Comments of the American Council for an Energy-Efficient Economy on EPA's Reconsideration of the Final Determination of the Mid-Term Evaluation of Greenhouse Gas Emissions Standards for Model Year 2022–2025 Light-Duty Vehicles and the Appropriateness of Model Year 2021 Greenhouse Gas Standards

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Introduction

The American Council for an Energy-Efficient Economy (ACEEE) advances energy efficiency policies, programs, and technologies through research and outreach. ACEEE strongly supported the fuel economy and greenhouse gas (GHG) emissions standards adopted in 2012 for model years (MY) 2017–2025, as well as EPA's determination earlier this year that the standards for MY 2022–2025 remain appropriate.

These comments respond to the "Request for Comment on Reconsideration of the Final Determination of the Mid-Term Evaluation of Greenhouse Gas Emissions Standards for Model Year 2022–2025 Light-Duty Vehicles; Request for Comment on Model Year 2021 Greenhouse Gas Emissions Standards" by the National Highway Traffic Safety Administration (NHTSA) and the Environmental Protection Agency (EPA) (EPA and NHTSA 2017).

The basis for the January 2017 Final Determination (FD) was sound, and consequently ACEEE does not support its reconsideration. In particular, the analysis presented in the draft Technical Assessment Report (TAR) released in 2016 provides very strong technical evidence that the MY 2022–2025 standards remain achievable and cost effective (EPA, NHTSA, and CARB 2016).

In the current Request for Comment (RFC), EPA states that "the agency is primarily interested in comments relevant to the reconsideration of the Final Determination, rather than the Technical Assessment Report (TAR), which is not being reopened for comment in this document." Hence the draft TAR remains the primary analytical basis for any further Mid-Term Evaluation (MTE) decisions (EPA, NHTSA, and ARB 2016).[1] Based on the TAR, public comments on the TAR, and

[1] The MY 2017–2025 rulemaking specifies that the TAR is to serve this purpose: "EPA, NHTSA and CARB will jointly prepare a draft Technical Assessment Report (TAR) to inform EPA's determination on the appropriateness of the GHG standards and to inform NHTSA's rulemaking for the CAFE standards for MY 2022–2025. The TAR will examine the same issues and underlying analyses and projections considered in the original rulemaking, including technical and other analyses and projections relevant to each agency's authority to set standards as well as any relevant new issues that may present themselves" (FR, 62784).

the subsequent Proposed Determination (PD) and accompanying materials, EPA stated the following in the FD:

> In [the administrator's] view, the current record, including the current state of technology and the pace of technology development and implementation, could support a proposal, and potentially an ultimate decision, to adopt more stringent standards for MY2022-2025. However, she also recognizes that regulatory certainty and consequent stability is important, and that it is important not to disrupt the industry's long-term planning (EPA 2017a).

ACEEE agrees with EPA's conclusion that the evidence indicates that more stringent standards are achievable. Any reconsideration of the Final Determination would need to evaluate thoroughly the appropriateness of strengthening the existing standards.

Should EPA pursue the reconsideration, ACEEE has a number of concerns and comments related to the process as follows.

Required Factors

EPA regulations cite eight factors that the agency must consider in making its determination. These are listed below, followed by our comments regarding new information and considerations beyond those discussed in prior comments to the docket.

<u>The availability and effectiveness of technology, and the appropriate lead time for introduction of technology</u>

As reflected in EPA's Final Determination, suppliers and manufacturers have continued to introduce new or improved automotive efficiency technologies that are not fully reflected in the draft TAR analysis. For example, Mazda, which already achieves the highest fleet fuel economy in the U.S., recently announced it would commercialize a homogeneous charge compression ignition engine within two years (Mazda 2016, Estrada 2017), and Delphi reported its Dynamic Skip Fire cylinder deactivation technology is ready for production (Birch 2017).

For the Draft TAR, EPA considered only six-, seven-, and eight-speed automatic transmissions. Multiple manufactures had already adopted or announced plans to adopt nine- and ten-speed automatics in time for the proposed or final determinations, but were excluded from EPA's analysis. In December 2016, Chevrolet announced that ten of its models would be available with a new nine-speed automatic by the end of MY 2017 (Truett 2016). At the time of the Draft TAR release, Ford and GM had announced deployment of a jointly developed 10-speed automatic in MY 2017, and Honda was road testing 10-speed automatics, which are now deployed in the 2018 Odyssey (Brooke 2017b; Brooke 2017c).

In its analyses for the MTE, EPA also makes conservative effectiveness or cost assumptions for a variety of efficiency technologies. New 48-volt mild hybrid systems are being deployed quickly by Volkswagen, Audi, Mercedes-Benz, and Volvo (Frost 2017, Atiyeh 2017). Suppliers state these systems enable a range of effective fuel economy improvements, from 10% to nearly 20%, rather than EPA's estimate of 7%-9.5%. EPA also assumes a cost of $806, while suppliers state costs ranging from $500-$1500. Table 1 shows a sampling of information recently offered by suppliers and manufacturers regarding new or improved technologies. These developments provide further evidence of the conservative nature of EPA's analysis in the MTE, reinforcing the feasibility of the existing standards and of the multiple options manufacturers have to achieve them.

<u>The cost on the producers or purchasers of new motor vehicles or new motor vehicle engines</u>

In many cases, manufacturers and suppliers have provided information on technology cost and/or effectiveness that serves to update assumptions in the TAR or the PD. Table 1 provides several examples.

Table 1. Recent supplier statements on technology effectiveness and/or cost

Technologies not considered in TAR, PD, or FD analysis				
Technology	**Description**	**Effectiveness**		
HCCI engine	Mazda, for MY 2019	20–30% FE[2]		
9-speed AT	2017 Chevrolet Malibu	3% over 2016 model with eight-speed automatic[3]		
10-speed AT	Honda Odyssey	6% FE over outgoing 6-speed[4]		
10-speed AT	Ford F-150 3.5L V6	1 mpg over 6-speed (approx. 10% FE) [5]		
Variable-compression-ratio ICE	Nissan TDS w/VCR	27% FE compared to outgoing 3.5L V6[6]		
Technologies considered in TAR, PD, or FD analysis, but with conservative effectiveness or cost assumptions				
Technology	**Description**	**Effectiveness**	**Cost**	**EPA assumptions**
48-volt mild hybrid	Valeo	12% FE	\$500[7]	7.0–9.5% GHG; \$580 (TAR, reaffirmed in PD[8])
48-volt mild hybrid	Continental	25% FE[9]		
48-volt mild hybrid	Delphi	10–15% FE	\$1,000[10]	
48-volt + cylinder deactivation	Delphi	>15% FE; 19% City FE	\$1,500[10]	
Cylinder deactivation	Delphi-Tula Dynamic Skip Fire	10–20% FE, CO_2 up to 20%[11]	\$350 (4-cyl)[10]	5.3%, \$115[12]
Other technologies or advancements relevant to future analysis				
Technology	**Description**	**Effectiveness**	**Cost**	
Lightweight doors	Magna	42.5% weight reduction of doors	\$2.59 per pound[13]	
Lightweight CFRP subframe	Magna, Ford	200 lb for equivalent part	\$20 per pound[14]	
Carbon-fiber composites			16x the price of steel[15]	

[2] Mazda 2017
[3] Chevrolet 2016
[4] Brooke 2017b
[5] Brooke 2017c
[6] Kendall 2016
[7] Brooke 2017a
[8] EPA 2017a
[9] Bolduc 2017
[10] Zoia 2017
[11] Delphi 2016
[12] EPA and NHTSA 2016
[13] Buchholz 2017
[14] Brooke 2017d
[15] Schweinsberg 2017c

This information points to lower costs and/or higher effectiveness for several technologies, relative to information used in the MTE.

The feasibility and practicability of the standards

The standards set out to 2025 were fundamentally conservative in that they could be met entirely with well-known technologies, as the agencies demonstrated in detail in the rulemaking. However those technologies have evolved and new technologies have emerged since the standards were adopted, as discussed above and as reflected in EPA's lower estimates of the cost of compliance in the draft TAR and the FD.

Furthermore, as an analysis by the International Council on Clean Transportation (ICCT) has demonstrated, even these more recent EPA analyses present an outdated account of the state of technology (Lutsey et al. 2017). Compared to draft TAR, current data on many technologies' cost and effectiveness are substantially more favorable than EPA estimates.

