ATTACHMENT

TRUMP'S $2 TRILLION MISTAKE,
THE "WAR ON ENERGY EFFICIENCY:

The "command-but-not-control" approach of fuel economy and energy efficiency performance standards delivers consumer pocketbook savings, grows the economy and protects public health

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TABLE OF CONTENTS

PART II.

PERFORMANCE STANDARDS: EFFECTIVE "COMMAND-BUT-NOT-CONTROL" POLICY TOOLS

PART III.
PUBLIC OPINION ABOUT AND SUPPORT FOR ENERGY EFFICIENCY STANDARDS

PART IV
BENEFIT COST METHODOLOGY AND ISSUES

PART V
MEDIUM AND HEAVY-DUTY (WORK)TRUCKS

PART VII.
FOUR DECADES OF SUCCESSFUL ENERGY EFFICIENCY PERFORMANCE STANDARDS

PART VIII.
AUTOMAKERS MEETING THE STANDARDS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

This document presents a comprehensive analysis of one of the most important consumer pocketbook/economic issues that policymakers deal with, although they do not always see it that way. It shows that the Trump administration is making a $2 trillion mistake by turning its back on four decades of remarkably successful energy efficiency performance standards.

Because the cost of energy saving technology is much lower than the amount of money saved to lower operating costs, energy efficiency standards increase the amount of money consumers have to spend on other things (pocketbook savings). This "respending" increases economic growth as the other goods and services they buy have higher multipliers (macroeconomic gains). Reduced pollution yielding (public health) benefits that are also substantial.

This projection of a $2 trillion mistake is based on a comprehensive analysis of the performance of energy efficiency standards in the past 40 years. We use the same methodology to look forward as others have used to look back. In fact, we apply the rigorous benefit-cost analysis that is required by the laws that govern standards setting for vehicles and appliances **and** the regulatory guidance offered by the Reagan, Clinton, Bush and Obama administrations. The "look back" demonstrates the massive benefits – over $5 trillion in net benefits – of past standards.

This comprehensive analysis provides a broad basis for commenting on both the general attack on regulation, at the Department of Transportation (due early in December 2017), the Department of Energy (slated for early next 2018), as well as rulemakings that deal with products, like the Environmental Protection Agency's mid-term review (expected in the spring of 2018).

PART I: THE LEGAL AND ANALYTIC FRAMEWORK FOR REGULATING ENERGY EFFICIENCY AND EMISSIONS

The analysis starts in **Section II** with the laws that set the goals and considerations that agencies must take into account in setting efficiency standards and protecting public health and the environment. The Section includes a discussion of executive branch guidance on the conduct of rulemakings, with a particular emphasis on benefit cost analysis. **Appendix A** provides a side-by-side analysis of the executive orders on regulation and standards issued by the Reagan, Clinton, Bush and Obama administrations. In **Section III**, we discuss the justification for policy actions and the analytic framework drawn from the economic literature that supports the legal mandates and executive branch guidance. This Section presents a broad review of the conceptual literature on the "efficiency gap," **Appendix B** presents detailed citations for the analytic frameworks that define the terrain of analysis.

PART II: PERFORMANCE STANDARDS: EFFECTIVE "COMMAND-BUT-NOT-CONTROL" POLICY TOOLS

Section IV describes the structure of effective performance standards, addressing the two key pillars on which its success stands. It begins by briefly identifying the empirical evidence that support the first pillar of an effective standard, market imperfections. It shows the link between market failure, benefit cost analysis and the selection of performance standards as highly effective policy tools to address the underlying problem of market imperfections. **Appendix C** gives citations to the empirical literature of the past decade which provides substantial empirical support for the framework. **Section V** reviews the literature that evaluates the relative effectiveness of policy instruments, showing that performance standards are deemed to perform extremely well compared to alternative policies.

PART III: PUBLIC OPINION ABOUT AND SUPPORT FOR ENERGY EFFICIENCY STANDARDS,

Section VI discusses ten years of surveys conducted by the Consumer Federation of America dealing with fuel economy standards, showing not only a high level, but also remarkably consistent, bipartisan support for standards. It also briefly reviews our findings on consumer attitudes toward regulation of the fuel use of heavy and medium duty trucks (work trucks). **Section VII** discusses the different opinions about fuel economy held by the public, which supports standards, and the automakers who are seeking to roll back the standards. It also shows that consumers are not as enamored of gasoline-powered muscle cars as automakers claim. **Section VIII** presents our survey evidence on attitudes about appliance efficiency standards. It also notes the survey results in the broader literature. We find similar levels of public support for appliance standards as we found for fuel economy standards.

PART IV: BENEFIT COST METHODOLOGY AND ISSUES

Section IX presents a discussion of discount rates and a critique of willingness to pay as an outcome measure. There are a large number of biases that standards overcome. **Appendix D** presents a list of the behavioral biases and major behavioral economic themes that contradict the market fundamentalist assumptions used to criticize standards as public policy. **Section X** discusses the persistent overestimation of costs by regulators and industry. The pattern of cost declines strongly supports the conclusion that product manufacturers are able to comply with standards and that standards do not undermine the ability of the industry to meet the standards. **Section XI** examines the question of economic multiplier effects of the "respending" of pocketbook savings, showing that macroeconomic benefits equal net pocketbook savings.

PART V: MEDIUM AND HEAVY-DUTY (WORK) TRUCKS

In **Section XII** we show that the fuel consumption of work trucks is a significant consumer pocketbook issue. It shows that for every dollar a household spends on directly on gasoline, it spends about $0.50 indirectly on work truck fuel costs (overwhelmingly diesel). **Section XIII** discusses the technological potential for the fuel savings and the market imperfections afflicting investment in energy efficiency in the work truck sector. The analysis shows that the potential is very large because the fuel consumption of these vehicles has not been significantly regulated in the past. **Section XIV** evaluates the work truck rule through the lens of the characteristics of effective performance standards developed earlier.

PART VI: APPLIANCE EFFICIENCY STANDARDS

Section XV reviews broad evidence from major national research institutions that show potential reductions in energy consumption of 20%-30% over the next couple of decades. The cost of energy savings is less than half of the cost of energy consumption. The economics of standards for gas furnaces, which were intensively analyzed in several rounds of rulemaking and put forward as a consensus standard, are reviewed. The section also reviews the long and successful track record of appliance standards for major household appliances, like air conditions, refrigerators, etc. **Section XVI** discusses energy efficiency standards for computers and monitors adopted by the California Energy Commission (CEC). California's role in the light duty vehicle space has been very prominent because the California Air Resources Board (CARB), utilizing California's special authority under the Clean Air Act, has set more aggressive standards than those at the federal level. But, California also plays a leadership role in adopting appliance standards. Since it can only act when federal regulators have not acted, its action may be even more important in this space. Digital devices are the fastest growing category of household energy expenditure, so it is no surprise that California has played a leadership role.

PART VII: FOUR DECADES OF SUCCESSFUL ENERGY EFFICIENCY PERFORMANCE STANDARDS

Section XVII shows the results for past standards covering two of the major categories addressed in this analysis, light duty vehicles and appliances. This analysis shows that over the past forty years, fuel economy standards have delivered $1.8 trillion in consumer net pocketbook savings, another $1.8 trillion in growth for the economy, and $0.8 trillion of environmental benefits. Adding the benefits of appliance efficiency standards pushes the total pocketbook and economic benefits over $5.5 trillion and the public health/environmental benefits close to $1 trillion. With the cost of achieving these benefits less than $1 trillion, the total benefit is over $6.5 trillion and the benefit cost ratio is about 7 to 1. **Section XVIII** examines the impact of the freeze and rollback of standards targeted by the Trump administration as well as the attack on future setting of standards. The threat of freeze and rollback of near term standards shows about $1.2 trillion in pocketbook and over $800 billion in macroeconomic. Here, as elsewhere, the public health/environmental benefits are likely to more than offset the costs, so the net savings are likely to be well over $ 2 trillion. **Section XIX** reviews the impact of standards on low income households, which is frequently highlighted by opponents of standards. Using recent analyses of light duty vehicles and gas furnaces, we show why standards do not harm low income households. In fact, low income households actually benefit more than the overall population, based on the obvious fact that, operating costs, which are lowered by standards, are much more important in the low-income segment. They also suffer great exposure and are more susceptible to the harms of pollution.

PART VIII: AUTOMAKERS MEETING THE STANDARDS SET BY THE NATIONAL PROGRAM

Section XX discusses the reasonableness of the standards in historical and cross-national perspective. **Section XXI** discusses auto industry compliance with the National Program standards. **Section XXII** examines the rapid development of electric vehicles, including surveys of consumer attitudes.

THE CHALLENGE AND OUR RESPONSE

Various aspects of over a dozen standards are examined in detail throughout this analysis to make and reinforce the general findings and conclusions. The agencies have reviewed mountains of evidence, conducted their own independent research, written extensive evaluations of the broader research literature, taken the factors identified in the laws into account and reached a conclusion.

With a new administration that is much friendlier to the industry point of view, several industries sought to overturn the balance that the agencies had struck, since the passage of EISA. The administration's bias in favor of industry contradicts the underlying statutes and disturbs the "objective" balance the executive orders sought to achieve. Because the underlying statutes and executive guidance are still in place, the challenge for the agencies will be to build hearing records that support a new direction. Throughout this analysis we show that they are very unlikely to be able to make a convincing case. We directly address the tired old industry arguments, which we are likely to be offered anew. In a sense, much of this analysis can be read as rebuttal of those arguments.

- The cost of compliance is invariably much less than anticipated, Section X on vehicles, Section XV on appliances, Section XVI on computers.
- Cost is closely linked to the feasibility of standards, a topic explicitly addressed in several Sections, including all of Part VIII, covering current fuel economy standards, Section VIII addressing past fuel economy standards, Section XIII on heavy-duty trucks and Section XVI covering computers.
- Consumer desires and abilities, frequently cited as evidence against standards are shown to be the opposite on both counts, they want more efficiency than the manufacturers admit (Sections VII and VIII), and have less ability to implement their desires than the manufacturers claim (Section IX)
- The claim that weakening standards helps low income households is shown to be incorrect on all three measures of the impact of standards in Section XIX, which reviews consumer pocketbook, public health, and macroeconomic stimulation.
- Claims that standards slow the economy, reduce sales and cost jobs are shown to be false (Section XI and XIX).

The document lays the foundation not only for regulatory review comments at DOT, but also the Department of Energy (early next year) and individual rulemakings (e.g. EPA/NHTSA's mid-term review, in the spring), as well as potential court challenges to unjustified changes to other rules, and not only at the federal level, but in state proceedings (e.g. the California Energy Commission and the Air Resources Board).

The legal/analytical framework, historical record and contemporary evaluation all demonstrate the clear benefit of hundreds of standards developed under the general approach of "command-but-not-control" regulation that the U.S. implemented for energy efficiency over the past four decades. Abandoning this approach, as the Trump administration has proposed, will impose a huge, $2 trillion loss on consumers and the economy.

From the consumer point of view, our analysis shows not only that the consumer stakes are huge, but also that both low **and** middle-income households benefit disproportionately from efficiency standards, which means that weakening the standards is a hidden tax on households in the bottom half of the income distribution.

From a legal/technical point of view, our analysis demonstrates two critical points that contradict the broad effort to gut standards.

- Independent technology assessments and the long history of declining costs for efficiency contradict the complaints from industry that the standards hurt them, which rebuts the primary rationale for freeze and rollback.

- There is an inseverable link between pollution reduction, consumer pocketbook savings and macro-economic growth, which means that complaints about agencies exceeding their authority by counting “co-benefits” are illogical and contradicted by the statutes.

I. INTRODUCTION

THE CONSUMER STAKE IN ENERGY EFFICIENCY STANDARDS

This document presents a comprehensive analysis of one of the most important consumer pocketbook/economic issues that policymakers deal with, although they do not always see it that way. It shows that the Trump administration is making a $2 trillion mistake by turning its back on four decades of remarkably successful energy efficiency performance standards.

Because the cost of energy saving technology is much lower than the amount of money saved in lower operating costs, energy efficiency standards increase the amount of money consumers have to spend on other things (pocketbook savings). This respending increases economic growth as the other goods and services they buy have higher multipliers (macroeconomic gains). Reduced pollution yields public health benefits that are also substantial.

This document bases the projection of a $2 trillion mistake on a comprehensive analysis of the performance of energy efficiency standards in the past 40 years – from their beginning in the mid-1970s to 2016. The "look back" demonstrates the massive benefits – over $5 trillion in net benefits – of past standards. We use the same methodology to look forward as others have used to look back. In fact, we apply the rigorous benefit-cost analysis that is required by the laws that govern standards setting for vehicles and appliances **and** the regulatory guidance offered by the Reagan, Clinton, Bush and Obama administrations.

The Trump administration is not only seeking to repeal specific rules governing individual energy using consumer durables (e.g. light duty cars and trucks), but it is turning its back on a tried and true "command but not control" approach to standards setting that has enjoyed bipartisan support and a great deal of success for four decades. It is not only trying to roll back standards in place, but ceasing to propose cost justified rules, and making it much more difficult for future administrations to adopt beneficial rules.

Foregone Energy Savings and Tax Reform

Because policymakers in Washington frequently throw around numbers with lots of zeros in their policy discussions, a trillion has 12 of them, it may be difficult to appreciate the magnitude of this mistake. Two other sets of numbers can give some perspective here.

Judging from reactions in the tax reform debate, $2 trillion is a big number. The prospect of increasing the national debt by $1.5 trillion over a couple of decades is a horror to some and a serious concern to others.[1] As part of that debate, the home builders feared that the elimination of the mortgage deduction would shrink house values by $1 trillion and do severe damage to the industry.[2]

Therefore, robbing consumers of $2 trillion of pocketbook savings would seem to be a pretty big deal. Recognizing that it would shrink future economic growth, because the multiplier for consumer spending is quite large, makes this $2 trillion loss quite important, even though, or perhaps especially because, it would be spread across the entire economy. This makes it an even bigger concern.

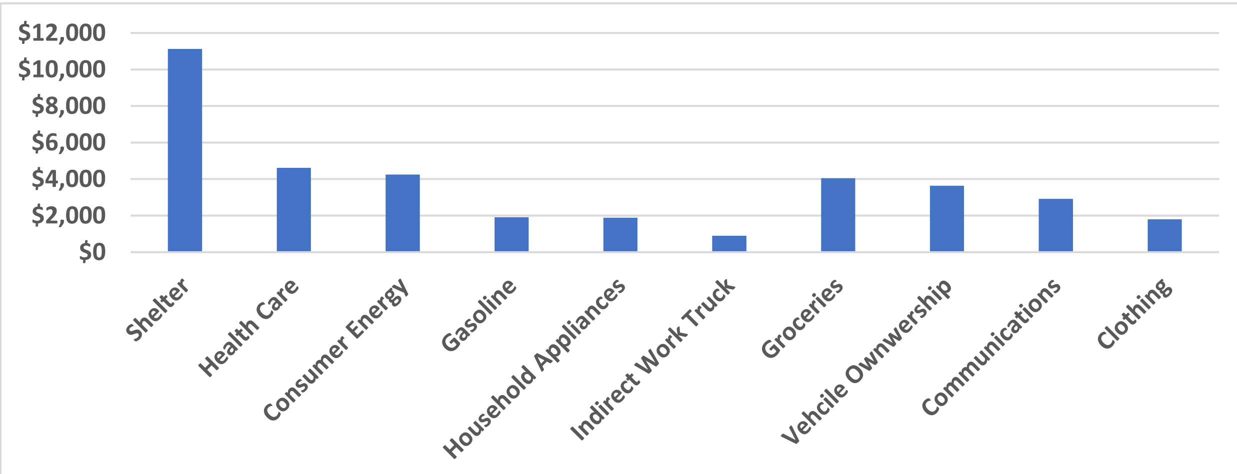
Because the $2 trillion-dollar figure is the net benefit of efficiency standards calculated in terms of discounted, real dollars, and it affects all consumers, we can give a rough idea of the value to households. Projecting an average of 150 million households in the U.S. over the next 30 years (the time horizon for many of the analyses of efficiency standards) yields a per household estimate of about $450 per year. For middle income households (incomes between $50,000 and $100,000), whose household energy bills are close to the national average, this represents about two-thirds of their 2021 tax savings in the Senate version of tax reform.[3]

While there are many complexities on the energy savings side and the tax reform side that might move this analogy in one direction or another, there is no doubt that a decision to freeze, rollback, or stop progress in efficiency standards will impose a great deal of harm on U.S. households.

Household Energy Expenditures

A second perspective, more directly related to individuals is household expenditures on the operation of energy-using consumer durables. Figure I-1 puts the consumer issues addressed in this document in perspective by identifying major categories of household expenditures.

FIGURE I-1: HOUSEHOLD SPENDING ON ENERGY



Source: Bureau of Labor Statistics, Consumer Expenditure Survey, 2016. Indirect Work Trucks, (see Part V), Communications includes wireline and wireless telephone, audio visual and other equipment and fees, which includes broadband and cable.

Household spending on gasoline for cars, SUVs and pickup trucks (light duty vehicles) that constitute the bulk of household transportation, were almost $2000 in 2016, the most recent year for which complete data is available. Spending to operate household appliances (space and water heating, lighting refrigeration, air conditioning) is about the same. Each of these represent just under 3 percent of total expenditures. Each would be one of the 6 largest subcategories listed in the consumer expenditure survey. Factoring in indirect expenditures on fuels consumed by commercial fleets, which consumers pay for in the price of goods and services and can be readily identified in the national economic data, would add about $1000 to the burden of energy costs on households that can be reduced by standards. This would push transportation fuel consumption well above 5%, making it the third or fourth largest household expenditure.

While it can be argued that consumers also pay for the use of electricity and natural gas by commercial establishments, much of the data reviewed below includes this expenditure, but many of the appliances used by commercial establishments are not regulated. Out of an abundance of caution, we do not estimate and include this category of indirect consumer expenditures in this analysis. It is certainly not zero and may be considerable. Therefore, our estimate of past, present and future consumer benefits from appliance efficiency is likely to be low.

Thus, the burden of energy expenditures on household budgets rivals that of health care and groceries and is much greater than other important household expenditures like vehicle ownership, communications and clothing. In short, energy consumption, in general, and transportation fuel consumption, in particular, are among the most important consumer pocketbook issues that policymakers must deal with. Throughout this analysis, we use light duty vehicles to frame the general issues, then apply the methods and observations to other energy-consuming durables. This approach is appropriate because fuel economy standards for light duty vehicles were the first enacted, have the largest impact, and have been the most intensively studied.

The fuel economy rules that are front and center on the chopping block are estimated to save households that purchase new vehicles about $1,600 over the course of the life of the vehicle. The rollback of 2017 standards would wipe out additional savings, pushing the total to $2000. How much an individual household will benefit depends on the length of time the vehicle is owned and the terms of purchase (buy v. lease). With the average life of vehicles about 15 years, pocketbook benefits are likely to be in excess of $1000 per households. This loss represents one of several rules that are at risk, so the total could be several times larger. Regardless of the details, the consumer stakes are very large.

A CONSUMER ISSUE ANALYZED FROM A CONSUMER POINT OF VIEW

The Origin of Efficiency Standards

This document is written from a consumer point of view. Its analysis relies on almost two dozen comments and testimony of the Consumer Federation of America that have been filed in regulatory proceedings and legislative hearings in Washington D.C. and Sacramento. These two venues are not only the two largest policy making venues in the U.S., but California has unique authority under the Clean Air Act to set standards for vehicles, not to mention the general authority that all states possess to regulate the energy consumption of household appliances, if the federal government has not adopted standards.

Although the analysis covers over forty years of energy efficiency standards, we devote special attention to the period since the passage of the Energy Independence and Security Act of 2007 (EISA). EISA rebooted and reformed the setting of energy efficiency standards and an intense period of activity ensued after over a decade of dormancy in energy efficiency standards setting.

This look at the impact of past energy efficiency performance standards establishes the foundation for understanding why the attack on standards launched by the Trump administration is such a bad idea. Regulatory reform that threatens to stymie the implementation and enforcement of current fuel economy, energy efficiency and public health/environmental protection standards would impose severe harm on the public.[4]

While the impact of energy expenditures provides a strong foundation for the sustained interest in public policy to address this issue, the origin of efficiency standards lies elsewhere. Triggered four decades ago by the oil price shocks of the 1970s, the strong bipartisan support for efforts to reduce energy consumption through standards was initially a national security reaction.[5] Environmental concerns were quickly added in the 1970s.[6] The use of standards to promote energy efficiency has enjoyed a remarkable degree of bipartisan and public support.[7] The Energy Policy Conservation Act was signed by a Republican president and had large majorities in both houses of congress. In fact, eight of the nine major pieces of legislation that effect the energy efficiency of consumer durables were signed by Republican presidents. Both the House and the Senate have voted overwhelmingly in favor of these laws (14 times in all) with over 85 percent voting in favor.

However, this analysis shows that, while the national security and public health benefits may have been the animus for the rules, the consumer pocketbook and macroeconomic benefits are much larger. In this sense, the long-term support for the standards can be seen to rest, in large part, on the obvious economic benefit of efficiency and the effectiveness of energy efficiency standards.[8] Efficiency standards deliver massive pocketbook savings to consumers that help to grow the economy. If the economic benefits had been small or non-existent, we doubt that the public and policymakers would have supported them so vigorously for such a long-time.

Moreover, this analysis shows that the long-term success of the standards rests on the fact that they are performance standards that generally took a “command-but-not control” approach. Rigid prescriptive standards would not have worked as well, would not have been as successful and would not have enjoyed so much support.

The Stakes for Consumers

This analysis shows that over the past forty years, fuel economy standards have delivered $1.8 trillion in consumer net pocketbook savings, another $1.8 trillion in growth for the economy, and $0.8 trillion of environmental benefits. Adding the benefits of appliance efficiency standards pushes the total pocketbook and economic benefits over $5.5 trillion and the public health/environmental benefits close to $1 trillion. With the cost of achieving these benefits less than $1 trillion, the total benefit is over $6.5 trillion and the benefit cost ratio is about 7 to 1.

Given this strong record of success, a freeze and rollback of current standards, as is being aggressively pursued by the Trump administration, would be a huge mistake. The roll back of current standard and the obstacles to the adoption of future beneficial standards would be a huge mistake. Using very conservative assumptions, this analysis shows that a freeze and rollback would rob consumers, the economy and the nation of $2 trillion, in net pocketbook, macroeconomic and public health environmental benefits.

This document lays out a comprehensive case based on very conservative assumptions to support not only the current standards, but also the continuation of the development of new standards, which is consistent with the underlying legal mandates. Trump administration executive orders and agency proposals focus on reviewing standards to ensure their continuing relevance and usefulness and to find ways to reduce burdens on industries that supply energy consuming durable goods. They make strong presumptions about the need to reduce regulation. However, the laws also require responsible agencies to deliver maximum energy conservation, environmental benefits and maximum net economic benefits on a continuous basis, which the Trump administration seems to disregard.

A Pragmatic Consumer Approach

The analysis takes a uniquely consumer view in two respects – approach and data. We approach the setting of standards starting from a basic set of questions:

- Are there significant energy expenditures that appear to be wasteful in the sense that there are technologies available that cost less than the savings on energy use? If there appears to be potential savings, we ask:
- Why is there an efficiency gap that imposes unnecessary costs on consumers? If we find market imperfections that prevent the gap from being closed and cost savings from being realized, we then ask:
- Why is a standard an appropriate policy to address the market imperfections? Finding that other policies are inadequate to address the market imperfections, we turn to performance standards and ask:
- How can the standard be best designed to achieve the goal of lowering consumer cost and protecting public health?

The analysis combines a review of the technical economic studies prepared by others and evidence on the market performance of energy using consumer durables to determine whether there are significant potential consumer savings that would result from a higher standard. The design of effective standards is the crucial next step.

The analysis relies, first and foremost, on comments, testimony and analyses prepared since the issuance of the Technical Analysis Report (TAR) in the National Program to increase fuel economy and reduce emissions from light duty vehicles. Where analyses are time sensitive, we update them to the extent possible. We reach farther back in the record before the agencies (to 2008) where the issues are foundational and not subject to variation across time.

The Consumer Federation of America (CFA),[9] which is the institutional source of all the analysis, has been a vigorous and continuous participant in the process of setting regulations throughout its fifty years.[10] However, in the year since the publication of the Technical Analysis Report (TAR) [11] for the National Program,[12] the regulatory calendar has been extremely busy.

CFA has filed comments on the fuel consumption of vehicles at the National Highway Traffic Safety Administration (NHTSA),[13] the Environmental Protection Agency (EPA),[14] EPA and NHTSA acting jointly,[15] the Department of Transportation (DOT)[16] and the California Air

Resources Board (CARB).[17] In addition CFA testified before the CARB[18] and the Committee on Energy and Commerce on the Midterm Review for Motor Vehicles.[19] CFA has also been active in regulatory proceedings dealing with medium and heavy duty trucks[20] and published a paper that explains why the fuels used by medium and heavy duty trucks to provide intermediate services to business and industry are an important consumer pocketbook issue.[21] CFA has also participated in complementary activities dealing with energy efficiency standards at the Department of Energy covering a variety of major appliances, like furnaces, air conditions and refrigerators[22] and lighting,[23] as well as smaller appliances,[24] and efficiency standards dealing with computers[25] and lighting[26] at the California Energy Commission. We have also appeared before congress[27] and the California Energy Commission[28] on the broad approach to writing effective appliance standards and for specific standards including computers and lighting.

OUTLINE

Part I: The Legal and Analytic Framework for Regulating Energy Efficiency and Emissions

The analysis starts in **Section II** with the laws that set the goals and considerations that agencies must take into account in setting efficiency and protecting the environment. The Section includes a discussion of executive branch guidance on the conduct of rulemakings, with a particular emphasis on benefit cost analysis. **Appendix A** provides a side-by-side analysis of the executive orders on regulation and standards issued by the Reagan, Clinton, Bush and Obama administrations. In **Section III**, we discuss the justification for policy actions and the analytic framework drawn from the economic literature that supports the legal mandates and executive branch guidance. This Section presents a broad review of the conceptual literature on the "efficiency gap," **Appendix B** presents detailed citations for the analytic frameworks that define the terrain of analysis.

Part II: Performance Standards: Effective "Command-But-Not-Control" Policy Tools

Section IV describes the structure of effective performance standards, addressing the two key pillars on which its success stands. It begins by briefly identifying the empirical evidence that support the first pillar of an effective standard, market imperfections. It shows the link between market failure, benefit cost analysis and the selection of performance standards as highly effective policy tools to address the underlying problem of market imperfections. **Appendix C** gives citations to the empirical literature of the past decade which provides substantial empirical support for the framework. **Section V** reviews the literature that evaluates the relative effectiveness of policy instruments, showing that performance standards are deemed to perform extremely well compared to alternative policies.

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Section XVII shows the results for past standards covering two of the major categories addressed in this analysis, light duty vehicles, work trucks and appliances. **Section XVIII** examines the impact of the freeze and rollback of standards targeted by the Trump administration as well as the attack on future setting of standards. **Section XIX** reviews the impact of standards on low income households, which is frequently highlighted by opponents of standards. Using recent analyses of light duty vehicles and gas furnaces, we show why standards do not harm low income households. In fact, low income households actually benefit more than the overall population, based on the obvious fact that, operating costs, which are lowered by standards, are much more important in the low-income segment. The also suffer great exposure and are more susceptible to the harms of pollution.

Part VIII: Automakers Meeting the Standards Set by the National Program

Section XIX discusses the reasonableness of the standards in historical and cross-national perspective. **Section XX** discusses auto industry compliance with the National Program standards. **Section XXI** examines the rapid development of electric vehicles, including surveys of consumer attitudes.

PART I:

THE LEGAL AND ANALYTIC FRAMEWORK FOR REGULATING ENERGY EFFICIENCY AND EMISSIONS WITH PERFORMANCE STANDARDS

II. THE LEGAL TERRAIN OF STANDARDS FOR FUEL ECONOMY AND ENVIRONMENTAL PROTECTION

The analysis of policy options and action must begin with the laws that empower executive branch agencies to take action. These laws, which establish the goals are discussed first. They are supplemented by executive orders that give further general guidance on how to proceed, which are discussed net.

LAWS GOVERNING AGENCY ACTION

As we pointed out in comments to the Department of Transportation[29] with regard to its review of regulations in relation to its infrastructure policy implementation, federal agencies cannot change or repeal three sets of laws: the laws of policy, physics and economics. That observation is even more relevant with respect to the setting of fuel economy standards because NHTSA must write an environmental impact statement and this process currently includes cooperating with the EPA and the CARB.

The laws of policy are set by Congress to state the goals and identify the considerations that agencies must take into account in working toward those goals. Congress generally recognizes the complexity of writing regulations in the modern economy, so it leaves discretion to the expert agency, giving guidance about what is to be considered and how the considerations are to be balanced.

Of course, Congress can change the goals and guidance (with the agreement of the executive branch), but, like the federal agencies, it cannot repeal or change the laws of physics or economics. The laws of physics dictate that rules governing fuel economy are, necessarily and inevitably, environmental rules that mandate reductions of emissions of pollutants to improve the public health. It is the case that the reduction in the use of fuel is linked directly to a reduction in emissions.

The laws of economics come into play in two respects. First, energy efficiency, in general, and improving fuel economy, in particular, tend to be very low cost (frequently the least cost) ways to lower emissions. To the extent that congressional or the executive branch guidance mandates least-cost, maximum net benefit approaches to lowering fuel consumption, it also mandates least-cost, maximum net benefit approaches to environmental protection and *vice versa*.

Second, when fuel economy standards yield a net benefit to consumers by lowering operating costs more than the increase in technology costs, it increases the disposable income in consumer pocketbooks. Consumers spend that disposable income on other goods and services. This "respending" has a multiplier effect, causing the economy to grow. The macroeconomic benefits are an inevitable result of improvements in fuel economy or environmental standards linked to reductions in energy consumption.

The Complex Terrain of Fuel Economy Standards Setting

The contemporary, substantive requirements for setting standards began at 42 U.S.C. Part A of Title III of the Energy Policy Conservation Act (EPCA), signed into law in 1975. This

Section established the Corporate Average Fuel Economy (CAFE) standards for automobiles. Congress designated the initial targets for three years. The Secretary of Transportation is then authorized to set standards that achieved the maximum feasible average fuel economy until 1985. In doing so, the Secretary must balance a number of factors. Standards must be technically feasible, economically practicable, take into account other standards and the need to save energy. The Energy Independence and Security Act of 2007 restarted the CAFE program and added a requirement for attribute-based standards. EPCA also legislated activity in appliance efficient. Soon after the Department of Energy Act (1977) added language that reinforced the EPCA language

As acknowledged in the EIS scoping notice, NHTSA faces two sources of complexity in setting a standard. The law governing the fuel economy standards is focused on "maximum feasible" average fuel economy. In amending the underlying statute (EPCA) with the Energy Independence and Security Act (EISA), the Congress emphasized the energy saving goal by referring to energy independence and security. Because of the need to consider environmental impacts, take other regulations into account and the agreement to cooperate with EPA, a second set of goals and considerations come into play, the Clean Air Act, as shown in Table II-1.

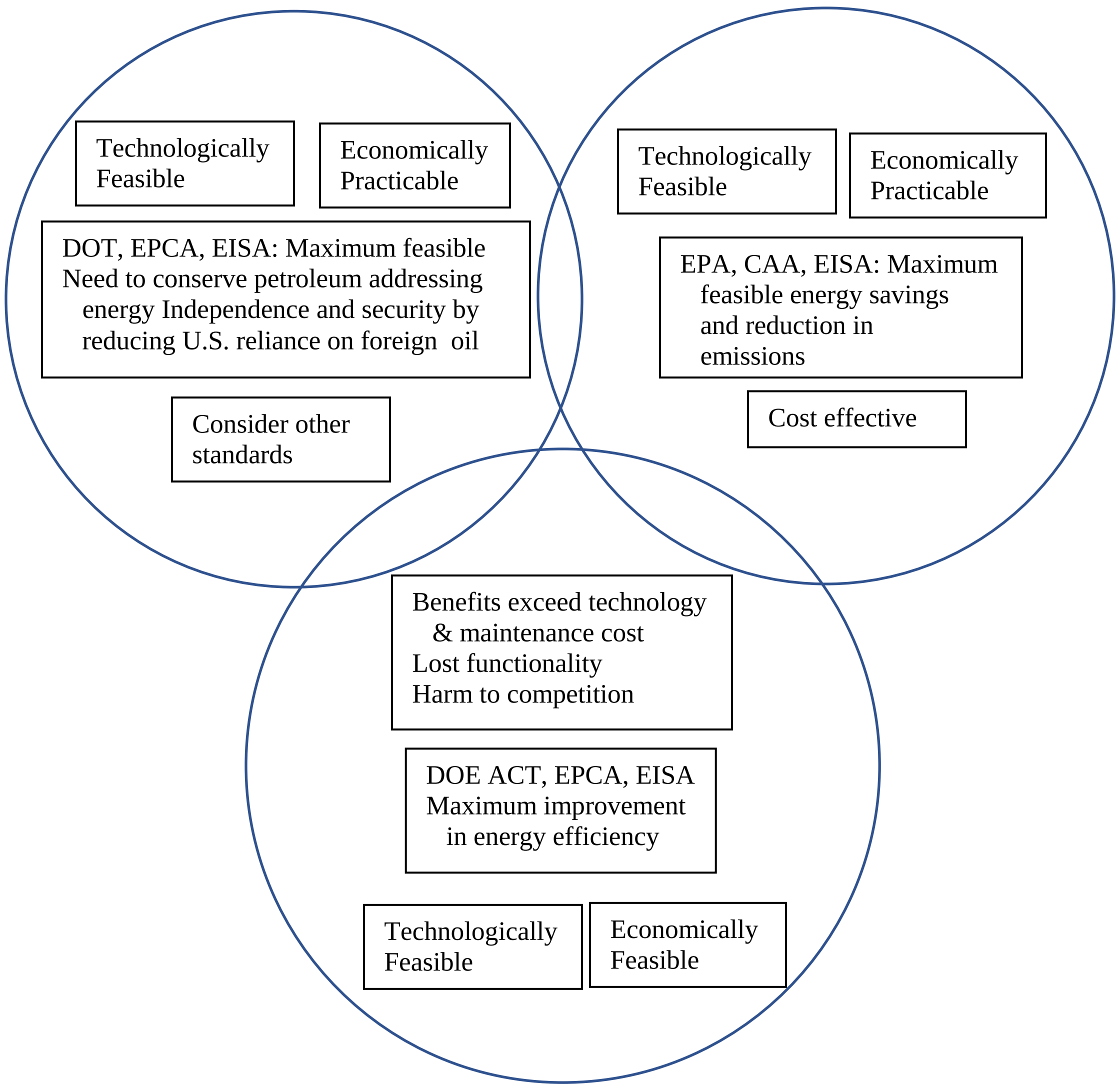
TABLE II- 1: PRIMARY GOALS AND BALANCING FACTORS IN ENERGY EFFICIENCY STANDARDS

	NHTSA/DOT	EPA	DOE
Goal	Maximum feasible average fuel economy need to conserve petroleum addressing energy independence and security by reducing U.S. reliance on foreign oil	Maximum feasible energy savings and reduction in emissions	Maximum improvement in energy efficiency Promote maximum possible energy conservation measures Promote the interest of consumers Assure incorporation of national environmental goals
Balancing Factors	Technological feasibility Economic practicability Consider other standards	Feasible Practicable Cost-effective	Feasible, Feasible, Economically justified Benefits exceed cost, lost Functionality, harm to competition

As we noted in our 2009 comments,[30] EPA's goals are expressed in terms of maximum reduction in emissions to protect the public health and welfare. The other considerations that EPA must take into account in terms of technology and economic analysis are less constraining than NHTSA. Nevertheless, the goals are very similar, particularly given the environmental and economic convergence (virtual identicality) of the physical relationship between fuel use and emissions. The California Air Resources Board, which joined in the cooperative effort, is charged with maximum feasible reduction in emissions that are cost-effective.[31] The National Program effectively harmonized the different goals into a consensus within the legal constraints, a harmonization that enjoyed widespread support.

As shown in Figure II-1, Congress enacted parallel and complementary goals and considerations for energy efficiency/environmental protection. Vehicle and appliance efficiency are included in the foundational Energy Policy Conservation Act (1975) and the critically important Energy Independence and Security Act (2007). The Department of Energy Act (1997) also establishes broad goals for the Agency, as the Clean Air Act and its amendments (1970, 1977) do for the Environmental Protection Agency. There are strong similarities and overlaps between these goals and considerations and there are cross references in the statutes. There are also tensions between them with different phases applied in each of the three areas.

FIGURE II-1: PARALLEL AND COMPLEMENTARY GOALS AND DECISION MAKING CRITERIA FOR STANDARD SETTING IN ENERGY EFFICIENCY AND ENVIRONMENTAL REGULATION



Identifying the Range of Options

In the scoping EIS notice, NHTSA identified a series of options that would bracket the possible levels it could choose within the confines of the law. Table II-2 shows three potential approaches to standard setting defined by language in the law and guidance. For each we offer a "formal" economic definition in terms of the benefit cost ratio it would reflect. This is consistent with the more detailed Bush administration guidance in OMB Circular A-4, as discussed in the next section. It is also consistent with the NHTSA/EPA analysis of the National Program, where multiple scenarios were analyzed.

TABLE II-2: EXPRESSING STANDARDS IN TERMS OF MARGINAL AND TOTAL COST BENEFIT PRINCIPLES

OBJECTIVE	STANDARD	COST CHARACTERISTICS: Move standards to the point where
Baseline	No Action	NA
Emphasize Economic Practicability	Maximum Net Benefit	Marginal Benefit = Marginal Cost
	Maximum Benefit @ zero cost	Total Benefit = Total Cost
Identify Limit of Technology	Incur costs to achieve maximum goal	Marginal benefit = 0 All technologies, regardless of cost

There are clearly benefits to be achieved above marginal costs. The OMB guidance on maximum net benefits identifies the point where marginal benefits equal marginal cost, where additional measures would increase marginal cost or lower marginal benefits. This point is well below the level that the statutes target. EPA can go to the technological limit. NHTSA can go to the point where total benefits equal to total cost. This is clearly another source of tension in setting a level of technology. One can argue that the statutes establish the highest level as the starting point, then allow the agencies to step down. The burden falls of those who want to step down.

RECONCILING THE INSTITUTIONAL AND LEGAL DIFFERENCES OF A COMPLEX ECONOMIC AND ENVIRONMENTAL CHALLENGE[32]

In recognition of the vehicle product cycle, the statute requires NHTSA to promulgate rules at least 18 months in advance of the model year to which the standard applies, but the redesign and refresh cycle of the industry where significant modifications can be made in the fuel economy of vehicles may require more lead time than that. At the same time, NHTSA cannot set standards for more than five years. This window may be too narrow to lead to optimum results.

From a policy perspective, it is critically important that the Clean Air Act's framing of the standard, which allows EPA to take a long-term view and a technology-forcing role, is being joined to the NHTSA approach. It must shake the standard setting process out of its lethargy. The decision to join NHTSA and EPA creates the opportunity for a major improvement in the regulation of automobiles because the Clean Air Act allows EPA to take a longer-term view with greater flexibility. Moreover, the lengthy discussion of the failure of the market to yield an efficient outcome with respect to energy efficiency has two critical purposes in these comments and the process of standard setting for both fuel economy and tailpipe emissions.

