CAR's Reply to the ICCT's "Comments on the Center for Automotive Research (CAR) June 2011 Report '*The U.S. Automotive Market and Industry in 2025*' "

Center for Automotive Research
July 18, 2011

The International Council on Clean Transportation (ICCT) issued a list of comments on June 17, 2011 titled "Comments on the Center for Automotive Research (CAR) June 2011 Report '*The U.S. Automotive Market and Industry in 2025*'." The ICCT stated that its critique pertains to the CAR study which was released on June 11, 2011 and represents a follow-up to its critique of an initial CAR forecast, or presentation, presented in December 2010.

CAR believes the ICCT critique which claims a "cumulative effect of errors and questionable assumptions," leads to a "CAR analysis" that "dramatically overestimate the vehicle price and significantly underestimate the available technology associated with potential greenhouse gas/CAFE standards" is without merit. In fact, the ICCT critique relies on misrepresentation and misinterpretation of the analysis, contents, and facts contained in the CAR and National Academy of Science (NAS (2011)) reports.[1] CAR responds to the eleven listed ICCT "shortcomings" of CAR's study below. The ICCT critiques appear below and the CAR responses follow in bold.

1. ICCT: The single largest problem is that the report uses the 2010 NAS CAFE report data for 2025 vehicles. This is despite several explicit statements in the NAS report constraining the applicability of its technology and cost data to the very near term, e.g.:

    a) "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]

    b) "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]

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

    CAR: The CAR study relies principally on the 2011 NAS study, "Assessment of Fuel Economy Technologies for Light-Duty Vehicles." The NAS study is not a Corporate Average Fuel Economy (CAFE) report for 2025 vehicles since it was charged with identifying the cost and effectiveness of technologies. There is no other source of similar data anywhere that is more timely, unbiased, and comprehensive. The most germane portion of the Statement of Task (SOT) is in the first paragraph of the study report (p. 1, "Summary"): "estimate the efficacy, cost and applicability of

[1] National Research Council of the National Academies, Committee on the Assessment of Technologies for Improving Light-Duty Vehicle Fuel Economy, *Assessment for Fuel Economy Technologies for Light-Duty Vehicles*, Washington D.C.: The National Academies Press, June 2011.

technologies that might be used over the next 15 years." The complete Statement of Task for this study is presented in detail in Appendix B (p. 163) of the report. The following excerpt is the first sentence from Appendix B:

"The committee formed to carry out this study will provide updated estimates of the cost and potential efficiency improvements of technologies that might be employed over the next 15 years to increase the fuel economy of various light-duty vehicle classes."

The referenced tables, S-1 and S-2, reflect the committee's estimates for short-term technologies (within 5 years), and is <u>not</u> presented as a summary of all the technologies addressed in the report. There are numerous other technologies throughout the report, not included in tables S-1 and S-2 that are capable of becoming mainstream in the five to 15 year timeframe, or beyond. Since the SOT covers a 15 year timeframe, both cost and effectiveness estimates are presented for this time period where practical. There are too many examples to list here, but some examples include: camless valvetrains, homogeneous charge compression ignition, advanced diesel engines, plug-in hybrids, diesel hybrids, electric vehicles, fuel cell vehicles, and advanced materials and body designs (p. 1). Another example is on page 94, Table 6.4, "Retail Price Estimates for Various Types of Hybrids Projected to 2025 (using an RPE of 1.33)."

The report also discusses technologies not anticipated to be commercially viable within the 15 year timeframe, and these include both battery electric and hydrogen powered vehicles. Since battery cost estimates were not included in the NAS study, the CAR study used government cost estimates for batteries from the Technology Assessment Report (TAR)[2] for 2025.

2. ICCT: The report ignores technologies not featured in the NAS report. As the NAS report only assessed current technologies, CAR's technology assumptions also fail to address specific technologies that will play a critical role in attaining 2025 CAFE targets. Chief among these are cooled/boosted EGR (exhaust gas recirculation)—which can extend the efficiency of SI (spark ignition) engine technology beyond levels associated with turbocharged, downsized, GDI (gas-direct injection) technology—and P2 hybrid vehicle technology—which can deliver powersplit hybrid type efficiency impacts at considerably reduced cost.