Volvo, a company that previously has chosen to pay CAFE fines and buy credits from other manufacturers in lieu of improving performance, announced that its entire fleet will be available with an electrified drivetrain option starting in 2019 (Gibbs 2017). With 48-volt mild hybrid being both more effective and cheaper than EPA assumed, manufacturers adopting the technology (including Volvo, VW, Daimler, and others) are likely to greatly improve their fuel economy and emissions performance.

The auto industry cited a Novation Analytics report (Novation 2015) extensively in its comments on the draft TAR. While the industry has continued to claim that the Novation analysis supports its concerns about EPA's demonstration of the appropriateness of the MY 2022-2025 standards (Hartrick 2016), EPA explained fundamental flaws in the Novation analysis in detail in the technical support document for the PD (EPA 2016d). Where EPA found that Novation's critique warranted further analysis (relating to variations in technology effectiveness based on performance specifications and the need for quality control checks on the powertrain efficiency of vehicles in the compliance packages), it undertook that analysis and applied the results in the PD.

The feasibility and practicability of the standards have been amply demonstrated by the agencies, and new information that has emerged since the TAR further justifies that conclusion.

The impact of the standards on reduction of emissions, oil conservation, energy security, and fuel savings by consumers

The vehicle standards are among the most significant steps the United States can take to lower GHG emissions and fuel consumption. In table ES-3 of the PD, EPA shows savings from the MY 2022–2025 standards of 537 MMT CO_2 and 1.2 billion barrels of oil over the life of vehicles of those model years; the standards reduce the vehicles' lifetime fuel consumption and GHG emissions by 12%.

The benefits of the standards to consumers far outweigh their costs. Even with the lower gas price projections used for the draft TAR, net savings to consumers remain large.

The impact of the standards on the automobile industry

Considerable evidence indicates that the standards will have a positive impact on the automobile industry. For example, ACEEE's 2012 analysis with the Blue-Green Alliance found that, in addition to 50,000 jobs in the auto industry itself, the standards would generate an estimated 570,000 jobs economy-wide by 2030 (Busch et al. 2012). A more recent study found that the standards have already created 288,000 American jobs in 48 states (Lipman et al. 2017). In its September 6th testimony to EPA, the Motor & Equipment Manufacturers Association (MEMA) claimed a 23% increase in automotive supplier employment since 2012—an increase of 171,000 jobs—and attributed these gains in part to the development of technologies that will help manufacturers comply with the standards (MEMA 2017a; MEMA 2017b).

Despite this evidence, auto industry sources continue to claim that the standards jeopardize vehicle sales and jobs. A Center for Automotive Research (CAR) study (McAlinden 2016) purported to demonstrate the standards' potentially large negative impacts on vehicles sales and jobs, but it contained multiple fallacies, as discussed in Kodjak (2017) and Martinez (2017). EPA found that merely replacing CAR's overblown and unsubstantiated technology cost assumptions with the agency's detailed and up-to-date cost estimates changes the results of the CAR analysis, yielding increases in vehicle sales, auto jobs, and national employment due to the standards (Charmley 2017).

Another analysis commissioned by the auto industry and conducted at Indiana University (IU) found that the standards would produce gains in GDP, income, and total jobs in the mid-to-long term (Carley et al. 2017). For example, the IU study projects net increases in total jobs ranging from 50,000 to 500,000 by 2035, depending on assumptions regarding technology costs and consumer behavior, among other factors. The IU report does find near-term negative economic impacts, however.

These negative impacts may be due to shortcomings in the macroeconomic modeling. In particular, as the study acknowledges, IU's REMI modeling does not reflect consumers' valuation of fuel economy in vehicle purchase decisions and thus would inappropriately project losses in vehicle sales based on the higher purchase prices of more fuel-efficient vehicles. This is likely reflected in the less favorable employment impacts in geographic regions where automotive manufacturing is concentrated, e.g. the northern Midwest. Moreover, the REMI modeling does not appear to reflect the financing of vehicles, even though, according to IU, cars loans and leases account for 70% of new vehicle purchases. Failure to account for vehicle financing would produce unrealistic, negative cash flows in the early years of the analysis, which may account for the near-term negative economic impacts. We believe these aspects of the IU study would require further investigation if EPA were to take this study into account in the MTE.

Vehicle sales

Recognizing that its macroeconomic modeling does not properly capture the standards' effects on vehicle sales, IU constructs a total cost of ownership (TCO) model to incorporate the full range of cost and savings resulting from the purchase of a vehicle with added fuel-saving technologies. IU presents results of the TCO model for a "2012 perspective," intended to reflect assumptions used by the agencies in the 2012 rule for MY 2017-2025, and for several "2016 perspectives," reflecting alternative data and assumptions. IU's primary finding is that, while the standards produced a strong sales increase after the first few years in the 2012 perspective, adjusting the assumptions reversed the outcome: the standards substantially *reduced* vehicle sales in most 2016 perspectives.

In order to better understand the IU results, ACEEE created a TCO model using information provided in the IU report.[16] This allowed us to clarify several points. First, IU uses the NHTSA's estimates of "required" fuel economy values and the accompanying technology costs, instead of NHTSA's "achieved" values. NHTSA's use of "required" values follows from statutory constraints on how they determine appropriate levels for the standards; but "achieved" values are the correct choice for determining the standards' real-world impacts, as IU seeks to do. We found that using "achieved" values produced more favorable vehicle sales results. In addition, there is no indication that IU applied NHTSA's assumption that costs of new technologies decline over time (through "learning") after MY 2025; incorporating learning would increase sales as well. We note that IU applies a 7% discount rate for fuel savings, whereas OMB guidance suggests using both 3% and 7%, though this choice has only a minor effect on the results. IU's 2012 perspective otherwise appears reasonable.

To create its 2016 perspectives, IU makes a variety of changes to the TCO inputs and assumptions, almost none of which could be accurately described as update to reflect new data or new consensus. Using more-recent fuel price projections is certainly appropriate. However, several of the changes to inputs for the 2016 perspectives, such as alternative assumptions regarding consumer valuation of fuel savings or NHTSA's projections of vehicle miles traveled from the TAR, reflect ongoing uncertainties or lack of consensus. Conveying the impression that the adjustments reflected in the 2016 perspectives represent an improved understanding of the factors affecting the standards' impacts on sales, as the IU report has done, is highly misleading. IU's figure ES.2 illustrates the problem. All 2016 perspectives in this figure show negative sales results.

[16] ACEEE's model reproduces IU's results very closely for cars. Our results for trucks differed somewhat from IU's, but we discuss only car results here.

IU's treatment of technology costs in particular warrants discussion. Assuming that the cost of technology will be bounded by NRC's high and low costs is misguided for several reasons. The NRC committee stated:

> It is important to note that these calculations did not include full CAFE/GHG program flexibilities so are not intended to be an estimate of actual compliance costs. In this example, technologies were applied to achieve the CAFE targets without consideration of other vehicles in a manufacturer's fleet and without consideration of credits. The results for other vehicle classifications may vary considerably from this example (NRC 2015).

Moreover, the NRC committee accepted many of the agencies' technology cost estimates from the rule, and these should be updated to reflect the agencies' latest estimates. Finally, the NRC discussed several emerging technologies that did not appear in the agencies' compliance packages for the rule but could create new compliance pathways. In the meantime, some of those very technologies have appeared on the market, as discussed above.

To create a more objective, but conservative, 2016 perspective, we used ACEEE's TCO with updated fuel prices, NHTSA's estimated achieved fuel economy values and technology costs in the rule, and the assumptions of four years' consumer valuation of fuel savings and 4% discount rate. We omit the ZEV mandate, because here we are interested specifically in the impacts of the federal program. Figure 1 shows three perspectives from IU's original figure ES.2, with this additional perspective (2016 ACEEE). Unlike IU's 2016 perspectives, the 2016 ACEEE perspective shows positive, though reduced, sales impacts from the standards.

