



COMMENTS ON:

**Proposed Determination on the Appropriateness of the Model Year 2022-2025
Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm
Evaluation**

Docket ID EPA-HQ- OAR-2015-0827

Environmental Protection Agency

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by the

Natural Resources Defense Council (NRDC)

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Executive Summary

The Natural Resources Defense Council (NRDC) appreciates the opportunity to comment on the *Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation* (Docket ID EPA-HQ-OAR-2015-0827.)

Strong Federal vehicle greenhouse gas and fuel efficiency standards are essential to address the climate challenge, protecting public health and enhance United States energy security by reducing consumption of oil. Strong model year 2022-2025 standards are a key strategy for reducing our nation's carbon pollution to meet the United States 2025 Paris Climate commitment and larger, longer-term reductions.

Greenhouse gas and fuel economy standards work to bring cleaner, more fuel efficient vehicles to the market. The Environmental Protection Agency (EPA) estimates that the standards for model years 2012-2016 have already avoided over 138 million metric tons of carbon pollution and saved American drivers over \$31 billion in fuel costs.

Moreover, these savings have been achieved as new vehicles have ramped up to record levels of both fuel economy and sales. New vehicles are also achieving record low emissions thanks to standards that tighten year over year.

The federal government should keep strong vehicle greenhouse gas emissions standards in place to ensure that the new automobile fleet continues annual carbon pollution reductions and fuel economy improvements.

NRDC agrees with the EPA's determination that there is no basis for weakening the existing standards for model years 2022-2025. While the EPA has proposed to maintain the existing standards, the agency also finds that it would be justified in strengthening them. After assessing the technical information that EPA has compiled, we strongly concur with the agency that the technical basis exists to support strengthening the standards.

The draft Technical Assessment Report (TAR) confirmed that automakers can meet the 2022-2025 carbon pollution and fuel economy standards with known technologies, on time, and at the same or lower cost than previously estimated in the 2012 Final Rule. In response to extensive comments to the TAR and new analysis provided in the Proposed Determination, EPA finds that technology costs are lower than the TAR estimates.

Through their thorough consideration of comments to the TAR and updated analysis, EPA has clearly demonstrated that automakers can comply with standards as least as stringent as the current 2022-2025 standards, using known technologies at cost at or below what the agency estimated in its 2012 Final Rule. Based on this agency technical data and data on actual cost of automaker compliance for previous emission standards, it is the technical conclusion of NRDC staff that the actual costs of compliance is likely to be either in line with what the regulators have estimated or lower, but almost certainly not higher.

The TAR analysis was sufficient to demonstrate that the vehicle standards could be strengthened. The Proposed Determination provides more support for strengthening. Using the TAR costs, net consumer savings of nearly \$4000 over the life of a 2025 vehicle compared to today's vehicle means that more clean vehicle technology could be applied. The lower costs in the Proposed Determination means that additional technologies could be applied to reduce emissions.

Additionally, the costs estimated by the TAR and Proposed Determination are conservatively high. The automotive industry and regulators have a history of overestimating the cost to comply with future regulations. But history also shows that innovation that occurs under standards brings new, lower cost technologies to production. The TAR and Proposed Determination note several technologies, including Atkinson cycle engines, 48-volt mild hybrid systems, 10-speed transmissions, and dynamic cylinder deactivation, which were not considered when the standards were first adopted just four years ago in 2012. The National Academy of Science (NAS) 2015 report on the fuel economy program supports the role of innovation in lowering costs too.

Even with the shortcomings of the analysis, the TAR and Proposed Determination clearly support the cost-effectiveness of fuel-saving technologies and the automakers abilities to meet the 2025 standards. No basis is provided for weakening the standards. The TAR analysis (and it's updates in the Proposed Determination) shows that we can have safe vehicles that are even cleaner and more efficient than those being sold today. That's good news for our economy and for vehicle consumers. A recent poll conducted by the Opinion Research Corporation, and commissioned by NRDC, shows strong, bipartisan support for continued fuel efficiency standards.¹ The poll found that 79 percent of Americans agree that the U.S. government should continue to increase fuel efficiency standards and enforce them.

American manufacturing workers in the automotive industry—from parts suppliers to assembly plants—are at the forefront of innovation and keeping our nation a global leader in fuel-efficient technologies. Strong federal standards will continue to keep our leadership and manufacturing based in the U.S. because the standards create certainty for companies to invest in innovation over the long-term. Weakening the standards would put the jobs of more than 150,000 workers building fuels-saving technologies at risk, while costing all drivers more at the pump. The TAR and Proposed Determination provide a strong basis for keeping strong standards in place through at least 2025.

NRDC appreciates the collaborative efforts of the EPA, National Highway Traffic Safety Administration and the California Air Resources Board in developing deep technical analysis that underpins the standards so important the planet's environmental health and our nation's energy security. NRDC's detailed comments are provided below.

¹ Opinion Research Corporation, "Attitudes toward Air Pollution, Transportation and Fuel Efficiency", August 4, 2016. Results available at https://www.nrdc.org/sites/default/files/media-uploads/nrdc_pollution_transpo_fuel_eff_survey_1.pdf.

I. Introduction: Strong Vehicle Standards Are Necessary to Address the Climate Challenge and Enhance our Energy Security

Preventing the worst impacts of climate change requires dramatic reductions in carbon pollution. Scientists point out that developed countries like the United States need to reduce carbon pollution by 80% from 1990 levels by 2050 to prevent global temperature rises of 2 degrees Celsius. The United States' commitment in Paris to reduce carbon pollution by 26-28% from 2005 levels by 2025 is a critical step toward achieving the necessary long-term reductions. Immediate reductions are necessary to curb long-term climate impacts, and as Environmental Protection Agency (EPA) itself noted in its Proposed Determination (PD), "emission reduction choices made today matter in determining impacts experienced not just over the next few decades, but in the coming centuries and millennia."²

Federal vehicle greenhouse gas (GHG) and fuel efficiency standards are essential strategies for meeting the 2025 Paris target. As EPA has noted, motor vehicles make up 23% of all U.S. carbon pollution.³ Mobile sources are responsible for 29% of U.S. GHG emissions, second only to the emissions generated by power plants.⁴ Light-duty vehicles are by far the largest class of transportation polluters, contributing 61% of total motor vehicle carbon pollution⁵ and about 17% of U.S. carbon pollution. In 2014, carbon pollution from the burning of gasoline, which comprises 99% of light duty vehicle fuel, dropped 9% below 2005 levels⁶, even as the demand for driving increased.⁷ EPA reports that vehicle carbon dioxide emissions have declined over the past decade, with model year 2015 cars producing 22% fewer emissions than in 2004.⁸ The agency has also calculated that the standards since 2012 have avoided over 138 million metric tons of carbon pollution and saved American drivers over \$31 billion in fuel costs.⁹

Weakening the 2022-2025 standards would place achievement of the U.S. Paris commitment in jeopardy. Weaker standards would increase emissions from those projected at the time of the agreement and delay the innovation needed to meet stronger standards in the future. The light-duty fleet is already going to have higher emissions due to the unforeseen shift in the market from cars to light trucks; weakening the standards would make meeting U.S., and therefore global, climate targets even more challenging.

² EPA, Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards Under the Midterm Evaluation (PD) at 12.

³ TAR at 1-21.

⁴ PD at 19.

⁵ EPA, "Fast Facts: U.S. Transportation Sector Greenhouse Gas Emissions 1990-2014", <https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockkey=P100ONBL.pdf>, last accessed December 2016.

⁶ EIA, Monthly Energy Review, Table 12.5, http://www.eia.gov/totalenergy/data/monthly/pdf/sec12_8.pdf, last accessed December 2016.

⁷ U.S. DOT, Bureau of Transportation Statistics, *National Transportation Statistics*, Table 1-35, http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/publications/national_transportation_statistics/html/table_01_35.html, last accessed December 2016.

⁸ EPA, Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2016, <https://www.epa.gov/sites/production/files/2016-11/documents/420s16001.pdf>, last accessed December 2016.

⁹ EPA, <https://www.epa.gov/greenvehicles>. Accessed December 19, 2016.

NRDC believes that reducing the carbon pollution is also essential for protecting public health. Rising temperatures due to global warming lead to more extreme heat events, worsening air pollution and the expanded range and timing of vector-borne illnesses. The current temperature trends are already concerning. According to the National Oceanic and Atmospheric Administration's State of the Climate:¹⁰

- Globally, 2016 was the hottest year in 137-year period of record;
- 15 of the 16 warmest years on record have occurred since 2000
- 2016 was the second hottest year in the contiguous United States' 121-year period of record. Such temperatures have serious consequences in key farm states like California, which produces about a third of the country's vegetables and two thirds of the country's fruit and nuts.¹¹ California is currently in its sixth year of severe drought.¹²

Another very important aspect of the 2017-2025 vehicle standards is their ability to reduce our nation's consumption of oil. In 2015, the transportation sector was responsible for 68% of national oil consumption¹³ and light-duty vehicles are the largest class of oil consumers, responsible for about 47% of U.S. petroleum demand.¹⁴ Because vehicle fuel economy and greenhouse gas emissions standards reduce petroleum demand they are effective at both enhancing our energy security and combating climate change. Conversely, U.S. policies that promote increased domestic petroleum supply through drilling serve neither goal.

Even with increased domestic supply, petroleum fuel prices in the U.S. are linked to the global petroleum market and subject to its volatility. Major oil producers outside the U.S. remain important contributors to global supplies – for example, OPEC countries produce 40% of the world's crude oil stocks¹⁵ – and can therefore affect prices in the U.S. However, drivers that have to fuel up less often because of improved fuel economy under the standards will be less impacted by swings in fuel prices. Also, as EPA's Technical Support Document (TSD) correctly asserts, large reductions in U.S. demand can put downward pressure on global petroleum prices because the U.S. is such a large consumer.¹⁶

Expanded domestic drilling investments could also tend to lock the U.S. into supply infrastructure that encourages continued petroleum extraction and use, opening up fossil fuel resources that, if used, will bust the global carbon budget needed to be sustained to avoid the worst impacts of climate change.

¹⁰ National Oceanic and Atmospheric Administration, State of the Climate Reports.

<http://www.ncdc.noaa.gov/sotc/>. Last Accessed December 21, 2016.

¹¹ California Department of Food and Agriculture, "California Agricultural Statistics Review, 2014-2015.

<https://www.cdfa.ca.gov/statistics/PDFs/2015Report.pdf>.

¹² United States Geological Survey, California Drought, <http://ca.water.usgs.gov/data/drought/>

¹³ EIA, Oil: Crude and Petroleum Products, http://www.eia.gov/energyexplained/index.cfm?page=oil_use, last accessed December 21, 2016.

¹⁴ *Id.*

¹⁵ EIA, What Drives Crude Oil Prices?, <http://www.eia.gov/finance/markets/crudeoil/supply-opec.php>, last accessed December 21, 2016.

¹⁶ EPA, Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation: Technical Support Document (TSD) at 3-25 – 3-26.

II. TAR and Proposed Determination Findings Support Strengthening Vehicle Standards

NRDC agrees with the Environmental Protection Agency’s determination that there is no basis for weakening the existing standards for model years 2022-2025. While the EPA has proposed to maintain the existing standards, the agency also finds that it would be justified in strengthening them. After assessing the technical information that EPA has compiled, we strongly concur with the agency that the technical basis exists to support strengthening the standards.

NRDC recognizes that the technical underpinnings of the existing standards have been developed over more than 7 years. The September 2009 notice of proposed rulemaking estimated costs of technologies to meet the 2012-2016 standards. Subsequent analyses—including the model year 2012-2016 Final Rule, the model year 2017-2025 Proposal, Technical Support Documents, and Final Rule and most recently the Midterm Evaluation TAR and Proposed Determination—have found increasing availability of emissions-reducing technologies and costs to meet the standards that are both reasonable and decreasing with each analysis.

A. Cost Estimates Continue to Support Strong Standards

The draft TAR confirmed that automakers can meet the 2022-2025 carbon pollution and fuel economy standards with known technologies, on time, and at the same or lower cost than previously estimated in the 2012 Final Rule. When taking the average of the EPA and National Highway Traffic Safety Administration (NHTSA) cost estimate from today’s vehicle, the net savings to a vehicle owner is nearly \$4,000 as shown in Table 1.

Table 1: Average Per-Vehicle Cost of Compliance in 2025

	2012 Final Rule		2016 Draft TAR (2013 \$)		
	2010 \$	2013 \$	EPA	NHTSA	Average
Incremental 2022-25 Cost	\$1,070	\$1,130	\$894	\$1,245	\$1,070
	2012 Final Rule		2016 Draft TAR (2013 \$)		
	2010 \$	2013 \$	EPA	NHTSA	Average
Incremental 2017-25 Cost	\$1,836	\$1,939	\$1,287	\$1,920	\$1,604
Lifetime Fuel Savings, Net Present Value*	\$7,400	\$7,906	\$6,130	\$6,130	\$6,130
Net Lifetime Savings, Net Present Value *,**	\$5,000	\$5,342	\$4,310	\$3,640	\$3,970

* NRDC calculations based on 2016 Draft TAR, AEO 2015, and 3% discount rate.

** Includes additional sales tax, insurance premiums and maintenance costs.

In response to extensive comments to the TAR and new analysis provided in the Proposed Determination, EPA finds that technology costs are lower than the TAR estimates. EPA’s updated analysis presented in the Proposed Determination and accompanying TSD finds that incremental 2022-2025 costs have declined from \$920 (\$894 in 2013\$ is \$920 in 2015\$) to \$875. This cost savings indicates that the net lifetime fuel savings per vehicle will be higher than those in Table 1.

Consistent with the 2012 Final Rule, TAR and the National Academy of Science 2015 CAFE report, EPA continues to find that “that the MY2022-2025 standards can be met largely through advancements in gasoline vehicle technologies, such as improvements in engines, transmissions, light-weighting, aerodynamics, and accessories, including moderate levels of mild hybridization (i.e., 48 volt systems which improve the efficiency of gasoline vehicles at much less cost than strong hybrids).” (38) NRDC strongly concurs with this assessment.