   CAR: The purpose of the NAS study was to identify the efficacy, cost and applicability of technologies that may play a critical role in attaining the 2025 CAFE targets. The NAS report did assess current and anticipated technologies over a 15 year horizon, as the Statement of Task specifically asked to include, "technologies that might be employed." Technologies that have not been invented yet were not included.

---

[2] Interim Joint Technical Assessment Report (TAR), National Highway Traffic Safety Administration, U.S. Environmental Protection Agency, *2017 and Later Model Year Light-Duty Vehicle GHG Emissions and CAFE Standards: Supplemental Notice of Intent,* Washington D.C.: 75 FR 76337, December 8, 2010; National Highway Traffic Safety Administration, U.S. Environmental Protection Agency, *Notice of Upcoming Joint Rulemaking to Establish 2017 and Later Model Year Light Duty Vehicle GHG Emissions and CAFE Standards,* Washington D.C.: 75 FR 62739, October 13, 2010; U.S. EPA Office of Transportation and Air Quality, National Highway Safety Traffic Administration Office of International Policy, Fuel Economy, and Consumer Programs, California Air Resources Board, and California E.P.A., *Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2017-2025,* Washington D.C.: U.S. EPA, September 2010.

Exhaust gas recirculation (EGR) is discussed in the SI chapter with references on pages 42, 50, 55 and 56. Finding 4.7 (p. 56) indicates that cooled EGR was given careful consideration, but, "because of either questionable benefits or major implementation issues, it is highly uncertain whether any of these technologies will have any significant market penetration even in the 10- to 15-year time horizon."

The P2 hybrid technology that employs a second clutch to separate the internal combustion engine (ICE) and the electric motor from the transmission is described on page 87 under the ISG/IMA Hybrid section.[3] Although P2 shows some promise to approach the efficiency of power-split technology at lower cost, it is unclear it will become the dominant technology. For example, "the idea that P2 is a clear winner is not true," said Larry Nitz, GM's director of hybrid powertrain engineering.[4] Power-split technology remains more effective than P2 at reducing fuel consumption.

3. ICCT: The report disregards the potential for increases in fuel economy technology benefits relative to those estimated by NAS for current conditions, despite the fact that the NAS report explicitly acknowledged such potential.

   CAR: The NAS study was not charged with forecasting future conditions that will influence costs. Chief among these conditions are economic factors, government incentives and legislative mandates. Future conditions may cause increases in technology costs or generate additional fuel economy benefits relative to those estimated by the NAS for current conditions. The estimates provided in the NAS study for effectiveness and costs are the committee's best estimates today given data available to the NAS committee. The study objective did include looking at technology readiness over the 15 year period. Therefore, technologies that are not ready today, but could become viable with future technological developments within 15 years were identified in the study. "These technologies include camless valvetrains, homogeneous-charge compression ignition, advanced diesel, plugin hybrids, diesel hybrids, electric vehicles, fuel cell vehicles, and advanced materials and body designs." Due to "significant technical and economic challenges," … "some of these technologies will remain perennially 10 to 15 years out beyond a moving reference" (p. 1). The uncertainty over the cost and effectiveness of these technologies described in the NAS study make it prohibitive to include them in a CAFE analysis in the CAR study.

4. ICCT: The report disregards the impact of air conditioning credits on the target CAFE level, despite the fact that such credits are included in the 2012–2016 standards and were proposed in the 2010 regulatory Notice of Intent related to 2017–2025 greenhouse gas (GHG) and CAFE standards. On page 18, CAR does acknowledge that the A/C credit used by EPA reduces the required rate of CO^2 reductions by about one percent for each scenario. CAR also analyzed the vehicle market based on CAFE requirements modified for the A/C credits in Appendix 1, but ignored the A/C credits in the analyses in the main report. In Appendix 1, CAR calculated that including the A/C credits would reduce the cost of the 3% scenario by $305, 4% scenario by $1,250, 5% by $1,100, and 6% by $2,764. And this is despite an increase of $300 per vehicle assumed by CAR for the air conditioning improvements; the actual cost will be far less than this.

[3] Note: the "P2" terminology recently became established within Chrysler, Ford and General Motors and was not explicitly used in the study.
[4] Washington Post, by Peter Whoriskey, May 9, 2011.