First, the explanation of why the vehicle fleet is less efficient than it should be is critical to understanding why fuel economy standards are the right policy to address the problem and how those standards should be set. The explanation of the "efficiency gap" (the gap between the optimal level of efficiency and the level the marketplace yields) involves a host of market imperfections, barriers and obstacles on both the supply and the demand side. Our analysis shows that setting fuel economy standards is an ideal approach to addressing the market imperfections, barriers, flaws and obstacles that underlie the market failure.

Second, and more importantly, the law and practice of setting fuel economy standards at NHTSA under the Energy Policy Conservation Act have severely restricted the ability of the agency to set fuel economy standards in the public interest (see Table II-3).

TABLE II-3: INSTITUTIONAL REASONS TO SHIFT THE FOCUS OF STANDARD SETTING TO EPA

Institutional Context of Standard Setting	**NHTSA (under the Energy Policy Conservation Act)**	**EPA (under the Clean Air Act)**
Mandate	**Permissive above 35 mpg, maximum feasible subject to constraints**	**Obligatory: to protect the Public health and welfare**
Time Frame	**Limited to a short 18-60-month period**	**Unlimited**
Economic Constraint	**Practicable, restricted by industry capacity**	**Costs considered**
Technological Innovation	**Restrained by industry Plans**	**Technology forcing**
Implementation	**Existing regulatory apparatus No responsibility for measurement**	**Existing regulatory apparatus Responsibility for measurement**

Thus, standards are the right policy instrument, and EPA is the right agency to take the lead for a variety of reasons. First, NHTSA is required to achieve only a 35-mile per gallon standard by 2020, but beyond that there is no mandate to achieve higher levels of fuel economy. In contrast, as a result of a recent Supreme Court ruling, EPA is obligated under the Clean Air Act (CAA) to regulate tailpipe emissions of pollutants, such as carbon dioxide.

Second, NHTSA is severely constrained in the time frame for which it can set standards. It must give the automakers at least 18 months advance notice of what the standard will be and it cannot set standards more than 5 years in advance. This narrow window for standard setting is too short for effective long-term planning. The rulemaking period barely covers a full product design cycle. NHTSA has repeatedly said that the time frame is too short to ask the industry to do too much. The short time horizon shortchanges the public. EPA is not under this time constraint. Therefore, it can give the industry a long-term trajectory that promotes energy efficiency and environmental clean-up. In other words, NHTSA has neither the legal mandate nor the ability to take a long-term view of fuel economy, but EPA has the ability to do so for tailpipe emissions. NHTSA's standards can reinforce the EPA long-term strategy. That is why the cooperation, created by the National Program is so important. Two agencies with the mandate to look to the long term (EPA and CARB) work with an agency that focuses on the short term.

Third, the economic constraint under which NHTSA operates is more restrictive than EPA's. NHTSA is bound to do what is "economically practicable," while EPA must consider cost. NHTSA has interpreted its mandate under the statute to be largely constrained by what the industry's capabilities are. It hesitates to be technology forcing, repeatedly finding that the industry has not planned and therefore cannot make significant changes. What the industry "can" do is largely a function of what it "wants" to do, not what is in the public interest or would be possible if the industry rose to a challenge. The result is the behavior and plans of the automakers play a prominent role in determining the outcome. Because the concept of economic practicability has been interpreted to rest substantially on the contemporary capabilities of the industry, it sets the primary constraints on progress. To the extent that automakers are deficient economic actors and market structures are imperfect, the reliance on their outputs to govern what can be done undermines the ability of the agency to write rules. Poor performance by the industry becomes a self-fulfilling prophecy, and in light of recent developments, a self-inflicted wound, in the setting of lax standards. It allows the industry to continue with its poor performance. EPA is not bound by this practice.

Fourth, NHTSA has chosen to assume that vehicle attributes remain constant. In recent years, consumers have proven to be willing to change their preferences, a shift that caught automakers by surprise. EPA has more flexibility to envision and promote changes in vehicle attributes in response to emissions standards. Experience supports the conclusion that NHTSA had been too timid in thinking about the ability of the industry to progress and the experience under the National Program reinforces that conclusion.

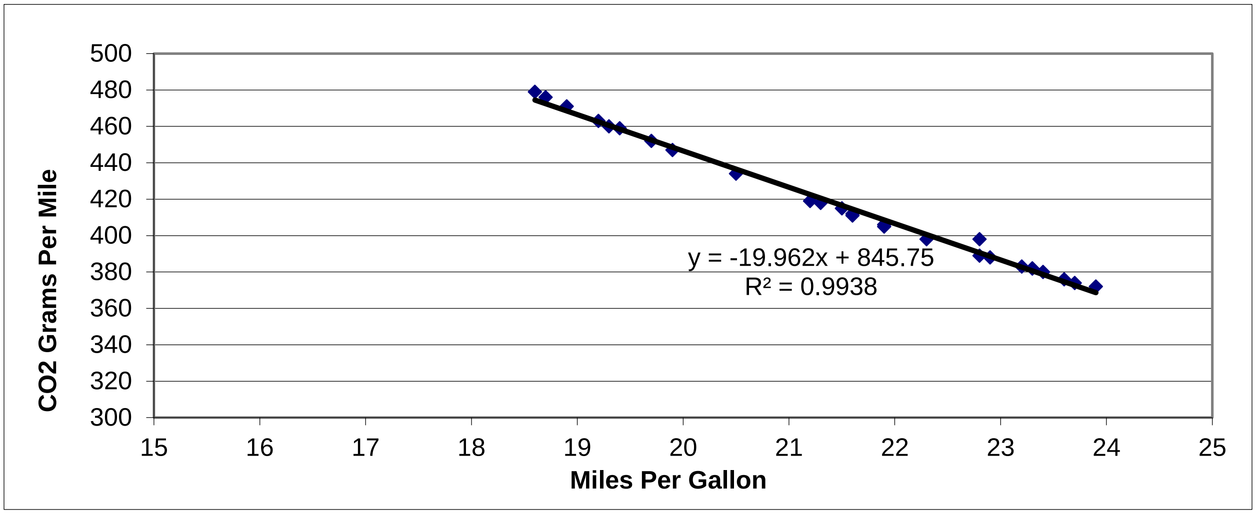
Finally, because there is a direct physical relationship between the amount of greenhouse gasses and other pollutants that a vehicle emits and the amount of gasoline it uses, EPA, by fulfilling its obligation to protect the public health and welfare under the Clean Air Act, will also be effectively establishing fuel economy standards. In fact, EPA has had the responsibility for measuring the fuel economy of vehicles since the Energy Policy Conservation Act (EPCA) established the Corporate Average Fuel Economy (CAFE) standards. Ironically, in order to measure fuel economy, EPA actually measures the tailpipe emissions of carbon dioxide and converts that to the number of gallons fuel consumed.

THE INSEVERABLE LINK BETWEEN ENERGY CONSUMPTION AND EMISSION OF POLLUTANTS

Figure II-2 shows data on fuel economy and greenhouse gas emissions for autos sold in the U.S. in 2006-2009. Figure II-3 shows more recent data and it highlights the continuing relationship as the fleet moves to higher levels of efficiency. These are adjusted, sales weighted data by manufacturer. There is a near perfect linear relationship between carbon dioxide emissions and fuel economy. Thus, there is no doubt that by regulating tailpipe carbon dioxide emissions, EPA can accomplish the goal of promoting energy conservation through higher fuel economy.

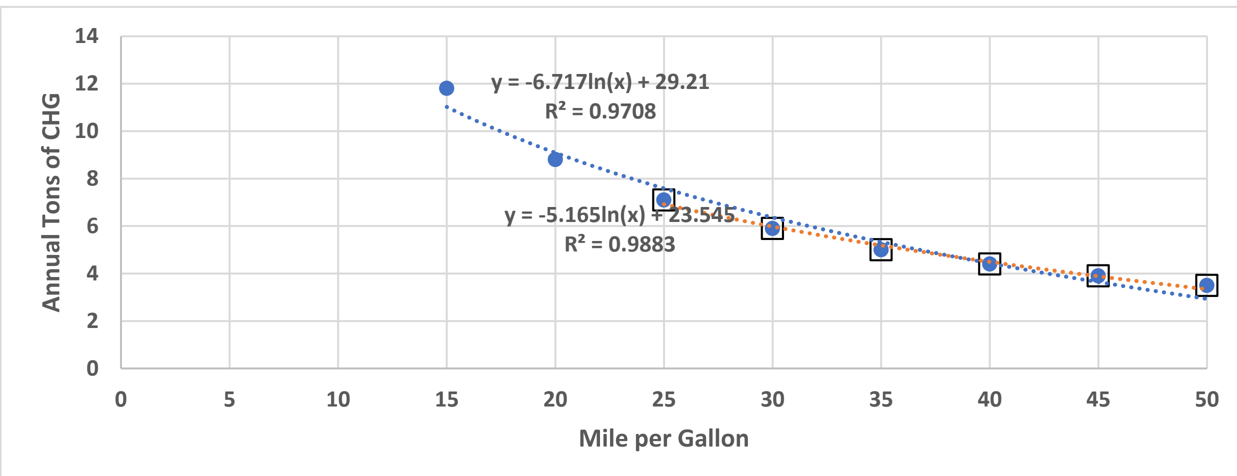
Because of the physical relationship between energy consumption and pollution emissions, one of the clear impacts of efficiency standards, whether instituted for energy, environmental, or public health reasons, is a reduction in pollution. The reduction of carbon emissions receives a great deal of attention today. The benefits of the reduction of emissions of non-carbon pollutants (e.g. SOX, NOX, VOC and particulates) are also important, have long been recognized, and the value of these is subject to less controversy.

FIGURE II-2: THE RELATIONSHIP BETWEEN FUEL ECONOMY AND CARBON DIOXIDE EMISSIONS



Source: Environmental Protection Agency, *Light Duty Automotive Technology: Carbon Dioxide Emission, and Fuel Economy Trends: 1975 Through 2009* November 2009, p. vii.

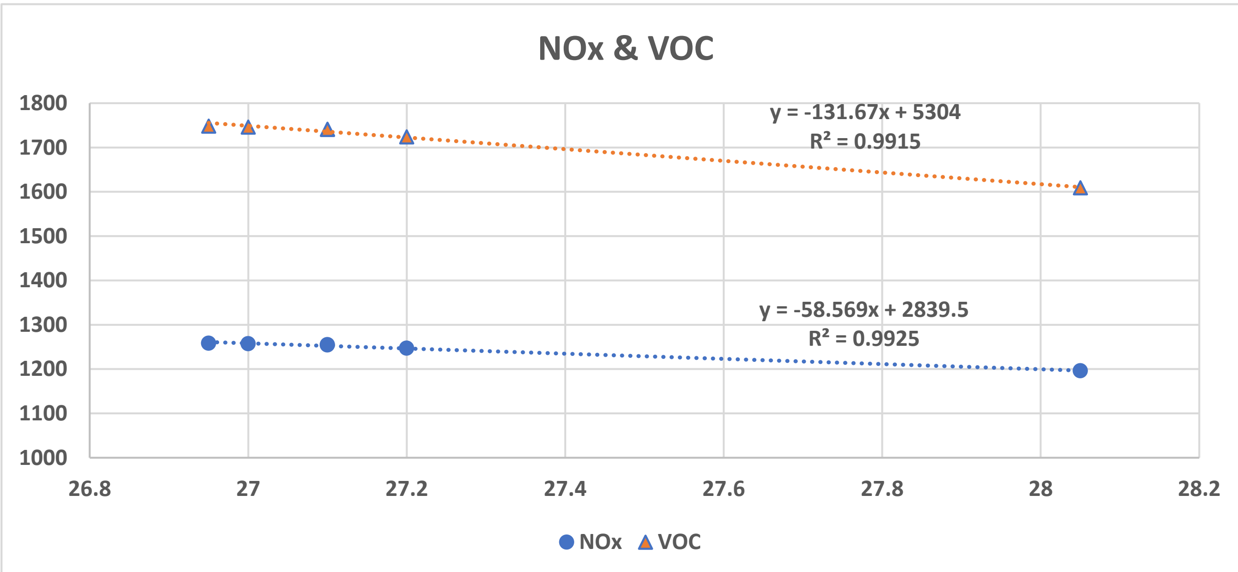
FIGURE II-3: THE NEAR PERFECT CORRELATION OF GREENHOUSE GAS EMISSIONS AND FUEL ECONOMY

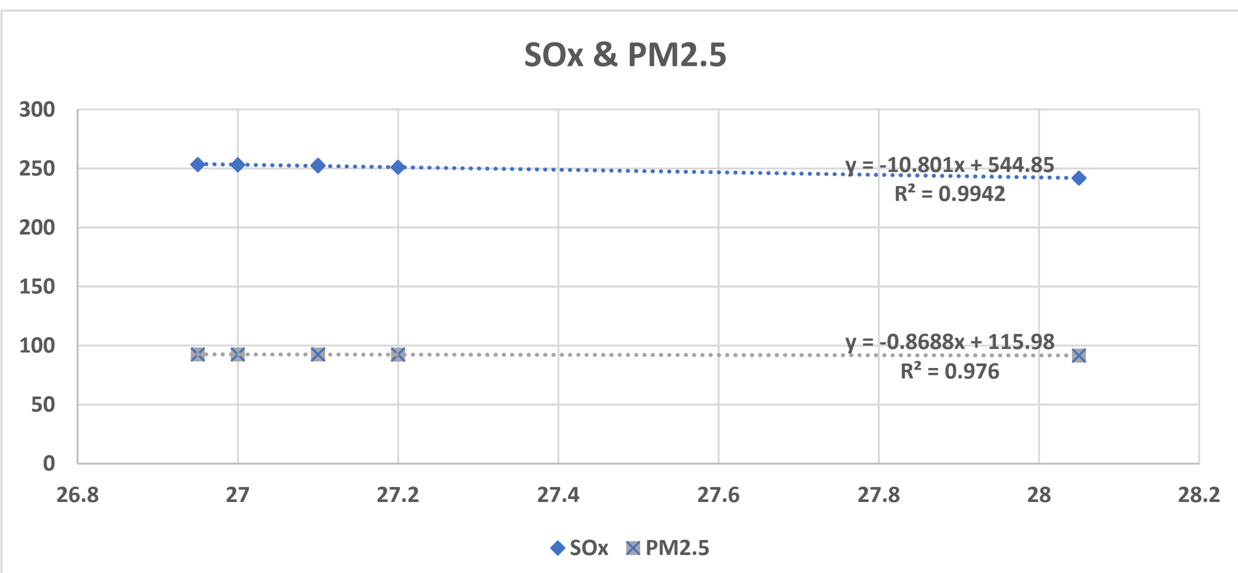


Source: EPA, *Sources of CO_2 Emissions for a Typical Household,* www.fueleconomy.gov/feg/climate.shtml

Figure II-4 shows the near perfect correlation between fuel economy and those other four pollutant that are incorporated in most efficiency analysis. In every case, the correlation coefficient is above .99. As we pointed out long ago in our work on the Clean Cars program,[33] the near perfect correlation between the emission of pollutants and consumption of petroleum products in vehicles creates a powerful and inevitable connection between environmental protection and consumer pocketbook savings. The same is true for other fossil fuels used directly by consumers or to produce electricity. The amount of pollution associated with electricity consumption will depend on the mix of resources used to generate it, and as reliance on fossil fuels declines, so too will the amount of pollution reduction, but the least-cost and most effective approach to reduction of emissions remains improving energy efficiency.[34] The least cost approach to emissions reductions is to improve the efficiency of vehicles and appliances by reducing their energy consumption. All the agencies involved in setting standards, EPA, NHTSA, DOT, DOE be they emissions, appliances, or fuel economy are required to consider this economic benefit.

FIGURE II-4: THE NEAR PERFECT CORRELATION BETWEEN MILEAGE AND EMISSION OF NON-CARBON POLLUTANT.





Source: National Highway Safety Transportation Administration, Average Fuel Economy Standards Passenger Cars and Light Trucks Model Year 2011, Table 1 and Table VII-12.

This physical relationship makes the adoption of pollution reduction unique in writing environmental standards to regulate pollution because the avoided cost of energy consumption are direct and immediate pocketbook benefits of the standard. Congress' broad language on benefits and the executive orders that seek maximum benefit reflect the fact that neither branch of government has the power to repeal or override the laws of nature. Viewed in this way, it can be argued that the consumer pocketbook savings are an inevitable, unintended consequence (an externality) of the reduction in pollution, which are not considered in the decision to consume energy (and externality of the market transaction).

AMERICAN FEDERALISM AT ITS BEST[35]

The National Program demonstrates not only the value of cooperation between federal and state agencies, but also the value of American federalism, which affords the states the role of laboratories to spur progress. The Clean Air Act allows California to exercise independent authority to adopt more stringent emissions standards because of the state's unique air pollution. Other states have the option to adopt either the California or the Federal standard. Many states followed California's lead in the past and will do so in the future. California's Clean Cars Program has helped to set a path that will improve the performance of light duty vehicles (cars and trucks) by a greater amount in a shorter time period than ever accomplished in U.S. history. The California Clean Cars Program enjoys widespread support from consumers, automakers and suppliers, business groups, national defense experts, public health advocates and environmentalists.

Similarly, California's Zero Emission Vehicle (ZEV) program and the states that have decided to participate in it have taken a leadership position in advancing a product that is vitally necessary to meet the needs of households for personal transportation in the 21st century. Our recent analysis of the diffusion of energy efficiency technologies provides strong reasons for our support of the Clean Cars ZEV program.[36]

- First, the innovation diffusion literature highlights the important role that supply-side leadership plays in moving new technologies into the market.
- Second, the efficiency gap literature demonstrates that performance standards can play a key role in creating a market for efficiency technologies.
- Third, the approach of the ZEV program has the key attribute that make performance standards successful.

There is an even more direct and important reason to believe that the ZEV program will play a leading role in creating an important market for new vehicles – the dramatic success of the Low Emission Vehicle (LEV) program, the immediate predecessor of the ZEV program.

- Electric vehicle sales certainly match those of hybrids in their early years on the market.
- Moreover, the number of makes and models available today is larger than the number of hybrid makes and models that were available in the early years of the hybrid experience.

Based on the historical experience of the hybrid, the targets set for the ZEV program are certainly achievable, but it would be a mistake to forget that the hybrid success was aided by the forward-looking regulation of the LEV states. The decision of the executive branch agencies of the Clean Cars states to embrace the ZEV program represents a leadership decision that is not only consistent with the extensive research literature and the experience in the LEV program, it is consistent with broad popular support for policies to promote greater energy efficiency of vehicles and state level action to reduce auto emissions.[37]

A decade ago, when California launched the LEV program, which jump-started the hybrid market, many predicted it would be a costly failure, but the LEV standard helped to stimulate the hybrid market. Today, hybrids are successful and profitable product, with millions sold. Many of the most popular automakers offer hybrids in the broad range of vehicles that consumers are most likely to buy. Given the success of the LEV program and its impact on the clean cars market, it is not surprising to find that, depending on the measuring stick one uses, today's electric vehicles are on par with or ahead of where hybrids were at a similar stage of their development.

Eight states representing a quarter of the U.S. auto-buying market are joining forces to push for more zero-emission vehicles (ZEVs). These actions, taken in the eight states across the country, will help accelerate the growth of the national market for the latest clean and efficient cars. One of the great benefits of American federalism is to allow the individual states to act as laboratories to discover better ways of accomplishing shared goals. The more eyeballs looking at a problem, the more likely it is that a good solution will be found. By allowing the largest economy in the nation to develop a set of standards independently of the federal standards and allowing the states to adopt either the Federal or the California standard, the Clean Air Act prevents fragmentation into fifty standards, but preserves the dynamic of state-based innovation.

By adding a layer of cooperation between federal and state agencies, the executive order issued by the Obama administration smoothed the process and increased the benefits of Federalism in this policy area that is important to the environment, public health and safety, the economy and national defense.

EXECUTIVE BRANCH GUIDANCE ON RULEMAKING

The Request for Information (RFI) issued by the Department of Transportation (published in the Federal Register on June 8, 2017) is among the first to contemplate fundamental changes in the approach to regulation in America under the Trump Administration.[38] As such, it demands a broad view of the process and how it has functioned in the past. The RFI recognizes that the recent Executive Orders on Regulatory Reform are laid atop the underlying statutes and Executive Orders in force that must be honored.[39] Executive Orders cannot repeal or redefine the Congressional intent of the authorizing statutes, they can only seek to improve the process by which the executive branch exercises the will of the Congress. Moreover, while Executive Orders can supplant earlier orders, great care should be taken in altering regulatory practice that has been successful and stood the test of time.

The Legal Context of Regulatory Reform of Fuel economy standards

In the case of the Department of Transportation (DOT) fuel economy standards, there is a remarkable record of success that must provide the context for any efforts to reform the regulatory process. Over the course of more than forty years, with careful statutory goals and guided by a Reagan-era Executive Order whose principles remain in force to give strong guidance to the regulatory review process, Department of Transportation regulations have yielded trillions of dollars of direct pocketbook benefits to consumers and indirect economic and environmental benefits to the nation. The consideration of reform of Department of Transportation regulation must be informed by that remarkable track record of success.

That review must consider both the benefits and costs of standards, not because the deregulatory executive order says so (which it now does),[40] but because the underlying statutes guided by Executive Orders have always required a full and careful benefit-cost analysis. Federal law not only imposes deadlines and requires benefit-cost analysis, but also requires that the conclusions be reasonably related to the facts before the agency.[41] Federal law constrains executive actions in other ways, requiring cooperation between federal and state agencies, and giving states a right to independent action under the American approach to federalism.

The rule of law requires an agency to reach decisions that reflect a reasonable interpretation of the evidence on the record before it. The impact of policy on consumer pocketbooks and public support for consumer-friendly policies is important evidence. Our public opinion polling data shows that consumers overwhelmingly support efficiency standards.[42] Our economic analysis, summarized below, explains why they are right to do so – these standards have saved and continue to save consumers vast sums.

Executive Orders

Agency efforts to implement sector specific goals through adoption of policy instruments are governed and guided by executive orders from the President and guidance offered by the Office of Management and the Budget. Over the past four decades this guidance has become highly defined, as shown in Table II-3 and Appendix A. The pedigree, longevity and success of this law and administrative practice create a formidable institutional structure that deserves a great deal of respect and deference. As a result, energy performance standards enjoy a remarkable degree of public and bipartisan support.[43]

E.O. 12291 (Reagan, 1981): Less than a month into the Reagan Administration, Executive Order 12291 outlined the principles and practices to govern the evaluation and promulgation of rules and standards. Although these were modified slightly by later presidents, the basic structure has remained the same. Since the law was quite new when Reagan took office and few standards had been written, his executive order essentially established the practice.

E.O. 12866 (Clinton, 1993): President Clinton replaced Reagan's executive order, but his Executive Order 12866 kept the essential elements of the approach in place. In terms of the analysis below, it rendered the review more flexible and encouraged greater reliance on market forces. It introduced the concept of performance standards and called for careful review across all standards.

OMB Circular A-4 (2003): The Bush Administration provided the longest guidance on benefit cost analysis with both a paper and a lengthy circular.

E.O. 13563 (Obama, 2011): The Obama Executive Order extended earlier orders by emphasizing efforts to achieve results at least costs and transparency.

The executive guidance is extensive, as outlined in Appendix A. Table II-3 culls out key principles focusing on cost benefit analysis that will play a prominent role in the analysis in the paper. Conducting analysis and implementing policy within the bounds of the law is a foundational principle of utmost importance. The balancing of costs and benefits and the targeting of maximum net benefits are central in the discussion that follows. Quantification, to the extent possible, based on the best available scientific information was a matter of routine that has taken on greater significance recently. Performance standards are clearly favored over command and control approaches.

TABLE II-3: EXECUTIVE BRANCH GUIDANCE ON BENEFIT COST ANALYSIS

Overall goal: Bush: A statement of the need for the regulatory action: Agencies should explain whether the action is intended to address a market failure or to promote some other goal, such as improving governmental processes, protecting privacy, or combating discrimination. If the action is compelled by statute or judicial directive, agencies should describe the specific authority and the extent of discretion permitted.

Scientific Basis: Bush: The agency should use the best reasonably obtainable scientific, technical, economic, and other information to quantify the likely benefits and costs of each regulatory alternative. Presenting benefits and costs in physical units in addition to monetary units will improve the transparency of the analysis.

Benefit Cost Principles: Reagan: Regulatory action shall not be undertaken unless the potential benefits to society from the regulation outweigh the potential costs to society; **Bush**: Regulatory analysis is a tool regulatory agencies use to anticipate and evaluate the likely consequences of rules. It provides a formal way of organizing the evidence on the key effects good and bad of the various alternatives that should be considered in developing regulations. The motivation is to (1) learn if the benefits of an action are likely to justify the costs or (2) discover which of various possible alternatives would be the most cost-effective; **Obama:** propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify) … It must identify and use the best, most innovative, and least burdensome tools for achieving regulatory ends.

Maximize Net Benefits: Reagan: Regulatory objectives shall be chosen to maximize the net benefits to society; Among alternative approaches to any given regulatory objective, the alternative involving the least net cost to society shall be chosen; **Clinton:** When an agency determines that a regulation is the best available method of achieving the regulatory objective, it shall design its regulations in the most cost-effective manner to achieve the regulatory objective; **Obama:** select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity)

Regulatory Design: Bush: To the extent feasible, agencies should specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt. It may be useful to identify the benefits and costs in the following manner: Benefits and costs that can be monetized, and their timing; Benefits and costs that can be quantified, but not monetized, and their timing; Benefits and costs that cannot be quantified. Whenever you report the benefits and costs of alternative options, you should present both total and incremental benefits and costs. In addition to the direct benefits and costs of each alternative, the list should include any important ancillary benefits and countervailing risks. Distributional effects. Transfer payments; **Obama:** to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt.

Full Range of Effects: Bush: Agencies should include the following effects, where relevant, in their analysis and provide estimates of their monetary values: Private-sector compliance costs and savings; Government administrative costs and savings; Gains or losses in consumers' or producers' surpluses; Discomfort or inconvenience benefits and costs; and Gains or losses of time in work, leisure, and/or commuting/travel settings.

Breakeven analysis: Bush: When quantification and monetization are not possible, many agencies have found it both useful and informative to engage in threshold or "breakeven" analysis. This approach answers the question, "How large would the value of the non-quantified benefits have to be for the rule to yield positive net benefits?"

Sources: See Appendix A.

PHYSICS, LAW AND ECONOMICS GO HAND IN GLOVE IN THE RULEMAKING PROCESS

In this section we have shown that legislation and executive branch guidance establish principles of law that recognize the basic physical linkage of energy consumption, emission of pollutant and economic impacts. Congress could no easier repeal the laws of gravity, than legislate the separation of efficiency and emissions, or ignore the co-benefits of improving one or the other. Fortunately, it has not tried to do so in these statutes. On the contrary, physics and law go hand in glove and policymakers have endeavored to craft an analytic framework that recognizes this reality.

The remainder of this document examines the economic framework laid atop this reality and shows that physics, law and sound economic principles can make for a very close fit. Having laid out the general principles of law that govern efficiency policy, the next section describes principles of economics that have been recommended and applied to crafting efficiency standards. With general principles of law and economics in hand, we turn our attention to the specifics of writing standards for specific products.

Various aspects of over a dozen standards are examined in detail throughout this analysis to make and reinforce the general findings and conclusions. They share two things in common that makes a strong point about the rulemaking process that should be emphasized. First, they were all directly mandated by the law – EISA in particular – or the courts – in the case of appliance standards. Second, all of the standards have gone through the vigorous, transparent vetting process that Congress and the executive branch have built over the past four decades. The agencies have reviewed mountains of evidence, conducted their own independent research, written extensive evaluations of the broader research literature, taken the factors identified in the laws into account, and reached a conclusion. Those who wanted weaker standards (e.g. industry) and those who wanted stronger standards (e.g. consumers) may complain that their point of view was not given sufficient weight, but the hearing records are extensive, with support documents running to thousands of pages.

With a new administration that is much friendlier to the industry point of view, several industries sought to overturn the balance that the agencies had struck, since the passage of EISA. The administration’s bias in favor of industry contradicts the underlying statutes and disturbs the “objective” balance the executive orders sought to achieve. Because the underlying statutes and executive guidance are still in place, the challenge for the agencies will be to build hearing records that support a new direction. Just saying that industry is not happy is not likely to be enough in the court cases that will inevitably follow if rules are not based on solid evidentiary records.

Because industry made its case, but did not prevail, in the original vetting process, it has a heavy burden of showing why things have changed. Throughout this analysis, we address the tired old arguments, which we are likely to be offered anew. In a sense, much of this analysis can be read as rebuttal of those arguments.

- The cost of compliance is invariably much less than anticipated, Section X on vehicles, Section XV on appliances, Section XVI on computers.

- Cost is closely linked to the feasibility of standards, a topic explicitly addressed in several Sections, including all of Part VIII, covering current fuel economy standards, Section VIII addressing past fuel economy standards, Section XIII on heavy-duty trucks and Section XVI covering computers.
- Consumer desires and abilities, frequently cited as evidence against standards are shown to be the opposite on both counts, they want more efficiency than the manufacturers admit (Sections VII and VIII), and have less ability to implement their desires than the manufacturers claim (Section IX)
- The claim that weakening standards helps low income households is shown to be incorrect on all three measures of the impact of standards in Section XIX, which reviews consumer pocketbook, public health, and macroeconomic stimulation.
- Claims that standards slow the economy, reduce sales and cost jobs are shown to be false (Section XI and XIX).

The document lays the foundation not only for regulatory review comments at DOT, but also the Department of Energy (early next year) and individual rulemakings (e.g. EPA/NHTSA's mid-term review, in the spring), as well as potential court challenges to unjustified changes to other rules, and not only at the federal level, but in state proceedings (e.g. the California Energy Commission and the Air Resources Board).

The legal/analytical framework, historical record and contemporary evaluation all demonstrate the clear benefit of hundreds of standards developed under the general approach of "command-but-not-control" regulation that the U.S. implemented for energy efficiency over the past four decades. Abandoning this approach, as the Trump administration has proposed, will impose a huge, $2 trillion loss on consumers and the economy.

From the consumer point of view, our analysis shows not only that the consumer stakes are huge, but also that both low **and** middle-income households benefit disproportionately from efficiency standards, which means that weakening the standards is a hidden tax on households in the bottom half of the income distribution.

From a legal/technical point of view, our analysis demonstrates two critical points that contradict the broad effort to gut standards.

- Independent technology assessments and the long history of declining costs for efficiency contradict the complaints from industry that the standards hurt them, which rebuts the primary rationale for freeze and rollback.
- There is an inseverable link between pollution reduction, consumer pocketbook savings and macro-economic growth, which means that complaints about agencies exceeding their authority by counting "co-benefits" are illogical and contradicted by the statutes.

III. THE IMPORTANCE OF RIGOROUS BENEFIT-COST ANALYSIS IN CORRECTING MARKET FAILURES

Because concerns about energy consumption were magnified by the energy price shocks of the 1970s, there is an extremely large and rich literature on why there is a significant and persistent "efficiency gap."[44] While the impetus to setting standards for energy consumption of durable goods was the urgent effect of price shocks on the economy and national security (both of which can be considered, "externalities" of energy consumption), engineering-economic analysis identifies numerous attractive opportunities to invest in energy saving technologies that cost less than the savings they generate. This literature offers a conceptual explanation based on the observation that there are imperfections on both the supply and demand sides of energy markets that lead producers to underinvest in energy efficiency and consumers to demand less efficiency than is economically justified.

That literature also contains hundreds, if not thousands, of peer-reviewed and published empirical studies of the actual and potential energy savings across a broad range of goods. It contains numerous comparisons of policy instruments in which performance standards repeatedly turn out to be among the most effective tools for addressing these market imperfections when they take a "command but not control," approach.[45]

Because the oil price shocks had a massive impact on the U.S., the issue has been prominent for a long time, with recent environmental concerns reinforcing its continuing importance. As a result, efficiency has received a great deal of policy, political and polling attention. This Section discusses the decision-making terrain of fuel economy standards.

THE FOUNDATION OF ENERGY POLICY IN MARKET IMPERFECTIONS[46]

Benefits and Costs

The principles that the laws and executive orders teach should be familiar to and learned by anyone who has taken Economics 101. Proper cost benefit analysis must include careful consideration of costs and benefits. In fact, an introductory economics text written by John B. Taylor,[47] who holds prestigious named appointments at Stanford University and the conservative Hoover Institute and who served as an Under Secretary of the Treasury in the George W. Bush administration,[48] defines cost benefit analysis as follows: "Cost-Benefit Analysis: an appraisal of a project based on the costs and benefits from it."[49]

A more advanced text on *The Economics of Regulation and Antitrust,*[50] calls it benefit-cost analysis and explains the obvious need to include costs and benefits as follows:

> From an economic efficiency standpoint, the rationale for a benefit-cost approach seems quite compelling. At a very minimum, it seems reasonable that society should not pursue policies that do not advance our interests. If the benefits of a policy are not in excess of the costs, then clearly it should not be pursued, because such efforts do more harm than good. Ideally, we want to maximize the net gain that policies produce…

> The requirement that benefits exceed costs for sound regulatory policies has also given rise to a simple shorthand. The ratio of benefits to costs, or the benefit-cost ratio, must exceed 1.0 for a policy to be potentially attractive. This requirement serves as the minimum tests for policy efficacy, as our overall objective should be to maximize the spread between benefits and costs.[51]

The recent OMB advice letter calls for careful cost-benefit analysis.[52] The challenge as always will be to ensure that agencies do not engage in "fuzzy math." The threat of "fuzzy math" is nothing new and the APA takes a pragmatic approach to evaluating whether the agency decision is consistent with the record before it.

Market Imperfections

The cornerstone of the cost benefit justification for standards is the potential to produce a benefit. If the marketplace is performing well, it is difficult to justify policy intervention. If it not performing well for any variety of reasons, policy interventions in the market can improve market performance. Viscusi, et al., present an overarching observation as the starting point for this analysis.

> "If we existed in a world that functioned in accordance with the perfect competitive paradigm, there would be little need for antitrust policies and other regulatory efforts. All markets would consist of a large number of sellers of a product, and consumers would be fully informed of the product's implications. Moreover, there would be no externalities present in this idealized economy, as all effects would be internalized by the buyers and seller of a particular product.
>
> Unfortunately, economic reality seldom adheres very closely to the textbook model of perfect competition. Many industries are dominated by a small number of large firms. In some instances, principally the public utilities, there may even be a monopoly…
>
> Not all market failures stem from actions by firms. In some cases, individuals can also be contributing to the market failure."[53]

The key elements of this analytic framework were put into place a quarter of a century ago in Executive Order 12866 and they remain in effect today. They have stood the test of time because they further the goals enacted by Congress and comport with the precepts of economic analysis. The empirical evidence with respect to energy efficiency indicates is that there is a significant failure of the market to produce optimum results. The recent literature, which has been reviewed in many recent proceedings, shows that there is a massive efficiency gap and there are numerous, well-documented market imperfections that lead to underinvestment and under-supply of energy saving technologies in consumer durable and commercial equipment markets.

Societal failures, like the national security implications of energy imports, were often the starting point for the consideration of policies to intervene in the market. Environmental externalities were another early and obvious market failure. The study of the market for energy efficiency has yielded many other sources of imperfections.

Externalities as the source of market failure are well grounded in traditional economic analysis. These analyses of benefits and costs reviewed in the previous section recognize that externalities play a key part in driving policies to spur investment in energy saving technologies, but they focus on other obstacles to investment. Externalities are factors that are not directly included in typical cost-benefit analysis of business investment decisions. In the case of investing in fuel efficient technologies, the failure to consider externalities leads to the undervaluation of improving energy efficiency from the societal point of view and a resulting underinvestment in efficiency because these benefits do not factor into typical and immediate business decisions. Because these considerations never enter into business calculations, they are considered market failures. They are distinct from cases where businesses do make the calculations, but arrive at the results that fail to invest in cost beneficial technologies for any of a variety of reasons. Different authors apply different labels to the various types of obstacles that inhibit investment but the underlying obstacles are similar.[54]

There are negative externalities that result from fuel consumption which do not enter into the typical business cost/benefit calculations, for example: tail pipe emissions create environmental and health problems. An externality that is unique to transportation fuel is the national security implications of dependence on oil imports. While externalities are generally not factored into business decision making, from a societal perspective they can, and should, be an important factor in standard development.

We have documented and discussed these at great length in comments, as well as papers and reports.[55] While a number of conceptual approaches have been taken, they all deliver the same message, as the discussion in the next section shows, market imperfections affect energy consumption choice significantly and pervasively. In this analysis we briefly review four conceptualizations that emphasize the diverse schools of thought that have added many different perspectives and a great deal of depth to the understanding of market imperfections over the past quarter century. Two-thirds of the Noble prizes in economics over the past quarter of a century have been to works that have enriched the critique of neoclassical model (up to and including the 2017 award), which devoted little attention and gave little credence to the analysis of market failures.[56]

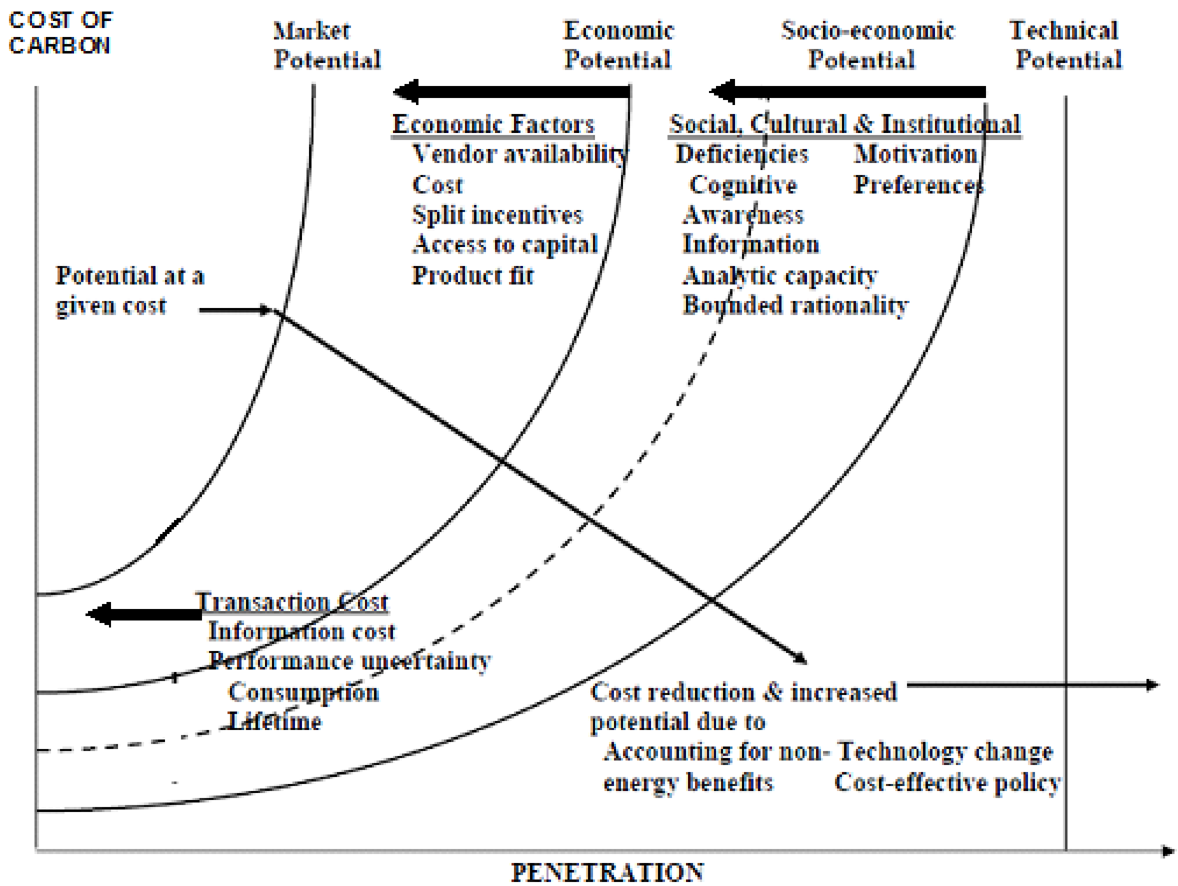
FUNDAMENTAL ECONOMIC PERSPECTIVES

The LBL Investment/Technology Adoption Framework

A 2004 report to the California Energy Commission from Lawrence Berkeley Laboratory captures much of the discussion of market failure in the form of technology penetration frontiers (see Figure III-1). The output variable is the reduction of greenhouse gas emissions, which is certainly appropriate for the current proceeding, from the EPA point of view and, since there is a direct physical relationship between tailpipe emissions and gasoline consumption, it fits the NHTSA purpose as well. We have preserved the labels from the original, but added in some of the specific factors the following analysis cites in its conceptual frameworks and case studies. The graph shows the penetration of energy efficiency technologies along the X-axis and cost of carbon along the Y-axis.

