0.5

Data from NREL indicates that while active seat ventilation may be slightly underestimated, the benefits of both active and passive cabin ventilation are wildly overestimated. The solar control technologies show data in agreement with the level of credit assessed under the off-cycle menu.

NATIONAL RENEWABLE ENERGY LABORATORY DATA

Researchers at the National Renewable Energy Laboratory (NREL) have published the most extensive look at a number of off-cycle technologies: active seat ventilation, both active and passive cabin ventilation, solar control glass, and solar reflective paint.[24] The results of these studies are shown in Table 5, compared to NHTSA's off-cycle credit menu values. Because there is a

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[22] "The fleetwide cap is being finalized because the default credit values are based on limited data, and also because EPA recognizes that some uncertainty is introduced when credits are provided based on a general assessment of off-cycle performance as opposed to testing on the individual vehicle models." (77 FR 62727)

[23] For ease of comparison with NREL data, off-cycle credit values are shown in g/mi CO_2. Under NHTSA's CAFE program, these values are converted to a mile-per-gallon adjustment value (40 CFR 600.510–12).

[24] Kreutzer, Cory, et al. 2017. "Impact of active climate control seats on energy use, fuel use, and CO_2 emissions." Presentation at the SAE 2017 Thermal Management Systems Symposium, October 10-12, 2017, Plymouth, MI. NREL/PR-5400-69119. Kreutzer, Cory, at al. 2017. "U.S. light-duty vehicle air conditioning fuel use and the impact of four solar/thermal control technologies." Presentation at the SAE 2017 Thermal Management Systems Symposium, October 10-12, 2017, Plymouth, MI. NREL/PR-5400-69047.

discrepancy between values assumed by NHTSA and NREL for the greenhouse gas emissions associated with air conditioning usage, we have used NREL's observed percentage improvement for the technologies but applied them to the baseline A/C efficiency value, in order to provide an apples to apples comparison with the off-cycle menu credits, which were derived from the agencies' assumed A/C values.

While the NREL data suggests that the menu credit may be conservative with respect to the benefit of active seat ventilation, the off-cycle menu has significantly overcredited both active and passive ventilation. The solar control technologies are comparable to the off-cycle credits awarded by the menu.[25] While just 16 percent of the fleet received credit for adopting active seat ventilation in MY2019, 70 percent of the fleet received credit for passive cabin ventilation, and an additional 9 percent received credit for active cabin ventilation. This overestimate indicates that NHTSA has significantly overcredited manufacturers with respect to thermal control technologies.

EPA TECHNOLOGY ASSESSMENT

EPA has also identified three technologies for which manufacturers have been receiving undue credit: passive cabin ventilation, active engine warm-up, and active transmission warm-up. In all three cases, manufacturers have been receiving credit for technologies that are less efficient than the technologies used to estimate the reduction in emissions.[26] NHTSA is currently seeking to adopt these same provisions.

UCS strongly supports NHTSA revising the off-cycle menu definitions for these technologies, and we concur that any manufacturers seeking credit for technologies that do not meet this revised definition must do so through the public comment process outlined in 40 CFR § 86.1869-12(d). In fact, we recommend that the agencies make these revised definitions effective immediately to avoid further unwarranted credits for these inferior technologies.

DOUBLE-COUNTING UNDER THE CURRENT THERMAL CONTROLS CREDITING PROCESS

The current assessment of the benefits of thermal control technologies does not recognize the simultaneous improvements in the efficiency of air-conditioning systems. Therefore, it inherently overstates the benefits of thermal control technologies, whose benefit is related to the reduced

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[25] Solar control glass is credited as a scalable technology under the off-cycle menu. However, our estimates of the average credit earned by manufacturers for this technology is similar to the single value assessed by NREL researchers.

[26] "This open dash vent technology [deployed by manufacturers] is not as effective as the combination of vents used by the NREL researchers to allow additional ambient temperature air to enter the cabin and also to reduce the restriction of heated air exiting the cabin" (86 FR 43764). "EPA expects that [the technologies deployed by manufacturers] may provide some benefit. But, as noted above since these system designs remove heat that is needed to warm-up the engine the Agency expects that these technologies will be less effective than those that capture and utilize exhaust waste heat" (86 FR 43765).

usage of the air-conditioning system—if the air-conditioning system has been improved, the emissions associated with the use of that system are reduced. NHTSA, together with EPA, should revise the process for awarding thermal control credits to reflect a manufacturer's improvement in A/C efficiency.

In MY2019, manufacturers were credited with improvements to A/C efficiency of 4.0 g/mi for cars and 6.1 g/mi for trucks; this is compared to baseline emissions of 11.9 g/mi for cars and 17.2 g/mi for trucks, a reduction in emissions of more than one-third.[27] The credit for thermal controls technology should scale accordingly.

The lack of justification for an increase in the off-cycle credit cap

Given the data to date that indicates manufacturers have received *too much* credit for off-cycle technologies, it is difficult to imagine why EPA would expand the program's use by increasing the off-cycle cap. In fact, if NHTSA were to fully adjust its program to eliminate these unwarranted credits, no manufacturer would be close to the 10 g/mi cap on menu technologies, with the vast majority of manufacturers below 7 g/mi with their MY2019 fleets (Figure 4).[28]

Not only would these revisions offset any potential justification for an increase in the menu cap, but it underlines the incredible amount of overcrediting in which the data-light off-cycle menu has resulted. Since the off-cycle menu went into effect in the CAFE program with MY2017, we estimate that credits equivalent to 7.68 billion gallons of lifetime gasoline usage have been awarded—of those, 2.96 billion gallons are not justifiable for the reasons stated above, or nearly 40 percent of all off-cycle credits awarded under the CAFE program. Unfortunately, this problem is getting worse over time, as manufacturers latch onto cheap-to-deploy credits like passive cabin ventilation which result in virtually no benefits but are awarded significantly under the off-cycle menu (Figure 5).

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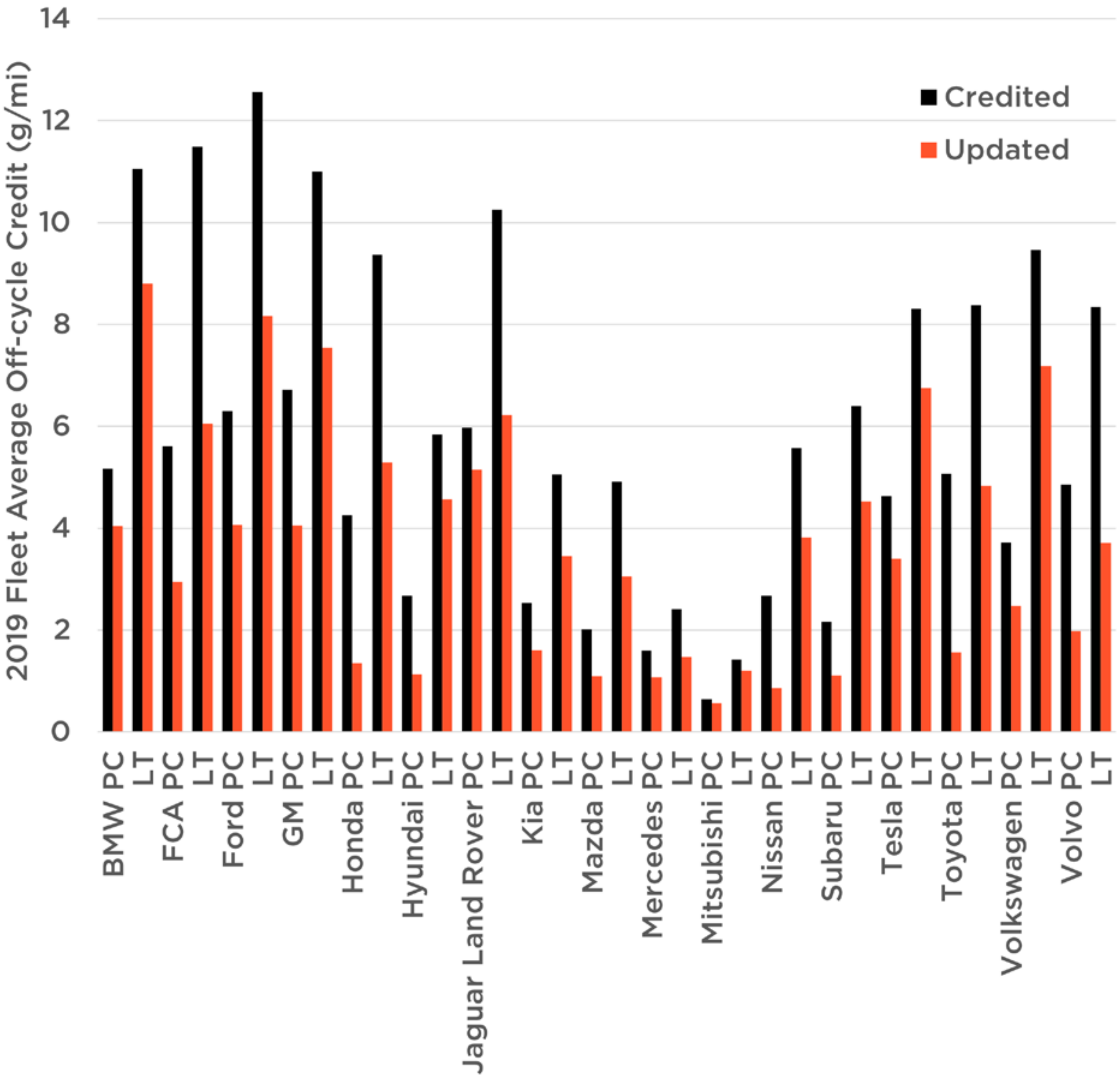
[27] MY2019 data: EPA. 2021. "Explore the Automotive Trends Data." Online at https://www.epa.gov/automotive-trends/explore-automotive-trends-data#DetailedData. Baseline data: EPA-420-R-12-901, p. 5—29.

[28] Values in Figure 8 are based on an imprecise reverse engineering process—EPA would be able to compare with the actual manufacturer-submitted data, to which UCS does not have access. The updated values reflect corrections for the NREL data, thermal control double-counting, and EPA's revised definitions for active engine and transmission warm-up. While EPA is proposing the complete elimination of credit under the menu for these technologies, with which UCS concurs, for modeling purposes we have eliminated only half of these credits under the assumption that some share of those credits would be awarded credit under the public comment procedure. It is further worth noting that these averages include credits awarded under the alternative methodology process as well, which includes credits for high-efficiency alternators for which EPA claims require an increase in the menu cap (86 FR 43763).

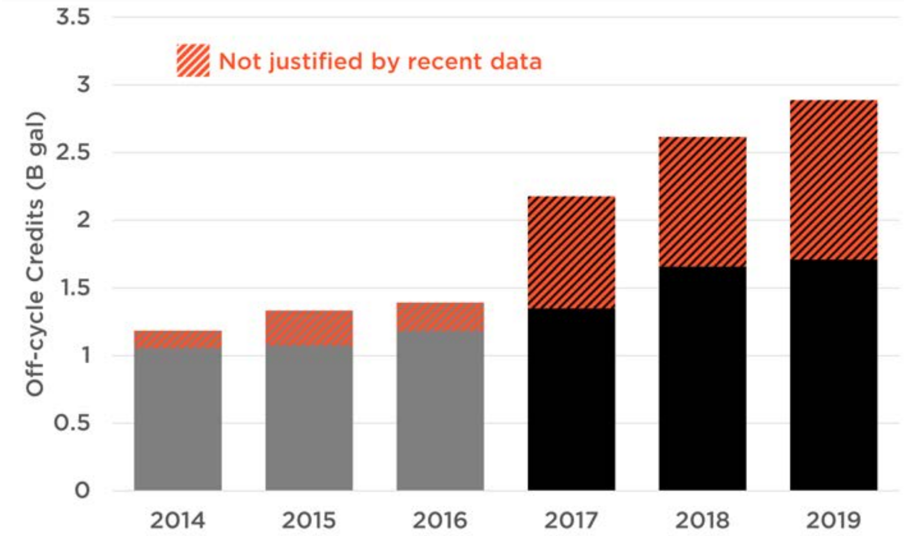
FIGURE 4 **Comparison of MY2019 off-cycle credits with and without adjustments to reflect the most recent data on the effectiveness of off-cycle technologies**



A number of MY2019 fleets are at or approaching the 10 g/mi average off-cycle credit cap, according to EPA data (black bars). However, a significant share of the credits responsible for these levels of crediting are not justifiable based on the latest data. When correcting for data on effectiveness of off-cycle technologies (red bars), industry sees an average reduction in fleet performance of 3.1 g/mi. This eliminates any concerns about restrictions caused by the cap and appropriately corrects for a long-overdue evaluation in the performance of these technologies.

Eliminating the increase in credit cap should not be used to justify any reduction in the stringency of the proposal. In fact, modeling by Dan Meszler, an independent consultant, showed that benefits improve significantly when manufacturers must respond to the proposal with powertrain

FIGURE 5 MY2014-2019 off-cycle credits



While off-cycle credits have been steadily rising over time, the share of credits which are awarded at a level incommensurate with the benefits of the technology has been rising at a much faster rate, the likely result of manufacturers seeking to maximize the impact of loopholes in the CAFE program at minimum cost. (MY2014-2016 values are shown for illustrative purposes only, as the menu technologies were not credited under the CAFE program until MY2017.)

technologies that lead to real-world performance.[29] Maintaining the 10 g/mi off-cycle cap while enforcing the preferred alternative increases the net present value of benefits through calendar year 2050 from $140 billion ($86 billion) at a 3 (7) percent discount rate to $170 billion ($110 billion).[30] One of the critical reasons for this improvement is a reduction in per-vehicle price increase from $1,044 in MY2026 down to $867.