CAR: The analysis by CAR does not include air conditioning credits for one simple reason: the EPA has not determined whether or not the credits will be available for the years 2017 to 2025. In fact, the EPA/NHTSA/CARB Technical Assessment report for 2017 to 2025 states this explicitly:

***"Note that EPA has not made any determination at this time whether reductions due to improvements in air conditioning should be treated as a credit or a requirement during the 2017-2025 timeframe."*[5]**

The EPA/NHTSA/CARB report goes on further to state:

***"The use of low GWP refrigerants in this analysis does not indicate a decision on behalf of EPA."*[6]**

Including A/C credits in the analysis would inadvertently skew results positively toward higher fuel economy targets. Until a clear direction is given regarding credits or requirements for advanced air conditioning systems, it is prudent not to include them in the analysis.

5. ICCT: The report factors in $1,500 for the potential cost of future safety equipment. Not only is this inappropriate for an analysis of CAFE impacts, but CAR compounds the error by entirely ignoring benefits that would accrue from that additional safety equipment.

CAR: The CAR study provides a full cost benefit analysis of higher fuel economy technologies without any addition or consideration of potential cost for future safety equipment. This analysis is presented in great detail on pages 27-37 of the study. Our results show, at a fuel price of $3.50 per gallon, <u>none</u> of the higher fuel economy standards pay for its technology cost. Only one fuel economy standard, the lowest at 47 m.p.g. CAFE fleet, pays for itself at a fuel price of $6.00 per gallon.

Subsequent to this analysis, potential safety costs are added in order to forecast the overall impact of both likely potential safety and fuel economy government mandates on U.S. sales, production and manufacturing employment by 2025. This was the stated purpose of the study in its introduction. It is an important policy and market reality that must be addressed for a full, not partial, impact analysis of government regulations on U.S. automotive markets in the decades ahead. CAR's 2025 study is not just about fuel economy regulations. NHTSA has already stated that it will mandate technologies such as Rearward Field of View at cost levels that far exceed expected benefits. Several automakers reported to us they expected the range of likely costs of the potential NHTSA safety actions, shown in Table 6 of the study, to amount to $1,500 – $3,000 per vehicle. CAR assumed a lower total of $1,500 in our analysis.

---

[5] Interim Joint Technical Assessment Report (TAR), National Highway Traffic Safety Administration, U.S. Environmental Protection Agency, *2017 and Later Model Year Light-Duty Vehicle GHG Emissions and CAFE Standards: Supplemental Notice of Intent,* Washington D.C.: 75 FR 76337, December 8, 2010; National Highway Traffic Safety Administration, U.S. Environmental Protection Agency, *Notice of Upcoming Joint Rulemaking to Establish 2017 and Later Model Year Light Duty Vehicle GHG Emissions and CAFE Standards,* Washington D.C.: 75 FR 62739, October 13, 2010; U.S. EPA Office of Transportation and Air Quality, National Highway Safety Traffic Administration Office of International Policy, Fuel Economy, and Consumer Programs, California Air Resources Board, and California E.P.A., *Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2017-2025,* Washington D.C.: U.S. EPA, September 2010, page 6-7.
[6] Ibid.

6. ICCT: The report assumes little learning or cost reduction in the future, especially for CAR-identified "mature" technologies. This has the effect of keeping their 2025 cost estimates for SI technology only marginally lower than their 2008 cost estimates for the same technology. Technology is only mature until a "better mousetrap" comes along, and for obvious reasons scientists and engineers are continually looking for a "better mousetrap." Take for example, automatic transmission technology, which CAR identifies as mature. No more than a few years ago, the design of the Lepelletier gear system produced substantial transmission technology cost savings. To assume that technology—even mature technology—will not continue to advance is, at best, shortsighted. Even for HEVs and BEVs, CAR assumes only 5 years of cost reduction at 1.9%–2.2% per year. CAR also ignores the recommendation in the 2010 NAS CAFE report on costs: "As noted in Chapter 3, estimates based on teardown cost analysis, currently being utilized by the EPA in its regulatory analysis for light-duty vehicle greenhouse gas emissions standards, should be expanded for developing cost impact analyses." [NAS report page 9-26]

   CAR: Anticipating technological advancements that will play a significant role on fuel consumption over the 15 year horizon was part of the charge given to the NAS committee, and therefore, has already been taken into account within the study.