NRDC also believes that the TAR and Proposed Determination analysis supports additional strengthening of the standards. First, as shown in Table 1 above, fuel savings in excess of costs means that additional fuel-saving technologies can be applied and still maintain cost neutrality. Second long-term projections tend to overestimate the cost of compliance because of unforeseen innovation.

B. Long-term Projections tend to Overestimate Costs

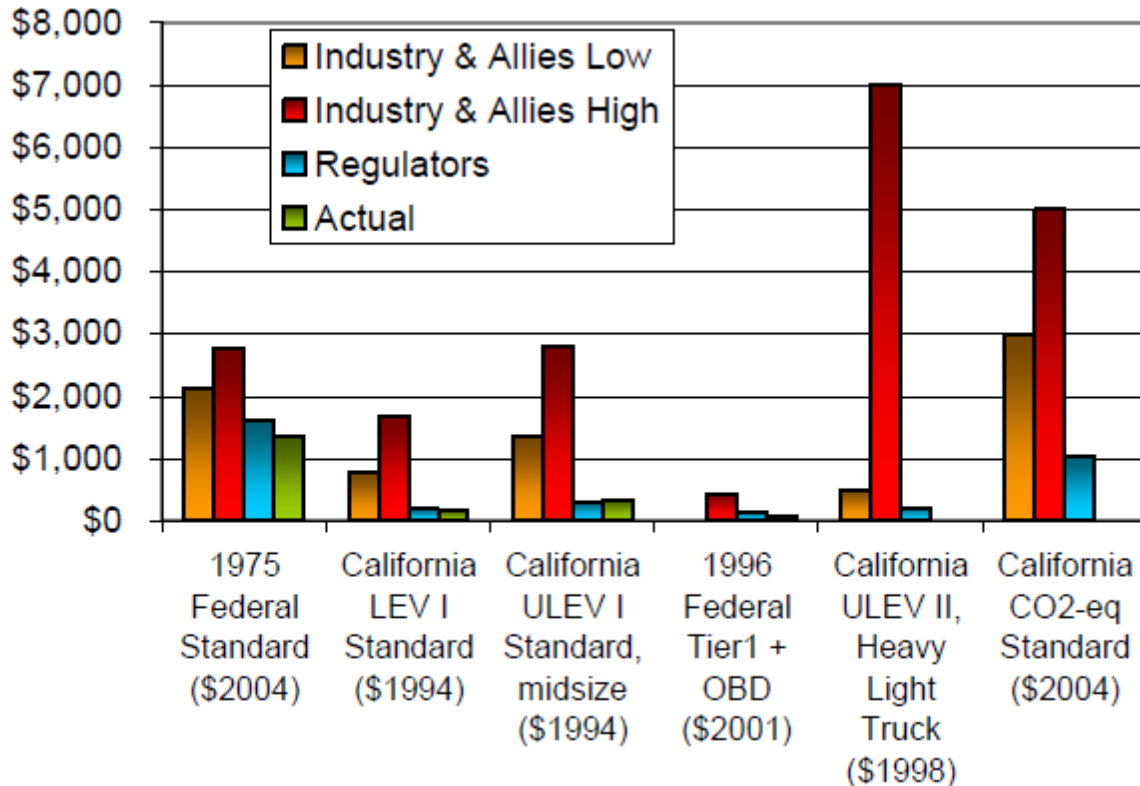
In testimony before the U.S. House of Representatives Energy and Commerce Committee Subcommittee on Commerce, Manufacturing, and Trade and the Subcommittee on Energy and Power automotive expert John German of the International Council on Clean Transportation summed up it up this way:

“During the course of my 40-year career, initial cost estimates for complying with emissions and efficiency requirements have consistently been overstated. Not some of the time, or even most of the time, but all of the time.”¹⁷

The reason that compliance costs are overestimated, German asserted, is that future innovation cannot be predicted. This is also the finding of a 2006 study by NRDC’s Roland Hwang, “Innovation and Regulation in the Automobile Sector: Lessons Learned and Implications for California’s CO₂ Standards Regulators”, which is included as Appendix A to these comments. The study provides decades of historical evidence that automakers and regulators overestimated the costs of complying with emissions and fuels regulations. Figure 2 below from the Hwang study compares initial estimates to actual compliance costs.

¹⁷ German, John, Statement before the Subcommittee on Commerce, Manufacturing, and Trade and the Subcommittee on Energy and Power Committee on Energy and Commerce, U.S. House of Representatives, Hearing on the Midterm Review and an Update on the Corporate Average Fuel Economy Program and Greenhouse Gas Emissions Standards for Motor Vehicles, September 22, 2016. Accessed at <http://docs.house.gov/meetings/IF/IF17/20160922/105350/HHRG-114-IF17-Wstate-GermanJ-20160922.pdf>.

Figure 1: Comparisons of Cost Estimates and Actual Costs for Meeting Select Emissions Standards



The study showed that auto industry and its allies overestimated costs at much higher levels than regulators.

Table 2: Ratio of Estimated to Actual Costs

Program	Industry & Allies	Regulators
1975 Federal Standard (\$2004)	1.6-3.2	1.2-1.8
California LEV I Program vs Tier 1 Baseline (\$1994)	9.5	1.4
California LEV I Program vs Tier 0 Baseline (\$1994)		
California TLEV Standard	2.9-7.2	1.2
California LEV I Standard	4.6-10.1	1.2
California ULEV I Standard (midsize)	4.0-8.3	0.9
1996 Federal Tier1 + OBD (\$2001)	4.9	1.7

Source: NRDC

Leading up to the rulemaking to establish the model year (MY) 2012-2016 vehicle fuel economy and greenhouse gas emission standards, the auto industry and its allies continued to put forth initial costs that were dramatically higher than regulator estimates. Eventually, the standards were finalized with

auto industry support and using the regulator estimates. Appendix B provides specific examples of statements by automakers and their allies of exaggerated costs.

C. Unforeseen Innovation Can Reduce Costs

Since the 2012 Final Rulemaking (FRM), new technologies have emerged—and are being deployed—that provide additional options for meeting the 2022-2025 standards. The TAR appropriately summed up the fact that innovation is on-going:

It is clear that the automotive industry is innovating and bringing new technology to market at a brisk pace and neither the GHG nor the CAFE analysis reflect all of the latest and emerging technology since the FRM.

While the cost, effectiveness, and implementation feasibility of individual technologies are generally consistent with the compliance pathways projected in the FRM, some developments were not foreseen by the agencies. Several new technologies or unforeseen application of technologies are now under active development and some have emerged into the light-duty vehicle market since the LD 2017-2025 Final Rule was completed. These technologies include the application of direct injection Atkinson Cycle engines in non-hybrids, greater penetration of continuously variable transmissions (CVT) and greater market penetration of diesel engines. In addition, the development of several technologies has proceeded differently than was assumed in the FRM, including development of downsized turbo-charged engines, cylinder deactivation and vehicle electrification. (TAR at 5-1)

Within vehicle electrification, John German also testified that emerging 48 volt mild hybrid systems will be less expensive than the 110 volt systems analyzed in the 2012 FRM. According to German, “48v systems provide much of the same benefits at lower cost, as they stay below the 60v lethal threshold, also improving safety. There are also excellent cost synergies with e-boost, as the same 48v controllers, inverters, and power electronics are used for both systems.”¹⁸

D. NAS Study Supports Role of Innovation in Lowering Costs

As shown in Figure 4, the 2015 NAS (specifically by the National Research Council, or NRC) study confirms the NHTSA’s and EPA’s assessment that a midsize car can comply with 2025 standards using just conventional gasoline engine technologies such as downsized turbocharged engines, 8-speed automatic transmissions, and a 7.5 percent weight reduction (which the committee believes is well in-line with what manufacturers are likely to implement). Electrified powertrains—including stop/start systems, conventional hybrid electric vehicles, and battery electric vehicles—were found to be unnecessary for a midsize car to meet the vehicle’s 2025 fuel economy target. The study indicates that automakers can meet 2025 clean car standards on time, using known technologies, and at reasonable cost. The dramatic reductions from the NRC’s previous fuel economy study—completed just four years ago—demonstrates how technological innovation is working to bring down the cost of meeting long-term standards.

¹⁸ Ibid.

The 2015 NRC study developed two possible direct manufacturing costs for a midsize car to meet 2025 standards of either \$1,181 or \$1,658 more than a 2016 baseline midsize car (see Table 8.5 of the study). For comparison, the study also estimated the cost using the values from NHTSA's and EPA's final rule for the 2017 to 2025 standards to be \$1,060. The lower of the committee's possible estimates, \$1,181, is consistent with the regulator's cost estimate of \$1,060.

Importantly, even the higher estimate is dramatically lower than the 2011 NRC study, bringing the latest NRC estimate in much greater agreement with the cost estimate using the regulators' values. As shown in Figure 4, using data from the 2011 NRC study results in a manufacturing cost increase of roughly \$3,200, compared to a baseline car.

As stated previously, the dramatic reductions from the NRC's previous fuel economy study—completed just four years ago—demonstrate how technological innovation is working to bring down the cost of meeting long-term standards. The 2011 NRC study was limited to assessing technologies and costs in the near-term (2015) and consequently found much higher costs.

The history of auto industry regulation shows car makers are typically able to innovate to meet standards on time and often at even lower cost than what regulators predicted. In fact, the 2015 NRC study agrees with regulator estimates for the cost to achieve 2016 standards. For the near-term 2016 standards, the latest NRC estimates of costs to meet the target -- \$312 or \$343 -- are virtually identical to the agencies' 2012 FRM cost estimate of \$312. If past trends hold, future NRC cost estimates will likely decrease the closer the industry gets to the 2025 compliance date.

Importantly, the NAS committee recognized the important role of innovation and that its estimates were conservative from the perspective of not being able to fully capture the impacts of future innovation that may lower costs:

The committee realizes that there will be unanticipated technological innovations and market trends that will produce vehicles with technologies not fully considered in the committee's analysis. The committee acknowledges the possibility that these unanticipated innovations may permit the industry to meet emission standards at lower than predicted cost. ...The committee does not believe that the automobile industry has reached the end of innovation, but quantifying possible improvements for unknown innovations was beyond the scope of the committee's study. (1-8)

The TAR is consistent with the committee's conclusion that unanticipated innovation may lower costs. The EPA analysis in the TAR finds that Atkinson cycle engines have progressed more rapidly than their previous analysis anticipated, allowing manufacturers to meet the standard at lower than originally anticipated costs. The NAS study, published just last year, did not include the non-hybridized Atkinson cycle engine in its primary technology pathway because there was insufficient data in the public domain at the time, despite the fact that the committee met with Japanese manufacturers who were clearly moving towards production of this technology at the time of the visits. Therefore it is reasonable to conclude based on historical evidence that manufacturers will continue to innovate to lower cost of compliance, and that obtaining full transparency of actual manufacturer plans will continue to be handicapped by proprietary considerations and competitive pressures.

Figure 2: New Cost Estimates Dramatically Lower than 2011 NRC Study

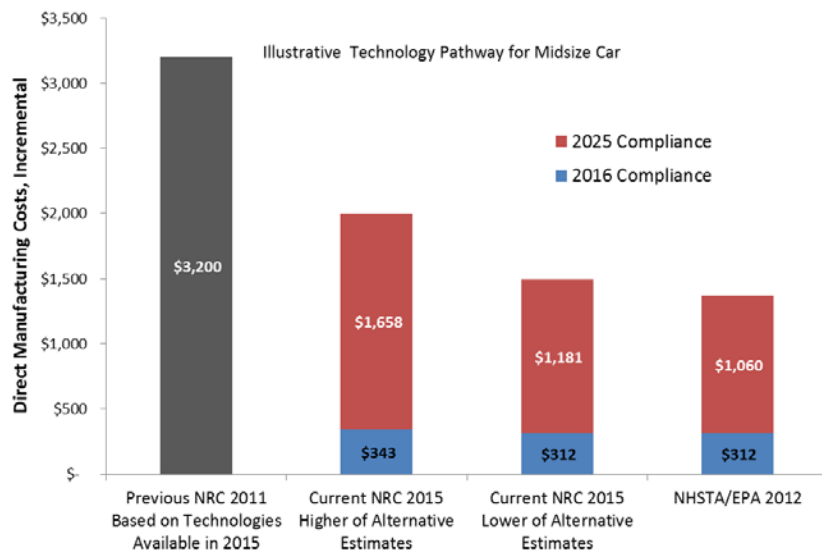
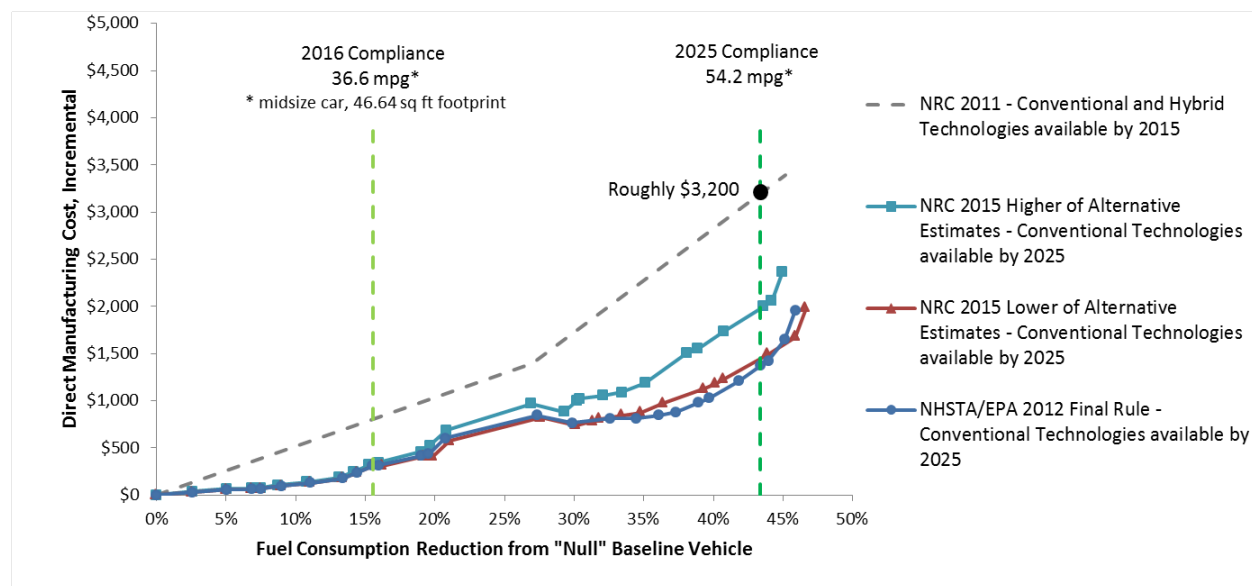


Figure 3: 2025 Standards Can Be Met with Known Technologies at Reasonable Cost



E. Compliance Costs are Overestimated When Increased Performance Is Included in the Baseline

According to EPA's *Fuel Economy Trends*, fleet performance reached new records in MY 2015 as measured by the lowest 0-60 mph time and highest horsepower. These performance increases come from the implementation of technologies that, in many cases, trade off fuel economy increases for the higher performance. The result is that additional technologies (and costs) must be applied to the vehicles to meet increasingly more stringent fuel economy and GHG emissions standards. NRDC repeats

the critique from its comments to the TAR – it is inappropriate to include the costs of performance-improving technologies in its baselines, particularly where such technologies are unrelated to fuel economy and emissions standards.