Timely awarding of off-cycle credits

NHTSA highlighted the lengthy delays in manufacturer requests for off-cycle credits.[31] Not only do these delays diminish public access to information on manufacturer compliance, but they are

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[29] To assess this, Mr. Meszler simply reduced the off-cycle cap in the EPA-CCEMS input files to 10 g/mi in all years. This prevents any adoption of credits above 10 g/mi and forces the additional stringency to be made up via improvements in powertrain or vehicle technologies. While this modeling used an older version of the Volpe model, its results are likely to be generally consistent with the current model used by NHTSA.

[30] There are two main reasons for this significant improvement: 1) off-cycle technology costs in the model are significantly higher than the marginal cost of powertrain or vehicle technologies to comply at the same level, so applying with 2-cycle technology in lieu of off-cycle credits reduces the cost of compliance; 2) the EPA-CCEMS model does not generate real-world benefits for off-cycle credits; this remains true in the Volpe updated Volpe model (§ III.a.). Implicit in their modeling is that no off-cycle credits result in real-world fuel savings or emissions reductions—any modeled differences in off-cycle credit deployment result in significant costs with no benefits, drastically skewing the results.

[31] 86 FR 49836.

indicative of an industry seeking to game the off-cycle credit system, including seeking retroactive off-cycle credits for vehicles sold long ago, credits which were not part of the manufacturer's initial product plans.

EPA has previously iterated that any credits awarded are required to be reported by the next credit reporting deadline and reiterated its stance that credits are generally required to be reported within four months after the end of a model year.[32] It is therefore disconcerting that NHTSA has identified ongoing manufacturer reporting issues.

UCS concurs with NHTSA's concern about the effect this has on compliance and the credit market, as well as public oversight and recommends that the agencies move forward with the changes to eligibility requirements for non-menu off-cycle technologies put forth by NHTSA in its proposal, adopting them beginning with MY2023.[33] Retroactively awarding credits for off-cycle technologies is a pure windfall for manufacturers and offers challenges for the agencies in their oversight of the off-cycle credit program. Manufacturers seeking approval of novel test procedures should be required to move forward with such requests well in advance of the model year in order to ensure adequate time for the assessment of such processes. Moreover, requiring timely filing for any credits granted under such programs maintains public awareness of manufacturer compliance, which strengthen the integrity of the program and the robustness of the credit trading market.

b. Strong pick-up credits

Another flexibility being considered by NHTSA is reinstating so-called "advanced technology" incentives for full-size pick-ups, which awards 20 g/mi additional credit per full-size pick-up that is either a strong hybrid or has a performance at least 20 percent better than the applicable standard, provided it represents at least 10 percent of production.

NHTSA has put forward a baffling rationale for this credit, claiming that precisely because manufacturers have now announced qualifying trucks that it makes sense to reinstate the credit for "the potential role incentives could play in increasing the production of these technologies, and the associated beneficial impacts on fuel consumption."[34] But if manufacturers are already putting forth these technologies without such incentives in place, reinstating the credit will simply reduce the stringency of the CAFE rule, acting as a windfall credit and resulting in a reduced incentive for technology adoption, similar to what has been documented with electric vehicles.[35]

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[32] EPA-420-R-17-003, p. 2.

[33] 86 FR 49837.

[34] 86 FR 49833.

[35] Gillingham, K. 2021. "Designing Fuel-Economy Standards in Light of Electric Vehicles." NBER working paper #29067.

The Ford PowerBoost hybrid went on sale earlier this year and is already selling at a take-rate of 8.4 percent over the past three months, despite a chip shortage that is currently limiting production, making it quite likely that this vehicle will qualify for the credit.[36] Additionally, Ford is slated to start producing the Lightning full-size EV pick-up in MY2022,[37] which shows that a strong hybrid pick-up isn't so "advanced." With a new production target of 80,000 units, the Lightning will also likely qualify for the credit under the performance provision. And it isn't just Ford who's rolling out these vehicles: Toyota's next Tundra full-size pick-up will only have two engine offerings, one of which is a hybrid.[38]

Even in the absence of the full-size pick-up strong hybrid/performance credit, manufacturers have moved forward with plans for full-size pick-ups that meet the criteria. The simple reason is that these vehicles are sold by only a small number of manufacturers, and as such represent a critical piece of the portfolio of those manufacturers—a company like Ford cannot afford for its best-selling vehicle to be a deficit-generator under the standards. Since these vehicles are already planned, the agency's reinstatement of the credit cannot be considered an incentive—instead, it is a windfall credit.

Because full-size pick-ups are a very concentrated part of the market, while the total credits generated under this flexibility may not be as large as some of the other proposed flexibilities, they will be available to only a small number of companies and thus have an outsized impact on those manufacturers. If 20 percent of F-150s sold qualify for this credit, this provision would generate credits equivalent to a 2.5 g/mi improvement in Ford's light truck fleet thanks to this potential windfall credit, corresponding to more than a 0.3 mpg increase in its fleet CAFE value.

In addition to the concentration of this credit in the hands of just a few manufacturers, there is an additional concern around the efficiency of the strong hybrid pick-ups. These vehicles are not being designed for efficiency, as acknowledged by the Tundra's Executive Program Manager.[39] Given that, it makes sense to eliminate the strong hybrid credit entirely, and if NHTSA wishes to

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[36] Share calculated from WardsAuto monthly sales data for the light-duty F-series for June, July, and August 2021. For information on the chip shortage, see Howard, Phoebe. 2021. "Ford is about to ship thousands of F-150s to dealers as pickup demand remains high." *Detroit Free Press*, July 2, 2021. https://www.freep.com/story/money/cars/ford/2021/07/02/ford-sales-f-150-semiconductor-chip-shortage/7836909002/.

[37] White, Annie. 2021. "Ford F-150 Lightning production to double thanks to strong demand." *Car and Driver*, August 24, 2021. https://www.caranddriver.com/news/a37384636/ford-f-150-lightning-ev-production-increase/.

[38] Toyota. 2021. "Absolute powerhouse: Next-generation 2022 Toyota Tundra." Press release, September 19, 2021. https://pressroom.toyota.com/absolute-powerhouse-next-generation-2022-toyota-tundra/.

[39] "'I think the priority was definitely performance,' Sackett said. 'We did see some improvements of efficiency and that was absolutely one of the things on our list. But one of the things we really wanted to focus on was the performance, and it was really centered around torque." Bell, Lucas. 2021. "The 2022 Tundra's twin-turbo V-6 hybrid is all about torque." *Road and Track*, September 22, 2021.

implement a full-size pick-up credit, it should only be for the 20 percent performance credit. This ensures that at least the credit windfall will be limited to efficient vehicles, not just a high-performance trim level.

UCS opposes the reinstatement of the full-size pick-up "advanced technology" credit. However, if NHTSA includes such a provision in its final rule, it should only be under the performance mechanism.

c. Minimum domestic passenger car standard adjustment

NHTSA has proposed once again to inappropriately adjusted the minimum domestic passenger car standard (MDPCS).[40] Not only is this inconsistent with its legal authority, but it implies that NHTSA does not believe in the validity of its own modeling. Below we detail the flaws in this approach and urge NHTSA to adhere to its mandate, finalizing a MDPCS lacking any spurious "offset."[41]

NHTSA's offset undermines its analysis of the NPRM

NHTSA's analyses of the standards in the NPRM are based on the footprint size of a vehicle—essentially, "passenger cars will have more stringent targets than light trucks regardless of footprint, and smaller vehicles will have more stringent targets than larger vehicles."[42] As a result, analyzing the impacts of the standards requires NHTSA to make projections about the footprint size of the vehicles in the fleet, as this affects average fleetwide fuel economy levels—and thus fuel consumption and emissions, as well as compliance costs.[43]

The analysis in the Final Rule is, therefore, premised on NHTSA's assumptions about the footprints of passenger cars and light trucks in the fleet. But in a separate part of the Final Rule, related to NHTSA setting the Minimum Domestic Passenger Car Standard (MDPCS), NHTSA states that it believes the footprint projections in the central analysis are wrong. This undermines the agencies' entire analyses.

The MDPCS is based on projections of average fuel economy under the CAFE standards.[44] In setting the MDPCS in the NPRM, NHTSA discussed automakers' complaints that the MDPCS's set

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[40] 86 FR 49789.

[41] These comments echo those of the UCS Petition for Reconsideration, § I.O. and II.

[42] 86 FR 49611.

[43] *Ibid.* "The proposed standards would be defined by a mathematical equation that represents a constrained linear function relating vehicle footprint to fuel economy targets for both cars and trucks."

[44] 49 USC § 32902(b)(4).

in the past have sometimes turned out to be more stringent than what the MDPCS would have been if it were set based on the actual average fuel economy required for a given model year.[45]

Based on this analysis, NHTSA claims that the MDPCS for MY2011-2018, calculated based on the Secretary's projection of passenger car fleet average fuel economy, has been more stringent by an average of 1.9% than it would have been if based on actual average passenger car fleet fuel economy. NHTSA states that, "this difference indicates that in rulemakings conducted in 2009 through 2012, NHTSA's and EPA's projections of passenger car vehicle footprints and production volumes, in retrospect, underestimated the production of larger passenger cars over the MYs 2011 to 2018 period."[46] As a result, and as discussed in the next section, NHTSA proposes to unlawfully "adjust" the MDPCS for MY2024-2026 down by 1.9%.

NHTSA's discussion undermines the agencies' footprint projections in the central analysis.

The agency effectively states that it believes those projections are wrong. It is patently arbitrary to conduct the analysis for CAFE standards using a certain set of projections, and then, when setting other standards in the same rulemaking, state that the projections in the main analysis are wrong. The agency either has confidence in the projections in the central analysis or they do not; and if they do not, they should change them.

This basic principle remains true in an alternative adjustment process concocted by NHTSA, which would project forward an alternative trend in footprint from that of its central analysis.[47] The agency shows no substantial benefit to this alternate approach, and instead finds quite clearly just how drastically either offset differs from the values found in its central analysis underpinning the rule.[48]

NHTSA's analysis demonstrates quite clearly the disparity between its assumed fleets in the MDPCS and its central analysis. NHTSA must reconcile these two projections. Previous analysis by UCS in response the MY2021-2026 FRM showed that adjusting the fleet footprint to yield a fleet consistent with the 1.9 percent reduction in fuel economy has a substantial effect on the benefits of the rule. We increased the footprint of all passenger car models by 2.07 percent for each MY in the analysis.[49] Doing so reduces the net benefits of the SAFE FRM from -$13.1 billion down to -$16.6

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[45] 86 FR 49789.

[46] *Ibid.*

[47] 86 FR 49790.

[48] 86 FR 49791, Table VI-4.

[49] This value corresponds to the corresponding shift in average footprint required for passenger cars to move from a fleet average target of 47.7 mpg to 46.8 mpg in 2026 (a 1.9% adjustment), according to the CAFE curves utilized by NHTSA in the CAFE compliance model, MY2021-2026 FRIA at 1916 (Table VIII-3).

billion at the 3 percent discount rate, and from $16.1 billion down to $12.8 billion at the 7 percent discount rate.[50]

NHTSA's statement in setting the MDPCS that it believes that the central analysis' projections of vehicle size are wrong undermines the NPRM analysis and its conclusions. If NHTSA in fact believes that vehicles will be larger than it projects in the central analysis, then it must re-do the central analysis as a result. Doing so would have significant impacts on NHTSA's analysis, as shown here.

NHTSA's "adjustment" to the Minimum Domestic Passenger Car Standard is improper and unlawful

As described above, NHTSA has "adjusted" the Minimum Domestic Passenger Car Standard (MDPCS) downward (i.e., making it more lenient), asserting that the adjustment is appropriate because the agency has underestimated the average footprint size of the passenger car fleet in the past. But EPCA specifies how the MDPCS is to be calculated and does not authorize the agency to depart from that methodology. NHTSA must correct the MDPCS and remove the adjustment that makes it less stringent than the statute requires.

EPCA requires that in addition to the CAFE standards:

> "Each manufacturer shall also meet the minimum standard for domestically manufactured passenger automobiles, which shall be the greater of— (A) 27.5 miles per gallon; or (B) 92 percent of the average fuel economy projected by the Secretary for the combined domestic and non-domestic passenger automobile fleets manufactured for sale in the United States by all manufacturers in the model year, which projection shall be published in the Federal Register when the standard for that model year is promulgated in accordance with this section."[51]

As noted in the NPRM, "[s]ince that requirement was promulgated, the '92 percent' has always been greater than 27.5 mpg, and foreseeably will continue to be so in the future."[52]

The statute clearly requires that the MDPCS must be calculated using the Secretary's projection of the average fuel economy that will be achieved by the passenger vehicle fleet sold in the United States in each model year. To make this projection, NHTSA must make projections about the

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[50] Note that these values reflect a single change to the modeling accompanying the MY2021-2026 FRM. Given the substantial disparity between the UCS model utilized in the rest of these comments, it is likely that this represents a significant underestimate of the potential impacts using an updated model.

[51] 49 USC § 32902(b)(4).

[52] 86 FR 49788.

footprints of those vehicles, as that determines the stringency of the fuel economy standards with which the fleet must comply.[53]

In the NPRM, NHTSA discusses automakers' complaints that the MDPCS's set in the past have sometimes turned out to be more stringent than what the MDPCS would have been if it were set based on the actual average fuel economy required for the combined domestic and non-domestic passenger automobile fleets manufactured for sale in the United States by all manufacturers in a given model year.[54] The actual level can only be known at the end of a model year, as it is based on the footprints of the vehicles actually produced.