At the extreme right is the maximum technical potential reduction in carbon achievable with the penetration of available technology. In the 2008 rulemaking, NHTSA calculated this limit as the "technology exhaust" scenario. The level of reduction in carbon that is achieved in the marketplace is lower because several factors keep the technologies from penetrating the market. The figure identifies all of the major categories of market imperfections, barriers, obstacles – behavioral factors (social, cultural & institutional), economic factors and transaction costs – each of which establishes a different frontier. Technological change, and public policy play an important role in determining where the market will settle along a given frontier as well as influencing where the technological limit is.

FIGURE III-1: PENETRATION OF MITIGATION TECHNOLOGIES: A CONCEPTUAL FRAMEWORK



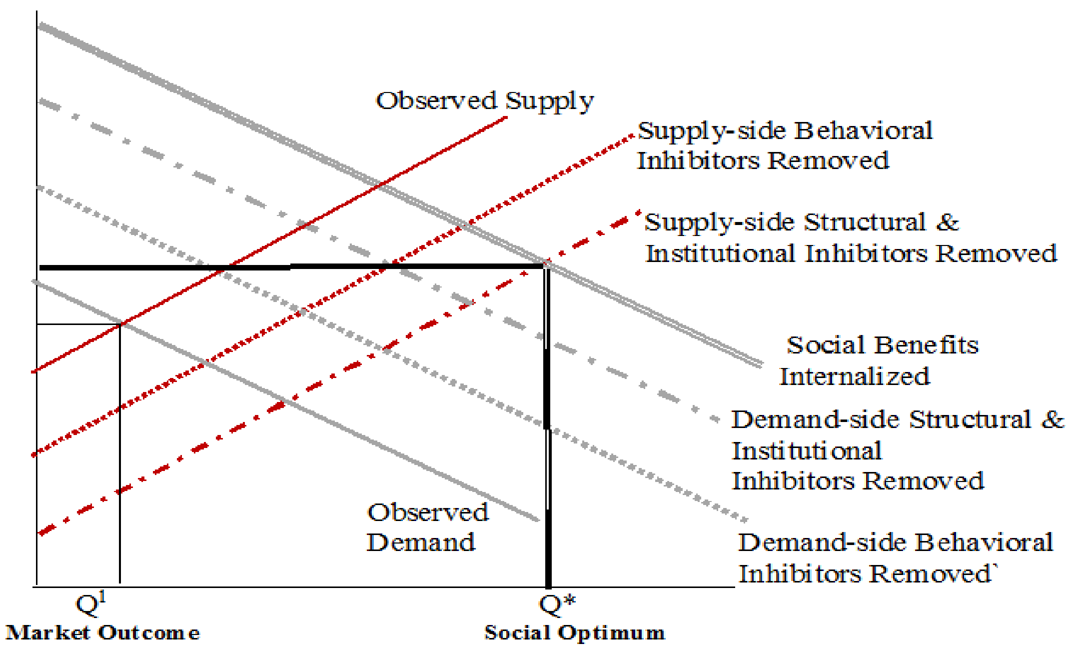
Source: Adapted from Jayant Sathaye and Scott Murtishaw, *Market Failures, Consumer Preferences, and Transaction Costs in Energy Efficiency Purchase Decisions* (California Energy Commission, November 2004), consultant report, p. 11.

We add a distinction within the Social/Cultural/Institutional category between what we call deficiencies, i.e. behavioral characteristics and processes that lead consumers to under invest in efficiency even though they are interested in doing so, and motivational factors, i.e. consumer preferences that lead to under investment in efficiency because they do not value it. This distinction is important in the current context because the agencies have assumed no change in product attributes. The goal is to achieve efficiency without changing the attributes of the vehicles. As the literature review shows, given constant preferences, there are numerous behavioral factors that reduce the amount consumers choose to invest in energy efficiency.

The Welfare Economics of Vigorous Policy Action

Figure III-2 presents a welfare economic view of the implementation of vigorous policies enhances social welfare. It provides a useful starting point to summarize the welfare economics of our argument because it starts by identifying the benefit of capturing positive externalities, the opposite of the typical approach that launches from negative externalities. The graph models behavioral barriers that reduce consumer purchases of a good that has a positive externality, i.e. the efficiency gap problem. In Figure III-2, we add market structural and new institutional barriers to the behavioral factors that drive consumer purchases farther from the social optimum.

FIGURE III-2: WELFARE ECONOMICS: INDUCED SUPPLY AND DEMAND SHIFT TO INCREASE SOCIAL WELFARE



Source: Adapted from Briggette Madrian, *Applying Insights from Behavioral Economics to Policy Design*, NBER Working Paper No. 20318, July 2014, p. 7.

We have constructed the graph to generally reflect the magnitude of effects suggested by the economic analysis and literature.

- Behavioral factors are a modest part of the problem and they affect both consumers and producers.
- Structural and new institutional factors are at least as important as behavioral and they affect both the supply and the demand sides.
- The supply side is at least as important as the demand side.

- The externality market failure is a significant cause of the underinvestment, although smaller than the market structure, institutional and behavioral barriers.
- The increase in price at the social optimum would be modest because technological progress lowers the supply-side cost, while demand side policies reduce the shift in demand.

In the large distance between the actual equilibrium and the equilibrium that reflects the removal of all barriers. Figure III-2 also reflects the fact that energy efficiency possesses two characteristics that make it a particularly difficult challenge for traditional neoclassical analysis as it has come to be practiced in the U.S. It involves very large impacts and a great deal of uncertainty, in part due to the very long-time frame of analysis of energy consumption's environmental impacts. This raises a host of questions about the discount rate, as discussed below. These characteristics interact to argue for a precautionary principle that supports more aggressive policy and the adoption of overlapping policy instruments.

CONCEPTUAL SPECIFICATIONS OF MARKET IMPERFECTIONS[57]

Lawrence Berkeley Laboratory

The identification and explanation of the nature and extent of market imperfections is central to the benefit cost framework, Table III-1 summarizes an earlier 1996 paper prepared by other analysts at the Lawrence Berkeley Laboratory (LBL).[58] The analysis was framed in terms of the role of policy intervention to promote efficiency as states restructured the electricity market. The paper "focuses on understanding to what extent some form of future intervention may be warranted and how we might judge the success of particular interventions."[59] Restructuring did not spread throughout the utility industry and in the past few years, reliance on interventions in the market to increase efficiency and renewables has grown, even in the deregulated states.[60] The growth of market interventions is consistent with the conclusions in the LBL paper.

> We conclude that there are compelling justifications for future energy-efficiency policies. Nevertheless, in order to succeed, they must be based on a sound understanding of the market problems they seek to correct and a realistic assessment of their likely efficacy.[61]

As shown in Table III-1, the Golove and Eto paper identified four broad categories of factors that inhibited investments in energy efficiency – barriers, transactions costs, market failures, and behavioral (noneconomic) factors. It identifies about two dozen specific factors spread roughly equally across these four categories. A key aspect of the analysis is to identify each of the categories as coming from a different tradition in the economic literature. The barriers category is made up of market structural factors. The market failure category is made up of externalities and imperfect competition. The LBL paper bases a substantial part of its argument on a transaction cost perspective as a critique of neo-classical economics.

> Neo-classical economics generally relies on the assumption of frictionless transactions in which no costs are associated with the transaction itself. In other words, the cost of activities such as collecting and analyzing information; negotiating with potential suppliers, partners and customers; and risk are assumed to be nonexistent or

insignificant. This assumption has been increasingly challenged in recent years. The insights developed through these challenges represent an important way to evaluate aspects of various market failures (especially those associated with imperfect information).[62]

TABLE III-1: MARKET BARRIERS TO ENERGY EFFICIENCY

Barriers[1]	Market Failures	Transaction Cost[2]	Behavioral factors[16]
Misplaced incentives	Externalities	Sunk costs[3]	Custom[17]
Agency[4]	Mis-pricing[20]	Lifetime[5]	Values[18] & Commitment[19]
Capital Illiquidity[8]	Public Goods[22]	Risk[6] & Uncertainty[7]	Social group & status[21]
Bundling	Basic research[23]	Asymmetric Info.[9]	Psychological Prospect[24]
Multi-attribute	Information	Imperfect Info.[10]	Ability to process info[27]
Gold Plating[11]	(Learning by Doing)[25]	Availability	Bounded rationality[26]
Inseparability[13]	Imperfect Competition/	Cost[12]	
Regulation	Market Power[28]	Accuracy	
Price Distortion[14]			
Chain of Barriers			
Disaggregated Mkt.[15]			

Source: William H. Golove and Joseph H. Eto, *Market Barriers to Energy Efficiency: A Critical Reappraisal of the Rationale for Public Policies to Promote Energy Efficiency.* For citations, see Appendix B.

Starting from the observation that "transaction costs are not insignificant but, in fact, constitute a primary explanation for the particular form taken by many economic institutions and contractual relations"[63] the LBL paper identifies such costs and information as a critical issue, pointing out that "the key issue surrounding information is not its public goods character, but rather its asymmetric distribution combined with the tendency of those who have it to use it opportunistically."[64] Indeed, information plays a very large role in the analysis, entering in six different ways. In addition to the public goods and asymmetry concerns, the paper identifies four other ways information can create a barrier to efficiency – "(1) the lack of information, (2) the cost of information, (3) the accuracy of information, and (4) the ability to use or act upon information."[65]

Resources for the Future

A more recent paper from Resources for the Future (RFF), entitled *Energy Efficiency Economics and Policy,* addresses exactly the same issues as the earlier LBL paper – the debate over the efficiency gap observed in energy markets. The authors of the RFF paper characterize the efficiency gap debate as follows:

> Much of the literature on energy efficiency focuses on elucidating the potential rationales for policy intervention and evaluating the effectiveness and cost of such interventions in practice. Within this literature there is a long-standing debate surrounding the commonly cited "energy efficiency gap..." Within the investment framework… the energy efficiency gap takes the form of under investment in energy efficiency relative to a description of the socially optimal level of energy efficiency. Such under investment is also sometimes described as an observed rate or probability of adoption of energy-efficient technologies that is "too slow."[66]

The RFF framework is summarized in Table III-2, but extended in two ways. In the market failure category, it shows the distinction between the structural and societal levels suggested by the paper. It also includes a few more specific failures that were discussed in the text, but not included in the original table. There are about a dozen specific market failures spread across these categories.

TABLE III-2: MARKET AND BEHAVIORAL FACTORS RELEVANT TO ENERGY EFFICIENCY

Societal Failures	***Structural Failures***	***Potential Behavioral Failures***[11]
Energy Market Failures	Capital Market Failures	Prospect theory[12]
Environmental Externalities[1]	Liquidity constraints[5]	Bounded rationality[13]
Energy Security	Information problems[6]	Heuristic decision making[14]
Innovation market failures	Lack of information[7]	Information[15]
Research and development spillovers[2]	Asymmetric info. >	
Learning-by-doing spillovers[3]	Adverse selection[8]	
Learning-by-using[4]	Principal-agent problems[9]	
	Average-cost electricity pricing[10]	

Source: Kenneth Gillingham, Richard G. Newell, and Karen Palmer, *Energy Efficiency Economics and Policy* (Resources for the Future, April 2009). For Citations, see Appendix B.

The RFF paper suggests three broad categories of market failures – the individual, the interaction between economic agents and the fit between economic agents and society. We refer to these three levels as the behavioral, the market structural and the societal levels. In the present context, we consider behavioral failures to represent consumer behavior that is inconsistent with utility maximization, or in the current context, energy service cost-minimization. In contrast, market failure analysis is distinct in presupposing individual rationality and focusing on the conditions surrounding interactions among economic agents and society.[67] The societal level market failures are closest to what the traditional sources of the economic literature refers to as market failure. These are primarily externalities and public goods. These were also considered market failures in the LBL framework. The LBL barriers and transaction costs fit in the category of interactions between economic agents, as would imperfect competition.

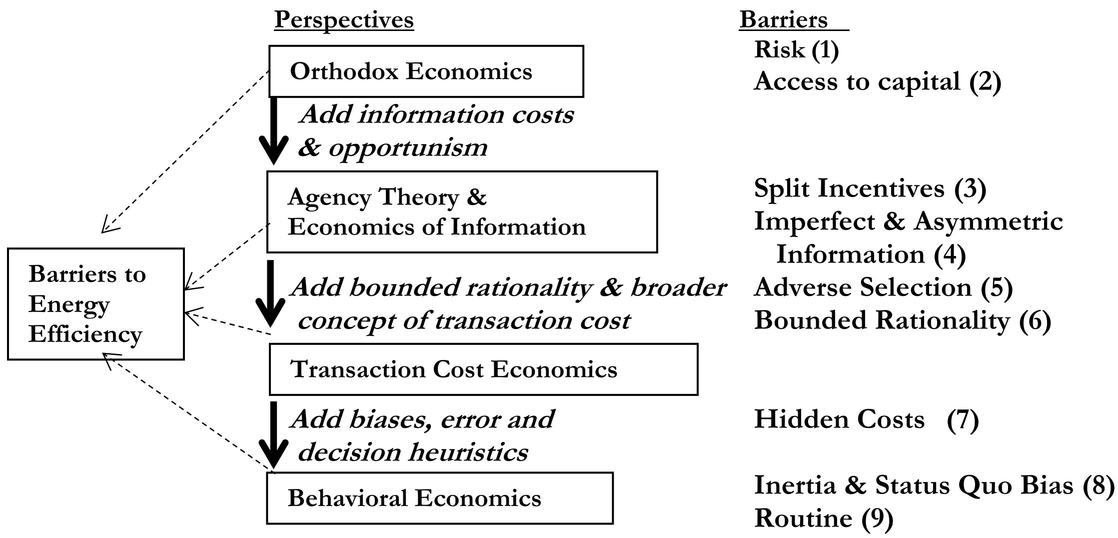
One obvious point is that, once again, information problems occur in all categories of the RFF analysis, with several manifestations in each. Information can be a problem at the societal level since it can be considered a public good that is not produced because the authors of the information cannot capture the social value of information. It is a structural problem because, where it is lacking, even capable, well-motivated individuals cannot make efficient choices. Finally, where it is asymmetric, individuals can take advantage of the less informed to produce outcomes that are not efficient. It is a problem at the behavioral level where individuals lack the ability to gather and process information.

OTHER RECENT COMPREHENSIVE EFFICIENCY GAP FRAMEWORKS

In the past few years, several comprehensive reviews have been offered that attempt to depict the many diverse factors that underlie the efficiency gap.

Figure III-3 summarizes a recent comprehensive review of the causes of the efficiency gap in industrial sectors across the globe. It is based on a conceptualization and analysis prepared for the United Nations Industrial Organization by analysts at universities in the United Kingdom (hereafter UNIDO). It is based on a review of over 160 studies of barriers to energy efficiency in industrial enterprises.

FIGURE III-3: BARRIERS TO INDUSTRIAL ENERGY EFFICIENCY



Source: Steve Sorrell, Alexandra Mallett & Sheridan Nye. *Barriers to industrial energy efficiency, A literature review*, United Nations Industrial Development Organization, Vienna, 2011, Figure 3.1 & Section 3. For citations, see Appendix B.

It can be argued that the analysis of industrial sectors provides the most compelling evidence that an energy efficiency gap exists, since these are contexts in which the incentive to adopt economically rational technologies should be strong, if not pure, and the knowledge and ability to evaluate alternatives should be greater than society at large. Moreover, since energy is a cost of doing business, records and data should be superior to the residential sector, so evaluation and calculation should be better. In spite of these factors pointing toward economic rationality, and notwithstanding assumptions of motivation and capability, these authors find solid empirical evidence that the efficiency gap exists.

As was the case in the LBL analysis, the UNIDO analysis identified a school of economic thought that can be closely associated with each of the categories of market barriers and imperfections. The broad categories in the UNIDO analysis match up well with the perspectives offered by LBL and RFF with the addition of the category of externalities. The UNIDO document offers six broad types of barriers, with two dozen subtypes.

Table III-3 presents the framework utilized by the California Energy Institute in evaluating policies to increase energy efficiency in businesses. It is notable in two respects. First, it is oriented toward businesses, which is a useful antidote to the overemphasis on residential consumers in the efficiency gap debate. Second, it explicitly endeavors to summarize and compile the various approaches to analyzing the "efficiency gap," used by others. In doing so, it returns to the traditional distinction that is made between market failures, which are recognized in neoclassical approaches, and other obstacles to investment in energy efficiency in the market. It identifies two other broad categories – market barriers and non-economic factors.

TABLE III-3: MARKET FAILURES, BARRIERS AND NON-ECONOMIC FACTORS

Neo Classical Economics

Explanations for the gap:

1. The gap is illusory
2. There are hidden or unaccounted-for costs of energy efficiency investments
3. Consumer markets are heterogeneous
4. High discount rates assigned to energy efficiency investments resulting from perceived risk

Conditions that are known to cause market failure:

1. externalities
2. public goods
3. imperfect information
4. imperfect competition

Market Barriers

1. Situations involving Misplaced or Split Incentives (also called agency problems)
2. Limited Availability of Capital,
3. Market Power
4. Regulatory Distortions
5. Transaction Costs
6. Inseparability of energy efficiency features from other desirable or undesirable product features

Non-Economic Explanations

1. Rationality is only one of several decision-making heuristics that may be applied in a given decision-making situation.
2. Decision makers employ varying decision-making heuristics depending on the situation.
3. Decision-making units are often not individuals.
4. Decisions made by organizations are affected by a wide variety of social processes and heavily influenced by the behaviors of their leaders.

Organizational Influences:

Authority

Size

Hierarchy of needs (1. Health and Safety Requirements,2. Regulatory Compliance, 3. Corporate Improvement Initiatives, 4. Maintenance) 5. Productivity, 6. Importance of Energy Efficiency to Profitability

Management policy 1. Whether the organization has annual energy efficiency goals. 2. Whether reserves and budgets are established for funding energy efficiency investments. 3. Whether hurdle rates for energy efficiency investments are high or low. 4. The review process that is to be used to evaluate energy efficiency improvements. 5. Who is responsible for "managing" the company's energy efficiency program).

Sources: Edward Vine, 2009, *Behavior Assumptions Underlying Energy Efficiency Programs for Businesses,* California Institute for Energy and Environment, January.

CONCLUSION: THE INCREASING URGENCY OF CLOSING THE EFFICIENCY GAP

The efficiency gap analysis and debate are not about externalities, although the environmental, national security and macroeconomic impacts of energy consumption stimulated interest in the value of reducing consumption, particularly after the oil price shocks and subsequent economic recessions of the 1970s. Although externalities like these attract attention, these are not the underlying cause of the efficiency gap. Because they are externalities, they are not priced into the market transactions, and we would not expect market behavior to reflect their value. The efficiency gap arises from the failure of market transactions to reflect the costs of energy that are in its price.

To the extent that there are externalities associated with energy consumption, they magnify the concern about market barriers and imperfections, if only because they would make efforts to respond to externalities more difficult. If climate change is recognized as an external cost of energy consumption, it may magnify the importance and social cost of failing to address the efficiency gap. This is where the efficiency gap and climate change analysis intersect.

The climate change debate reinforces the lessons of the efficiency gap and innovation diffusion literatures in another way. The climate change literature has squarely confronted the problem of market barriers and imperfections that affect innovation and diffusion of new technologies. In order to induce rapid change in economic activities, policy must overcome the inertia created by established investment and behavior patterns built up over decades. The set of factors that underlies the inertia to respond to climate change are similar to the market barriers and imperfections that underlie the efficiency gap. Targeted innovations and induced technological change are advocated.

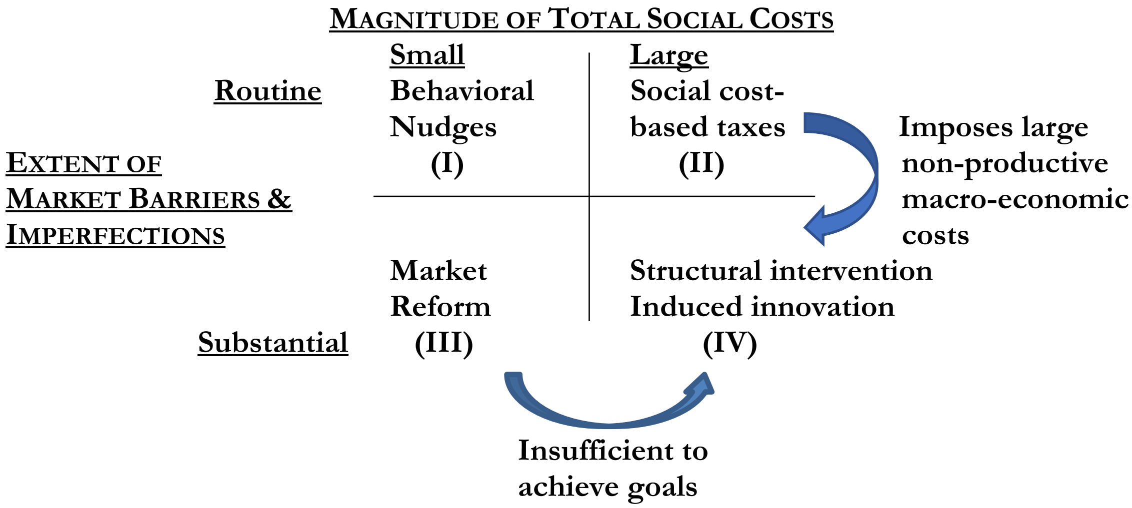
Thus, the debate among economists grappling with the analysis of climate change replicates and parallels the efficiency gap debate. The conceptual and empirical analysis of climate change adds a great deal of evidence to reinforce the conclusions about the barriers and imperfections that affect energy markets. Because the potential external costs are so large, climate change puts a spotlight on technological innovation. The growing concern over adjustment leads to concern over an "innovation gap."[68]

Thus, over the course of the last decade, the climate change analysis has come to highlight the question of the extent to which market processes through the reaction to price increases can be relied upon, or policies that seek to direct, target and accelerate technological innovation and diffusion are needed. The evidence suggests that the cost of inertia is quite large, whereas targeted approaches lower costs and speed the transition.[69]

At a high level, the most important implication of this broadening of the framework to include large externalities is to underscore the need for vigorous policy action to address a problem that is now seen as larger and more complex than it was in the past. It is the combination of substantial market imperfections and large externalities that demonstrates there is an urgent need for vigorous policy action, as suggested by Figure III-4.

If market imperfections are routine and the social costs of poor market performance are small (cell I), modest policies like behavioral nudges may be an adequate response. If market imperfections are small and costs are large (cell II), then price signals might be sufficient to deal with the externalities. If market imperfections are substantial but costs are small, market reform would be an appropriate response (cell III), since the slow response and long time needed to overcome inertia does not impose substantial costs. If both market imperfections and social costs are large (cell IV), more aggressive interventions are in order. The challenge is to choose policies that reduce the market barriers in an effective (swift, low cost) manner

FIGURE III-4: TYPOLOGY OF POLICY CHALLENGES AND RESPONSES



.

We believe the energy consumption of consumer durables has been located in cell IV for decades. Reducing the energy consumption of consumer durables has had the potential for substantial consumer pocketbook benefits and significant national security, energy policy and macroeconomic benefits. The existence of these potential benefits reflected significant market barriers, imperfections and failures. The current context of concern about climate change merely increases the urgency for taking action by adding major environmental costs to the calculation.

PART II. PERFORMANCE STANDARDS:
EFFECTIVE “COMMAND-BUT-NOT-CONTROL” POLICY TOOLS

IV. THE STRUCUTRE OF EFFECTIVE PERFORMANCE STANDARDS

MARKET IMPERFECTIONS

The foundation on which effective standards rest is the identification of market imperfections that need to be addressed. While these will be defined by the specific consumer durable or energy use being analyzed it is important to note at the start there is a vast literature that documents market imperfections, as a general proposition. Table IV-1 lists the full array of market failures, barriers and imperfections that cause the underinvestment in energy saving technologies derived from the conceptual discussion above. It identifies the individual problems that the recent empirical literature observed in the energy market. Citations are provided in Appendix C.

Embedded in the literature reviews for each of the recent studies are citations to earlier empirical studies that provide the context for the more recent research. All of the failures, barriers and imperfections have been supported in the empirical literature, which is why they have been recognized in the conceptual frameworks. We will not review all the many studies that support each problem. Here we summarize several important, repeated broad themes.

At the outset it is important to note that the schools of thought used to organize the market imperfections that call forth policy have grown into a very substantial critique of neoclassical economics, which recognizes only a very small number of market imperfections and failures. On indicator of the power of this critique is the fact that over the past quarter century, more than half of the prizes have been awarded award of numerous Nobel prizes in economics to the economists who have advanced these schools of thought.

Traditional: Fogel, 1993; Krugman, 2008, Heckman, 2008; Tirole 2014; Deaton, 2015.
Transaction Cost New Institutional: Coase, 1992; North, 1993; Williamson, 2009; Ostrom, 2009
Endemic Flaws: Stiglitz, 2001; Spence, 2001.
Behavioral: Nash Jr., 1994; Selton, 1994; Harsanyi, 1994 Akerloff, 2001; Kahneman, 2002; Smith, 2002; Shiller, 2013; Thaler, 2017.
Political: Sen, 1998 (others North, Stiglitz, Krugman, Ostrom, Shiller)

Externalities

There is a very large literature on the externalities associated with energy consumption. Importantly, it goes well beyond the negative national security and environmental externalities, which are frequently noted in energy policy analysis. The macroeconomic effects of energy consumption and energy savings are important externalities of the efficiency gap.

There are two macroeconomic effects that have begun to receive a great deal of attention – multipliers and price effects. These will be discussed in greater length in the next section, as they belong in the cost benefit analysis as a substantial benefit. They can be briefly described as follows. Reducing energy consumption tends to reduce economic activities that have relatively small multipliers (especially when energy imports are involved as in the transportation sector) and increase economic activities that have large multipliers (including the direct effects of spending on technology and the indirect effect of increased household disposable income).

TABLE IV-1: EMPIRICAL EVIDENCE SUPPORTING THE MARKET IMPERFECTION AND POLICY ANALYSIS

Schools of Thought/ Imperfection	Efficiency	Climate
<u>Traditional</u>		
Externalities		
Public goods & Bads	28, 55, a, b	24,132, 177, 197, ZL
Basic research/Stock of Knowledge		46, 37, N
Network effects	127,.ak	134, I
Learning-by-doing & Using	47, i	134, 105,120, 153 E
Localization		101, 153, 182, H
Industry Structure	122, 127, 163, 167	
Imperfect Competition		
Concentration	16, m	
Barriers to entry		
Scale	39, r	
Cost structure		44, 106, 134, I
Switching costs	165, t	
Technology	136, w	
R&D		90, 143, 15, E
Investment		
Marketing		
Bundling: Multi-attribute	162, 21, 116, z	
Cost-Price		
Limit impact of price	74, 116,, ac	
Sluggish Demand/Fragmented Mkt.		82, 97, 110, W
Limited payback	74, 165, ae	
<u>Behavioral</u>	117,133,144,149,159,173	
Motivation & Values	6, 10, h	39, ZM
Influence & Commitment		
Custom	145, 146	
Social group & status	6, h	97, ZN
Perception	13, al	
Bounded Vision/Attention	1,162, k	
Prospect/ Risk Aversion	151,165, l	
Calculation.		78, Z
Bounded rationality	10, 75, d, o	
Limited ability to process info	4, q	
Heuristic decision making	95, s	
Discounting difficulty	47,95,96,113,136, v	

Schools of Thought/ Imperfections	Efficiency	Climate
<u>Transaction Cost/ Institutional</u>		
Search and Information	88, 108	
Imperfect information	10, 100, n	19, 62, 90, U
Availability	10, 185, d	
Accuracy		
Search cost	41, 185, u	
Bargaining		
Risk & Uncertainty	32, 33, 165, t	42, 83, 103, 180, 188, R
Liability		
Enforcement		
Fuel Price		82, 134.
Sunk costs		83
Hidden cost	185, ab	106
High Risk Premia		106, T
Incomplete Markets		82, 97, 179
<u>Endemic Imperfections</u>		
Asymmetric Info		
Agency	72, 163, 185, c, ad	83, 193, Q
Adverse selection	41, e	79, 44, X
Perverse incentives	167, f	
Lack of capital		
<u>Political Power & Policy</u>		
Monopoly/lack of competition		101, 155, 187, 188, ZB
Incumbent power		182, ZA
Institutional support	167, af	
Inertia	136, ag	83, 1, 69, 106, M, V
Regulation	al	
Price	41, 88, 121, ah	
Aggregate, Avg.-cost	95, ai	
Allocating fuel price volatility		82, 98, 203, O
Permitting		
Lack of commitment	108, aj	83, 110, 156, 181,

Energy Efficiency Performance Standards: The Cornerstone of Consumer-Friendly Energy Policy, October 2013. (Updated)

A second set of externalities that receives considerable attention is the effect of learning that can be stimulated by a performance standard that pushes firms to make investments they would not have made without the presence of the standard. This will be discussed in the next section, since it affects the cost side of the cost-benefit calculation.

Information and Behavior

Consumers and producers are poorly informed, influenced by social pressures and constrained in their ability to make the calculations necessary to arrive at objectively efficient decisions. Consumers and producers apply heuristics that reflect rationality that is bounded by factors like risk and loss aversion. Inattention to energy efficiency is rational, given the magnitude, variability and uncertainty of costs, as well as the multi-attribute nature of energy consuming durables. Consumers are influenced by social norms and advertising. The product is a bundle of attributes in which other traits are important and energy costs are hidden costs. The resulting energy expenditures are important components of total household spending. Important benefits of energy consuming durables may be "shrouded" in the broader multi-attribute product.

Market Structure and Transaction Costs

Uncertainties about the nature of the market and the value and cost of technology and limitations of technological expertise and information play an important role, increasing the cost and raising the risk of adopting new technologies.

As a result of these factors, the marketplace yields a limited set of choices because producers and consumers operate under a number of constraints. Split incentives flowing from the agency problem are a frequently analyzed issue. When the purchaser of the energy consuming durables and the users are different people, inefficient choices result.

The market exhibits a high "implicit" discount rate, which we interpret as the result of the many barriers and imperfections that retard investment in efficiency enhancing technology. There are several aspects of the high discount rate that deserve separate attention. There is a low willingness to pay and a low elasticity of demand.

WELL-CRAFTED STANDARDS

Even with well-documented market imperfections, there is no guarantee that the standards will deliver the benefits they claim. The design of standards is important. Viscusi, et al., go on to describe several attributes of regulation that improve its efficacy, stating that "performance-oriented regulation," "gives firms some discretion in terms of the means of their compliance," "utilization of unbiased estimates of benefits and costs," and "avoid… regulation of prices and production."[70] This observation is often repeated with respect to energy efficiency performance standards. Other key characteristics that the literature identifies as making for effective standards that promote innovation, in addition to flexibility, include certainty of standards, progressive moving targets, and elimination of information asymmetry.[71]

> There is a lot of empirical evidence that energy savings measures often provide an effective, cost-efficient approach to reducing greenhouse gas emissions, while generating co-benefits on employment and competitiveness…

> Well-designed regulation that is strict in ambition, but flexible in implementation would point companies to the problem of inefficiencies, trigger information gathering, reduce uncertainty and create a market push within an overall level-playing field. Compliance to regulation will lead to greater innovation (cleaner technologies, processes) as key means to reduce inefficiency, which will lead to environmental benefits, hence lower overall costs. Moreover, cost savings can (but do not always) lead to partial or full offset of regulatory compliance and innovation cost and hence increase overall competitiveness.[72]

Market Imperfections and Policy Responses

Of utmost importance in our framework we find that, "command but not control" performance standards work best when they embody six principles, which are clearly at the core of the National Program: long-term, product neutral, technology-neutral, responsive to industry needs, responsive to consumer needs, and procompetitive.

The extensive and intensive analysis of the current standards demonstrates that in the National Program, EPA/NHTSA/CARB have designed an extremely effective performance standard, as the following table shows. As Table IV-2 shows, the agencies have identified a number of potential market imperfections that the standards address. These follow the imperfections that we identified as important in our earlier analysis. One can argue about which imperfections are most important or most prominent, but there is no doubt that there are many that affect the energy efficiency market.

The Key Characteristics of Performance Standards[73]

Evaluations of policy options to close the efficiency gap consistently find that standards that require consumer durables to use less energy are a very attractive approach to closing the gap. Energy performance standards address many of the most important market barriers and imperfections. They tend to reduce risk and uncertainty by creating a market for energy saving technologies, lower technology costs by stimulating investment in and experience with new technologies, reduce the need for information and the effect of split incentives, all of which help to overcome the inertia of routine and habit.

However, the literature points out that performance standards have positive effects if they are well-designed, enforced and updated. The current approach to standard setting, which is technology neutral, product neutral and long-term, transforms standards into consumer friendly, procompetitive instruments of public policy. Key principles for the design of performance standards to ensure they are effective include the following.

Long-Term: Setting a high standard for the next fifteen years is intended to foster and support a long-term perspective for automakers and the public, by reducing the marketplace risk of investing in new technologies. The long-term view gives the automakers time to re-orient their thinking, retool their plants and help re-educate the consumer. The industry spends massive amounts on advertising and expends prodigious efforts to influence consumers when they walk into the show room. By adopting a high standard, auto makers will have to expend those efforts toward explaining why higher fuel economy is in the consumer interests. Consumers need time to become comfortable with the new technologies.

TABLE IV-2: IMPERFECTIONS POTENTIALLY ADDRESSED BY STANDARDS

Societal Failures[2]	Structural Problems[3]	Endemic Flaws	Transaction Costs	Behavioral[4]
Externalities[5]	Scale[6]	Agency[7]	Sunk Costs, Risk[8]	Motivation[9]
Information[10]	Bundling[11]	Asymmetric Information	Risk & Uncertainty[12]	Perception[13]
	Cost Structure[14]	Moral Hazard	Imperfect Information[15]	Calculation[16]
	Product Cycle			Execution[17]
	Availability[18]			
	Product differentiation[19]			
	Incrementalism[20]			

Source: Framework developed in Comments of the Consumer Federation of America, Proposed Rulemaking to Establish Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, Environmental Protection Agency 40 CFR Parts 86 and 600, Department of Transportation 49 CFR Parts 531,633, 537, et al., November 28, 2009. Italicized references are additional factors added by the Technical Assessment Review. Page references are to the TAR

1 The efficiency gap persists, P. 6-5, despite these developments and uptake of energy efficiency technologies, lags behind adoption that might be expected under these circumstances." Quoting the National Academy of Sciences, P. 6-7, [T]here is a good deal of evidence that the market appears to undervalue fuel economy relative to its expected present value.".
2 P. 6-7, The nature of technological invention and innovation.
3 P. 6-7, Consumers cannot buy technologies that are not produced; some of the gap in energy efficiency may be explained from the producers' side.
4 P. 6-5, Behaviors on the part of consumers and/or firms that appear not to be in their own best interest (behavioral anomalies).
5 P. 6-8, Dynamic increasing returns. network effects; p.4-35, the potential existence of ancillary benefits of GHG-reducing technologies… These can arise due to major innovation enabling new features and systems that can provide greater comfort, utility, or safety.
6 P. 6-8, The structure of the automobile industry may inefficiently allocate car attributes.
7 P. 6-7, Product differentiation carves out corners of the market for different automobile brands.
8 P. 6-6, Consumers may be accounting for uncertainty in future fuel savings.
9 P. 6-6, Consumers may... not optimize (instead satisficing).
10 P. 6-5 Lack of perfect information.
11 P. 6-6 Fuel-saving technologies may impose hidden costs.
12 P. 6-6, Consumers might be especially averse to short-term loses…. relative to long term gains.
13 P. 6-5, Consumers might be "myopic" and hence undervalue future fuel savings; p. 6.6 Consumers may focus on visible attributes... and pay less attention to attributes such as fuel economy that typically do not visibly convey status.
14 P. 6-8, First mover disadvantages, p. 4-33, Thus, instead of the first-mover disadvantage, there is a regulation-driven disincentive to "wait and see.".
15 P. 6-6, Consumers might lack the information necessary.
16 P. 6-6, Consumers might... not have a full understanding of this information.
17 P. 6-6, Selecting a vehicle is a complex undertaking... consumers may use simplified decision rules.
18 P. 6-7, The role of business strategies.
19 P. 6-7, Separating product into different market segment… may reduce competition.
20 P. 6-8, Automakers are likely to invest in small improvements upon existing technologies.

Product Neutral: The new approach to standards accommodates consumer preferences; it does not try to negate them. The new approach to standards is based on the footprint (size) of the vehicles and recognizes that SUVs cannot get the same mileage as compacts. Standards for larger vehicles will be more lenient, but every vehicle class will be required to improve at a fast pace. This levels the playing field between auto makers and removes any pressure to push consumers into smaller vehicles.

Technology-neutral: Taking a technology neutral approach to the long-term standard unleashes competition around the standard that ensures that consumers get a wide range of choice at that lowest cost possible, given the level of the standard. There will soon be hundreds of models of electric and hybrid vehicles using four different approaches to electric powertrains (hybrid, plug-in, hybrid plug-in, and extended range EVs), offered across the full range of vehicles driven by American consumers (compact, mid-size family sedans, large cars, SUVs, pickups), by half a dozen mass market oriented automakers. At the same time, the fuel economy of the petroleum powered engines can be dramatically improved at consumer-friendly costs and it will continue to be the primary power source in the light duty fleet for decades.