The costs associated with the use of technologies to increase performance should not be ascribed to the fuel economy and GHG standards. When the agencies updated their baseline fleets in the draft TAR to MY 2014 (EPA) and MY 2015 (NHTSA), they included increases in acceleration and power that manufacturers have enabled since the FRM cost estimates based on a MY 2010 fleet. The costs in the TAR associated with meeting 2022-2205 standards should be discounted to reflect that some technologies have been applied to improve performance instead of fuel economy. In other words, the sunk costs by automakers to apply efficiency technology to boost acceleration or power should not be counted toward the cost of compliance with the fuel economy and emissions standards.

In regards to “tradeoffs”, the NAS committee notes the market shift to crossover utility vehicles (CUV) from truck-based SUVs resulted in higher fuel economy but traded towing, off-road, and low-gear-capabilities. This tradeoff for CUV drivers “offers improved value”. (333) Critically, this demonstrates that the current market baseline for attributes other than fuel economy are not necessarily being optimally allocated, and the shift to more efficient technologies does not necessarily result in a loss in consumer welfare. Put another way, “revealed preferences” based on attributes of the actual fleet do not necessarily imply the actual consumer preferences. Consequently, in addition to above reasons, including increased performance into a revised baseline would be inappropriate since based on real-world experience, current attributes are not necessarily being efficiently allocated.

III. EPA’s Cost Assessment Uses Best Practices

A. EPA’s Technology Cost Tear-down Methodology Recommended by National Academy of Science

The 2015 NAS Committee found that the EPA and NHTSA original analysis to support the MY2017 to 2025 standards was “thorough and high caliber on the whole.” In particular, the committee noted that the methodologies the agencies employed have improved the cost estimates, namely full simulation modeling combined with lumped parameter model, testing of actual vehicles, and tear-down studies. (S-2 to S-3) As a member of that NAS committee, it is the assessment of Roland Hwang, Director of NRDC’s Energy & Transportation Program, that the draft TAR and Proposed Determination analysis is also extremely thorough and of high caliber since its methodologies are consistent with the NAS recommendations to increase the use of these approaches.

B. EPA Appropriately Includes Compliance with the Zero Emission Vehicle Program in the Baseline Reference Fleet

NRDC agrees with EPA’s inclusion in the baseline reference fleet of electrified vehicles needed to comply with the Zero Emission Vehicle (ZEV) Program in California and the states that have adopted the ZEV program under Section 177 of the Federal Clean Air Act. NRDC agrees that because these vehicles are required as part of the existing California and Section 177 state ZEV programs the cost of complying with

ZEV should be excluded from the cost of complying with the federal GHG program. NRDC commends EPA for its continued use of this methodology, which most accurately reflects the costs of compliance with federal standards.¹⁹

To reiterate the comments by NRDC to the TAR, the ZEV programs should be treated the same as the federal Tier 3 and California LEV III standard costs for other criteria pollutants. The ZEV program was originally adopted in 1990 by the California Air Resources Board to help meet federal mandated NAAQS for ozone, CO and PM. Large-scale adoption of ZEVs remains central to the CARB's current mobile source control strategy to meet state and federally mandated air quality standards. The GHG vehicle standards were not required by state law until the passage of AB1493 (Pavley) in 2002. The fact that ZEV programs also help to lower the cost of complying with the current GHG program does not, in fact, make it solely a GHG control program. Consequently it would be entirely inappropriate and inconsistent to consider the ZEV program costs as part of the GHG or CAFE program costs.

NRDC recommends that NHTSA also include ZEV compliance in the agency's reference fleet for future rulemakings. Automakers selling vehicles in California and the nine 177 states ZEV program states must comply with existing ZEV regulations independently from the federal CAFE program. NHTSA's failure to include ZEVs in its TAR reference fleet causes the agency to overestimate CAFE compliance costs because unnecessary technology is included in the NHTSA CAFE compliance model.

NRDC notes that NHTSA finds that compliance with the 2022-2025 augural standards is very cost-effective even with the overestimate of CAFE compliance costs because ZEV compliance is left out of the NHTSA reference fleet.

IV. Consumers are Choosing More Fuel Efficient Vehicles

Recently U.S. auto sales have reached record high levels of both fuel economy and vehicles sales. Clearly, the auto industry can enjoy robust sales while complying with fuel economy and greenhouse gas emissions standards. While the agencies have failed to find a causal relationship between sales and meeting the standards, it could still be possible that fuel efficiency is actually helping to drive sales. The recent shift toward trucks, for example, could be bolstered by the fact that the market is offering the most fuel efficient trucks ever.

A. Vehicle Standards are Improving Fuel Economy and Cutting Pollution

The greenhouse gas and fuel economy standards have led to significant improvements in vehicles since they started with model year 2012. According to EPA's *Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975-2016* (Table 3.2) emissions from cars, car-based SUVs, pickup trucks, and truck-based SUVs all declined from MY 2012 through MY 2015.

¹⁹ See TSD at 1-32 to 1-33.

Importantly, the emissions improvements have resulted in automaker compliance with the car and truck standards. In fact, the auto industry over-complied with the emissions standards in model years 2012-2015.²⁰

In MY 2016, light-duty vehicles are also expected hit record high fuel economy and record low emissions across all segments (including minivan/van) and on a fleet average basis for MY 2016 based on EPA's *Fuel Economy Trends* preliminary estimates.

The improvements on a fleet average level are occurring despite a shift in consumer purchasing from cars to trucks due to low gas prices. Large increases in truck fuel efficiency—the second largest increase in 30 years for MY 2014—have effectively offset the fleet average fuel efficiency decreases that would have been caused by the mix shift.

B. Consumer Choice Models Should be Vetted through Public Review Before Use in Models for Evaluating or Setting Standards

EPA investigated the potential for consumer choice models to predict the future sale of vehicles subject to fuel economy and GHG emissions standards.²¹ NRDC agrees with EPA's decision to exclude consumer choice models from their evaluation of the future fleet vehicle configurations given that the existing models are subject to too many uncertainties.

NHTSA similarly decided in the TAR that their consumer choice model was not robust for use in the current assessment.

NRDC believes that the agencies should not proceed with use of a vehicle choice model in their modeling frameworks for assessing and determining standards until the models are found to be robust through an extensive public review.

While vehicle choice models may be useful for analyzing the potential result of some market-based policies, they are inappropriate for standards that drive technology adoption. Vehicle choice models rely on stated or revealed preferences based on only existing choices in the marketplace. By requiring better efficiency, the standards will offer consumers more choices for fuel-efficient vehicles across all vehicle configurations and segments. These improvements may be larger or more significant than historical data can represent so even reliance on recent data could be faulty.

NRDC remains concerned that integrating a consumer choice model into the agencies' modeling baselines, reference fleets and future standard cases can have a large impact on the stringency of the standards and therefore the ultimate oil and GHG reductions that are achieved.

²⁰ EPA, *Greenhouse Gas Emission Standards for Light-Duty Vehicles: Manufacturer Performance Report for the 2015 Model Year*, November 2016.

²¹ See PD at A-46 to A-48, TSD at 4-16.

C. EPA Surveys Show Wide Consumer Acceptance of Vehicle Technologies to Reduce Carbon Pollution

EPA's recent evaluation of reviews by professional automobile critics indicates strong acceptance of new technologies that reduce GHG emissions. NRDC agrees that the survey provides a fair assessment because it relies on a range of critics that are used to scrutinizing vehicle performance.

There is a broad consensus that consumers value fuel economy. According to the NAS committee, "Consumers are buying fuel-efficient versions of the vehicles that suit their wants and needs" and notes that consumers are "simultaneously assigning high value to fuel economy." (327, 333) Consequently as noted by the NAS committee, the current structure of the program is consistent with how consumers value fuel economy and other attributes.

D. Public Strongly Supports Government-set Vehicle Standards

A recent poll conducted by the Opinion Research Corporation, and commissioned by NRDC, shows strong, bipartisan support for continued fuel efficiency standards.²² Specifically the poll found that:

- 95 percent of Americans agree with the statement: 'Automakers should continue to improve fuel economy for all vehicle types.' This view is held by 97 percent of Democrats, 94 percent of Independents, and 93 percent of Republicans.
- 79 percent of Americans agree with the statement: 'The U.S. government should continue to increase fuel efficiency standards and enforce them.' This view is held by 90 percent of Democrats, 76 percent of Independents, and 68 percent of Republicans.

E. Manufacturer Risk-Aversion Leads to Undersupplying of Market for Fuel Efficiency

The agencies in the 2012 FRM also raise a supply-side problem—that automakers may be risk-averse to investing in fuel efficiency and therefore undersupplying fuel economy to the marketplace in the absence of regulation. The NAS committee also found evidence to support this possibility. It concluded that "[i]n the absence of increasingly stringent fuel economy standards, vehicle manufacturers may be risk-averse to long-term investments in fuel economy technologies" and that "[b]etter understanding of manufacturer risk aversion and other supply-side barriers would improve the assessment of the benefits and costs of the CAFE and GHG rules." (Finding 9.5, page 333)

The committee also found that there is some evidence in the literature that auto industry exhibits risk-averse behavior around attributes that are considered too uncertain and risky to create a competitive advantage versus safer bets of comfort, convenience, power, and style.

²² Opinion Research Corporation, "Attitudes toward Air Pollution, Transportation and Fuel Efficiency", August 4, 2016. Results available at https://www.nrdc.org/sites/default/files/media-uploads/nrdc_pollution_transpo_fuel_eff_survey_1.pdf.

As noted by the agencies and the NAS committee, “requiring all manufacturers to increase fuel economy can reduce the manufacturer’s perceived or actual risk of investing in a fuel economy strategy and potentially lead to a more optimal provision of fuel economy in the marketplace.” (319)

As noted by the NAS committee, the recent era of higher gasoline prices (2005 to 2014) provides some anecdotal evidence that stronger standards are benefiting automakers in the market place. The Alliance of Automobile Manufacturers statement of support for the 2009 National Program agreement highlighted the benefit of long-term planning certainty.²³ According to the NAS Committee “[d]omestic manufacturers of large vehicles have particularly benefited from the new footprint standards since it provides them an incentive to improve all their vehicles rather than shift to smaller cars.” (319) An *Automotive News* article from 2011 found the following:

Many automakers believe that the work they've done since the last big [gas] price surge, and in anticipation of higher government fuel-economy standards, leaves them better prepared this time, with stables of more competitive small cars and crossovers...It could be a fairer fight this time. GM and Ford not only have more competitive small cars, but hot-selling crossovers such as the Chevrolet Equinox and Ford Edge that could benefit if consumers abandon big SUVs.²⁴

V. Strong Standards Fuel Innovation and Job Growth

Americans increasingly want more from their vehicles, and to spend less at the pump. The U.S. automotive industry has responded with innovative technologies to meet tightening standards that improve fuel efficiency and cut carbon pollution, all the while turning large profits and creating jobs. Despite recent low gasoline prices, the automakers have been able to comply with the standards while increasing sales and bolstering their bottom lines.

Vehicle sales have been ramping up over the time that fuel economy and GHG standards have been tightening. The Proposed Determination states that vehicle “sales have increased to record levels during the same time period that the MY2012-16 standards came into effect.” (A-40) Jobs in the auto industry have grown along with sales and improved fuel economy. From June 2009 (an industry low point) to June 2016, the auto industry has added over 665,000 jobs, according to the Bureau of Labor Statistics. Over 300,000 of those jobs are in motor vehicle and parts manufacturing.²⁵ These are conservative estimates because they leave out jobs in other industries spurred by vehicle fuel efficiency, such as aluminum, high strength steel and other materials manufacturing.

There are over 1200 facilities in the United States are employed to engineer and manufacturer vehicle components designed to improve efficiency according to recent analysis conducted by the BlueGreen

²³ Alliance of Automobile Manufacturers, Automakers Support President in Development of National Program for Autos. Press Release, May 18, 2009.

²⁴ Colias, Mike, “Buyers move toward better fuel economy”, *Automotive News*, March 14, 2011.

²⁵ Bureau of Labor Statistics, “Automotive Industry: Employment, Earnings, and Hours”, <http://www.bls.gov/iag/tgs/iagauto.htm/>.

Alliance and NRDC with auto analysts Baum and Associates.²⁶ The facilities span 48 states to develop and supply the full range of technologies that improve fuel economy and cut carbon emissions, from lightweight automotive steel and aluminum, and advanced engines and transmissions, to electric motors and batteries. They range from facilities owned by major automakers and suppliers employing thousands of people, to small family- and entrepreneur-owned manufacturers with just a few employees.