NHTSA rejected a petition from automakers to set the MDPCS retroactively, once the required level of average passenger car fuel economy is known for a given model year, but the agency "recognizes industry concerns that actual total passenger car fleet standards have differed significantly from past projections."[55]

Based on an examination of previous rulemakings, NHTSA claims that the MDPCS's for MY2011-2018, calculated based on the Secretary's projection of passenger car fleet average fuel economy, have been more stringent by an average of 1.9 percent than they would have been if based on actual average passenger car fleet fuel economy.[56] NHTSA states that, "[t]his difference indicated that in rulemakings conducted in 2009 through 2012, NHTSA's and EPA's projections of passenger car vehicle footprints and production volumes, in retrospect, underestimated the production of larger passenger cars over the MYs 2011 to 2018 period."[57]

Consistent with its previous illegal act in the MY2021-2026 rule, "NHTSA is [again] proposing to retain [a] 1.9 percent offset for the MDPCS for MYs 2024-2026, ... recalculated based on the current projections for passenger cars based on the current analysis fleet."[58]

NHTSA's actions are unlawful and in direct contradiction with the statute. NHTSA projected the new passenger car vehicle fleet that will be sold in the respective model years—that projection is a core component of the central analysis of the NPRM. Under EPCA, the MDPCS must be set at 92 percent of that projection.[59] If NHTSA does not believe in the fleet projections underlying its

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[53] 86 FR 49611. "The proposed standards would be defined by a mathematical equation that represents a constrained linear function relating vehicle footprint to fuel economy targets for both cars and trucks."

[54] 86 FR 49789.

[55] 86 FR 49789.

[56] *Ibid.*

[57] *Ibid.*

[58] *Ibid.*

[59] 49 USC § 32902(b)(4).

central analysis for the CAFE standards, it must change them to ones it does believe in. But the MDPCS must be based on "the average fuel economy projected ... for the combined domestic and non-domestic passenger automobile fleets manufactured for sale in the United States by all manufacturers in the model year, which projection shall be published in the Federal Register when the standard for that model year is promulgated."[60] NHTSA must base the MDPCS on NHTSA's passenger car footprint projections in the central analysis of the rule, as is legally required.

NHTSA incorrectly assumes its fleet projections can be wrong in one direction

Throughout its discussion of the adjustment factor and its new, ad hoc proposed linear adjustment factor, it is assumed by the agency that footprint trend only goes in one direction.[61] And yet, the agency "expresse[s] concern that consumer demand may shift even more in the direction of larger passenger cars if fuel prices continue to remain low," going on to explain that "sustained low oil prices can be expected to have real effects on consumer demand for additional fuel economy, and consumers may foreseeably be even more interested in 2WD crossovers and passenger-car-fleet SUVs than they are at present."[62]

Today, prices for U.S. crude oil is the highest it has been since 2014, and oil futures prices have climbed to a 3-year high.[63] If sustained low oil prices can shift demand *toward* crossovers, then that implies that sustained high oil prices can shift demand *away* from those same vehicles, suggesting that not only are NHTSA's concerns overblown, but that they should consider whether their projected MDPCS values are underestimating the footprint as a result of outdated projections of fuel price. Indeed, this is precisely the fuel price scenario that led to a massive shift towards passenger cars when NHTSA was first revising its CAFE standards.[64]

Additionally, the agency's model calculates relative sales mix already as part of its dynamic fleet share model.[65] As "dynamic" implies, this responds to shifts in relative costs of fueling the vehicles, and can go in either direction, depending upon changes in fuel price and fuel economy. The agency in its own model understands that mix shift can go in either direction, so why would NHTSA propose an adjustment to the MDPCS that implies a unidirectional shift?

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[60] ***Ibid.***

[61] **86 FR 49790, Figure VI-1.**

[62] **86 FR 49789.**

[63] **https://www.reuters.com/business/energy/oil-prices-edge-lower-wake-jump-opec-supply-restraint-2021-10-05/**

[64] **https://www.reuters.com/article/uk-usa-economy-oil/oil-shock-threatens-lasting-changes-to-u-s-economy-idUKN2320596920080523**

[65] **CAFE Model Documentation NPRM August 2021, p. 91.**

NHTSA has a central analysis that takes into consideration many of the factors identified by the agency as responsible for a potential shift in fleet mix. If the agency does not think that its model is good enough at projecting the fleet, it must say so as part of that central analysis, and it should seek to remedy such concerns by correcting that underlying model, not in some ad hoc approach that confuses correlation with causation and lacks any underlying scientific or technical basis.

III. NHTSA's latest Volpe model behaves irrationally

During the MY2021-2026 rulemaking process, UCS outlined a number of failings with the agency's compliance modeling tool, the Volpe model.[66] NHTSA has updated its compliance modeling tool since the MY2021-2026 FRM;[67] however, many of these errors remain intact. Moreover, additional changes to the model appear to lead to erroneous, irrational compliance behavior, particularly in the model's baseline, which dramatically reduces the perceived net benefits of the rule. While the inputs to the model and the model's source code itself work together to produce erroneous results, the discussion is divided in order to provide more clarity for the agency.

NHTSA should continue to revise its model until it more accurately reflects industry behavior; in lieu of such achievement, it should note the flaws and shortcomings in the model clearly and consider how those errors are reflected in analysis to ensure that such flawed modeling is not overweighted with regards to the agency's determination of a "maximum feasible" standard.

a. Erroneous behavior of the Volpe model

While NHTSA continues to refine the Volpe model, there are some fundamental issues with the model that remain. Many of these fundamental problems result in aberrant behavior which is neither consistent with industry practice nor economically efficient or rational and serves primarily to erroneously increase costs of compliance. The specifics of these flaws are discussed below, as well as NHTSA's erroneous attempts to rationalize these flaws away.

Evidence of massive overcompliance

Figure 6 compares the results of UCS' modeling of both EPA and NHTSA programs to help illustrate the degree to which the modeling supporting NHTSA's NPRM represents an illogical and incongruous degree of overcompliance. There are many reasons for this incredible degree of overcompliance, which are discussed in further detail below.

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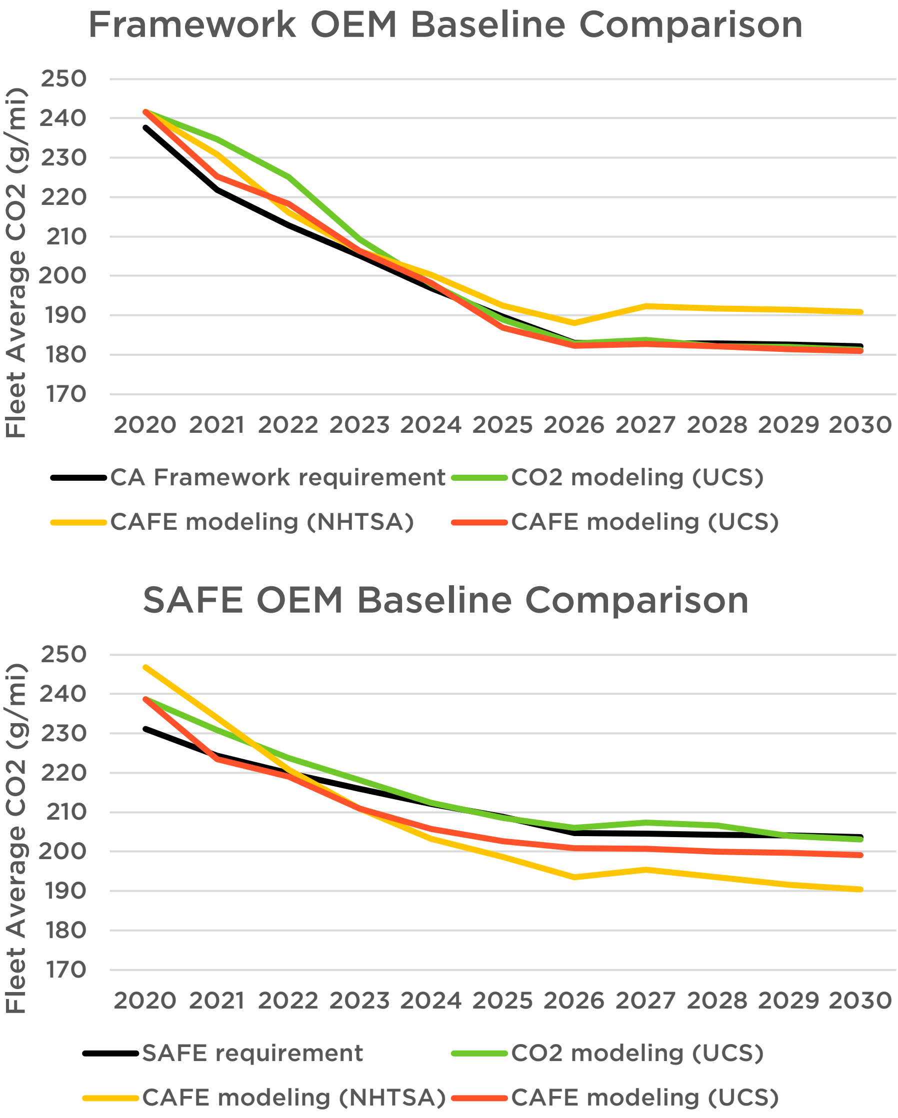
[66] See UCS comments at NHTSA-2018-0067-12039 and UCS, Petition for Reconsideration of NHTSA's Final Rule—The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks, June 12, 2020.

[67] 86 FR 49625

FIGURE 6 **Comparison of NHTSA and UCS modeling**



The modeling supporting the MY2024-2026 standards (yellow lines) shows the manufacturers who did not *sign on to the voluntary agreements (lower figure) achieving roughly the same level of fleet greenhouse gas performance as the manufacturers who did (upper figure). UCS analysis shows no such discrepancy. UCS' CAFE model does show a significant level of overcompliance for the non-framework manufacturers; however, this is almost entirely attributable to the lack of trading of CAFE credits, since Tesla alone results in a significant overcompliance with the standard.*

The clearest depiction of the faulty behavior inherent in NHTSA's modeling is that under the baseline standards, there is virtually no difference in the level of achieved CO_2 performance between those manufacturers who have voluntarily signed agreements with the state of California to overcomply with the current federal CO_2 standards and those which have not: as modeled by the agency, the former move from 231 g/mi performance in 2021 to 191 g/mi performance in 2029; the

latter from 234 g/mi to 192 g/mi.[68] This flies in the face of rational industry behavior—if there were no difference in baseline performance, why would only a subset of manufacturers sign these voluntary agreements?

Reasons for the model's incredible levels of overcompliance

There are a litany of flaws in the agency's model, many of which were pointed out previously in the SAFE rule.[69] Principle among the model's flaws is the application of technology regardless of the level of compliance, which leads to significant overcompliance and credit underutilization.[70] This is now made even more complicated in the latest iteration of the Volpe model, with the model's attempts to comply simultaneously with multiple programs. This results in a one-way ratcheting of technology adoption. Because the model prioritizes CAFE compliance, it uses the CAFE cost-effectiveness to "rank" the technology options. Once it is compliant with CAFE, if it is not complying with the CO_2 program, it continues to adopt technologies efficient for the CAFE program, regardless of their relative effectiveness towards compliance with the CO_2 program. Additionally, it does not then remove any technologies that would have been unnecessary for that compliance, thus maximizing overcompliance. Because the model underutilizes credits, this overcompliance results in significant inefficiency.

This overcompliance is especially insidious in the baseline fleet, when many cost-effective technologies would not be required by the baseline regulations. NHTSA takes note of the significant levels of overcompliance in its analysis of the baseline fleet for those manufacturers who have not signed onto the voluntary agreements with California but brushes them aside with erroneous arguments about overcompliance (see below for a rebuttal).[71]

A principal issue, ultimately, is the way in which overcompliance leads to increased costs, which is related to the inefficient way in which NHTSA's Volpe model utilized credits earned by manufacturers. Most significantly, the model applies technology it deems to be cost-effective, regardless of whether or not there is sufficient credits to comply with the standards. This inevitably leads to the expiration of credits—under a model with an identical compliance algorithm, industry adopted $40 billion in additional direct technology costs to offset allowing $6 billion worth of credits expire.[72]

While less significant under the CAFE program, where a manufacturer can simply pay a fine in lieu of compliance, manufacturer-to-manufacturer trading does occur, albeit in a non-

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[68] Here we use 2029 to account for the maximum 3-year window of carryback allowed under the program. By 2026 the values are 188 g/mi and 194 g/mi, respectively.

[69] NHTSA-2018-0067-12039 Technical Appendix, Section I.A.2.

[70] *Ibid.*, p. 39.

[71] NHTSA MY2024-2026 TSD, pp. 50-57.

[72] NHTSA-2018-0067-12039 Technical Appendix, p. 36.

transparent way.[73] Such manufacturer-to-manufacturer trading can be modeled in a number of ways, but NHTSA refuses to do so.[74] Because NHTSA's CAFE program lacks public data, we must estimate the amount of trading which is likely to occur by looking to EPA's greenhouse gas program, which provides significantly more transparency: EPA's greenhouse gas emissions rules required approximately 1 billion Mg of reductions from the fleet through MY2019; 30 million Mg of credits with vintage MY2014 or earlier were traded and used in that same timeframe, or about 3 percent of the requirement.[75] At a minimum, it is likely that overcompliance would be expected to be about 3 percent as a result of the lack of manufacturer-to-manufacturer trading, a difference similar to that seen in UCS's analysis.[76] Because credit trading is limited due to an excess of credits owing to the one-time lifetime extension of MY2010-2015 credits under the EPA program, this could likely be an underestimate of the impact of credit trading on future, more stringent standards. Tesla alone generates more CAFE credits in a single year than the entire sum of deficits generated by SAFE manufacturers in the baseline analysis—that these credits remain entirely unused is a clear inefficiency in the model. NHTSA's own assessment of CAFE flexibilities shows that credit trading has been utilized about as much as the total sum of carryback, credit transfers, and non-compliance paid for by civil penalties, making it the second-most utilized flexibility after carryforward, covering 19 percent of the deficits generated over this time period.[77] Since the CAFE model also does not consider carryback of credits,[78] this means that the model excludes 27 percent of the flexibilities actually used by industry to comply from MY2011-2017.