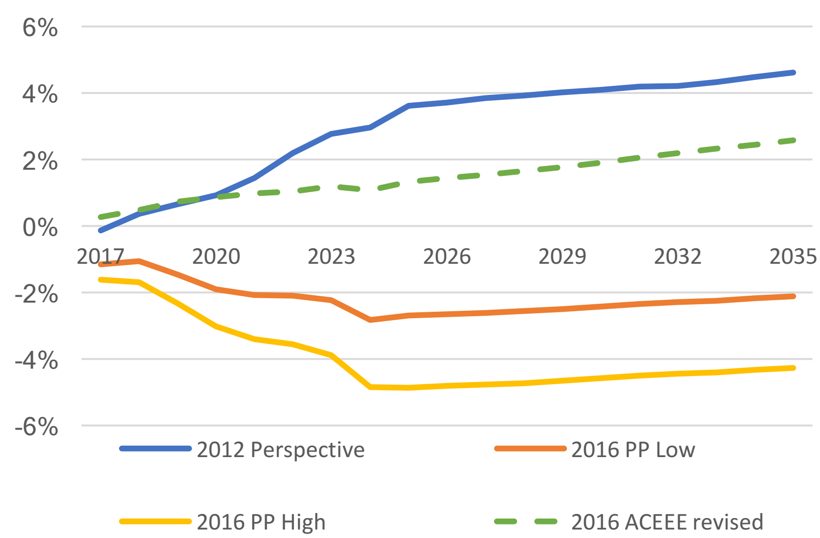

Figure 1. Estimated percentage change in car sales in various scenarios

While the TCO analyses reflect many uncertainties, we conclude that it is incorrect to say that new information available since the adoption of the MY 2017-2025 standards shifts the outlook for vehicle sales impacts of the standards from positive to negative.

Global competitiveness

A key consideration not discussed in the studies referenced above is the need for manufacturers producing vehicles for the US market to also meet requirements in other parts of the world. If standards in other major markets are more rigorous than those in the United States, companies, including domestic manufacturers with a strong US focus, are likely to be at a disadvantage in competing in the foreign markets while also producing less-efficient vehicles in the United States. To remain competitive, all manufacturers will need to continue investing in advanced technology, and both the manufacturers and the country will benefit most from that investment in an environment of steady advances in emissions and fuel economy requirements in the United States.

<u>The impacts of the standards on automobile safety</u>

Understanding of the relationship between vehicle GHG and fuel economy standards and safety has improved greatly in recent years, due to extensive research (NRC 2015). The advent of size-based standards in MY 2011 has gone far to mitigate concerns. Parties surfacing on occasion to raise the specter of the standards' negative safety impacts seem ill informed on the current state of knowledge. For example, in recent testimony before EPA on the MTE, CEI cited multiple safety studies and articles from the 1990s purporting to confirm fuel economy's adverse safety implications, but cited no recent studies (Kazman 2017).

<u>The impact of the greenhouse gas emission standards on the Corporate Average Fuel Economy standards and a national harmonized program</u>

(No comment at this time.)

<u>The impact of the standards on other relevant factors. (40 CFR 86.1818-12(h)(1))</u>

(No comment at this time.)

Other Relevant Factors

In the RFC, EPA lists several additional "relevant factors." Those factors are a small fraction of the full set of considerations relevant to setting and reviewing GHG standards for vehicles. While the required factors discussed above are indeed distinguished from the many other relevant considerations in that they are identified in the 2017–2025 rule, the additional factors listed have no such special status, and any new action taken in the midterm review based on these factors to the detriment of EPA's obligations under the Clean Air Act or to the required factors would be unjustified.

EPA does not explain the other factors listed in the RFC, and it is not always clear what they mean. Where the meaning of the factors listed is clear, they are largely not new at all, but rather are issues that have been discussed in earlier EPA documents relating to the 2017–2025 rule and/or in comments on those documents. These factors and our comments on them are as follows.

<u>The impact of the standards on compliance with other air quality standards</u>

(No comment at this time.)

<u>The extent to which consumers value fuel savings from greater efficiency of vehicles</u>

(No comment at this time.)

<u>The ability for OEMs to incorporate fuel-saving technologies, including those with "negative costs," absent the standards</u>

The meaning of this factor in the RFC is not clear, but we note that NHTSA used similar language in the draft TAR:

> The default assumption in the [Volpe] model is that manufacturers will treat all technologies that pay for themselves within the first three years of ownership (through reduced expenditures on fuel) as if the cost of that technology were negative. This holds true up to the point at which the manufacturer achieves compliance with the standard – after which the manufacturer treats all technologies that pay for themselves within the first year of ownership as having a negative effective cost (EPA and NHTSA 2017, 12–10).

This assumption reflects the understanding that manufacturers are more likely to adopt efficiency technologies, including those with fairly short payback periods, when subject to binding standards. Several reasons have been identified for the fact that they often fail to incorporate such technologies absent the standards, as discussed at length in the FRM. Some commenters have maintained this behavior indicates that the technologies in question must compromise other vehicle properties, but extensive EPA research has found that this is rarely the case (Helfand et al. 2015).

<u>The distributional consequences on households</u>

EPA responded in the Proposed Determination and in its response to comments for the final determination that fuel economy improvements are progressive and reduce expenditures for all income groups (EPA 2016c, EPA 2017b). A report cited by EPA shows using historic data that all income quintiles benefit from improved fuel economy. Highest quintile households realize the greatest net savings, but the lowest-income quintile sees the greatest relative benefit. Fuel economy improvements since 1980 have saved 4.7% of annual income, or over $500, for households in the lowest income quintile. Highest income quintile households realized a savings of $1,500, which is a much smaller portion (0.9%) of household income (Greene 2010, Welch 2016).

The appropriate reference fleet

(No comment at this time.)

The impact of the standards on advanced fuels technology, including but not limited to the potential for high-octane blends

The standards through MY 2025 are feasible with the octane levels of regular fuel today. High-octane fuel blends, including those made by increasing the ethanol content in gasoline, present opportunities for further improvements in efficiency. However, based on comments delivered at EPA's September 5, 2017 hearing in Washington, DC on the Midterm Evaluation, even those advocating higher-octane blends are not necessarily recommending a mandate for higher fuel octane. Benefits from the optional use of higher-octane fuels are not guaranteed, because modern vehicles are able to run on lower-octane fuels at the expense of performance and fuel economy. Many consumers will choose cheaper, lower-octane fuel if given the option.

The availability of realistic technological concepts for improving efficiency in automobiles that consumers demand, as well as any indirect impacts on emissions

Consumer demand for a given technology is not always apparent from its uptake in the market. In its response to the PD, Toyota voiced concern that the agency hasn't appropriately accounted for low fuel prices potentially shifting consumer preference to vehicles or powertrain types that make compliance more challenging. Yet consumers are frequently driven away from more-efficient powertrains because they are available only in packages with a cost far greater than that of the technology. Manufacturers regularly package fuel-saving technology with other features or higher trim levels that the consumer may not desire or cannot afford, thus discouraging adoption of already mature fuel-saving technology. For example, the 2016 Toyota Highlander Hybrid was available only in the $49,500 Limited or $52,200 Limited Premium trims (US News 2016) that come with features such as Blu-ray players, premium audio, and heated and ventilated seats. For 2017, the Highlander Hybrid is available in the $36,270 LE trim (Toyota 2017). This pricing change may explain why Toyota has realized a 197.1% increase in Highlander Hybrid sales through August 2017 compared to the same period of 2016. Sales of all Highlander models have increased by only 21.3% (Schweinsberg 2017a; Schweinsberg 2017b). As another example, Chevrolet's 2017 Silverado 1500 pickup with eAssist mild-hybrid system is available in some states as a $500 option, but only in packages that include under-bed cargo lights, remote start, and power seats, which add significantly to price (GM 2017).

Off-cycle technologies

The reference to "realistic technological concepts" having "indirect impacts on emissions" in this factor could be a reference to off-cycle technologies. The auto industry continues to request easier access to credits for such technologies. In the PD, EPA affirmed that the MY 2022-2025 standards are appropriate with the off-cycle credit provisions currently in place. Moreover, any relaxation of the off-cycle credit program's requirements could undermine the credibility and effectiveness of the standards overall.

In our comments on the draft TAR, ACEEE noted that off-cycle credits must be based on a credible technical demonstration of real-world benefits. EPA responded partly by stating that it "is not proposing to make changes to the off-cycle credits program as part of the Midterm Evaluation, as there is no reason within the scope of the MTE to revisit these provisions" (EPA 2016d). The agency also stated:

> EPA agrees […] that off-cycle credits must continue to be based on data demonstrating the real-world benefits of the off-cycle technology per the regulations that are currently in place. By ensuring that the credits are based on demonstrated real-world benefits, which we believe the current off-cycle regulatory framework does, EPA ensures that emissions reductions associated with the standards are maintained. The existing credits process in place today ensures that credits are legitimate and maintains the integrity of the program (EPA 2016d, A-104).