This recent assessment includes three times more facilities than noted five years ago. In 2011, a joint report by NRDC, the United Auto Workers and National Wildlife Federation found that there were 300 facilities and over 150,000 U.S. engineering, research and manufacturing jobs associated equipment to make vehicles save fuel.²⁷ At the time, it was expected that these jobs were poised to grow with the greater penetration of fuel efficient technologies and growing sales of fuel-efficient vehicles under the standards.

Conversely, a decision to weaken the standards could put these jobs and the global competitiveness of U.S. auto manufacturing at risk. Suppliers and automaker component operations are on the front lines of innovation, producing new fuel-saving and low-emission technologies that add new content to vehicles on the assembly line. By expanding production of these new technologies—including advanced internal combustion engine components, turbochargers, improved transmissions, lightweight structures, electric traction motors, electronic controllers, advanced battery materials, traction batteries, and smart charging systems—suppliers can maintain existing jobs and create new ones.

Improved vehicle fuel economy and pollution performance standards provide the certainty necessary to foster investment in fuel-saving technologies. Long-range standards in the U.S., Europe and Asia, allow automakers and their suppliers to leverage the efficiency of global platforms and powertrains that add scale and reduce costs, leading to lower prices and higher profits.

Further, with ongoing innovation and higher volumes of fuel-saving components that are required to meet U.S. standards, domestic manufacture of these fuel-saving technologies becomes more likely. Strong standards through 2025 and beyond will help make sure that investments in technology and the jobs needed to make new components are sustained.

The fuel savings to consumers that result from the standards also serve to boost jobs. Although EPA did not quantify this affect, the agency correctly acknowledges that “...consumer spending is expected to affect employment through changes in expenditures in general retail sectors; net fuel savings by consumers are expected to increase demand (and therefore employment) in other sectors.” (A-95) This

²⁶ BlueGreen Alliance, “SUPPLYING INGENUITY II PREVIEW : U.S. Suppliers of Key Clean, Fuel-Efficient Vehicle Technologies”, December 2016. Available at <https://www.bluegreenalliance.org/wp-content/uploads/2016/12/Preview-of-Supplying-Ingenuity-II-vFINAL.pdf>.

²⁷ Natural Resources Defense Council, United Auto Workers and National Wildlife Foundation, “Supplying Ingenuity: U.S. Suppliers of Clean, Fuel-Efficient Vehicle Technologies”, August 2011. Available at <https://www.nrdc.org/file/4293/download?token=Of4X6i7W>.

responding effect can be very large. Studies have shown the potential to create approximately 500,000 jobs economy-wide by 2030 under the 2012-2025 standards.^{28, 29}

VI. Safety

As stated in our comments to the TAR, NRDC believes strongly that the 2025 standards can be achieved without an increased risk to safety. The fleet of future vehicles can be built lighter weight, and less polluting and safe. The size-based standards do not provide an incentive to reduce vehicle size to meet stronger standards and size, along with smart design, are key components to maintaining safety as indicated by several studies.^{30, 31, 32}

EPA's analysis for the Proposed Determination continues to rely on the conservative assessment from the TAR by NHTSA. The primary analysis used by NHTSA (NHTSA's "Relationships between Fatality Risk, Mass, and Footprint in Model Year 2003-2010 Passenger Cars and LTVs: Preliminary Report," June 2016) to assess the impact of the 2025 standards on safety is very limited in its applicability to future vehicles. While the study finds no fatality changes that were statistically significant at the 95% confidence level, it found lower confidence results that indicate that mass removed from lighter cars without reductions in heavier trucks could result in a small increase in fatalities (1.49% point estimate in cars <3,197 lbs for a 100-lb decrease in weight).

We know that weight reductions are occurring throughout the fleet. For example, one of the highest-selling trucks, Ford's F-150, has shed hundreds of pounds by switching materials from steel to aluminum during a recent redesign. NHTSA's results indicate that weight removed from trucks can actually enhance safety. The agency "concluded that, as a result, any reasonable combination of mass reductions while holding footprint constant in MYs 2017-2025 vehicles – concentrated, at least to some extent, in the heavier LTVs and limited in the lighter cars – would likely be approximately safety-neutral; it would not significantly increase fatalities and might well decrease them." (8-16).

²⁸ American Council for an Energy Efficient Economy and BlueGreen Alliance, "Gearing Up: Smart Standards Create Good Jobs Building Cleaner Cars, September 2012. Available at <https://www.bluegreenalliance.org/resources/gearingup/>.

²⁹ Ceres, "More Jobs Per Gallon: How Strong Fuel Economy/GHG Standards Will Fuel American Jobs", July 2011. Available at <https://www.ceres.org/resources/reports/more-jobs-per-gallon/view>.

³⁰ R. M. Van Auken and J. W. Zellner. Dynamic Research, Inc. *An Assessment of the Effects of Vehicle Weight and Size on Fatality Risk in 1985 to 1998 Model Year Passenger Cars and 1985 to 1997 Model Year Light Trucks and Vans*. SAE International 2004.

³¹ R. M. Van Auken and J. W. Zellner. Dynamic Research, Inc. *A Further Assessment of the Effects of Vehicle Weight and Size Parameters on Fatality Risk in Model Year 1985-98 Passenger Cars and 1985-97 Light Trucks*. January 2003.

³² R. M. Van Auken and J. W. Zellner. Dynamic Research, Inc. *Updated Analysis of the Effects of Passenger Vehicles Size and Weight on Safety*. February 25, 2011.

The NHTSA report appropriately acknowledges that the database analyzed is not necessarily representative of future vehicles:

The vehicles manufactured in the 2003-2010 timeframe were not subject to a footprint-based fuel-economy standard. NHTSA and EPA expect that the attribute-based standard will affect the design of vehicles such that manufacturers may reduce mass while maintaining footprint more than has occurred prior to 2022-2025. Therefore, it is likely that the analysis for 2003-2010 vehicles may not be fully representative of those vehicles that interact with the existing fleet in 2022 and beyond.

...Estimates can be generated for the combined effects of mass reductions in various groups of vehicles, as required for the regulatory analysis of CAFE, with confidence bounds. In general, these estimates will not be statistically significant (except if mass reduction is limited to vehicle classes with statistically significant estimates). In other words, it cannot be concluded from the statistical analysis that mass reduction would have been harmful if it had been applied uniformly across the 2003-2010 fleet."³³

A review of the NHTSA study by Lawrence Berkeley National Laboratory (LBNL) analyst Tom Wenzel pointed to additional limitations of the study. For example, other factors that can impact safety, such as a male (instead of female) driver, driving at night, or driving on roads with speed limits higher than 55 mph, can have much bigger impacts on fatality risk. As the TAR describes, “[t] The 2016 LBNL Phase 1 report notes that many of the control variables NHTSA includes in its logistic regressions are statistically significant, and have a much larger estimated effect on fatality risk than vehicle mass.”(TAR at 8-30)

NRDC recommends that future assessments of safety impacts include inputs (e.g. regression coefficients) that account for the deficiencies identified by LBNL.

Regarding safety, the NAS committee noted that the footprint based standard was adopted in large part due to the intention for the standards to be “safety-neutral.” The committee concluded the following:

The committee found the empirical evidence from historical data appears to support the argument that the new footprint-based standards are likely to have little effect on vehicle and overall highway safety. (S-9)

The committee also found reason to believe that the standard will have a beneficial effect on safety. It found that “mass will be reduced across all vehicle sizes, with proportionately more mass removed from heavier vehicles” and as result “will have a beneficial effect on societal safety risk.” (Finding 6.5, page 240)

³³ NHTSA, “Relationships between Fatality Risk, Mass, and Footprint in Model Year 2003-2010 Passenger Cars and LTVs: Preliminary Report,” June 2016. Pg. viii.

VII. Credits, Incentives and Flexibilities

The existing standards through 2025 include a number credit, incentive and flexibility provisions including off-cycle credits and advanced technology vehicle incentives. NRDC believes that the robust technical analysis of the TAR and Proposed Determination demonstrate that the standards can be achieved at costs at or below those determined in the 2012 Final Rulemaking. Therefore, changes to the credit, incentive and flexibilities for the 2022-2025 model years are unnecessary and we agree with EPA's decision not to propose changes for those years.

VIII. Conclusion

NRDC believes that the TAR and technical updates presented in the Proposed Determination demonstrate that the 2022-2025 standards can be strengthened. No basis is provided for weakening the standards. The U.S. needs the strongest possible GHG and CAFE standards to keep the nation's on track to meet its climate and oil consumption reduction goals.

For questions regarding these comments, please contact Luke Tonachel at ltonachel@nrdc.org or (212) 727-4607.

Appendix A:

NRDC report “Innovation and Regulation in the Automobile Sector: Lessons Learned and Implications for California’s CO₂ Standards Regulators”

Innovation and Regulation in the Automobile Sector

Lessons Learned and Implications for California's CO₂ Standards

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April, 2006

Introduction

Over four decades of air pollution history control demonstrates that California's leadership actions play a vital role in leveraging pollution reductions by other states, nationwide, and even globally. Other jurisdictions have learned from and followed California's leadership, and air pollution technologies pioneered in California have often been widely adopted.

Based on a review of previous analyses, we find that the auto industry and its allies have historically overestimated the actual costs by a factor of about 2 to 10 times the actual costs. Regulators (California Air Resources Board [CARB] and the U.S. Environmental Protection Agency [EPA]) also tend to overestimate costs, albeit to much less extent. A typical regulator estimate of actual automaker compliance costs are 1 to 2 times the actual costs. A primary reason for regulator cost overestimates is the role of unanticipated technological innovation which has dramatically lowered the actual compliance costs in many instances.

Consequently, it is reasonable to anticipate that the new California CO₂ standards for automobiles will have a nationwide, if not global impact, on greenhouse gas emission control and that the cost of compliance will be consistent with CARB staff estimate. Furthermore, as history has demonstrated, unanticipated innovation could very likely reduce the cost of compliance by an even greater degree in the future.

A Review of Auto Industry's Past Estimates of the Impact of Proposed Emission Standards

There is a clear historical pattern of automakers overestimating the cost of compliance with proposed air pollution emission standards, and often regulators overestimating the cost, albeit to a much lesser extent. According to a study done for Northeast air regulators (NESCAUM,) "...pre-regulatory estimates, particularly those on the high-end, can usually be considered to reflect worst case scenarios and do not necessarily form a reliable basis for policy decisions."¹ Another study by the U.S. EPA of gasoline and passenger vehicle regulations found that the "general pattern that is revealed indicates that all *ex ante* estimates tended to exceed actual price impacts, with the EPA estimates exceeding actual prices by the smallest amount."² Researchers have identified the primary reasons for these overestimates:³

1. unanticipated innovation;
2. conservative estimates by both regulators and industry;
3. regulators lacking full access to industry data; and
4. intentional inflation by industry with the purpose to weaken or delay regulations.

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A number of studies have compared pre-regulatory cost estimates (*ex ante*) to the costs that actually occurred once the regulation was implemented (*ex post*) and are summarized below.

1975 Requirement for Catalytic Converters (eventually delayed nationally until 1981, but implemented in California in the mid 1970s.)

The automakers strongly opposed the introduction of catalytic converters. Automobile executives claimed the regulations were not technically feasible and would cause severe economic hardship for their industry. For instance, during a 1972 congressional testimony, General Motors vice president Earnest Starkman declared that if automakers were forced to introduce catalytic converters on 1975 models, “It is conceivable that complete stoppage of the entire production could occur, with the obvious tremendous loss to the company, shareholders, employees, suppliers, and communities.”⁴ Ford president Lee Iacocca claimed that “If the U.S. Environmental Protection Agency does not suspend the catalytic converter rule, it will cause Ford to shut down and would result in: 1) reduction of gross national product by \$17 billion; 2) increased unemployment of 800,000; and 3) decreased tax receipts of \$5 billion at all levels of government so that some local governments would become insolvent.”⁵ Despite these claims, California implemented the regulations and automobile pollution was drastically reduced, requiring the first catalytic converters in 1975 and the first 3-way catalytic converters in 1977.

Chrysler claimed it would cost \$1,300 more to comply with the proposed 1975 federal pollution standards.⁶ In today’s dollars, this is equivalent to \$2,770.⁷ Ford estimated that the cost of a Pinto might rise to \$1,000 (equal to \$2,130 in 2004 dollars.) However, a 1972 report by the White House Science Office estimated the cost would be \$755 (equal to about \$1,600 in 2004 dollars.)^{8,9} The actual cost to comply with the standard, which was delayed until 1981, is estimated to have been \$875 to \$1,350 in 2002 dollars.¹⁰

California LEV I Program (adopted 1990)

In 1990, the CARB adopted the first Low Emission Vehicle (LEV) program that allowed automakers to choose among four different emission standards (TLEV, LEV, ULEV and ZEV) to meet an increasingly stringent fleetwide average for hydrocarbons. Due to automaker concerns, the Board also required a biennial technology review to ensure that the technology would be ready in time for implementation. Throughout the process, the automakers claimed higher compliance costs than what actually occurred.

For instance during the 1994 biennial review, the automakers estimated the cost of meeting the “transitional low emission vehicle” (TLEV) standard to be \$862, the “low emission vehicle” (LEV) standard to be \$1,689, and the “ultra low emission vehicle” (ULEV) standard to be \$2,799.¹¹ In 1998, CARB staff analyzed the actual costs and found them to be much lower.¹² As described in the following section when adjusted for the same baseline vehicle (Tier 0), the actual costs were about \$120, \$168 and \$336 for the TLEV, LEV, and ULEV technologies respectively.¹³ In some cases, the actual cost to the consumer may have been even lower. In 1993, General Motors submitted to the California Energy Commission a request for approval that indicated a \$0 incremental cost for a 1994 model-year TLEV engine.¹⁴ Nissan Motor Company as well as Toyota Motor Corporation indicated \$0 incremental costs for two 1994 model-year engine families corresponding to LEV emission standards.¹⁵

During the first two biennial reviews, automakers focused particularly on the ULEV standard, claiming that costly and complicated technologies would have to be developed and used to meet the ULEV standard, especially in their bigger V-6 and V-8 engine vehicles. In fact, by the time

Honda introduced the first ULEV vehicle in 1998, it achieved this superior emission rating using technologies that were mostly refinements of existing technology and met the standard for about \$336.¹⁶ For the 2003 model year, approximately 70 different models of vans, trucks, and SUVs and 67 different models of cars (comprising nearly 40 percent of all cars sold in California) met the ULEV standard, including on their largest vehicles, such as the Chevrolet Suburban (with a 5.3 liter V-8 engine) and the Dodge Durango (with a 5.9 liter V-8).