(Because of the lack of transparency and lack of disclosure under NHTSA's CAFE program, we cannot determine precisely to what degree compliance with the CAFE program is likely to be made through trading moving forward, and we urge NHTSA to rectify this by disclosing information on the volumes of credits traded, by manufacturer, as is done under the EPA CO_2 program.)

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[73] **83 FR 42998**

[74] **85 FR 24307**

[75] **In total, 118 million Mg of credits have been traded through MY2019; however, most of these credits have not yet expired or been applied to offset deficits, so it would not be appropriate to compare the full sum to the 1 billion Mg requirement.**

[76] **Because the SAFE rules are met easily with little technology application and are virtually identical for the CAFE and EPA programs, comparing the red and green curves in Figure 6 for the SAFE manufacturers yields an approximation of the difference between turning credit trading on and off. The difference in the two curves is ranges from 2.1 to 3.3 percent over the 2021-2029 period.**

[77] **86 FR 49823, Figure VII-7**

[78] **85 FR 24307**

The impacts of the model's tendency towards massive overcompliance has a significant impact on the cost-benefit analysis of the rule, as noted by NHTSA: "If NHTSA had instead used a baseline in which fuel economy only ever improved due to CAFE regulation, net benefits attributable to the proposal would have increased by about $17 billion."[79] Our own estimates put this figure even higher (§ I.a), owing to differences in the model with respect to key inputs such as sales elasticity and rebound (§ III.b).

Lack of evidence of historical overcompliance

NHTSA claims that "the last 15 years' worth of CAFE compliance data show that [manufacturers] do [improve fuel economy even in the absence of standards."[80] However, this assertion ignores a massive amount of data and context which directly undermines this assertion.

Most clearly, the existence of overcompliance does not itself mean that manufacturers apply technology towards fuel economy in absence of standards. For example, prior to EISA amending EPCA in 2007, manufacturers were significantly more limited in their path to compliance, including total restrictions not just on manufacturer-to-manufacturer trading, but even transfers of credits between fleets, as well as a smaller window of time to use credits. These restrictions naturally coerce manufacturers towards overcompliance in order to ensure enough of a "compliance buffer."

On top of this, in the window analyzed by the agency, federal CAFE standards were increasing the entire time,[81] and state greenhouse gas emissions standards were finalized years prior to increased federal passenger car CAFE and greenhouse gas emissions standards,[82] and NHTSA has not even attempted to disentangle manufacturer compliance with any of those standards from any additional expenditure on technology which could increase fuel economy with respect to gas prices. In fact, analysis by automotive consultant Dan Meszler shows precisely how little influence gas prices have on fuel economy improvements in this timeframe (Appendix A), and UCS supports his summary conclusion:

> **"As shown in the regression analysis presented above, it is highly probable that virtually none of the significant fuel economy improvement observed since 2005 would have accrued in the absence of increasingly stringent fuel economy standards. The chimera of consumer-driven fuel economy demand should be removed from the CAFE model and alternative fuel economy standards credited with their full fuel savings benefits (as has historically been the case)."**

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[79] ***Ibid.*, p. 58.**

[80] **NHTSA MY2024-2026 TSD, p. 44.**

[81] **67 FR 16052, 68 FR 16868, 70 FR 51414, 74 FR 14196.**

[82] **CARB. 2005. Rulemaking on the proposed regulations to control greenhouse gas emissions from motor vehicles. https://www.arb.ca.gov/regact/grnhsgas/grnhsgas.htm.**

Inaccurate accounting of off-cycle credit benefits and costs

In addition to the flaws related to overcompliance, there is a fundamental problem with the approach taken by the agency to its handling of off-cycle credits. By excluding them from the normal technology application process, NHTSA's model neither reflects reasonable adoption of the technology, nor does it accurately reflect the benefits.

OFF-CYCLE CREDIT COSTS

When it comes to the costs of the off-cycle technologies, these are far out of line with what is appropriate or reasonable, particularly given the hamfisted approach to simulating their adoption. NHTSA chooses to adopt a set level of off-cycle technologies regardless of compliance levels or the costs of those technologies. While it may be reasonable to assume that manufacturers will maximize the utilization of any flexibility in the regulation, it is an economically irrational decision by the model when the marginal costs of adopting this technology exceed that of other technologies.

Unlike other technologies, off-cycle technologies are simply forcibly applied in all scenarios per a pre-determined schedule defined in the market-ref.xlsx file. Ostensibly, this should mean that it has little effect on the costs and benefits of the rule because the same level of deployment is assume in the baseline case as in the regulatory case. However, because the response to the increase in the regulatory cap from 10 g/mi to 15 g/mi forces the technology to be adopted regardless of whether or not it is cost-effective, it can produce significant regulatory cost increases. Moreover, because of an issue with the underlying model, improvements from off-cycle credit technologies are not considered as part of a vehicle's real-world performance, and thus provide no benefit at that high additional cost if different levels of off-cycle technology are applied in a regulatory scenario compared to the baseline. This is a non-trivial reason why the modeling runs capping the off-cycle level to 10 g/mi show such significant benefits.

We assume that manufacturers are not going to adopt the technology unless it is no more expensive per g/mi improvement than other technologies it is considering. To approximate a reasonable marginal cost for off-cycle technologies, we've relied upon data provided by the National Academies for a range of technology packages.[83] Comparing the incremental cost for the SUV and medium car packages for 2017 to 2025 to the savings in g/mi leads to a marginal cost for the total tech packages of $12-20 per g/mi improvement. For comparison, the value for off-cycle technology improvements in the Volpe model is credited at $76-90 per g/mi. For the UCS model, we have divided the assumed off-cycle costs by 4—while this is still generally higher than the

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[83] NAS 2021, Tables 3.4-3.6.

TABLE 6 SAFE OEM compliance costs in MY2021-2026

	CO_2 Rating (g/mi)		Total Costs ($)		Average total cost ($/[g/mi])		Marginal cost ($/[g/mi])	
Year	+5 OC	+0 OC	+5 OC	+0 OC	+5 OC	+0 OC	+5 OC	+0 OC
2020	239	239	$316	$316				
2021	231	231	$377	$377	$8	$8	$8	$8
2022	225	225	$428	$428	$8	$8	$8	$8
2023	218	218	$471	$471	$8	$8	$7	$7
2024	189	191	$998	$951	$14	$13	$18	$17
2025	177	177	$1,169	$1,178	$14	$14	$15	$17
2026	171	170	$1,513	$1,562	$18	$18	$55	$57

Reducing assumed off-cycle credit costs by a factor of four leads to roughly comparable regulatory costs with (+5 g/mi off-cycle) and without (+0 g/mi off-cycle) the increase in the cap.

values estimated, it leads to roughly similar costs of compliance with and without the assumed +5 g/mi increase in off-cycle credits, with only slightly higher costs in the absence of increased off-cycle credit availability, as one would expect for a flexibility that the agencies assume will be fully exhausted (Table 6). And the observed regulatory costs are in line with our input values for off-cycle credits in the timeframe ($19-21/[g/mi]).

OFF-CYCLE CREDIT BENEFITS

While updating the costs of off-cycle technologies helps address some of the concerns with high regulatory costs associated with an increase in the cap, it does not fix the issue with the Volpe model not recognizing them as benefits.

As far as can be determined from the accompanying documentation, NHTSA has not acknowledged that its Volpe model does not consider increased adoption of off-cycle technology to yield any real-world benefit. While UCS has concerns about the overcrediting of off-cycle technologies (§ II.a), there is supportive evidence of their real-world benefits, and at any rate NHTSA must state explicitly its rationale for excluding these technologies from the benefits of the rule, as the credits associated with these technologies represent a substantial share of the credits accrued for compliance by manufacturers.

As it does for A/C efficiency credits,[84] NHTSA should correct the Volpe model to ensure it adjusts a vehicle's fuel economy to account for reductions in emissions and fuel use from off-cycle technologies, which will yield a more accurate accounting of the benefits from the CAFE program.

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[84] See `EffectsModel.cs`, ln 1930.

b. Inputs to the Volpe model

In addition to fundamental problems with the inner workings of the Volpe model, many of the issues in NHTSA's modeling are the direct result of bad inputs to the flawed model. A number of these have been identified and corrected in the UCS model;[85] however, below we respond to a few new changes made explicitly for the current NPRM.

Rebound

NHTSA's use of a 15 percent rebound effect is inconsistent with the latest available data and represents a departure from the 10 percent rebound effect used in all prior CAFE rulemakings except for the deeply flawed 2020 final rule. The relevant research suggests that 10 percent is actually the likely *maximum* of the rebound effect, and there is a substantial amount of evidence for even lower values. For a complete discussion of the latest evidence and why NHTSA's characterization is incorrect, please see comments submitted elsewhere to the docket.[86] UCS has conservatively adopted a 10 percent rebound effect in its own modeling, and we recommend that NHTSA do the same.

Real-world factor

As noted in our petition to NHTSA for reconsideration of the SAFE rule, the agency erroneously assumed a 2-cycle to 5-cycle gap of just 20 percent.[87] This value does not adequately account for a shift to Tier 3 fuel and its impact on real-world usage. In our own analysis, we have assumed a "gap" of 23 percent for ethanol and gasoline-fueled vehicles, consistent with EPA Trends data that takes into consideration both fuel and an increasing share of highway mileage.[88] However, NHTSA's independently calculated value of the gap is quite similar, and we support the agency adopting this revised approach.

30-month valuation

As noted previously, the impact of NHTSA's assumed payback is significant as a result of the incorrect assumption that manufacturers will adopt technology regardless of compliance levels. The precise value of this assumption is therefore quite important. NHTSA acknowledges that its assumption is based solely upon manufacturers' stated opinion and does not necessarily reflect new vehicle buyers' preferences.[89] Previously, NHTSA themselves differentiated a manufacturer's

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[85] EPA-HQ-OAR-2021-0208-0277, Appendix A.

[86] Joint Summary Comments of The Center for Biological Diversity, Chesapeake Bay Foundation, Conservation Law Foundation, Earthjustice, Environmental Law & Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Sierra Club, and Union of Concerned Scientists.

[87] UCS, Petition for Reconsideration of NHTSA's Final Rule—The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks, June 12, 2020, Section I.N.

[88] EPA-420-R-21-003, Appendix D.

[89] NHTSA MY2024-2026 TSD, p. 405.

willingness to deploy additional technology based on whether or not the manufacturer was in compliance, reducing the assumed payback when in compliance to just 12 months and covering a range of sensitivities.[90] In spite of the scant amount of data supporting its 30-month payback assumption, the agency has provided just a single additional sensitivity case in this rule.

NHTSA should re-examine the basis for its presumed payback and consider a wider range of alternative assumptions in its analysis. Additional discussion of this issue can be found elsewhere in the docket.[91]

c. Impact of flaws on results

The difference between NHTSA's modeling and that of UCS are quite significant and are an indication of just how important it is for NHTSA to get its modeling effort right. Below we compare a subset of critical datapoints NHTSA may be considering. The errors in NHTSA's baseline are likely the single biggest factor and related to the fundamental flaws in its underlying algorithm, but differences in technology costs and availability, rebound, grid emissions profiles, and a host of other inputs are also significant contributors to NHTSA's consistent underestimation of the benefits of stronger standards.[92]

Correcting for the flaws in its modeling show clearly that Alternative 3 represents the maximum feasible standard considered by NHTSA.

TABLE 7 Comparison of social costs and benefits for Alternative 2 through MY2029

Cost/Benefit	NHTSA results ($B, 3% discount rate)	UCS results ($B, 3% discount rate)
Total social costs	$121.1	$62.0
Total social benefits	$121.4	$111.5
Net social benefits	**$0.3**	**$49.5**
Greenhouse gas emissions benefits	$32.0	$22.5
Non-GHG emissions benefits	$0.4	$6.6
Technology costs	$67.6	$36.1
Retail fuel savings	$73.0	$75.5

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[90] UCS, Petition for Reconsideration of NHTSA's Final Rule—The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks, June 12, 2020, Section I.L.

[91] Institute for Policy Integrity Comments on NHTSA MY2024-26 NPRM, Section I.E.; Joint Summary Comments of The Center for Biological Diversity, Chesapeake Bay Foundation, Conservation Law Foundation, Earthjustice, Environmental Law & Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Sierra Club, and Union of Concerned Scientists, Section III.H.

[92] Joint Summary Comments of The Center for Biological Diversity, Chesapeake Bay Foundation, Conservation Law Foundation, Earthjustice, Environmental Law & Policy Center, Natural Resources Defense Council, Public Citizen, Inc., Sierra Club, and Union of Concerned Scientists.

TABLE 8 Comparison of social costs and benefits for Alternative 3 through MY2029

Cost/Benefit	NHTSA results ($B, 3% discount rate)	UCS results ($B, 3% discount rate)
Total social costs	$176.3	$126.5
Total social benefits	$172.9	$199.3
Net social benefits	**-$3.4**	**$72.8**
Greenhouse gas emissions benefits	$45.6	$42.3
Non-GHG emissions benefits	$0.3	$10.3
Technology costs	$100.1	$78.0
Retail fuel savings	$103.8	$138.5

APPENDIX A: Previously unpublished analysis from Dan Meszler, 2020

Consumer Demand for Fuel Economy

The Agencies model future fuel economy under an assumption that consumers will demand, and manufacturers will supply, all fuel economy technology that pays for itself (in terms of fuel savings) in 2.5 years, independent of the existence (or nonexistence) of fuel economy standards.[1] This leads to substantial (and growing) levels of overcompliance throughout the forecast period. Moreover, this overcompliance is most pronounced for less stringent standards since the level of fuel economy technology required beyond that which returns a 2.5 year payback (hereafter 2.5 year technology) is lower. This effectively reduces the stringency differential between the augural standards and less stringent alternatives. Figure 1 shows the level of overcompliance forecasted by the Agencies for the alternative where fuel economy standards are unchanged after 2020. As indicated overcompliance increases from less than 1 mpg in 2020 to over 4 mpg by 2030. The increase results from the combined influences of the staggered adoption of 2.5 year technology in accordance with the redesign cadence of the CAFE model, the general increase in fuel price over the forecast period, and the general reduction of technology costs over time due to learning (with the latter two influences carrying the potential to create more 2.5 year technology as the forecast progresses).