Responsive to industry needs: Establishing a long-term performance standard recognizes the need to keep the standards in touch with reality. The standards can be set at a moderately aggressive level that is clearly beneficial and achievable. With thoughtful cost estimates, consistent with the results of independent analyses of technology costs, a long-term performance standard will contribute to the significant reduction of cost.

Responsive to consumer needs: The approach to standards should be consumer-friendly and facilitate compliance. An attribute-based approach ensures that the standards do not require radical changes in the available products or the product features that will be available to consumers. We include the principle that standards should be attribute based as the key to this criterion. Consumers purchase and use durables for specific purposes. The attributes of the durables are extremely important. To the extent that agencies design standards to ensure consumers get the functionalities they need, the standards will be more effective. The setting of a coordinated national standard that lays out a steady rate of increase over a long-time period gives the market and the industry certainty and time to adapt to change.

Procompetitive: All of the above characteristics make the standards pro-competitive. Producers have strong incentives to compete around the standard to achieve them in the least cost manner, while targeting the market segments they prefer to serve. Well-designed performance standards that follow these principles command but they do not control. They ensure consumer needs are met while delivering energy savings and increasing consumer and total social welfare.

LIGHT DUTY VEHICLES[74]

Swift Compliance

The standards keep in touch with reality in several important ways.

- The standards are set at a moderately aggressive level that is clearly beneficial and achievable.
- The cost estimates are consistent with the results of independent analyses of technology costs made over the past decade.
- The standards are consistent with the rate of improvement that the auto industry achieved in the first decade of the fuel economy standard setting program.

The new approach to setting standards is consumer-friendly and facilitates automaker compliance.

- The attribute-based approach ensures that the standards do not require radical changes in the types or size of vehicles consumers drive; so, the full range of choices will be available to consumers.
- The standards do not require dramatic shifts in power train technologies or reductions in weight and offer flexibility and incentives for new technologies, and include a mid-term review.

- The setting of a coordinated national standard that lays out a steady rate of increase over a long-time period gives consumers and the industry certainty and time to adapt to change.

The Industry Response to Well-Crafted Performance Standards

The continuing positive results and the fact that automakers are not only complying with the early standards, but over complying, is driven by the careful design of the standards and the rational response of the automakers.

- As we noted and advocated, the original standards were responsible, and did not seek to push fuel economy/pollution reduction to the limit of technology. The original goals were "inframarginal" with respect to the capabilities of the industry.
- The standards remain inframarginal, with many combinations of technologies available to comply.
- While the biggest potential game changer in terms of compliance – electric vehicles – are not necessary to meet the standards, the evidence continues to grow that they could play a much larger part in the vehicle fleet.

As our historical analysis showed, the industry has responded as market theory and past experience predicts, a process that is observable at both the macro and micro levels.

- The industry has found lower cost ways of complying with the standards than originally thought.
- The mix of technologies likely to be chosen has shifted due to different speeds of development in knowledge and cost.
- There is no evidence that the costs of compliance are disrupting the auto market in any way and consumers are having no difficulty in finding the vehicles that they prefer at prices that are affordable.

THE EFFECTIVENESS OF THE BALANCED APPROACH

DOT "Opportunities" to Improve Standards

Given the intensive analysis and extensive cooperation between three agencies, we believe that the National Program achieved the balance that Congress intended. All issues were heard, considered and parsed into the final rule. No one set of interests dominated, nor should they. We believe this is apparent in the "opportunities" for improvement in the rule identified by DOT in the Notice (summarized in Table IV-3). The performance standards in place for light and heavy-duty vehicles already possess the characteristic that DOT identifies as providing opportunities for improvement.

TABLE IV-3: THE LIGHT AND HEAVY-DUTY MILEAGE RULES ARE WELL-DESIGNED PERFORMANCE STANDARDS

Opportunities to Improve Standards	Features or Current Fuel Economy-Environmental that Accomplish the goals
(1) Simplify or clarify language in a regulation;	EISA established the approach and the footprint metric is effective.
(2) eliminate overlapping and duplicative regulations, including those that require repetitive filings for conducting business with the Department;	The cooperation between NHTSA, EPA and CARB has accomplished this to an unprecedented degree
(3) eliminate conflicts and inconsistencies in the Department's regulations and those of its agencies;	The cooperation between NHTSA, EPA and CARB has accomplished this to an unprecedented degree
(4) eliminate conflicts and inconsistencies with the rules of other Federal agencies or state, local, or tribal governments,	The cooperation between NHTSA, EPA and CARB has accomplished this to an unprecedented degree
(5) determine if matters in an existing regulation could be better handled fully by the states without Federal regulations;	For decades of interaction between California and Federal regulators has made it clear that dynamic American Federalism which encourages action at both the Federal and state levels is necessary and effective.
(6) revise regulations in which technology, economic conditions or other factors have changed in the area affected by the regulation	The experience in the vehicle space demonstrates that regulation and market forces are complements, rather than substitutes. Automaker innovation will lag without the stimulus and risk reduction afforded by regulation.
(7) reconsider regulations that were based on scientific or other information that has been discredited or superseded;	Far from discrediting or superseding fuel economy standards, the scientific and engineering evidence reinforces the value of the standards.
(8) reconsider the burdens imposed on those directly or indirectly affected by the regulation and, specifically, those that are costly when compared to the benefit provided;	The benefit cost ratio of the standards is strongly positive, yielding large consumer pocketbooks, macroeconomic and environmental benefits that far exceed the costs. Freezing or rolling back the standards have a negative benefit cost ratio.
(9) reconsider burdens imposed on small entities;	By and large, the automakers are very large entities. To the extent that small entities are impacted by the standards, they are likely the suppliers of innovative energy saving technologies.
(10) foster innovation by revising regulations to include performance standards for regulatory compliance; and	The fuel economy-environmental standards are well-designed performance standards, as required by EISA and implemented by the agencies. They are excellent examples of an effective "command-but-not-control" approach to regulation.
(11) reduce burdens by incorporating international or industry consensus standards into regulations.	The U.S. standards are slightly below, but catching up with global regulation. While not the result of formal regulatory negotiations, they enjoyed substantial industry support at the time they were adopted.

Source: Notice, pp. 45751-45752.

The Automaker View is Equally Distorted

We believe that the automaker view of the standards is equally misguided. Table IV4 summarizes the recommendation of an automaker funded critique of the National Program. There are a dozen specific recommendations embodied in the report.

We believe one is out of bounds, in the sense that EPA/NHTSA lack the authority to implement changes in the California ZEV program, although they certainly could discuss changes with the California Air Resources Board. However, we do not think the ZEV program is malfunctioning or in need of repair. Of the remaining eleven recommendations, EPA/NHTSA have addressed 10 and their extensive analysis shows that the National Program is functioning quite well. Prior analysis in the 2012 Technical Support Document suggests that the one recommendation that has not yet been addressed will also support the National Program.

TABLE IV-4: RECOMMENDATION FROM *RETHINKING AUTO FUEL ECONOMY* COMPARED TO THE EPA/NHTSA DRAFT *TECHNICAL ASSESSMENT REPORT*

Issue/Recommended for Analysis of the National Program	EPA/NHTSA Action	Impact on Evaluation
Technical		
1. Gas price changes	Use EIA estimates	+
2. Expert Technology Analysis	Integrate NRC/Teardown analysis	+
3. Rebound	Extensive literature Review	+
Consumers		
4. Perceptions	Extensive literature Review	+
5. Capabilities	"Efficiency Gap" analysis	+
6. Sensitivities	Extensive literature Review	+
Economic Impacts		
7. New Vehicle Effects	Extending 2012, little Impact	+
8. Non-vehicle macroeconomic Effects likely to be positive	Mentioned, but not analyzed,	(+)
ZEV		
9. Consider Impact on Market	Small fleet acknowledged	+
10. Modify Standards if Needed	Out of Bounds, EPA/NHTSA lack authority	=
11. Consider Complementary Policies	Discussed	+
12. Risk Assessment	Sensitivity analysis, wide range of plausible scenarios considered	+

Source: Issues/Recommendations from Sanya Carley, et al., *Rethinking Auto Fuel Economy Policy: Technical and Policy Suggestions for the 2016-17 Midterm Reviews,* February, 2016.

We understand that the automakers did not win every point in the final rule, but that is the correct outcome. The automakers are not in the driver's seat; it is the job of the agencies to balance the industry, consumer and national interests. We believe that the national program did an excellent job of finding that balance. Consumers have lowered their costs and had their needs for new vehicles met while the automakers have thrived and pollution has been reduced.

We do not mean to suggest that regulation cannot be improved, of course it can be. But the thrust of the analysis should be to get the best regulation that moves society toward the goals embodied in the underlying regulation. That simple goal seems to be lost in the focus of DOT and the Trump Administration Executive Order on reducing costs and responding primarily to industry, rather than maximizing benefits.

V. EVALUAITONS OF PERFORMANCE STANDARDS

Performance standards should be among the first assets added to the policy portfolio. They are a structural intervention that address more barriers and are more effective in overcoming them and more likely to achieve their goals. The ability of standards to address the market failure problems goes beyond their ability to address the barriers to investment in efficiency enhancing technologies that focus on consumer behavioral and transaction cost economics. Standards can address the behavioral and transaction cost problems that afflict the supply-side of the market, as well as some of the structural problems. This evaluation of the important role of performance standards is supported by the recent evaluations.

Comparisons of Policies

Resources for the Future identifies standards conceptually as one of the two main policies to address the behavioral market barriers and imperfections, with labelling being the other policy identified. Analysts at LBL offered a broader view of the impact of performance standards on market.

> In some cases, the direct regulation of equipment performance might side-step problems of asymmetric information, transaction costs and bounded rationality, obviating the need for individual consumers to make unguided choices between alternative technologies.[75]
>
> Subjective uncertainty, however, may stem from the fact that precise estimates of energy prices and equipment performance are costly to obtain from the perspective of individual consumers. If the costs of gathering information were pooled across individuals, substantial economies of scale should be achieved which could reduce the uncertainties associated with certain technologies.
>
> The informational requirements that must be met to identify an efficient tax regime, however, are particularly onerous. The government must know not only the level of consumer expectations but also the specific way in which they are formed, and this information must be effectively conveyed to manufacturers through the structure of the tax. In practice, such information may be very difficult to obtain reducing the efficacy of tax instruments.
>
> Such limitations suggest a potential role for the direct regulation of equipment performance. Energy efficiency standards led to demonstrable improvement in the fuel economy of automobiles in the 1970s and early 1980s. State and local governments set requirements concerning the thermal performance of building elements. [76]

A number of the comprehensive studies we have reviewed above also include evaluations of potential policy options for addressing the market barriers and imperfections. Table V-1 through C-3 summarize five of those efforts. One of the clearest conclusions that can be derived from these assessments is that performance standards, -- appliance efficiency standards, auto fuel economy standards and building codes – are seen as the most attractive of the policies because they are effective and address multiple, important barriers. The building sector studies provide strong support for performance standards. For example, the European study identifies over half a dozen ways in which performance standards address more than half a dozen barriers.

TABLE V-1: MCKINSEY AND COMPANY FRAMEWORK FOR ANALYZING MARKET BARRIERS TO HOME ENERGY EFFICIENCY

CFA Category	CFA Nature	Kckinsey Category	McKinsey Nature	McKinsey Description	Cluster
Behavioral	Value	Behavioral	Awareness	Low priority, Preference for other attributes	CD, RLA
Behavioral	Value	Availability	Availability	Restricted procurement, 1st cost focus	CD
Behavioral	Value	Behavioral	Awareness	Shop for price and features	RD
Behavioral	Calculation	Behavioral	Awareness	Limited understanding of use and savings	CEPB, EH, GB, RLA
Behavioral	Motivation	Behavioral	Custom & Habit	Little attention at time of sale	NH
Behavioral	Calculation	Behavioral	Custom & Habit	Underestimation of plug load	RD
Behavioral	Custom	Behavioral	Custom & Habit	Aversion to change	CI,
Behavioral	Custom	Behavioral	Custom & Habit	CFLS perceived as inferior	RLA
Behavioral	Discount Diff.	Behavioral	Hurdle	Payback-Hurdle, 28% discount rate	CEPB
Behavioral	Discount Diff.	Behavioral	Hurdle	Payback-Hurdle,40% discount rate	EH
Behavioral	Implementation	Behavioral	Use	Improper use and maintenance	CEPB, EH, RD
Endemic	Perverse Incentives	Behavioral	Awareness	Not accountable for efficiency	CI
Endemic	Capital	Availability	Capital	Competing use of capital	EH, GB, RLA, CI
Endemic	Agency	Structural	Agency	Tenant pays, builder ignores	CEPB, EH, RD
Structural	Availability	Availability	Availability	Lack of contractors	EH
Structural	Availability	Availability	Availability	Lack of availability in area	NH
Structural	Public Good	Availability	Availability	Lack of demand => lack of R&D	RD
Structural	Marketing	Availability	Availability	Emergency replacement	RLA
Structural	Bundling	Availability	Bundling	Efficiency bundled with other features	RLA
Structural	Limited Payback	Structural	Owner Transfer	Lack of premium at time of sale	CD, NH, NPB, RLA
Structural	Limited Payback	Structural	Owner Transfer	Limits payback to occupancy period	EH
Transaction	Cost	Structural	Transaction	Lack of information	NPB
Transaction	Sunk	Structural	Transaction	Disruption during improvement process	EH
Transaction	Imperfect Info.	Structural	Transaction	Difficult to identify efficient devices	RD
Transaction	Risk/Uncertainty	Behavioral	Risk/Uncertainty	Business failure risk	CEPB
Transaction	Risk/Uncertainty	Behavioral	Risk/Uncertainty	Lack of reliability	CI
Transaction	Search cost	Structural	Transaction	Research, procurement and preparation	EH, GB, RLA

Legend: **Clusters =** CD = Commercial Devices; CEPB = Commercial Existing Private Buildings; CI = Commercial Infrastructure; EH = Existing Homes; GB = Government Buildings; NH = New Homes; NPB = New Private Commercial Buildings; RD = Residential Devices; RLA = Residential Lighting and Appliances

SOURCES: McKinsey and Company, *Unlocking Energy Efficiency in the U.S. Economy,* July 2009, Tables 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, Exhibits 14, 15, 16, 19, 21, 24, 26, 27, 29, 30.

In the McKinsey analysis, the combination of building codes and appliance standards addresses every one of the barriers (Table C-1). We have long argued that performance standards are attractive for exactly this reason. The innovation diffusion analysis and these evaluations suggest that standards have important impacts at key points in the process, reducing risk and helping to establish a market.

In the EU evaluation of policies in Table V-2, efficiency and performance standards rank highest across the following dimensions. The study identifies over half a dozen ways in which performance standards address barriers. The barriers addressed include transaction costs, economic uncertainties, lack of technical skill, barriers to technology deployment, inappropriate evaluation of cost efficiency, insufficient and incorrect information on energy features, operational risks, and bounded rationality constraints. Similarly, in the McKinsey analysis discussed above, the combination of building codes and appliance standards address a large number of market failures.

Table V-3, presents an evaluation of policy instruments for addressing climate change. Performance standards are identified as the most effective policy instruments available.

Table V-4 is another evaluation in which performance standards fare quite well in terms of the magnitude of the targets and their ability to hit them.

Flexibility Across time

Standards also allow the level to be raised as technology develops. Burtraw and Woerman offered a vigorous defense of well-designed performance standards applying an institutional analysis to the acid rain program, citing the recent update of the fuel economy standards as an example.

> Compared to the unintended consequences and complexities of regulation, setting prices to equal the social cost of environmental damages appears simple. Since Pigou (1920), this economic idea has made a large intellectual contribution, yet it has rarely been adopted in environmental policy. One reason that is sometimes offered for the limited influence of environmental prices in environmental policy is the multitude of market failures that prevent a single price from solving the problem…Vested economic interest in the status quo helps to explain institutional inertia and reluctance to change. In any context, a change in the rules will create losers who will act to obstruct such a change, and we invoke this explanation at some points. However, we have a more general case in mind where institutions may have strong justifications as solutions to historic problems and serve as watchtowers that protect the precedents of values of previous social decisions. By design or evolution, they affect how change will occur….
>
> The flaw of the SO_2 cap-and-trade program was its inability to adapt to new information that benefits were substantially greater than anticipated and that costs were substantially less. Emissions trading policy for CO_2 in the United States would likely face many of the same issues as SO_2 emissions trading including the inability to update the policy over time…

TABLE V-2: ASSESSMENT OF POLICY INSTRUMENTS IN PLACE IN THE EUROPEAN UNION

POLICY EVALUATION CRITERIA / POLICY APPROACH	Importance of main barrier the policy instrument addresses	Impact/ expected impact of policy instrument	Increased impact by further broadening or strengthening	Policy for specific barrier/ tackles several barriers	Clear/ appropriate to target/ barrier	Compatible with other instruments	Compatible with MS/ appropriate as EU instrument
Directive on energy end-use efficiency and energy services	5	5	3	4	3	3	4
Energy performance of buildings directive	4	5	4	2	4	3	5
EPBD-related CEN mandate to develop a set of standards	3	4	4	2	4	3	4
Eco-design directive	3	3	4	2	3	4	4
Eco-label regulation	3	2	3	3	5	3	3
Energy labeling directive	2	3	4	3	4	4	4
Environmental technology verification	2	3	na	2	3	2	3
'Intelligent energy Europe" programme	2	2	na	3	3	1	4
Structural, Cohesion Funds & European Investment Bank	3	2	2	2	3	1	3
Energy taxation	1	1	2	1	3	1	1

Source: Andreas Uihlein and Peter Eder, *Toward Additional Policies to Improve the Environmental Performance of Buildings,* European Commission, Joint Research Centre, Institute for Prospective Technological Studies, 2009, Table 9.

TABLE V-3: POLICY INSTRUMENT FOR REDUCING GREENHOUSE GAS EMISSIONS FROM BUILDINGS

Policy	Energy/CO2 Effectiveness	Cost Effectiveness	# of Barriers Addressed	Economic	Hidden Cost	Market Failure	Culture	Political
Appliance standards	High	High	3	1	1	1		
Energy efficiency obligations	High	High	2	1		1		
DSM	High	High	2	1		1		
Tax exemptions/ reductions	High	High	2	1		1		
EPC/ESCO	High	Medium/High	3	1	1	1		
Building codes	High	Medium	3	1	1	1		
Coop. Procur.	High	Medium	2	1		1		
Public leadership programs	Medium/High	High/Medium	4		1	1	1	1
Labeling and certification programs	Medium/High	High/Medium	3	1		1	1	
Procur.	Medium/High	High/Medium	3	1	1	1		
Energy certificates	Medium/High	High/Medium	2	1		1		
Energy certificates	Medium/High	High/Medium	1	1				
Voluntary and negotiated agreements	Medium/High	Medium	2			1	1	
Mandatory audit requirement	High & variable	Medium	1				1	
Public benefit charges	Medium	High	2	1		1		
Capital subsidies,	High	Low	2	1		1		
Detailed disclosure programs	Medium	Medium	2			1	1	
Education and information programs	Low/Medium	Medium/high	2			1	1	
Taxation (on CO2 or fuels)	Low/Medium	Low	1	1				
Kyoto Protocol flexible	Low	Low	1			1		

Source: Sonja Koeppel, Diana Urge-Vorsatz and Veronika Czako, *Evaluating Policy Instruments for Reducing Greenhouse Gas Emissions from Buildings – Developed and Developing Countries*, *Assessment* of Policy Instruments for Reducing Greenhouse Gas Emission from Buildings, Center for Climate Change and Sustainable Energy, Central European University, 2007, Tables 1 and 3.

TABLE V-4: VALUATION OF 20 POLICIES

Policy Type	Policy Instrument	Target	Achieved
Regulation	Building performance standard	2	4
	Building regulation	2	1
	Efficiency commitment	2	2
	Mandatory target on consumption	2	2
	Top runner	2	2
	Labelling of appliance	2	2
	Obligation on manage	1	1
Financial	Soft loans	2	3
	Investment deductions	1	1
Information	Local advice	1	1
	Energy audits public	2	4
	Energy audits private	2	2
	Network	1	1
	Industry concepts	1	1
	Individual advice service	1	1
	Eco-driving	2	3
	FEMP	2	2
Voluntary	Efficiency agreements	2	2
	ACEA	2	2
Procurement	Energy	1	1
	BELOK	1	4
		2=Quantitative	4=Achieved or overachieved

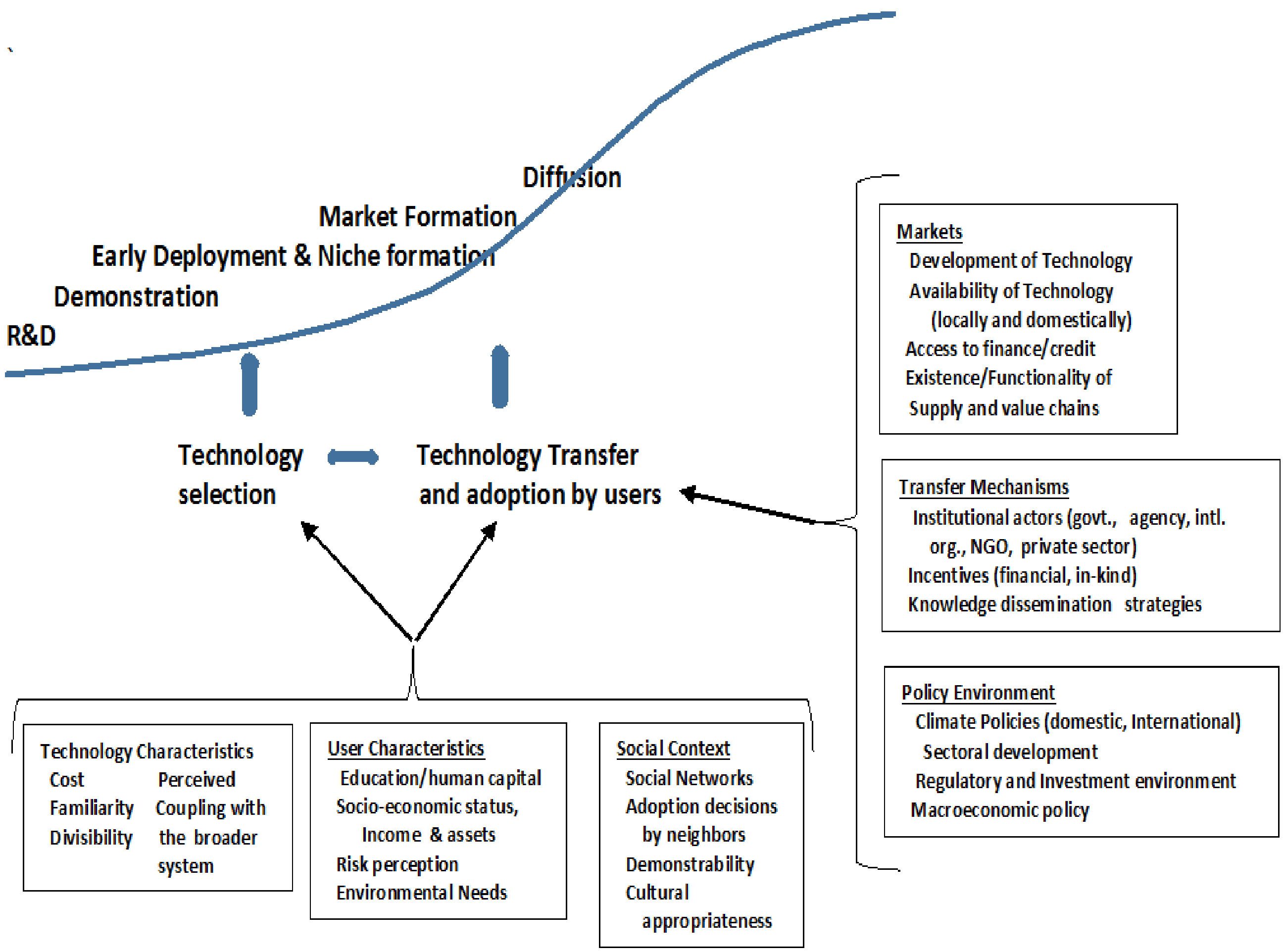
Source: Mirjam Harmeling, Lara Nilsson, and Robert Harmsen, "Theory-based Policy Evacuation of 20 Energy Efficiency Instruments," *Energy Efficiency,* (2008:1), p. 148.

The third factor is the actual mechanism of the Clean Air Act. In 2007 the U.S. Supreme Court affirmed the authority of the EPA to regulate greenhouse gasses under the Clean Air Act. Under threat of private lawsuits against the agency, EPA initiated an investigation culminating in a formal finding that greenhouse gas emissions endangered human health and the environment. Under pressure from subsequent lawsuits EPA initiated regulations. Tighter vehicle emissions standards that took effect in 2011 implement a 5% per year improvement in the vehicle fleet resulting in an average of 35.5 miles per gallon of 35.5 in 2016. A second set of standards will take effect in 2017 and will require efficiency improvements to reach 54.5 miles per gallon by 2025. Preconstruction (design) permitting of new and modified sources for greenhouse gas emissions is also now in effect…

Differences in institutional structure between a cap-and-trade policy and the Clean Air Act regime cause the regulatory systems to vary in two important ways in how they would react to these changes. One way is the ability to update the emission cap or regulation. If secular or regulatory changes occur that make achieving emissions reductions cheaper and if the cap or regulation is set to approximately equalize marginal costs and marginal benefits, then the availability of cheaper reductions suggests that the cap level or regulation should be tightened to achieve additional reductions. As we have argued, this is unlikely to occur in a timely manner. The Clean Air Act regime, however, requires the EPA to regularly update regulations to ensure new information such as new market conditions or scientific information (depending on the relevant portion of the act) is assimilated into the stringency of the regulation. A second way is the natural ability of the regulatory mechanism to react to these changing market conditions. Detailed simulation modeling of these institutional differences described in the next section indicates the Clean Air Act regime is projected to yield greater permanent domestic emissions reductions than would have occurred under the Waxman–Markey legislation.[77]

In addition to the ability to adjust the level of the standard, performance standards can provide different functions. A recent description of standards in the diffusion framework underscore this point. Standards are seen as playing different roles at different points in the diffusions process (see Figure V-1).

FIGURE V-1: A MODEL OF TECHNOLOGY TRANSFER AND ADOPTION



Source : Bonizella Biagini1, et al., "Technology transfer for adaptation," Nature Climate Change, 4 (2014), p. 829.

The graph illustrates a cycle of market transformation, which begins with inefficient models being regulated out of the market through minimum energy performance standards (MEPS). Next fleet efficiency is raised using incentive programs. Incentives programs target HE technologies with the best efficiency rating identified by the labeling program. They raise the efficiency ceiling through a combination of upstream, midstream and downstream programs that address specific market barriers. Incentives increase demand, and thus market penetration, for early-stage HE technologies, leading to economies of scale for manufacturers. Economies of scale, and the learning effects engendered by increased demand, streamline production and decrease the costs of production. The efficiency gains achieved through the incentive program can then be cemented by implementing standards that are more ambitious, resulting in a continuous cycle of improvement. This cycle can be repeated indefinitely as innovation produces more and more efficient technologies. Other market interventions, such as most-efficient awards, energy-efficient procurement or awareness programs can help complement this cycle to further accelerate the diffusion rate.[78]

Figure V-1 shows the diffusion process going through five phases, from research and development to diffusion. The key challenges that affect the flow of the process are technology selection, predominantly a supply-side issue, and technology adoption, a demand-side issue. Six sets of factors are seen as influencing the outcome of these two tasks. The dominant factors that affect both technology selection and diffusion are technology and user characteristics, and social context. The earlier discussion of the virtuous cycle identified factors in each of the six areas that triggered the powerful innovation cycle of the Internet.

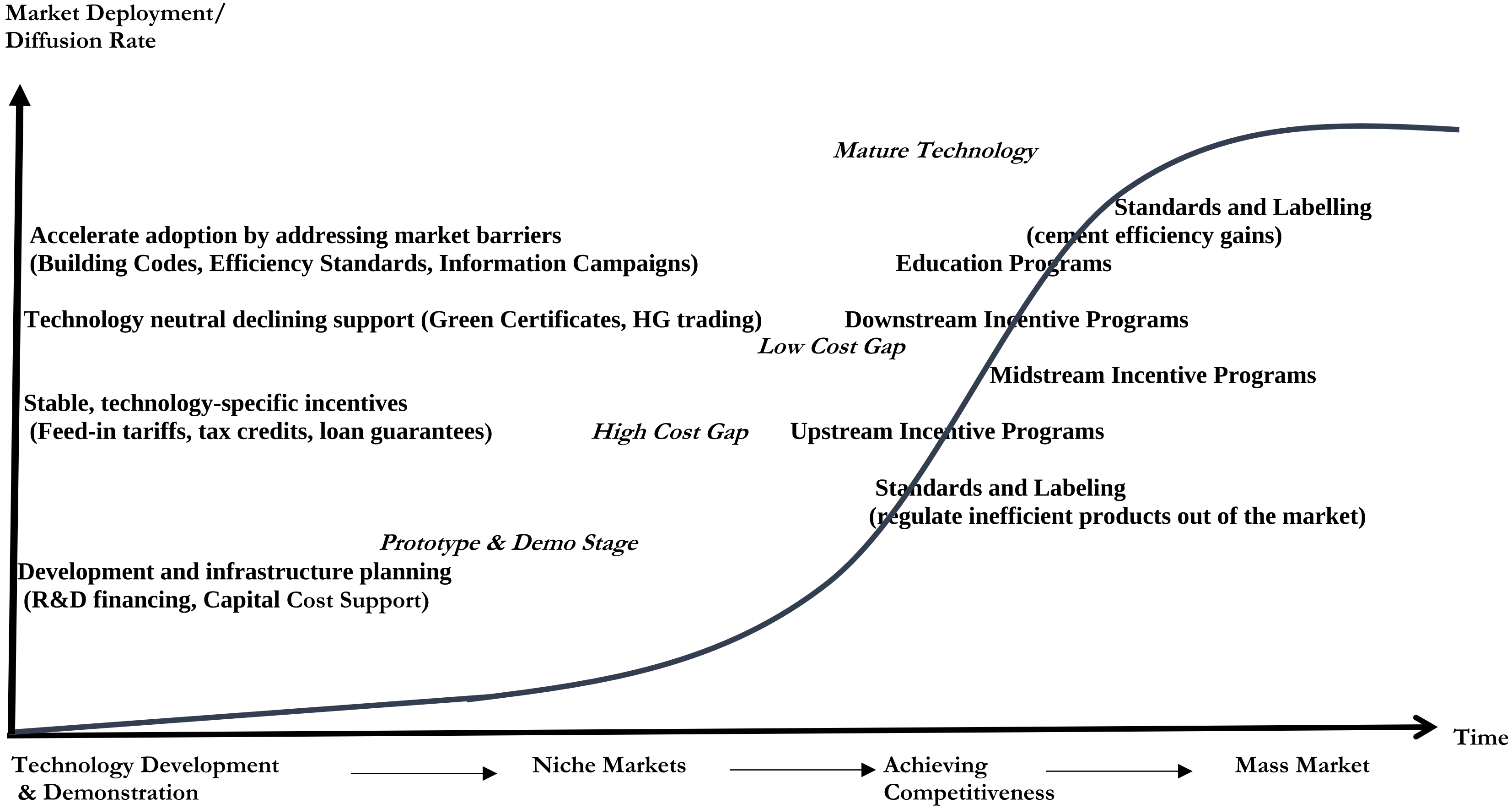
Burtraw and Woerman focus on the ability of a standard setting process to evaluate the development of costs therefore shift the target to capture more benefits. De la Rue du Can emphasize qualitative adjustment in the target of the standards. The suggestion that policy in general and standards in particular need to monitor the changing terrain and adapt is evident in the literature in a number of ways.

The study of the diffusion of innovation produced a prodigious literature and is the original source of much of the framework of Innovation Systems analysis. In keeping with the central themes of this paper, Figure V-2 a framing that emphasizes market formation and the role of policy. Figure V-2 presents a traditional diffusion curve approach. The following description of the graph in Figure V-2 ties together many of the themes discussed in this section and connects them to the theme of the next section: policies that support innovation invoke a cycle of policy implementation that helps the market progress.

The process begins

> "with inefficient models being regulated out of the market through minimum energy performance standards (MEPS). Next fleet efficiency is raised using incentive programs. Incentives programs target HE [high efficiency] technologies with the best efficiency rating identified by the labeling program… Incentives increase demand and thus penetration… leading to economies of scale for manufacturers. Economies of scale, and the learning effects engendered by increased demand, streamline production and decrease the costs of production. The efficiency gains… can then be cemented by implementing standards that are more ambitious, resulting in a continuous cycle of improvement. This cycle can be repeated indefinitely.[79]

FIGURE V-2: TAILORING SUPPORT TO MEET NEEDS ALONG THE INNOVATION CHAIN
(Impact of Interventions on Highly-Efficient (HE) Technology Diffusion Rate)



Sources: Entries above the curve, International Energy Agency, *Energy Technology Perspective, 2014: Harnessing Electricity's Potential,* 2014, p. 55. Entries below the curve, Stephane de la Rue du Can, et al., "Design of incentive programs for accelerating penetration of energy-efficient appliances," Energy *Policy*, Energy Policy, 72, 2014, p. 59.

PART III.

PUBLIC OPINION ABOUT AND

SUPPORT FOR ENERGY EFFICIENCY STANDARDS

VI. CONSUMER SUPPORT FOR FUEL ECONOMY STANDARDS

The economic success mentioned above and analyzed below and the legal and analytic frameworks provide a firm foundation for the adoption and continued development of fuel economy standards. This foundation rests on a strong base of public support, which we have been measuring regularly. We discuss that record briefly in this section. Here we present the analysis of consumer attitudes in two distinct periods.

First, we analyze the responses to our surveys of public opinion in the decade leading up to the National Program. This provides the context for the adoption of the new approach.

We then fast forward to public opinion polls we have conducted since the publication of the TAR. This provides the context for the current policy discussion.

LONG-TERM CONSUMER ATTITUDES

Concerns about Gasoline

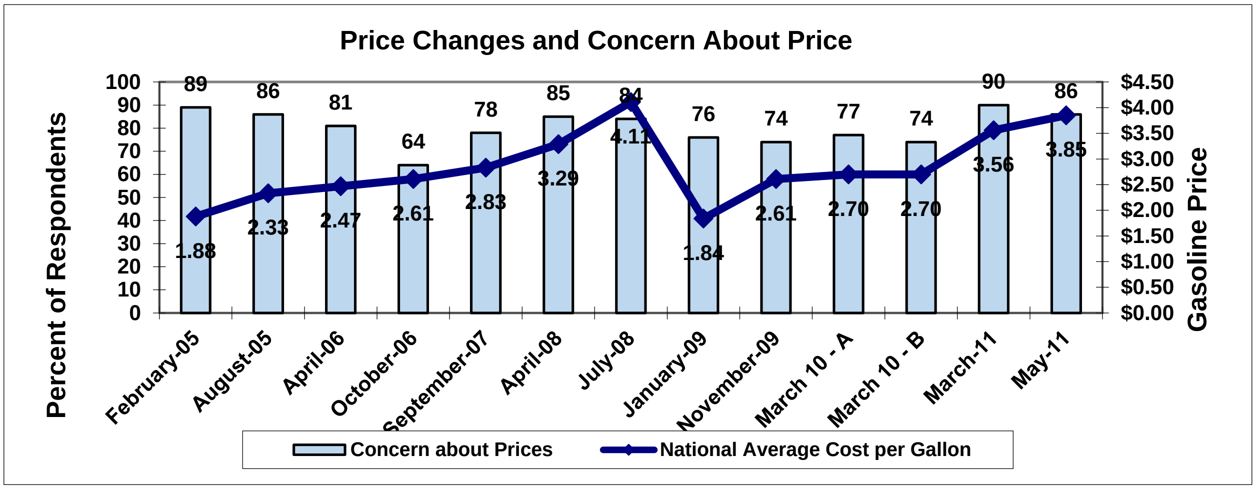
Our surveys of consumer attitudes over the past ten years, which encompasses the worst of the price spikes, provide systematic evidence in support of those statements. They support policies to reduce oil consumption by increasing the fuel economy of the vehicle fleet. Figure V-1 shows responses to a standard question CFA has asked relating to concerns about gasoline prices and Mid-East oil dependence starting in 2005.[80]

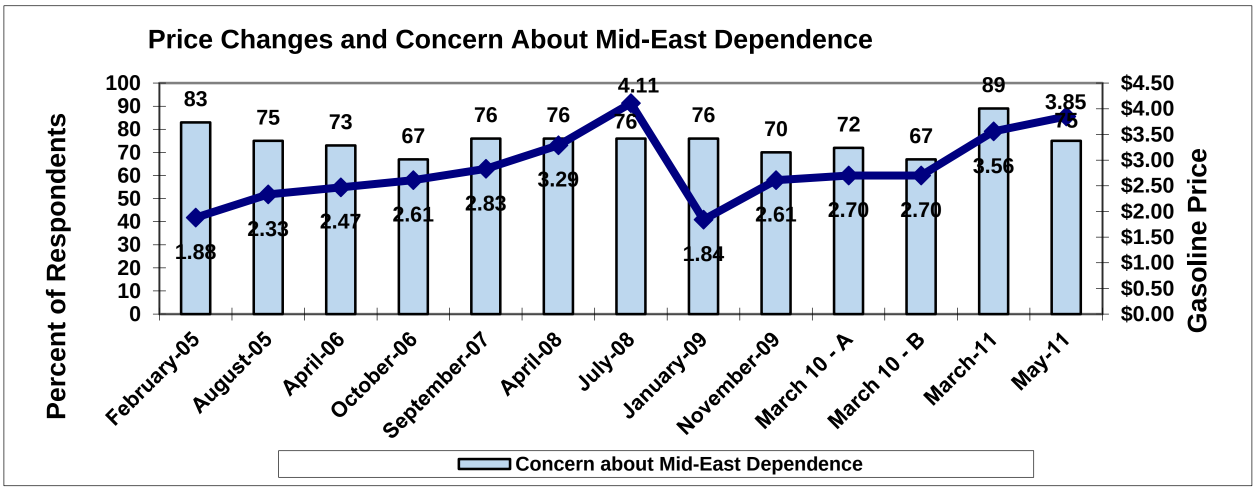
We find that consumers express a great deal of concern about prices and Mid-East imports. Even when prices were around $2.00 per gallon, approximately three quarters of the respondents expressed concern about prices. With prices above $3.50 per gallon.

In our 2011 survey, we doubled the sample size so we could examine whether attitudes were different in different groups of states. We have identified four categories of states. California, Clean Cars, Automotive and Other. California is not only the largest state in the nation, but it has also been a leader in the effort to address concerns about the environmental impact of automobiles. California does not regulate fuel economy, but it does regulate emissions from vehicles. Standards that reduce pollution from auto tailpipes often have the effect of increasing fuel economy. The double sample yields just under 200 respondents in California.

