**ICCT Comments in Response to the Proposed Rulemaking Issued by the National Highway Traffic Safety Administration and the Environmental Protection Agency on 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards**

**Docket No. NHTSA–2010-0131**

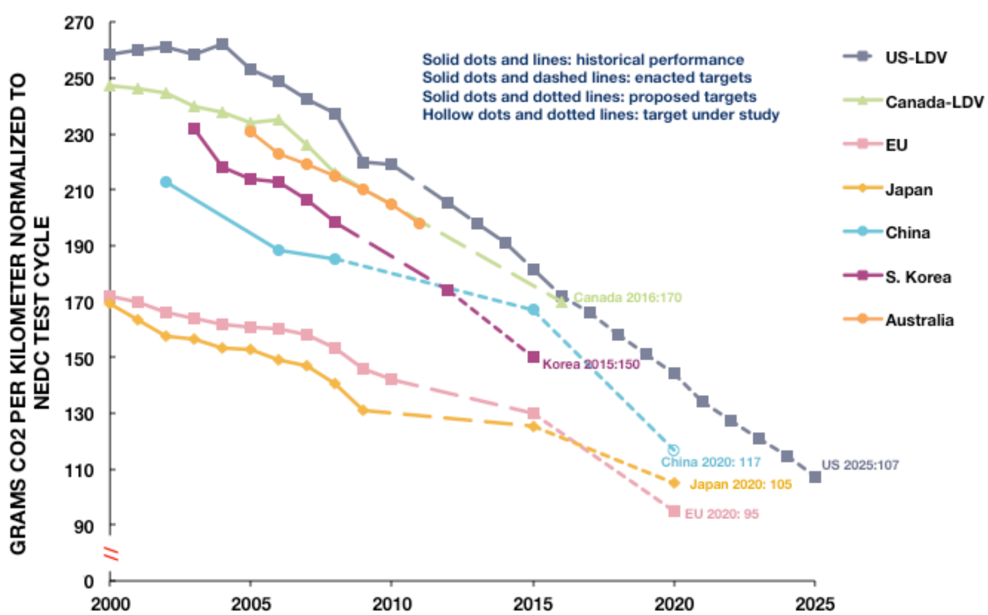
**Docket ID No. EPA–HQ–OAR–2010–0799**

**February 13, 2012**

These comments are submitted by the **International Council on Clean Transportation (hereafter, "ICCT").** The ICCT is made up of leading government officials and experts from major countries and regions around the world who participate as individuals based on their experience with air quality and transportation issues. The ICCT promotes best practices and comprehensive solutions to improve vehicle emissions and efficiency, increase fuel quality and sustainability of alternative fuels, reduce pollution from the in-use fleet, and curtail emissions of local air pollutants and greenhouse gases (GHG) from international goods movement.

## Overall Summary

This proposed rule builds upon the impressive improvements in the 2012-16 final rules and takes another large step towards catching up with vehicle efficiency in Europe, Japan, and other nations (Figure 1). We applaud EPA and NHTSA, along with California, the Administration, and the vehicle manufacturers, for taking another step along the road to a sustainable transportation system and enhancing U.S. credibility worldwide.




[1] China's target reflects gasoline fleet scenario. If including other fuel types, the target will be lower.
[2] US and Canada light-duty vehicles include light-commercial vehicles.

**Figure 1.** Comparison of global passenger vehicle greenhouse gas emission standards

There are tremendous opportunities to dramatically reduce climate change emissions from passenger vehicles in the near term. Internal combustion engines are over a century old and are widely perceived as nearing the end of their development, but the reality is exactly the opposite. The same is true for materials that make up the vehicle body and parts. Rapid improvements in computer-based tools are opening up technology gains that were never possible before. Computer simulations and computer-aided-design are enabling vastly improved designs and on-board computers allow unprecedented integration of engine, transmission, and hybrid operation. Instead of slowing down, the pace of technology development just keeps accelerating. This is especially true of lightweight material design.

Aggressive standards and long-term signals are needed to fully realize this technology potential. ICCT strongly supports a strong federal rule and recognizes and applauds the constructive role that California has played in building the technical and public support for this critical rulemaking.

The proposed 2017-25 rules provide the long-term goals needed for manufacturers to develop consistent, long-term technology and product plans, and serves as a valuable precedent for other countries worldwide evaluating future efficiency and greenhouse gas standards. The overall stringency of the proposed rules is potentially adequate, provided that it is not eroded significantly by additional credits or changes in the final rule.

The ICCT has two overall objectives for our comments. First, given the accelerating pace of technology development and cost reduction, the proposed standards are not pushing the limits of technology and it will not be difficult or expensive for manufacturers to meet them. Second, many cost effective technologies may not be adopted should the stringency be weakened due to unwarranted credits.

Our comments are focused on ensuring that the final rule is as robust as possible, including data and information on technology and consumers and suggestions for improvements to the credits.

ICCT is providing comments in support of the following positions on the issues:

1. Cost-effective opportunities to reduce fuel consumption and climate change emissions in the near term are far larger than most people realize. Thanks to computer aided design and computer controls, the pace of technology development is accelerating and much of the underlying data in the technology assessments is already out of date or is only representative of near term vehicles. Meeting the standards will be easier and will cost less than assumed in the proposed rule and no rollback of the stringency should be considered.
2. The impact of computer-aided design is especially important for lightweight materials. None of the existing studies on lightweight material costs are adequate. The results of Lotus and FEV lightweight material studies will be far more accurate for future designs and must be used to assess weight reduction costs for the final rule.
3. The use of advanced lightweight materials in smaller cars – or in any vehicle – will not increase fatalities. Analyses by DRI suggest Kahane's results are not robust, likely due to improperly controlled driver, vehicle, environment or accident factors.

Once these factors are appropriately controlled, the effect of weight reduction on fatalities may not be statistically significant. More importantly, high-strength steel and aluminum have better crash properties than the conventional steel used in most vehicles in the historical analysis and their use will reduce fatalities.

4. The benefits of the proposed rule on consumer welfare and jobs are very large and should be included in the final rule. In particular, the economy-wide benefits from reduced fuel consumption on GDP, employment, and energy security are large and indisputable.
5. While the 2011 NAS Report was well done, it specifically stated that only current and near term technologies and costs were analyzed. Thus, the sensitivity analysis using the 2011 NAS Report benefits and costs is inappropriate and should be removed from the Final Rule.
6. Mainstream customers severely discount the value of future, highly uncertain fuel savings. The primary purpose of efficiency standards is to make up for this discounting and push technology into the fleet beyond what would have otherwise been demanded by the market. Considering the stringency of the 2011-2016 standards, the sensitivity analysis for market-driven increases in efficiency after 2016 should be removed from the Final Rule.
7. RPE indiscriminately spreads all indirect costs over all components, while ICMs reflect only those elements of indirect costs that would be expected to change in response to a regulatory-induced technology change. The use of RPE is not appropriate and the sensitivity analyses presented in Tables IV-88, IV-89 and IV-90 should be removed from the final rule.
8. Many, if not most, future Li-ion batteries will use air-cooling. Future versions of the ANL BatPac model should include an option to select either air or liquid cooling.
9. Given the long lead times in the proposed rule, stranded capital costs will be virtually eliminated and should be removed or greatly reduced in the cost analyses.
10. ICCT enthusiastically supports a midterm review, as we believe it will find that costs have been significantly overstated. The criteria and analyses used for the midterm review should be similar to those used for any CAFE or greenhouse gas rulemaking process. EPA and NHTSA should also provide periodic status updates on technology progress and the results of additional benefit and cost analyses.
11. The estimates of net benefits should fully value fuel savings over the lifetime of the vehicle. The alternative NHTSA estimates reducing the net benefits are speculative and should be removed from the final rule.
12. Historical VMT rebound estimates should not be used, as they do not consider the impacts of personal income, vehicle efficiency, and fuel prices. Only dynamic models of the future VMT rebound effect are appropriate and should be used in the final rule.
13. While the ICCT strongly supports development of electric and fuel cell vehicles, one of our core principles is that efficiency and greenhouse gas emission standards should be technology neutral. Default zero upstream electric and fuel cell vehicle credits and multipliers violate this principle and reduce the benefits from the rule. The provision will also give windfall credits to vehicles required by the CA ZEV

mandate, reducing benefits from the rule without any additional advanced vehicle sales. Electric and fuel cell vehicle credits should at least be limited to vehicles that are additional to those required by the ZEV mandate. A proposed system that strikes a balance between providing appropriate incentives for advanced vehicles and maintaining the effectiveness of the standards is detailed in our comments

14. Similarly, the full-size pickup truck credits also violate the principle that efficiency and greenhouse gas standards should be technology neutral, and reduce the benefits from the rule. As a minimum, the credits should only be given if the sales targets are met each year and the credits should be phased out in the final rule.
15. Full-size pickups have been defined by the ability to fit four foot wide construction materials between the wheel wells at least since the introduction of the F-series pickup in 1948. The full-size pickup truck credits should not be expanded to pickups with less than 48 inches wheelhouse width.
16. The ICCT strongly supports off-cycle credits in principle, as they can reduce compliance costs and increase benefits. However, the credits must avoid double counting and must be valid and verifiable. ICCT has provided detailed suggestions on how to improve the off-cycle credits so they are verifiable and do not inadvertently weaken overall standard stringency.
17. Separate footprint curves for cars and light trucks distort the requirements by making it easier for vehicle classified as light trucks to comply. Unlike the 2012-2016 requirements, the 2017-2025 rule increased the gap between cars and light trucks, providing stronger incentives for manufacturers to reclassify cars as light trucks and potentially undermining the benefits of the rule. A single footprint function would still give larger trucks a less stringent target to meet, while avoiding vehicle classification games.
18. Black carbon is an important climate-forcing agent. EPA should regulate black carbon indirectly via stringent limits on particulate matter and expedite the congressionally mandated black carbon study report followed by all appropriate steps to regulate this pollutant as a climate-forcing agent.

Following are our detailed comments on these positions, numbered as per the above summary.

# 1) Technology Benefit and Cost Assessments

The ICCT supports the proposed standard stringency. However, it is important to understand that the simulation modeling used to assess future technology benefits is actually quite conservative and that the future technology benefits will be larger than projected and the costs lower. This is due to rapid improvements in computer-based tools, which are opening up technology gains that were never possible before. Computer simulations and computer-aided design are enabling vastly improved designs and technologies. On-board computer controls provide unprecedented integration of engine, transmission, and hybrid operation. Instead of slowing down, the pace of technology development just keeps accelerating.

The sophistication of assessing technology efficiency improvements has been increasing as well. The 2001 National Research Council report applied technologies stepwise to estimate fuel economy improvement possible through regulations. Some manufacturers criticized this method, claiming it could overestimate fuel economy benefits because it does not account for synergies between technologies. This is especially important as more technologies are added to the vehicle. The next step in sophistication is the use of "lumped-parameter" models that can account for first-order interactions between technologies. These models can assess the effects of technology in a broad array of vehicle types and for a class of vehicles. However, this method is generally limited to "proven" technologies. This was fine as long as standards were set only a few years in advance, but it is not adequate for setting standards with longer leadtimes.

Full-system simulation modeling is needed to capture the physics of the vehicle and powertrain system and assess interactions of the various components. It can also assess new technologies or combinations of technologies when experimental data are sparse. The 2011 National Research Council report on light-duty vehicle technologies supported the need for full-system modeling:

> "The committee thinks that the most accurate method of analyzing potential reductions in fuel consumption, which considers the extent to which any of the efficiency improvements or energy loss reductions identified above can be realized while maintaining energy balance criteria, utilizes full system simulation (FSS)."[1]

To support development of 2025 standards, EPA contracted with Ricardo Inc. to conduct such simulations. Ricardo is a highly respected engineering organization that does the vast majority of its work for OEMs and suppliers.

ICCT was involved with this simulation modeling from the beginning, including providing the initial contract for Ricardo to start work, hiring independent experts to review Ricardo's hybrid control simulations, and participating along with CARB on an advisory committee. After intensive involvement in the simulation process for the last two years, it is clear to us that the technologies being assessed by Ricardo are on the conservative side. In fact, this is unavoidable due to the restriction to currently available data and engine maps. Engine technology is improving much faster than we can keep up with and engines better than those modeled by Ricardo are already in development. For example:

- The diesel maps used by Ricardo for the US simulations are already out of date and ICCT has contracted with Ricardo to rerun the diesel simulations for Europe using maps representative of the latest diesel technology.
- The engine map used by Ricardo for the gasoline engine with boosted-EGR is similar to the single-stage turbocharger engine map developed by the HEDGE consortium two years ago, which is already out of date. The map used by Ricardo in the

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[1] Assessment of Technologies for Improving Light-Duty Vehicle Fuel Economy; National Research Council, ISBN-13: 978-0-309-15607-3, 260 pages, 8 1/2 x 11, 2011.

simulations for a two-stage turbocharger is shown in Figure 2 below. Figure 3 shows a boosted-EGR engine map provided by the HEDGE consortium in February 2010 for a single-stage turbocharger. The minimum brake-specific fuel consumption (BSFC) for the HEDGE engine is about 4% lower than the map used by Ricardo in the simulations. While the engine map used by Ricardo has broader BSFC contours and better efficiency at low loads, the single-stage turbocharger could not provide sufficient air under all conditions and was boost limited. The HEDGE consortium is already working on a two-stage turbocharger system that will enable larger amounts of EGR, higher compression ratio, lower minimum BSFC, and a broader range of lower fuel consumption.