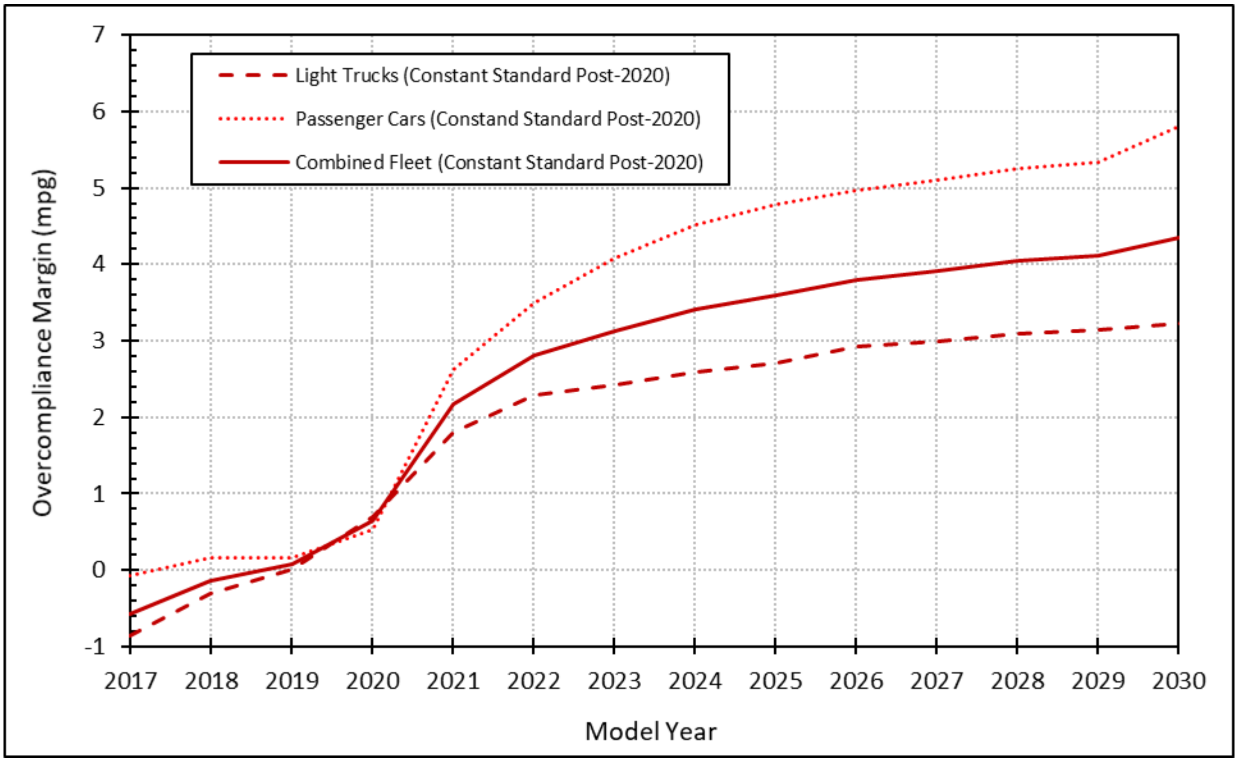

Figure 1. CAFE Model (Standard Setting Mode) Forecasts for a Constant Post-2020 Standard

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[1] 85FR24232

The assumption of consumer demand for 2.5 year technology is flawed for several reasons. First, it conflates a consumer's willingness to pay for fuel economy technology with a demand for that same technology in the absence of market availability (i.e., it'll be purchased if available, or demanded if not). How consumers are kept abreast of the cost and cost-effectiveness of technology available to manufacturers but not offered for sale is not explained. Second, the assumption erroneously constrains the utility of fuel economy technology. It inherently (and incorrectly) assumes that manufacturers are limited in their ability to offer such technology only in terms of its potential fuel savings. All fuel economy technologies carry an inherent trade-off between efficiency and performance, and can be marketed to promote either (or both). Performance can be improved for a given (or reduced) level of efficiency, efficiency can be improved for a given (or reduced) level of performance, or other content can be added to vehicles without either performance or fuel economy loss. Fuel economy technology generally reduces the amount of fuel energy required to perform a given vehicular function. As the fuel energy required to perform that function declines, the level of performance can be held constant (and fuel economy will increase), the level of performance can be improved to offset some or all of the potential fuel economy benefit, or the technology efficiency benefit can be consumed by changes in vehicle design or content that would otherwise degrade both fuel economy and performance. In other words, manufacturers have choices. Fuel economy technology does not "sit on the shelf" until it is needed as a solution to a unidimensional problem. It is available for manufacturers to implement in response to the multidimensional consumer preference market. CAFE standards are one of the dimensions that manufacturers must consider in their decision-making. The absence (or reduced stringency) of such standards frees manufacturers to weigh other technology aspects more than would otherwise be the case. To assume that the level of fuel economy and performance derived from a given 2.5 year technology will be identical with and without standards is simply wrong.[2]

Most egregiously, the Agencies have 40 years of fuel economy data at their disposal if they want to show the existence of this consumer demand for fuel economy. Even ignoring the fact that the very existence of the fuel economy standards themselves are premised on the non-existence of such demand (at least until now), the Agencies can surely use their own data to demonstrate the demand if it were more than a chimera. The agencies purport to do this with three charts for the period 2004-2016, showing achieved versus required fuel economy for domestic cars, import cars, and light trucks.[3] These charts show overcompliance with fuel economy standards to be as high as nearly 8 mpg for import cars in 2010. The Agencies assert that these levels of overcompliance are due to this "well documented" consumer demand amplified by high fuel prices.[4] What the Agencies don't show, is any real support for their assertions, instead relying on cherry picked data for a snapshot in time to infer a non-existent trend. While this snapshot in time may or may not be representative of a more robust trend (as will be discussed in detail below), it is informative to see if trends over even this limited timeframe support the Agencies' assertion.

For the 2004-2016 period isolated by the Agencies, fleetwide (combined import car, domestic car, and light truck) fuel economy was at most 3.9 mpg above applicable fuel economy standards (in model year 2010). This undoubtedly represents a substantial level of overcompliance – but overcompliance abruptly dropped to 1.6 mpg in model year 2011 and steadily declined thereafter through model year

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[2] See Figures 7 through 10 and associated narrative at the end of this document for additional discussion on this topic.

[3] 85FR24233-24234.

[4] 85FR24232.

2016, when the fleet was actually out of compliance by 0.5 mpg. So, either manufacturers used up all the 2.5 year technology between model years 2004 and 2010 (in which case there would be no such technology left to promote 2.5 year technology-driven overcompliance for any of the standards evaluated under the SAFE rulemaking), or there are other factors in play that the Agencies choose not to recognize.

Figure 2a depicts the relative change in fleetwide fuel economy and gasoline prices during the Agencies snapshot in time (both expressed relative to a 2004 baseline). The solid blue line shows that gasoline price fluctuated widely throughout the time period, while fuel economy increased at a reasonably consistent rate, averaging about 0.7 mpg per year. The correlation between annual gas prices and fuel economy is both poor (i.e., insignificant) and negative. If we assume that the price signal is insensitive to "temporary" declines (as represented by the dotted blue line in Figure 2a), then we do indeed see a significant positive correlation between price and fuel economy, wherein gas prices "explain" about three-quarters of the observed variation in fuel economy. But … gas prices were not the only market characteristic changing in this period.

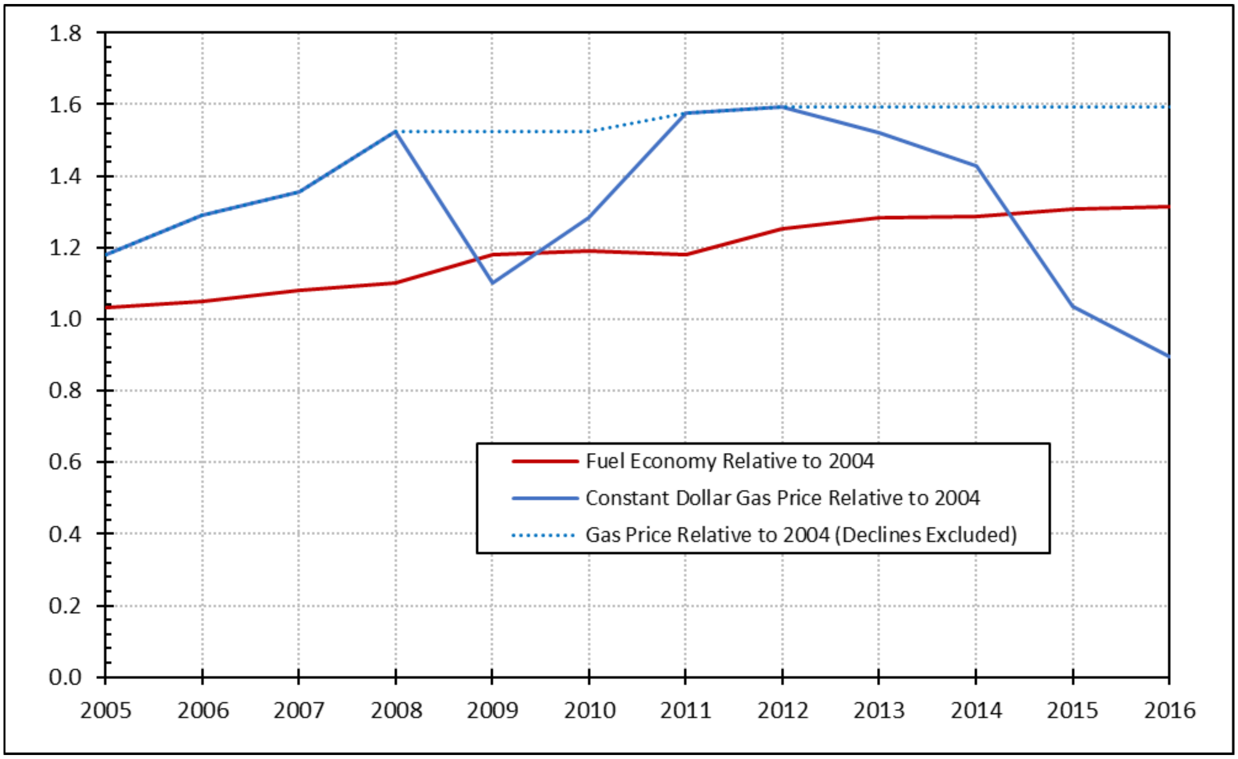

Figure 2a. 2005-2016 Fuel Economy and Gasoline Prices (Relative to a 2004 Baseline)

As shown in Figure 2b, the fuel economy standard was also changing during the 2004-2016 period. In fact, the standard alone (i.e., without any consideration of a gasoline price influence) explains over 90 percent of the observed variation in fuel economy. Including a consideration for actual gas prices adds no additional explanatory power to the relation. Excluding gas price declines from the price signal does enhance the fuel economy relation, boosting correlation to about 95 percent. While this is an improvement, the fuel economy standard remains the dominant relationship driver.[5]

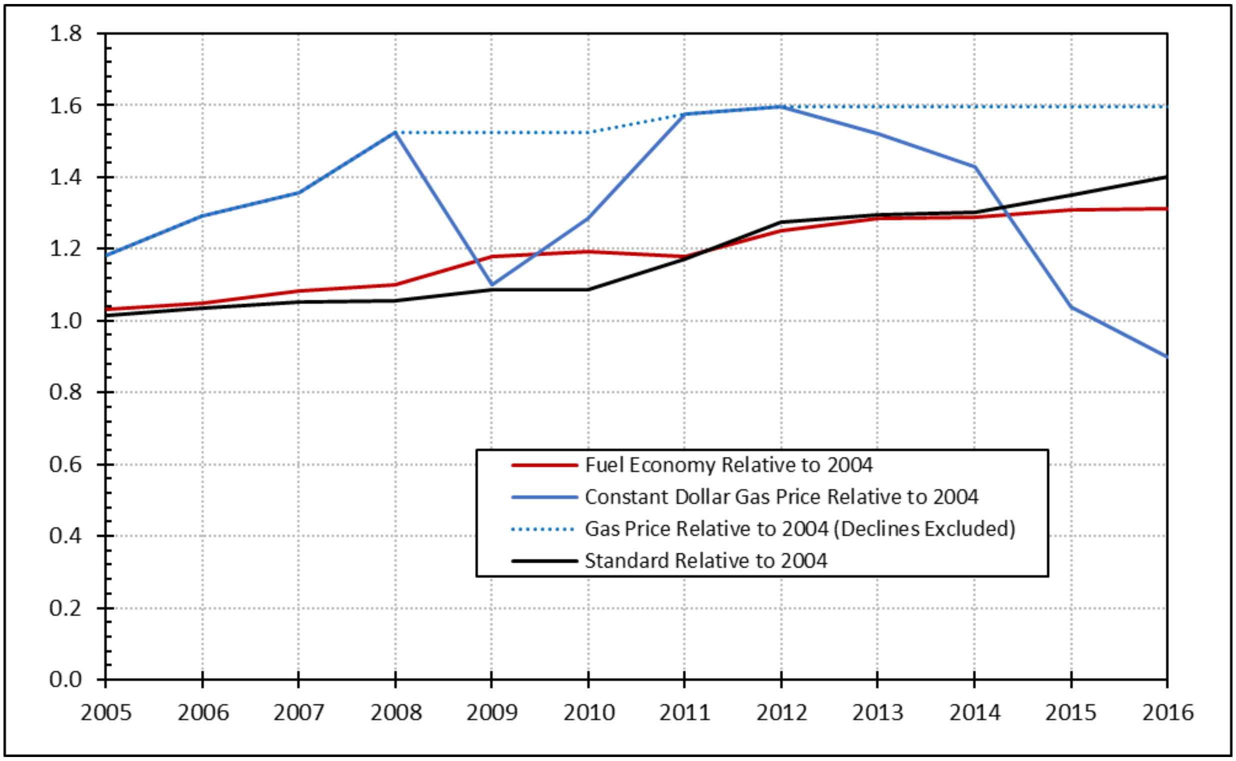

Figure 2b. 2005-2016 Fuel Economy and Gasoline Prices (Relative to a 2004 Baseline)

Of course, this limited analysis is of little real interest since it addresses only a small snapshot in time that may or may not be representative of long term influences. In fact, the statistics provided here are intended only to show that attributing fuel economy change to a consumer driven response to increasing gas price does not hold, *even during the window of time isolated by the Agencies*. More detailed analysis might fine tune the relationships for this time window, but restricting analysis to such a window of time is both unnecessarily limiting and inappropriate to isolate any fuel price driven fuel economy demand.