   Forecasting a better mousetrap for today's technologies is not a sure bet. Today's widely-used mousetrap technology was developed over 100 years ago (in 1897), and in spite of over 4,400 mousetrap patents since its inception, the technology has not progressed. Blindly extrapolating development and implementation of technology advancements in the automobile, especially over a relatively short 15 year period is, at best, overly optimistic. Given today's life cycle for powertrain components, including transmissions, it can easily take over 10 years to implement a better mouse trap (invention) after its already been invented. The cost reduction for mature technologies reflects cost savings that may be experienced through learning in the manufacturing process. These percentage cost reductions are applied to the Retail Price Equivalent (RPE), which are "intended to represent costs after an initial period of rapid cost reduction that results from learning-by-doing." (p. 25). Cost estimates throughout the study were drawn from many sources, and as the study indicates, teardown cost analyses are an effective source when available. Teardown studies, however, are not feasible on advanced technologies where the development is not yet finalized. The NAS study uses EPA cost estimates from teardown studies in situations where that data is available (e.g., turbochargers and downsizing), and this data was used in the CAR analysis.

7. ICCT: The report assumes that costs for mass reduction will not change in the future, despite the extended lead-time and associated ability for optimized system-wide redesign that it enables.

   CAR: The CAR study does assume that the cost for mass reduction goes down by 0.5% per year for five years. This may be optimistic with aggressive mass reduction goals (e.g., 15% or more) that will necessitate the use of more exotic, low-mass materials (e.g., aluminum, carbon fiber, magnesium) that have greater price volatility and sensitivity to supply-demand fluctuations than steel. As more variations of materials get introduced into the automobile, it will become more difficult to achieve economies-of-scale in each one because each will have its own manufacturing process that optimally runs at different output levels.

The 15 year horizon is not an extended lead-time for introducing a so-called optimized redesign. The NAS table of product development timing, Table 7-6 (p. 110) indicates the timing for a total vehicle redesign is six to eight years. For vehicles already in development, it could take two redesign cycles (12-16 years) to realize the implementation of a completely redesigned vehicle. Even in this case, major components like powertrain and structural members are likely to be reused from previous vehicle models and not optimized for a specific vehicle.

System-wide redesign is not the normal process for designing vehicles for a variety of reasons. Complete re-designs are rarely done in the industry because of their high cost and demand for engineering resources. A system-wide redesign requires many "inventions" which the industry tries to avoid because of product development time, cost and risk. For example, the concern that mass reduction will compromise vehicle safety is an ongoing debate, and the chance that NHTSA will further increase safety requirements over 15 years is nearly certain. Maintaining or even increasing vehicle crash worthiness while reducing vehicle mass will prove extremely challenging without increasing material costs. A gradual vehicle development process is preferred to mitigate uncertainty.

8. ICCT: The report applies a fuel savings discount to "current year" mileage, resulting in an underestimate of fuel savings (a 9 percent underestimate given CAR's assumed discount rate) relative to an analysis that discounts savings only (sic) "future year" mileage.

   CAR: CAR believes fuel savings that occur in the first year of vehicle ownership should be discounted because they are in the future – not on the first day of ownership or at the time of purchase. Higher fuel economy technology cost at the time of purchase (as part of vehicle price) is the only additional cost not discounted in the CAR analysis. In other words, the only amount that should not be discounted is the "immediate" upfront technology price or cost paid to enable consumers to have future fuel savings. The "current year" (a.k.a. first year) savings are subject to discounting, because the savings are not "immediate" but "future" cash flows that occur throughout the year. In theory, a continuous discounting method could be used to obtain the most accurate present value of fuel savings perhaps with the use of a decay rate. CAR simplified the calculation and adopted an end-of-period or discrete method of discounting with the understanding that this method would not change the present value of savings estimates by a significant amount. In any case, both continuous and end-of-period discounting methods require first year savings to be discounted. CAR also used a discount rate that is lower than that suggested by both the research literature on the consumer valuation of future fuel savings and that recommended by marketing and product planning departments of major automakers.

9. ICCT: By directly using the NAS report pathways, the report includes the cost of powersplit hybrid systems instead of a basic parallel hybrid system. The NAS report listed the ISG hybrid as a 34% fuel consumption reduction at an RPE of $3,325 and the powersplit as a 37% fuel consumption reduction at an RPE of $5,187 (both for V6 engines). Thus, the report implicitly adds $1,862 cost for a fuel economy reduction of only 3%.