Federal Tier 1 Program (adopted 1990)

The 1990 federal Clean Air Act required the automakers to meet more stringent emission standards in states outside of California by 1996. The automakers claimed that the costs of meeting the 1996 federal Tier 1 standards (including Cold CO, OBD, Certification Short Test, and Enhanced Evaporative standards) would be equivalent to \$432. The EPA staff estimated the cost to be \$150. Using actual data submitted by the automakers to the US Bureau of Labor Statistics, EPA staff estimated the actual costs to be \$88.42 (all values cited in 2001 dollars).¹⁷

California LEV II Program (adopted 1998)

In 1998, CARB adopted the LEV II program. The primary automaker lobbying group, the American Automobile Manufacturers Association (AAMA), claimed it was unrealistic and infeasible to make large SUVs and full-size trucks meet the proposed standards.¹⁸ The California Dealers Association estimated the cost for a heavy light truck to meet the ULEV II standards to be \$500.¹⁹ The group “Californians for Realistic Vehicle Standards” (which was set up by Detroit automakers with the assistance of the California Chamber of Commerce)²⁰ claimed that the only way for industry to meet the new standards would require 25 percent of the vehicles sold in California to run on alternative fuels at an increased cost of \$7,000 per vehicle.²¹ This organization also claimed there would be 33 percent fewer full-size vehicles available to consumers.

CARB’s cost estimate for the ULEV II standard was \$206.²² No studies of actual costs have been completed at this point since the standard is just beginning to be phased in for large pickups, but at least one large pickup is already meeting the standard (2006 Toyota Tacoma), as well as some mid-size SUVs (e.g., 2006 Ford Explorer, Jeep Grand Cherokee.)

California AB 1493 Greenhouse Gas Pollution Program (standards adopted 2004)

Finally in 2004, CARB estimated the fleet average cost of meeting the proposed greenhouse gas emission standards to be \$1,018.²³ The auto industry estimates are much higher, \$3,000, with at least one industry-funded group claiming even higher, \$5,000.^{24,25} Implementation of this program begins in model year 2009, so actual cost estimates are not available

Detailed Comparison of Sierra Research and CARB Cost Estimates for LEV I

Cost estimates of the LEV I program have been well studied by CARB and the automakers and so serves as a useful example to examine in greater detail. The auto industry hired a consulting firm, Sierra Research, to provide a more independent assessment of LEV cost then provided by the individual automakers.²⁶ The study (Austin and Lyons 1994) provided three estimates: a high estimate that was provided by the domestic automakers and two lower, adjusted costs estimates that reflected what Sierra Research believed to be a more plausible estimate for a California only and national implementations.

Table 1 shows the Sierra Research estimate for the LEV program for both “California” and “Nationwide” implementation. Note that costs are lower for nationwide implementation due to the greater economies of scale. Unlike CARB’s analysis which used the federal Tier 1 as a baseline vehicle (see Cackette 1998,) Austin and Lyons 1994 use the previous federal standard,

Tier 0, as its baseline. Note that the industry provided estimates were roughly double what Austin and Lyons believed to be plausible for a nationwide implementation.

Table 1. Industry Cost Estimates for California and Nationwide LEV I Implementation (\$ 1994, Tier 0 Baseline)

	Manufacturers	California	Nationwide
California TLEV Standard	\$862	\$463	\$ 344
California LEV I Standard	\$1,689	\$1,019	\$ 775
California ULEV I Standard (midsize)	\$2,799	\$1,475	\$ 1,347

Source: Austin and Lyons 1994

In contrast, CARB 1994 Biennial Review of the LEV program estimated \$61, \$114, and \$227 for TLEV, LEV and ULEV incremental costs, respectively, from a Tier 1 baseline (see Table 2.) Cackette 1998 estimated the actual costs of compliance to have been \$35, \$83, and \$251 for TLEV, LEV and ULEV incremental costs, respectively, again from a Tier 1 baseline. When adjusted (see below) to compare to the Tier 0 baseline costs, the actual costs of compliance are about \$120, \$168, and \$336 (all values in 1994 dollars).

We adjust the CARB cost estimates and actual costs estimates to reflect the additional costs of moving from a Tier 1 to a Tier 0 baseline using the following methodology. To account for the additional cost of the Tier 1 vehicle versus a Tier 0 vehicle, we used data from Anderson and Sherwood 2002 for the actual compliance costs for Tier 1 vehicles. According to Table 8 in the paper by Anderson and Sherwood, the actual vehicle price changes for the Clean Air Act requirements reported to the Bureau of Labor Statistics was \$39.46 in 1994 when Tier 1 was 40% phased in and \$53.51 when Tier 1 was 80% phased in. Subtracting \$12 to account for the Cold CO standard (see Table 10 in Anderson and Sherwood) and accounting for the phase-in percentage yields an average cost of Tier 1 in 1994 and 1995 of \$85.

Table 2. CARB LEV Program Costs, Estimates and Actual (\$ 1994)

	1994 Biennial Review (Tier 1 baseline)	Actual (Tier 1 baseline)	1994 Biennial Review (Tier 0 baseline)	Actual (Tier 0 baseline)
California TLEV Standard	\$61	\$35	\$146	\$120
California LEV I Standard	\$114	\$83	\$199	\$168
California ULEV I Standard (midsize)	\$227	\$251	\$312	\$336

Source: Cackette 1998 and NRDC estimates

Table 3. Ratio of Estimated to Actual Costs (Estimated divided by Actual)

	Manufacturers (cited in Austin and Lyons 1994)	California (Austin and Lyons 1994)	Nationwide (Austin and Lyons 1994)	CARB 1994 Biennial Review
California TLEV Standard	7.2	3.9	2.9	1.2
California LEV I Standard	10.1	6.1	4.6	1.2
California ULEV I Standard (midsize)	8.3	4.4	4.0	0.9

Source: NRDC

The estimates by Sierra Research for the California LEV program are 4 to 6 times higher than the actual costs (see Table 3 above). We use the California level numbers since the CARB actual cost estimates were presented in 1998, prior to the implementation of the National LEV program and

therefore represent California-only implementation costs. The basic conclusion remains the same regardless of which numbers are used for comparison. If Sierra Research's nationwide numbers are used, the cost overestimate is about 2.9 to 4.6 times higher versus 3.9 to 6.1 when California numbers are used. Compared to the manufacturers' cost estimates cited in Austin and Lyon 1994, the automakers' estimates were 7 to 10 times higher than actual costs. In contrast, CARB estimates were 0.9 to 1.2 times higher; with the ULEV cost estimates for a mid-size car slightly underestimated (\$312 versus \$336).

Summary of Cost Estimates

Table 4 and Figure 1 summarize our review of past cost estimates and actual costs for light duty vehicle pollution control. Our results show that the industry's typical pre-regulatory cost estimates for gasoline vehicle emissions controls have been 2 to 10 times higher than the actual compliance costs (see Table 5). Regulators also have a tendency to overestimate costs, albeit to much lesser extent. A typical regulator estimate of actual automaker compliance costs are 1 to 2 times the actual costs.

Table 4. Comparison of Estimated Costs to Actual Price Changes

Program	Industry & Allies	Regulators	Actual
1975 Federal Standard (\$2004)	\$2,130-2,770	\$1,609	\$875-\$1,350
California LEV I Program vs Tier 1 Baseline (\$1994)	\$788	\$120	\$83
California LEV I Program vs Tier 0 Baseline (\$1994)			
California TLEV Standard	\$344-862	\$146	\$120
California LEV I Standard	\$775-1,689	\$199	\$168
California ULEV I Standard (midsize)	\$1,347-2,799	\$312	\$336
1996 Federal Tier1 + OBD (\$2001)	\$432	\$150	\$88
California ULEV II, Heavy Light Truck (\$1998)	\$500-7,000	\$206	not estimated
California CO ₂ -eq Standard (\$2004)	\$3,000-\$5,000	\$1,048	not estimated

Sources: Doyle 2000; Sperling et al 2004; Austin and Lyons 1994; Cackette 1998; Anderson and Sherwood 2002; CARB 1999; CARB 2004; AAM 2004; and NRDC

Figure 1. Comparison of Cost Estimates versus Actual Costs

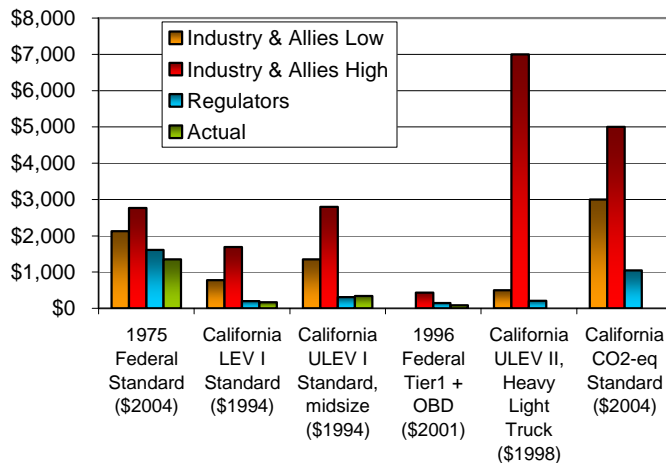


Table 5. Ratio of Estimates to Actual Costs

Program	Industry & Allies	Regulators
1975 Federal Standard (\$2004)	1.6-3.2	1.2-1.8
California LEV I Program vs Tier 1 Baseline (\$1994)	9.5	1.4
California LEV I Program vs Tier 0 Baseline (\$1994)		
California TLEV Standard	2.9-7.2	1.2
California LEV I Standard	4.6-10.1	1.2
California ULEV I Standard (midsize)	4.0-8.3	0.9
1996 Federal Tier1 + OBD (\$2001)	4.9	1.7

Source: NRDC

Cost Overestimates in Other Air Pollution Regulatory Programs

Cost overestimates by both industry and regulators are not limited to the automobile sector and are seen across many other programs, including reformulated fuels and power plant emissions controls.

California Phase 2 Reformulated Gasoline

In 1991, the ARB estimated that the cost to meet California's proposed Phase 2 Reformulated Gasoline (RFG) requirements would translate into an estimated increase in cost of 12 to 17 cents per gallon of gasoline (see Table 6). However, a study sponsored by the oil industry, represented by the Western States Petroleum Association (WSPA), placed the increase in the cost of gasoline at 23 cents per gallon. Four California refiners that were cited in the 1991 staff report also estimated an increase in cost of as much as 30 cents per gallon of gasoline when the regulation was implemented statewide in 1996. A price study was performed in 1997 that compared the price differential of California reformulated gas over the average price of five representative cities (Phoenix, Portland, Dallas, Milwaukee, and New York City) from before Phase 2 RFG implementation, in 1995, to after Phase 2 implementation, in 1997. This study concluded that even though gas prices were very volatile due to market forces, the price differential was only 5.4 cents per gallon.

Table 6. ARB Cost Predictions vs. Actual Price Increase of California Phase 2 Reformulated Gas

Year	ARB Increased Cost Estimates (c/gallon)	WSPA Increased Cost Estimates (c/gallon)	Actual Consumer Price Increase
1991	12-17	23	-
1996	10 (5 – 15 range)	-	-
1997	-	-	5.4

Source: Cackette 1998

EPA Fuel Control Programs

In a study of six EPA fuel control programs (see Table 7), EPA staff analyst compared estimates by the EPA, the Department of Energy (DOE), the American Petroleum Institute (API), and, on some occasions, Charles River Associates (CRA) or the American Institute of Automobile Manufacturers (AIAM). The EPA made accurate estimations for the Phase 2 RFG (which was underestimated) and the 500ppm highway diesel sulfur regulations, yet overestimated Phase 2 RVP control by 120 percent and Phase 1 reformulated gas by 41 to 132 percent.

Other estimations were often less accurate. The DOE overestimated the increase in cost by 55 to 86 percent for Phase 1 RFG and 49 to 100 percent for Phase 2 RFG while the API overestimated Phase 2 RVP by 260 percent, Phase 1 RFG by 273 to 536 percent, and Phase 2 RFG by 118 to 280 percent. The industry representatives CRA and the NPRA overestimated Phase 1 RFG by 236 percent, Phase 2 RFG by 135 percent, and 500 ppm highway diesel by 50 percent.

Table 7. Comparison of Inflation Adjusted Estimated Costs and Actual Price Changes for EPA Fuel Control Rules

	Inflation Adjusted Cost Estimates (c/gal)				Actual Price Changes
	EPA	DOE	API	Other	
Gasoline					
Phase 2 RVP Control (7.8 RVP – Summer)	1.1 ^a		1.8 ^a		0.5
Reformulated Gasoline Phase 1	3.1-5.1 ^b	3.4-4.1 ^b	8.2-14.0 ^b	7.4 ^b (CRA)	2.2
Reformulated Gasoline Phase 2 (Summer)	4.6-6.8 ^c	7.6-10.2 ^c	10.8-19.4 ^c	12.0 ^c (CRA)	7.2 (5.1) ^d
Diesel					
500ppm sulfur highway diesel fuel	1.9-2.4 ^b			3.3 ^b (NPRA)	2.2

Notes: ^a 1995 dollars. ^b 1997 dollars. ^c 2000 dollars. ^d Corrected to 5yr average MTBE price (Source: Anderson and Sherwood, 2002)

SO₂ Controls for Powerplants

In a study by NESCAUM, researchers found that for the Title IV SO₂ control costs for powerplants, EPA's pre-regulatory estimates were consistent with actual costs, whereas industry overestimated actual control costs by more than 80 percent. A similar tendency for industry to exaggerate costs was also found for NO_x control technologies.²⁷

Another study of powerplant controls found that for SO₂ scrubbers, control costs decreased by 11 percent for each doubling in installed capacity. The same study found a NO_x control technology (SCR) that decreased cost by 12 percent by doubling capacity.²⁸

How Regulation Induces Technological Innovation: Engineering Case Studies

As stated above, there are at least four factors that researchers have identified to account for the differences in *ex post* and *ex ante* regulatory cost estimates. As seen from the above review, a significant portion of the industry cost over estimates are due to highly conservative estimates, either intentional or unintentional. However, even regulators often overestimate the cost.