California's leadership role was reinforced by thirteen states (and the District of Columbia) who have adopted the 2016 tail pipe emission standards authored by California. These fourteen jurisdictions (plus California) are the "Clean Cars States." In our double sample, there are over 500 respondents in the "Clean Cars States" other than California. Michigan, Ohio and Indiana are identified as automotive states. They have a level of employment in the automobile manufacturing industry that is at least twice as large as the fourth ranked state, and five to ten times as high as the national average. These are states where automobile production is a uniquely important part of the economy. In our double sample, there are 200 respondents in the "Automotive States." All respondents who do not reside in states that fall into one of the above three categories are categorized as "other States." In our sample, there about 1100 respondents.

FIGURE VI-1: TRENDS IN PRICES AND CONSUMER CONCERNS





Source: National Survey Shows that Most Consumers Support 60 MPG Fuel Economy Standards by 2025, 09/28/10.

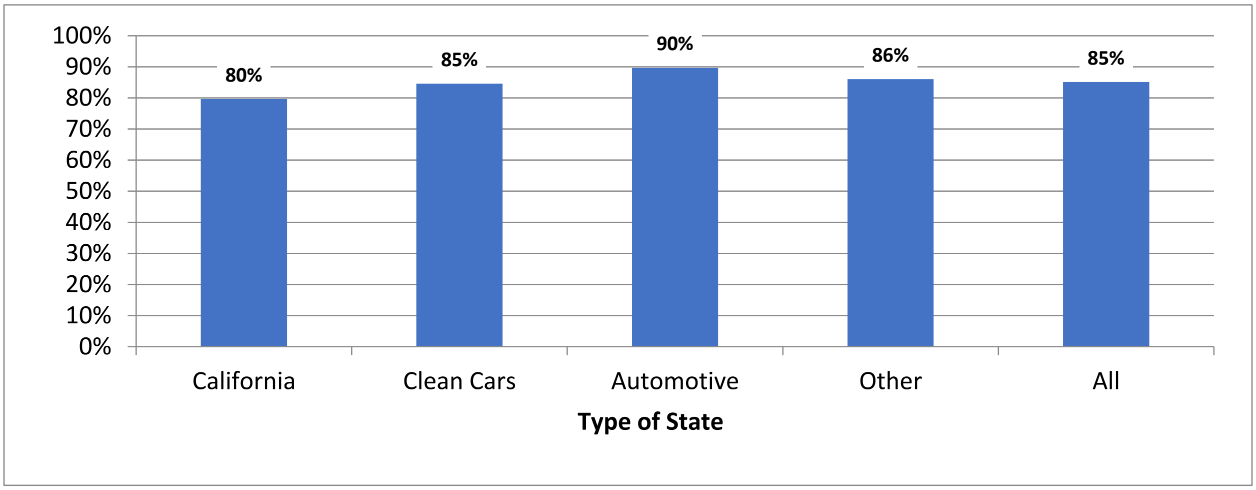
Figure VI-2 shows that there is very little difference in concern about gasoline prices or Mid-East imports across the states. There are no statistically significant differences between the four groups of states. Approximately 80%-90% of respondents' express concern about prices. Approximately 75%-80% of respondents' express concern about dependence on Mid-East imports.

Importance of Reducing Oil consumption

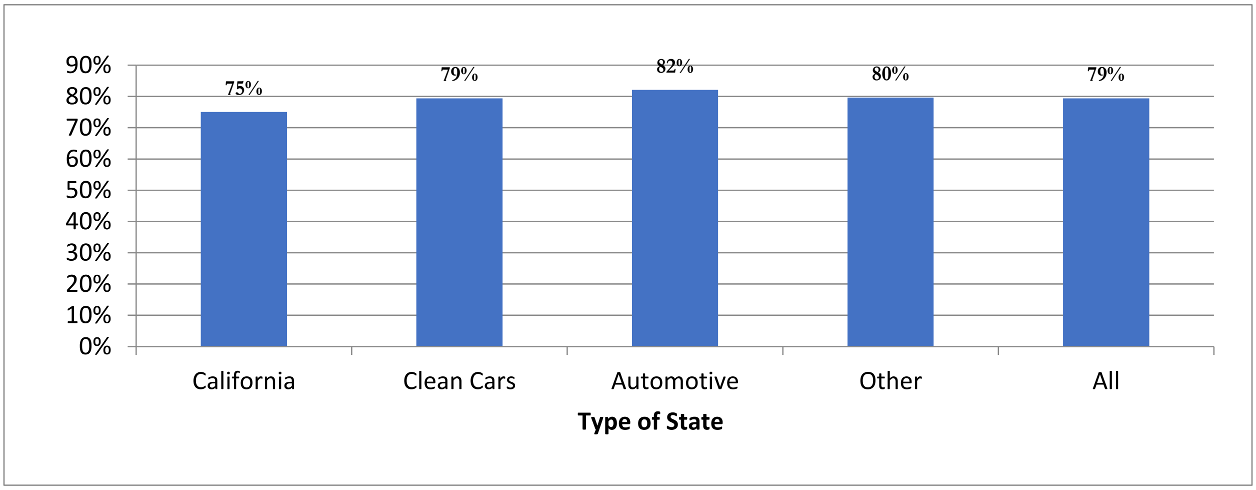
Concerns about gasoline prices and Mid-East oil dependence translate into support for the reduction of U.S. oil and gasoline consumption. In the 2010 survey, we asked several questions about this issue. We asked separate questions about whether it is a good idea, in general, to reduce gasoline consumption.[81] Then we asked how important increases in fuel economy are in accomplishing the goal of reduced consumption.[82]

FIGURE VI-2: CONSUMER GASOLINE CONCERNS ACROSS THE STATES

Gasoline Prices



Mid-East Oil Dependence

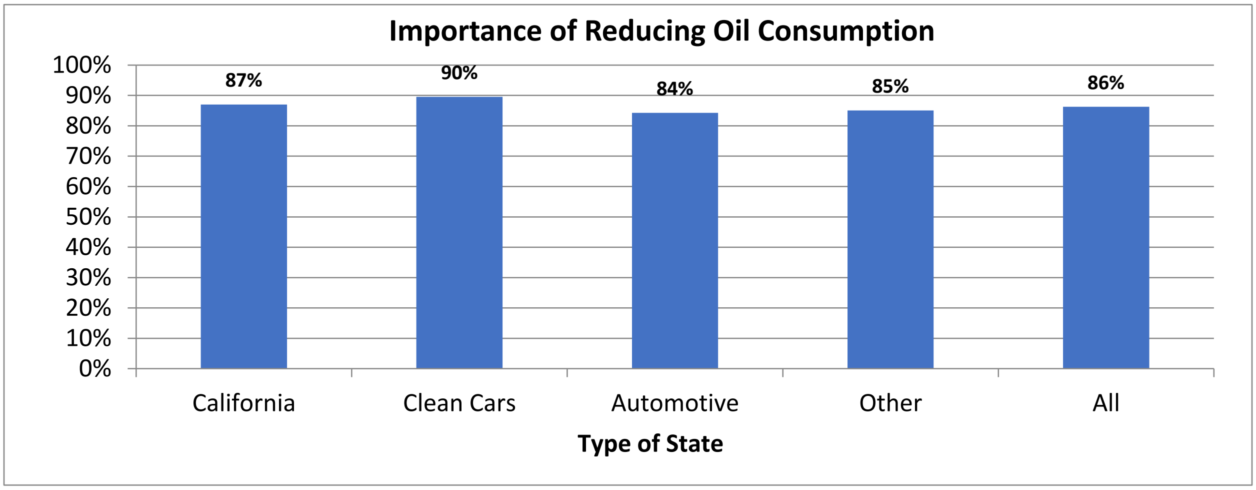


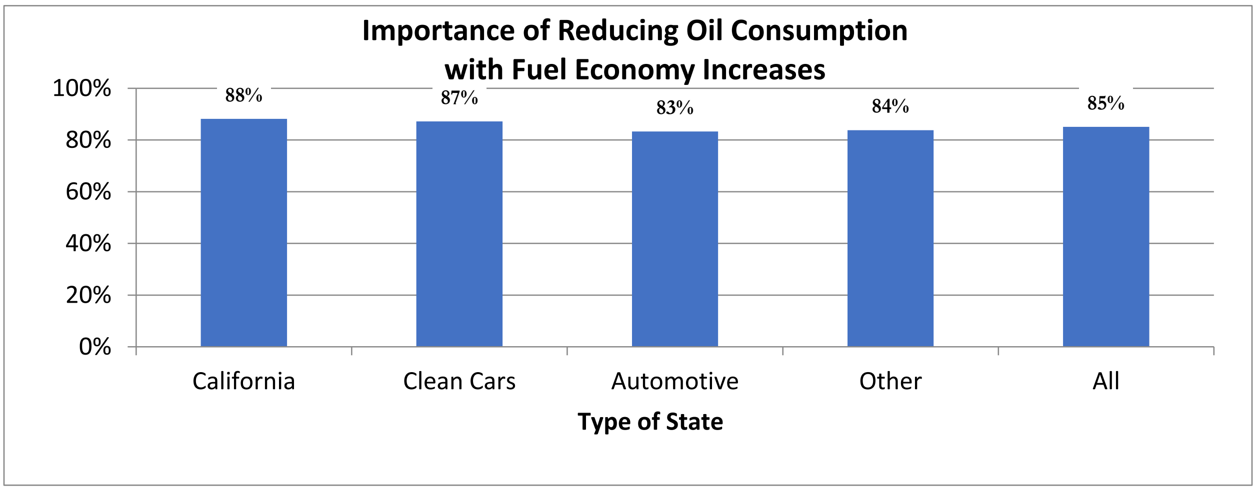
Source: National Survey Shows that Most Consumers Support 60 MPG Fuel Economy Standards by 2025, 09/28/10.

As shown in Figure VI-3, we found high levels of support for the proposition that reduced oil consumption is important and that increased fuel economy is important in accomplishing that goal.

- Over 80% of respondents think it is important to reduce oil consumption (about 60% strongly agree).
- The importance of reducing oil consumption through fuel economy increases receives similar levels of agreement.
- The differences between respondents in the various types of states are small.

FIGURE VI-3: REDUCING OIL CONSUMPTION





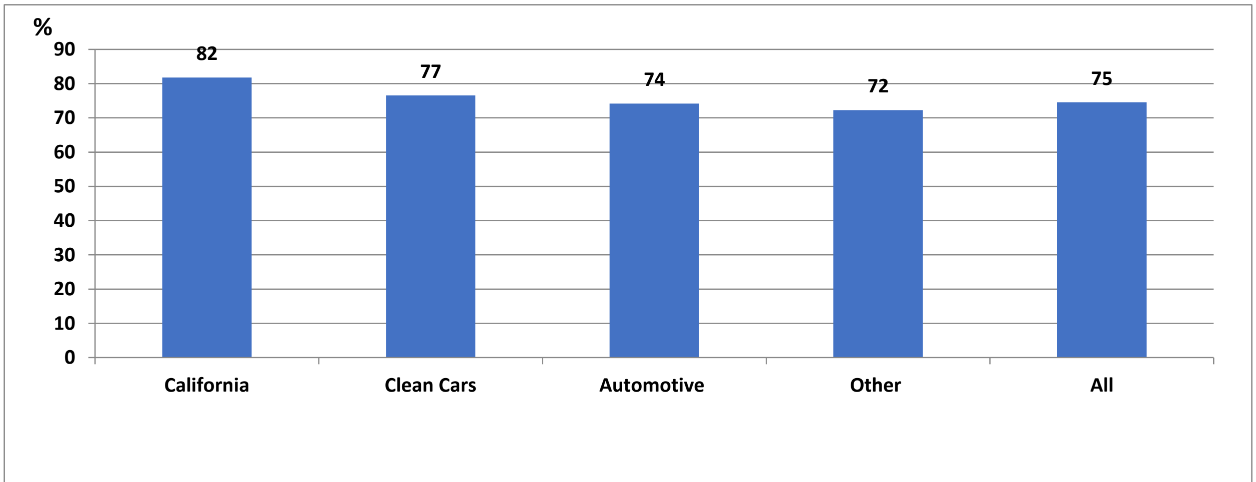
Source: National Survey Shows that Most Consumers Support 60 MPG Fuel Economy Standards by 2025, 09/28/10.

Support for Fuel Economy Standards

In order to gauge support for fuel economy standards over the years, we have asked questions in a number of ways. A question on general support for fuel economy standards typically receives the most positive response.[83] As Figure VI-4 shows, three quarters of the respondents' express support for fuel economy standards. The support is somewhat higher in California and the "Clean Cars states."

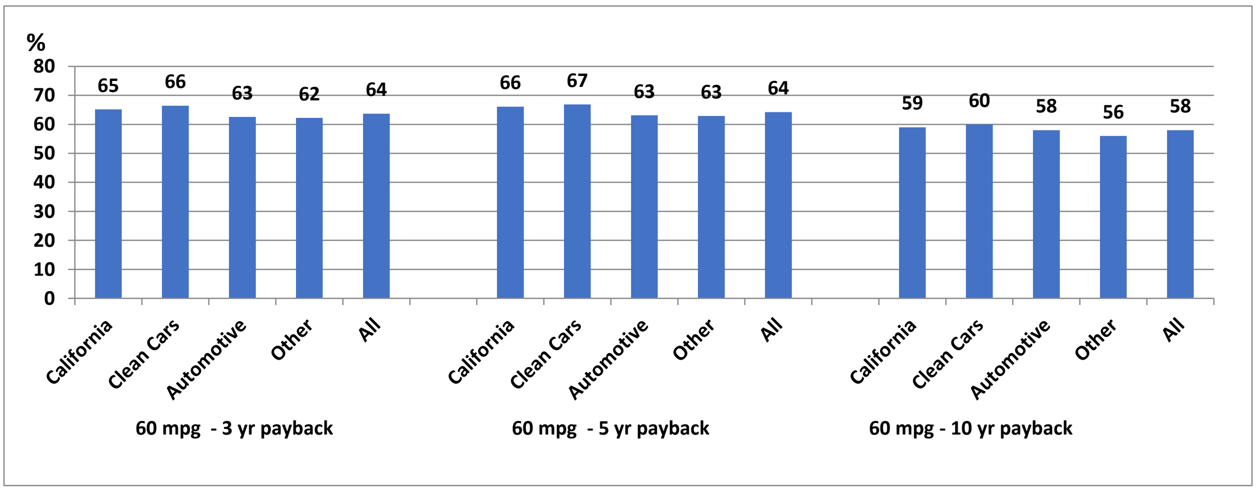
In the last 2011 survey, in addition to the general question about support for fuel economy standards, we also respondents asked whether they support a standard of 60 miles per gallon (see Figure VI-5).[84] For the latter question, we asked about support depending on how long the fuel saving technology would take to pay for itself. We asked about a 3-year, 5-year and 10-year payback period.[85] The specific target of 60 mpg is supported by over 60% of respondents with payback periods of three and five years. This support declines to the high 50% range with a ten-year payback period.

FIGURE VI-4: GENERAL SUPPORT FOR FUEL ECONOMY STANDARDS



Source: National Survey Shows that Most Consumers Support 60 MPG Fuel Economy Standards by 2025, 09/28/10.

FIGURE VI-5: SUPPORT FOR A 60-MPG STANDARD AND STATE INVOLVEMENT IN SETTING EMISSIONS STANDARDS



Source: National Survey Shows that Most Consumers Support 60 MPG Fuel Economy Standards by 2025, 09/28/10.

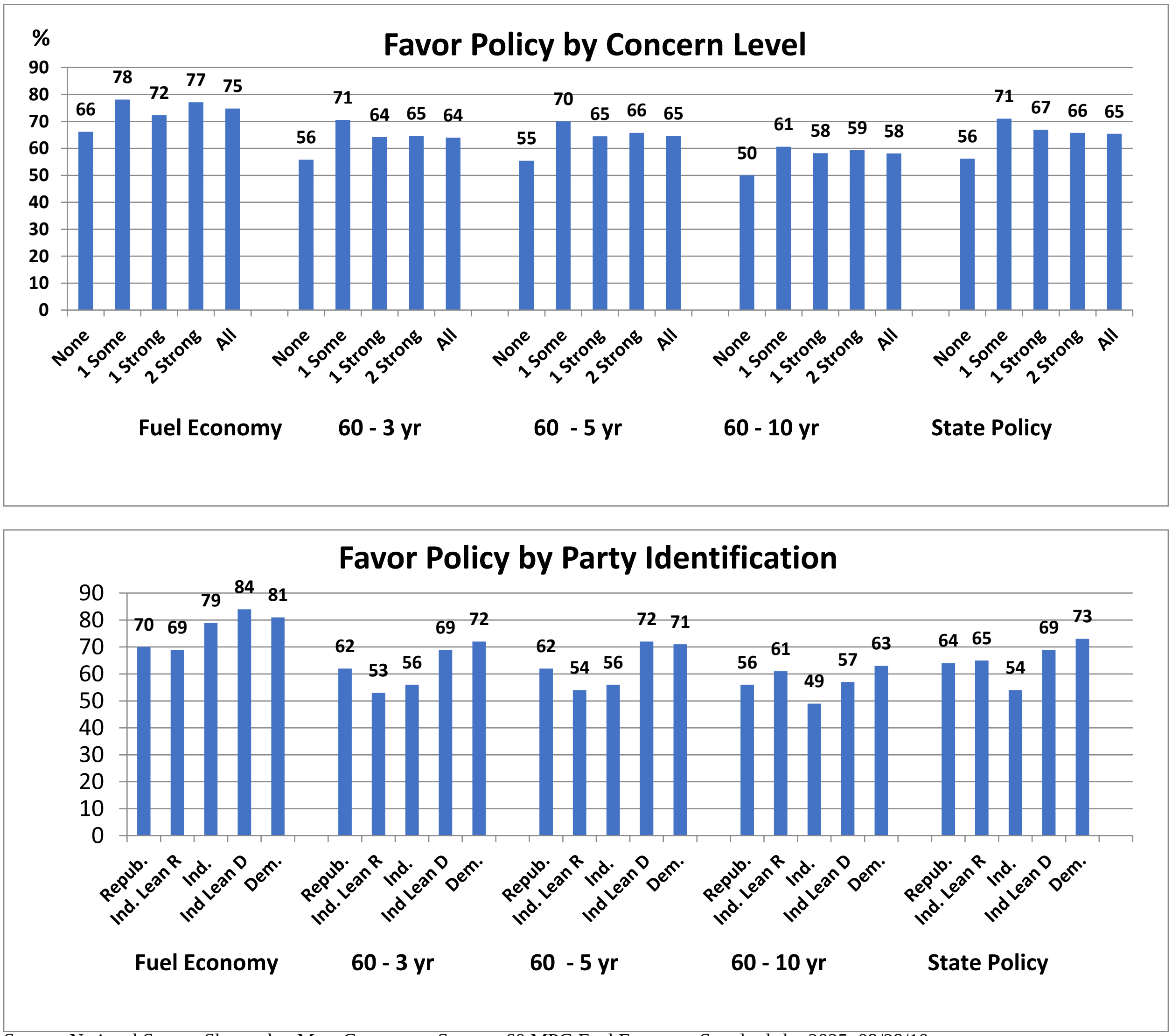
Our public opinion polling provides some insight into the consensus that has developed in support of higher fuel economy standards. In the 2011 poll, in addition to conducting analysis of subgroups of respondents defined by the state in which they live, we used the large sample to examine subgroups defined by the extent to which they perceived gasoline as a concern and their political identification. For political identification, we used the standard self-identifications – Republican, Leans Republican, Independent, Leans Democrat, Democrat. For the measure of the intensity of concern, we created a four-point scale that reflected the level of concern about gasoline and imports.

- Approximately 11% of the respondents said they were concerned about neither gasoline prices nor Mid-East dependence.
- Approximately 8% of the respondents said they had some concern about both of these issues.

- Approximately 25% of the respondents said they are greatly concerned about one of these issues.
- Finally, about 56% of the respondents are greatly concerned about both of these issues.

Figure VI-6 presents the results across levels of concern and political orientation for both the general question on support for fuel economy standards and the question about a 60-MPG standard.

FIGURE VI-6: SUPPORT FOR FUEL ECONOMY STANDARDS



Source: National Survey Shows that Most Consumers Support 60 MPG Fuel Economy Standards by 2025, 09/28/10.

When the respondents are broken down by their level of concern, we find that those who express no concern about prices or Mid-East oil dependence are less likely to support fuel economy standards in general and at all levels of payback. About two-thirds of those who express concerns about prices or Mid-East oil dependence, support fuel economy standards. About 60% of these respondents favor fuel economy standards, even with a 10-year payback.

Respondents who have concerns are also more likely to support continued state involvement in setting policy in this area.

Responses across categories of political identification are also informative. Although those who are self-identified as Democrat or leaning Democrat are clearly more supportive of the policy, in every case, a majority of those who are Republican or lean Republican also supports the policy. Among Democrats or those who lean Democrat, over 80% favor the fuel economy standards, and 70% favor a 60-mpg standard with a 3 or 5-year payback, and 70% favor continued state involvement. Among those who are Republican, two-thirds support the general concept of fuel economy standards, and over half support the 60-mpg level. Continuing state involvement in standards setting receives the same level of support as 60 mpg with a 3-year payback.

PUBLIC OPINION ABOUT STANDARDS IN MID-2017

In mid-July 2017, CFA commissioned its tenth national random sample public opinion poll in the past ten years dealing with the public support for fuel economy standards.[86] In that decade, we have been through three presidents and ridden a gasoline price roller coaster, but one thing has remained constant, public support for fuel economy standards. Given the tumultuous times, the strength and consistency of public support is a testament to the importance and power of this policy.

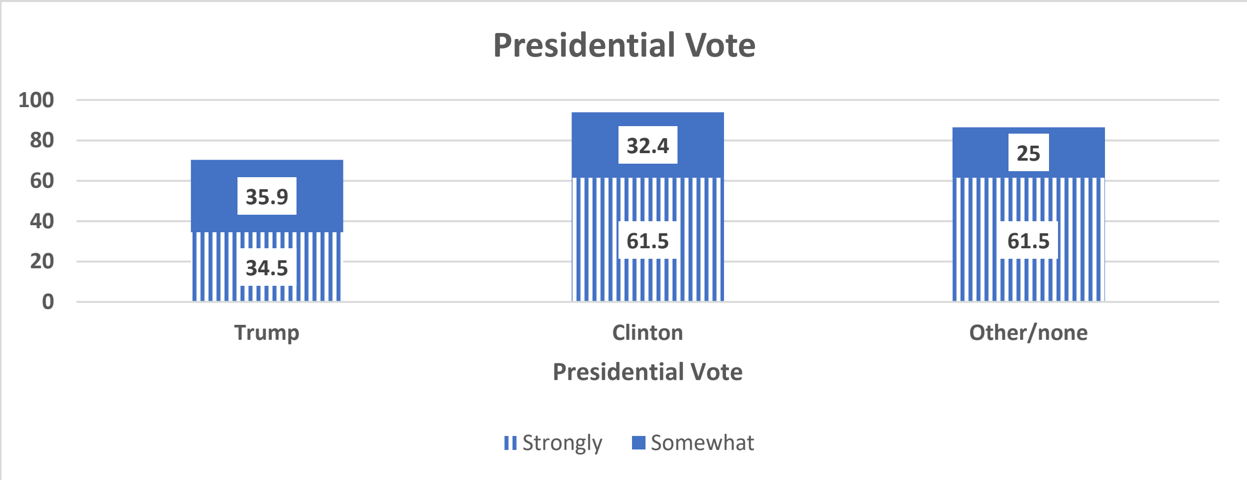
In the most recent survey, increasing federal fuel economy standards for cars and light duty trucks to 42 MPG by 2025 is supported by 79% of respondents; just, eighteen percent oppose this increase. These results reinforce public support for preserving the higher standards which the Administration is reconsidering. There is also legislation pending in Congress to weaken them. Yet, 68 percent of Republicans support this increase in standards (see Figure VI-7).

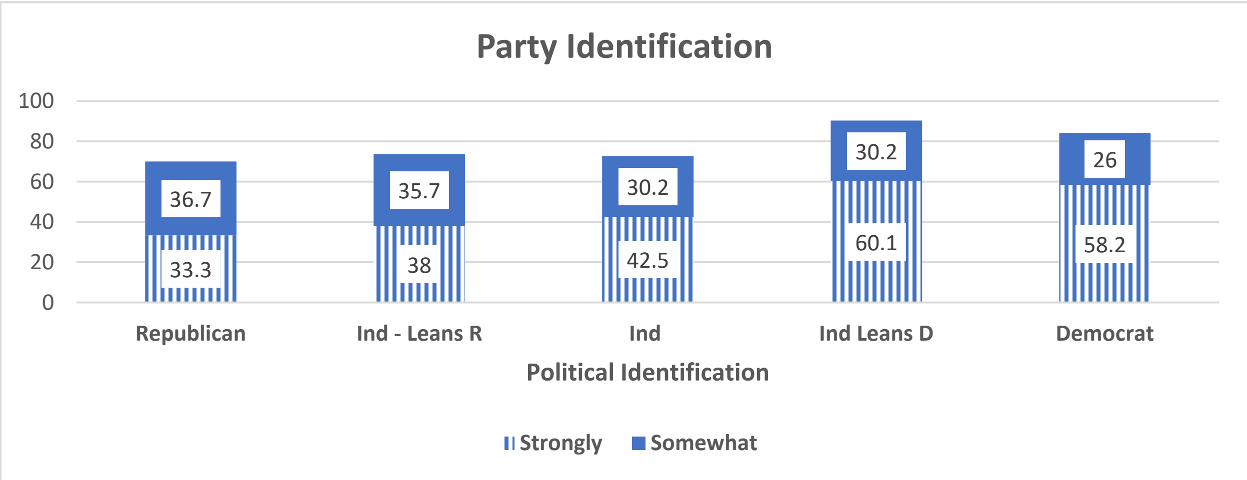
One reason for the widespread support of higher standards is that a large majority (79%), of those intending to purchase a motor vehicle in the future, think that the vehicle's fuel economy is important in the purchase of their next vehicle. In part, this concern may reflect their belief that gas prices will rise in the future. When asked to guess the price of gasoline in five years, the average price given by all respondents was $3.90. Today's average price is only $2.27.

Another reason for the support for fuel economy standards is the fact that the public recognizes the broader impact of fuel consumption. Over the years we have asked about the public's concerns about three broad energy policy issues – environment (climate change), Mid-East imports (with implications for economic and political vulnerability), and future prices (which impact not only consumer pocketbooks, but also the economy).

Three-fifths of all respondents to the 2017 survey said they had strong concerns about climate change, Mid-East oil, or gasoline prices. Another one-seventh expresses some concern about one of these. Combined, three quarters of respondents express a concern about one of these.

FIGURE VI-7: PUBLIC SUPPORT FOR FUEL ECONOMY STANDARDS ACROSS THE POLITICAL SPECTRUM, POST-2016 ELECTION



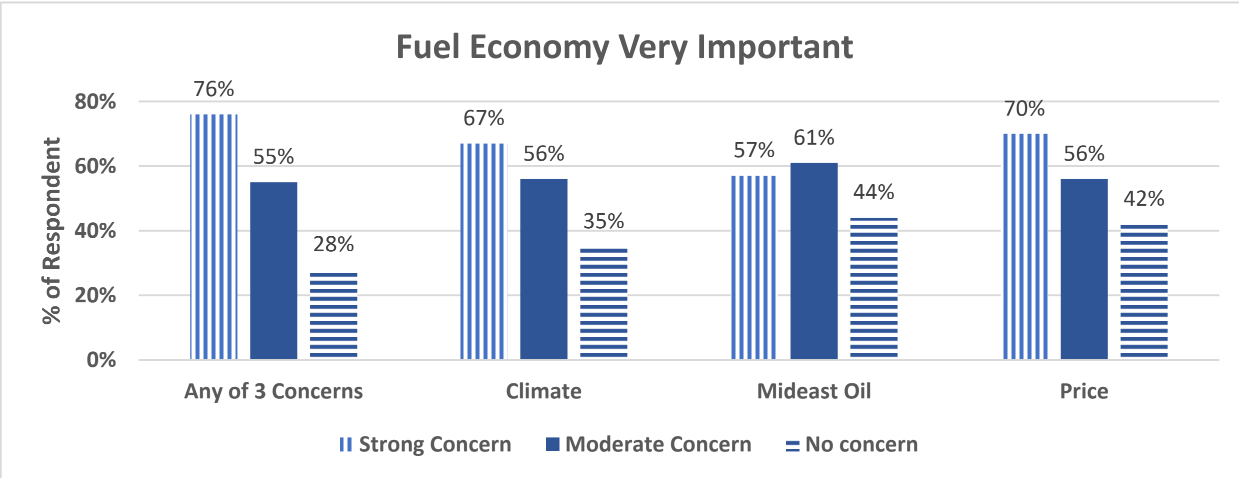


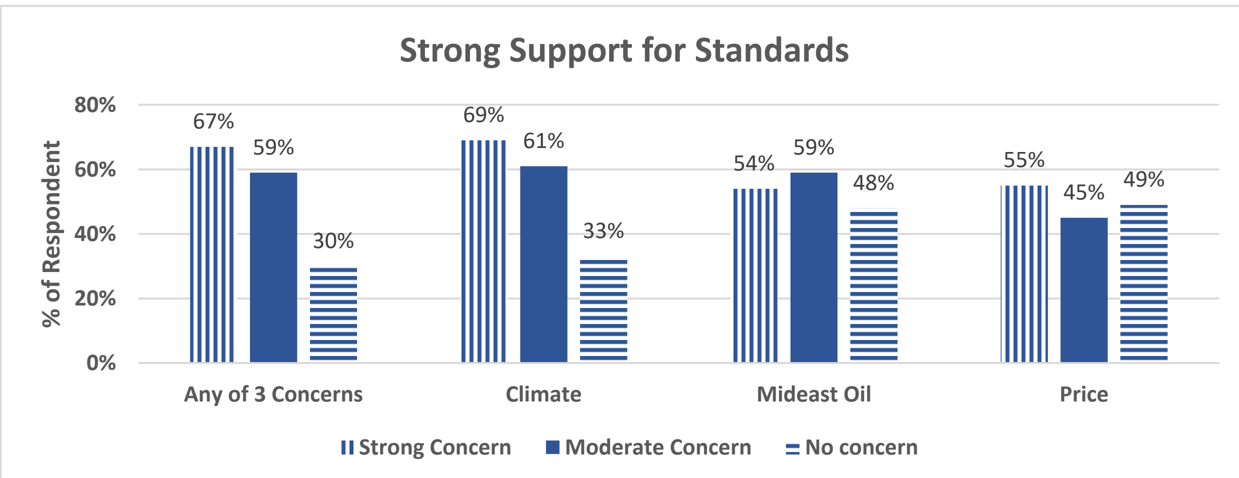
Source: CFA commissioned public opinion poll conducted by ORC, December 8-11, 2016.

Each of these has a significant relationship to the extent to which these concerns are related to the level at which fuel economy will be an influence in the next vehicle purchase decision. Concern about fuel economy has a statistically significant relationship to support for standards. Climate change has a statistically significant relationship to support for standards.

We find that the difference between those who are concerned about these three issues are much more likely to support standards. Any level of concern triggers the commitment, but the stronger the concern, the stronger the commitment. As shown in Figure VI-8, among those who express great concern about one of the three issues, we find that over three-quarters say fuel economy will be very important in their next vehicle purchase, which is two and a half times as high as those who express no concern about any of the three. Those with moderate concern fall between these two extremes. Similarly, two thirds of those who express a strong concern about one of the three issues strongly support fuel economy standards, which is more than twice the percentage of support among those who do not express any strong concerns. Again, those who express moderate concerns fall between the two.

FIGURE VI-8: EXTERNALITY CONCERNS AND ATTITUDES TOWARD FUEL ECONOMY





Source: CFA, ORC, National Random Sample Public Opinion Poll, July 2017

CONCLUSION ABOUT LIGHT DUTY VEHICLES

The survey evidence in support of fuel economy standards can be summarized as follows:

In September 2007, we asked about support for the broad goals of EISA in a question that began with fuel economy but also mentioned greater reliance on renewables and ethanol.

- Support for the legislation stood at 84%.

We followed that up with a question that laid out the arguments for passage (lower consumer spending on energy, dependence on imports, and global warming emissions) and against (rising prices and lost jobs).

- Support for the legislation stood at 75%.

After the passage of EISA we shifted our questioning to the level of standards being considered in rulemakings.

In March 2008, we asked consumers about the U.S. oil situation (share of global reserves and level of consumption) and split the sample. We noted that regulations were being considered to increase fuel economy from 25 mpg to 35 mpg by 2016 and asked about support for raising that target to 50 mpg by 2025. Among those who gave correct answers to the questions on the U.S. oil situation,

- Support for the increase stood at 73%.

Among those who did not give correct answers, without being provided the correct information,

- Support for the increase was 65%.

After correct information was provided,

- Support for the increase rose to 69%.

In September 2010, we asked about a much larger increase, in addition to going from 25 mpg to 35 mpg by 2016, we asked about going to 60 mpg by 2025.

- Support for the increase stood at 59%.

In May 2012, we shifted to evaluating the standard that had been adopted for 2025, with the lab test goal of approximately 55 mpg.

- Support for the standard stood at 74%.

In April 2013, we repeated the survey question.

- Support for the standard stood at 85%.

In June 2014, we again surveyed on the proposed standard.

- Support for the standard stood at 83%.

The previous surveys relied on the laboratory miles per gallon estimates used in the regulatory documents, but the economic analysis of the CAFE standards and the EPA stickers on vehicles have always relied on the estimated on-road mileage that consumers are likely to see. As the mpg increases, the difference between the lab tests and on-road mpg grows. In our recent surveys we have shifted to using the on-road numbers, since that is more familiar to consumers.

In our April, 2016 survey we shifted to the projected on-road mileage of about 42 mpg.

- Support for the standard stood at 81%.

The December 2016 survey analyzed above also reflects this change.

Support for the standard stands at 76%.

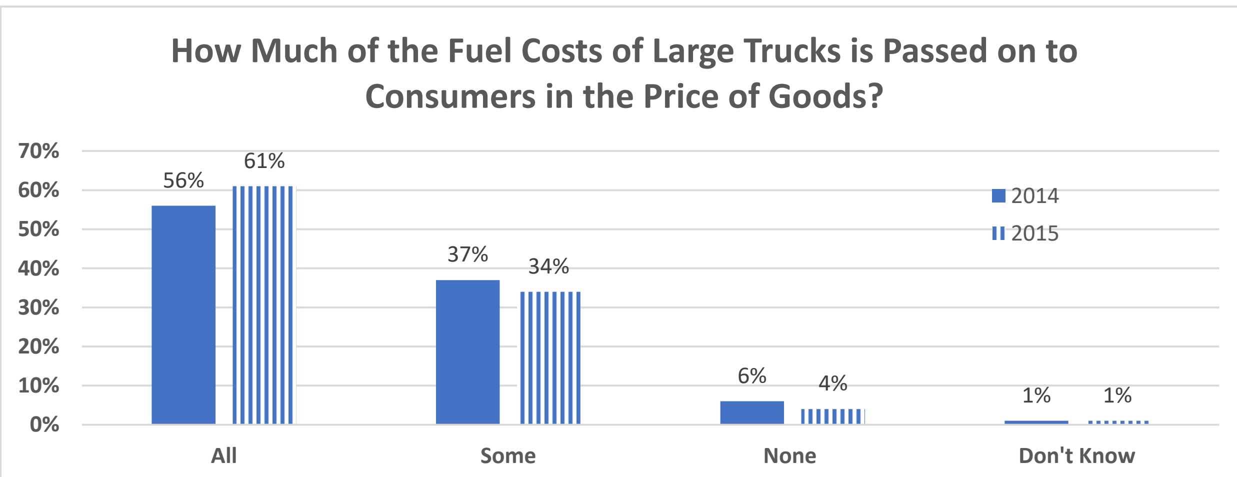
WORK TRUCKS

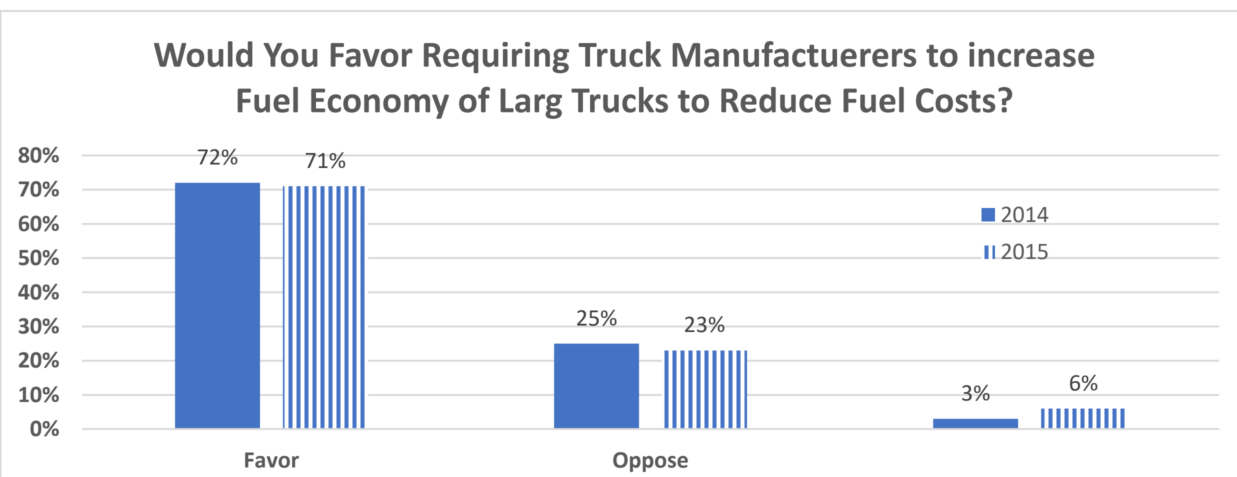
The analysis in Part V shows that the services of work trucks are intermediate goods, whose costs are passed through to consumers. We have been able to demonstrate that these fuel costs are considerable. It is not surprising that to find that consumers recognize the impact of work truck operating costs.

Two recent Consumer Federation of America surveys found that the vast majority of consumers (over 90%) understand that "some, most, or all" of the fuel costs of heavy-duty trucks, which transport virtually every consumer good, are passed on to consumers, as shown in the upper graph of Figure VI-9. In fact, over 55 percent believe that "all or most" of these costs are passed on to the consumer.

In both of the CFA surveys, consumers clearly understood the possibility of these savings as nearly three quarters of the respondents favored requiring truck manufacturers to increase the fuel economy of large trucks (see the lower graph in Figure VI-9).