   CAR: The NAS study that packaged technology options did so by starting with higher cost/benefit technologies (lower cost per amount of fuel consumption savings). Hence, the ISG hybrid was introduced before the power-split. The pathway could have stopped at that ISG option, but in order to achieve a higher level of fuel savings, the more expensive power-split option was

introduced. Examples of vehicles using this proven architecture today are the Toyota Prius, the Ford Escape and the Nissan Altima. While reasonable judgment was applied by the committee in selecting the order of combining technology packages, different manufacturers will make different decisions, even when faced with the same data. CAR was not in a position, nor equipped with the necessary modeling software, to alter the NAS analysis that was conducted by the NAS committee. Given the industry acceptance of both ISG and power-split technologies, either technology option is acceptable.

10. ICCT: The report uses a baseline 2008 fuel economy of 27.5 m.p.g. to assess fuel savings. NHTSA reports 27.1 m.p.g. for 2008 and EPA reports 26.3 (EPA's numbers exclude the FFV (flexible fuel vehicle) credit that is part of NHTSA's official fuel economy calculations)

    CAR: In fact, CAR uses a 22.0 m.p.g. level for "real world" fuel economy in 2008 in order to calculate fuel savings. CAR used the reported NHTSA fuel economy levels for passenger cars and trucks listed in the Ward's 2009 Motor Vehicle Facts and Figures publication. CAR gave equal weight to both the car and truck fuel economy averages which reflected market share that year for cars and trucks in order to calculate a combined fuel economy of 27.5 m.p.g. CAR then reduced this average by 20% to gain a credible estimate of real world fuel economy performance in the market that adjusted for real road conditions and some of the NHTSA procedures such as fuel economy credits for flexible fuel vehicles and the harmonized averaging procedure legislated by Congress. CAR chose this approach after discussing this procedure with a staff member of the EPA's National Emissions Laboratory in Ann Arbor in April 2011. The EPA uses separate procedures for cars and trucks but agreed that the 20% reduction was adequate. It is also interesting to note that the EPA's report, "Light Duty Automotive Technology, Carbon Dioxide Emission, and Fuel Economy Trends," released in November 2010, issued adjusted Fuel Economy estimates for model year (MY) vehicles of 21.0 m.p.g. for MY 2008, and 22.4 m.p.g. for MY 2009. CAR used 22.0 m.p.g. The ICCT criticism is groundless.

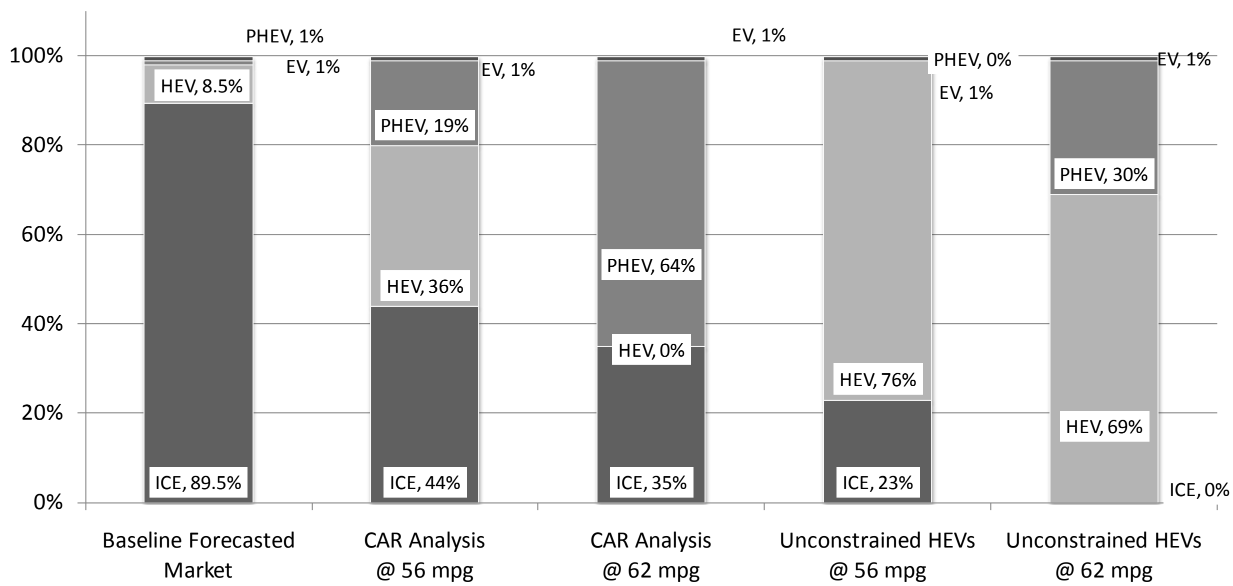
11. ICCT: Finally, the report includes large numbers of BEVs and PHEVs in its scenarios, instead of first increasing HEV sales. This not only overstates vehicle costs, but also the costs of charging equipment, which CAR calculated to be $40/vehicle for the 3% scenario, $175 for 4%, $348 for 5%, and $1,105 for 6%. The HEV constraints put in table 4 (page 15) are unrealistic. As they admit on page 22, "An alternative to this scenario (assuming no PEV market penetration) would require over 80 percent HEV market share–also drastic by today's predictions." 80% market share of HEVs in 2025 is far less drastic than 64% market share of PHEVs in 2025. Rather than constraining HEV shares while letting PHEV shares go unrestricted, CAR should restrict the PHEV market share.