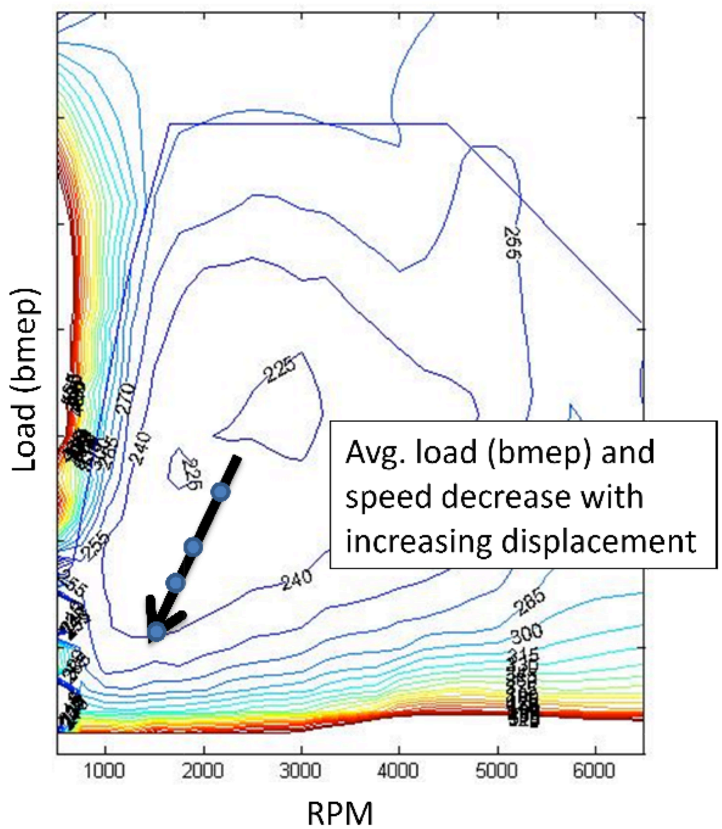


**Figure 2.** Advanced engine BSFC map (27-bar cooled EGR turbocharged GDI engine for large car)

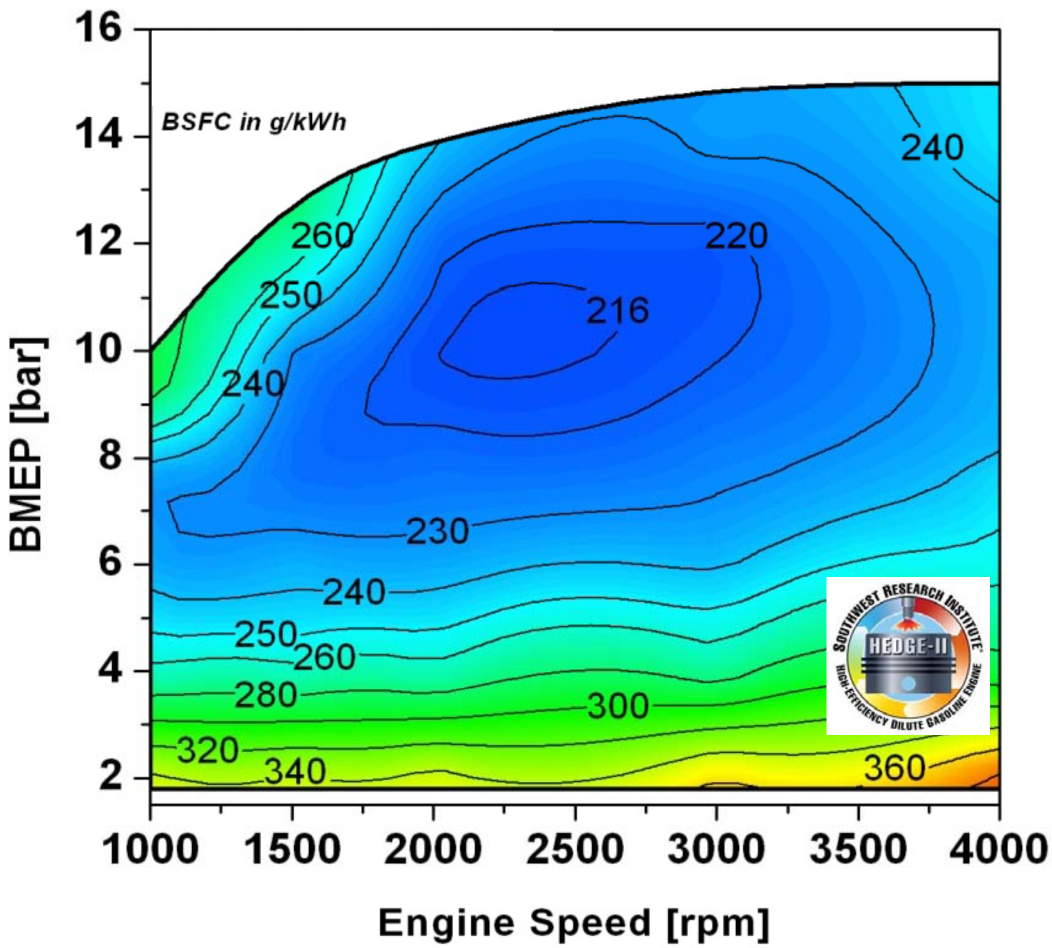


**Figure 3.** High Efficiency Dilute Gasoline Engines (HEDGE) Application [2.4L I4, 11.4:1 CR, Max EGR ~ 30%, boost limited (turbocharger hardware could not provide sufficient air), proprietary SwRI ignition system.] extracted from "Examples of HEDGE Engines", Dr. Terry Alger, SwRI, February 2010

This rapid technology improvement can also be seen by looking at historical data. For example, the 2001 National Research Council report found that turbocharging and downsizing would improve fuel economy by 5 to 7 percent. The most recent estimates in the draft RIA found that turbocharging and downsizing alone will provide a 12 to 15 percent improvement with 33 percent downsizing and16 to 20 percent for higher-pressure turbos with 50 percent downsizing. This 2 to 3 times increase in the efficiency benefit of turbocharging is not due to the older estimates being wrong, but rather to rapid improvements in combustion and turbocharging technology over the last 10 years. In addition, adding cooled and boosted EGR, a technology that wasn't even considered 10 years ago, is estimated to increase the benefits of turbocharging to 20 to 24 percent, or a 4 times increase.

This dramatic improvement in turbocharger systems also applies to cost. The estimated manufacturing cost for a turbocharger system, including downsizing but without a reduction in the number of cylinders, for 2017 in the proposed rule is $478. This compares with an estimated manufacturing cost of $815 from NHTSA just three years ago for the 2011 CAFE standards.[2] Other costs estimates have also fallen dramatically in the last three years:

- 6-speed automatic transmission cost for 2011 CAFE standard was a $215 cost increase, compared to a $13 cost decrease in the proposed rule.
- Dual-clutch automated transmission was a $145 cost increase for the 2011 standard, compared to a $205 cost decrease in the proposed rule.

It should also be noted that the estimated costs in the proposed rule to comply through 2020 are less than half of the estimated costs to comply in 2025. Passenger car costs for 2020 are $885 compared to $2,023 for 2025 and light truck costs for 2020 are $688 compared to $1,578 for 2025.[3] ICCT is confident that continued technology development will reduce costs in the future and that the midterm review will find that the current estimates of compliance costs in 2025 are greatly overstated.

ICCT is also paying FEV to do additional teardown cost assessments in connection with our work in Europe. These include updating the P2 hybrid costs and new cost assessments for advanced diesel engines, basic stop-start systems, manual transmissions, and cooled EGR systems. P2 costs in the proposed rule are overstated, as the system size is not reduced to maintain constant performance, cost savings from deleting the torque converter are not subtracted from the system cost, and future hybrid batteries will be smaller and cheaper due to new Li-ion chemistries with much higher power to energy ratios. All of the FEV results will be shared with EPA and NHTSA as they become available.

**The 2025 rules are 13 years away. With the rapid improvements in technology due to computer-enhanced development, it would be completely irrational to assume that there will be no further technology improvements beyond what is known today. Thus, the efficiency and cost estimates in the draft rule are quite conservative and there should be no consideration to rolling them back.**

## 2) Lightweight Material Costs

The cost of lightweight materials in the proposed rule is roughly twice that in the TAR. It is important to understand that computer simulations will especially impact lightweight material design. In the past, interactions between the thousands of parts on the vehicles and their impacts on safety, ride, noise, and vibration were impossible to predict.

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[2] Final Regulatory Impact Analysis, Corporate Average Fuel Economy for MY 2011 Passenger Cars and Light Trucks, Office of Regulatory Analysis and Evaluation National Center for Statistics and Analysis, March 2009.

[3] Preamble, Tables IV-110 and IV-111.

Optimization of materials was a long, slow process of gradually changing a few parts at a time to avoid unanticipated problems. Secondary weight reductions were similarly difficult to achieve. The recent development of sophisticated and accurate vehicle simulations is opening up a new world. The initial use of these models was to improve safety design. The simulations are so effective that 5-star crash ratings became almost universal and NHTSA had to revise their rating criteria for the 2011 model year. The simulations are continuing to rapidly improve, to the point where they are starting to be used to simultaneously optimize the material composition, shape, and thickness of every individual part, including secondary weight reductions.

This shift in material design capabilities also impacts the cost to reduce vehicle weight. Previous lightweight material cost studies did not assess part interactions and secondary weight reductions. While they may have accurately reflected historical costs for lightweight materials, they all overstate the cost of future vehicle weight reduction. Studies in progress by Lotus and FEV are using highly sophisticated simulation models to optimize part materials and design.

The results of Lotus and FEV lightweight material studies will be far more accurate of future designs and must be used to assess weight reduction costs for the final rule.

## 3) Safety

The ICCT appreciates the much improved modeling of safety by NHTSA, in particular the separation of the impacts of size and weight and the inclusion of non-sporty 2-door cars in the analyses. This has addressed many of our comments on safety in response to the 2012-2016 proposed rule.

Despite the improvements, the latest Kahane study, referenced in the proposed rule, still finds that reducing the weight of smaller cars leads to increased fatalities. This issue is important, as the proposed rule assumed that small cars will have zero weight reduction due to the concern with potential fatality increases. The ICCT believes that this increase in fatalities is an artifact of the methodology used by Kahane and that weight reduction using lightweight materials and better vehicle design will reduce fatalities for vehicles of all sizes.

Dynamic Research Inc. (DRI) recently completed a Phase 2 report[4] focused on replicating Kahane's results with the updated 2000-2007 data. They were able to match Kahane's results very closely, indicating that they were able to closely duplicate Kahane's methods and data. The Phase 2 report also conducted analyses using DRI's two-stage method, which separates the fatality impacts into the number of accidents per exposure and the number of fatalities per accident. The two-stage results for lighter passenger vehicles, included in

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[4] DRI, UPDATED ANALYSIS OF THE EFFECTS OF PASSENGER VEHICLE SIZE AND WEIGHT ON SAFETY, PHASE II: PRELIMINARY ANALYSIS BASED ON 2002 TO 2008 CALENDAR YEAR DATA FOR 2000 TO 2007 MODEL YEAR LIGHT PASSENGER VEHICLES, Volume I: Technical Report DRI-TR-12-01, R. M. Van Auken J. W. Zellner, January 2012

Table 1, below, indicate that the increase in fatalities for lighter vehicles is entirely due to an increase in the number of accidents per exposure. The crashworthiness and crash compatibility of the smaller cars did not contribute to the fatality increase.

**Table 1.** Estimated percent change in fatalities due to weight reduction (DRI, 2012)

Table II. Summary of the Estimated Percent Changes In Crash Fatalities Due to a 100 Pound Curb Weight and Corresponding Footprint Reduction in Passenger Vehicles by Crashworthiness/Crash Compatibility and Crash Avoidance (Based on Data for 2000-2007 Model Year Passenger Vehicles in 2002-2008 Calendar Year Data)

| Light Passenger Vehicle Type | Crash Fatalities After ESC (Kahane 2011 Table 3-5) | Estimated Percent Change In Fatalities Due To 100 lb Curb Weight Reduction | | | | | |
|---|---|---|---|---|---|---|---|
| | | Crashworthiness and Compatiblity (F/A) | | Crash Avoidance (A/VMT) | | Combined Effect (F/VMT) | |
| | | Est. | (2-sig) | Est. | (2-sig) | Est. | (2-sig) |
| Cars Weighing Less Than 3106 lbs | 5,900 | **-1.60%** | **(0.64%)** | **2.87%** | **(0.38%)** | **1.27%** | **(0.61%)** |
| Cars Weighing 3106 lbs or More | 9,498 | 0.10% | (0.77%) | 0.38% | (0.47%) | 0.49% | (0.73%) |
| Truck Based LTVs Weighing Less Than 4594 lbs | 4,258 | **-0.81%** | **(0.44%)** | **1.32%** | **(0.28%)** | **0.51%** | **(0.42%)** |
| Truck Based LTVs Weighing 4594 lbs or More | 8,898 | **-1.28%** | **(0.37%)** | **0.79%** | **(0.24%)** | **-0.49%** | **(0.34%)** |
| Minivans and CUVs | 4,572 | **1.68%** | **(0.89%)** | **-2.32%** | **(0.32%)** | -0.64% | (0.89%) |

These counter-intuitive results strong suggest that Kahane's methodology has some driver, vehicle, environment or accident factors that have not been controlled for in the current analyses. Lighter vehicles have theoretical advantages in handling and braking and should be involved in slightly few accidents, not more accidents. From a theoretical view, any increase in fatalities should be due to compatibility issues in crashes with larger vehicles, yet the results do not show any increase in the rate of fatalities once a crash occurs.

DRI also issued a supplemental report,[5] which discussed in further detail two key assumptions used in the Kahane report and two alternative assumptions. First, Kahane assumed that the effects of vehicle weight and size can be best modeled using curb weight and footprint. DRI believes it is more appropriate to model weight and size using curb weight, wheelbase, and track width. Wheelbase and track width have different effects on vehicle crashworthiness, crash compatibility, and crash avoidance. These effects are confounded when a single "footprint" index is used. DRI also found that using footprint and weight had more multi-collinearly than using wheelbase, track width, and weight. As indicated in Table 2, below, the use of wheelbase and track width reduced the number of fatalities associated with weight reduction and the coefficients for all of the vehicle classes are not statistically significant.

Second, Kahane assumed that the crash exposure is best represented by non-culpable vehicle induced-exposure data. While there are valid reasons supporting the use of non-

[5] Updated Analysis of the Effects of Passenger Vehicle Size and Weight on Safety: Supplemental Results on the Sensitivity of the Estimates for 2002 to 2008 Calendar Year Data for 2000 to 2007 Model Year Light Passenger Vehicles to Induced-Exposure Data and Vehicle Size Variables, DRI-TM-12-09, R. M. Van Auken J. W. Zellner, February 2012

culpable vehicle induced-exposure data, the DRI report discussed the reasons why it may be better to represent crash exposure using stopped vehicle induced-exposure data:

> "Non-culpable vehicle induced-exposure data can include crashes where the non-culpable vehicle was moving prior to the crash. Therefore some drivers may be more likely to be involved in these crashes than other drivers, even if the driver is not culpable in the crash. This is because some drivers may be better able to avoid a crash in which they are not culpable than are other drivers, due to driver skill, driver alertness and/or ability to properly react in time to avoid a collision. Therefore this under-representation in the non-culpable induced-exposure data of good drivers, and over representation of bad drivers, is undesirable and may introduce a numerical bias in the results."

While the necessary data for evaluating the impacts of wheelbase and track width are in the updated 2000-2007 database, DRI does not yet have stopped-vehicle induced exposure data for the new dataset. Thus, DRI's supplemental report provides a rough evaluation based on the differences that DRI observed in the Phase I regression results using the older data. Assuming that the correlation in the induced exposure estimates in the new dataset will be similar to the correlation in the older data, Table 2 also shows that use of stopped vehicles for induced-exposure data creates a statistically significant **reduction** in fatalities for weight reduction in larger light trucks and an insignificant increase for the other vehicle classes using footprint and an insignificant decrease in fatalities for the other vehicle classes using wheelbase and track width.

**Table 2.** Separating wheelbase and track-width and stopped vehicle induced exposure shows limited impact of weight reduction on fatalities (DRI, 2012)

Table I. Summary of Estimated Percent Changes in Crash Fatalities Due to a 100 Pound Curb Weight Based on Different Weight and Size Models and Induced-Exposure Data
(One-Stage Estimates Based on Data for 2000-2007 Model Year Vehicles in 2002-2008 Calendar Year Data)

| Light Passenger Vehicle Type | Induced-Exposure / Weight and Size Parameters | Non-Culpable Vehicle: Curb Weight and Footprint | Non-Culpable Vehicle: Curb Weight, Wheelbase and Track Width | Stopped-Vehicle: Curb Weight and Footprint | Stopped-Vehicle: Curb Weight, Wheelbase and Track Width | Kahane (2011) Jackknife Relative Confidence Interval |
|---|---|---|---|---|---|---|
| Cars Weighing Less Than 3106 lbs | | **1.44%** | 0.82% | 0.26% | -0.47% | ± 1.15% |
| Cars Weighing 3106 lbs or More | | 0.48% | 0.20% | 0.49% | 0.13% | ± 1.05% |
| Truck Based LTVs Weighing Less Than 4594 lbs | | 0.52% | -0.03% | 0.56% | -0.04% | ± 0.95% |
| Truck Based LTVs Weighing 4594 lbs or More | | -0.40% | -0.62% | **-1.41%** | **-1.70%** | ± 0.67% |
| Minivans and CUVs | | -0.46% | -0.34% | n/a | n/a | ± 1.29% |

Estimated Percentage Change In Fatalities Due To a 100 Pound Curb Weight Reduction (spanning the Non-Culpable Vehicle and Stopped-Vehicle columns).

Notes: Numbers in **bold font** denote point estimates that are larger in magnitude than the Kahane (2011) "jackknife" relative confidence intervals, and therefore are considered to be statistically significantly different than zero. Numbers in gray **font** denote point estimates that are smaller in magnitude than the Kahane (2011) jackknife relative confidence intervals, and therefore are not considered to be statistically significantly different than zero. It is assumed that the jackknife relative confidence intervals, which were calculated for the curb weight and footprint model with non-culpable vehicle induced-exposure data, are approximately the same as the true confidence intervals for the alternative estimates (which are unknown). Note the jackknife confidence intervals may not include some sources of uncertainty such as the accuracy of the vehicle miles traveled exposure data on a make-model-year basis. Stopped-vehicle induced-exposure results are rough estimates based on comparing stopped-vehicle and non-culpable vehicle results from the DRI Phase I study based on 1995 through 2000 calendar year data with different vehicle types and crash types. "n/a" indicates the stopped-vehicle results were not available in the DRI Phase I analysis.

DRI's results strongly indicate that the fatality increase seen on smaller cars in Kahane's analysis is not robust and is likely due to improperly controlled driver, vehicle, environment or accident factors.