FIGURE VI-9: CONSUMERS ATTITUDES ABOUT FREIGHT FUEL COSTS AND STANDARDS





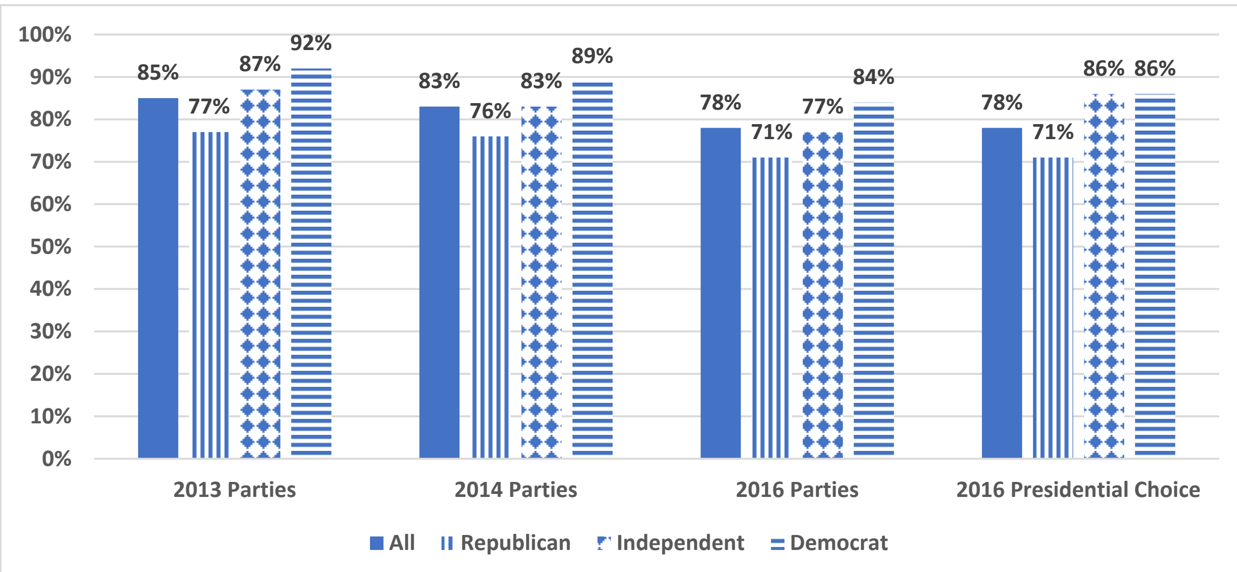
Source: **Average American Household Pays $1,100 a Year to Fuel the Nation's Trucking Fleet, August 18, 2015.**

VII. AUTOMAKER ROLL BACK v. CONSUMER SUPPORT FOR STANDARDS

THE AUTOMAKERS' POLITICAL GAMBIT CONFLICTS WITH SUPPORT FOR FUEL ECONOMY STANDARDS

The automakers were quick to seize on the election outcome to demand a rollback in the standards – sending the President-elect a letter barely 48 hours after the winner was declared.[87] This rush by the industry to catch the ear of the President-elect clearly was intended to influence any decision about the future of the standards and establishes the context in which the rigorous analysis of the National Program should be evaluated. Our survey suggests this was not a very popular action. As pointed out earlier and shown in Figure XVII-1, standards enjoy strong, bipartisan support.

FIGURE VII-1: SUPPORT FOR THE CURRENT STANDARD



Source: CFA commissioned public opinion polls conducted by ORC.

We explored this further with an election year style question about how a policy position would affect the likelihood to vote for a candidate. The sequence of questions we asked was as follows:

> Federal and state standards now require automobile manufacturers to increase the fuel economy of the new cars they sell to an on-road average of 42 miles per gallon by 2025. What is your view of this increase in fuel economy standards? Would you say you…
>
> (READ ENTIRE LIST BEFORE RECORDING ONE ANSWER)
> 01 Support strongly
> 02 Support somewhat
> 03 Oppose somewhat
> 04 Or, oppose strongly
> 99 DON'T KNOW
>
> In the past several years, automobile manufacturers have made good progress increasing the fuel economy of their vehicles and are on schedule to meet the 42 miles per gallon requirement, which

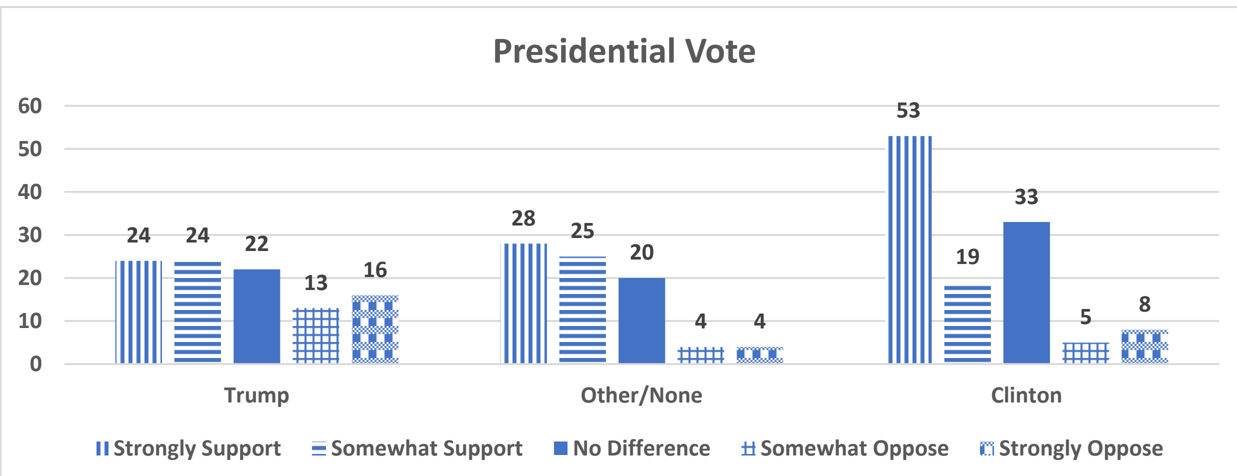
varies by type of vehicle. But now some auto manufacturers are objecting to the standard and are asking the new administration in Washington to scale it back.

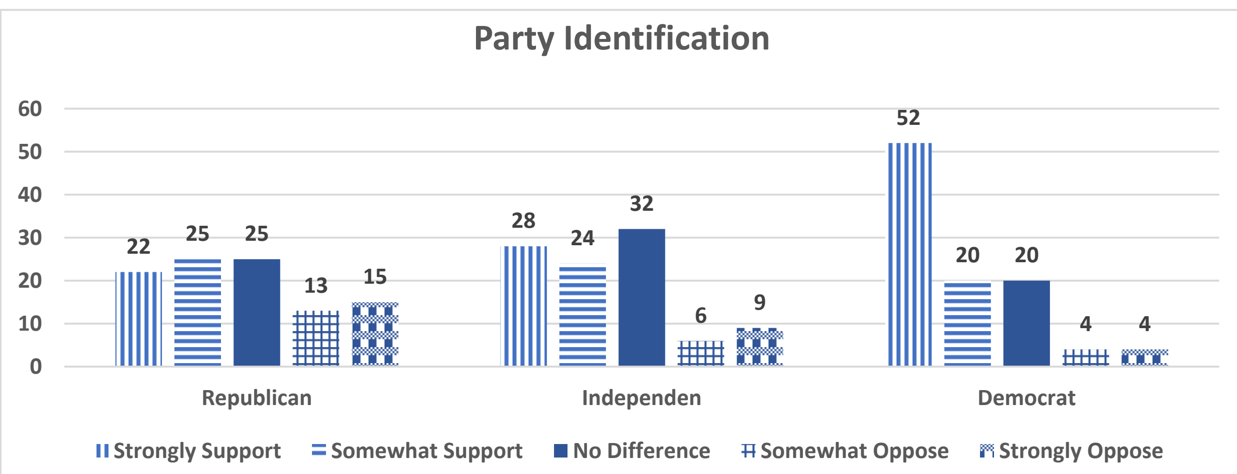
Knowing this, are you more likely to support or oppose the federal and state standards that require automobile manufacturers to increase the fuel economy of the new cars they sell to an on-road average of 42 miles per gallon by 2025? Would you say you are…

(READ ENTIRE LIST BEFORE RECORDING ONE ANSWER)
01 Much more likely to support
02 Somewhat more likely to support
03 Somewhat more likely to oppose
04 Much more likely to oppose
05 Or, does it make no difference
99 DON'T KNOW

Figure VII-2 shows the responses to this question. It indicates that, when presented with the two salient and somewhat contradictory facts – that the automakers are currently meeting the standard and they want to roll them back – respondents are more likely to support the standard.

FIGURE VII-2: SUPPORT FOR STANDARDS WITH INFORMATION ON AUTOMAKERS





Source: CFA commission public opinion poll conducted by ORC, December 8-11, 2016.

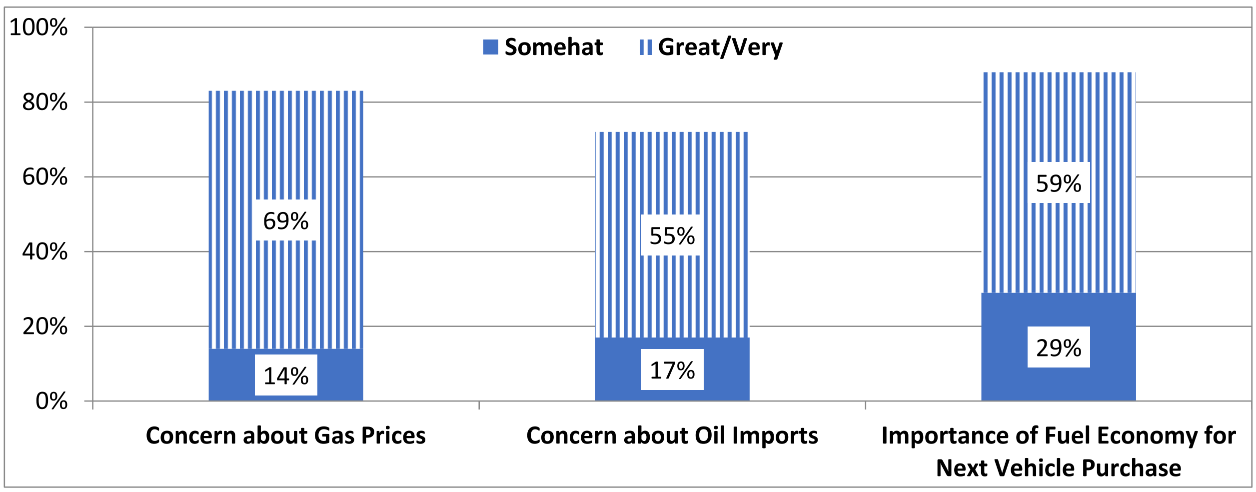
Respondents were three times as likely to support the program (57%), compared to a small minority (17%) who said it would make them oppose the program. About one quarter said it did not matter. The shift in attitude was even greater when we consider strong changes, with 35% more strongly supporting verses 9% more strongly opposing.

CONTINUING CONSUMER DEMAND FOR HIGHER FUEL ECONOMY

Automaker efforts to roll back the standards not only flies in the face of strong support for the standards, it also flies in the face of consumer interest in higher fuel economy. Shortly after the National Program went into effect, CFA commissioned a public opinion poll to explore consumer attitudes toward increased fuel economy and standards. Figure XVII-3 3 shows that the importance placed on higher fuel economy is also consistent with the expectation of respondents about changes in fuel economy. Respondents expect the gas mileage of their next vehicle to be considerably higher, an average of almost 31 mpg, compared to their current vehicle. They expect increased mileage across the full range of vehicle types, with the smallest improvements expected in large vehicles and pickup trucks.

Figure VII-3 summarizes the basic attitudes that shape consumer behavior in the auto market. Approximately 83% of respondents express concern about gasoline prices in the next five years (69% expressing great concern). Predictably, low and moderate-income respondents (less than $50,000) expressed the greatest concern – 74% said great concern) compared to upper income households (above $100,000) where 56% expressed great concern.

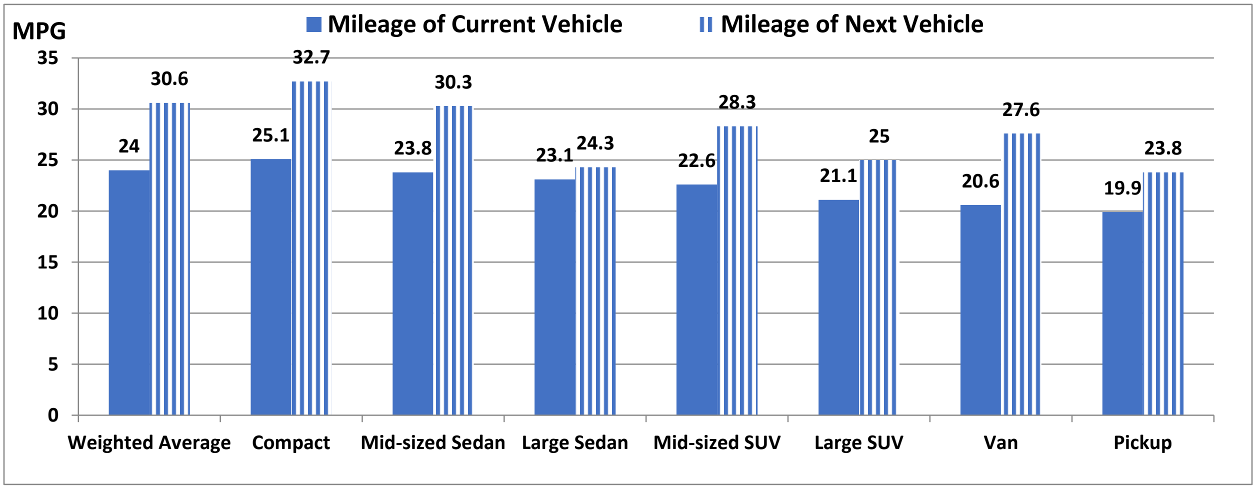
FIGURE VII-3: WHY CONSUMERS ARE CONCERNED ABOUT FUEL ECONOMY



Source: National Survey, conducted for CFA by ORC, April 11-14, Questions as follows:
Thinking about the NEXT FIVE YEARS, how concerned, personally, are you about the following issues? Please use a scale of 1 to 5, where 1 means ‘no concern’ and 5 means ‘great concern’.
Thinking about the next motor vehicle you will purchase, how important will gas mileage—that is, how many miles to the gallon it will get—be in your decision about the type of vehicle you will purchase? Would you say … Very important (5), Somewhat important, not very important, Or, not at all important (1); Won’t purchase another vehicle; Don’t Know.

Concerns about Mid-East oil imports remains high, with 73% expressing concern (55% great concern). Respondents older than 45 years old are more likely to express great concern (above 60% express great concern); younger respondents are less likely (less than 50% express great concern (see Figure VII-4).

FIGURE VII-4: WHAT CONSUMERS WANT FOR FUEL ECONOMY IN THEIR NEXT VEHICLE



Source: National Survey, conducted for CFA by ORC, April 11-14: Questions as follows:
What is the gas mileage of the motor vehicle you are currently driving? That is, about how many miles to the gallon does this vehicle get?
What type of motor vehicle are you currently driving the most miles? Would you say... Subcompact or compact sedan, Mid-sized sedan, Large sedan, Medium-sized SUV, Large SUV, Minivan, Pick-up truck, Other, Don't Know.
What is your best guess as to its gas mileage, that is, how many miles to the gallon will it get?
What is your best guess about the type of motor vehicle this will be? Would you say it will be a… Subcompact or compact sedan, Mid-sized sedan, Large sedan, Medium-sized SUV, Large SUV, Minivan, Pick-up truck, Other, Don't Know.

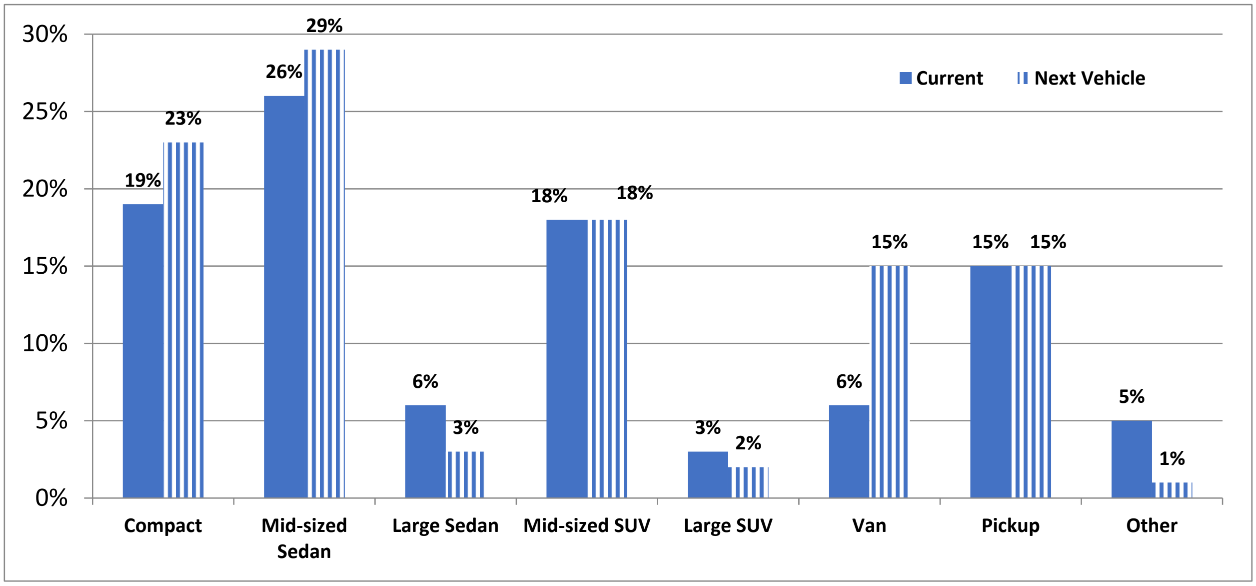
Approximately 88% of respondents say that gas mileage will be very important in the purchase of their next vehicle, with 59% saying it will be very important. This finding is consistent with past surveys conducted by CFA as well as research conducted by Consumers Union, publisher of Consumer Reports. Respondents with low and moderate income (less than $50,000) are more likely to say mileage is very important, with 64%, than upper income households (incomes above $100,000, with (46%).

Six percent of the respondents say they do not own a vehicle. Households, with incomes less than $25,000, are much more likely to not own a vehicle (15%), than households with incomes above $25,000 (2%). All subsequent analysis of the survey data is based on respondents who own a vehicle.

CONSUMER ATTITUDES AND THE DYNAMIC IMPROVEMENT IN FUEL ECONOMY

As Figure VII-5 shows, responses also indicate a shift in consumer purchasing patterns toward more fuel-efficient types of vehicles, which is consistent with the longer-term trends, discussed throughout this report. The market share of smaller vehicles (subcompacts and compacts) and mid-sized cars is expected to increase while the share of large sedans, large SUVs and other vehicles is expected to decline.[88] Given the higher current mileage of these types of vehicles and the larger increase expected in their mileage, this shift would have a significant impact on the average fuel economy of the future vehicle fleet.

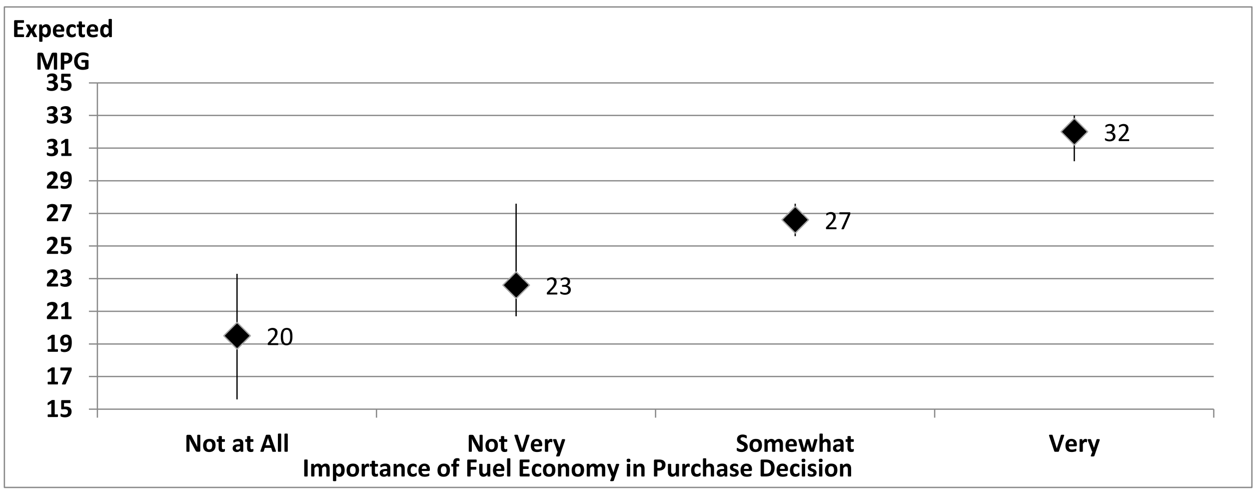
FIGURE VII-5: THE TYPE OF VEHICLES CONSUMERS EXPECT TO PURCHASE NEXT



Source: National Survey, conducted for CFA by ORC, April 11-14: Questions, see Exhibit 2.

Figure XVII-6 shows that there is a clear relationship between the importance that respondents place on fuel economy in their purchase decision and the level of fuel economy they expect to get. Those who say fuel economy is very important in their purchase decision expect to get 32 mpg, about 10 mpg more than those who say it is not important.[89]

FIGURE VII-6: IMPORTANCE OF MILEAGE AND EXPECTED FUTURE MILEAGE (Mean and 95% Confidence Interval)



Source: National Survey, conducted for CFA by ORC, April 11-14: Questions, see Exhibit 2.

In looking at the respondents' answers, we were able to determine how various factors influenced the importance of fuel economy in their next purchase.[90] The most important factor was how fuel efficient their current vehicle was. The higher their current fuel economy, the more important higher fuel economy would be with their next purchase and the higher the fuel economy they want in their next vehicle. Respondents who intend to purchase compacts expect higher mileage, while those who expect to purchase pickups and large sedans expect to get lower mileage.

CONFLICT BETWEEN CONSUMER NEEDS AND AUTOMAKER WANTS

These survey results put the automakers' efforts to roll back the standards at odds with public opinion. In our comments in response to the Technical Analysis Report we showed that the automakers are out of step with consumers in another way. While the automakers claim that what they want to do with vehicles is "just what consumers want," we showed that their own survey results contradicted that claim. Because we believe this misreading of consumers has been persistent and their erroneous portrayal of consumer attitudes will likely play an important part of the debate over the standard, some of our earlier analysis bears repeating.

The AAM analysis makes a remarkable series of erroneous assumptions and misleading comparisons and claims.[91]

It claims that "only OEMs have real skin in the game."[92] In fact, since the consumer pocketbook benefits exceed the technology costs by a substantial amount, consumers have a great deal of "skin in the game." As noted above, environmental, public health and macroeconomic benefits should also be included. In other words, consumers and society have as much as four to six times as much "skin in the game" as the automakers.[93] The claims ignore the fact that the agency analyses show that the total cost of driving declines.

The automakers present numerous nonsensical comparisons. For example, on the list of public concerns they note that terrorism, race relations and a weak economy are a greater concern to the public.[94] Improving fuel economy does not detract from policies to address these bigger problems. Indeed, it can be argued that reducing oil consumption and imports helps to undermine the leverage of terrorists, while the resulting macroeconomic growth improves the economy.

Even when they present bogus choices, their arguments do not work. They state that the global threat of climate change "requires government regulations…[95] that raise the price on new cars… pricing new cars out of the reach of many American families." In spite of this introduction, more respondents opt for more regulation (42% to 41%). Similarly, they point out that 69% of respondents want to encourage mobility, vs. 16% that want to discourage mobility.[96] Since the standards lower the cost of driving (and have a rebound effect to increase driving), they obviously encourage mobility.

The key question on regulation reported by the AAM is extremely biased.[97] First, the question uses the laboratory standard of 54.5 miles per gallon, while EPA/NHTSA do all their economic analysis at the adjusted, real world mileage of about 42 MPG. Survey respondents live in the real world and 42 MPG would certainly seem more realistic than 54.5. Second, in presenting the choice, the AAM survey presents only one side – the automakers' side. "OEMs say that under the new standard, consumers will have to pay more for cars and buy more hybrids and EVs." Remarkably, even with this double-barreled bias, while 47% of the respondents said the target of 54.5 was too aggressive, 46% said it was about right or too lenient.

In 2006, when automakers were having difficulties, long before the financial meltdown and the bankruptcy of two of the Big Three U.S. automakers, we asked consumers what role fuel economy might be playing: "Both Ford and General Motors are having well-publicized financial problems. To what extent do you think these problems have resulted from their emphasis on producing and marketing SUVs and pick-up trucks with relatively low miles per gallon?" Two-thirds said that it was playing a part.

THE PUBLIC IS NOT AS ENAMORED OF GASOLINE POWERED MUSCLE CARS AND TRUCKS AS THE AUTOMAKERS CLAIM.

Although our primary focus has been on analyzing the standards, rather than arguing with the industry, over the years, we have asked questions that reinforce the evidence of the automaker misunderstanding of consumers. We find that consumers have consistently expressed a desire for vehicles that get about 20% high fuel economy than the sales weighted average of new vehicles sold. Until recently, when the standards changed automaker behavior, the show rooms did not have vehicles to meet consumer efficiency demands.

The automakers spend a great deal of time complaining about policies to promote electric vehicles (EVs), claiming they will drive up the cost of the National Program. We have shown that the EV program will have little impact on the cost of compliance for three reasons.

First, electric vehicles are projected to make up a very small part of the fleet in the targeted compliance period.

Second, the cost of electric vehicles is plummeting, with a number of cost-competitive, consumer-friendly vehicles planned for the market long before the compliance period.

Third, as frequently happens in efficiency programs, the cost of compliance declines as producers learn and volumes rise. This is the powerful intersection of "command but not control" regulation and the market forces on which it relies.

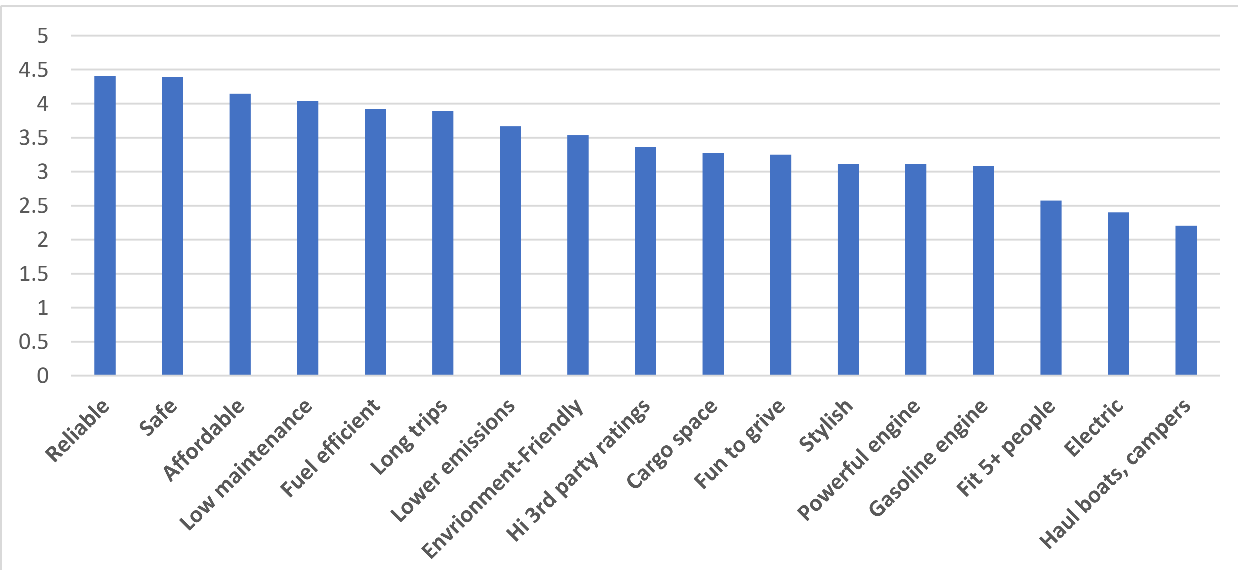
As we pointed out during the House hearing, this was the experience with hybrid vehicles. California's leadership in the LEV program created the global market for those vehicles. With respect to EV's, the global market is rapidly emerging. In this case, California's leadership will help to ensure that the U.S. automakers are not left behind.

Moreover, the automakers' survey evidence does not support their claim. If an EV and gasoline vehicle were matched on cost and travel length[98], more would prefer the electric vehicles (48% to 43%) and a clear majority (57%) are willing to pay more for an electric vehicle. As Figure XVII-7 shows, the analysis of desirable vehicle attributes shows that consumers want reliable, safe, affordable and low maintenance vehicles.[99]. There is no reason to believe that fuel efficient gasoline engines or electric vehicles (EVs) cannot fill the bill and automakers are working hard to achieve that goal.

As Figure XVII-7 shows, after the big four attributes, respondents care as much about fuel efficiency as the ability to take long trips and the automakers are working on that too. Beyond these big six attributes, the valuation of others falls off, but even here the message for EVs is positive. Environmental impacts rank a lot higher (8th and 9th) than powerful engines (13th) or engine type (gasoline power =14th, electricity = 16th). Fitting more than 5 people (15th) or hauling boats and campers don't matter much (ranks dead last).

If you watch the TV ads and go into the showrooms, you would have to conclude that the automakers are pushing the wrong vehicles. More importantly, there is nothing in this data that suggests EVs cannot be a big success. Our survey results, this data and automaker investments can be interpreted to mean that EVs are on the early part of the adoption curve and there is a very strong basis to expect success.

FIGURE VII-7: ALLIANCE OF AUTOMOBILE MANUFACTURERS, VEHICLE ATTRIBUTE SURVEY



Source and Notes: Mitch Bainwol, President and CEO, Alliance of Automobile Manufacturers, *Consumers & Fuel Economy,* CAR Management Briefing Seminars, Traverse City, Michigan, August 2016, p. 10. The winter related question, specific to the North East, has been discarded. It would rank 12th of 18, low in California, high in New England).

VIII. ATTITUDES ABOUT APPLIANCE EFFICIENCY STANDARDS

Although the fuel economy of the vehicle fleet receives a great deal of attention, the consumption of energy by household appliances, which we refer to as home energy, does not. This is surprising since in 2016 home energy consumption for heating, cooling, lighting, cooking and hot water ($1784), took a bite out of household budgets that was almost as large as expenditures for gasoline ($1909).

Over the past decade, the Consumer Federation of America has conducted a dozen surveys that examine public knowledge about and attitudes toward the fuel economy of cars and trucks. As discussed in the previous section, we have found that the public: is concerned about oil consumption for several reasons, including cost and dependence on imported oil; believes that lowering consumption is good for consumers and the nation; is willing to spend more on more efficient vehicles as long as the investment has a reasonable payback period; supports minimum fuel economy standards, and the better informed they are about fuel economy, the more they support minimum standards.

Since home energy home energy consumption deserves as much attention as gasoline consumption from the point of view of the impact of energy policy on the consumer pocketbook,[100] it should come as no surprise that a survey we conducted found that consumer attitudes toward home energy consumption and efficiency are quite similar to the attitudes about vehicle fuel economy. A large majority believe it is beneficial for appliances to become more energy efficient for several different reasons, including lowering electric bills as well as reducing pollution. They are willing to pay more for the product with a reasonable payback period, and they support the government setting minimum efficiency standards for appliances.

This section examines the underlying pattern of attitudes toward appliance energy efficiency and minimum energy efficiency standards to gain further insight into public opinion about this important area of consumer spending and energy policy. A key goal is to provide policy makers with a deeper understanding of the nature of support for minimum appliance efficiency standards. We also briefly note non-CFA surveys that deal with a broader range of issues.

METHODOLOGY

In January 2011, the Consumer Federation of America commissioned a survey of public attitudes toward energy consumption of household appliances and support for government standards that set minimum levels of energy efficiency for appliances like refrigerators, clothes washers, and air conditioners. The national random sample survey of 1,000 people was conducted by Opinion Research Corporation (ORC).

The survey posed five questions about appliance energy efficiency and minimum standards.

Benefit: Do you think it is beneficial or harmful for appliances like refrigerators, clothes washers, and air conditioners to become more energy efficient, that is, to use less electricity?

Specific benefits: In your view, how important is each of the following reasons to improve the energy efficiency of appliances?

Lowering your electric bills
Reducing the nation's consumption of electricity to avoid building new power plants
Reducing the nation's consumption of electricity to reduce air pollution
Reducing the nation's consumption of electricity to reduce greenhouse gas emissions

Payback: Now, suppose improvements in the energy efficiency of appliances increased their purchase price but reduced the cost of using them. If these price increases were offset by reduced electricity costs over the following time periods, would you say you would strongly favor this, somewhat favor, somewhat oppose or strongly oppose?

Three years
Five years
Ten years

Awareness of Standards: Are you aware that the government requires new appliances like refrigerators, clothes washers, and air conditioners to meet minimum energy efficiency standards, that is, to use no more than a certain amount of electricity?

Support for minimum standards: In principle, do you support or oppose the idea that the government should set minimum energy efficiency standards for appliances?

The survey gathered data on the standard set of demographics that are typically included in survey research – gender, age, education, income, household tenure, region, – as well a question on summer electricity bills. After examining the data, several summary indices were created for specific analyses.

Recoded variables:

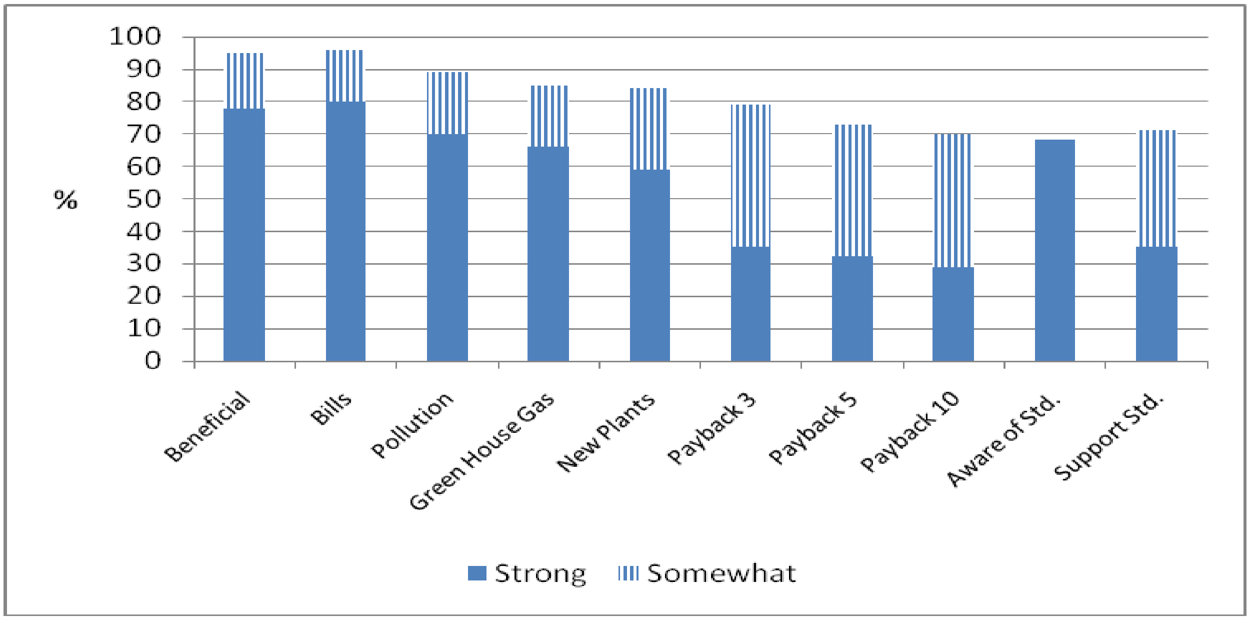
Sum of benefits: All very important…. mixed… none very important.
Payback sum: Strongly favors both 3-year and 10-year…. Mixed…. Strongly opposes both 1-year and 10-year

ATTITUDES TOWARD APPLIANCE EFFICIENCY AND STANDARDS

As shown in Figure VIII-1, nearly all Americans (95%) think it "beneficial for appliances like refrigerators, clothes washers, and air conditioners to become more energy efficient," with 78% believing this increased efficiency to be "very beneficial."

Nearly all Americans (96%) think improved appliance efficiency is important for personal financial reasons – "lowering your electric bills" – with 80% considering this to be very important. However, large majorities also believe improved appliance efficiency to be important for environmental reasons – because it reduces the nation's consumption of electricity "to reduce air pollution" (92% important, 77% very important) and "to reduce greenhouse gas emissions" (84% important, 66% very important).

FIGURE VIII-1: PERCEPTION OF BENEFITS OF EFFICIENCY, AWARENESS AND SUPPORT FOR STANDARDS



http://www.consumerfed.org/elements/www.consumerfed.org/file/Gas_Oil_Survey_Oil_Spill_PR_5_18_10.pdf, http://www.consumerfed.org/pdfs/MVFE-Survey-PR092810.pdf

Substantial majorities also favor improved energy efficiency of appliances even when this increases their purchase price. This support predictably varies with the payback period: 3 years (79% favor, 35% favor strongly), 5 years (73% favor, 32% favor strongly), and 10 years (60% favor, 29% favor strongly).

Only about two-thirds of Americans (68%) are aware that the "government requires new appliances like refrigerators, clothes washers, and air conditioners to meet minimum energy standards." Awareness is highly correlated with income (53% below $25k, 81% $100k and above) and education (50% no high school degree, 84% college degree). But nearly three-quarters of Americans (72%) support "the government setting minimum energy efficiency standards for appliances," with strong support from 28%.

We next examine how these basic responses relate to each other and the demographic characteristics of respondents. In the following discussion, we examine all of the variables for which we have data that show a statistically significant relationship with support for minimum standards in both bivariate analyses and a multivariate analysis. All of the relationships discussed in this section are statistically significant by a Chi Square test with $p < .01$. The following analyses also exclude the respondents who refused to answer questions, or said they did not know. Therefore, the percentages vary slightly from the overall percentages cited above.

PERCEPTION OF BENEFITS AND SUPPORT FOR MINIMUM STANDARDS

Table VIII-1 shows that there is a statistically significant relationship between perceived benefits of energy efficiency and support for minimum standards. Those who perceive benefits are more likely to support minimum standards and the more benefits perceived to be very important, the greater the support. Thus, 83 percent of those who think that all four benefits are very important support minimum standards. This percentage declines steadily as the number of perceived benefits declines. Among those who find none of the benefits very important, only 44 percent support efficiency standards, while 56 percent oppose it.

TABLE VIII-1: PERCEIVED BENEFIT AND SUPPORT FOR MINIMUM STANDARDS

Efficiency Benefit	N	Support For Standards (% of Respondents) Very Strong Support	Somewhat Support	Somewhat Oppose	Strongly Oppose
Sum of Benefits					
All 4 very Important	393	52	31	8	7
3 very Important	203	49	34	6	10
2 very Important	115	27	38	19	16
1 very important	133	16	32	16	37
0 very Important	110	8	36	14	42
Bills					
Very important	775	42	32	12	15
Somewhat important	189	28	37	12	23
Somewhat unimportant	19	21	21	15	48
Very unimportant	12	17	33	0	50
Plants					
Very important	548	51	31	8	10
Somewhat important	270	27	44	15	14
Somewhat unimportant	82	26	28	17	29
Very unimportant	79	8	18	11	63
Pollution					
Very important	680	50	32	10	8
Somewhat important	204	17	43	17	24
Somewhat unimportant	53	11	19	17	53
Very unimportant	51	4	16	10	71
Greenhouse Gases					
Very important	617	52	33	8	8
Somewhat important	201	24	40	14	21
Somewhat unimportant	61	11	30	33	26
Very unimportant	93	4	20	10	66

http://www.consumerfed.org/elements/www.consumerfed.org/file/Gas_Oil_Survey_Oil_Spill_PR_5_18_10.pdf, http://www.consumerfed.org/pdfs/MVFE-Survey-PR092810.pdf

ATTITUDES TOWARD PAYBACK PERIODS AND MINIMUM STANDARDS

Results for the response to the payback questions parallel those for the perception of benefits question (see Table VIII- 2). We have observed a high level of support for energy efficiency, even with a ten-year payback period, but there is stronger support with shorter payback periods. While the difference between the distribution of responses based on the three-year payback and the five-year payback is not statistically significant, the difference between the distribution of responses based on the three-year payback and the ten-year payback is statistically significant, as is the difference between the distribution of responses based on the five-year payback and the ten-year payback is statistically significant.