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[5] Note that for this limited analysis, issues such as the lag time associated with a manufacturers ability to respond to any consumer demand for fuel economy (should it exist) have been ignored. The Agencies go to great length to tout the design of the CAFE Model around a vehicle redesign schedule that is intended to mimic the way the industry functions (see, for example, the discussion at 85FR24222). This design feature necessarily inhibits the ability of manufacturers to "turn on a dime" and alter the fuel economy performance of a large fraction of its fleet in any single model year. As a result, there should be a significant lag between price-driven market influences and the ability of a manufacturer to respond thereto. Since fuel prices were below their long term average leading into the time period isolated by the Agencies, this lag has been ignored for this simplified analysis. Suffice it to say that the non-existence of any such lag in the trends observed over the time period isolated by the Agencies is suggestive that either the price signal is not a primary driver of the fuel economy trend or the foundational premise for the redesign restrictions of the CAFE Model is misguided.

If we look at the entire history of the fuel economy program, a more robust explanation for the data cited by the Agencies emerges. Since the Agencies cite gasoline prices as the driver for the "observed" fuel economy demand (as higher gas prices will result in a greater number of technologies paying for themselves in 2.5 years), let's establish that trend first. Figure 3 shows historical gas prices since 1949.[6,7] The shaded area between 2004 and 2016 is the period covered by the Agencies' snapshot in time. As indicated, prices did spike post-2004, but the spike in constant dollar terms was not an outlier in a historical context, and prices have since fallen back to historical norms. Comparing the historical norm through 2002 with that through 2019 shows a long term increase in the normal gas price of about 6 percent. As we are currently on the tail of a short term price spike, it is not possible to know if this change in the long term normal price will hold, or will drop back to that observed before the recent spike, but there is no question that price signals were significant during the timeframe isolated by the Agencies.

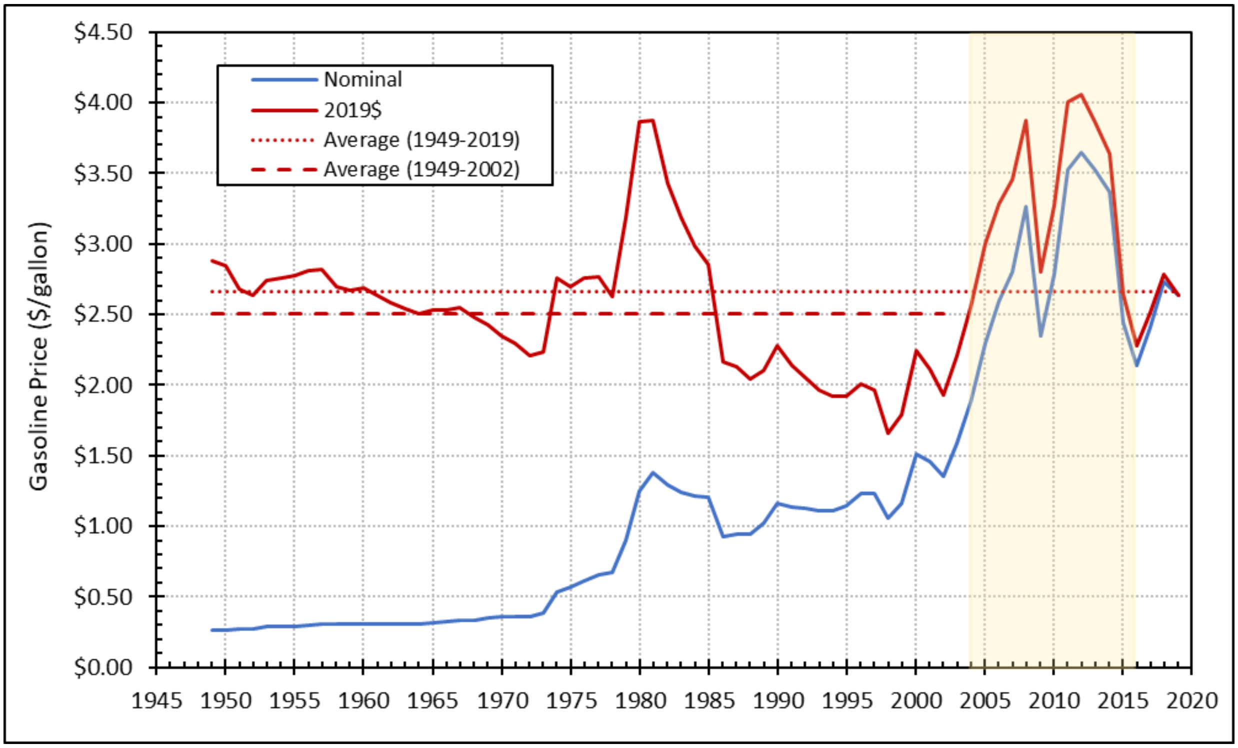

Figure 3. Historical Gasoline Prices

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[6] Current dollar gasoline prices are from the Energy Information Administration's Monthly Energy Review, April 2020, Table 9.4 ("Table_9.4_Retail_Motor_Gasoline_and_On-Highway_Diesel_Fuel_Prices.xlsx"), https://www.eia.gov/totalenergy/data/monthly/.

[7] Consumer price index data are from the Bureau of Labor Statistics' Report CUUR0000SA0 (U.S. city average, all items, not seasonally adjusted, "SeriesReport-20200522130225_3117b1.xlsx"), https://data.bls.gov/cgi-bin/surveymost?cu.

Figure 4 shows superimposed historical fuel economy and gasoline price data.[8,9] These are the data from which more robust relationships (if they exist) can be derived. It should be emphasized that what follows in not an attempt to investigate all possible fuel economy influences, as such analysis is not possible given the time and resources available. However, the analysis is sufficiently robust to determine whether gasoline price is or is not a significant influence as posited (with no analytical support) by the Agencies in their assertion that consumers will demand and manufacturers will supply all technology with a 2.5 year payback.

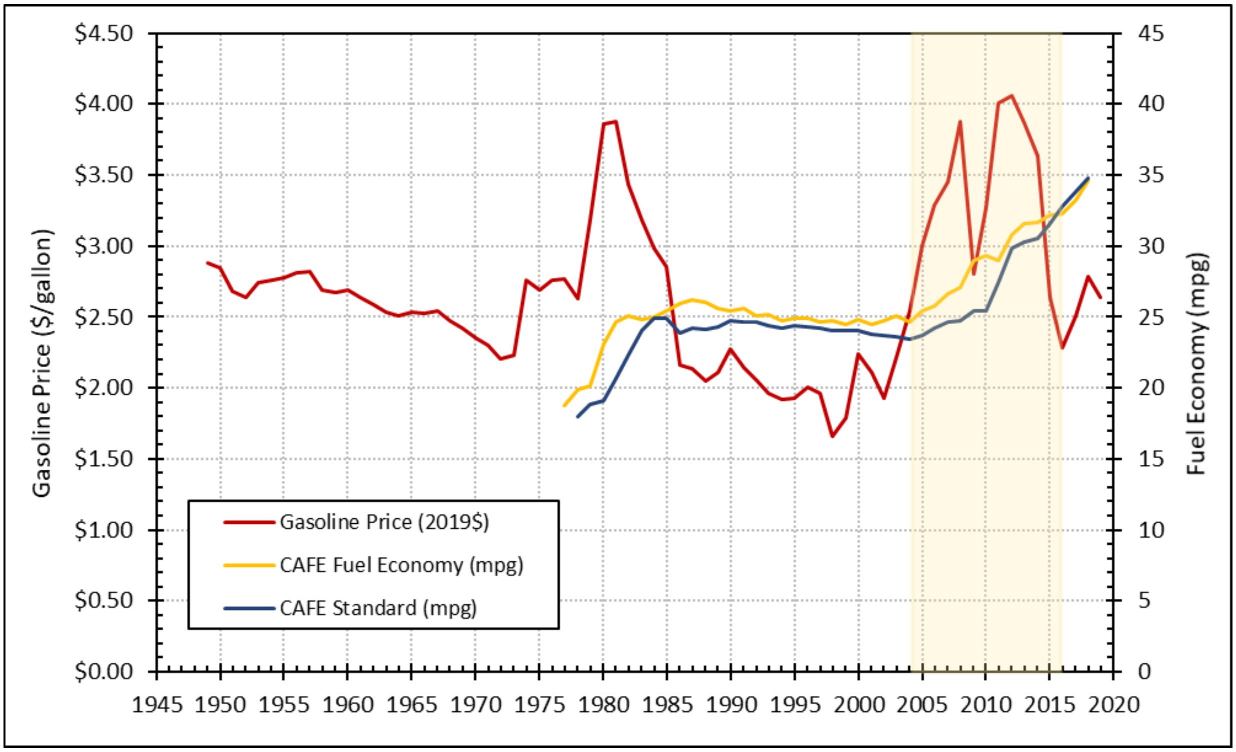

Figure 4. Historical Gasoline Prices and Fuel Economy Data

Observed fleetwide fuel economy data for 1978 (the first year in which a CAFE standard was in effect) through 2018 (the last year for which complete data was available) was regressed against both applicable fuel economy standards and gasoline prices. Because a vehicle model year begins during the numerically preceding calendar year (e.g., model year 2020 vehicles are available for sale in calendar year 2019) and because manufacturers cannot respond to fuel economy demands without some lead time, relations were investigated with both unlagged, lagged, and look ahead parameters. Examples of such parameters include gas prices for the previous year (to better reflect consumer influences) and fuel

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[8] CAFE standards were first established by the Energy Policy and Conservation Act of 1975 and took effect with model year 1978.

[9] Fuel economy data are from NHTSA, “Summary of Fuel Economy Performance (Public Version), December 15, 2014” and NHTSA’s CAFE Public Information Center, https://one.nhtsa.gov/cafe_pic/cafe_pic_home.htm.

economy standards for a future year (to better reflect the standards which manufacturers are anticipating and designing to achieve). Investigated relations include:[10,11]

1) $mpg = a(std) + b$
2) $mpg = a(std) + b(price_{my-1}) + c$
3) $mpg = a(price_{my-1}) + b$
4) $mpg = a(std) + b(yoy\ price_{my-1}) + c$
5) $mpg = a(std) + b(std_{my+x}) + c(price_{my-1}) + d$
6) $mpg = a(std_{my+x}) + b(price_{my-1}) + c$
7) $mpg = a(std_{my+x}) + b$
8) $mpg = a(std) + b(std_{my+x}) + c$
9) $yoy\ mpg = a(yoy\ price_{my-1}) + b$

where: “mpg” is fleetwide certification (rated) fuel economy,
“std” is the fleetwide fuel economy standard,
“price” is the gasoline price in constant dollars,
“my” is model year,
“yoy price” is the year-over-year gasoline price ratio,
“yoy mpg” is the year-over-year fleetwide fuel economy ratio,
“x” is 1, 2, or 3, and
“a,” “b,” “c,” and “d” are regression coefficients.

With the exception of the gasoline price only regression (#3 above) and the yoy mpg regression (#9 above), all relations explain over 90 percent of the observed fuel economy variance (i.e., $r^2 > 0.9$). This includes the simple non-lagged fuel economy standard regression. Table 1 presents key statistics for the evaluated regressions. As indicated, the best fit regression (identified as #5) explains 97 percent of the observed fuel economy variance and has a standard error of prediction of about 0.6 mpg. The specific relation is:

$$mpg = 0.3552(std) + 0.4499(std_{my+2}) + 0.4343(price_{my-1}) + 4.6387$$

All three independent parameters are significant at 99 percent confidence, so it is possible to isolate the individual influences of fuel price and fuel economy standards. Note that the two year look ahead standard carries a greater weight than the current model year standard, indicating (as expected) that

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[10] Note that there are several sources of fuel economy data available. These include historical data encoded in the CAFE Model Parameters input file, data from the EPA’s annual trends report (2019 EPA Automotive Trends Report, https://www.epa.gov/automotive-trends/explore-automotive-trends-data#DetailedData), and fuel economy performance data reported periodically by NHTSA (Summary of Fuel Economy Performance (Public Version), December 15, 2014 and data from NHTSA’s CAFE Public Information Center, https://one.nhtsa.gov/cafe_pic/cafe_pic_home.htm). The data from the CAFE Model and the EPA trends report are quite consistent, but both deviate from the data in the NHTSA performance reports. In an effort to avoid treating any of the sources preferentially, regressions were developed for two separate fuel economy data sets – one based on the CAFE Model/Trends data and one based on the NHTSA Performance data. The relationship findings are consistent across the two data sets, but fuel price influences are generally greater for the NHTSA Performance data set. Moreover, the NHTSA Performance data set matches the data presented in the charts included in the 2.5 year payback discussion of the SAFE rulemaking. For these reasons, the statistics presented herein are for the NHTSA Performance data set regressions (unless otherwise specified).