Even more important, all of the historical analyses of the impacts of weight on fatalities are based upon vehicles primarily using conventional steel. This means that the results implicitly assume that the materials in the vehicle will not change. However, high strength steel (HSS) and aluminum both have better crash properties than standard steel. Thus, reducing weight of small cars using better materials will reduce fatalities. Aluminum provides more uniform management of crash forces. High-strength steel helps prevent intrusion and better absorbs crash forces, which is one of the primary reasons for its rapidly increased market penetration in recent years. For example, Honda has moved aggressively towards using HSS in small cars in part because of the safety benefits:

> "The extensive use of high-strength steel in the Advance Compatibility Engineering (ACE) body structure creates a new-generation platform that is safer and stronger, enhancing the vehicle's ability to deal with crash energy during impact."[6]
>
> "A new body design with the ACE Body Structure and extensive use of high strength steel create a new generation platform that is safer and stronger." [7]

In addition, fatalities are linked more strongly to intrusion into the passenger compartment than to vehicle mass. Safety experts in Japan and Europe raised this issue previously. Their research suggests the main cause of serious injuries and deaths is intrusion due to the failure of load-bearing elements to properly protect occupants in a severe crash:

> "The results from this project have overturned the original views about compatibility, which thought that mass and the mass ratio were the dominant factors."[8]
>
> "moreover, if mass appears to be the main parameter linked to aggressivity of cars, it is because this is the easiest and universal parameter that is collected in all accident databases."[9]
>
> "The scientific community now agrees that mass does not play a direct role in compatibility."[10]

Reducing vehicle weight while maintaining size helps to reduce intrusion, as the lower

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[6] "Honda Civic Captures AISI Great Designs in Steel Automotive Excellence Award", http://www.theautochannel.com/news/2008/04/09/083742.html

[7] 2006 Honda Civic Body, Advanced Personal Compact with ACE Body Structure, 2006 Honda Civic Press Information.

[8] Edwards, M., Happian-Smith, J., Davies, H., Byard, N., and Hobbs, A., "The Essential Requirements for Compatible Cars in Frontal Collisions (158)", Proceedings of the 17th International Technical Conference on the Enhanced Safety of Vehicles, Amsterdam, the Netherlands, 2001.

[9] Faerber, E., "EEVC Research in the Filed of Improvement of Crash Compatibility between Passenger Cars (444)", Proceedings of the 17th International Technical Conference on the Enhanced Safety of Vehicles, Amsterdam, the Netherlands, 2001.

[10] Delannoy, P. and Faure, J., "Compatibility Assessment Proposal Close from Real Life Accident (94)", Proceedings of the 18th International Technical Conference on the Enhanced Safety of Vehicles, Nagoya, Japan, 2003.

weight reduces crash forces while maintaining size preserves crush space. This also supports that size-based standards that encourage the use of lightweight materials should reduce intrusion and, hence, fatalities.

Further improvements in Kahane's methodology would likely correct the artificial increase in fatalities for reducing the weight of smaller cars and, in any case, high-strength steel and aluminum have better crash properties than the conventional steel used in most vehicles in the historical analysis. Thus, **there is no basis to support the idea that using advanced lightweight materials in smaller cars – indeed in any vehicle – will increase fatalities.**

## 4) Sales, Employment and GDP

As proposed, the 2017-2025 standards will have major economic benefits. Analyses conducted for the initial submission for interagency review, but not included in the NPRM, concluded that:

- New vehicle sales will increase by more than 300,000 vehicles by 2025
- Net employment will increase by between 1,800 and 4,500 jobs in 2017 and between 22,300 and 56,100 jobs in 2025
- US GDP will increase by 0.26% in 2020 and by 0.88% in 2030

As discussed above, the cost to comply with the proposed requirements is likely to be substantially less than estimated by EPA and NHTSA. The fuel savings will pay for the cost of the technology many times over, effectively putting billions of dollars into consumers' pockets to buy other products. This will raise the standard of living, increase GDP, and create economy-wide jobs.

There are other advantages to society from reducing the amount of fuel we consume. The benefits for energy security are the same as investing in new oil wells – reduced oil imports, improved balance of trade, and downward pressure on worldwide oil prices.

Efficiency standards or incentives tied directly to vehicle efficiency are necessary to capture these huge benefits for energy security and the economy. There are no other options. Certainly, care must be taken to set the standards appropriately, as has been done in the proposed rule, but rolling back or stopping the standards is equivalent to shutting down oil wells in the US. In fact, it is worse due to the missed opportunity to improve the economy.

As shown in Figure 1, countries worldwide are also adopting efficiency standards and promoting technology improvements. Similar standards are needed in the US to ensure that our domestic manufacturers remain fully competitive in the world market and maintain domestic employment.

Efficiency standards are a win for consumers, a win for energy security, a win for manufacturers, and a win for the economy. It is all paid for by oil exporting countries, as efficiency standards will both reduce their oil exports and depress the amount they get paid per barrel.

Given these huge and obvious benefits, it is essential that the rule assess the beneficial impacts of the rule on sales, jobs, and GDP. The initial submission for interagency review[11] contains these analyses, but they were not included in the final rule proposal.

ICCT has reviewed the methodology EPA used for estimating the impact on vehicle sales in the initial submission for interagency review. We find that it is consistent with the approach in the 2012-16 light-duty GHG and CAFE rule, and in several previous CAFE rulemakings by NHTSA. The method balances the changes in demand due to vehicle price increase and the economic benefits of fuel economy using a 5-year payback period, and found an increase in new vehicle sales of more than 300,000 vehicles by 2025 due to the fuel savings benefit.[12]

These sales impact results are also required as input to other economic impact analyses, such as employment and GDP. As a result of the lack of new vehicle sales impact data, the employment impacts due to changes in the demand of new vehicles was not estimated in the proposed rule. The initial submission for interagency review also conducted a careful analysis of associated increases in employment.[13] The method for calculating employment effects included the demand effect, or the labor required to build more vehicles; the cost effect, which represents the labor required for new technologies manufacturing; and the factor shift effect, which looks at labor intensity changes due to changes in technology. The effect on employment was originally estimated to add between1800 and 4500 jobs in 2017 and to add between 22300 and 56100 jobs in 2025.[14] ICCT supports these analyses and believes they are appropriate and should be included in the final rule.

Most importantly, the effect of the rule on GDP was also not included in the proposed rule. The initial submission for interagency review used computable general equilibrium (CGE) modeling to evaluate the effects of this rule on consumer expenditure and predicted that the US GDP would increase over time as a result of the increase in consumer expenditure (by 0.26% in 2020 and by 0.88% in 2030).[15] This is an appropriate methodology and clearly shows that, due to fuel savings, consumer expenditure and consumer demand would increase, with substantial economy-wide benefits on GDP and employment.

The agencies state that the reason they do not include sales impact estimates is that there is no good analytical basis to make this calculation:

> USEPA: "The empirical literature does not provide clear evidence on whether consumers fully consider the value of fuel savings at the time of purchase. It also generally does not speak to the efficiency of manufacturing and dealer pricing

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[11] Docket item EPA–HQ–OAR–2010–0799-1224, Section III-H

[12] Summary of interagency working comments received on draft rule under EO 12866 review. Pages 439-443.

[13] Docket item EPA–HQ–OAR–2010–0799-1224, pages 454-455

[14] Summary of interagency working comments received on draft rule under EO 12866 review. Table III-88, page 458.

[15] Docket item EPA–HQ–OAR–2010–0799-1224, pages 460-461

> decisions. Thus, for the proposal we do not provide quantified estimates of potential sales impacts. Rather, we solicit comment on the issues raised here and on methods for estimating the effect of this rule on vehicle sales."[16]
>
> NHTSA: "As discussed below, for this analysis we have conducted a fresh search of the literature for additional estimates of consumer valuation of fuel savings, in order to determine whether the 5 year assumption was accurate or whether it should be revised. That search has led us to the conclusion for this proposed rule that consumer valuation of future fuel savings is highly uncertain. A negative impact on sales is certainly possible, because the proposed rule will lead to an increase in the initial price of vehicles. A positive impact is also possible, because the proposed rule will lead to a significant decrease in the lifetime cost of vehicles, and with consumer learning over time, this effect may produce an increase in sales. In light of the relevant uncertainties, the agency therefore decided not to include a quantitative sales estimate and requests comments on all of the discussion here, including the question whether a quantitative estimate (or range) is possible.[17]

ICCT is not in agreement with the agencies assertion that the analytical basis for sales, employment, and GDP analyses is inadequate. While there are large uncertainties in how customers behave, such analyses are widely used in other contexts (e.g. the CARB analysis of the LEV III GHG rule uses CGE modeling and includes employment and GDP impacts) and are appropriate here as well. Further, the uncertainty in consumer behavior does not change the fact that the fuel savings will pay for the cost of the technology many times over.

The agencies may be confused by studies that rely on standard economic theory, which says that assuming full information and no uncertainty, consumers will make optimal tradeoffs between the purchase price and subsequent operating costs. However, the standard economic theory does not apply in this case because mainstream consumers undervalue fuel savings due to uncertainty and loss-aversion.

There is substantial circumstantial evidence that most consumers in the U.S. place a low value on fuel economy. For example, Turrentine and Kurani[18] conducted an in depth survey of the car-buying histories of 57 California households. None of these 57 households made any kind of quantitative assessment of the value of fuel savings and only 9 stated they compared the fuel economy of vehicles in making their choice. The selected consumers were largely unaware of their annual fuel cost, in contrast to general knowledge of the daily price fluctuations of a gallon of gasoline. Turrentine and Kurani concluded that: "When consumers buy a vehicle, they have neither the tools nor the motivation nor the basic building blocks of knowledge to make a calculated decision about fuel costs."

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[16] NPRM p. 493-494

[17] NPRM p. 709

[18] Turrentine, Thomas S., and Kenneth S. Kurani, "Car Buyers and Fuel Economy?" Energy Policy 35 (2007): 1213-1223.

The question that has been debated for decades is simply – why? This is an extremely important question, as most of the calculation of consumer welfare is based on the answer. If consumers are already receiving their optimum level of fuel economy, then efficiency standards will decrease their welfare. However, if there are valid reasons why consumers are not making optimal tradeoffs at the time of vehicle purchase, or if the entire question is not being framed properly, then efficiency standards would increase consumer welfare.

ICCT believes uncertainties about the cost and value of fuel economy improvements, combined with general loss-averse behavior by consumers, offers a rational and accurate explanation of the failure of the market to optimize fuel cost savings. Green 2010[19] found that using reasonable estimates of the uncertainty of in-use fuel economy, future fuel prices, annual vehicle use, vehicle lifetime, and incremental vehicle price yielded an average customer payback period of roughly 3 years. While economists refer to this as a market failure, given the large uncertainties in the actual amount of future fuel cost savings and the other ways that consumers can spend their money, the typically loss-averse customer is being quite rational in only wanting to pay for 2-5 years of projected fuel savings.

If consumers only value 2-5 years of fuel savings, does this mean their consumer welfare will decrease if standards force them to save money on fuel from technologies that achieve a fuel-savings based payback in more than 2-5 years? Greene's paper also addressed this issue and found there are two important issues that invalidate this conclusion:

(1) Standards change the status quo by removing the option to buy a vehicle without the additional efficiency technology – it is not presented to the customer at all. Loss aversion is context dependent, which leads to the paradox that consumers who would decline a risky bet may reach a higher level of utility if forced to accept the bet. Efficiency standards mandate that only vehicles with additional efficiency technology can be sold. There is no reason why consumers should evaluate the choice limited by standards in the same way they perceive the choice without standards. ICCT believes the only valid reference point for loss aversion is the updated status quo that exists when the consumer actually makes the purchase decision.

(2) Standards require everyone to purchase higher levels of efficiency technology, not just individual customers, leading to indirect consumer welfare benefits. The concept of consumer welfare under standard economic theory is based upon individual choices. However, efficiency standards affect everyone, not just individual customers. The individual's welfare is now the sum of the direct impact on the individual and the indirect benefit to the individual of forcing other customers to buy more efficient vehicles. There are substantial benefits to an individual if everyone else buys more efficient vehicles. It reduces demand for oil, which leads to lower fuel prices and reduced energy security risks. It also reduces

[19] Greene, David 2010. "Uncertainty, loss aversion, and markets for energy efficiency", Energy Economics.

> carbon emissions and slows down global warming. Most people are aware of these benefits if standards are imposed on everyone and place significant value on them.

While the ICCT believes it is clear that the standards will have a positive impact on vehicle sales and direct vehicle-related employment, we do acknowledge that there is substantial uncertainty in how consumers will react to the higher vehicle prices, new technology, and lower fuel payments. It is possible that the direct sales and employment benefits might be small. However, it is inexcusable to ignore the economy-wide benefits from the large reduction in vehicle fuel consumption. No matter how customers react, the fuel savings will pay for the cost of the technology many times over. This will give customers billions of dollars to buy other products, raising their standard of living, increasing GDP, and creating economy-wide jobs.[20]

There will be further economy-wide and energy security benefits from reducing oil imports and helping our balance of trade. These economy-wide benefits are certain and their exclusion from the proposed rule is inappropriate.

**The ICCT strongly supports adding consumer welfare analyses back into the final rule, as they provide relevant and important information regarding employment and GDP. In particular, the economy-wide benefits from reduced fuel consumption are large and indisputable.**

## 5) Sensitivity Case using the 2011 NAS Report Benefits and Costs

NHTSA included a sensitivity case using costs and effectiveness from the 2011 NAS Report.[21] This sensitivity run increases vehicle cost by 40 to 50 percent, adding about $800 to the per vehicle cost.

It is inappropriate to use the 2011 NAS Report technologies and technology benefits and costs for 2017 to 2025 efficiency regulations. While the 2011 NAS Report is an excellent report, it makes several explicit statements constraining the applicability of its technology and cost data to the very near term, e.g.:

> "Tables S-1 and S-2 show the committee's estimates of fuel consumption benefits and costs for technologies that are commercially available and can be implemented within 5 years. The cost estimates represent estimates for the current (2009/2010) time period to about 5 years in the future." [NAS report page S-1]
>
> "Again, except where indicated otherwise, the cost estimates provided are based on current conditions and do not attempt to estimate economic conditions and hence predict prices 5, 10, or 15 years into the future." [NAS report page S-6]

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[20] See, for example, the Next10 study at http://next10.org/next10/publications/vehicle_efficiency.html.

[21] preamble, Section IV.G, page 75307 and table IV-90

> "The cost estimates represent estimates for the current (2009/2010) time period to about 5 years in the future." [NAS report page 9-8]

While sensitivity analyses can illuminate the impacts of important uncertainties, in this case the 2011 NAS Report expressly states that it is not applicable to the period considered by the proposed rule. In addition, as noted in our comments in section 1, above, the technology benefit and costs in the proposed rule are conservative and overstate the costs of the rule, not understate them.

**ICCT recommends that the sensitivity analysis using the 2011 NAS Report benefits and costs be removed from the Final Rule.**

## 6) Baseline Assumption Sensitivity Case

There is a difference between how EPA and NHTSA handled the modeled Reference Fleet Scenario. EPA projects that in the absence of the proposed GHG and CAFE standards, the reference case fleet in MY 2017–2025 would have fleetwide GHG emissions performance no better than that projected to be necessary to meet the MY 2016 standards.[22]

While NHTSA used the same baseline assumptions for their primary analyses, they also conducted a sensitivity analysis with an alternative baseline, which assumed that fuel economy would continue to increase after 2016 without regulation.[23] NHTSA stated:

> “The assumption is that the market would drive manufacturers to put technologies into their vehicles that they believe consumers would value and be willing to pay for.”

Again, while sensitivity analyses can illuminate the impacts of important uncertainties, there is little or no evidence supporting this particular case. Except during the oil crisis in the 1970s and a brief period for passenger cars in the late 2010s, the market has never driven improvements in vehicle fuel economy. Even these two examples are not relevant to the current situation. The demand for higher fuel economy in the 1970s was driven primarily by fears of oil unavailability and ongoing future increases in fuel price. The modest increase in passenger cars in the late 2010s followed 20 years of unchanging CAFE standards. Thus, NHTSA’s sensitivity analysis inappropriately calculates a lower estimate of net benefits of the rule.

The proposed 2017-25 standards follow aggressive increases in standards from 2011 through 2016. Further, the change to a footprint-based standard means that all manufacturers must increase the efficiency of their vehicles to comply, even manufacturers of primarily smaller vehicles. Thus, the 2012-16 standards have already driven the market beyond the level of efficiency it would have demanded in the absence of standards.