TABLE VIII-2: PAYBACK AND SUPPORT FOR MINIMUM STANDARDS

	N	Support for Standards (% of Respondents)			
		Very Strong Support	Somewhat Support	Somewhat Oppose	Strongly Oppose
Payback Sum					
Support All		54	24	8	14
Mixed		35	39	13	13
Oppose All		9	27	9	55
3-Year					
Favor strongly	404	56	27	6	10
Favor somewhat	405	27	43	15	15
Oppose somewhat	109	25	22	20	33
Oppose strongly	65	21	23	5	17
5-years					
Favor strongly	327	57	26	5	11
Favor somewhat	408	32	42	14	12
Oppose somewhat	140	22	31	19	28
Oppose strongly	94	28	21	11	40
10-year					
Favor strongly	265	56	27	6	11
Favor somewhat	324	34	42	11	12
Oppose somewhat	175	31	31	19	18
Oppose strongly	285	29	33	11	38

http://www.consumerfed.org/elements/www.consumerfed.org/file/Gas_Oil_Survey_Oil_Spill_PR_5_18_10.pdf, http://www.consumerfed.org/pdfs/MVFE-Survey-PR092810.pdf

The more favorable the respondent is to the payback period, the stronger the support for minimum standards. The response patterns are similar for each of the payback periods. Those who find any payback unacceptable are three times as likely to strongly oppose minimum standards. We have used the responses to the three and ten-year payback questions to develop a general index of "willingness to pay." Respondents who strongly favor the three and ten-year periods have the higher score of 8. Those who oppose both the one and 10-year periods have a score of 1. This captures the strong difference between the extremes. Sixty four percent of those who find any payback period unacceptable oppose both of the payback periods strongly oppose minimum standards; whereas 64% of those who strongly favor both the 3 and 10-year payback periods strongly support the standards.

Table VIII-3 shows several background characteristics that exhibit significant relationships to support for minimum efficiency standards in addition to education. It starts with the data that show awareness of minimum standards is associated with support for them. Forty-two percent of those who are aware of the standards strongly support them, while only 31 percent of those who are not aware, do not support them.

TABLE VIII-3: BACKGROUND CHARACTERISTICS AND SUPPORT FOR MINIMUM EFFICIENCY STANDARDS

	N	Support for Standards (% of Respondents)			
		Very Strong Support	Somewhat Support	Somewhat Oppose	Strongly Oppose
Awareness of Standard					
Unaware	284	31	34	11	20
Awareness	714	42	33	10	16
Education					
LT 8th Grade	35	27	27	20	27
8th Grade	55	40	29	13	18
High School	254	32	36	12	20
Associate Coll.	83	27	45	11	18
Some College	196	43	28	14	15
College Grad	213	42	34	9	15
Post Doc.	170	45	33	9	16

http://www.consumerfed.org/elements/www.consumerfed.org/file/Gas_Oil_Survey_Oil_Spill_PR_5_18_10.pdf, http://www.consumerfed.org/pdfs/MVFE-Survey-PR092810.pdf

Among the demographic variables, only education exhibits a statistically significant relationship to support for minimum standards in both the bivariate and multivariate analyses (income drops out in the multivariate analysis, since education is a stronger predictor). Education also exhibits a relationship to awareness that minimum efficiency standards exist. To be clear, gender, region, marital status, age and housing tenure (owner v. renter) do not exhibit significant relationships to support for minimum standards in either the bivariate or multivariate analysis.

The multivariate model including five variables – education, political leaning, payback attitude, perceived benefit and awareness – explains about 15% of the variance, which is high for attitudinal variables such as these.

APPLIANCE EFFICIENCY STANDARDS COMPARED TO FUEL ECONOMY STANDARDS

The public attitudes toward appliance efficiency standards are quite similar to their attitudes toward fuel economy standards, as shown in Table VIII-4. Respondents perceive the importance of reducing energy consumption as both an important personal benefit and a benefit to the nation. There is strong majority support for standards and the better informed the respondents are, the stronger their support.

TABLE VIII-4: COMPARISON OF ATTITUDES TOWARD APPLIANCE EFFICIENCY STANDARDS AND FUEL ECONOMY STANDARDS

	Appliances	Fuel Economy
Benefits/Concerns		
Overall benefit of Efficiency	78	79
Price	80	72
Greenhouse Gasses	66	57
Payback		
1-year	na	81
3-year	79	na
5-Year	78	72
10-year	60	na
Support for Standards		
General	71	na
27 to 35 mpg (current)	na	78
35 to 50 mpg by 2025	na	65
35 to 60 mpg by 2025	na	59
Awareness & Support for Standards		
Aware	74	72
Unaware	64	66

http://www.consumerfed.org/elements/www.consumerfed.org/file/Gas_Oil_Survey_Oil_Spill_PR_5_18_10.pdf, http://www.consumerfed.org/pdfs/MVFE-Survey-PR092810.pdf

OTHER SURVEYS

While CFA has focused it surveys on consumer opinions about energy consumption, energy efficiency, and energy efficiency standards, academic surveys explore the details of consumer understand and action with respect to energy efficiency. They document many of the market imperfections that were discussed earlier.

Table VIII-5 describes the key elements and finding of a dozen such studies. These provide support for the earlier discussion of market imperfections.

Key perception barriers and factors that slow adoption include risk aversion in general and risk of technology adoption in particular, social influence, identity effects, association of fuel economy with poor quality. Calculation is hampered by lack of knowledge, lack of skill at estimating costs, inattention to fuel costs and lifetime benefits and costs and the multi-attribute nature of the product. Financial issues matter, but economics can get in the way as a barrier including price sensitivity, adjustment costs, operating costs, capital rationing, hurdle rates, Culture, Gov't policy. Demographics are important, including income and gender. Policy orientation matters including political ideology, importance of energy issues, reduce dependence on foreign source, and environmental concerns.

TABLE VIII-5 : NON-CFA SURVEY EVIDENCE

Author, Date	Sardinaou, 2008	Qui, 2014	Lillemo, 2014	Park, 2014
Products	Industrial 19 sectors, 2848 Cos.	Appliances	Energy Savings Econometric	Smart Grid
Size		43	1000 Internet	300
Scope		U.S.	U.S.	Korea
Actors	Perception of Barrier	Consumers Policymakers	Internet users	Consumers
Aspect studies	Barriers Risk, Lack of knowledge Lack of skill, adjustment costs operating costs, Capital rationing, hurdle rates, Culture, Gov't policy	Adoption Risk aversion retards investment	Attitudes Procrastination slows adoption	Technology Perceived risk equals ease of use

Author	Axsen, 2013	Hicks 2014	Anderson, 2013	Ohler, 2014
Product	Workplace Vehicles	LED lighting	Auto safety	Energy Savings
Size	21	500 Craig's list	920	1100
Scope	UK	4 U.S. cities	Sweden	US Midwest
Actors	Users	Policy makers	Willingness to pay time frame	Motives, Cost/comfort
Aspect Studies	Attitudes	Policy Impact	WTP sensitive to time	Self-interest >
Key Findings	Social Influence Identity Price sensitive	Rebound extend >Intensify (7to1) Lifetime rarely Considered Education is important	1 year 70% > 1 month Combine tools private & public	concern for commons Holistic approach supply & demand

Author, date	Poortinga, 2003	Kurani & Turentine, 2004	Li, et al., 2009
Products	Energy-saving measures	Autos	Willingness to pay for R&D Expenditures
Method, period, size	National Poll 455 respondents	Interview 57 respondents	Contingent Valuation, National Referendum 2000+ respondents,
Scope	Netherlands	US	US
Actors	Consumers Market outcome	Consumer	Consumers
Aspect Studied	Preference for types	Attitudes	Attitudes
Key Findings	Technical > Behavior Shift in consumption Home > Transport Amount of energy saved is unimportant Environmental concern increases support	Consumers: do not pay much attention to fuel cost have ephemeral knowledge, are unable to estimate savings are overly optimistic about savings associate fuel economy with poor quality see vehicle as multi-attribute where fuel economy is not important use crude reference points: loan life, monthly cash flow	Willingness to pay: $137 per year > Increase R&D spending Reduce dependence on foreign Promote crop based fuels Demographics are important Income Gender Attitudes that matter Importance of energy issues Political ideology

Author, Date	Ozaki & Sevastyanova, 2011
Products	Hybrid Autos
Size	1200+
Scope	US
Actors	Consumers
Aspect studied	Attitude
Key Findings	Financial benefits are important Social norms influence consumer behavior Practical, experimental & affective values should be communicated

Sources:

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Sardianou, Eleni. "Barriers to Industrial Energy Efficiency Investment in Greece." *Journal of Cleaner Production* 16 (2008): 1416–1423.

The conclusion is clear: The public overwhelmingly believes that improving appliance energy efficiency is beneficial and strongly supports appliance efficiency standards. Those people who are aware of minimum efficiency standards set by the government support them. They are willing to pay more for the product knowing that that the additional cost will be made up over time in lower energy bills, and in fact, that they will ultimately save money. The public recognition of the benefits of efficiency and support for performance standards is consistent across products and across time.

PART IV. BENEFIT COST METHODOLOGY AND ISSUES

IX. BENEFIT-COST ANALYSIS, THE DISCOUNT RATE AND POCKETBOOK SAVINGS

CONTINUING CONTROVERSIES

In spite of the emergence of a general approach in the laws, executive branch guidance and litigation, and widespread public and bipartisan support, there remain important areas of debate that we examine in this section before we outline our specific approach. Needless to say, the analysis is deeply affected by the manner in which these key decisions are handled. Table IXI-1 identifies the issues we address in these comments in terms of their magnitude, measured as a percentage of the average base case benefits we estimate below.

TABLE IX-1: MAJOR POINTS OF DEBATE IN BENEFIT COST ANALYSIS

Type of Benefit	As a % of Base Case Net Benefits
Pocketbook Savings	60%-80%
Macroeconomic benefits	60%
Value of Environment/Public Health	33% - 50%
Discount Rate	40%
Tendency of costs to decline	30%
Rebound effect on pocketbook	10%

Opponents of regulation endeavor to narrow the benefits included, which makes it more difficult to justify standards. Supporters tend to argue against narrow quantification and for a broader qualitative approach. As suggested by the review of executive branch guidance, the response has been to make the benefit cost benefit analysis as rigorous as possible, while recognizing that qualitative considerations could drive decisions to support broader or more aggressive standards. Even without considering broader qualitative issues, there are a number of important issues within the quantitative benefit-cost frame that are extremely important (as shown in Table IX-1).

In our analysis, we follow the typical agency practice by including pocketbook savings and environmental benefits, discounted at the 3% rate, while subtracting the rebound effect. In this section we explain why pocketbook savings should be included valued at the 3% discount rate. Our analysis also identifies an alternative approach that recognizes the tendency of compliance costs to fall (discussed below in Section ??). We also argue that proper benefit cost analysis should include macroeconomic benefits and a value for the rebound effect that reflects its pocketbook increase in welfare (discussed in Section ??). We also present a scenario that includes only "pure externalities" (macroeconomic and environment, Section ??).

A 3% DISCOUNT RATE IS A "HIGH" ESTIMATE FOR CONSUMERS AND SOCIETY

No matter how lofty the goal of policy, the use of the public's money (whether for increased costs for energy consuming durables or to administer programs) to achieve a goal must not only deliver a benefit above the cost, it should also deliver a return at least as large as it could have if put to other uses. This is the opportunity cost of capital which is operationalized as the discount rate in the cost-benefit analysis.

Discounting over long periods of time has the effect of reducing the present value of dollars spent or saved later. However, when costs are incurred and benefits enjoyed over a long period, the benefit cost ratio is less affected than the total dollar amount. This is particularly true with standards that increase over time, since the marginal cost of later savings are assumed to increase in real terms. At year 15, a discounted dollar is worth $0.66 at 3%, while it is worth $0.38 at 7%. At year 30, which tends to be the time horizon for the analysis, it is worth $0.42 at 3% and $0.14 at 7%. Since later values have less impact, the average value over 30 years is close to the mid-point value, $0.63 at 3% and $0.32 at 7%.

We have frequently argued that the 3% discount rate is the correct discount rate from the consumer point of view. It is a good, perhaps somewhat high estimate of the opportunity cost of consumer capital. It is also one of the anchor points ordered by the Office of Management and Budget (OMB), making it available in all formal agency evaluations.[101]

In Table IX-2, we show a variety of estimates of the opportunity cost of consumer capital. Here we show current estimates for how much consumers earn on relatively low risk investments, and how much they pay to borrow money. We include borrowing as an alternative use of consumer credit. These capture the essence of the idea of the discount rate by proving metrics for the "alternative investments."

TABLE IX-2: OPPORTUNITY COST OF CONSUMER CAPITAL

Savings/ Investing	Bank Account		1
	5-year Interest rates	CD	2
	Home value	1996-2016	3.2
		2006-2016	-1.9
	Municipal Bonds	1-year	1
		2-year	1.2
		5-year	1.8
		10-year	2.4
		30-year	3.2
	Inflation Protected Treasury (TIPS)	5-year	0
		10-year	0.5
		20-year	0.7
		30-year	1
Borrowing	5-year Interest rates	New Car	2.4
		Used Car	2.7
	15-year fixed Refi	Home	2.9

Sources: Auto loans: Bankrate.com boot screen, Rate of return, homes, Stocks, Bonds: http://money.cnn.com/calculator/pf/home-rate-of-return/, Saving account: http://www.money-rates.com/savings.htm, 5-7ear CD http://www.interest.com/cd-rates/news/5-year-cd-rates/

It is clear that the consumer discount rate is in the range of 1-3%. While federal agencies are required to consider 3% and 7%, this data shows that the 3% figure is a far better (perhaps even high) proxy for the opportunity cost of consumer capital. Reflecting this analysis, we have always focused on the agency analyses based on the 3% discount rate.

The 3% discount rate is not only a somewhat high estimate of the consumer discount rate, it also serves as a somewhat high estimate of the social discount rate when intergenerational and incommensurable impacts are being analyzed, as OMB Circular A-4 noted.

> Some believe, however, that it is ethically impermissible to discount the utility of future generations. That is, government should treat all generations equally. Even under this approach, it would still be correct to discount future costs and consumption benefits generally (perhaps at a lower rate than for intragenerational analysis), due to the expectation that future generations will be wealthier and thus will value a marginal dollar of benefits or costs by less than those alive today. Therefore, it is appropriate to discount future benefits and costs relative to current benefits and costs, even if the welfare of future generations is not being discounted. Estimates of the appropriate discount rate appropriate in this case, from the 1990s, ranged from 1 to 3 percent per annum.[102]

Emissions from vehicles clearly have intergenerational impacts, most notably in their impact on climate change. Therefore, for us, 3% is the reasonable compromise for the central analysis of the discount rate. Since it is generally available in agency analysis, we use it. A range would be justified, but the agencies, which routinely report analyses with a 7% discount rate do not report (or conduct) analyses with a 1% discount rate. **Rather than bias the picture presented by showing one side of the range, we show only the center point, which is widely available.**

HIGH IMPLICIT, MARKET DISCOUNT RATES ARE MISLEADING

The discount rate is linked to a broader and more fundamental issue. Some, citing the fact that the market exhibits a high "implicit" discount rate for energy efficiency, argue that consumer pocketbook savings should not be counted at all. Opponents of regulation take the view that since there are choices in the marketplace, there can be no consumer utility gain from imposing standards. Consumers express their preferences and get what they want. We believe this is wrong on several counts.

In a sense, the discount rate is the centerpiece of the market fundamentalist objection to performance standards, but it is based on a view that ignores all the market imperfections that inflate the discount rate.[103] In other words, the claim boils down to the belief that whatever the implicit discount rate the market puts on a decision must be right. Therefore, regulators must be wrong to apply a lower discount rate to justify policy, which implies an economic loss from failing to adopt an energy saving technology to justify policy.

First, the outcome in the market is not simply the result of consumer preferences, it is the result of all the forces that affect the options presented to consumers and that weigh on and constrain their choices. Manufacturers determine a narrow range of choices to present consumers and seek to influence consumers, through advertising and incentives, to purchase the vehicles that manufacturers want to sell. Consumer are imperfect in their calculations and projections about fuel usage and prices. Market imperfections matter and cannot be dismissed.

Second, consumers do express a great deal of interest in and concern about energy usage.

Third, more importantly, as noted, once a well-crafted standard is adopted and implemented, it lowers the cost of driving.

Thus, we interpret the high market discount rate differently. It is the result of the many barriers and imperfections that retard investment in efficiency enhancing technology.[104] These barriers inhibit the adoption of efficiency enhancing technology, driving up the apparent discount rate.

There are several aspects of the high discount rate that deserve separate attention. The empirical evidence on consumer rationality in the literature paints a picture that bears little resemblance to the rational maximizer of neoclassical, market fundamentalist economics. We find a risk averse, procrastinating consumer, who responds to average, not marginal prices. The consumer is heavily influenced by social pressures, with discount rates that vary depending on a number of factors and has difficulty making calculations. To make matters more complicated, the consumer does not have control over key decisions. The decision of which energy consuming durable to purchase is made by someone else, like the landlord (i.e. the agency problem). Bundles of attributes are decided by producers in circumstances in which the consumer cannot disentangle attributes (the shrouded attributes problem.)

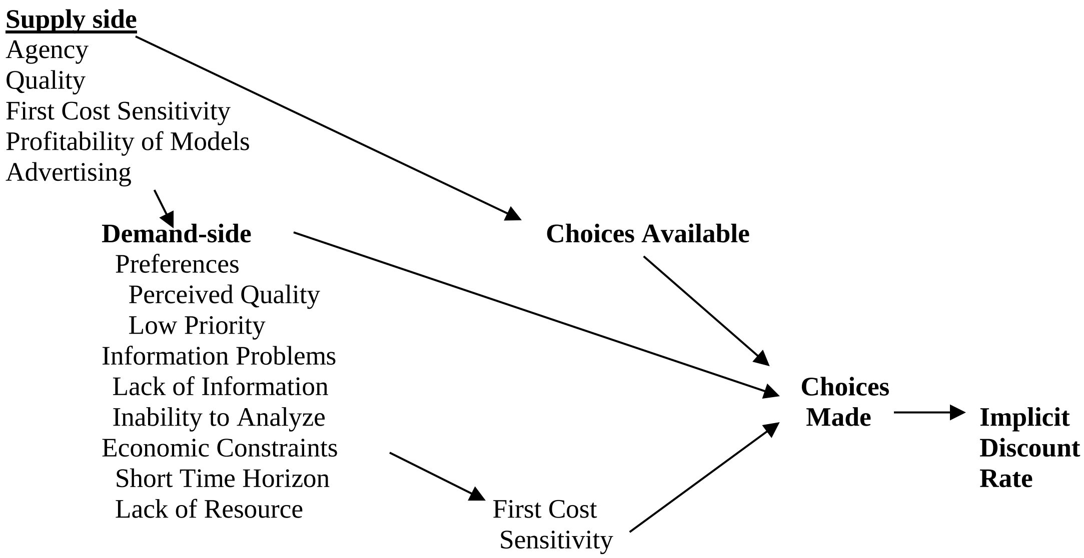
Consumers are influenced by advertising and my not perceive quality properly. The priorities afforded to any particular attribute are difficult to discern in a multi-attribute product. They lack the information necessary to make informed choices. The life cycle cost calculation is difficult, particularly when projections about future gasoline prices and vehicle use are necessary.

Even when they do consider efficiency investments, they may not find the more efficient vehicles to be available in the marketplace. Thus, we do not accept the claim that consumers are expressing irrational preferences for high returns on efficiency investments; irrational because they appear to be a return that is so much higher than they can get on other investments they routinely have available. Rather, we view the implicit discount rate as a reflection of the fact that the marketplace has offered an inadequate range of options to consumers who are ill-informed and unprepared to conduct the appropriate analysis and who lack the resources necessary to make the correct actions.

Firms suffer similar problems. We find organizational structure matters a great deal in routine bound, resource strapped organizations confronted with conflicting incentives and a great deal of uncertainty about market formation for new technologies. Knowledge and skill to implement new technologies is lacking and firms have little incentive to create it because of the difficulty of capturing the full value. Public policy efforts to address these problems have been weak and inconsistent. The supply-side does not escape these factors and it exhibits the added problem of powerful vested interests and institutional structures that are resistant, if not adverse to change.

The cars that are sold in the marketplace reflect not only what consumers want to but also, what automakers want to sell. Automakers spend millions on advertising and promotions to move the metal that makes the most profit for them. It is simply wrong to claim that all the advertising and marketing has no effect (see Figure IX-1).

FIGURE IX-1: AUTO MARKET IMPERFECTIONS CREATE THE HIGH IMPLICIT DISCOUNT RATE



Source: Comments and Technical Appendices of the Consumer Federation of America, Re: National Highway Traffic Safety Administration Notice of Proposed Rulemaking; Docket No. NHTSA 2008-0089, RIN 2127-AK29; Average Fuel Economy Standards, Passenger Cars and Light Trucks; Model Years 2011-2015, July 1, 2008.

Failing to recognize the imperfections on the supply-side leads NHTSA to an over reliance on automaker product plans. Thus, it is a much better representation of reality to say that the auto market undervalues fuel economy. The problem is not just the consumer. Indeed, the automakers may be a bigger part of the problem. If automakers are required to produce and sell more fuel-efficient vehicles, they will have to change their advertising and marketing focus. With the automaker resistance to more fuel-efficient vehicles dampened, the apparent market valuation of fuel economy will rise quickly. It is the automakers who have been at least as large a drag on fuel economy as consumers.

Auto makers prefer to sell certain models because they are more profitable. They prefer simple technologies that are less demanding to produce and maintain. They have a first cost bias, seeking to keep the sticker price low. They seek to influence the public to purchase the vehicles that best suit their interests.

On the supply-side there is an agency problem – a separation between the builder or purchaser of buildings and appliances and the user. Suppliers may not choose to manufacture or stock efficient vehicles if they are less profitable, hoping that advertising and showroom persuasion can point consumers in the direction the manufacturers want them to go.

The apparently grossly irrational discount rate reflects market imperfections and failures, not irrational consumers, a conclusion that has been clear in throughout the long history of the efficiency gap debate.

> The implicit discount rates calculated from consumer choices reflect not only individual time preferences but a whole collection of variables that may depress the ultimate level of investment. The calculated discount rate is affected by consumers' price expectations

> and their levels of certainty about these; the extent to which available information is imperfect, mistrusted, or ignored; the purchase of some equipment to quickly replace nonfunctioning equipment rather than to minimize life-cycle cost; the presence in the market of builders, landlords, and other purchasers who will not pay for the energy the equipment uses; the fact that consumers with limited capital do not always purchase what they would if they had more capital; differential marketing efforts for different products, and so forth. Recognizing such possibilities, some analysts say that the data reflect "market discount rates."[105]

This observation on the market discount rate, combined with the recognition that a 3% discount rate is a good estimate for the consumer discount rate, provides a realistic framework for understanding consumer discount rates and applying them in economic analyses. We applaud the agencies for arriving at this view and encourage them to affirm both in the final rule so that future rulemakings can be grounded on this solid basis.

There are two implications for NHTSA's analysis. First, CAFE standards correct market failures and therefore can result in economically beneficial outcomes (increases in sales). Second, CAFE standards address important supply-side market imperfections. They counter the tendency to want to produce low cost, energy inefficient vehicles that generate higher rates of profit. CAFE standards also give automakers an incentive to advertise and market more fuel-efficient vehicles. NHTSA's framework needs to fully reflect this alternative, more realistic view of the auto market.

CONSUMER PREFERENCES AND MARKET IMPERFECTIONS: WILLINGNESS TO PAY STUDIES MISS THE MAIN POINT

Willingness-to-pay studies that address the core issue in benefit-cost analysis – valuing benefits – have been prominent in the benefit-cost literature and extensively criticized for underestimating the value of public policies that correct market imperfections.[106] The willingness-to-pay observed in survey analysis and derived as implicit through econometric analysis reflect opinions and decisions offered or made by individuals in the context of all the imperfections that afflict the market. They reflect the market structure the policy is intended to correct more than the "true" value of correction, as shown in TableIXI-3. The problems with willingness-to-pay analysis are not limited to survey (contingent valuation) based studies. They also apply to econometric studies that base their estimates on econometrically identified implicit willingness-to-pay.

A recent study from Resources for the Future provides a lens to identify some of the key concerns.[107] It advances the art significantly, but leaves many of the underlying issues unaddressed. RFF finds a substantial "efficiency gap" based on a hedonic analysis that puts the willingness to pay at just $0.54 on the $1.00. It goes on to argue that the welfare gains of increased fuel economy created by increasing fuel economy standards is offset by lost value of performance.

The argument is that, even though the pocketbooks of consumers have more money as a result of the standards, they would have preferred to have the increased performance (horsepower/weight). In a sense this is an encouraging result, since all of the public benefits are "free." The authors recognize that this analysis does not take into account the social value of reduced fuel consumption in terms of improved national security, pollution reduction, and climate change. The welfare value of these benefits could be significant. In other words, while consumers are no worse off in their total utility, society is much better off because it values the environmental, public health and other external benefits of the standards.

TABLE IX-3: QUESTIONS ABOUT THE CONCEPT OF WILLINGNESS-TO-PAY

Conceptual Problems	Methodological Problems
Individual Lack of (sufficient & appropriate) information Willingness v. Capacity to pay Inherent discrimination (value) Risk aversion Marginal v. average Respondent Characteristics SES Experience v. Hypothetical Market Structure Information asymmetries Availability in market Aggregation of preferences Lack of competition Externalities Positive effects Importance of public (social) value	Internal and External validity Representativeness Variability Generalization Surveys Questions Order & presentation of Open v. Closed Provision of information Response sets Choice Set Emphasis on costs, not benefits

Sources: Benjamin Leard, et al., 2017, *How Much Do consumers Value Fuel Economy and Performance? Evidence from Technology Adoption,* Brookings Institution, June; David Green, et. al., 2017, *Consumer Willingness to Pay for Vehicle Characteristics: What Do We Know?,* March; Mark Sagoff, What does willingness to pay measure/" University of Maryland; Frank Ackerman,, 2008 *Critique of Cost-Benefit Analysis, and Alternative Approaches to Decision-Making,* Report toe Friends of the Earth Engaln,, Wales and Northern Ireland; , Joaquin F. Mould Quevedo, et al., "The Willingness-to-Pay Concept in Question," Rev. Sauide Publica: 43(2), for health care.

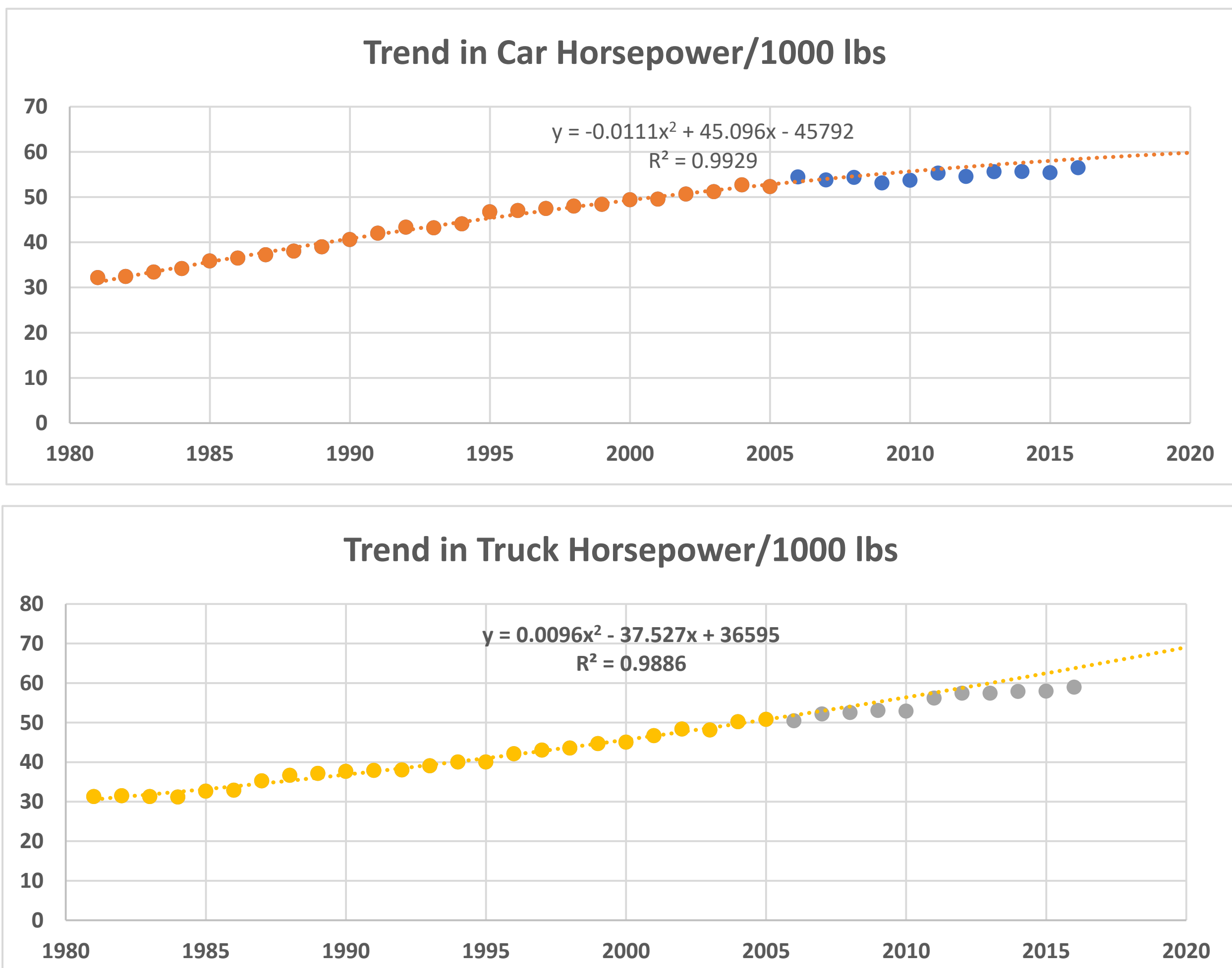
The analysis also does not take into account the welfare value of the good and services consumers purchase with the increased disposable income that fuel economy standards create. Since they cannot spend their money on more performance and they have more money in their pockets, they spend it on other things. Consumers did not buy nothing with the extra disposable income they could have spent on performance, the multiplier still operates.

There is also a sense in which the analysis conceptually begs the question. The analysis ignores the fundamental problem – it assumes no market failure. The preferences reflect the market imperfections, the restricted choices the automakers choose to offer and the distorted choices consumers make, given the limitations on their time and ability to search and calculate. The specific market imperfections not considered include induced innovation, insufficient incentives for innovation, imperfect competition, the interaction between new and used vehicles, and transitional dynamics.[108] As is typical of these studies, the supply-side does not play a key role in determining the outcomes observed in the marketplace.[109]

Of equal, if not greater importance are empirical and measurement questions. The study appears to derive an implicit cost per MPG of about $300, engineering estimates are less than $100. Although it has tried to capture the impact of other "quality" factors, it has failed. Given the value of pocketbook savings in the study, adjusting the cost of fuel economy would double it, meaning that the performance preference is half the fuel economy value. Of course, consumer might be overestimating the cost of fuel economy, which would be a market imperfection that the standards could correct.

The study may have overestimated the value placed on performance. The authors note that automaker behavior is inconsistent with their theoretical approach, in that under their assumptions the automakers should not trade off fuel economy for performance, absent the standard[110]. There is clear evidence that they did. A quick look at trends in fuel economy and horsepower suggests that attitudes may have changed (see Figure IX-2). Declining marginal value of going faster at 0-60 mph and a shift in attitudes highlights one of the great weaknesses of and questions about willingness to pay analysis – whose willingness and under what circumstances.

FIGURE IX-2: TRENDS IN PERFORMANCE INCREASES



Source: EPA, 2016, Trends Report, 2016, pp. 26-27, Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2016, November.,

CONCLUSION

It is difficult to overestimate the devastating impact that behavioral economics has had on the belief that market outcomes can be accepted as the result of utility maximizing behaviors of consumer and producers. As shown in Appendix C, there are now fifteen broad constructs and well over 100 cognitive ones that challenge this conclusion. Over 100 studies of discount rates that reflect immense variation, leading one introductory text to conclude that "the anomalies in the DUM (Discounted Utility Model) should not be regarded as mistakes or errors in judgement. Instead they imply that the model lacks both descriptive and normative validity."[111]

X. DECLINING COST OF COMPLIANCE AND TECHNOLOGICAL FEASIBILITY

Market imperfections and the availability of policy responses to reduce them are the key background conditions that justify policy action. The availability of energy/pollution reducing technologies at a cost that makes them attractive (less than the cost of energy use and the harm it imposes) is the immediate trigger for policy. Interestingly, the starting point of the analysis of one of the most anti-regulation groups is not only the agency estimate of the costs of standards,[112] but they also have used the costs estimated by the agencies in their technical and regulatory analyses, with a 3% discount rate. We believe this is the appropriate basis for the analysis, but it is only the starting point.

The costs presented by the agencies are an appropriate starting point because the agencies tend to spend an immense amount of time analyzing these costs, including technology and maintenance. They do not just accept the high costs suggested by industry or the low costs put forward by efficiency advocates. They do independent analysis of costs, frequently engaging in engineering (tear down) studies and reviewing the technical literature, as well as numerous reports from the National Research Council of the National Academy of Sciences.[113] Although, as discussed below, the regulatory agencies still tend to overestimate costs because they do not fully reflect the dynamic, cost-reducing effects of market forces and market-driven innovation, their cost estimates are the best place to start and anchor the analysis.

THE TENDENCY FOR COST TO DECLINE THROUGH THE IMPLEMENTATION PHASE

In this section, we argue that the strong evidence of overestimation of cost should be recognized in the cost benefit analysis. We recognize that the agencies run multiple scenarios to test the sensitivity of the results to assumptions and frequently apply Monte Carlo statistical tests to assess the likelihood of outcomes. But with strong historical evidence and well-documented economic processes that explain a persistent and systematic pattern of declining costs, the pattern demands more than just Monte Carlo sensitivity treatment. The outcome is more likely than a random disturbance.

As noted above, policies to reduce the efficiency gap, like performance standards, will systematically improve market performance.[114] By overcoming barriers and imperfections, well-designed performance standards will stimulate investment and innovation in new energy efficient technologies. A natural outcome of this process will be to lower not only the level of energy consumption, but also the cost of doing so. The efficiency gap literature addresses the question of how "learning curves" will affect the costs of new technologies as they are deployed. There are processes in which producers learn by experience to lower the cost of new technologies dramatically. The strong focus on the supply-side and innovation underlies the observation that well-designed, aggressive policies to stimulate innovation and direct technological change can speed the transition and lower the ultimate costs.

In the efficiency gap area, the issue of declining costs driven by technological change has received significant examination as a natural extension of the effort to project technology costs. One of the strongest findings of the empirical literature is to support the theoretical expectation that technological innovation will drive down the cost of improving energy efficiency and reducing greenhouse gas emissions. A comprehensive review of *Technology Learning in the*

Energy Sector found that energy efficiency technologies are particularly sensitive to learning effects and policy.

> For demand-side technologies the experience curve approach also seems applicable to measure autonomous energy efficiency improvements. Interestingly, we do find strong indications that in this case, policy can bend down (at least temporarily) the experience curve and increase the speed with which energy efficiency improvements are implemented. 1. For the past several decades, the retail price of appliances has been steadily falling while efficiency has been increasing. 2. Past retail price predictions made by the DOE analysis of efficiency standards, assuming constant price over time, have tended to overestimate retail prices. 3. The average incremental price to increase appliance efficiency has declined over time. DOT technical support documents have typically overestimated the incremental price and retail prices. 4. Changes in retail markups and economies of scale in production of more efficient appliances may have contributed to declines in prices of efficiency appliances [115]

The findings on learning curve analysis are extremely important because decisions to implement policies that promote efficiency and induce technological change are subject to intensive, *ex ante* cost-benefit analysis. Analyses that fail to take into account the powerful process of technological innovation that lowers costs will overestimate costs, undervalue innovation, and perpetuate the market failure. Detailed analysis of major consumer durables including vehicles, air conditioners, and refrigerators find that technological change and pricing strategies of producers lowers the cost of increasing efficiency in response to standards.

> The more specific point here is that, while regulatory compliance costs have been substantial and influential, they have not played a significant role in the pricing of vehicles. Vehicle prices have steadily increased over time, far exceeding the costs of emission control and safety equipment…
>
> These cost increases, to the extent they are substantial, are dealt with in the short run by a variety of pricing and marketing strategies and by allocating R&D costs further into the future and over more future models. As with any new products or technologies, with time and experience, engineers learn to design the products to use less space, operate more efficiently, use less material, and facilitate manufacturing. They also learn to build factories in ways that reduce manufacturing costs. This has been the experience with semiconductors, computers, cellphones, DVD players, microwave ovens – and also catalytic converters.
>
> Experience curves, sometimes referred to as “learning curves,” are a useful analytical construct for understanding the magnitude of these improvements. Analysts have long observed that products show a consistent pattern of cost reduction with increases in cumulative production volume. …
>
> In the case of emissions, learning improvements have been so substantial, as indicated earlier, that emission control costs per vehicle (for gasoline internal combustion engine vehicles) are no greater, and possibly less, than they were in the early 1980s, when emission reductions were far less.[116]

A comparative study of European, Japanese and American auto makers prepared in 2006, before the recent reform and reinvigoration of the U.S. fuel economy program, found that standards had an effect on technological innovation. The U.S. had lagged because of the long period of dormancy of the U.S. standards program and the fact that the U.S. automakers did not compete in the world market for sales, (i.e. it did not export vehicles to Europe or Japan).