    CAR: The CAR report utilizes recent market forecasts to develop market share capacities for competing technology. The market capacities included a 9.5% combined PHEV and HEV market at the baseline. At a targeted CAFE of 47 m.p.g. the baseline market forecast capacities were sufficient for reaching the required fuel economy. At 51, 56, and 62 m.p.g. CAFE the baseline market forecast capacities were no longer sufficient. The market capacities for both PHEVs and HEVs were loosened to achieve the higher fuel economy targets. The CAR report DOES NOT leave PHEVs unrestricted. The CAR report DOES put a combined restriction for PHEVs and HEVs. In such a case, the model adjusts the market such that PHEVs and HEVs do not exceed the capacities and are done at their lowest combined cost.

The CAR study was very lenient toward HEVs and PHEVs to achieve the targeted fuel economy standards. While recent market forecasts by all major automotive forecast firms show a HEV market share penetration of 10% at the most by 2020, the CAR study allowed HEVs and PHEVs to gain as much as 65% of the total U.S. market by 2025. If anything, the CAR study is too generous in its use of HEVs and PHEVs to achieve the fuel economy targets given certain market realities.

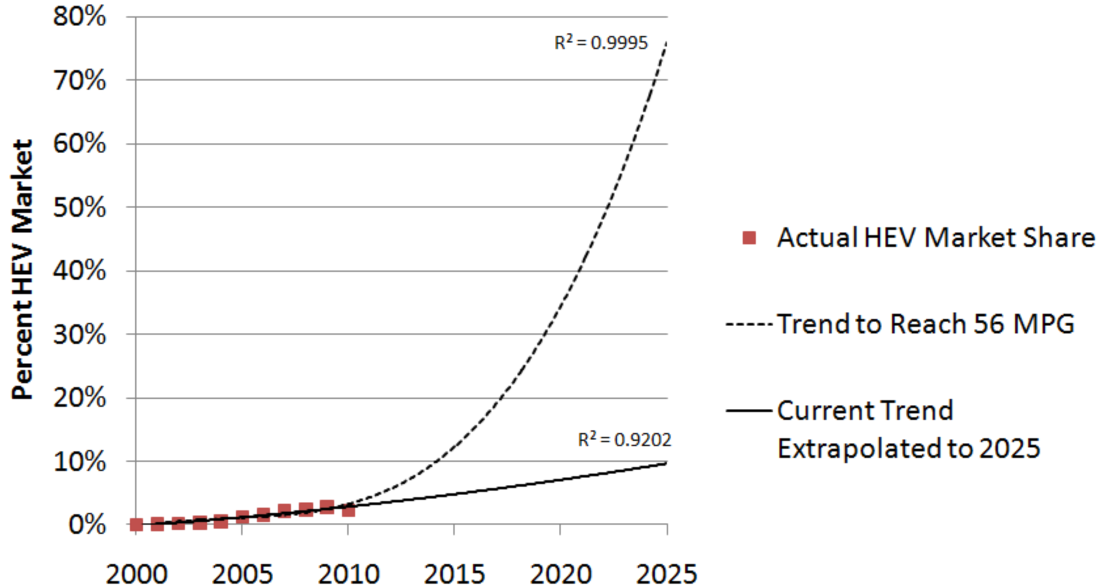
The figure on page 8 demonstrates the divergence of the baseline forecasted market share utilized by the CAR study against the CAR analysis and an alternative unconstrained HEV market at 56 and 62 m.p.g. Both the constrained and unconstrained markets are in complete disagreement with the baseline market forecasts. At 62 m.p.g., with an unconstrained HEV market, the 90% internal combustion engine market would be replaced by a 100% BEV, PHEV, and HEV market.