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[22] preamble III.D.1.A page 75031, EPA draft RIA section 3.5.1

[23] preamble, Section IV.G, page 75305, NHTSA draft RIA

The reason why efficiency standards are effective and needed is consumer discounting of uncertain, future fuel savings, as explained above. Efficiency standards move the market from the level of efficiency demanded by loss averse consumers to the level of efficiency desired by society. It will be many years after 2016 before additional technology development and lower cost will finally fall to the level demanded by consumers from the higher level demanded by society through efficiency standards. The historical precedent is that it took 20 years of unchanging CAFE standards combined with high real and nominal fuel prices before the market started to demand additional fuel economy for passenger cars in the late 2000s.

**ICCT recommends that the sensitivity analysis for market-driven increases in efficiency after 2016 be removed from the Final Rule.**

## 7) RPE and ICM

ICCT agrees with the use of indirect cost multipliers (ICM) instead of Retail Price Equivalent (RPE) and the general approach of assigning technologies to several complexity classes for determining the ICM value. Trying to determine the indirect multiplier for each technology would be extremely difficult and time consuming, but it is also important to use more appropriate and targeted adjustments than a single, indiscriminant RPE.

For this rule proposal EPA improved the original ICM factors that have been used in other regulatory assessments in two ways. First, the original ICM factors for low and medium technology complexity were updated; the updated ICM factors were developed following expert panel recommendations on newer technologies (passive aero-reduction, engine downsizing and turbocharging and 40-mile range PHEV). Second, the way ICM factors are applied was modified, "…resulting in the warranty portion of the indirect costs being applied as a multiplicative factor (thereby decreasing going forward as direct manufacturing costs decrease due to learning), and the remainder of the indirect costs being applied as an additive factor (thereby remaining constant year-over-year and not being reduced due to learning)". In addition, the original RPE values used by EPA were increased from 1.46 to 1.5 as a way to reflect long-term average RPE values. Table 3 shows the evolution of ICM and the change to RPE values on the 2017-2025 Rule (High 2, Long term).

ICMs are a better methodology for indirect cost estimation than the RPE multipliers used in previous rulemakings. The development of ICMs as a tool for indirect cost assessment has been conducted in a most rigorous way and the study results have been peer reviewed in well known scientific journals.[24] The most critical distinction between ICMs and RPE is that ICMs have been developed "to reflect only those elements of indirect costs that would be

[24] Rogozhin, A., Gallaher, M., Helfand, G., McManus,. W., Using Indirect Cost Multipliers to Estimate the Total Cost of Adding New Technology in the Automobile Industry, *International Journal of Production Economics* 124 (2010): 360–368.

expected to change in response to a regulatory-induced technology change."

**Table 3.** ICM Values Sources and Values used in EPA Regulations

| | Original ICM (a) | | Modified ICM (b) | | 2012-2016 Rule (c) | | 2017-2025 Rule (c) | |
|---|---|---|---|---|---|---|---|---|
| Complexity | Near | Long | Near | Long | Near | Long | Near | Long |
| Low | 1.05 | 1.02 | 1.16 | 1.12 | 1.17 | 1.13 | 1.24 | 1.19 |
| Medium | 1.20 | 1.05 | 1.29 | 1.20 | 1.31 | 1.19 | 1.39 | 1.29 |
| High1 | 1.45 | 1.26 | 1.64 | 1.39 | 1.51 | 1.32 | 1.56 | 1.35 |
| High2 | | | | | 1.70 | 1.45 | 1.77 | 1.50 |

(a) Evaluates Low RR tires, Dual Clutch and Hybrid Vehicle. EPA, Feb. 2009, Prepared by RTI, Multipliers

Rogozhin et al. Automobile Industry Retail Price Equivalent and Indirect Cost

(b) Update on the February 2009 work. Evaluates Aero, downsizing and PHEV. EPA, Aug, 2009. Documentation Technologies of the Development of Indirect Cost Multipliers for Three Automotive

(c ) EPA, Nov 2011. Draft Joint Technical Support Document: Proposed Rulemaking for 2017-2025

Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards

However, in the Sensitivity Analysis section IV (*NHTSA Proposed Rule for Passenger Car and Light Truck CAFE Standards for Model Years 2017–2025*, page 75307 of the Federal Register), the proposal presents two sensitivity calculations that neglect the fundamental advantages of using ICMs. The first sensitivity calculation evaluated the economic impact of technology cost on CAFE fuel economy using RPE for indirect costs for all technologies instead of ICMs (Table IV-88). The second sensitivity calculation (Table IV-89) involves cost values derived from a different source, namely the National Academy of Sciences assessment on LDV fuel economy technologies; the NAS report uses two sets of RPEs, one for non-electrification technologies and another one for electrification technologies (Hybrids and EVs).[25]

The use of a single RPE of 1.5 for all technologies, instead of a technology based ICM, inflates the costs per vehicle by 24%, from $2023 to $2509. The second method uses a RPE of 1.5 for non-electrification technologies, which are mostly low- and medium-complexity options and comprise the bulk of the technologies to be adopted in the future; as a result the cost per vehicle is inflated by 39%.

The ICCT believes that the use of RPE for these two sensitivity analyses is inappropriate

[25] NAS. (2011). *Assessment of Technologies for Improving Light Duty Vehicle Fuel Economy.* National Academy of Sciences, Committee on the Assessment of Technologies for Improving Light-Duty Vehicle Fuel Economy; National Research Council. National Academies Press. Washington, DC.

and distorts the cost results. The problem stems from lumping indirect costs indiscriminately, as the RPE method does. The RPE method does not consider that new technologies will not necessarily incur *additional* indirect costs. RPE spreads all indirect costs over all components, while ICMs reflect only those elements of indirect costs that would be expected to change in response to a regulatory-induced technology change. For example, it is appropriate to include warranty costs in the indirect costs for new technologies, while marketing costs would not change in response to adding many incremental technologies. Unless the technology is directly marketed to consumers, it is inappropriate to spread existing marketing costs to the new technology. Many individual technologies are small in scale and should reflect only a subset of RPE costs; as a result, for low complexity technologies, the ICM should be lower than the RPE. This is not always the case, as ICM estimates for particularly complex technologies, specifically hybrid technologies (for near term ICMs), and plug-in hybrid battery and full electric vehicle technologies (for near term and long term ICMs) reflect higher than average indirect costs. As a result, the ICMs for those technologies can equal or even exceed the averaged RPE for the industry."

**The ICCT strongly supports the continued use of ICMs and the adjustments made for the proposed rule. The sensitivity analyses presented in Tables IV-88, IV-89 and IV-90 should be removed from the final rule.**

## 8) Battery Cooling System Cost

The ANL report on the BatPac battery cost model[26] includes an Active Cooling System section and briefly explains why Water-50% glycol was selected:

> "There are several choices of coolant that have been considered for cooling battery packs including air from the cabin, which may be heated or cooled, water-ethylene glycol solutions and dielectric liquids such as transformer coolants. Air is the least expensive, but it is less effective than the liquids because of its poor conductivity, the need for large flow passages and high pumping power. Dielectric liquids are expensive, but have the advantage of being compatible with terminals and other parts at electrical potential. Water-50% glycol solution is inexpensive and has good conductivity; we have selected it as the coolant for this study."

Unfortunately, the general design select for cost analysis does not allow for air cooling:

> "We selected a general cell and battery design that can be adapted to all of the electric-drive batteries from micro-HEVs packs to EV packs (section 2). This design incorporates a hermetically sealed module closure. Unfortunately, the enclosure does not have sufficient surface area to be cooled effectively by air."

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[26] ANL, 2011, Modeling the Performance and Cost of Lithium-Ion Batteries for Electric-Drive Vehicles, Final Report prepared by Paul A. Nelson, Kevin G. Gallagher, Ira Bloom, and Dennis W. Dees, Argon National Laboratory , Argonne, IL" Docket EPA-HQ-OAR-2010-0799-1078

Section 5.2.3.3 *Balance of Thermal Management System* acknowledges that air cooled systems are less expensive and are more likely to be used in micro HEVs and HEV-HPs. In addition, air-cooling was studied by the authors of the BatPac report (docket item EPA-HQ-OAR-2010-0799-1078) and presented at the Electric Vehicle Symposium in 2009 and 2010.[27,28] The initial cell design for those studies involved flat-wound cells. Flat-wound cells have more surface area and can be effectively cooled by air. Finally, it should be noted that the Nissan Leaf battery pack does not use liquid cooling, only a circulating fan inside a sealed battery pack. It is inappropriate to exclude air-cooling in the modeling of battery cost.

**The ICCT strongly recommends that future versions of the BatPac model include an option to select either air or liquid cooling.**

## 9) Stranded Capital Costs

The agencies state that " potential for stranded capital occurs when manufacturing equipment and facilities cannot be used in the production of a new technology".[29] This is a valid concern, but it applies primarily to rulemakings with shorter leadtimes. Perhaps the most important purpose of proposing standards through 2025 is that it gives manufacturers far more certainty about the future standards. This enables the manufacturers to plan and implement technologies and products in an orderly manner and minimizes issues with stranded capital. Also, the standards are not stringent enough to force technology introduction at a rate faster than normal production cycles.

**The ICCT recommends that stranded capital costs be eliminated to reflect the long leadtime of the proposed standards.**

## 10) Mid-Term Review

The ICCT enthusiastically supports a midterm review, as we believe the proposed rule significantly overstates the cost of compliance. Continued technology advancements will both increase the benefits of many technologies, such that not as much technology would need to be installed, and reduce the cost of technologies that are used. Capturing these future improvements in the midterm review will allow the agencies to **increase** the stringency of the 2022-2025 standards.

The process for the midterm review is critical to the 2022-25 standards. It is impossible to

[27] Nelson P.A., Santini D. J., Barnes J., Factors Determining the Manufacturing Costs of Lithium- Ion Batteries for PHEVs, Electric Vehicle Symposium 24, Stavanger, Norway, May 13-16, 2009.

[28] Santini D.J., Gallagher K. G., Nelson P.A., Modeling of Manufacturing Costs of Lithium-Ion Batteries for HEVs, PHEVs, and EVs, Electric Vehicle Symposium 25, Shenzhen, China, Nov. 5-9, 2010.

[29] section 3.2.2.3 of the TSD, Table V-24 of NHTSA RIA, and Sections 3.8.7

define all the criteria for the review at this time, just as it is not possible to define all of the criteria for any rulemaking process. EPA and NHTSA need latitude to apply their best analyses and base the requirements on the results of these analyses. The ICCT believes that the criteria and analyses used for the midterm review should be similar to those used for any CAFE or GHG rulemaking process.

The ICCT also recommends that EPA and NHTSA conduct periodic updates on technology progress and consider periodic status reports. Tear-down cost assessments should continue in order to assess the cost of newer technologies as they are introduced into the market. Simulation modeling also needs to be updated to keep pace with technology development. The scope and timing of reports should be up to the Agencies, but we see value in documenting progress in technology improvements and implementation. Manufacturers do not release details of their technology development, so periodic reports can summarize technology and cost developments and technology deployment for all interested parties, including other manufacturers. The ICCT also expects continued improvement in the science of assessing technology benefits and costs, which can be disseminated through the periodic progress reports. Forward-looking analyses would provide a better foundation going into the midterm review and should be updated as appropriate.

## 11) Discounting of Consumer Benefits

The NPRM evaluates the costs and benefits of the proposed rule, and concludes that the net benefits to society of the National Program will be in the range of $311 billion to $421 billion (7 and 3 percent discount rates, respectively) over the lifetimes of those vehicles sold in MY 2017-2025.[30] Most of these benefits are attributed to reductions in fuel consumption.[31]

The reference case analysis of benefits includes the value of fuel savings over the entire lifetime of the vehicle. EPA summarizes its rationale for this approach as follows:

> EPA continues to value fuel savings from the proposed standards using the projected market value over the vehicles' entire lifetimes, and to report that value among private benefits of the proposed rule. Improved fuel economy will significantly reduce consumer expenditures on fuel, thus benefiting consumers. Real money is being saved and accrued by the initial buyer and subsequent owners. In addition, using a measure based on consumer consideration at the time of vehicle purchase would involve a very wide range of uncertainty, due to the lack

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[30] Environmental Protection Agency and National Highway Traffic Safety Administration, 2017 And Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions And Corporate Average Fuel Economy Standards, Notice of Proposed Rulemaking p.16

[31] Ibid, p.64

> of consensus on the value of additional fuel economy in vehicle choice models.[32]

NHTSA's reference case analysis similarly assumes that there is no loss in value to consumers resulting from vehicles that have an increase in price and higher fuel economy. However, NHTSA also performed sensitivity analyses that assumed that there is a 25 percent or 50 percent loss in value to consumers--equivalent to the assumption that consumers will only value the calculated benefits they will achieve at 75, or 50 percent, respectively of the main analysis estimates.[33] This is intended to account for possible unspecified or poorly understood negative impacts of the rule on consumer preferences.

The sensitivity analyses conclude that these alternative assumptions have a large impact on the magnitude of net benefits, reducing the estimated net benefit by 63.0% and 31.5% respectively. Even in the worst case, however, total benefits still exceed costs.[34]

ICCT agrees that estimates of net benefits should fully value fuel savings over the lifetime of the vehicle. As noted by EPA these are real-world impacts that have tangible value. **The alternative NHTSA estimates presented in the NPRM are speculative and should not be given any consideration.**

## 12) VMT Rebound Effect

The agencies used a fixed estimate of 10% for the rebound effect. This estimate was not based upon the latest research, but instead was a compromise between the latest research and outdated historical data:

> "In summary, the 10 percent value was not derived from a single estimate or particular study, but instead represents a compromise between historical estimates and projected future estimates."[35]
> "As we discussed in the 2012–2016 rulemaking and in Chapter 4 of the Joint TSD, this value was not derived from a single point estimate from a particular study, but instead represents a reasonable compromise between the historical estimates and the projected future estimates."[36]

The agencies quoted the latest research from Small and VanDender and David Greene demonstrating that the rebound effect is linked to personal income and vehicle efficiency, as well as fuel prices, and has been declining over time. EPA also referenced recent work by Kenneth Gillingham, who provides suggestive evidence that consumers may be less responsive to changes in fuel efficiency than to changes in fuel prices. Yet, when it came

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[32] Ibid, p. 453

[33] Ibid, p. 693

[34] Ibid, p. 697

[35] preamble, page 75211

[36] preamble, page 75126

time to select the number used for the rebound effect, outdated studies with strictly historical effects were given equal weight to the recent studies projecting the future VMT effect.

The proposed rule asks for the submission of new data regarding estimates of the rebound effect and comments on the methodology for applying the rebound effect. Additional data is not needed. The Greene and Small and VanDender work is the proper basis for calculating the rebound effect. They made a major contribution to the field by incorporating economic impacts and the cost of driving into calculations of price elasticity of demand. This is much more appropriate than assuming a fixed 10% rebound effect that does not take into account future changes in vehicle efficiency, fuel prices, and future income. **Only future projections of the rebound effect that include the impacts of personal income, vehicle efficiency, and fuel price should be used to calculate the future rebound effect.**

## 13) Upstream Plug-in and Fuel Cell Vehicle Credits

The ICCT was founded around the Bellagio Principles[37], set forth in 2001 by regulators from the largest car markets around the world to help guide the future of worldwide motor vehicle technology and transportation fuels. A key principle states: "Policymakers must...base policies solely on performance compared to societal objectives, and not give special consideration to specific fuels, technologies, or vehicle types."

Technology-neutral standards have a number of advantages over policies that specifically target distinct technologies. Picking the right "winners" is challenging, and the wrong choices may hinder technologies that could have had the greatest potential benefit over the long run. Technology-specific bonuses reduce transparency and at the same time introduce opportunities for windfall credits at the expense of alternative technology development, consumer cost savings, and GHG reductions.

EPA has proposed two electric vehicle (EV) technology-specific bonus credits[38]:

1. A default GHG compliance value of zero g/mi for battery electric vehicles (BEVs), fuel cell electric vehicles (FCEVs), and the electric operation fraction of plug-in hybrid electric vehicles (PHEVs).
2. A system of multipliers that allows manufacturers to count EVs as more than one vehicle in manufacturers' compliance calculations during the 2017 to 2021 model years.