One very powerful factor that can partially explain both the industry and regulator estimates is the role of unanticipated innovation. The history of automotive regulation indicates that manufacturers very often utilize technologies and implement compliance paths different from initial predictions, resulting in lower than predicted costs. A clear theme also emerges from the study of the history of air pollution regulation, that *a strong regulation spurs innovation*.²⁹ A strong regulation eliminates regulatory uncertainty and provides a powerful competitive incentive for automakers and their suppliers to innovate to sometimes radically reduce costs.

The concept of innovation improving the performance and lowering the cost of products is a well-observed phenomenon across many industries. The concept has been described using a “learning curve” (or experience curve)³⁰ and there is “overwhelming empirical support” for this

relationship.³¹ In addition, technological “spillover” effects provide powerful, unanticipated, advances, such as electronic controls, fuel injection, and advanced sensors spurring the ability to provide much more precise control of the air/fuel ratio inside the engine cylinder.

By examining case studies, one can clearly see how the incentive to meet strong emission standards has spurred engineering advances that often eliminate the need for most costly and complex control technologies thereby lowering compliance costs.

1970s: Honda Innovates Lower Cost, Non-Catalyst Solution (CVCC)

Before 1969, it was commonly thought that the only way to reduce automobile pollution was by using end-of-pipe technology such as catalytic converters. Yet, as California emission standards came into effect, influenced national policy, and culminated nationally in the 90 percent reduction in auto emissions as required by the Federal Clean Air Act of 1970, one automobile manufacturer, Honda, pursued alternative methods of pollution reduction. The company’s founder, Soichiro Honda, instructed his engineers to “try to clean up the exhaust gases inside the engine itself without relying on catalytic converters.”³² These engineers proceeded by combining existing technologies in a new way to achieve a cleaner burn.³³

Their efforts resulted in the “Compound Vortex Controlled Combustion” (CVCC) engine that was designed with a small “pre-burn” chamber upstream of the cylinders. Honda discovered that by pre-burning the gasoline/air mixture, more impurities were removed before they reached the tailpipe. This technology allowed Honda to meet the 1970s Clean Air Act standards without the use of catalytic converters. It also proved beneficial to Honda as Detroit manufacturers, who initially scoffed at Honda’s accomplishments, each licensed the technology from Honda in 1973.³⁴ The implementation of CVCC technology on the Honda Civic in the 1970s disproved Detroit’s claim that meeting emissions and fuel economy standards simultaneously was impossible, as the EPA ranked the Civic first in fuel economy among all models.³⁵

LEV I: Improved Catalysts and Other Refinements Eliminate the Need for Electrically Heated Catalysts and Dual Catalysts

In 1994, automakers claimed that meeting LEV I vehicles would have to use close-coupled catalysts, electrically heated catalysts (EHCs), and/or hydrocarbon traps, especially for their bigger V-6 and V-8 engine vehicles. Actual costs turned out to be much lower, principally by eliminating the need for a costly electrically heated catalyst and dual catalysts through technologies not originally anticipated by CARB in 1990. Table 8 presents a comparison of 1990 and 1994 ARB technological projections with actual 1998 four, six, and eight cylinder LEVs. Highlighting denotes where inaccurate predictions were made.

A critical innovation was in catalyst technology, enabled by advances in design and materials, which allowed faster “light off” of the catalyst. While three-way catalytic converters traditionally utilized rhodium and platinum as the catalytic material, advances in palladium and tri-metal (i.e., palladium-platinum-rhodium) catalyst technology allowed converters to increase high-temperature durability over previous catalysts and lower the temperature at which 50 percent pollution conversion occurs (called “light-off” performance). Heat-optimized exhaust pipes and heat-producing engine calibrations further contributed to quicker catalyst light-off. This improvement in light-off capability allowed catalysts to be placed further from the engine than was previously predicted and virtually eliminated the need for other, more complicated after-treatment devices in light-duty vehicles such as electrically-heated catalysts and their complementary air injection systems.

Important innovations were more precise fuel control systems enabled by fuel injection, sensor and computer controls. The development of dual oxygen sensors and adaptive transient fuel control systems reduced engine-out emission levels which allowed the utilization of technologies that were refinements of existing Tier 1 standard technologies rather than more costly and complex after treatment emission control technologies.³⁶

Table 8. LEV Technologies, Projected versus Actual

X = 1998 LEV Honda Civic Four Cylinder O = 1998 LEV Toyota Camry Six Cylinder V = 1998 LEV Ford Crown Victoria Eight Cylinder			
Technology	1990 ARB Projected	1994 ARB Projected	1998 Actual
<i>Projected and actually employed</i>			
Dual Oxygen Sensors	X O V X	X O V X	X O V X
Adaptive Transient Fuel Control Systems	O V X	O V X	O V X
Sequential Air-Assist Fuel Injectors	O V -	O V X	O - X
Heat Optimized Leak-Free Exhaust	- - X	O V X	O V X
Greater Catalyst Loading	O V	O V	O V
<i>Innovations</i>			
Dual Close-coupled Catalyst	- - - -	- - - X	- - V X
Close-coupled Catalyst	- -	80% of fleet -	O -
<i>Projected but mostly not needed</i>			
Under-floor Catalyst	X O V X	X 80% of fleet V -	- O - -
Electrically Heated Catalyst	O V -	20% of fleet V -	- - -
Air Injection	O V	20% of fleet V	- -

Source: Cackette 1998

PZEV: “Partial ZEV” Standards Cost Estimates Rapidly Fall

Another very good case study has to do with the technologies used to meet the “partial zero emission vehicle” (PZEV) standard. In order to move from the next cleanest standard (SULEV) to PZEV emission levels, the ARB predicted in August 2000 that vehicles would need to be equipped with separate hydrocarbon absorbers and attendant switching valves. It was also assumed that, as was the case for the first PZEV system in California, all PZEVs would be required to increase catalyst volume. Furthermore, the ARB believed that additional carbon trap capability, improved seals, and some reconfiguration of components (necessary to move from near-zero to zero evaporative emission control systems) would be required.³⁷ The ARB figured that the cost of this additional hardware would be \$200. It also estimated that another \$300 would be required to cover the expense associated with increasing the warranty to 15 years/150,000 miles. This figure assumed three repairs per vehicle over the extended warranty period, due in part to the more complex technology involved. Altogether, the ARB estimated that the incremental cost of going from a SULEV to a PZEV would be about \$500.

Yet, only a year later in the Fall of 2001, the ARB revised their predictions as it became apparent that the use of simpler PZEV technology would be utilized. By 2003, the ARB said that, as in the LEV I program, technology would actually be simpler than predicted³⁸ due to the appearance of innovative PZEV systems. Instead of separate hydrocarbon absorbers and attendant switching valves, soon to be introduced PZEVs would utilize a combined hydrocarbon absorber and catalyst. Also, increased catalyst volume would not be required to meet PZEV compliance. Thus, incremental cost estimates for necessary hardware were reduced from \$200 to between \$60 and \$85. The ARB also realized that the less complex nature of underlying technology and the increased durability of emission control components used by PZEVs made their \$300 warranty estimate too high. This figure was revised to between \$125 and \$150 per vehicle, making the total incremental cost of PZEVs relative to SULEVs about \$200, which is 60 percent less than their original estimate. The ARB now estimates that the incremental cost of PZEVs relative to SULEVs will soon be less than \$100. It is unclear yet whether this prediction is accurate.

A look at one example of a PZEV, the 2003 Ford Focus, indicates that the car met the standard not because of any single or even multiple new technologies, but, as Ford's vice president of Powertrain Operations Dave Szczupak explained, because of "attention to every little detail."³⁹ Among these details was the new 2.3-liter engine's computer-designed, friction-welded plastic intake manifold. Within each of the manifold's four runners was a butterfly valve that restricts airflow at low speeds and increases flow at higher speeds, an innovation that enhances more complete fuel combustion. Other details included a four-hole injector design that also contributes to better combustion and lower emissions and a precise computer-controlled sequential electronic fuel injection. As a result of these modifications and despite its strict emissions qualification, the car's engine was of larger displacement than the one it replaced, weighs less, produces more horsepower, and is more fuel-efficient. A partial list of new technologies implemented on the Ford Focus to reduce emissions by complete combustion and exhaust scrubbing is listed below in Table 9.

Table 9. New Emission-Reduction Technologies Not Predicted by CARB Implemented on the Ford Focus PZEV

Technology	Effect
12-hole fuel injectors	Better atomizes fuel and results in improved combustion.
Charge Motion Control Valves (CMCVs)	Induces tumble in the intake charge below 1800 rpm by partially blocking the intake port. This fills the cylinder better at low speeds, improves the mixing of gasoline and air, and thus improves combustion.
Upgraded catalysts	Cleans exhaust better and are more durable.
Electric air injection into the exhaust manifold	Burns off excess hydrocarbons at startup and heats the catalytic converter to its most efficient operating temperature (called "light off") faster.
"Black Oak" engine management computer	A new engine management computer that runs at a higher speed and contains more memory than the previous computer, thereby allowing a better optimization of the air-fuel ratio.
Coil-on-plug (COP) ignition	Provides a stronger spark that helps stabilize combustion.
Improved seals on the piston rings, valves, and PCV system.	Reduces oil consumption.
Improved engine cylinder bore finish and cylindricity.	Reduces oil consumption.

Source: Carney 2003

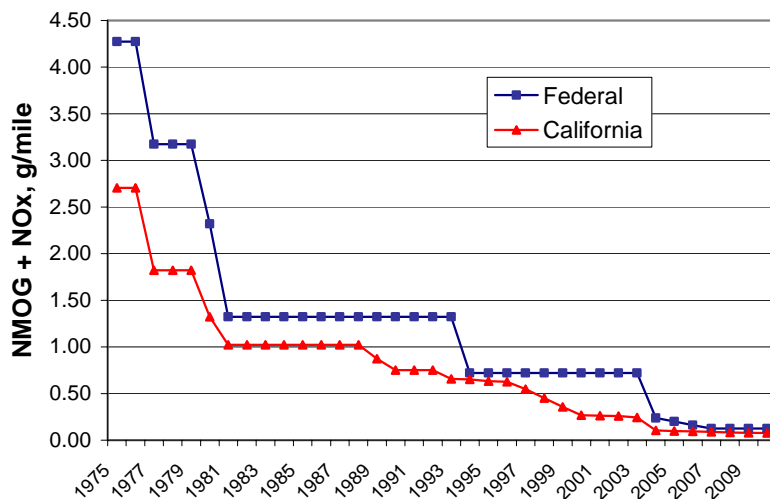
By the 2003 model year, popular manufacturers such as Honda, Toyota, BMW, and Volvo offered 12 different models of PZEVs while Honda offered their Civic Hybrid as an AT-PZEV. These clean cars benefit not only California, but the rest of the nation as well since several of the

manufacturers, such as Ford, Toyota, and Honda offer their vehicles for sale nationwide. The new Ford Focus PZEV has a global effect as its engine replaces a total of eight different engines formerly used by various Ford entities around the world, could ultimately reach an annual production volume of 1.5 million units, and is destined to be produced at four plants and power up to 20 percent of the vehicles Ford produces worldwide.⁴⁰ The engine is also used in the Mazda 6, Ford Ranger pickup trucks, the Futura, and the hybrid-electric Escape.⁴¹ Eventually, the engine could replace nearly all of the other inline four-cylinder engines used by Ford and its subsidiaries worldwide.⁴²

California Leadership: Examples of How California Standards Have Had National and Global Impacts

California has historically led the nation in setting tough new air pollution standards (see Figure 2.) California standards and approaches have often been adopted by other states and at the national level (see Tables 10 and 11.) Other countries have adopted the clean air technologies and programs pioneered in California, such as the three-way catalytic converter and reformulated gasoline. It appears highly likely that the adoption of new CO₂ standards in California will perform the same function for global warming pollution. Historically and legally, California has served two clear functions that have led to national pollution benefits of its program.

Figure 2. California Has Historically Led the Nation on Automotive Air Pollution Standards



Source: CARB and EPA

First, California serves as a “laboratory” or “pioneer” of new technologies and new approaches. The California “model” then allows the federal government to adopt the same or a similar approach. This role is explicitly recognized in federal law and by Congress which granted California the only state to have the authority to set its own motor vehicle pollution standards. This occurred with the 1966 California tailpipe standards (adopted by the federal government in 1968), the 1990 California LEV program (which became the model for the National LEV program) and finally the 1998 California LEV II program (which served as the model for the federal Tier 2 program.) California also pioneered compliance testing, smog check, and reformulated gasoline and diesel, all of which were adopted nationally.