However, EPA did not respond to our comment that the MY 2017-2025 rule prohibits credits for "technologies which provide those improvements by indirect means […] or may provide benefit to other vehicles on the road more than for themselves." This prohibition is appropriate, given that the standards are based on an approach focused on a vehicle's performance as measured in specified, repeatable conditions.

We urge that, in considering whether to grant credits for off-cycle technologies, EPA continue to observe the following principles:

- The purpose of off-cycle credits is to bring into the market new technologies that reduce emissions and fuel consumption.
- Award of off-cycle credits must be based on a credible technical demonstration that the technology will provide benefits in the real world.
- A technology used as a basis for the standard is not eligible for off-cycle credits.
- A technology may receive off-cycle credits based only emissions reductions in the vehicle in which the technology is installed.

<u>The advantages or deficiencies in EPA's past approaches to forecasting and projecting automobile technologies, including but not limited to baseline projections for compliance costs, technology penetration rates, technology performance, etc.</u>

EPA's staff expertise and facilities at the National Vehicle and Fuel Emissions Laboratory in Ann Arbor have been absolutely critical to the development of these standards. EPA has done the tear-down analyses to estimate the costs of new technologies, benchmarked recent implementations of engine and transmission technologies to assess their fuel efficiency performance, and developed and made freely available to the public a vehicle simulation tool (ALPHA) to model the benefits of technology packages.

The most recent NRC fuel economy committee, which included leading automotive engineers, found that the agencies' analysis in developing the 2017–2025 standards was "thorough and of high caliber on the whole." The committee also noted the high value of EPA's teardown studies to estimate technology costs, stating that "the added cost is well justified because it produces more reliable assessments" (NRC 2015).

EPA has carried out a vast number of technical projects in support of its work on automotive standards and has routinely published its analyses in engineering journals and subjected its models to rigorous peer review. It has been responsive to critiques arising from those reviews and from formal comment processes, as in the case of the Novation Analytics critique cited above.

By requesting comments on "[t]he advantages or deficiencies in EPA's past approaches" as well as "[t]he use of alternative methodologies and modeling systems" (discussed below), the RFC suggests the possibility of a diminished role for EPA, and/or the analytical approaches it has developed, in the technology assessments for setting vehicle standards. Such a shift would be inappropriate and would detract from the integrity of EPA's regulatory processes and the standards program. EPA and NHTSA have distinct statutory obligations to regulate vehicles' GHG emissions and fuel economy, respectively, that impose differing constraints on their analyses. While the agencies have agreed to harmonize the two programs to the extent possible, EPA must exercise its independent judgment regarding the matters under its jurisdiction.

Furthermore, any reduction in EPA's role in the technical analysis for the standards would necessitate greater reliance on NHTSA's analysis, which would greatly reduce the robustness and transparency of the technical basis for the standards. As ACEEE noted in its TAR comments, much of NHTSA's work for the TAR was deficient:

> Given the complexity of technology effectiveness and cost estimation in the TAR, and its importance to the MTE, it is essential that the agencies' findings be presented in a transparent fashion. Hence it is unacceptable that NHTSA does not provide effectiveness estimates explicitly in the TAR. NHTSA's approach to the modeling of technologies was problematic as well, in that it relied upon a simulation model that requires a license and work done on proprietary, and in some cases outdated, engine maps to determine technology fuel consumption benefits (ACEEE 2016a).

A 2010 report from the US Government Accountability Office (GAO) describes the unequal partnership between EPA and NHTSA on the analysis of vehicle standards. GAO notes EPA's far greater experience and investment in automotive technology analyses and states:

> By comparison [to NHTSA], EPA has been able to develop and maintain automotive engineering expertise. This expertise has proved helpful in setting GHG emissions standards for automobiles. For example, EPA has been home to the National Vehicle and Fuel Emissions Laboratory since 1971, and in the early 1990s, it expanded its activities to conduct research and development of technologies used to reduce emissions, which are often marketed and licensed to the automobile industry. Although NHTSA brings safety expertise to CAFE standards, which has been a concern with raising CAFE standards in the past, the agency's primary mission and expertise is in vehicle safety, not vehicle power train design and the impact of vehicle emissions on the environment. Thus NHTSA cannot be expected to have the same level of in-house expertise related to vehicle power train design and environmental issues as EPA (GAO 2010, 23-24).

Automotive technology is a rapidly evolving field with enormous environmental and economic implications for the nation. Accordingly, EPA must continually update and improve its information and analysis tools in this area, as it has done in the past. It is essential that EPA maintain and invest in its vast capabilities in automotive analysis, rather than allow them to stagnate.

<u>The impact of the standards on consumer behavior, including but not limited to consumer purchasing behavior and consumer automobile usage behavior (e.g., impacts on rebound, fleet turnover, consumer welfare effects, etc.)</u>

As discussed in our comments on the PD (ACEEE 2016c), the average price of a new vehicle in real dollars has remained essentially flat for nearly 10 years. Yet auto interests continue to argue that the standards will make vehicles unaffordable to many Americans. For example, the National Automobile Dealers Association stated that the average price of a new car has increased 57% since 1996 while average household income has increased only 21% (Welch 2017). This is an apples-to-oranges comparison. As in an earlier comparison by the Alliance of Automobile Manufacturers (AAM 2016), vehicle price increase appears to be given in terms of nominal dollars, while income growth is in real dollars.[17] When appropriately adjusted for inflation, average vehicle price (cars and trucks combined) has increased only 10% over this

[17] In addition, AAM cites KBB transaction prices, which does not include applied consumer incentives or rebates (AAM 2016). Our statements are based on transaction price, which includes concessions, discounts, and rebates. Consumer incentives can be significant, especially for pickup trucks. On October 5, 2017 for zip code 20001, GMC is offering up to $12,000 in discounts on its 2017 Sierra 1500 4WD Crew Cab, Ford is offering $6,550 in discounts on its 2017 F-150 XLT with 2.7L V6 Ecoboost, and RAM is offering $13,311 in discounts on its 2017 RAM 1500 models. Screen clippings of these offers are attached to these comments.

period, and this increase is due in part to an increase in truck sales share.[18] The inflation-adjusted price of cars alone actually declined 10% on average over this period.

Any relevant information in light of newly available information

In the final rule for MY 2017–2025, EPA committed to a midterm evaluation to review the MY 2022–2025 standards using updated information. Analysis conducted since the adoption of the final rule has confirmed the fundamental soundness of the agencies' approach. Predictably, new technologies have emerged since that time, with the likely result that compliance with the standards will be less expensive than projected in the rulemaking. EPA's TAR analysis confirms this, and additional technology gains not reflected in the TAR analysis will reduce compliance costs further. The primary factor that has emerged to work against the cost effectiveness of the standards is the reduction in gasoline prices. The gasoline prices used in the TAR, which are from the Energy Information Administration's Annual Energy Outlook (AEO) 2015, are roughly a dollar per gallon lower through 2025 than projected by AEO 2012 Early Release, which was the source of fuel prices in the rule. As demonstrated in the TAR, the impact of those price reductions, while significant, does not alter the conclusion that the standards through 2025 are highly cost effective.

Since the TAR, EIA has released AEO 2017, which further reduces fuel price projections by 4-18% per year between 2025 and 2040. Weighting these price reductions by expected annual miles of travel by a MY 2025 vehicle, the reduction in discounted fuel costs over the life of the vehicle would be about 6%. At the same time, a recent assessment of technology availability and cost conducted by the ICCT indicates a reduction of 34-40% in the cost of compliance in MY 2025 relative to EPA's analyses for the midterm review (Lutsey et al. 2017). This reduction more than offsets the reduction in projected benefits due to the AEO 2017 fuel price projections. Furthermore, preliminary EIA modeling indicates gasoline price projections will rise again slightly in AEO 2018 (EIA 2017). Hence an update to the TAR, PD, and FD analyses can be expected to show further improvement to the cost effectiveness of the MY 2022-2025 standards.

In addition to the "new factors" discussed above, EPA requested comment on the following topic:

The use of alternative methodologies and modeling systems to assess both analytical inputs and the standards, including but not limited to the Department of Energy's (DOE's) Argonne National Laboratory's Autonomie full vehicle simulation tool and DOT's CAFE Compliance and Effects Model.