Figure 1. Baseline 2025 market share, market share at 56 and 62 m.p.g. using HEV/PHEV constraints in CAR report, and market share at 56 and 62 m.p.g. for an unconstrained HEV market.



To put the above market shares in perspective, in the 11 years from the time the Honda Insight and Toyota Prius were introduced until today, HEVs have captured less than 3% of the total annual U.S. market. This low market share exists despite a constantly rising price for fuel throughout the period (including ever higher summer spikes in fuel prices), the existence of government subsidies, and government-buying programs for electrified vehicles. At the current rate, the hybrid market would only be 10% by the year 2025. Yet to achieve 56 m.p.g. the total U.S. HEV market would need to achieve close to 80% and at 62 m.p.g. the market share would need to be even more extreme. Incidentally, CAR used a combined PHEV/HEV market share cap of 55% and 65% at 56 and 62 m.p.g. respectively, well above the current trend shown in the figure below and forecasted market presented earlier.

Figure 2. Recent HEV market share and trends for the year 2025



CAR also has severe differences with ICCT in its use of our study results in a so-called "Summary Table: Costs and Benefits Calculations." In the section of this table labeled "CAR Analyses from June 11, 2011 Report," incorrect figures are listed under the column heading "Actual m.p.g." Instead of 47.0, 51.0, 56.0, and 62.0 m.p.g., the CAR study actually used real world fuel economy levels of 37.6, 40.8, 44.8, and 49.6 m.p.g. Fuel economy savings were calculated from a base level of 22.0 m.p.g. in 2008 as explained in point 10. above. Thus the CAFE levels achieved with fuel economy credits supposedly in the CAR analysis are misreported by ICCT.

A more accurate presentation of CAR's results is shown in the table below for each real world fuel economy level.

CAR 2025 Study
Calculations of Net Consumer Savings from
Higher Fuel Economy Technologies
(Fuel Price = $3.50/gallon)

Real MPG	Fuel Savings ($3.50/Gal.)		Technology Cost		Cost of Electricity		Total Consumer Net Savings	Changes in Consumer Savings
22.0	--	-	--	-	--	=	--	--
37.6	$3,451	-	$3,744	-	$66	=	($359)	($359)
40.8	$3,885	-	$5,270	-	$259	=	($1,644)	($1,285)
44.8	$4,363	-	$6,714	-	$507	=	($2,858)	($1,214)
49.6	$4,865	-	$9,790	-	$1,600	=	($6,525)	($3,667)

The above table nets five year discounted fuel savings at each real world fuel economy standard for the cost of technology needed to achieve it and the sales-weighted electricity and charger cost

associated with that level of fuel economy. None of the fuel economy standards produce a positive total consumer net savings at a price of $3.50 per gallon of fuel. In other words, consumers are always worse off. What is striking about the ICCT summary table results for the "EPA/NHTSA analyses in the Joint Technical Report for the 2017-25 Notice of Intent (best pathway)," is that it essentially shows the same results in terms of what fuel economy level is best for the automotive consumer. This is shown in the table below:

Calculations of Net Consumer Savings from Higher Fuel Economy Technologies, ICCT version of EPA/NHTSA 2025 analyses in Joint Technical Report for the 2017-25 Notice of Intent (best pathway)

"Actual MPG"	Fuel Savings ($3.50/Gal.)		RPE			Total Consumer Net Savings	Changes in Consumer Savings
	--	-	--		=	--	--
43.2	$3,620	-	$1,070		=	$2,550	$2,550
47.1	$4,182	-	$1,700		=	$2482	($68)
51.4	$4,710	-	$2,400		=	$2,310	($172)
56.0	$5,193	-	$3,100		=	$2,093	($217)

This table uses data listed in ICCT's "Summary Table: Costs and Benefits Calculations." In the ICCT analysis of the EPA/NHTSA TAR results, automotive consumers maximize their net savings at $2,550, at the actual fuel economy level of 43.2 m.p.g. Consumer net savings then fall from this level at each higher level of fuel economy. There would be no reason, then, for a rational consumer to ever desire higher levels of fuel economy beyond 43.2 m.p.g. This outcome is obvious despite the severe underestimation of technology costs by EPA/NHTSA in their TAR analysis. Real world costs and fuel savings, however, are very different from those professed by EPA/NHTSA in their TAR analysis.