Table 10. List of Automobile Pollution Standards Pioneered in California and Adopted Nationally

Technology or Standard	California Debut	Federal Debut
First air pollution control requirement (Positive Crankcase Ventilation)	1963	
First HC and CO standards	1966	1968
First NOx standard	1971	1973
First Catalytic Converter (2-way)	1975	
First Catalytic Converter (3-way)	1977	1981
First Ban on Leaded Gasoline	1992	1995
First Reformulated Gasoline	1992	1995
LEV I (NLEV)	1994	1999 Northeast, 2001 National
LEV II (Tier 2)	2004 (adopted 1998)	2004 (adopted 1999)

Source: CARB, Doyle 2000, NRDC

Table 11. Chronology of California Automotive Emission Control Leadership

Year Adoption/Effect	Event
1961/1963	California adopts the first automotive emissions control technology in the nation, the Positive Crankcase Ventilation (PCV) . Goes into effect on new passenger vehicles for sale in California for model year 1963.
1964/1966	California adopts the first-ever tailpipe emission standards for hydrocarbons and carbon monoxide which go into effect 1966.
1965/1968	Congress passes Motor Vehicle Control Act of 1965 that adopts California's 1966 standards nationally as of 1968. (NESCAUM 2000, II-4)
--/1971	The first automobile nitrogen oxides (NOx) standards in the nation go into effect in California
--/1973	First federal standards for NOx.
1973/1975	California adopts stringent new standards, prompting first catalytic converters to come into use in California.
1975/1977	California approves adoption of stringent new HC and NOx standards that requires the use of three-way catalytic converters for the first time. (Doyle 2000, p108)
1977/1981	New federal law passed with standards for HC and NOx similar to the 1977 standards beginning in 1981, delaying the debut of three-way catalysts nationally until 1981 (Doyle 2000 p 147-8).
1980	California requires compliance testing on automobiles as they age to encourage the manufacturing of more durable emissions control equipment.
1984	California Smog Check Program goes into effect.
1990/1994	California adopts the strictest emission standards, the Low -Emission Vehicles I (LEV I) Program , begins in 1994. EPA, bowing to northeast state pressure, adopts National LEV (NLEV) program modeled after the California LEV I program.
1990/1992	CARB adopts first-ever reformulated gasoline program which takes effect beginning in 1992 (Phase I California Cleaner Burning Gasoline) including the phase out of leaded gasoline.
1994/1995	EPA adopts its federal reformulated gasoline program modeled on California's program, including the phase out of leaded gasoline.
1998/2004	California adopts the Low Emission Vehicle II (LEV II) Program for the strictest new emission standards on vehicles.
1999/2004	US EPA adopts Tier 2 Program, largely modeled on California's LEV II.

Source: CARB, Doyle 2000, NRDC

A 2006 National Academy of Sciences (NAS) study confirmed the powerful role that California has played in forcing new technologies. According to this study:

This history of the LEV and ZEV demonstrates the benefits of using California as a laboratory to experiment with aggressive, high-risk strategies. The technology-forcing requirements that CARB imposes can result in major breakthroughs in emission controls.⁴³

Second, under the Clean Air Amendments of 1977, Section 177 allows other states with air quality problems to adopt the California motor vehicle pollution standards. Because of this provision according to the NAS, “the technology-forcing nature of California standards can benefit not California but also the rest of the country.”⁴⁴ Prior to the adoption of the CO₂ standards in 2004, seven states had adopted the California LEV II program and thirteen states have adopted California heavy-duty standards (so-called “Not-to-Exceed” limits). As of early 2006, ten other states have adopted California’s LEV II program with its CO₂ standards. Consequently about 33 percent of the nation’s new vehicles sales fleet is subject to the more stringent California LEV II program standard, including its CO₂ standards (see Figure 3).

The “threat” of state adoption under Section 177 of more stringent California standards puts pressure on the industry and federal EPA to develop standards more stringent than the existing federal standards or to maintain strong federal standards (e.g., the National LEV program, and the 2007 diesel truck standards).

Figure 3. California LEV II States



Source: NRDC

Because of the long-standing success of California’s role in setting its own mobile source standards, the NAS strongly recommended that California continue its unique authority. Specifically, its recommendation is that:

California should continue its pioneering role in setting mobile-source emissions standards. The role will aid the state’s efforts to achieve air quality goals and will allow it to continue to

be a proving ground for new emissions-control technologies that benefit California and the rest of the nation.⁴⁵

Other Examples of California Programs Serving as a Model for National Standards

Besides motor vehicle pollution control, there are other programs that have been pioneered in California that have been adopted nationally and even internationally (appliance and building codes in Russia and China for example). Again, this further demonstrates that a California CO₂ vehicle standard will likely have impacts that go well beyond California's borders.

Appliance efficiency standards⁴⁶

A major discussion of energy policy options in California in the early 1970s that was undertaken due to environmental concerns regarding new power plant siting prompted California to take the lead on appliance efficiency issues by passing the Warren Alquist Act in 1974. This act established the California Energy Commission with the authority to set appliance efficiency standards. The technical and policy analysis undertaken in California had impacts on the national level, as the federal government's interest in appliance efficiency grew. In 1975, the Ford administration initiated an executive order and later signed the Energy Policy and Conservation Act of 1975 establishing the use of voluntary targets for appliance efficiency to reduce new appliance energy use by 20 percent relative to current levels.

Yet, California and other states were unhappy with the uncertainty of voluntary reductions in energy use and, therefore, began to adopt mandatory energy efficiency standards between 1975 and 1977. This state-level work changed the dynamic at the federal level, prompting newly elected President Carter to propose legislation that would replace the voluntary efficiency targets with mandatory standards. Despite negative reactions by manufacturers, Congress passed and the President signed the National Energy Conservation and Policy Act (NECPA) in 1978. Manufacturers' concerns were placated, in part, by giving these DOE standards preemptive power over state standards.

Upon the change in administration in Washington in 1980, many states became concerned about the government's new hostility towards standards and the lack of progress on appliance efficiency. It was apparent that for progress to be made, it would have to be initiated on the state level. California, with its EPA waiver, adopted stringent two-tiered standards for refrigerators and central air conditioners in 1984. By 1986, Arizona, Florida, Kansas, Massachusetts, and New York had adopted standards on one or more products. In response to the growing desire by manufacturers to preempt these state efforts at setting standards, Congress passed and the President signed the National Appliance Energy Conservation Act (NAECA) in 1987.

Building efficiency standards⁴⁷

Before the DOE established energy efficiency standards for new buildings, the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) promulgated an energy standard, "Standard 90", that was the predominant influence on standards adopted by states. This standard, which was comprised of Standard 90.2 (for residential buildings) and 90.1 (for commercial buildings), drew heavily from California's pioneering work in the field.

California's standards originated in 1975 when the newly established CEC, under a mandate by the Warren Alquist Act, adopted efficiency standards for residential buildings. California's work continued when, after a comprehensive review of the standards, the state adopted new standards in 1980 that required significantly increased levels of energy efficiency as well as embodied several regulatory innovations. Then, in 1987, the state made modifications that resulted in great improvements in the energy efficiency and political acceptability of the standards. Much of the

research and regulatory structure developed in California was adopted directly or in modified form by the ASHRAE committees and thereby adopted by most states.

Conclusion

The past four decades of California leadership and pioneering efforts in automobile pollution control also strongly suggests that the California CO₂ standards will have a national and probably even global impact. In this paper, we have also demonstrated that there is a clear historical pattern of automakers overestimating the cost of compliance with proposed air pollution emission standards for gasoline automobiles. Our review of previous estimates from as far back as 1975 finds that the auto industry and its allies have historically overestimated the actual costs by a factor of about 2 to 10 times the actual costs. Regulators have also tended to overestimate costs, albeit to a much lesser extent. A typical regulator estimate of actual automaker compliance costs are 1 to 2 times the actual costs. Hence, based on this past three decades of historical evidence, it is fair and reasonable to assume that both the automakers and the regulator air pollution control cost estimates, including for the proposed California CO₂ standards, will be higher than actual costs. A primary reason for regulator cost overestimates is the role of unanticipated technological innovation which has dramatically lowered the actual compliance costs in many instances. Furthermore, as history has demonstrated, unanticipated innovation could very likely reduce the cost of compliance by an even greater degree in the future.

¹ NESCAUM, "Environmental Technology and Technology Innovation: Controlling Mercury Emissions from Coal-Fired Boilers," Northeast States for Coordinated Air Use Management, September 2000.

² Anderson and Sherwood, "Comparison of EPA and Other Estimates of Mobile Source Rule Costs to Actual Price Changes," presented at the SAE Government Industry Meeting, DC, May 14, 2002, SAE 2002-01-1980.

³ See Harrington et al., "On the Accuracy of Regulatory Cost Estimates," Resources For the Future, January 1999, and NESCAUM 2000.

⁴ Doyle, Jack. *Taken For A Ride*, New York: Four Walls Eight Windows, 2000, p. 42.

⁵ Sierra Club of Canada. "Will the Kyoto Protocol shutdown Canada? No it won't. Our economy will continue to grow and grow." October 11, 2002. [online] <http://www.sierraclub.ca/national/media/kyoto-economy-02-10-11.html>

⁶ Doyle 2000, p. 77.

⁷ NRDC calculation based on Producer Price Indexes for automobiles from the Bureau of Labor Statistics.

⁸ Doyle 2000, p. 77 and p. 92.

⁹ NRDC calculation based on Producer Price Indexes for automobiles from the Bureau of Labor Statistics.

¹⁰ Sperling, et al., "Analysis of Auto Industry and Consumer Responses to Regulations and Technological Change, and Customization of Consumer Response Models in Support of AB 1493 Rulemaking," June 1, 2004.

¹¹ Austin and Lyons, "Cost Effectiveness of the California Low Emission Vehicle," SAE Technical Paper Series 940471, presented at the International Congress & Exposition, Detroit MI, February 28-March 3, 1994.

¹² Cackette, "The Cost of Emission Controls, Motor Vehicles and Fuels: Two Case Studies," presentation at MIT, 1998.

¹³ CARB staff estimated the cost to be \$35 from a Tier 1 baseline (Cackette 1998). We adjusted the CARB estimate by adding another \$85 to account for the cost difference between a Tier 0 and Tier 1 vehicle based on data in Anderson and Sherwood 2002.

¹⁴ Kourt, J.M., Letter to Charles Mizutani of the CEC, *Request for Approval of \$0.00 Incremental Cost for General Motors 1994 Model Year TLEV 2.2L Engine Equipped J and L Models (Engine Family RIG2.2V7G2EA)*, April 22, 1993.

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- ¹⁵ Patterson, Susan. Letters to Motoko Katoh (Nissan Motor Company) regarding \$0.00 incremental cost for Nissan engine family RNS2.4VJG2EA, and David Hermance (Toyota Motor Corporation) regarding \$0.00 incremental cost for engine family number RTY2.2VJG2GA.
- ¹⁶ CARB staff estimated the cost to be \$251 from a Tier 1 baseline (Cackette 1998). We adjusted the CARB estimate by adding another \$85 to account for the cost difference between a Tier 0 and Tier 1 vehicle based on data in Anderson and Sherwood 2002.
- ¹⁷ Anderson and Sherwood 2002.
- ¹⁸ CARB, “‘LEV II’ and ‘CAP 2000’ amendments to the California Exhaust and Evaporative Emission Standards,” Final Statement of Reasons (FSOR), September 1999, p 26.
- ¹⁹ CARB 1999.
- ²⁰ According to the New York Times (“Light Trucks Face Tougher Standards,” November 3, 1998), the so-called “Californians for Realistic Vehicle Standards” was set up by Detroit automakers with the assistance of the California Chamber of Commerce:
- The address of the month-old lobbying group is the Sacramento headquarters of the California Chamber of Commerce, while the group’s telephone number is that of the Sacramento office of Burson-Marsteller, an international public relations firm often used by the auto industry.
- ²¹ CARB 1999, p. 42.
- ²² *ibid.*, p. 45.
- ²³ CARB, “Addendum Presenting and Describing Revisions to: Initial Statement of Reasons and Proposed Rulemaking, Public Hearing to Consider Adoption of Regulations to Control Greenhouse Gas Emissions from Motor Vehicles,” September 10, 2004.
- ²⁴ AAM press release, September 22, 2004.
- ²⁵ High is Ron Defore of SUVOA, cited in article “‘Cool gray city’ projected to turn murderously hot, temperatures likely to rise by mid-century as a result of global warming study warns,” Carl T. Hall San Francisco Chronicle September 14, 2004.
- ²⁶ Austin and Lyons 1994.
- ²⁷ NESCAUM 2000.
- ²⁸ Rubin, E et al. “Learning curves for environmental technology and their importance for climate change policy analysis,” *Energy* 29 (2004) 1551-1559.
- ²⁹ NESCAUM 2000.
- ³⁰ For example, see Arrow K, “The Economic Implications of Learning by Doing”, *Review of Economic Studies*, p. 155, 1962, and Argote, L. and Epplé, D. “Learning Curves in Manufacturing”, *Science*, Vol. 247, p. 920, 1990.
- ³¹ IEA, *Experience Curves for Energy Technology Policy*, OECD/IEA, 2000.
- ³² Sakiya, Tetsuo. *Honda Motor: The Men, The Management, The Machines*, Tokyo and New York: Kodansha International, 1982, p. 181, in Doyle, Jack. *Taken For A Ride*, New York: Four Walls Eight Windows, 2000, p. 326.
- ³³ *ibid.*, p. 326.
- ³⁴ *ibid.*, p. 328.
- ³⁵ *ibid.*, p. 328.
- ³⁶ California Air Resources Board. *Low Emission Vehicle and Zero Emission Vehicle Program Review*, staff report, November 1996.
- ³⁷ California Air Resources Board, *2000 Zero Emission Vehicle Biennial Review*, staff report, August 7, 2000.
- ³⁸ California Air Resources Board, *Revised Discussion of PZEV Incremental Cost*, 2003.
- ³⁹ *Ford’s Focus Bringing Thousands of PZEVs to Worldwide Markets*, Green Car Journal, Volume 12, Number 3, March 2003, p. 29.
- ⁴⁰ *ibid.*
- ⁴¹ Carney, Dan. *Global 14 goes PZEV*, Automotive Engineering International, Volume 111, Number 7, July 2003, p. 76-78.
- ⁴² *ibid.*
- ⁴³ National Research Council, *State and Federal Standards for Mobile Source Emissions*, prepublication copy, Committee on State Practices in Setting Mobile Source Emission Standards, National Research Council of the National Academies, the National Academy Presses, 2006, p. 115.
- ⁴⁴ *ibid.*, p. 117.