The ICCT strongly agrees with the need to commercialize BEVs, FCEVs and PHEVs. These technologies are key components needed to meet the ambitious 2050 GHG reduction

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[37] Bellagio Memorandum on Motor Vehicle Policy, Principles for Vehicles and Fuels in Response to Global Environmental and Health Imperatives, Consensus Document: 19-21 June, 2001, Bellagio, Italy

[38] Preamble page75012

targets necessary to avert the worst impacts of climate change.[39] To promote these vehicles without violating the principle of technology neutrality, ICCT is proposing an alternative accounting method for EV upstream fuel cycle GHG emissions that strikes a balance between providing advanced vehicle credits and maintaining technology-neutral standards. We also propose eliminating or restricting the use of multipliers and eliminating windfall credits for vehicles that are required under the California ZEV mandate. This would appropriately reward benefits inherent to EV technology, while also encouraging a number of other technology options to further improve EV efficiency.

The NPRM[40] estimates that the two credit types proposed in the rule would erode 80 to 110 million metric tons of benefits from the MY 2017-2025 GHG standards. Our detailed comments below describe the benefits of ICCT's proposed technology-neutral EV emissions accounting system, contrasting them with the large windfall credits and unfavorable cost/benefit ratios that would result from the currently proposed EV incentives.

*Electric Vehicle Net Upstream Fuel Cycle GHG Emissions Accounting*

There are a number of compelling reasons why the regulatory proposal should properly account for the EV fleet's upstream GHG emissions from grid electricity and/or hydrogen. First, such a system would achieve all of the benefits of a technology-neutral standard. As noted earlier, transparency would increase and windfall credits would be avoided. Windfall credits are discussed in further detail later.

In addition, full EV upstream net-GHG emissions accounting would incentivize efficiency improvements and fully legitimize, for EVs, the application of many important and desirable off-cycle incentives proposed by the US EPA. ICCT expects that EVs can earn low or zero g/mile compliance values (as shown in Table 4) both because of intrinsic advantages to electric drive technology and the ability to capitalize on other improvements such as:

- Inherent efficiency advantages over petroleum combustion engines
- Further efficiency improvements through lightweighting, aerodynamics, and low rolling resistance tires
- Displaced petroleum upstream emissions
- Reduced air conditioning GHG emissions through low Global Warming Potential (GWP) refrigerants, low-leak technologies and/or improved AC system efficiency
- Other off-cycle credits, when justified

We recommend that the net EV emissions be calculated in the same way as the example for

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[39] See for example California Air Resources Board. 2011 Staff Report: Initial Statement of Reasons, Advanced Clean Cars, 2012 Proposed Amendments to the California Zero Emission Vehicle Program Regulations; Vehicles." (ZEV ISOR)

[40] Preamble page 75024

BEVs provided by US EPA,[41] with the explicit addition of off-cycle credits:

> net upstream EV emissions = fuel carbon intensity x vehicle efficiency – off-cycle credits – displaced petroleum upstream emissions

EVs with specific technologies not reflected on FTP/HWFET test cycles, upon meeting specific criteria, would receive credit for displacing off-cycle internal combustion engine (ICE) GHG emissions. As opposed to giving credit for avoided BEV upstream emissions only (based on displaced upstream), this approach would not understate the overall BEV benefit compared to a conventional ICE.

In response to US EPA's request for comments on FCEV hydrogen carbon intensity, we recommend using California's expected carbon intensity values as a default at least until the mid-term review of the national GHG standards. California cumulative FCEV deployments are expected to reach more than 50,000 by 2017[42] and California is currently establishing hydrogen stations through the use of incentives and regulations.[43] We encourage US EPA to establish an initial California transportation hydrogen carbon intensity placeholder value based on 67% steam methane reformer (SMR) hydrogen production (a widespread method of production in the United States today) and 33% hydrogen production from renewable resources. This would be reflective of California's approach and could be updated over time as FCEVs spread to other states.

We encourage US EPA to model regional variations in grid electricity carbon intensity, as suggested in the NPRM. Potential reductions in grid carbon intensity, changing over time due to mandatory state renewables or other carbon-reduction standards, should be accounted for as well. In the meantime, California has conducted extensive analysis estimating electricity carbon intensity for 2020, including imported electricity, which could be used for a substantial portion of US BEV and PHEV placements. As this information is currently available, US EPA could establish an interim California value of 270 g/kw-hr[44] along with a parallel aggregate value for the remaining 49 states. We agree with US EPA's proposed inclusion of transmission and distribution losses, as well as upstream fossil fuel production emissions.

Table 4 provides an example of the ICCT's recommended emission calculations, using a

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[41] 76 FR 231(December 1, 2011) p75014.

[42] Source: CARB. 2011. Initial Statement of Reasons, Advanced Clean Cars 2012 Proposed Amendments to the Clean Fuels Outlet Regulation. (CFO ISOR) November. p12. Available at http://www.arb.ca.gov/regact/2012/cfo2012/cfoisor.pdf, last accessed 2-6-2012. Note that factors such as transportation hydrogen station infrastructure deployment and the Zero Emission Vehicle regulation will favor FCEV deployments in California initially.

[43] CARB. 2011. Initial Statement of Reasons for Proposed Rulemaking, Public Hearing to Consider the "LEV III Amendments" (LEV III ISOR) etc. p 136. CARB expects that California's 33% renewable transportation hydrogen requirement (California Senate Bill 1505 of 2006) will be effective in the 2017-2025 timeframe

[44] CARB LEV III ISOR. 2011. p136

2020 BEV fueled by projected California or US average 2020 electricity. We would encourage US EPA to determine a similar example with a 49-state electricity carbon value.[45] This example is not intended to predict future vehicle emissions, but rather to illustrate the methodology explained above and show the potential for "earned zero" net g GHG/mile ZEV compliance values.

**Table 4.** Example Credit Calculations[46]

| | 2020 BEV | |
|---|---|---|
| | California | US |
| FTP/HWFET (kwhr/mile) | 220 | 220 |
| Base score ($gCO_2$/mi) | 59 | 131 |
| ICE off-cycle emissions avoided (g $CO_2$/mi) | 6 | 6 |
| Alternate AC refrigerant credit (g $CO_2$/mi) | 14 | 14 |
| Petroleum upstream displacement credit ($gCO_2$/mi) | 39 | 39 |
| Final Score (g $CO_2$/mi) | 0 | 72 |

*Windfall Credits for Mandatory ZEV Deployments and Lost Benefits*

We agree with the importance of EV technology deployment. However, we emphasize that EV credits should be earned based on performance, rather than awarded, independent of

[45] US EPA US EPA Draft Regulatory Impact Analysis: Proposed Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse gas Emission Standards and Corporate Average Fuel Economy Standards (DRIA) RIA p4-31 and 4-32 and Federal Register Volume 76, Number 231, "2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards; Proposed Rule", p75014.

[46] Sources: 2012 Leaf vehicle efficiency: (0.22 kw/hr FTP/HWFET) US EPA Draft Regulatory Impact Analysis: Proposed Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse gas Emission Standards and Corporate Average Fuel Economy Standards (DRIA) p. 4-32

2007 US grid carbon intensity: US EPA DRIA p. 4-32; 2020 grid carbon intensity: California (270 g/kwh) from CARB. 2011. Initial Statement of Reasons, Advanced Clean Cars 2012 Proposed Amendments to the Clean Fuels Outlet Regulation. November. Available at http://www.arb.ca.gov/regact/2012/cfo2012/cfoisor.pdf, p. 136; US (597 g/kwh) from ICCT Power sector Roadmap. We assumed a roughly 5% decrease in overall US electricity grid carbon intensity for this example.

Estimated BEV efficiency improvement rates: (1% per year 2012 through 2020) from ICCT.

Petroleum upstream GHG avoided: (39 g/mile) 76 FR 231, p75014. Value may vary yearly.

Maximum AC refrigerant credit: (13.8 g/mile) 76 FR 231(December 1, 2011) p75000.

Off-cycle: off-cycle credits are illustrative, based on ICCT estimate of 0.9 g/mile for lighting (see ICCT comments on off-cycle emission reductions) and 5 g/mile AC system efficiency from 11-16-2011 draft TSD; actual amount could be greater or less.

performance, for the production of a certain vehicle type.

The ICCT has two significant issues related to (a) the proposed EV multipliers (also referred to as "supercredits") and (b) the concept of giving vehicles a default zero gram per mile compliance score:

1. Large windfall credits for mandatory ZEV deployments.
2. High costs in terms of lost consumer savings and GHG benefits, even for vehicle deployments beyond mandatory levels.

Incentive programs are normally structured to avoid rewarding activity that is already otherwise required.[47] The NPRM itself cites this principle, noting in the discussion of off-cycle credits that "EPA would not provide credits for a technology required to be used by Federal law, such as tire pressure monitoring systems, as EPA would consider such credits to be windfall credits (i.e. not generated as a results of the rule)."[48] We agree with this principle, and in these comments we discuss how it can be applied to EV incentives.

The California Air Resources Board and Section 177 states have adopted the Zero Emission Vehicle program, requiring that manufacturers deploy large numbers of EVs.[49] CARB has forecast vehicle deployments out to 2025, although in terms of vehicle numbers the deployments are not specific regulatory targets due to flexibilities included in the ZEV rule. US EPA projections imply that for model years 2017 through 2025, deployments of BEVs and FCEVs mandated under California's ZEV rule are likely to account for 85 to 90+% of such vehicles nationally, whereas CARB forecasts show that PHEV deployments would be much higher than the US EPA's projection, as shown below in Table 5. Thus the vast majority of "supercredits" generated under the proposed multipliers would likely be awarded to vehicles that manufacturers will be required to build even in the absence of the incentive. Furthermore, the total allocation of windfall credits seems likely to exceed the high-end scenario considered by US EPA in determining potential emission detriments stemming from the multiplier.[50]

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[47] See for example the California Carl Moyer Memorial Air Quality Standards Attainment Program, which "provides incentive grants for *cleaner-than-required* engines, equipment and other sources of pollution providing early or extra emission reductions". (emphasis added)

[48] 76 FR 231 (December 1, 2010) p 75024

[49] Currently, there are 10 states which have adopted the California ZEV regulation: Connecticut, Maine, Maryland, Massachusetts, New Jersey, New Mexico, New York, Oregon, Rhode Island, and Vermont. CARB, 2011. ZEV ISOR.BEVs and FCEVs are mandatory, and PHEVs can be used to partially satisfy the mandate.

[50] 76 FR 231 (December 1, 2011) p75015.

**Table 5.** California and USEPA Estimates of ZEV and PHEV Production (in thousands)(Source: California Air Resources Board and US EPA[51])

| | 2017-2021 | | 2022-2025 | | Total | |
|---|---|---|---|---|---|---|
| | ZEV | PHEV | ZEV | PHEV | ZEV | PHEV |
| ARB estimate, CA and Section 177 states | 395 | 1,005 | 853 | 1,668 | 1,248 | 2,673 |
| USEPA estimate 1 (OMEGA model) | 300 | 300 | 650 | 650 | 950 | 950 |
| USEPA estimate 2 (alternative projection) | 400 | 400 | 1,000 | 1,000 | 1,400 | 1,400 |

While manufacturers receive benefit from bonus GHG credits, as noted below, ICCT finds that the societal costs of "supercredit" multipliers and related default zero g/mi compliance values would be significantly greater than any potential incentive to manufacturers. Excess GHG credits allow manufacturers to decrease fuel efficiency across non-EVs in the fleet, and the resulting increase in overall fuel consumption and expenditures is the main factor responsible for this result.[52]

Higher fleetwide fuel consumption along with related costs are shown in Table 6 below. Increased petroleum fuel costs range from $17,200 in MY2017 to $9,400 in MY2021 (in 2009$) at a 3 percent discount rate per EV from the proposed excess credits. We also estimate that fleetwide $CO_2$ would increase significantly per incremental EV due to the excess credits. Results for PHEVs would be scaled down based on different multipliers and the electric fraction of mileage.

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51 76 FR 231 (December 1, 2011) p75015, and CARB ZEV Calculator" undated Excel spreadsheet http://www.arb.ca.gov/msprog/clean_cars/clean_cars_ab1085/clean_cars_ab1085.htm last accessed 2-8-2012. Assumes that manufacturers accounting for 15 percent of sales will make use of a provision under which overcompliance with the national GHG program may be used to reduce in part the ZEV obligation.

52 The zero g/mi compliance value and related multipliers applied to ZEVs allow a de facto increase in the fleet average GHG standard that must be met by the conventional (non-ZEV) portion of the fleet. Thus each ZEV deployed results in a small increase in allowable emissions from the remainder of the fleet, and a related small decrease in mandated fuel economy.

**Table 6.** Impacts of Additional ZEV Using NPRM Incentives (cost figures rounded to nearest $100 in 2009 dollars).[53]

| | MY2017 | MY2018 | MY2019 | MY2020 | MY2021 |
|---|---|---|---|---|---|
| Estimated using a 3 percent discount rate | | | | | |
| Increased consumer fuel expenditures[54] | $17,200 | $16,600 | $16,100 | $12,600 | $9,400 |
| Increased energy security impacts[55] | $2,700 | $2,600 | $2,500 | $1,900 | $1,400 |
| Estimated using a 7 percent discount rate | | | | | |
| Increased consumer fuel expenditures | $13,600 | $13,100 | $12,700 | $10,000 | $7,400 |
| Increased energy security impacts | $ 2,100 | $ 2,000 | $ 2,000 | $1,500 | $1,100 |
| Other Impacts | | | | | |
| Increased GHG emissions (tons)[56] | 66 | 64 | 62 | 49 | 36 |

Table 7 shows two potential scenarios for the magnitude of the potential incentive manufacturers would see from the multiplier and zero upstream credits. ICCT selected scenarios of $25 and $35 per g $CO_2$/mi for illustrative purposes in Table 7 to represent a range of estimates of the potential marginal cost to move below 2020 emission levels for a

[53] The table calculates fuel consumption based on lost fuel economy due to the bonus credits by converting increased allowable GHG emissions in g/mile to increased petroleum consumption in gallons. We assume that AC refrigerant credit values would not be changed as a result of the EV incentive credits.

[54] Car lifetime miles calculated from data in US EPA/NHTSDA "Draft Joint Technical Support Document: Proposed Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards (note that ICCT recognizes that ZEV lifetime mileage may vary from the fleet average); FTP/HWFET to real world fuel economy adjustment = 0.2 for ICE vehicles per US EPA draft TSD 11-16-2011 p4-5; grams CO2/mile converted to gallons fuel per mile at a conversion of 8887 grams/mile.

[55] Energy security premium, per barrel = $18.22 76 FR 231(December 1, 2011) p75137; gallons of gasoline per barrel of oil = 42

[56] EV compliance value emissions = 72 g/mi (ICCT estimate, national average) for BEV

midsized vehicle.[57] As noted in several of our earlier comments, we believe that technology development will tend to result in lower costs than these estimates, reducing the potential value of bonus credits to manufacturers. ICCT used assumptions from NHTSA to calculate the reduction in a manufacturer's sales price for less efficient vehicles, which would reduce the net value of a GHG credit to a manufacturer.[58]

In all of these cost scenarios, the societal cost of the proposed EV incentives (as shown in Table 6) is significantly higher than the net benefit incentivizing the manufacturer (as shown in Table 7). We also note that the net manufacturer cost savings in these scenarios is less than the incremental cost of producing a BEV or FCEV in 2020, which is estimated by ARB to be $12,400-$12,900.[59] The magnitude and uncertainty of this benefit is such that the EV bonus credits are unlikely to be effective in the absence of other types of consumer benefits, incentive programs, or manufacturer priorities.

We also find that the system proposed in the NPRM could create confusion in the minds of consumers by creating a linkage between EV purchases and increased overall GHG emissions. Surveys show that drivers in the US, Canada, and 11 other countries overwhelmingly would want to know the source of electricity for a plug-in vehicle, and in the US 43% of respondents said that the source of electricity would affect their decision of whether to purchase the vehicle or not.[60] While drivers were not directly asked whether indirect $CO_2$ increases linked to an EV purchase would discourage them from buying an EV this could be an unintended side-effect of these bonus credits.

[57] As a first-order approximation, ICCT estimated an average cost of $29 per g/mile for midsize car technology packages, excluding AC reduction, to reduce emissions from the level of the 2020 standard. Technology package costs are from the CARB LEV III ISOR p124. LEV III ISOR technology costs generally listed in 2009 dollars, see for instance ES-12. Some packages would cost more while others less.