[18] In our response to the PD, we discussed average vehicle prices limited to years where light truck price data was available. For these comments, and to include light trucks back to 1996, we use DOE VTO Fact of the Week #988, "Average Price of a New Light Vehicle, 1970-2016."

Replacing EPA's methodologies and modeling systems with NHTSA's will detract from the quality and integrity of the standards programs. As noted in the draft TAR:

> [T]he EPA GHG and NHTSA CAFE assessments were done largely independently. These independent analyses were done in part to recognize differences in the agencies' statutory authorities and to reflect independent choices regarding some of the modeling inputs used at this initial stage of our evaluation. The agencies believe that independent and parallel analyses can provide complementary results (EPA et al. 2016, ES-6).

Apart from the agencies' responsibility to conduct independent, complementary analyses using tools appropriate to their respective obligations, the notion that Autonomie is objectively superior to EPA's ALPHA model, or DOT's Volpe model to EPA's OMEGA model, is counter to ACEEE's experience and understanding. At a minimum, inputs to the models used for DOT's analysis have reflected in several instances long-outdated assumptions, inadequate documentation, or opaque results. Moreover, it would be unreasonable to move EPA from purpose-built tools to modeling platforms developed by other entities in the midst of the MTE, and after the primary technical document (i.e., the draft TAR) has been completed.

Furthermore, unlike EPA's ALPHA simulation tool, Autonomie requires users to purchase a license, at considerable cost. ACEEE requested a quote for a single license of MATLAB (December 2, 2015) and was quoted $1,659 for one year of access or $4,846 to purchase it outright. While open-source alternatives to MATLAB exist, Autonomie also requires Simulink and Stateflow, which have no open-source alternatives. For Simulink and Stateflow, a single license is $3,250 each; combined with the MATLAB purchase, the minimum cost to run Autonomie is more than $8,150 (MathWorks 2017a; MathWorks 2017b).

Reopening MY 2021 Standards

EPA notes that NHTSA may reevaluate model year 2021 standards and that, "in the interest of harmonization between the GHG and CAFE programs," EPA also is requesting comment on whether the model year 2021 standards are appropriate.

The impetus for EPA to reopen the 2021 standards is unclear. In NHTSA EIS comments regarding MY 2021 standards, the automakers' trade groups focused entirely on "harmonization" issues:

> Due to the unfulfilled commitment from the 2012 joint EPA-NHTSA final rule that was touted as creating a truly harmonized set of CAFE and GHG standards, reexamination of MY 2021 requirements is appropriate and NHTSA should consider whether any provisions developed to address harmonization should be applied (AAM and AGA 2017).

The record does not support granting the automakers' requests in their petition, as discussed in ACEEE et al. (2017). In any case, the harmonization requests reference CAFE program changes only, not changes to EPA's GHG program.

Weakening MY 2021 standards would be both inappropriate and unwarranted. Many vehicles of all types already meet future standards. In the 2016 *Trends Report*, EPA notes that, because overall manufacturer compliance is determined on a production-weighted average footprint and CO_2 emissions, in future years, only about 50% of manufacturers' vehicles will need to meet or exceed the standard. Table 2 shows that 17% of MY 2016 vehicles already meet or exceed the 2020 standard, and 3.5% meet or exceed the 2025 standard, based on performance over the test cycle. When off-cycle credits are taken into account, over 20% of all MY 2016 vehicles meet or exceed the 2020 standard (Charmley 2017). Even popular SUVs are comfortably meeting future standards. For example, the 2017 Honda CRV all-wheel-drive model meets its 2022 target (Charmley 2017). With an increasing number of models meeting future standards, manufacturers are demonstrating their ability to make the necessary improvements in their product lineups.

Table 2. Number of MY 2016 vehicles that meet or exceed future standards

Future standard MY	Number of MY 2016 vehicles	Source
2020	17%	2016 EPA *Trends Report*
2025	3.5%	2016 EPA *Trends Report*

Figure 2 shows that the majority of vehicles meeting the MY 2020 standard are conventional gasoline vehicles. Comparing this to the MY 2012 vehicles, where the majority of vehicles meeting the 2020 standard were hybrids, indicates the industry's improvement capabilities.

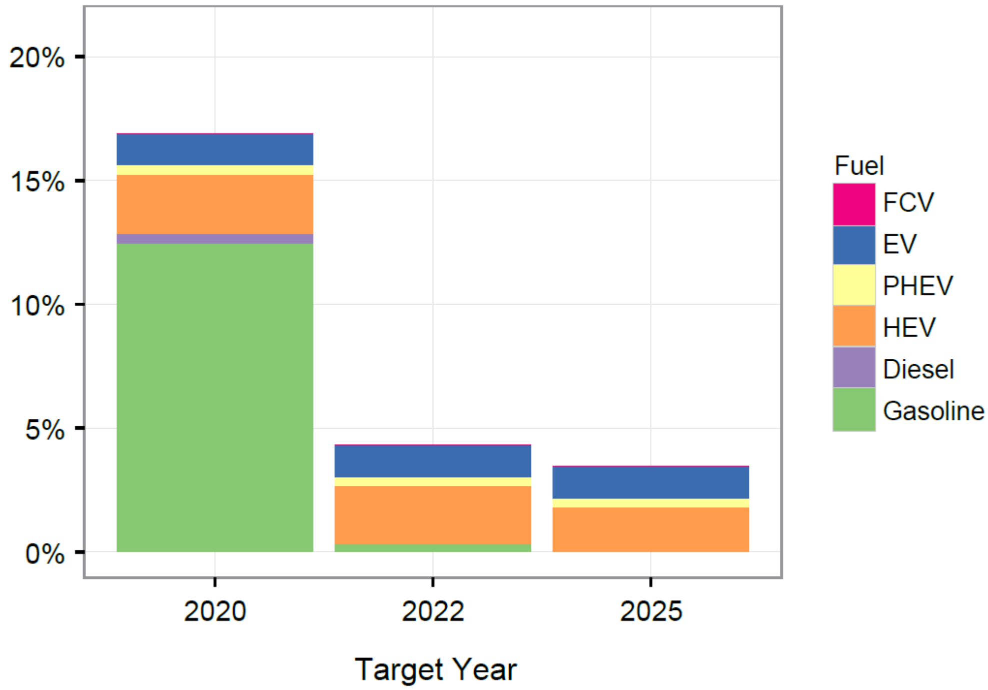

Figure 2. MY 2016 vehicle production that meets or exceeds future CO_2 emission targets (EPA 2016b)

Likewise, ICCT recently reported that the 2018 Camry, a very high-volume vehicle, meets its MY 2022 standard on 2-cycle alone. When including off-cycle and A/C credits, the 2018 Camry nearly meets its MY 2024 standard (German 2017).

In addition to producing many conventional vehicles that meet their footprint targets several years into the future, manufacturers have accrued numerous credits that will facilitate their compliance with the standards through at least MY 2021. ACEEE modeled a variety of fleet compliance pathways for future model years by considering the GHG credit provisions. We used EPA's 2015 model year *Manufacturer Performance Report* (EPA 2016a) for fleet performance in MY 2012–2015 and a Novation Analytics report for forecasts of the use of various flexibilities (off-cycle, A/C efficiency, A/C leakage) (Novation 2016).

By overcomplying with the standards in MY 2012–2015, the industry banked more than 285 million metric tons of GHG credits (EPA 2016b). We found that, as a result, the industry would be able to comply through model year 2021 by reducing 2-cycle emissions only 2% per year after MY 2016 and spending down banked credits, while using flexibilities as projected in the draft TAR and the Novation MY 2016 Baseline Study (Novation 2016).[19] This rate of emissions reduction is slower than the improvement achieved between 2012 and 2015 (2.5% per year on average), and it is not credible that industry requires relief from this standard.

[19] MY 2016 flexibility projections are from the Novation MY 2016 Baseline Study. Projected use of flexibilities for MY 2017-2020 are interpolated from Novation's MY 2016 values and MY 2021 values from TAR table 12.7 (cars) and 12.8 (light trucks).