[11] A subset of the larger 1978-2018 data set consisting of 1982-2019 data was also investigated separately. This subset was selected to test whether there were nuances in the initial years following the 1978 start-up of the CAFE program that might affect regression results. Upon investigation, both data sets performed similarly. Statistics for both are presented, but only statistics for the complete 1978-2018 data set are applied.

Table 1. Regression Analysis Results

Relation	1978-2018 Data			1982-2018 Data		
	r^2	StdErr	Margin Min/Max (Avg)	r^2	StdErr	Margin Min/Max (Avg)
Observed			-0.6/+4.0 (+1.3)			-0.6/+3.9 (+1.1)
1	0.91	0.98	-0.2/+2.4 (+1.3)	0.91	0.91	+0.0/+1.6 (+1.1)
2	0.95	0.77	-0.7/+3.1 (+1.3)	0.94	0.74	-0.6/+2.7 (+1.1)
3	0.13	no significant relation		0.25	no significant relation	
4	0.91(1)	0.97	-0.2/+2.5 (+1.3)	0.91(1)	0.92	+0.1/+1.6 (+1.1)
5 (x=2)	0.97	0.60	-0.2/+3.8 (+1.3)	0.97(2)	0.51	-0.5/+3.6 (+1.1)
6 (x=2)	0.96(3)	0.70	not calculated	0.97	0.52	not calculated
7 (x=2)	0.96	0.69	not calculated	0.97	0.56	not calculated
8 (x=2)	0.96	0.65	not calculated	0.97(4)	0.56	not calculated
9	0.15	no significant relation		0.06	no significant relation	

The relation in blue is the best fit relation developed.

All independent regression parameters are significant at 95 percent confidence or greater unless otherwise indicated.

StdErr is the standard error of prediction.

Margin is the difference between the predicted fuel economy and the fuel economy standard (where "min" is the minimum margin, "max" is the maximum margin, and "avg" is the average margin).

(1) The year-over-year price parameter is not significant.

(2) The current model year standard parameter is significant only at 88 percent confidence.

(3) The gasoline price parameter is not significant.

(4) The current model year standard parameter is not significant.

manufacturers are making technology changes in advance of the applicability of specific standards. In effect, they seek to accumulate early credits to both ensure compliance and buffer the year-to-year impacts of future standards. As indicated above, one, two, and three year look ahead periods were evaluated. Although the two and three year periods performed similarly, the two year look ahead has marginally superior performance statistics.

The fit of the regression (identified as #5) is shown in Figures 5 and 6, along with that of a corresponding relation (identified as #8) that excludes the gasoline price influence.[12] Clearly the gasoline price influence is small. In fact, as indicated in Figure 6, the regression without the fuel price parameter actually predicts the largest observed compliance margins as well or better than the regression that explicitly includes the fuel price influence. To determine precisely how much of an influence fuel price might have over the period evaluated by the Agencies for the SAFE rulemaking, the best fit regression was evaluated for the augural and SAFE standard in conjunction with the fuel prices assumed in the SAFE rulemaking for calendar years 2026 through 2050. In other words, once the standards stabilized (in model year 2025 and 2026 respectively), how much additional fuel economy would be "demanded" by the modeled fuel prices. For both sets of standards, the influence between the maximum and minimum fuel prices over the 25 or 26 year period of stable fuel economy standards is 0.2 mpg. That is 0.2 mpg over roughly 25 years, or an average of about 0.008 mpg per year. In contrast (see Figure 1 above), the CAFE Model shows overcompliance with fuel economy standards growing from 0.65 mpg in

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[12] mpg = 0.2272(std) + 0.5860($\text{std}_{\text{my+2}}$) + 5.4869, with all coefficients significant at a 98 percent or greater confidence level.

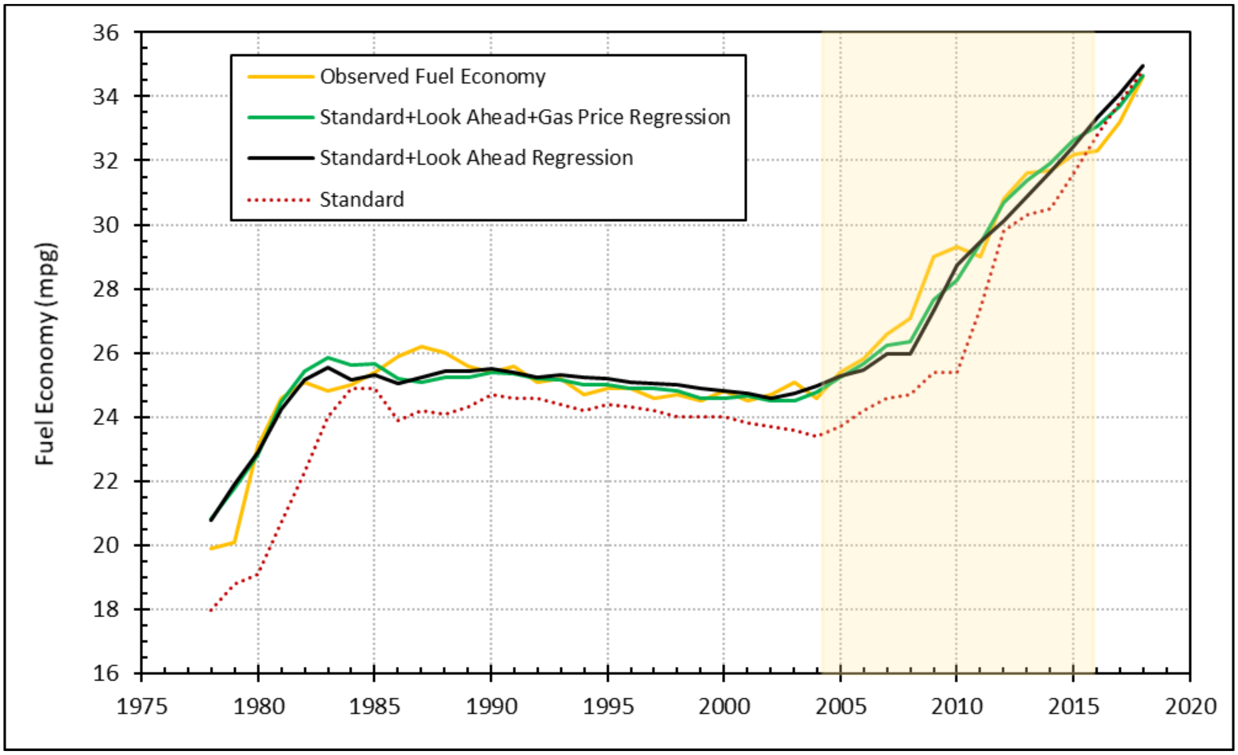

Figure 5. Observed Versus Predicted Fuel Economy

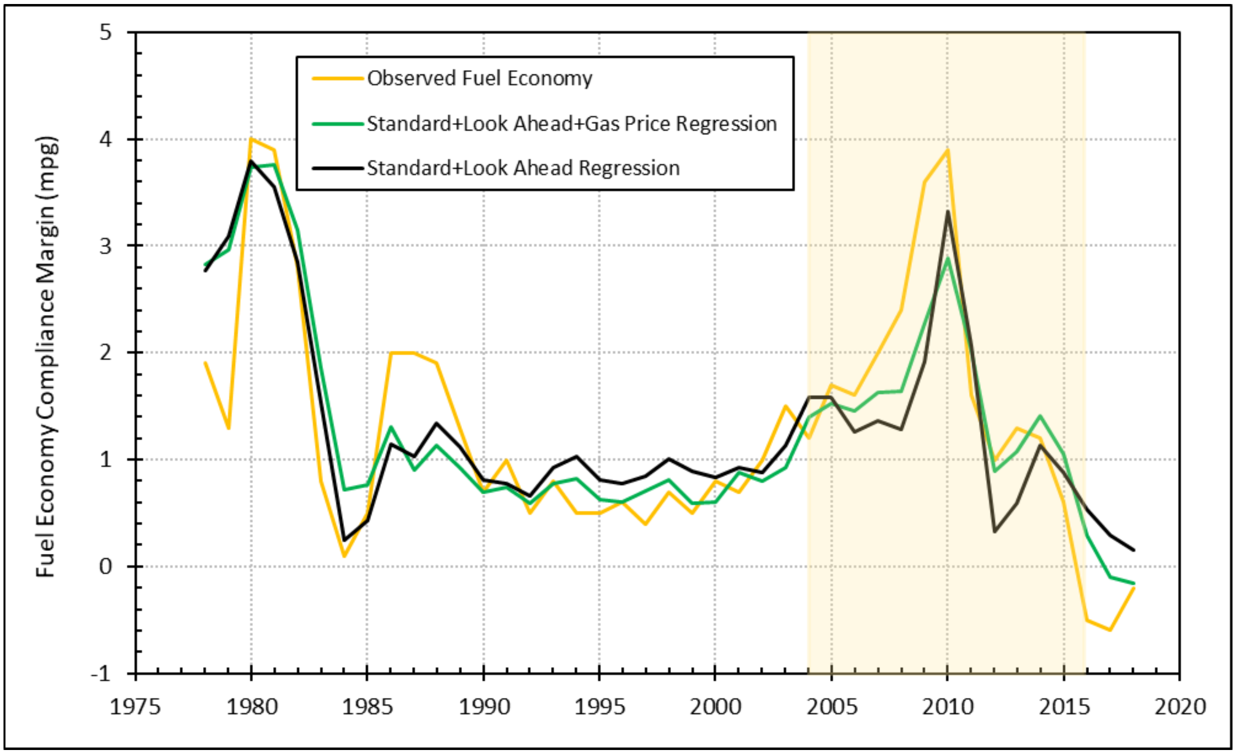

Figure 6. Ability of Regressions to Predict Compliance Status

2020 to 4.35 mpg by 2030, or by roughly 0.37 mpg per year for standards that are held constant after model year 2020. For these same data, the regression predicts a *total* fuel price influence of 0.18 mpg, or about 0.018 mpg per year; *less than 5 percent of the overcompliance increase estimated by the CAFE Model*. In effect, the CAFE Model is erroneously reducing the impact of more stringent standards by ascribing a significant portion of the benefits of such standards to an imagined consumer-driven demand for fuel economy that does not exist in the absence of fuel economy standards. Extensive studies have been performed over the years that have investigated the cause(s) of this seeming irrationality, identifying influences such as consumer and manufacturer risk aversion. However, the reason for the non-existence of this demand is not important to the evaluation of alternative fuel economy standards; such evaluation need merely acknowledge and respond appropriately to its non-existence. The SAFE rule and the CAFE Model do neither, which effectively masks a substantial fraction of the benefits associated with more stringent fuel economy standards.[13]

Finally, Figures 7 through 9 graphically depict the inherent trade-off available to manufacturers with regard to fuel economy technology.[14] Figure 7 shows the relationship between vehicle horsepower and fuel economy. As indicated, fuel economy generally declines with increasing horsepower. In other words, when a manufacturer utilizes an efficiency technology to enhance horsepower, this enhancement generally comes at the expense of fuel economy. For convenience, trends are indicated for four separate model years spanning the period 1975 through 2015. The shift in the trend through time demonstrates that while manufacturers have indeed succeeded in increasing both fuel economy and horsepower, the inherent tradeoff between the two attributes remains. Vehicle horsepower has generally increased by about 100 hp (on average) between 1975 and 2015, with a corresponding increase in fuel economy of about 15 mpg. However, if horsepower had remained at 1975 levels, fuel economy increases of 25 mpg or more were possible by 2015. In effect, about half of the potential fuel economy benefit of efficiency technology has been used to enhance vehicle performance.

Figure 8 shows a similar relationship for vehicle weight, with manufacturers successfully increasing the efficiency with which they are able to move heavier vehicles. Due to weight reduction technology, the trend for vehicle weight over time has not been as pronounced as that for horsepower, but average vehicle weight has steadily increased back to 1975 levels after a short term decrease of as much as 20 percent between 1975 and 1985. The ramp up in weight between 1985 and 2015 has come at a fuel economy cost of about 5 mpg. Figure 9 summarizes how increasing horsepower-to-weight ratios over time have reduced 0-60 mph acceleration time by over 40 percent between 1985 and 2015, from an average of 14.1 seconds in 1985 to 8.3 seconds in 2015. Certification fuel consumption has decreased by 20 percent during this same period, almost exactly half the rate of the performance improvement.

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[13] Actual overcompliance varies from year to year as manufacturers optimize credit accrual and usage, but averages roughly 1.3 mpg (based on NHTSA performance data, or 0.8 mpg based on CAFE Model input and EPA trends report data). For the 1982 and later period, these same sources show an average compliance margin of 1.1 and 0.7 mpg respectively. Thus, an average compliance margin of about 1 mpg is generally consistent with historic trends and quite reasonable given that manufacturers have no way to assure a given level of sales for each of their vehicles, so in the absence of accumulated credits, there is an incentive to "beat" the standards by a modest amount to accommodate unexpected deviations in the distribution of actual sales versus that forecast. But it is critical to note that this incentive exists independent of the level of standards, so that the differential between alternative standards is not affected and is indeed consistent with the differential between the standards themselves. There is simply no evidence that overcompliance under one set of standards will be greater than that under another, notwithstanding the Agencies' attempt to assert otherwise.