[58] 76 FR 231(December 1, 2011) p75206.

[59] CARB. 2011. ZEV ISOR, p. 62.

[60] Accenture. 2011. "Plug-in electric vehicles: Changing perceptions, hedging bets". http://www.accenture.com/us-en/Pages/insight-plug-in-electric-vehicles-changing-perceptions-summary.aspx last accessed 10-13-2011. pp. 5, 17. 1,000 of 7,000 surveys were conducted in the US, 500 in Canada, and 3,502 in Europe.

**Table 7.** Scenarios of Net Value of Credits Earned by Manufacturers (sources: various) (cost figures rounded to nearest $100 based on theoretical GHG compliance credit values, 2009 Dollars)

| Calendar Year | 2017 | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|---|
| Standard, fleet average g/mi (achieved) | 245 | 234 | 224 | 214 | 201 |
| EV multiplier | 2.00 | 2.00 | 2.00 | 1.75 | 1.50 |
| Excess Credit from Zero Upstream and Multiplier, g/mi[61] | 317 | 306 | 296 | 233 | 173 |
| Manufacturer cost savings @ $25 per g/mi | $7,900 | $7,700 | $7,400 | $5,800 | $4,300 |
| Manufacturer cost savings @ $35 per g/mi | $11,100 | $10,700 | $10,400 | $8,100 | $6,000 |
| Reduced purchase price due to reduced consumer value[62] | -$6,100 | -$5,900 | -$5,700 | -$4,500 | -$3,300 |
| Manufacturer net cost savings @ $25 per g/mi | $1,800 | $1,800 | $1,700 | $1,300 | $1,000 |
| Manufacturer net cost savings @ $35 per g/mi | $5,000 | $4,800 | $4,700 | $3,600 | $2,700 |

*Alternative Recommendation*

If US EPA chooses not to eliminate MY2017-2021 multipliers and does not require EV fuel cycle net GHG upstream accounting, we would strongly encourage two modifications to the NPRM. First, EV incentives should be eliminated for all mandated vehicles. Direct coordination with CARB and Section 177 states would be the preferred approach, or an acceptable alternative would be to set a corresponding minimum deployment floor below which vehicles would not qualify for the incentives. Table 8 shows a potential scenario of ZEV and PHEV sales in California and Section 177 states as a percentage of national

[61] ICCT uses a potential BEV value of 72 g GHG/mile for upstream emissions for simplicity. ICCT expects that FCEV deployments will continue to increase in the future and may have different upstream compliance values than this potential EV compliance value.

[62]This sceanario shows the results if consumers value three years of fuel savings among differing estimates of consumer fuel cost valuations based on Greene, David 2010. "Uncertainty, loss aversion, and markets for energy efficiency", Energy Economics. Using NHTSA assumption that consumers value 5 years of fuel cost savings at a 7% discount rate would result in lower manufacturer incentive levels.

passenger vehicle sales, by model year.

**Table 8.** Potential ZEV and PHEV Sales, California and Section 177 States as a Percentage of National Sales (Sources: US EPA and CARB[63])

| | Model Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 |
| ZEV sales (percent) | 0.1% | 0.3% | 0.5% | 0.7% | 0.9% | 1.1% | 1.2% | 1.3% | 1.4% |
| PHEV sales (percent) | 0.5% | 1.1% | 1.3% | 1.6% | 1.8% | 2.1% | 2.4% | 2.6% | 2.8% |

In addition, we would also recommend setting ambitious performance requirements to restrict eligibility for multipliers to the top performers. Real world range is a key determinant of environmental impact (due to gasoline vehicle miles displaced) as well as consumer acceptance, and could be used to establish performance criteria for each of the multiplier ratios that US EPA is considering. An example of this concept is shown in Table 9.[64]

**Table 9.** Possible Range Based Multipliers

| Real-world all-electric range (presumptively 5-cycle test values) | MY2017-MY2021 multiplier |
|---|---|
| 120 - 149 | 1.2 |
| 150 - 159 | 1.5 |
| 160 - 174 | 1.6 |
| 175-199 | 1.75 |
| 200 and greater | 2.0 |

[63] Vehicle deployment numbers from ARB "ZEV Calculator" undated Excel spreadsheet. http://www.arb.ca.gov/msprog/clean_cars/clean_cars_ab1085/clean_cars_ab1085.htm last accessed 2-8-2012, and US sales data from US EPA/NHTSA Draft Joint Technical Support Document Proposed Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards November 2011. Chapter 4

64 1.45 and 1.5 multiplier categories merged for simplicity. Note that while this suggested table would not provide an additional timing incentive, early deployments would generally receive greater credits through a more favorable credit due to the higher level of the standards in earlier years.

Finally we would also encourage US EPA to add a cap on incentives offered for MY 2017-MY2021, and to generally set these caps for those model years as low as possible. In the proposed rule, the lack of a cap for MY 2017-2021 leaves open the possibility of significant foregone emission reductions in the event that electric vehicle sales greatly exceed US EPA's expectations. If such high sales levels occur, then presumably the technology is succeeding beyond expectations and the incentive is either unnecessary or excessive. We recommend establishing caps, with eligibility on a "first come-first served" basis, even if US EPA initially gives each manufacturer credit eligibility for a minimum number of vehicles in order to encourage broader adoption of EV technology.

## 14) Pickup Truck Credits

A second type of technology-specific bonus credit currently in the proposed rule applies to full-size pickup trucks. For the same reasons we expressed in the last section on upstream credits, the ICCT encourage US EPA to eliminate the proposed bonus credits for pickup trucks.

The NPRM proposes two types of pick-up bonus credits. First, the NPRM proposes a bonus credit of 10 g/mile for each full-sized pickup truck that is either equipped with mild hybrid technology, or achieves an emission rate 15% better than the standard in any year from MY2017 to MY2021 (assuming minimum fleet deployment rates are met). Second, the NPRM proposes a bonus credit of 20 g/mile for each full sized pickup that is either equipped with strong hybrid technology, or achieves an emission rate 20% better than the standard in any year (assuming certain fleet deployment rates are achieved).

These proposed credits are not related to any additional fuel or $CO_2$ reductions and could hinder, rather than promote, additional technology advancement for two reasons. First, there is no inherent reason why hybrid systems for pickup trucks would be different from hybrid systems for other vehicles. Even if hybrid development proceeded initially on other vehicles, it could easily be spread to pickup trucks when it is ready. In fact, Toyota and Ford have already announced a joint venture to develop hybrid systems for pickup trucks.[65]

Second, OEMs could use the bonus credit to delay introducing this technology on other models and/or delay introduction of stronger hybrids, zero tailpipe emission vehicles, and other superior technologies. In addition, once a vehicle qualifies in a given year, future production of the model can also qualify for the 10 g/mile credit up until 2021, even as the expected benefit over the standard shrinks toward zero.

Technology-neutral standards, without the 10 g/mile and 20 g/mile pick-up credits, would best achieve the valuable benefits of this rulemaking.

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[65] http://www.nytimes.com/2011/08/23/business/ford-and-toyota-to-work-together-on-hybrid-trucks.html

As a minimum, OEMs should be required to achieve a performance standard of 15% (10 g/mile credit) or 20% (20 g/mile credit) better than the compliance curve for a given model **in each year that the credit is awarded to that model. In addition, the pickup truck credits should be phased out in the final rule and not be allowed to continue indefinitely.**

## 15) Pick-up Truck Definition

For the purposes of the full size pickup truck hybrid technology incentive credit or the full size pickup truck performance-based incentive credit, EPA is seeking comment on expanding the definition of a full-size truck by reducing the minimum wheelhouse width requirement from 48 inches to a value around 42 inches, provided the vehicle is able to tow at least 6,000 lbs. Note that this is 1,000 lbs higher than the requirement for 48 inch wide pickup trucks.

It is inappropriate to expand the definition of full size pickup trucks to include trucks with less than 48 inches between the wheelhouse. The ability to haul standard four foot wide building sheets, such as plywood and drywall, between the wheelhouse has been the marketing definition of a full size pickup at least since the introduction of the F-series pickup in 1948. Reducing the wheelhouse width to 42 includes will allow virtually all pickup trucks to qualify for the artificial pickup truck credits, further distorting technology requirements and reducing the benefits of the rule.

ICCT strongly opposes expansion of the full size pickup credits to pickups with less than 48 inches wheelhouse width.

## 16) Off-Cycle Credits

*ICCT general comment on off-cycle credits and testing*

ICCT strongly supports credits for off-cycle reductions in concept. Such credits can reduce the cost to manufacturers for compliance in the short run and can create cost-effective pathways for greater fuel consumption and GHG emission reductions in the long run.

However, it is extremely important that the credits properly reflect actual in-use reductions, do not duplicate on-cycle benefits, and can be validated. Credits that are artificial and do not directly result in comparable in-use reductions can severely undermine the effectiveness and credibility of the standards.

The same principle applies to default off-cycle credits. In theory they are a good idea that can create incentives for manufacturers to invest in off-cycle technologies, but if not assessed properly they create windfall credits that reduce fuel consumption and GHG emissions benefits of the program.

The ICCT recommends that EPA establish procedures to quantify and validate off-cycle benefits before granting a specific default off-cycle credit value. Absent a solid case for default off-cycle credit values, traditional case-by-case testing is needed to properly access off-cycle credits. Any default credits should be based on:

1. Robust data showing real and quantifiable reductions that are not double counted on the regulatory test cycles, and
2. Effective performance benchmarks and verification that ensure vehicles receiving these credits will achieve the potential emission reductions in the real world.

The off-cycle approval procedures adopted by EPA for the 2012-2016 final rule provide accurate and appropriate guidelines for approval of off-cycle credits. These procedures should be followed both for granting specific approvals to manufacturers for off-cycle credits and for establishing default off-cycle credit values.

Given the importance of maintaining the benefits of this rulemaking and the ability to make additions to the default lists later as additional data is generated, technologies that do not clearly meet these requirements should be dropped from the default list during this rulemaking.

Because some uncertainty is inherent even in a well-designed process the ICCT also supports the proposed 10 g/mile cap. ICCT's comments on specific off-cycle credits below are designed to make the off-cycle credit system as accurate as possible and to maximize the overall benefits of the rule. The NPRM and draft TSD show that some of the technologies meet ICCT's recommended criteria for off-cycle credits, such as some of the proposed AC system credits, while other proposed off-cycle credits do not. We note that excluding the later category will not affect the very favorable benefit-cost ratio for this rule because the draft TSD did not consider these technologies in that analysis.[66]

*A/C off-cycle efficiency credits*

ICCT appreciates US EPA and NHTSA's efforts to thoroughly document the potential benefits of AC off-cycle credits based on both testing and engineering studies for each of the potential A/C technologies. While we have not fully reviewed the test data and studies for each type of credit, overall the agencies' basis for inclusion of credits for AC system efficiency, leak reduction and alternative refrigerants is well documented.

ICCT also supports combining the menu of credits for specific A/C technologies with manufacturer performance testing to justify application of these credits. Creating a menu of credit values will help quantify emission reductions for components/technologies that may be hard to quantify through testing individually, while performance testing will verify that an effective overall package meets the minimum threshold for improvement and achieves the claimed emissions reductions. We encourage US EPA's continued work to improve the A/C test procedures in parallel with the rulemaking effort.

We note that the USEPA/NHTSDA November 2011 draft TSD (page 5-51) suggests that only one or two vehicles per year may be tested per manufacturer on average. Given the wide

[66] Draft TSD chapter 3.1

range of changes in new product offerings, engine technology, A/C system operations, and alternative refrigerants, we believe that each significantly changed model should be tested. We recommend deleting this statement in the final TSD.

Our primary concern with the air conditioning credits calculation is that methodology changes are needed to avoid double-counting the benefits from A/C load reductions and A/C system efficiency improvements. Currently, the efficiency credits and the load reduction credits are calculated independently. This is not appropriate. The efficiency reductions and the load reductions must be treated as a system to avoid double-counting.

To avoid double-counting, the ICCT recommends a multiplicative approach to A/C credit generation. Following is how the credit calculations should be done in concept:

> A/C efficiency credits ($CO_2$ g/mi) = baseline A/C indirect emissions ($CO_2$ g/mi) – improved A/C indirect emissions ($CO_2$ g/mi),
> where A/C indirect emissions are calculated as:
> A/C indirect emissions ($CO_2$2 g/mi) = cooling load (degrees) x efficiency (kwhr/degree cooling) x engine $CO_2$/kWh

The baseline calculation is done using the baseline cooling load and A/C efficiency and the improved calculation is done using the improved values for cooling load and A/C efficiency. Note that the improved cooling load should include the impacts of solar reflective paint, window glazing, and active and passive ventilation, if these technologies are being counted towards off-cycle credits.

This approach should apply across the A/C system efficiency credits and the load reduction credits contained on the menu of non-A/C default credits. For instance, if an OEM claimed a 30% improvement in A/C system energy efficiency and a 40% reduction in solar load, the new energy consumption rate would be 42% of baseline (70% times 60%) for a total benefit of 58% times the engine $CO_2$/kw-hr, rather than a benefit of 70% times the engine $CO_2$/kw-hr. This multiplicative assessment should also hold true for determining the cumulative effects of individual A/C system efficiency improvement technologies. In addition, future engine efficiency should be verified as proposed including advanced engine technologies such as hybrids that may operate the AC system with the internal combustion engine entirely turned off during idle.

US EPA and NHTSA should also account for the system efficiency impact of alternative refrigerants. In particular, any system efficiency disbenefit with a new refrigerant should offset either any alternative refrigerant credit or A/C system efficiency credit in this case.

*Solar Reflective Paint and Window Glazings*

We agree with the criteria used for this category of off-cycle credits. US EPA has determined that it will achieve real reductions that are not counted in the regulatory test cycle through detailed technical studies including the CARB regulatory development process (these off-cycle credits are in lieu of CARB regulation). Specific benchmarks in the draft TSD are based on well-established principles of solar gain and OEMs must meet performance criteria to verify the emission reductions. Thus, these credits meet the general principle of being verifiable and additive off-cycle benefits.

As noted earlier, the off-cycle credits for solar reflective paint and window glazings must be combined with other load reductions and A/C system efficiency in a multiplicative manner in cases where an OEM wishes to claim both types of credits.

*Active or Passive Ventilation*

Vehicle active or passive ventilation may have the technical potential to reduce air conditioning load, but they do not meet the general criteria discussed above for default credits. The NREL report on these technologies was developed based on limited data and states that further evaluation is needed.[67] The NREL report also notes that floor-level ventilation could allow dust, animals, and/or exhaust to enter the vehicles.[68] Thus drivers (or dealers) may be motivated to close them off. Similarly, the driver's response to ventilated seats is unclear at this time.

These ventilation technologies could also compete with glazings and paints, which have been more thoroughly evaluated, for solar load reduction credits. **Default credits for active or passive ventilation should be deferred.** They can be reconsidered later if there is further study to verify real-world performance and if a performance benchmark for verification is developed.

Should credits be granted, the method of combining AC system efficiency and any such credits in cases where an OEM wishes to claim both types of credits must be used, as noted above.

*A/C alternative refrigerant credits*

The ICCT supports the agencies' proposal to issue credits for alternative refrigerants, which can dramatically reduce the potential for greenhouse gas emissions from servicing, leaks, and end-of-life disposal. We commend EPA for tying the leakage credit to the refrigerant being used in the vehicle. A flat leakage credit would have potentially overstated or underestimated the climate benefit of the intervention, depending on the refrigerant contained in the vehicle. We also commend EPA for including a disincentive for systems that utilize a low GWP refrigerant but do not also adopt low leakage equipment.

We also agree with US EPA and NHTSA that the credits should account for the possibility of dropping in higher GWP refrigerant such as HFC-134a (GWP 1430) as a replacement for 1234f in use.[69] This potential for backsliding is not fully addressed in the proposed rule. High prices for alternative refrigerants will very likely encourage vehicle owners to use lower cost but higher GWP replacements. EPA estimates that 49 percent of direct refrigerant leakage occurs during servicing and maintenance and nine percent occurs

[67] J Rugh and R Farrington, Vehicle Ancillary Load Reduction Project Close-out Report, January 2008 p51

[68] Ibid p15

[69] ICCT recognizes that HFC-132 phase-out would diminish the potential for 1234f replacement with HFC-132a.

during end of life.[70] This suggests the possibility for continued release of these higher GWP refrigerants, particularly among poorly maintained vehicles. Meanwhile, EPA assumes in its credit calculation that low GWP refrigerant will be used throughout the full life of the vehicle.