⁴⁵ *ibid.*, p. 3.

⁴⁶ All the information for this section was obtained from: Nadel, Steven and Goldstein, David. *Appliance and Equipment Efficiency Standards: History, Impacts, Current Status, and Future Directions*, Proceedings of the 1996 ACEEE Summer Study on Energy Efficiency in Buildings, American Council for an Energy Efficient Economy, Washington, DC, 1996.

⁴⁷ All the information for this section was obtained from: Goldstein, David. *The American Experience with establishing energy Efficiency Standards for New Buildings: Case studies of California and National Energy Standards*, Presented at the third Soviet American Symposium on Energy Conservation, Yalta Crimea, U.S.S.R. National Resources Defense Council, San Francisco, 1988.

Appendix B:

NRDC Retrospective Look at Cost Claims to Meet 2016 Fuel Economy and Greenhouse Gas Emissions Standards

**Automakers Cost Claims versus Reality:
Retrospective Look at Cost Claims to Meet 2016 Fuel Economy and Greenhouse Gas Emissions
Standards**

SUMMARY OF COST CLAIMS

Automakers of a long history of exaggerating cost of compliance for pollution, fuel economy and safety standards. A recent example of this was during the past decade when automakers strongly fought the adoption of California's ground-breaking CO₂ tailpipe standards, the equivalent of 35.5 mpg in model year 2016, which eventually become the national standard.

While the regulators estimated the average, fleet-wide cost of compliance to be about \$1,000, auto manufacturers claimed the cost would be as high as \$6,000. In 2015, a National Research Council fuel economy committee estimated the cost of compliance for a model year 2016 mid-size car to be the equivalent of less than \$500.

- **CARB adoption of Pavley Standards (September 2004)**
 - Automakers relied primarily on their key technical consultant, Tom Austin of Sierra Research, to claim the costs are three times higher than what CARB staff estimate.
 - Automakers and their consultant (Sierra Research) testified in front of the California Air Resources Board that the average cost for cars and light trucks to meet 2016 standards would be an approximately \$3,000 per vehicle versus the California Air Resources Board's estimate of about \$1,000.¹
 - Sierra Research estimated the costs are even higher for cars, \$4,573 versus CARB's estimate of \$1,308.²
- **Vermont Pavley Case, Automaker Testimonies (April 2007)**
 - Under oath, automakers and their expert witness (Tom Austin) expand on their claims in front of the CARB Board. GM cost claim jumps to over \$6,000 and claims even at that cost, they would fall 7 mpg short of the standard. Detroit manufacturers claim they will have to withdraw from the car market in the clean car states.
 - GM (Alan Weverstad) testified that GM's cost to meet California's standard would be greater than \$6,000 per vehicle but would still fall 7 mpg short of meeting the standard, and they would have to completely stop selling cars and small trucks.
 - Automaker's expert witness, Tom Austin of Sierra Research, testifies that Honda, Toyota and Hyundai costs would be \$2,500, Ford and DaimlerChrysler costs were greater than \$3,500 per vehicle, and Volkswagen, General Motors, and Nissan costs were greater than \$4,500. DaimlerChrysler, Ford, and General Motors would withdraw car products and become primarily truck manufacturers in those states.
- **Automaker Restructuring Plan submitted to Congress (December 2008)**
 - Less than a year after the automakers claim under oath extremely high cost and technical infeasibility of meeting standards to the Vermont court, GM and Ford submit

¹ California mix is 70/30 PC-LDT1/LDT2, with estimate costs for PC-LDT1 = \$1064 and for LDT2 = \$1029, so average cost estimated by CARB is \$1054.

² CARB must have revised its cars cost downward from when Sierra Research made their comparison.

restructuring plans to Congress in hopes of getting government bailout loans shows that the automakers have been planning to substantially raise fuel economy levels.

- GM restructuring plan states that it will achieve 2012 fuel economy levels of 37.3 mpg and 27.5 mpg for their new car and light truck fleets, respectively. NRDC estimated that GM's combined fleet fuel economy would be 31.4 mpg by 2012 and would enable GM to comply with a national version of the California GHG standards in 2012.
- Ford's plan states that, compared to its 2005 baseline, it will improve the average fuel economy of its fleet by 26 percent by 2012, and by 36 percent by 2015. NRDC estimated that Ford would increase its fuel economy to 30.3 mpg by 2012 and 32.7 mpg by 2015, as substantial increase in its 2005 level of 24.1 mpg. This would enable Ford to comply with a national version of the California GHG standards in 2015.
- **Proposed National Program Rule (September 2009)**
 - Automakers support adoption of the National Program standards for 2012-16 which adopts California's stringency levels nationwide by 2016. EPA and NHSTA re-affirm CARB's cost estimates of ~\$1,000. Automakers no longer challenge the cost estimate.
 - EPA and NHSTA release proposed rule that adopts California's stringency level nationwide by 2016. Agencies confirm CARB's cost estimates and estimates cost will be less than \$1,100.
- **National Research Council of the National Academies of Science, *Cost, Effectiveness and Deployment of Fuel Economy Technologies for Light-Duty Vehicles* (2015)**
 - Although primary focus was 2025 costs, NRC committee also estimate for mid-size car segment (not entire fleet), the manufacturing cost to comply with MY 2016 standards (\$312 to \$321) to be essentially the same as when using the agencies assumptions for cost of individual components (\$312).
 - Note: Unlike other costs cited in above bullets, these are all manufacturing costs rather than retail price or cost to consumer since NRC 2015 did not estimate retail price. Rough rule of thumb is to multiply the manufacturing cost by 1.5 yielding \$468 to \$482 for cost to consumer or retail price.

BACKGROUND INFORMATION

Emphasis in quotes added by NRDC.

Comments delivered at CARB hearing, September 10, 2004

Source: CARB Hearing, Final Statement of Reason, August 4, 2005 <http://www.arb.ca.gov/regact/grnhsgas/fsor.pdf>

- **Alliance of Automotive Manufacturers, Appendix C to letter**

"The average per-vehicle cost of technology required to comply with the proposed regulation is approximately **\$3,000** per vehicle for the average of all cars and light trucks. The lifetime gasoline savings would average about 1,000 gallons. The cost of the technology is more than double the net present value of gasoline savings."

- **Fred Webber, The Auto Alliance**

"The proposed regulation will cost California new car buyers not an up front cost of a little over a thousand dollars, but by our calculations, this is going to be an up front cost of over **\$3,000**. The \$3,000, in our opinion, will not be recoverable through fuel cost savings, nor will that \$3,000 surcharge provide any measurable improvements in air quality.

The current estimated costs still substantially underestimate the real costs of the regulation. Sierra Research found that when all costs are considered, not just the ones selected in the staff report, the real costs of this proposal is closer, as I mentioned earlier, to \$3,000 for motor vehicles in the state of California. And as we discussed in our comments, this cost is not fully recoverable by fuel cost savings, nor does it provide any measurable improvement in air quality."

- **Sierra Research, September 22, 2004**

<http://www.azclimatechange.gov/download/alliance.pdf>

"...we conclude that an average per-vehicle cost of compliance should be estimated at **\$4,573** for vehicles that the proposed rules would classify in the PC/LDT1 category, compared to the **\$1,064** estimate in the ISOR materials. The average compliance costs in the LDT2/MDPV category defined by CARB, accepting the same three assumptions, would be **\$1,308**, compared to the ISOR materials' estimate of **\$1,029**."

Vermont Court Decision, VT Order 9/12/2007

http://ag.ca.gov/globalwarming/pdf/Vermont_trial_order.pdf

- **Tom Austin, Sierra Research (page 145-146)**

"For the lower cost manufacturers--**Honda, Toyota and Hyundai**--Austin's expected cost per vehicle was close to **\$2,500.00**. For higher cost manufacturers, including **Ford, DaimlerChrysler, Volkswagen, General Motors, and Nissan**, costs were universally greater than **\$3,500.00** per vehicle, and greater than **\$4,500.00** per vehicle for **Volkswagen, General Motors, and Nissan**. *Id.* The path to compliance that Austin outlined would be very costly, particularly for Ford, DaimlerChrysler and General Motors, manufacturers that would have to introduce **large percentages of hybrid vehicles** into their fleets. Austin estimated that **Honda, Toyota, and Hyundai** would need to introduce less than **thirty percent hybrids**, **Ford and DaimlerChrysler** would need to introduce between **fifty and sixty percent**, **General Motors** would need to introduce around **sixty percent** and **Nissan** would need to introduce

between **seventy and eighty percent hybrids**. PX 1039.”

Based on the costs that he estimated for each manufacturer, Austin concluded that it was infeasible for some manufacturers to implement the necessary technology changes across their entire product lines, and that DaimlerChrysler, Ford, and General Motors would ultimately be unable to sustain themselves in the full market in states enforcing the regulation. He predicted that these companies would become primarily truck manufacturers in those states.”

- **Alan Weverstad, GM (April 10, 2007) pages 147+**

“In the maximum technology scenario, General Motors modeled installing the advanced Hybrid **System II in eighty-nine percent of the vehicles in the PC/LDT1 category and eighty-one percent in the LDT2category**. Vehicles without room to package the hybrid technology were given six speed automatic transmissions.

According to Weverstad the maximum technology scenario would result in lower emissions than required by the regulation in 2009, but would result in a **seven mile per gallon shortfall** by 2016. Tr. vol. 1-B, 47:11-48:14. The total unrecoverable cost of these insufficient improvements would be **greater than \$6,000 per vehicle in each category**, with total costs of more than ten billion dollars in the PC/LDT1 category and more than fifteen billion dollars in the LDT2/MDPV category.

General Motors’ regular business plan, as opposed to the maximum technology scenario, would result in a shortfall of more than ten miles per gallon in the PC/LDT1 category, and a shortfall of more than four miles per gallon in the LDT2/MDPV category, in 2016.

General Motors’ alternative to the maximum technology scenario is a gradual restriction of products in order to remain in compliance with the regulation. Following this alternative, it would simply remove products from the market in the affected states. By the year 2011, according to Weverstad, General Motors would offer only six models in the PC/LDT1 category for sale in Vermont, and none by model year 2016. Tr. vol. 2-A, 56:2-58:2, 59:16-18; PX 0908. By the year 2015 there would be no LDT2 models remaining in the market.”

- **Reginald Modlin, DaimlerChrysler (April 11, 2007) page 150+**

“Ultimately, Modlin testified, DaimlerChrysler would have to convert ninety percent of its fleet to fuel economy-optimized hybrid and diesel vehicles, drastic steps which still would not result in compliance in 2016 without some product restrictions.

Under the restrict product scenario, DaimlerChrysler would begin removing products from the Vermont market in 2012. Id. At 57:11-59:5. In 2016, the only DaimlerChrysler vehicles in the PC/LDT1 category still offered in Vermont would be a tiny vehicle called “Smart,” seating only two people with virtually no storage space, and a B-segment vehicle smaller than a Dodge Neon, called a “Chery.” Id. at 60:5-21. Only one or two LDT2s would be available.”

- **Ford**

“Ford calculated that its average cost of compliance per vehicle would range from \$500 to \$2,000.”

Automaker Bailout Plans, December 2, 2008

GM and Ford Investment Plans and California Greenhouse Gas Emission Standards, *Fuel Economy Improvements in Federal Loan Plans Show that Automakers Can Comply with California Greenhouse Gas Standards Nationwide*, Natural Resources Defense Council, December 8, 2008
http://docs.nrdc.org/energy/files/ene_08120801a.pdf

General Motors and Ford are now positioned to comply with California's landmark global warming standards if they are applied nationwide, according to new data released today by the Natural Resources Defense Council (NRDC). These new findings are critical as Congress considers a major bailout of the auto industry. Despite the capacity to meet these standards, however, GM and Ford remain embroiled in efforts to block the California standards through lawsuits and lobbying.

The NRDC study is based on the fuel economy levels in the plans submitted by GM and Ford to Congress on December 2, 2008. The study converted the miles per gallon (mpg) values in the companies' business plans to greenhouse gas (GHG) emission rates. NRDC experts then assessed whether the companies' plans would place them in compliance with the California program. The study uses methodologies that are consistent with those developed by the California Air Resources Board and uses publicly available data from the U.S. Department of Transportation and the California Air Resources Board, as well as from the companies' reports.

- See Table 7 of General Motors Corporation, *Restructuring Plan for Long-term Viability*, Submitted to Senate Banking Committee & House of Representatives Financial Services Committee, December 2, 2008.

GM's plan states that it will achieve 2012 fuel economy levels of 37.3 mpg and 27.5 mpg for their new car and light truck fleets, respectively. The projected GHG emission level would enable GM to comply with a national version of the California GHG standards in 2012. While GM does not provide 2015 fuel economy levels, if it simply matches Ford's rate of improvement between 2012 and 2015 (as stated in Ford's plan), GM would also easily meet the 2015 California GHG standards nationwide.

- See page 14 of Ford Motor Company, *Ford Motor Company Business Plan*, Submitted to the House Financial Services Committee, December 2, 2008.

Ford's plan states that, compared to its 2005 baseline, it will improve the average fuel economy of its fleet by 26 percent by 2012, and by 36 percent by 2015. The projected GHG emission level would enable Ford to comply with a national version of the California GHG standards in 2015. In 2012, the Ford fleet average falls just 6 grams per mile above compliance, a modest shortfall that Ford could make up by applying additional technologies, rebalancing their vehicle sales mix, or doing a combination of both.

Proposed National Program Rules (September 2009)

<http://epa.gov/otaq/climate/proposedregs.htm>

- EPA and NHSTA release proposed rule that adopts California's stringency level nationwide by 2016. Agencies confirm CARB's cost estimates and estimates cost will be less than \$1,100.
- October 2009, GM (Mike Robinson) and Ford (Sue Ciske) testify at public hearing in Detroit in strong support of program and do not challenge the EPA and NHSTA cost estimates.