[14] All data is from the EPA's annual trends report (2019 EPA Automotive Trends Report, https://www.epa.gov/automotive-trends/explore-automotive-trends-data#DetailedData).

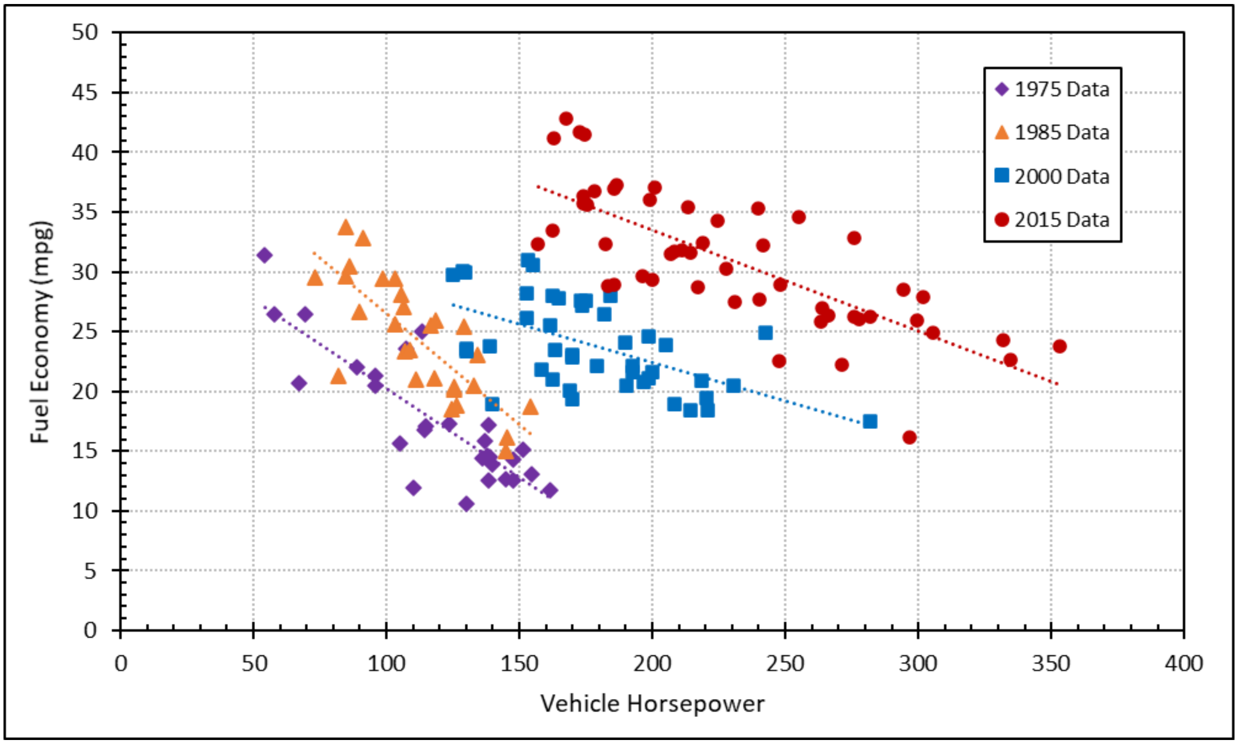

Figure 7. Vehicle Fuel Economy Versus Vehicle Horsepower

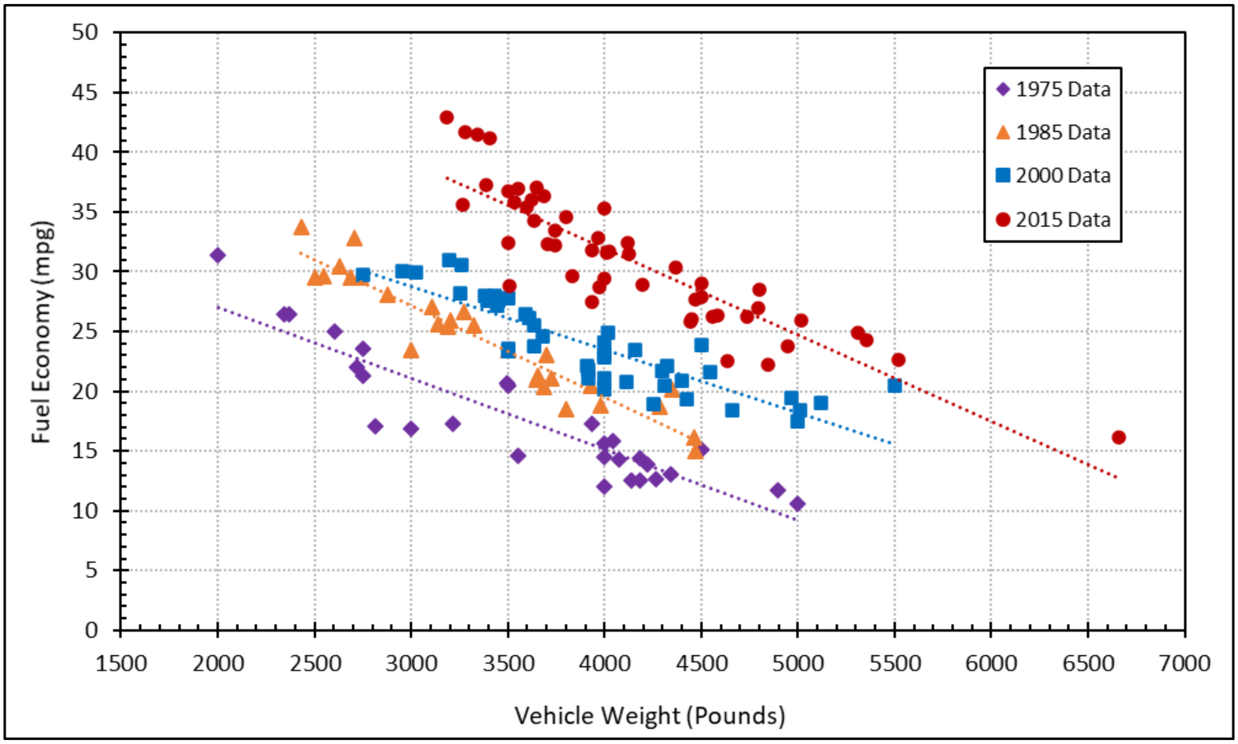

Figure 8. Vehicle Fuel Economy Versus Vehicle Weight

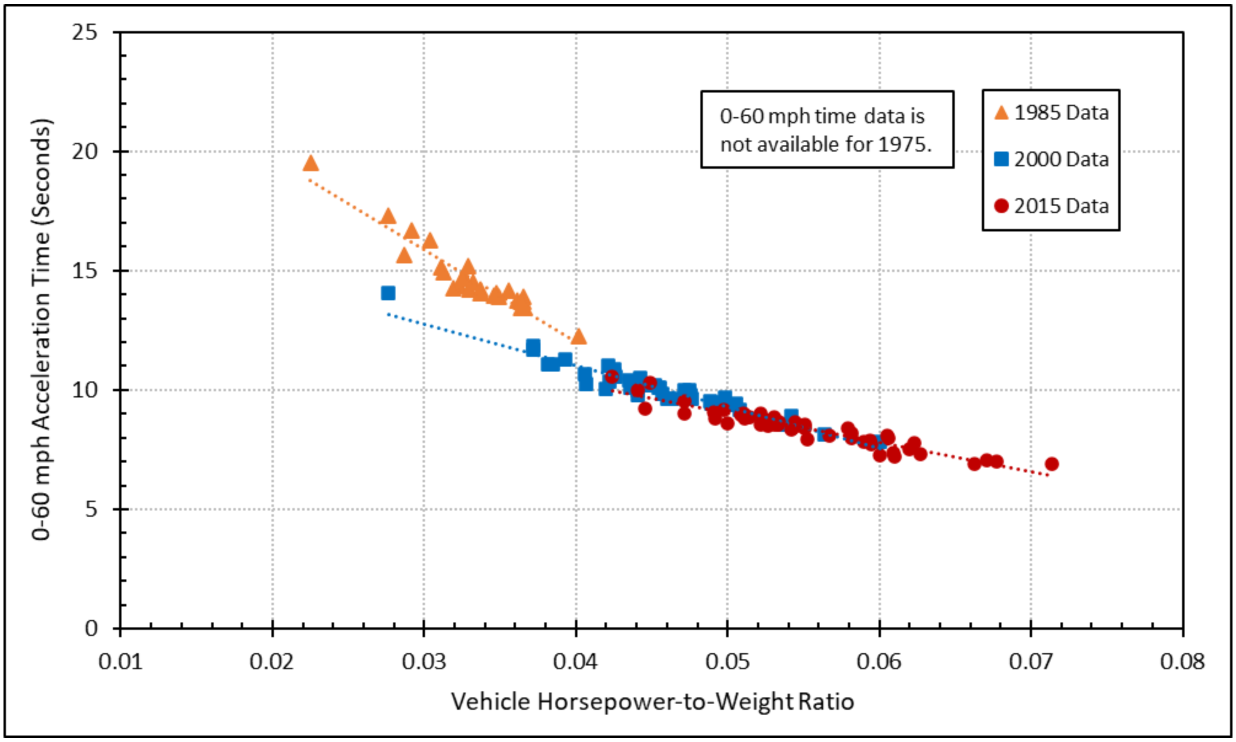

Figure 9. Vehicle Fuel Economy Versus Vehicle Acceleration Time

Figure 10 depicts the long term trend in various performance metrics versus the long term in fuel consumption. During the first 10 years of the CAFE program, from legislative adoption in 1975 through 1985, manufacturers achieved compliance with the first-ever standards largely by reducing vehicle size and performance. However, for nearly two decades, from 1985 through the first few years of the 21st century, fuel economy standards remained virtually unchanged and manufacturers responded by using efficiency technology to nearly double average vehicle horsepower, increase average vehicle weight by 25 percent, and reduce 0-60 mph acceleration time by 40 percent. This technology did not sit on the shelf waiting to fulfill an imagined consumer demand for fuel economy; it was employed and marketed by manufacturers for its performance benefits. From 2005 until today, manufacturers have again had to address rising fuel economy standards and the slopes of the performance trends have flattened a bit, but to date manufacturers have achieved improvements in both performance and fuel economy throughout the period. As shown in the regression analysis presented above, it is highly probable that virtually none of the significant fuel economy improvement observed since 2005 would have accrued in the absence of increasingly stringent fuel economy standards. The chimera of consumer-driven fuel economy demand should be removed from the CAFE model and alternative fuel economy standards credited with their full fuel savings benefits (as has historically been the case).

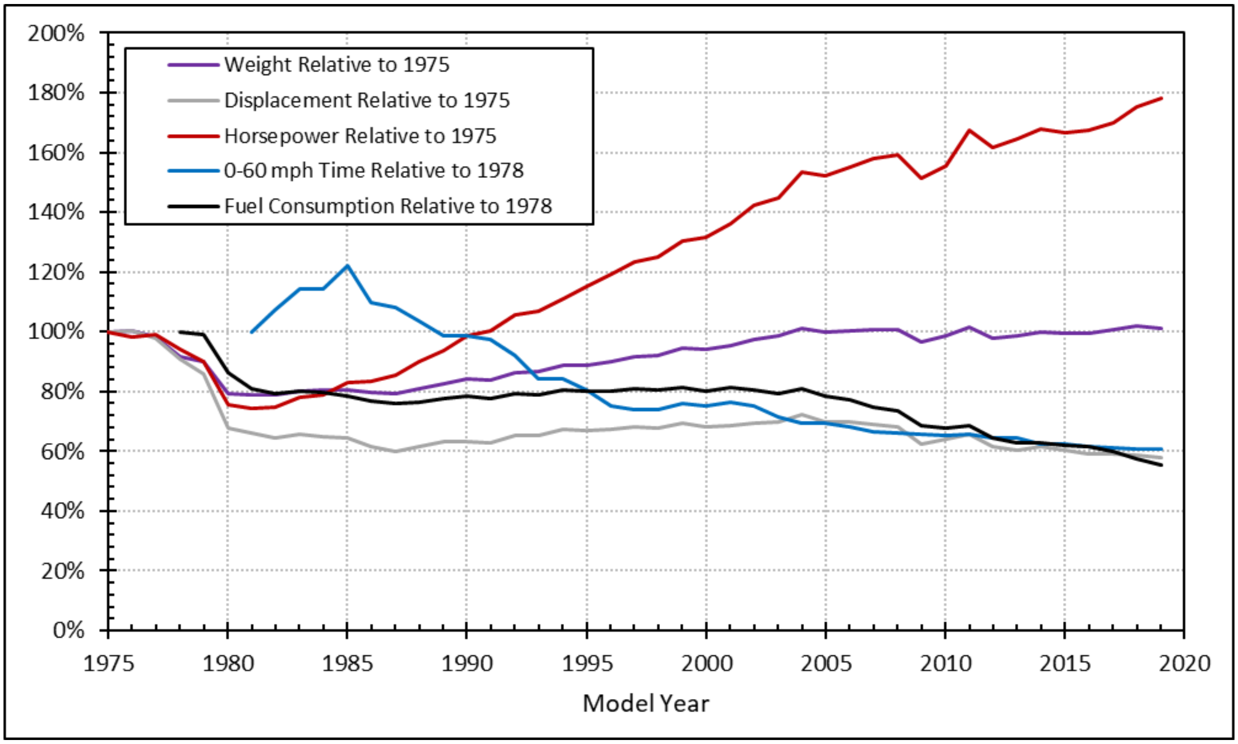

Figure 10. Relative Vehicle Performance and Fuel Consumption Data over Time