To address this concern in part, EPA has proposed to reduce the eligible credit available to the manufacturer when low-leak hoses and valves are not incorporated into the system (p 75002). While we strongly support this proposed anti-leak credit and agree that it may reduce the rate of servicing and maintenance, we remain concerned that poorly maintained vehicles or 'superemitters' will be re-charged with high GWP refrigerant and contribute substantial emissions over the course of the vehicle life.

**The ICCT recommends that the credit be further modified to reflect the likelihood of the use of higher GWP refrigerant**. Currently, the credit assumes that low GWP refrigerants will be used throughout the life of the vehicle, such that accidental releases during service events and disposal will be releases of only low GWP refrigerant. EPA should instead assume this only for systems where manufacturers demonstrate designs that cause the system to fail to operate when recharged with higher GWP refrigerants.

EPA should require manufacturers to demonstrate applicability to this criterion. When the criterion isn't met, EPA should reduce the amount of the credit to a level that represents only the share of total refrigerant consumption represented by the first initial charge of a new vehicle.

This approach may only apply to HFO 1234yf at the moment, since HCF-134a is essentially a drop-in replacement. Other systems like HFC-152a and $CO_2$ may not suffer this weakness. For HFO 1234yf, automakers would receive credit only for the refrigerant they put in the vehicle.

In our view, it is not enough to say that SAE design standards are being met. Additional measures are needed to encourage chemical manufacturers and auto manufacturers to find solutions that will more reliably deliver climate benefits. Such measures could be patterned after the requirements for approval of low viscosity and low friction oils for vehicle testing.[71] In this way, EPA would further ensure that design and operational limitations adopted by manufacturers fully realize the A/C emission reduction credits.

*Credit Continuity with 2012-2016 Final Rule*

EPA describes in the draft TSD that:

> EPA made the policy decision to maintain continuity with the 2012-2016 FRM analysis, and is proposing to incorporate this level of the credit in the standard

[70] (TSD Table 5-1).

[71] EPA guidance letter CISD-08-11;Use of 0W Multi-grade Engine Oils in Gasoline Fueled EPA Test Vehicles, Sept. 18, 2008. EPA guidance letter CCD-04-7; Use of GF-4 Engine Oil in EPA Test Vehicles, March 2, 2004

> setting process.[72]

This was done despite new information that suggests a need to revise the emissions inventory and the leakage credits derived from this. The reason for continuing the previous leakage credits is:

> “A reduction in A/C credits would artificially increase the stringency of the standard for those manufacturers who generated leakage credits in 2016 ... alternatively, the stringency of the 2017 standards would have to be relaxed." "…need for stability for the standards...".

We understand the need for stability of the standards for those manufacturers who generate leakage credits in 2016. However, the proposed rule acknowledges that the credits do not represent the emission reductions they are designed to represent. We strongly urge that this approach be re-evaluated in order to provide manufacturers who generate leakage credits in 2016 a means to generate alternative emission reductions equivalent to those represented by the credits based on the latest understanding of the emissions inventory.

We are concerned that the proposed policy may stimulate manufacturers to pursue these credits more aggressively as a means to avoid on-cycle reductions. We recommend that staff quantify the differences between a revised leakage credit based on a revised TAR inventory, and the credits being proposed, so as to justify the continuation of the existing leakage credits. If the differences are considerably larger, we recommend reconsideration of the proposed credits. But if they are small, then it is justifiable to maintain the credits as-is.

*Lead Time for Low-GWP Refrigerant Penetration*

EPA assumes a long lead time for penetration of low GWP refrigerants, claiming that automakers expect a full re-design to be necessary.[73] However, automakers in Europe are already selling vehicles with low GWP refrigerant. For example, EPA assumes 20 percent penetration in 2017, while Europe will be requiring 100 percent penetration that year. In addition, some refrigerant options like 1234yf require only minor changes to the refrigerant system. EPA cites confidential discussions with vehicle manufacturers who say "it may be possible to modify the hardware for some alternative refrigerant systems between redesign periods."[74] Thus, the ICCT strongly recommends harmonization with the European rule. At a minimum, EPA should explain its expectation of 20 percent penetration in 2017 and 20 percent additional penetration in each subsequent year through 2021. **We feel the long lead time is unjustified and recommend that EPA expect full adoption of low GWP refrigerant along a more accelerated time frame.**

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[72] TSD page 5-15

[73] Preamble page 75001

[74] (TSD 5-7).

*Refrigerant OBD Monitoring*

In its 2012-2016 rulemaking, EPA considered additional leak credits for systems that monitor refrigerant charge on-board the vehicle, but these ultimately were not adopted. EPA is again opening the door to this type of monitoring, considering that most A/C systems contain sensors that detect low refrigerant pressures.[75] The ICCT would be supportive of a refrigerant OBD monitoring credit in principle, although it would be challenging to accurately model and estimate the emissions benefits of OBD monitoring. Despite this, we think providing such information to the vehicle owner would cause many owners to seek repair and maintenance of the A/C system. **In light of the potential benefits and the difficulty in estimating a credit, the ICCT recommends that EPA require such on-board monitoring.** Another approach might be to estimate the proportion of time that owners would have the A/C system repaired in response to a Malfunction Indicator Light (MIL) illumination and multiply this percent by the calculated amount of leakage used for other A/C refrigerant credits.

*Vehicles without air conditioning*

The proposed crediting system is designed to mitigate the rather significant climate impacts of the air-conditioning unit, based upon both its efficiency and its refrigerant emissions. Based on this perspective, a vehicle without an air-conditioning system would have fundamentally lower climate impacts, as no refrigerant would be consumed and emitted and no energy would be required to operate the A/C system.

A potential concern is aftermarket installation of air conditioning systems, especially kits provided by OEMs and installed by dealers at the time of purchase. **The ICCT recommends that vehicles without air conditioning systems be given an appropriate amount of credits, provided that the manufacturer commits to monitoring and reporting on dealer-installed AC systems**.

*General Credit Calculation for Reducing or Offsetting Vehicle Load*

The draft TSD bases the "off-cycle" benefits of reducing engine load by 100 W on the simulated values provided in table 5-18 of the draft TSD. The benefits calculated on FTP/HWY cycle are appropriate. However, the calculations of the 5-cycle benefits of a 100 W load reduction were inappropriately applied, as they used a g/mile offset instead of a percentage offset.

Table 10 compares the benefits of a 100 w load reduction on the FTP/HWY to the benefits on the 5-cycle. For each vehicle, the benefits on the 5-cycle are less then than the 2-cycle testing benefits in terms of percentage $CO_2$ reduction. While the g/mi reductions for 5-cycle testing is greater in terms of g/mi that on the 2-cycle testing, this is only because the baseline $CO_2$ is much higher on the 5-cycle. The benefits of reducing or offsetting vehicle

[75] (TSD 5-23).

load on the 5-cycle are actually proportionally less than they are on the FTP/HWY. It is not appropriate to apply 5-cycle $gCO_2$/mi reductions to FTP/HWY baseline $gCO_2$/mi values. This is mixing apples and oranges.

The last row in the table illustrates that using the 5-cycle g/mi instead of the percent benefit produces a percentage benefit that is larger than the benefit on either the FTP/HWY or the US06. This is artificial and unwarranted. **The FTP/HWY percentage benefits must be used for any electrical load reduction that does not occur on the test cycles (for instance headlights) and no additional credits should be given for any electrical load reduction that occurs on the test cycle (for instance thermoelectric generation).**

**Table 10.** Efficiency benefits of a 100 W load reduction

| | | small car | mid-sized car | large car | pick-up truck | average |
|---|---|---|---|---|---|---|
| **FTP/HWY** | **100 w load reduction** | 160.8 | 188 | 245.7 | 414.7 | 252.3 |
| | **baseline** | 164 | 190.8 | 248.8 | 417.9 | 255.4 |
| | **diff in g/mi** | 3.2 | 2.8 | 3.1 | 3.2 | 3.075 |
| | **diff in %** | 2.0% | 1.5% | 1.2% | 0.8% | 1.2% |
| | | | | | | |
| **5-cycle** | **100 w load reduction** | 221.2 | 252.8 | 325.9 | 539 | 334.7 |
| | **baseline** | 225 | 256.2 | 329.5 | 542.8 | 338.4 |
| | **diff in g/mi** | 3.8 | 3.4 | 3.6 | 3.8 | 3.6 |
| | **diff in %** | 1.7% | 1.3% | 1.1% | 0.7% | 1.1% |
| | **5-cycle g/mi v FTP/hwy base** | 2.3% | 1.8% | 1.4% | 0.9% | 1.4% |

*LED Lighting*

We agree that this technology has the potential to reduce emissions that are not captured on FTP/highway testing cycles. However, as discussed above, the off-cycle credits must be based upon the FTP/HWY percent and g/mile reductions and not on the 5-cycle g/mile reductions. As a result the credit value should be 0.8 grams per mile rather than 1.1 g/mile, or 0.9 g/mile with headlights, based on actual load reduction scaled to the potential benefits that US EPA modeled for FTP/highway testing cycle as shown in Table 11 and Table 12.

**Table 11.** LED lighting benefits in watts (Source: baseline, high efficiency, and % night use data from US EPA-NHTSA 11-16-2011 draft TSD page 5-61)

| component | baseline (W) | high eff (W) | Savings (W) | % night use | % total use | net savings (W) |
|---|---|---|---|---|---|---|
| low beam | 112.4 | 108 | 4.4 | 91% | 46% | 2.0 |
| high beam | 127.8 | 68.8 | 59 | 9% | 5% | 2.7 |
| parking/position | 14.8 | 3.3 | 11.5 | 78% | 39% | 4.5 |
| turn signal, front | 53.6 | 13.8 | 39.8 | 5% | 3% | 1.0 |
| side marker, front | 9.6 | 3.4 | 6.2 | 100% | 50% | 3.1 |
| stop | 53 | 11.2 | 41.8 | 8% | 4% | 1.7 |
| tail | 14.4 | 2.8 | 11.6 | 100% | 50% | 5.8 |
| CHMSL | 17.7 | 3 | 14.7 | 8% | 4% | 0.6 |
| turn signal, rear | 53.6 | 13.8 | 39.8 | 5% | 3% | 1.0 |
| side marker, rear | 9.6 | 3.4 | 6.2 | 100% | 50% | 3.1 |
| backup/reverse | 35.4 | 10.4 | 25 | 1% | 1% | 0.1 |
| license plate | 9.6 | 1 | 8.6 | 100% | 50% | 4.3 |
| Total Savings | | | | | | 29.8 |
| Total Savings minus headlights | | | | | | 25.2 |

**Table 12.** LED Lighting Benefits in g/mile

| | | |
|---|---|---|
| US EPA/NHSTA estimated benefit of 100 W load reduction: | 3 | g/mile FTP/highway |
| ICCT estimated lighting credits with headlights | 0.9 | g/mile FTP/highway |
| ICCT estimated lighting credits minus headlights | 0.8 | g/mile FTP/highway |

*Thermoelectric and Solar Electrical Generation*

Thermoelectric and solar electrical generation could reduce vehicle consumption of energy generated by the engine by recharging the battery pack in hybrids or electric vehicles. However, the premise that engine load reduction is undercounted on the FTP/HWY is incorrect, as noted above.

In addition, the benefits of these technologies would be difficult to quantify and verify. An NREL study indicates that potential thermoelectric output changes dramatically based on temperature conditions.[76] A rating based on theoretical peak output may not reflect real world conditions with rapidly varying engine loads, competition for exhaust heat, high thermal stress, etc. Similarly, the tailpipe benefits of vehicle rooftop solar electrical generation are highly variable. A plug-in Prius may see little solar availability during early and late commute hours, and displace grid electricity if parked at a vehicle charger during the day while a delivery vehicle in use all day may get more benefits. Solar availability also varies hourly, seasonally and geographically.

Appropriate in-use data would be necessary to quantify and verify any proposed off-cycle credit. Further any credit, including default credit, granted should be based on the FTP/HWY results in Table 5-18, as discussed above.

*Engine Heat Recovery*

The off-cycle benefits for engine heat recovery are entirely based upon the erroneous assumption that there are larger benefits off-cycle than on cycle for electricity generation or load reduction, as discussed above. The benefits of electricity generation are larger on-cycle than on the 5-cycle test. Thus, **the proposed default off-cycle credits for engine heat recovery are not appropriate.**

There is some reason to believe that high vehicle loads will cause engine heat recovery systems to operate more efficiently. However, there are at least three different ways to recover exhaust heat as electricity; Rankine cycle devices, turbo-compounding, and thermo-electric generators. Each operates very differently and has a different profile of energy captured. Thus, credits could be appropriate, but only if a performance benchmark for verification is developed and valid data is generated.

*Active Transmission Warm-Up and Active Engine Warm-Up*

The proposed off-cycle credits for active transmission and engine warm-up are highly questionable. The primary problem is that EPA assumed no benefit from an active transmissions/engine warm-up during the FTP.

However, normal engine operating temperatures are about 180°F. This is about 105°F above the FTP test temperature and about 160°F above the 20°F test temperature. Thus, the benefit of active engine warm-up on the FTP should be about two-thirds of the benefit at 20°F and the proportional benefit will be even closer.

The statement about transmission warm-up is similarly incorrect:

> "In cold temperatures, the exhaust heat warms the transmission fluid much more quickly than if the vehicle relies on passive heating alone."

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[76] J Rugh and R Farrington, Vehicle Ancillary Load Reduction Project Close-out Report, January 2008 p11.

In reality, the exhaust heat will warm the transmission fluid much more quickly than if the vehicle relies on passive heating alone at **all ambient temperatures**. Thus, most of the benefit of the warm-up systems will occur on-cycle during 2-cycle testing.

Another concern is the statement about the benefits of active warm-up:

> "The Ricardo data indicates that there is a potential to improve GHG emissions by 7% at 20°F if the vehicle is fully warm."

The ICCT has thoroughly read the Ricardo report and all references to the Ricardo report in the draft TSD. There is no reference of any kind to any modeling, detailed or otherwise, on active transmission warm-up or accelerating powertrain warm-up from 20°F. More importantly, no data is presented by the agencies to show what the improvement in GHG emissions would be at 75°F if the vehicle is fully warm, as would also occur with active warm-up. Only if the percentage improvement in GHG emissions at 20°F is larger than the percentage improvement at 75°F would off-cycle credits be warranted – and even in this case the benefit would only be the difference in the percentage improvement, averaged over the annual temperature distribution.

Performance benchmarks need to be established and valid data generated before granting credits for active engine and transmission warmup. As a minimum, the effect of active warmup needs to be evaluated at both 20°F and at 75°F on the 2-cycle and the 5-cycle procedures, and evaluations at intermediate temperatures would be helpful. Most vehicles are equipped with engine temperature sensors, and usually also transmission temperature sensors, which could be helpful in evaluating the length of the warm-up time, but efficiency data associated with warmup and ambient temperatures is also needed.

The ICCT agrees that there may be some incremental off-cycle benefits from active warmup systems, but most of the benefit will occur on cycle and it is important to properly evaluate the incremental benefits before granting default credits.

*Active Aerodynamics*

Active aerodynamic devices may have real benefits beyond what is measured on the regulatory test cycles, but such devices would also improve efficiency on the 2-cycle tests. Thus, additional verification is needed to determine whether active aerodynamics would show incremental improvement. Benchmarks would also be necessary to quantify any benefits for active aerodynamics above and beyond the test cycle.

Coast-down testing for regulatory compliance could either understate or overstate the benefits of active aerodynamics. Grill shutters could activate at higher speeds than tested, while on the other hand the technology may be more active during the test cycle than when encountering real world conditions, such as AC load and deactivation when there is a risk of freezing.[77] In addition, quantification and verification would be necessary for any

[77] Draft TSD, page 5-62 to 5-63

technologies that are not "active" or fully "active" on the test cycle. For instance, the draft TSD notes that the potential benefits range from 0-5%. **Thus, we strongly encourage US EPA to develop performance criteria before granting any off-cycle credits for active aerodynamics.**

*Start-Stop Technology*

We agree with US EPA and NHTSA's principle that technologies inherent to the vehicle (mass, tire rolling resistance, etc) are not appropriate for off-cycle credits. This principle also applies to start stop technology.[78]

The draft TSD states that real world vehicle stop times and start-stop emission benefits are higher than reflected on the regulatory test cycle. However, this is based upon two erroneous assumptions.