Light truck targets

Although the agencies have provided no explanation of why they may consider reopening the MY 2021 standards, some external accounts have drawn attention to the relatively large jump in truck CO_2 targets from 2020 to 2021 (Briggs 2017). The increment, however, follows years of minimal reductions in the truck emissions targets at the large end of the footprint spectrum. These minimal reductions were adopted with the understanding that later targets would partially compensate for this early leniency in MY 2021 and beyond. ACEEE expressed concern about this approach in our comments on the proposed rule:

> The small improvements required of large trucks in 2017-2020, followed by a larger improvement in 2021 is of particular concern given the agencies' plan to conduct a midterm evaluation. This situation raises the possibility that the more significant improvements proposed for large trucks in the period 2021-2025 will never be realized, because manufacturers may allow technology development for these vehicles to stagnate in the early years of the rule and use this to influence the outcome of the midterm evaluation (ACEEE 2012).

EPA dismissed this concern, stating in part that "if there are cost effective technologies that have not yet been applied, the manufacturer will implement them in advance in order to earn credits for the 5%/yr period…" (EPA 2012, 2–103). Yet the agencies demonstrated the existence of exactly such "cost effective technologies that have not yet been applied" in producing compliance pathways in the TAR. Both agencies showed that large pickup trucks could meet their emissions targets in 2021; in fact, tables 12.3 and 12.4 in the draft TAR showed light trucks overcomplying in both MY 2021 and MY 2025, offsetting shortfalls in compliance for cars in both years. Hence we do not believe that large trucks' alleged difficulty in meeting MY 2021 targets provides a legitimate reason to reopen MY 2021 standards.

Loss in savings if standards are held flat at 2020 levels

ACEEE estimated emissions in various scenarios using Argonne National Laboratory's VISION model (2016 version). Savings from the MY 2022-2025 standards (discussed earlier) were determined by comparing a scenario representing the standards to a scenario in which the standard is held flat at MY 2021 levels. Similarly, we determine the savings from MY 2021-2025 by comparing them to a scenario in which the standard is held flat at MY 2020 levels. Table 3 shows that over the lifetime of the affected vehicles, savings from the MY 2021-2025 standards account for an additional 56% of CO_2 emissions and oil use over the MY 2022-2025 standards.

Table 3. Loss in lifetime savings in GHG emissions and oil use relative to existing standards

Scenario	Affected Model Years	GHG emissions (MMT)	Oil (billion barrels)
Flat at MY 2020	2021–2025	890	1.75
Flat at MY 2021	2022–2025	571	1.12

Losses due to these scenarios should also be viewed in terms of annual losses in savings due to weakened emissions standards in all future years, not just the model years nominally covered by the standards. Holding the standards flat at model year 2020 would result in an annual loss of savings of 476 million barrels oil and 226 MMT GHG in 2035 alone, and holding flat at MY 2021 would result in a loss of 354 million barrels and 168 MMT GHG, respectively. Comparing the two scenarios, figure 3 shows that holding the standards flat at MY 2020 would lead to an additional 58 MMT of CO_2 emissions in 2035. Similarly, we find that holding the standards flat at MY 2020 levels would increase oil consumption by an additional 0.3 MBD in 2035, or nearly 122 million barrels. Table 4 shows the annual emissions increase associated with keeping the standards flat at model years 2020 and 2021, compared to maintaining the current MY 2022-2025 standards.

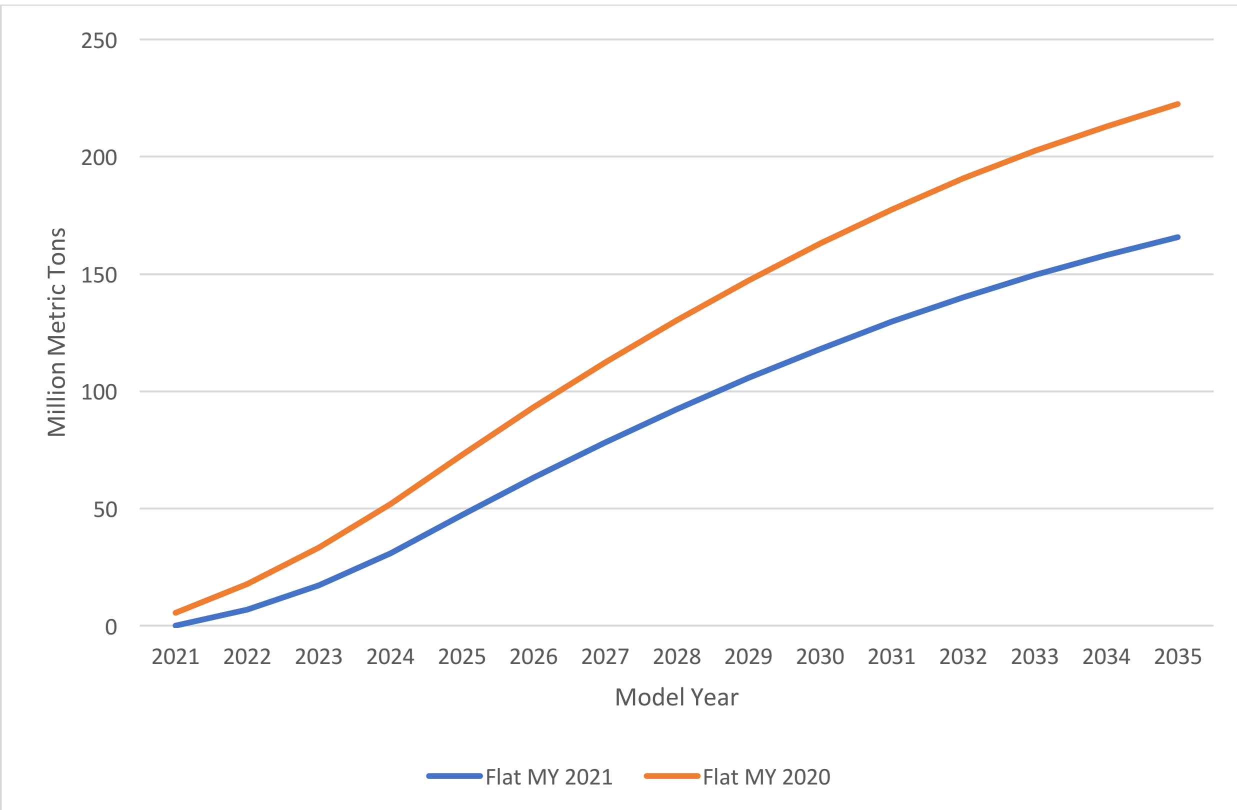

Figure 3. Additional CO_2 emissions each year if the standards are kept flat after MY 2020 vs. after MY 2021

Table 4. Annual loss in savings, GHG emissions relative to the standards (million metric tons)

Scenario	2025	2030	2035	2040	2045	2050
Flat at 2020	73	164	226	263	282	285
Flat at 2021	47	119	168	198	213	216

The central aim of EPA standards is to address emissions, yet these changes would result in a large loss of avoided emissions. As discussed above, there is no evidence that such changes are justified.

Conclusion

In light of the considerations discussed above and the large volume of evidence produced elsewhere in the midterm evaluation process, ACEEE believes that the light-duty GHG standards for MY 2021–2025 remain appropriate. We urge EPA to finalize standards through 2025 that are at least as strong as those now in place and begin looking forward to the next phase in creating an efficient and sustainable transportation future.

References

AAM (Alliance of Automobile Manufacturers). 2016. Statement of The Alliance of Automobile Manufacturers Before The: Energy and Commerce Committee Subcommittee on Commerce, Manufacturing, and Trade And the Subcommittee on Energy and Power, U.S. House of Representatives. Hearing Title: Midterm Review and Update on the Corporate Average Fuel Economy Program and Greenhouse Gas Emissions Standards for Motor Vehicles. September 22, 2016. https://democrats-energycommerce.house.gov/sites/democrats.energycommerce.house.gov/files/09.22.16_Testimony_Bainwol.pdf.

AAM and AGA 2017 (Alliance of Automobile Manufacturers, Association of Global Automakers). "Alliance of Automobile Manufacturers and Association of Global Automakers Comments on Notice of Intent to Prepare an Environmental Impact Statements for Model Year 2022-2025 Corporate Average Fuel Economy Standards." September 25, 2017.

ACEEE 2012. "ACEEE Comments on the NPRM for Fuel Economy and Greenhouse Gas Emissions Standards for Light-Duty Vehicles of Model Years 2017-2025." February 13, 2011. Docket number EPA–HQ–OAR–2010–0799 and NHTSA–2010–0131.