Center for Automotive Research

The Center for Automotive Research a nonprofit organization based in Ann Arbor, Michigan has worked with the global auto industry for over 30 consecutive years in the areas of manufacturing, product development, purchasing, and policy at every level. No other not-for-profit research center can make this claim.

CAR conducts industry research, develops new methodologies, forecasts industry trends, advises on public policy, and sponsors multi-stakeholder communication forums.

CAR is involved in research of significant issues that relate to the future direction of the global automotive industry. This research is conducted by four distinct research groups:

- Automotive Analysis Group
- Labor and Industry Group
- Manufacturing, Engineering and Technology Group
- Sustainable Transportation and Communities Group

Dr. Jay Baron, President & CEO
Research Focus: Manufacturing systems research, particularly in automotive body materials and processes, concentrating on program performance, productivity, and system economics.

Education:
Ph.D., Industrial and Operations Engineering, The University of Michigan, Ann Arbor, Michigan, 1992
Masters Degree in Business Administration, Rensselaer Polytechnic Institute, Troy, New York, 1984.
Master of Science in Engineering (Industrial and Operations Engineering, The University of Michigan, Ann Arbor, Michigan, 1978.
Bachelor of Science in Engineering (Industrial and Operations Engineering), The University of Michigan, Ann Arbor, Michigan, 1976, cum laude.

Dr. Sean P. McAlinden, Executive Vice President of Research and Chief Economist
Research Focus: The economic contribution of the motor vehicle industry to the U.S. economy, economic policy and forecasting.

Education:
Ph.D., Economics, The University of Michigan, Ann Arbor, Michigan, 1986
Master of Arts in Economics, The University of Michigan, Ann Arbor, Michigan, 1978
Bachelor of Arts in Economics, Michigan State University (Honors College), East Lansing, Michigan, 1975.

Greg Schroeder, Research Analyst
Research Focus: Evaluating opportunities for mass reduction of new automobiles through advanced materials, conducting technology reviews of advanced light weighting technology, investigated the impact of advanced lightweight materials on the automotive workforce, and conducted case studies documenting new applications with advanced materials.

Education:
Master of Science in Engineering, The University of Michigan, Ann Arbor, Michigan, 2005.
Bachelor of Science in Mechanical Engineering, Wayne State University, Detroit, Michigan, 2000

List of Abbreviations

BEV – Battery Electric Vehicle (see NAS 2011).

CAFE – Corporate Average Fuel Economy (see TAR).

CAR – Center for Automotive Research (http://www.cargroup.org/).

CARB – California Air Resource Board (http://www.arb.ca.gov/homepage.htm).

EGR – Exhaust Gas Recirculation (see NAS 2011 report).

EPA – U.S. Environmental Protection Agency (www.epa.gov).

FFV – Flexible Fuel Vehicles (http://www.fueleconomy.gov/feg/flextech.shtml).

HEV – Hybrid Electric Vehicle (see NAS 2011).

ICCT – International Council on Clean Transportation (http://www.theicct.org/).

NAS – National Academy of Science (http://www.nationalacademies.org/nrc/).

NHTSA – National Highway Traffic Safety Administration (www.nhtsa.gov).

P2 – A hybrid electric vehicle (HEV) technology with parallel, two-clutch systems that separate the operation of the gas engine from the electric motor (for example, see "Ring Shaped Motor-Integrated Electric Drive for Hybrid Electric Vehicles," Dr. Tadros, Dr. Ranneberg and Dr. U. Schafer, http://www.iisb.fraunhofer.de/de/arb_geb/les/DC_2003.pdf).

PHEV – Plug-in Electric Vehicle (see NAS 2011).

RPE – Retail Price Equivalent (see NAS 2011 report).