First, the idle rate during the FTP is listed at 16% in Table 5-23 of the draft TSD. This is incorrect. Prior EPA documentation lists a 19% idle rate[79] and a simple accounting of the LA finds a 19.1% idle rate (1372 total seconds with 262 seconds at zero speed). A smaller error is that the highway cycle was considered to have zero idle, while a simple accounting shows a 0.5% idle rate (764 total seconds with 4 seconds at zero speed). Weighted 55% for the FTP and 45% for the highway cycle, this yields an idle rate of 10.7%, not the 9% listed in the table.

Second, and more important, the draft TSD improperly accounts for the reduction in idle-off operation at cold temperatures. The TSD assumes that the engine will continue to run 25% of the time to provide cabin heating at cold ambient temperatures (vehicles that reduce this percentage can apply for a separate credit). If the engine is also needed to power the air conditioner during start stop then further adjustment will be needed. However, the draft TSD first calculates the idle-off benefits assuming 100% idle-off time, then applies the 25% reduction only to the calculated benefit. This is not appropriate. The proper accounting should reflect the fact that the total idle-off time has been reduced by 25% and should apply the 25% reduction to the total in-use idle-off time. The total in-use idle-off time is estimated to be 13.5%, so the actual amount of idle-off time in-use is 10.1% (13.5% times 75%).

To the extent that air conditioning use further causes the engine to stay on at idle, in-use idle time will be even lower. Accounting for both heating and air conditioning use, the in-use idle-off time could be as low as 6%. (This is assuming that the idle-off time from MOVES is accurate. No documentation of the source of the 13.5% estimate is presented.)

The amount of idle-off time in-use is significantly less that the idle-off time on the FTP-

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[78] draft TSD page 5-65

[79] see Table 6-9 of Federal Test Procedure Review Project: Preliminary Technical Report May 1993 EPA 420-R-93-007

HWY cycles. Thus, the FTP-HWY overstates the benefit of idle-off and **no off-cycle credit is warranted for idle-off systems**.

*Electric Heater Circulation Pumps*

We agree that electric heater circulation pumps have the potential for increment benefits for start-stop and that further evaluation will help better quantify those benefits.[80] As the base engine-off time was not calculated properly, the assessment of the benefit of electric heater circulation pumps needs to be redone as well with the proper assumptions about engine-off time.

In addition, it is reasonable to reflect the entire idle period when calculating the engine-off time on the FTP test cycle, since cabin heating is not active and not captured during FTP under any circumstances (which is different than start-stop as noted in our comments on start-stop). However, a downward adjustment is needed at colder ambient temperatures to account for some idle conditions where the engine may be operated, such as for warm-up purposes and for defroster use. Also, the amount of water pump electrical consumption needs to be accounted for in calculating the emissions benefit of this technology.

Finally, off-cycle credits should be granted only if the total amount of engine-off time is less than occurs on the 2-cycle tests and only for the amount of this reduction.

Performance criteria need to be developed and valid data generated to quantify the potential incremental improvement, including consideration of total engine-off time versus that on the 2-cycle test, before granting off-cycle credits for electric heater water circulation pumps.

## 17) Footprint Curves

We commend EPA and NHTSA for continuing to use a footprint-based adjustment to the CAFE standards instead of weight-based adjustments. Footprint-based adjustments fully encourage manufacturers to introduce lightweight materials, which can improve vehicle efficiency by 20% or more in the long run. Lightweight materials also extend the electric drive range of fuel cell and plug-in vehicles by a similar amount. This is one area of policymaking where the U.S. is ahead of the rest of the world. Japan, Europe, and China have all adopted standards with weight-based adjustments that effectively discourage the use of lightweight materials.

The proposed 2022-25 standards would set consistent improvements for all cars and light trucks, with annual CAFE increases of 4.7% per year and annual GHG reductions of 5.0% per year. However, both EPA and NHTSA proposed a lower annual rate of improvement for light-trucks in the early years of the program. EPA is proposing an annual GHG reduction for cars of 5%, but only 3.5% for light trucks. Similarly, NHTSA is proposing an annual fuel

[80] Draft TSD, page 5-67

economy increase of 4.3% for cars, but only 2.9% for light trucks. The required reductions for light trucks are also tilted, such that the smallest light trucks have larger increases (but still less than cars), while the larger light trucks have smaller increases. Figure 4 illustrates this effect. The annual fuel economy increases from 2016 to 2021 for cars is almost flat and ranges from 4.2% to 4.4%. The annual fuel economy increase for light trucks starts at 4.0% for the smallest trucks, drops to 2.3% for larger SUVs, and falls off to only 0.4% for the largest pickup trucks. Note that the 2012-16 standards also imposed smaller increases on the larger vehicles than they did on smaller vehicles.

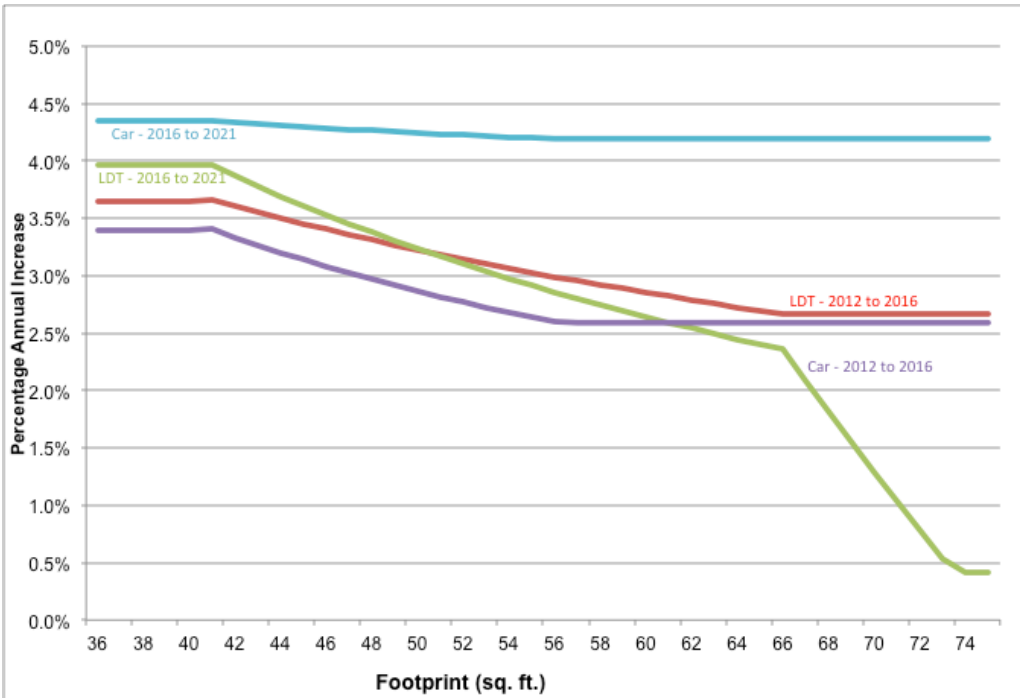


**Figure 4.** Percent annual increase in CAFE target: 2021 vs. 2016 and 2016 vs. 2012

Footprint systems are designed to encourage the use of lightweight materials (unlike weight-based standards) without affecting the mix of vehicles sold in the market. Under a footprint-based system, selling more small vehicles does not necessarily help manufacturers meet the standards, as smaller vehicles are subject to more stringent targets. However, the slope of the footprint curve and the difference between the car and light truck curves matter. The steeper the slope of the footprint curve, the more incentive manufacturers have to increase the size of their vehicles. And the larger the difference between the car and light truck curves, the more incentive a manufacturer has to add four-wheel drive and jack the vehicle up just enough to meet the ground clearance criteria so that the vehicle can be reclassified as a light truck. These are perverse incentives, as increasing the size of the vehicle or reclassifying cars as light trucks makes it easier for a manufacturer to meet the requirements while also increasing the fuel consumption and $CO_2$ emissions from the vehicle.

The tilt in the increase in light truck stringency, as illustrated in Figure 4, increases the incentive for manufacturers to increase the size of light trucks, especially pickup trucks.

More importantly, the lower requirements for all light trucks would increase the incentive to reclassify cars as light trucks. As illustrated in Figure 5, the 2012-2016 standards and the 2022-2025 standards have almost no impact on the relationship between the stringency of the car and the light truck targets. However, during the 2017 to 2021 timeframe, when the annual efficiency gains for light trucks are much lower than for cars, the difference in stringency between cars and trucks grows dramatically. As proposed, the 2017-2021 standards will increase the incentive to reclassify cars as light trucks, with a small additional incentive for the smallest cars and gradually increasing for larger cars. Fortunately, few cars have a footprint larger than about 54 sq.ft at present.

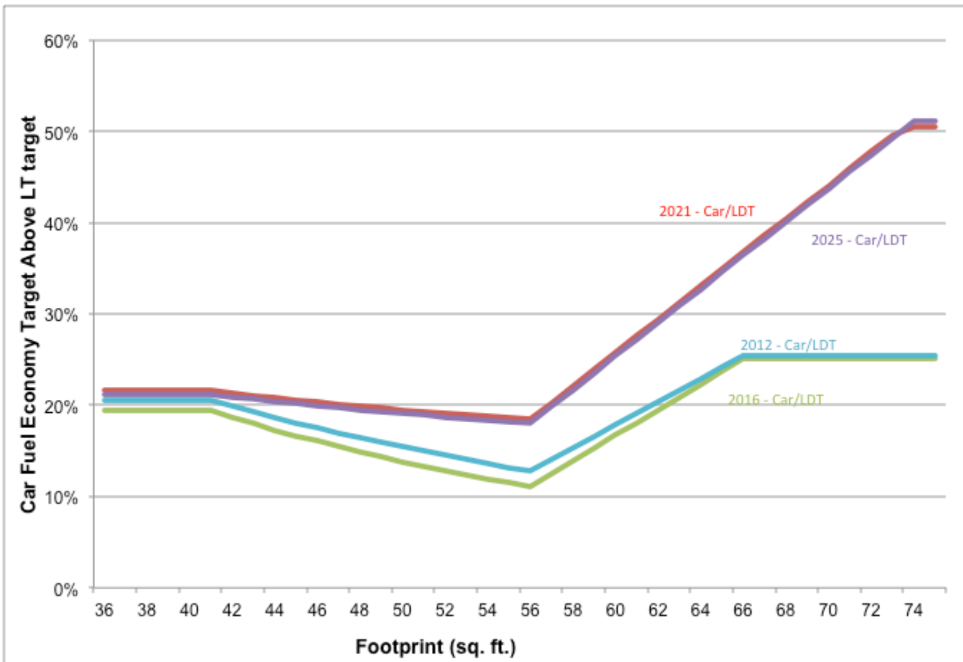


**Figure 5.** Fuel economy target for cars compared to light trucks, by footprint

*Single footprint curve*

The proposed rule maintains separate footprint curves for cars and light trucks. This subjects light trucks with the same footprint to much less stringent standards and gives manufacturers a tremendous incentive to reclassify cars as light trucks. In the future it is likely to cause manufacturers to drop many 2wd versions of their small SUVs and make less efficient 4wd versions standard, so that they can be classified as light trucks instead of cars. This will actually increase overall real world fuel consumption and $CO_2$ emissions in two ways. First, it will increase 4wd installation and directly increase the fuel consumption of the fleet. Second, it makes it easier for manufacturers to meet the standards, so that they do not have to implement as much technology on other vehicles.

The large majority of light trucks today are based on car platforms with unibody construction. All minivans use unibody construction and cab-and-chassis construction for SUVs is rapidly disappearing. Except for pickup trucks, full-size cargo vans, and a few relatively low volume SUVs, such as the Jeep Wrangler and the Suburban, in the 2017-25 timeframe of the rule all light trucks will be based on car platforms. In addition, due to the empty pickup bed and empty cargo box, pickup trucks and cargo vans are considerable lighter than SUVs with the same footprint and fit well on a single footprint line. Thus, there is no technical reason to maintain separate footprint lines for cars and light trucks.

EPA recognized the importance of this issue when it established a single Tier 2 emission standard for all cars and light trucks. The issue here is just as important. It is time to begin the process to end this artificial distinction between cars and light trucks for fuel efficiency and greenhouse gas emissions. **The ICCT recommends a single footprint function, which will still give larger trucks a less stringent target to meet, while avoiding vehicle classification games and helping to ensure fuel consumption and GHG emission goals are actually met.**

## 18) Black Carbon

Black carbon is the light-absorbing fraction of particulate matter that causes warming. In January 2012 an article published in the journal Science found emission standards for new light- and heavy-duty vehicles, as well as scrappage of high emitting vehicles, to be one of a handful of measures to control black carbon that are necessary to guarantee stabilization of global average temperatures no greater than 2°C above temperatures in the pre-industrial period.[81]

EPA acknowledges the climate benefits of reductions in particulate matter emissions that would be generated by this rule, though they would be small.[82] However, EPA does not evaluate the concomitant reductions in black carbon, nor does it propose to regulate black carbon. Previously the agency cited its concern that no definitive scientific assessment on the climate impacts of black carbon had been made.[83] EPA has been directed by Congress to conduct a review of black carbon climate science to be completed in 2010, but this is now overdue and remains unpublished.

Other actions on black carbon are worth noting. In December 2010, the executive body of the Convention on Long Range Transport of Air Pollution directed its Working Group on Strategies and Review to consider the inclusion of black carbon in the revision of the Gothenburg Protocol.[84] In May 2011 the Arctic Council put forward an assessment of emissions and mitigation options for control of black carbon climate impacts on the Arctic. In June 2011, the International Maritime Organization adopted a workplan to investigate the definition, measurement, and control options for black carbon. In November 2011, the

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[81] (Shindell et al, 2012)

[82] Preamble, p75102

[83] 74 FR 66520

[84] http://www.unece.org/fileadmin/DAM/env/documents/2010/eb/eb/eb%20decisions/Decision_2010.2.e.pdf

Arctic Monitoring and Assessment Program published a report on the impact of black carbon on Arctic Climate. And in January 2012, CARB issued a staff report that captures the current state of scientific knowledge and remaining areas of investigation for black carbon.[85] These actions reflect a growing international scientific and policy interest in identifying mechanisms to regulate the climate impacts of black carbon.

There is reason to believe that black carbon emissions from current on-road vehicles have been underestimated. Testing conducted by EPA and CARB staff of PFI engines caused an upward revision of emission factors for PM in the California emissions inventory from less than 1 mg per mile to 4 mg per mile.[86] This suggests that black carbon emissions have also been underestimated, although speciation of these emissions was not conducted. High cold start emissions contributed the bulk of this increase, but oil burning and engine degradation also contribute. According to our calculations, a light-duty vehicle emitting on average 0.004 g PM/mile would represent approximately 2.4 g CO2-eq/mile black carbon emissions assuming 75% of PM is black carbon and the GWP-100 value is 800.

Both the US EPA and CARB have regulatory provisions for non-CO2 climate forcing agents, such as methane, nitrous oxide, and hydroflourocarbons. The IPCC in its Fourth Assessment Report quantified estimated that the radiative forcing of black carbon ranks third among the climate pollutants. Meanwhile, research conducted more recently by Ramanathan and Carmichael concluded that IPCC estimates of radiative forcing are overly conservative, putting black carbon second after carbon dioxide in terms of global contribution to radiative forcing.[87] From this perspective, black carbon deserves greater priority than other climate forcing agents currently regulated by EPA.

We recognize that EPA must initiate a process to bring black carbon into the basket of regulated climate forcing agents, so regulation under this rulemaking may be premature. In light of this, we strongly urge the agency to consider (a) regulating black carbon indirectly via stringent limits on particulate matter in future rulemakings; and (b) expeditiously finalizing the congressionally mandated black carbon study report to inform future direct regulation of this pollutant.

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85 CARB. 2011 Appendix U Proposed Technical Support Document: LEV III Climate Change Impacts of Black Carbon Particles. Sacramento, CA: California Air Resources Board. November, 2011. See http://www.arb.ca.gov/regact/2012/leviiighg2012/levappu.pdf

86 CARB, 2012

87 Dr. V. Ramanathan and G. Carmichael, 2008