ACEEE 2016a. "ACEEE Comments to the Environmental Protection Agency and the National Highway Traffic Safety Administration on the Technical Assessment Report." September 26, 2016. Docket number EPA-HQ-OAR- 2015-0827 and NHTSA-2016-0068.

ACEEE 2016c. "ACEEE Comments on EPA's Proposed Determination." December 30, 2016. Docket number EPA-HQ-OAR-2015-0827.

ACEEE et al 2017. American Council for an Energy-Efficient Economy, Natural Resources Defense Council, Safe Climate Campaign, Sierra Club, Union of Concerned Scientists. Comments on "Grant of petition for rulemaking submitted by the Alliance of Automobile

Manufacturers and the Association of Global Automakers." Docket number NHTSA—2016—0135.

Atiyeh, C. 2017. "2018 Audi A8 to Feature 48-Volt Hybrid System." Car and Driver, June 13, 2017. Accessed October 5, 2017. https://blog.caranddriver.com/2018-audi-a8-to-feature-48-volt-hybrid-system/.

Busch, C., J. Laitner, R. McCulloch, I. Stosic. 2012. *Gearing Up: Smart Standards Create Good Jobs Building Cleaner Cars*. Washington, DC: American Council for an Energy-Efficient Economy, Blue Green Alliance. http://aceee.org/research-report/e127.

Birch, S. 2017. "Delphi and Tula show NVH benefits from Dynamic Skip Fire." *SAE Automotive Engineering,* August, 2017.

Bolduc, D. 2017. "Can Continental score big with 48-volt hybrids?" *Automotive News,* February 25, 2017. Accessed September 29, 2017. http://www.autonews.com/article/20170225/OEM06/302279995/can-continental-score-big-with-48-volt-hybrids%3F.

Briggs, J. "For pickup trucks, more than half all fuel savings come in 2022-2025 CAFE rules." *Green Car Reports*, August 9, 2017. Accessed October 3, 2017. http://www.greencarreports.com/news/1111946_for-pickup-trucks-more-than-half-all-fuel-savings-come-in-2022-2025-cafe-rules.

Brooke, L. 2017a. "Bridging the power gap with 48 volts." *SAE Automotive Engineering,* January, 2017.

Brooke, L. 2017b. "Honda's new 10-speed is a slick shifter." *SAE Automotive Engineering, January 18, 2017.* http://articles.sae.org/15215/.

Brooke, L. 2017c. "New 10-speed is a delight in the 2017 F-150." *SAE Automotive Engineering, January 19, 2017*. http://articles.sae.org/15216/.

Brooke, L. 2017d. "Innovations for Lightweighting." *SAE Automotive Engineering,* May, 2017.

Buchholz, K. 2017. "Lightweight door module aims to trim vehicle weight." *SAE Automotive Engineering*. January 11, 2017. http://articles.sae.org/15200/.

Carley, S., D. Duncan, J. Graham, S. Siddiki, N. Zirogiannis. 2017. "A Macroeconomic Study of Federal and State Automotive Regulations with Recommendations for Analysts, Regulators, and Legislators." Bloomington, IN: School of Pulbic and Environmental Affairs, Indiana University.

Charmley, B. 2017. “EPA GHG Update for 2017 Fuel Economy Detroit.” Washington, DC: U.S. Environmental Protection Agency. Accessed September 27, 2017. https://www.epa.gov/sites/production/files/2017-03/documents/fuel-economy-detroit-2017-03-16.pdf.

Chevrolet. 2016. “Chevrolet’s First 9-Speed Auto Debuts in 2017 Malibu.” Press release, December 6, 2016. Detroit, MI: General Motors. Accessed 10/5/2017. http://media.chevrolet.com/media/us/en/chevrolet/news.detail.html/content/Pages/news/us/en/2016/dec/1206-9speed.html.

Delphi. 2016. “Gasoline Engine Management Systems, Delphi-Tula Dynamic Skip Fire Cylinder Deactivation System.” Product description. Accessed October 5, 2017. https://www.delphi.com/manufacturers/auto/powertrain/gas/ems/delphi-tula-dynamic-skip-fire-cylinder-deactivation-system.

EIA (Energy Information Administration. 2017. “Annual Energy Outlook: Preliminary results for oil, natural gas, & liquid fuels.” https://www.eia.gov/outlooks/aeo/workinggroup/oil-naturalgas/pdf/AEO2018%20PNGBA%20working%20group%20session%202_2017_09_21.pdf.

EPA (U.S. Environmental Protection Agency). 2012. “2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards: EPA Response to Comments.” Accessed 10/3/2017. Washington, DC: U.S. Environmental Protection Agency. https://nepis.epa.gov/Exe/ZyPDF.cgi/P100EZXG.PDF?Dockey=P100EZXG.PDF.

EPA (U.S. Environmental Protection Agency). 2016a. “GHG Emission Standards for Light-Duty Vehicles: Manufacturer Performance Report for the 2015 Model Year.” Accessed 9/29/2017. Washington, DC: U.S. Environmental Protection Agency. https://www.epa.gov/regulations-emissions-vehicles-and-engines/greenhouse-gas-ghg-emission-standards-light-duty-vehicles.

EPA (U.S. Environmental Protection Agency). 2016b. “Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2016.” Accessed 10/1/2017. Washington, DC: U.S. Environmental Protection Agency. https://www.epa.gov/fueleconomy/light-duty-automotive-technology-carbon-dioxide-emissions-and-fuel-economy-trends-1975-0.

EPA (U.S. Environmental Protection Agency). 2016c. “Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation.” Washington, DC: U.S. Environmental Protection Agency.

EPA (U.S. Environmental Protection Agency). 2016d. “Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation: Technical Support Document.” EPA-420-R-16-021. Washington, DC: U.S. Environmental Protection Agency.

EPA (U.S. Environmental Protection Agency). 2017a. “Final Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation.” Washington, DC: U.S. Environmental Protection Agency.

EPA (U.S. Environmental Protection Agency). 2017b. “Final Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation: Response to Comments” Washington, DC: U.S. Environmental Protection Agency.

EPA and NHTSA (U.S. Environmental Protection Agency, U.S. National Highway Traffic Safety Administration). 2016. “Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022-2025.” Washington, DC: U.S. Environmental Protection Agency, U.S. National Highway Traffic Safety Administration.

EPA and NHTSA (U.S. Environmental Protection Agency, U.S. National Highway Traffic Safety Administration). 2017. “Request for Comment on Reconsideration of the Final Determination of the Mid-Term Evaluation of Greenhouse Gas Emissions Standards for Model Year 2022–2025 Light-Duty Vehicles; Request for Comment on Model Year 2021 Greenhouse Gas Emissions Standards.” Washington, DC: U.S. Environmental Protection Agency, U.S. National Highway Traffic Safety Administration. Federal Register Vol. 82, No. 160.

EPA, NHTSA, and ARB (U.S. Environmental Protection Agency, U.S. National Highway Traffic Safety Administration, and California Air Resources Board). 2016. “Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022-2025.” EPA-420-D-16-900.

Estrada, Z. 2017. “Mazda could have the tech to save the internal combustion engine.” *The Verge*. Accessed September 29, 2017. https://www.theverge.com/2017/8/8/16099536/mazda-compression-ignition-engine-technology.

Frost, L. 2017. “VW, PSA, Volvo, others adopt 48-volt mild hybrids in response to diesel decline.” *Automotive News,* September 25, 2017. Accessed September 25, 2017. http://www.autonews.com/article/20170925/COPY01/309259965/vw-psa-volvo-others-adopt-48-volt-mild-hybrids-in-response-to-diesel.

German, J. 2017. “Technology Leapfrog: Or, all recent auto technology forecasts underestimate how fast innovation is happening.” Blog post, September 25, 2017. Washington, DC: The International Council on Clean Transportation.” Accessed 10/1/2017.

Gibbs, N. 2017. “Who’s killing the gasoline car? At Volvo, combustion-only days are numbered.” *Automotive News,* July 10, 2017. Accessed September 29, 2017. http://www.autonews.com/article/20170710/OEM05/170719961/volvo-electric-gasoline-combustion.

GM (General Motors). 2017. “2017 Silverado with eAssist.” Brochure. Accessed September 29, 2017. http://www.vehicleaccessorycenter.com/inc/files/editor/files/17CHSL_eAssist%20HC_Feb2017_FINAL.pdf.

GAO (Government Accountability Office). 2010. “NHTSA and EPA’s Partnership for Setting Fuel Economy and Greenhouse Gas Emissions Standards Improved Analysis and Should Be Maintained.” GAO-10-336. Washington, DC: General Accounting Office.

Greene, D., J. Welch. 2016. “The Impact of Increased Fuel Economy for Light-Duty Vehicles on the Distribution of Income in the United States.” Knoxville, TN: The Howard H. Baker Jr. Center for Public Policy, University of Tennessee. http://bakercenter.utk.edu/wp-content/uploads/2016/09/Equity-Impacts-of-Fuel-Economy-Report_final.pdf.

Hartrick, M. 2016. “Alliance of Automobile Manufacturers Comments on Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation.” https://www.regulations.gov/document?D=EPA-HQ-OAR-2015-0827-6156.

Helfand, G., J.M. Revelt, L. Reichle, K. Bolon, M. McWilliams, M. Sha, A. Smith, R. Beach. 2015. “Searching for Hidden Costs: A Technology-Based Approach to the Energy Efficiency Gap in Light-Duty Vehicles. Draft. EPA-420-D-15-010. Accessed October 5, 2017. https://nepis.epa.gov/Exe/ZyPDF.cgi/P100NNNG.PDF?Dockey=P100NNNG.PDF.

Kazman, S. 2017. “Fuel Economy Regulations Threaten Vehicle Safety.” Washington, DC: Competitive Enterprise Institute. Accessed 10/1/2017. https://cei.org/blog/fuel-economy-regulations-threaten-vehicle-safety.

Kendall, J. 2016. “Nissan unveils variable-compression-ratio ICE for 2018 Infiniti production model.” *SAE Automotive Engineering,* November, 2016.

Kodjak, D. 2017. “No, the fuel economy standards do not put a million US jobs at risk.” Washington, DC: The International Council on Clean Transportation. Accessed September 29, 2017. http://www.theicct.org/blogs/staff/fuel-econ-stds-do-not-put-1m-us-jobs-at-risk.

Lipman, Z., L. Tonachel, A. Baum, E. Daly, R. Johnson, M. Manson. 2017. "Supplying Ingenuity II: U.S. Suppliers of Key Clean, Fuel-Efficient Vehicle Technologies." New York, NY: Natural Resources Defense Council. https://www.nrdc.org/sites/default/files/supplying-ingenuity-clean-vehicle-technologies-report.pdf.

Lutsey, N., D. Meszler, A. Isenstadt, J. German, J. Miller. 2017. "Efficiency technology and cost assessment for U.S. 2025-2030 light-duty vehicles." Washington, DC: The International Council on Clean Transportation. Accessed September 29, 2017. http://www.theicct.org/US-2030-technology-cost-assessment.

Martinez, M. 2017. "Fields' CAFE claim comes with an asterisk." *Automotive News,* February 6, 2017. Accessed September 29, 2017. http://www.autonews.com/article/20170206/OEM11/302069936/fields-cafe-claim-comes-with-an-asterisk.

MathWorks. 2017a. Simulink pricing and licensing. Accessed 10/1/2017. http://articles.sae.org/15200/.

MathWorks. 2017b. Stateflow pricing and licensing. Accessed 10/1/2017. https://www.mathworks.com/pricing-licensing.html?prodcode=SF.

Mazda. 2016. EPA Names Mazda the Most Fuel-Efficient Automobile Manufacturer in the U.S. Press release, November 2, 2016. Hiroshima, Japan: Mazda. Accessed October 5, 2017. https://insidemazda.mazdausa.com/press-release/most-fuel-efficient-automobile-manufacturer-us/.

Mazda. 2017. Mazda Announces Long-Term Vision for Technology Development, 'Sustainable Zoom-Zoom 2030. Press release, August 8, 2017. Hiroshima, Japan: Mazda. Accessed October 5, 2017. https://insidemazda.mazdausa.com/press-release/mazda-announces-long-term-vision-technology-development-sustainable-zoom-zoom-2030/.

McAlinden, S., Y. Chen, M. Schultz, D. Andrea. 2016 . "The Economic Implications of Potential NHTSA and EPA Regulatory Revisions on U.S. Light Truck Sales and Manufacturing*." CAR (Center for Automotive Research)*. http://www.cargroup.org/publication/the-potential-effects-of-the-2017-2025-epanhtsa-ghgfuel-economy-mandates-on-the-u-s-economy/.

MEMA (Motor & Equipment Manufacturers Association). 2017a. "Driving the Future: The Employment and Economic Impact of the Vehicle Supplier Industry in the U.S." Accessed September 27, 2017. https://www.mema.org/sites/default/files/MEMA_ImpactBook.pdf.

MEMA (Motor & Equipment Manufacturers Association). 2017b. "Oral Statement of the Motor & Equipment Manufacturers Association (MEMA) Before the U.S. Environmental Protection Agency RE: Request for Comment on Reconsideration of the Final Determination of the

Mid-Term Evaluation of Greenhouse Gas Emissions Standards for Model Year 2022–2025 Light-Duty Vehicles; Request for Comment on Model Year 2021 Greenhouse Gas Emissions Standards .” Accessed September 20, 2017. https://www.mema.org/sites/default/files/resource/MEMA%20Testimony%20EPA%20MTE%20Sept%206%202017.pdf.

NRC (National Research Council). 2015. “Cost, Effectiveness, and Deployment of Fuel Economy Technologies for Light-Duty Vehicles.” Washington, DC: The National Academies Press. https://doi.org/10.17226/21744/.

Novation (Novation Analytics). 2015. “Final Report for Technology Effectiveness – Phase I: Fleet Level Assessment.” October 19.

Novation (Novation Analytics). 2016. “MY 2016 Baseline Study.” Version 1.0. December 20.

Schweinsberg, C. 2017a. “Toyota Up, Nissan Down in August.” *Wards Auto,* September 1, 2017. Accessed September 28, 2017. http://wardsauto.com/industry/toyota-nissan-down-august.

Schweinsberg, C. 2017b. “Toyota Localizing Hybrid Transaxle Production in U.S.” *Wards Auto,* September 26, 2017. Accessed September 28, 2017. http://wardsauto.com/engines/toyota-localizing-hybrid-transaxle-production-us.

Schweinsberg, C. 2017c. “No Silver Bullet for Lightweighting.” *Wards Auto,* September 28, 2017. Accessed September 28, 2017. http://wardsauto.com/technology/no-silver-bullet-lightweighting.

Toyota. 2016. Toyota comments to U.S. EPA on the Proposed Determination of 2022-2025 standards. Washington, DC: Toyota Motor North America. Submitted to docket number EPA-HQ-OAR-2015-0827.

Toyota. 2017. Model year 2017 Highlander Hybrid product listing and description. Accessed September 29, 2017. https://www.toyota.com/highlanderhybrid/.

Truett, R. 2016. “10 GM models to get 9-speed automatic by end of ’17.” Automotive News, December 11, 2016. Accessed October 5, 2017. http://www.autonews.com/article/20161211/OEM04/312129937/10-gm-models-to-get-9-speed-automatic-by-end-of-17.

Undercoffler, David. 2017. “So much technology, so little progress.” *Automotive News*, September 10, 2017. Accessed September 29, 2017. http://www.autonews.com/article/20170910/OEM11/170919966/emissions-analytics-study-fuel-efficency-technologies.

US News. 2016. 2016 Toyota Highlander Hybrid Overview. Accessed September 29, 2017. https://cars.usnews.com/cars-trucks/toyota/highlander-hybrid/2016.

Wayland, Michael. 2017. "Ford ups capability, convenience on F-150." August 16, 2017. Accessed September 29, 2017. http://www.autonews.com/article/20170816/BLOG06/170819879/ford-ups-capability-convenience-on-f-150.

Welch, Peter. 2017. National Automobile Dealers Association. "Fuel Economy and Greenhouse Gas Emissions." CAR Management Briefing Seminars. http://www.cargroup.org/wp-content/uploads/2017/08/Welch.pdf. Accessed September 29, 2017.

Zoia, D. 2017. "Delphi Touts 48V/DSF System as Inexpensive Diesel Alternative." *Wards Auto,* August 25, 2017. Accessed September 29, 2017. http://wardsauto.com/engines/delphi-touts-48vdsf-system-inexpensive-diesel-alternative.