> The European car industry is highly dynamic and innovative. Its R&D expenditures are well above average in Europe's manufacturing sector. Among the most important drivers of innovation are consumer demand (for comfort, safety and fuel economy), international competition, and environmental objectives and regulations… One element of success of technology forcing is to build on one or more existing technologies that have not yet been proven (commercially) in the area of application. For improvements in the fuel economy of cars, many technological options are potentially available… With respect to innovation, the EU and Japanese policy instruments perform better than the US CAFE program. This is not surprising, given the large gap between the stringency of fuel-efficiency standards in Europe and Japan on the one hand and the US on the other….
>
> One of the reasons for the persistence of this difference is that the US is not a significant exporter of cars to the European and Japanese markets.[117]

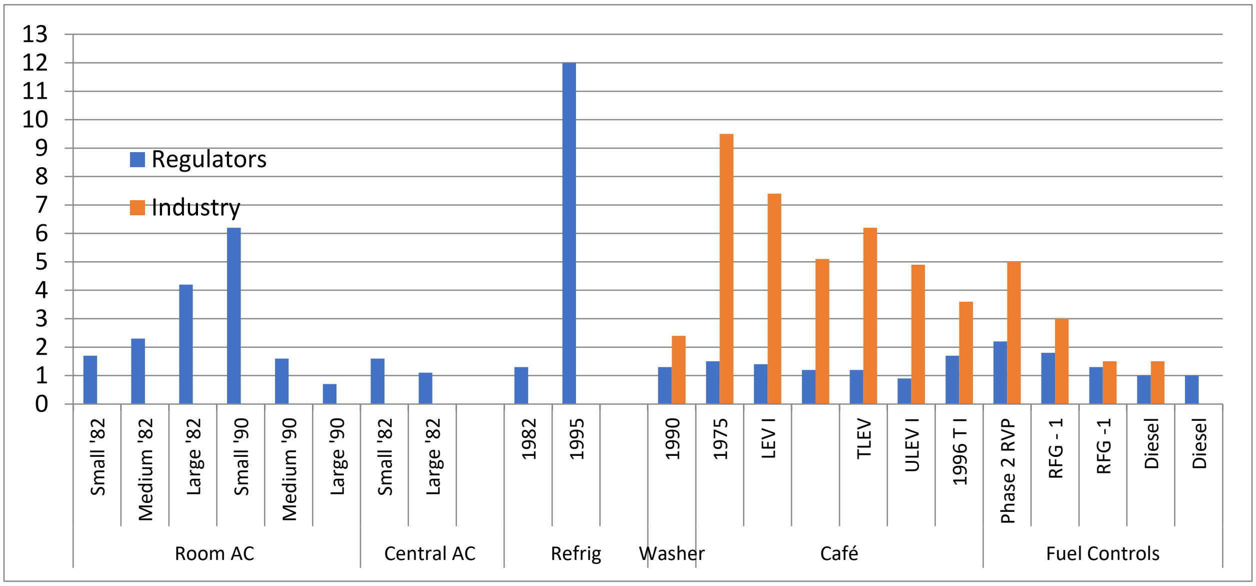
Figure X-1 shows the systematic overestimation by regulators of the cost of efficiency improving regulations in consumer durables. The cost for household appliance regulations was overestimated by over 100% and the costs for automobiles were overestimated by about 50 percent. The estimates of the cost from industry were even father off the mark, running three times higher for auto technologies.[118] Broader studies of the cost of environmental regulation find a similar phenomenon, with overestimates of cost outnumbering underestimates by almost five to one with industry numbers being a "serious overestimate."[119]

While the very high estimates of compliance costs offered by the auto manufacturers can be readily dismissed as self-interested political efforts to avoid regulation, they can also be seen as a worst-case scenario in which the manufacturers take the most irrational approach to compliance under an assumption that there is no possibility of technological progress or strategic response. A simulation of the cost of the 2008 increase in fuel economy standards found that a technologically static response was 3 times costlier than a technologically astute response.

> We perform counterfactual simulation of firms' pricing and medium-run design responses to the reformed CAFE regulation. Results indicate that compliant firms rely primarily on changes to vehicle design to meet the CAFE standards, with a smaller contribution coming from pricing strategies designed to shift demand toward more fuel-efficient vehicles... Importantly, estimated costs to producers of complying with the regulation are three times larger when we fail to account for tradeoffs between fuel economy and other vehicle attributes.[120]

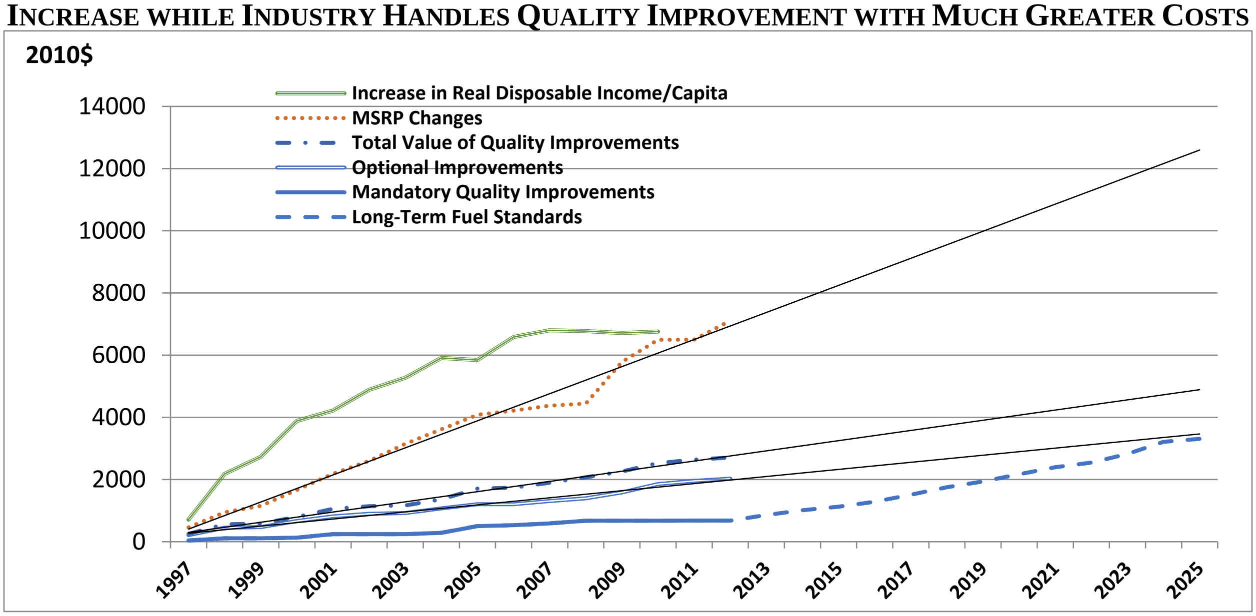
As shown in Figure X-2, in comments on the light duty truck and auto standards, CFA presented a historical analysis of cost increases associated with mandates that reflects the ability and strategy of producers to keep cost increases within the broad limits of industry practices.

FIGURE X-1: THE PROJECTED COSTS OF REGULATION EXCEED THE ACTUAL COSTS: RATIO OF ESTIMATED COST TO ACTUAL COST BY SOURCE



Sources: Winston Harrington, Richard Morgenstern and Peter Nelson, "On the Accuracy of Regulatory Cost Estimates," *Journal of Policy Analysis and Management* 19(2) 2000, *How Accurate Are Regulatory Costs Estimates?,* Resources for the Future, March 5, 2010; ; Winston Harrington, *Grading Estimates of the Benefits and Costs of Federal Regulation: A Review of Reviews*, Resources for the Future, 2006; Roland Hwang and Matt Peak, *Innovation and Regulation in the Automobile Sector: Lessons Learned and Implications for California's CO_2 Standard*, Natural Resources Defense Council, April 2006; Larry Dale, et al., "Retrospective Evaluation of Appliance Price Trends," *Energy Policy* 37, 2009.

FIGURE X-2: GRADUAL FUEL ECONOMY IMPROVEMENTS CAUSE SLOW AND STEADY PRICE INCREASE WHILE INDUSTRY HANDLES QUALITY IMPROVEMENT WITH MUCH GREATER COSTS



Source: Bureau of Labor Statistics, Quality Changes for Motor Vehicles, various years; Consumer Price Index data base; Sources: Office of Regulatory Analysis and Evaluation, *Regulatory Impact Analysis, Corporate Average Fuel Economy,* 2011, 2012-2016, 2017-2025.

Many of the factors that are cited as causes of the declining cost, such as learning, standardization and homogenization of components, competitive outsourcing of components, and technological improvements in broader socio-economic environment) represent market factors or externalities that are difficult for individual firms to control or profit from (appropriate), so they constitute externalities that policy must address, if the externalities are to be internalized in transactions. At the same time, performance standards simply shift the baseline of competition to a higher level of energy efficiency. To the extent that markets are competitive, normal competitive processes drive down the costs of innovation such as competition driven technological change, declining markups, and economies of scale.

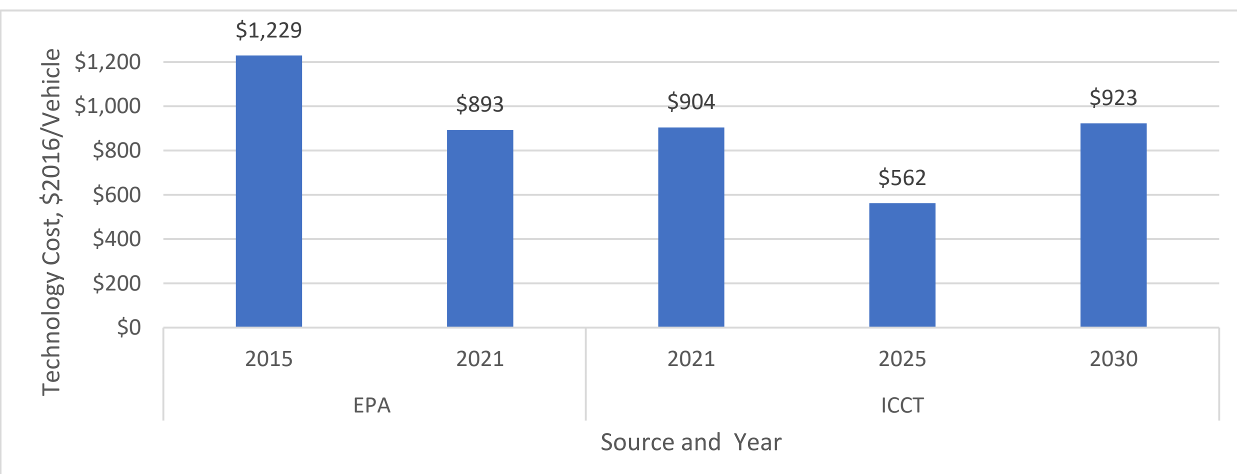
Even more fundamentally, there is evidence that the decision to increase energy efficiency can stimulate broader innovation and productivity growth.

> The case-study review suggests that energy efficiency investments can provide a significant boost to overall productivity within industry. If this relationship holds, the description of energy-efficient technologies as opportunities for larger productivity improvements has significant implications for conventional economic assessments... … This examination shows that including productivity benefits explicitly in the modeling parameters would double the cost-effective potential for energy efficiency improvement, compared to an analysis excluding those benefits.[121]

THE NATIONAL PROGRAM

EPA's analysis of the National Program demonstrates that this process is continuing to operate with respect to fuel economy standards, as shown in Figure X-3.

FIGURE X-3: COST OF EFFICIENCY TECHNOLOGY CONTINUES TO DECLINE



Sources: Environmental Protection Agency and National Highway Traffic Safety Administration, *2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards; Final Rule*, Federal Register, 77: 199, October 15, 2012, Table I-128. Environmental Protection Agency, *Final Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Emission Standards under the Midterm Evaluation,* January 2017, Table ES-1. International Council on Clean Transportation, *Efficiency Technology and Cost Assessment for U.S. 2025-2030 Light-Duty Vehicles,* March 2017, Table 2.

EPA found that a technology that had not even been considered is likely to have a substantial penetration, driving costs down by over 25%. Looking forward, a recent study from the

International Council on Clean Transportation projects an additional 25% decline in the cost of compliance. This is consistent with the broad pattern of earlier research.

Explanations for the Overestimation of Costs

There may be several factors, beyond an upward bias in the original estimate and learning in the implementation that produce this result, including pricing and marketing strategies.[122]

These findings of declining cost are not merely descriptive. Several analyses have introduced controls for quality and underlying trends using regression techniques. The findings are affirmed in these more sophisticated analyses. With such strong evidence of costs far below predictions by regulators who undertake engineering analysis, many authors have sought to identify the processes that account for this systematic phenomenon. For both vehicles and appliances, a long list of demand-side and supply-side factors that could easily combine to produce the result has been compiled.

On the supply-side, a detailed study of dozens of specific energy efficiency improvements pointed to technological innovation.[123] A comprehensive review of *Technology Learning in the Energy Sector* found that energy efficiency technologies are particularly sensitive to learning effects and policy.[124] This was attributed to increases in R&D expenditures, information gathering, learning-by-doing and spillover effects. Increases in competition and competitiveness also play a role on the supply side. As noted above, a comparative study of European, Japanese and American automakers prepared in 2006, before the recent reform and reinvigoration of the U.S. fuel economy program, found that standards had an effect on technological innovation. The U.S. had lagged because of the long period of dormancy of the U.S. standards program and the fact that the U.S. automakers did not compete in the world market for sales, (i.e. it did not export vehicles to Europe or Japan).

While the supply-side drivers of declining costs are primarily undertaken by manufacturers, a number of demand side effects are also cited, which are more the direct result of policy. Standards create market assurance, reducing the risk that cheap, inefficient products will undercut efforts to raise efficiency. Economies of scale lead to accelerated penetration, which stimulates and accelerates learning-by-doing. The effects of demand stimulus through macroeconomic stimulus also grows demand and accelerates innovation. Experiencing increasing economies of scale and declining costs in an environment that is more competitive, leads to changes in marketing behaviors.

The Cost of Increasing Fuel Economy

Estimating the cost of increasing fuel economy has been a matter of great debate for decades. As noted above, empirical analyses that look at actual costs show that regulators overestimate the cost by a factor of two and automakers overestimate it by much more than that.

David Greene, one of the leading experts on fuel economy recently conducted a review of the literature from which he concluded that an estimate of 27% of increased auto costs, or about $150 for every mile per gallon improvement was too high. He gave two reasons for this.[125] First, backward looking analysis of cost increases that included used vehicles (as his analysis did), were double counting the cost of increasing fuel economy because the sellers of vehicles were capturing a significant part of the capitalized value of better fuel economy equal to about 20% of the estimated cost of efficiency) in their sales price. This factor alone would lower the estimate to 21.6% of the increase in price or about $120 for each 1-mile improvement in the MPG. Second, real world experience showed that there was a learning process in which costs fell as automakers gained more experience with increasing fuel economy. He suggested that 2% per year was a reasonable estimate. Over the redesign cycle of vehicles (e.g. five years) this learning rate would lower the cost by about 10%. Thus, one might argue that the appropriate numbers would be about 20% per year and $108 dollars per MPG, as shown in Table X-1.

There is a third factor that is implicit in Greene's analysis. The distribution of the cost of vehicles is skewed. The much more expensive vehicles purchased by upper income households ae likely to include a larger amount of costs incurred to upscale the vehicles, rather than for fuel economy. In a subsequent analysis Greene estimated the cost of improving fuel economy directly with an econometric model that corroborated the above concerns. The simple adjustment to a constant 20% of total cost moves the estimate much closer to the empirical evidence offered by Greene, which suggests that costs are about two thirds of what was found in the literature review—about 18% or $99/MPG.

TABLE X-1: HISTORICAL AND ENGINEERING ESTIMATES OF THE COST OF INCREASING MILEAGE

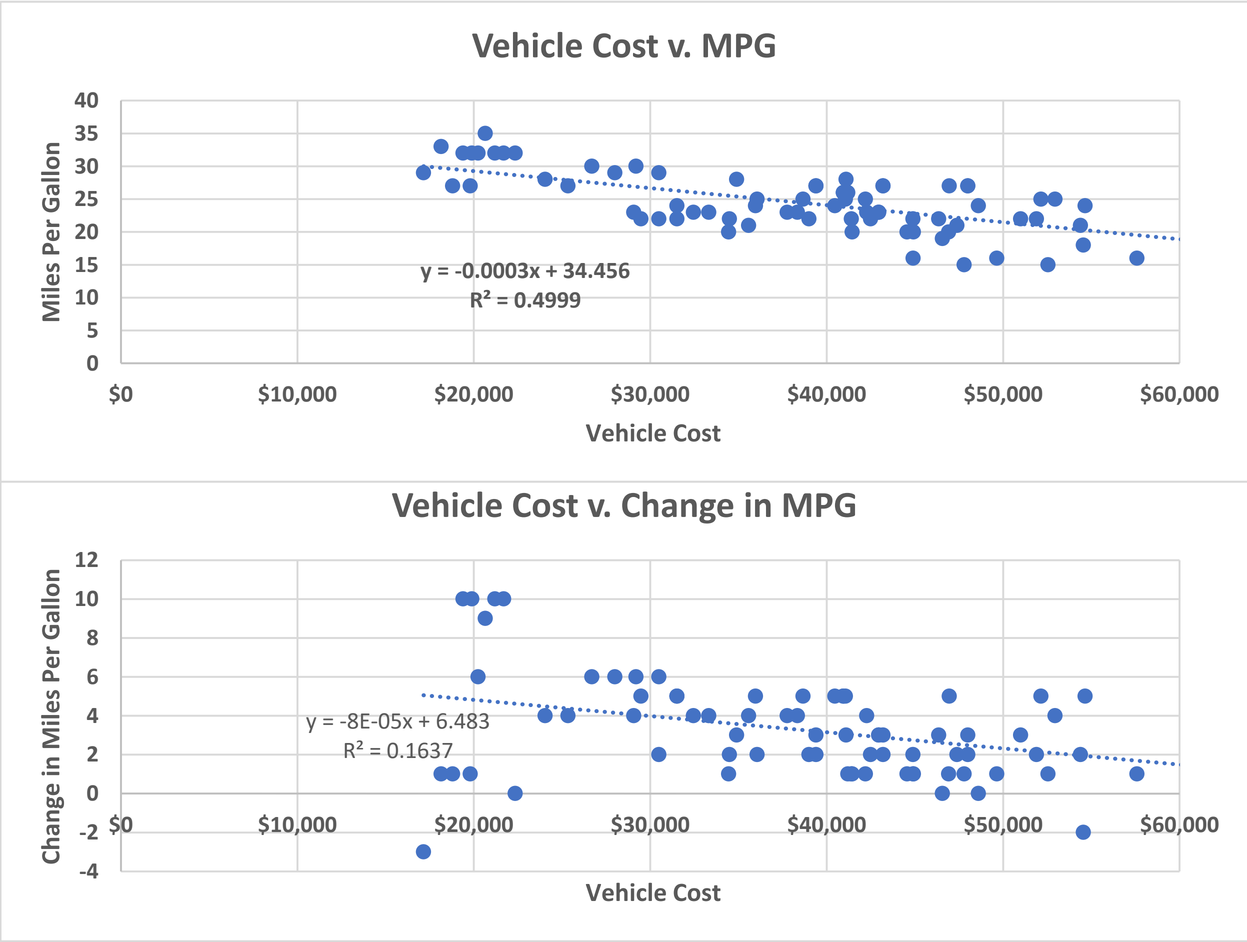
	Greene Literature Review	Simple Adjustment Approach	Greene Direct	EPA Final 2017- 2025	ICCT Estimate for 2025-2030 4.5%/year
Annual Cost	$213	na	$141	$97	$110
% of Total Cost Increase	27%	20%	18%	na	na
$/MPG	$150	$108	$99	$97	$86

Sources: David Greene and Jilleah G. Welch, *The Impact of Increased Fuel Economy for Light-Duty Vehicles on the Distribution of Income in the United States*, Oak Ridge National Laboratory and the Energy Foundation, September 2016; David Greene and Jilleah G. Welch, *The Impact of Increased Fuel Economy for Light-Duty Vehicles on the Distribution of Income in the United States*: *A Retrospective and Prospective Analysis* Oak Ridge National Laboratory and the Energy Foundation, March 2017; Environmental Protection Agency and National Highway Traffic Safety Administration, *2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards; Final Rule*, Federal Register, 77: 199, October 15, 2012, Table I-128. Environmental Protection Agency, *Final Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Emission Standards under the Midterm Evaluation*, January 2017, Table ES-1. International Council on Clean Transportation, *Efficiency Technology and Cost Assessment for U.S. 2025-2030 Light-Duty Vehicles*, March 1017, Table 2.

EPA's analysis of the cost of the National Program currently yields an estimate in fuel savings that is similar, $97/MPG. This estimate reflects considerable technological progress over the early years of the National Program, which is consistent with the historical pattern. A recent study by the ICCT offers an estimate of going forward costs of improvement close to the rate of the national program (national program = 3.3%, ICCT = 4% per year). The ICCT study also includes continuing technological progress.

Moreover, our emissions/fuel economy data on new models since the National Program supports the key problem with using a simple percentage of the total cost of the vehicle to approximate the cost of improving fuel economy, as shown in Figure X-4. There is a strong, negative correlation (r = -.7) between the cost of a vehicle and the mileage and a moderate, negative correlation (r= -.4) between the cost of the vehicle and the change in mileage. A fixed percentage makes no sense. In light of this analysis, we believe a cautious estimate of the cost of fuel economy improvements is $100/MPG improvement.

FIGURE X-4: VEHICLE COST AND MILEAGE



Source: Section XVI and Appendix D.

TECHNICAL FEASIBILITY OF THE STANDARDS

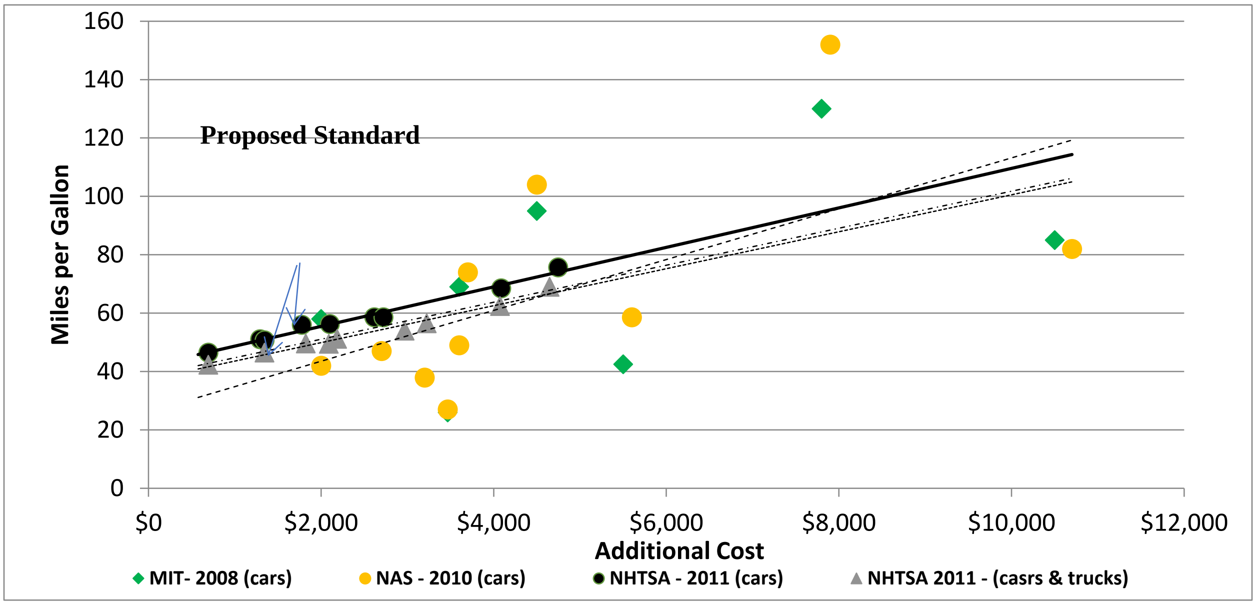
The clear pattern of declining costs links directly to and central issue in the writing of standards – the technical feasibility of achieving them. The ability of automakers to comply with the standards at lower costs than anticipated suggests that technologies were readily available. There is direct evidence that supports this conclusion, especially when the level of standards chosen is taken into account.

Technology Cost Curves

As noted, the agencies do independent analysis of technology availability and cost, frequently engaging in engineering (tear down) studies and reviewing the technical literature, as well as numerous reports from the National Research Council of the National Academy of Sciences and other independent sources. Figure X-5 locates the agency analysis in the context of the general knowledge about technology costs. The upper graph in Figure X-5 shows the cost curves for light duty vehicles. The agency costs curves are consistent with the level of cost estimated by others with similar levels of fuel savings. The Figure shows that the proposed standards are moderate from the point of view of a number of studies.

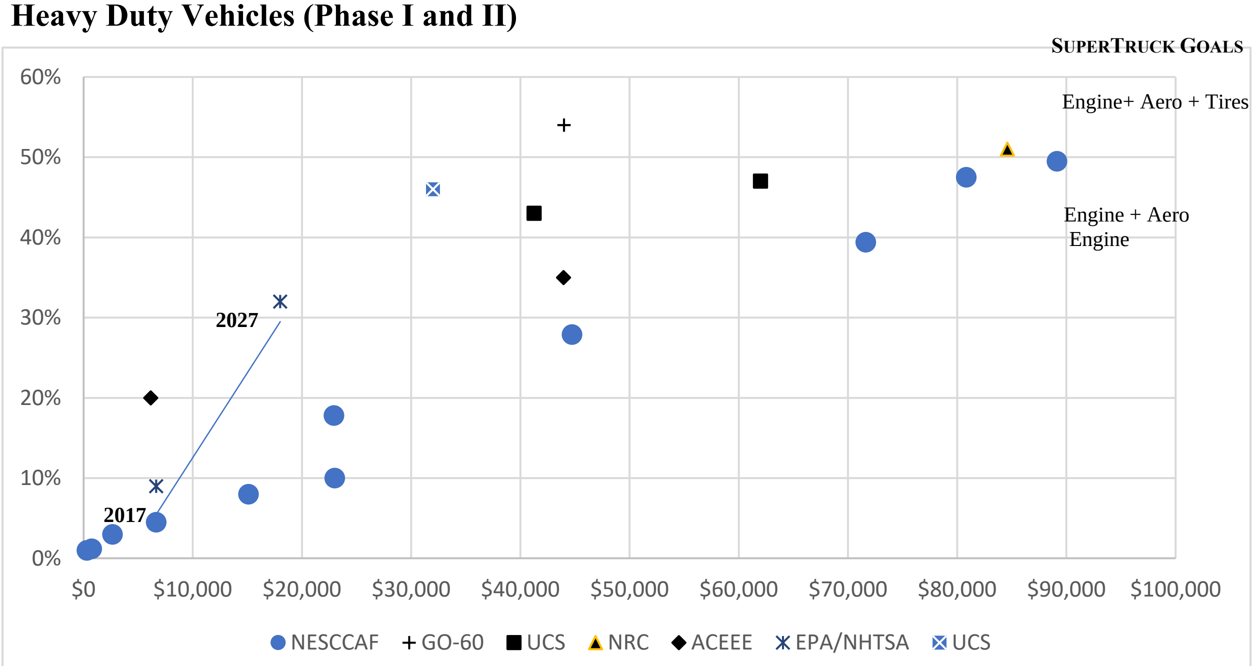
FIGURE X-5: TECHNOLOGY COST CURVES

Light Duty Vehicles



Sources: MIT, 2008; Laboratory of Energy and the Environment, *On the Road in 2035: Reducing Transportation's Petroleum Consumption and GHG Emissions,* Cambridge: July, 2008), Tables 7 and 8; NAS -2010, National Research Council of the National Academy of Science, America's Energy Future (Washington, D.C.: 2009), Tables 4.3, 4.4; NHTSA-EPA 2011;Office of Regulatory Analysis and Evaluation National Center for Statistics and Analysis, *Preliminary Regulatory Impact Analysis, Corporate Average Fuel Economy for MY 2017-MY 2025 , Passenger Cars and Light Trucks,* November 2011, Table 2 and Tables 3, 5.

Heavy Duty Vehicles (Phase I and II)



Sources: See Figure IV-3; EPA/NHTSA, PHASE II NOPR, Table X-1; EPA/NHTSA, PHASE I NOPR, Tables I-10, III-6; SuperTruck Goals from Nic Lutsey, "Will the U.S. Truck Standards Bring "SuperTrucks" to the Market?", ICCT.org, blog; Dave Cooke, Engines for Change: From Cell Phones to Sodas, How New Truck Standards Can Improve the Way America Ships Good, Union of Concerned Scientists, March 2015.

The lower graph in Figure X-5 shows the cost curves for tractor trailer technology. Tractor trailers are the single largest category of work trucks by far. It plots the Phase I and Phase II standards energy savings and costs in the same axes as the third-party studies. The graph highlights the anomaly. To make the cost curves comparable, we have included both Phase I and Phase II and have stated all costs in 2009$, which would be equivalent to the third-party analyses. Again, it is clear that the agencies have used cost estimates that are consistent with the broader literature. This Figure also puts a recent analysis by the ICCT in perspective. Responding to some claims by members of the industry that the proposed standards exceed even the super truck projects, the ICCT analysis shows that the super combining all the elements of the super truck program (engine, aerodynamics and tires), the improvement in fuel economy would be 2.4 times larger. They do not give costs, however. Moreover, that includes every truck maxing out on each technology, not something regulatory agencies generally require.

Choosing Standards

After establishing a technology cost curve, the agencies set the standard. Second, there are much higher levels of fuel savings possible, at higher costs. The proposed standards are in the middle of the pack at the lower end of the range. Figure X-6 presents the full range of cases and scenarios considered by the agencies. It plots the costs (on the x-axis) and the benefits (on the y-axis) for the eight different target levels considered with each target level evaluated at discount rates of 3% and 7%. It also shows the results of the sensitivity analyses that were conducted at the 3% discount rate. In all, there are 28 cases/scenarios shown. The Figure also includes a break-even line. If a case/scenario falls above the line, the benefits exceed the costs.

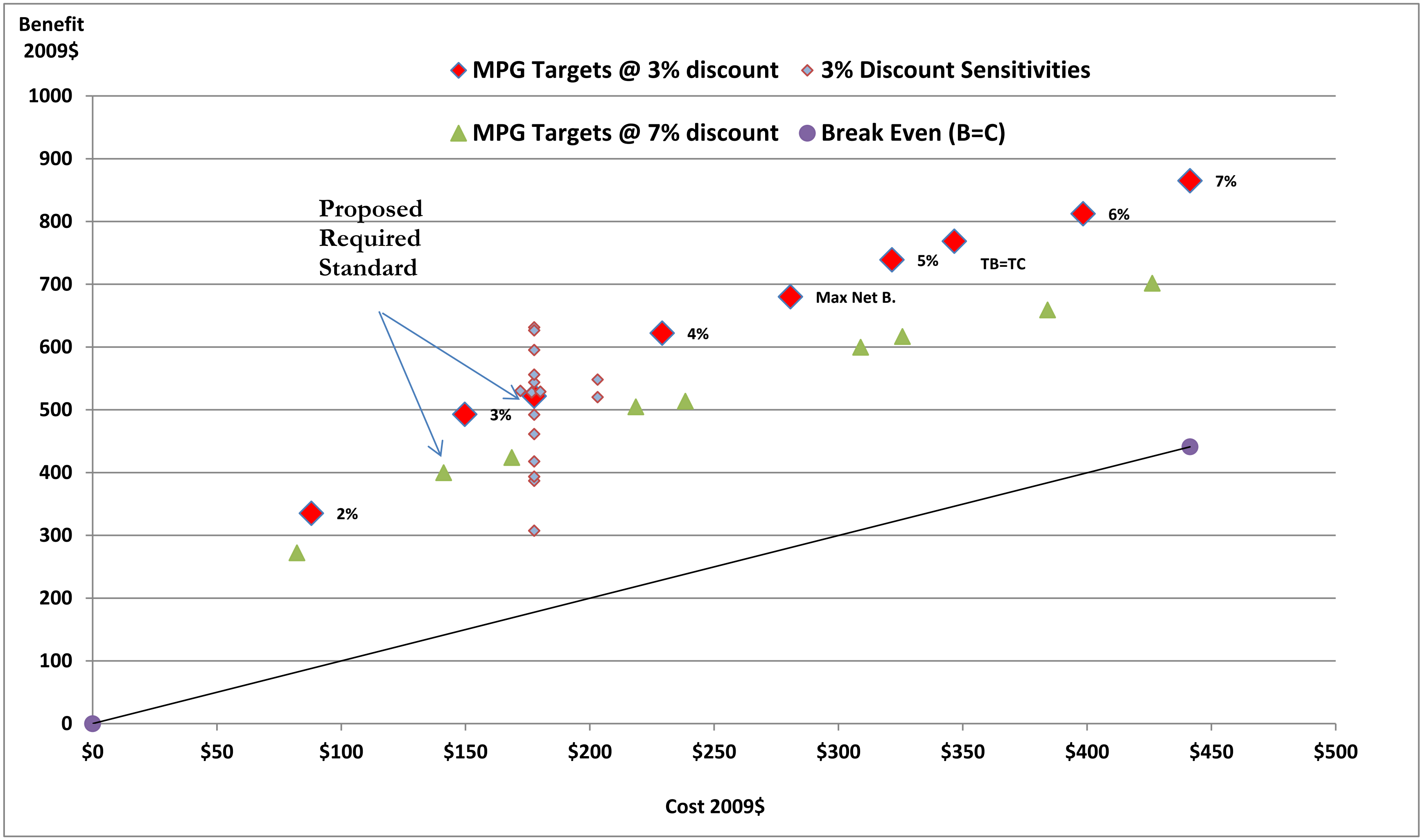
- In every sensitivity analysis conducted by the agencies, no matter how extreme the assumptions, the benefits exceed the costs.

The exhibit makes it clear that the benefits are likely to exceed the costs by a wide margin. Even under the most extreme assumption – i.e. that consumer pocketbook savings are only one-quarter of the base case calculation, the benefits are almost twice as large as the costs at the 3% discount rate.

The agencies have presented over two dozen cases and scenarios to assess the level of confidence that policy makers can have in the conclusion of the base case cost benefit analysis. In traditional agency fashion, they present a Monte Carlo simulation of expected outcomes under the full array of alternative assumptions. They conclude that there is a high probability that the outcome of the policy will be positive. The probability that net benefits will exceed zero between now and the mid-term review, is 95 percent or more for cars and at least 99 percent for trucks.

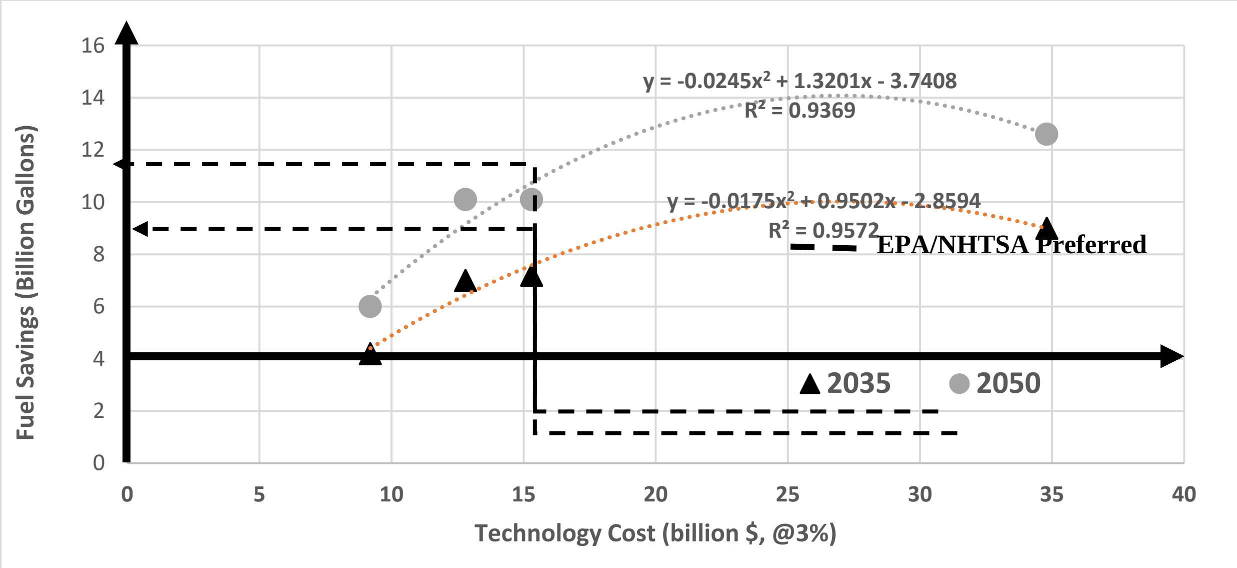
Figure X-7 shows the cost curves implicit in the analysis. If one accepts their cost curves, EPA/NHTSA have done a pretty good job. They have chosen to set the standard at the point where the marginal benefits start to decline (the inflection point). The level of the standard chosen for both 2030 and 2050 captures about 80% of the benefits at about 60% of the cost.

FIGURE X-6: NHTSA NATIONAL COST BENEFIT ANALYSIS SHOWS THE 2025 STANDARD IS A MODERATE, MID-RANGE TARGET



Source: Office of Regulatory Analysis and Evaluation National Center for Statistics and Analysis, *Preliminary Regulatory Impact Analysis Corporate Average Fuel Economy for MY 2017-MY 2025, Passenger Cars and Light Trucks*, November 2011, Table 2 and Table X-12c.

FIGURE X-7: EPA /NHTSA COST OF SAVED ENERGY CURVES FOR TRACTOR TRAILERS



Source: EPA/NHTSA, PHASE II, NOPR, Tables X-1 and X-8.

One can argue that under both statutes the agencies are not required to "optimize" the benefit in this way. The Clean Air Act (under which EPA sets standards) calls on EPA to advance the technology. The Energy Conservation and Production Act (ECPA), under which NHTSA sets standards, only requires it to be technically feasible and economically practicable. The regulatory analysis and technical support documents raise the constraint that NHTSA faces in terms of practicability. The cost estimates note that they do not include potential costs of accelerating technology and the regulatory discussion explicitly says that there is concern that a higher standard which requires a more rapid incorporation of untested technology may not be feasible.

XI. MACROECONOMIC GROWTH AS A POSITIVE EXTERNALITY OF WELL-DESIGNED PERFORMANCE STANDARDS

To the dismay of anti-standard, free market ideologues, and the surprise of consumers who end up with a more fuel-efficient car than they thought they could get, fuel economy standards puts more money in the consumer's pocket. The inevitable result is to increase disposable income and, under any reasonable assumption, trigger the macroeconomic multiplier effect, which includes a consumption externality that lowers prices because of reduced energy consumption. The environmental and public health benefits of reduced pollution are also realized.

In this section, we argue that one major externality has been present throughout the history of the energy efficiency standard setting process and should be recognized in rigorous cost benefit analysis. The macroeconomic stimulus that results from efficiency standards is a true externality, which Taylor broadly defined as "the situation in which the cost of producing or the benefits of consuming a good spill over onto those who are neither producing nor consuming the good."[126] These changes are invariably driven by the adoption of the rule and are not likely to be considered by the parties to the transaction.

CONCEPTUALIZING THE SOURCES OF MACROECONOMIC STIMULUS

The macroeconomic impact of energy policy has taken on great significance in the current round of decision making. Every policy is evaluated for its ability to stimulate growth and create jobs. Assessing the macroeconomic impact of policy choice generally relies on complex models of the economy. Economically beneficial energy efficiency investments yield net savings; the reduction in energy costs exceeds the increase in technology costs. Such investments, in this case, have two effects from the point of view of the economy. The increase in economic activity resulting from spending on new technology and the increase in consumer disposable income flows through the economy, raising the income of the producers of the additional products that are purchased and increasing employment.

Expenditures are shifted from purchasing energy to purchasing technology, which has a larger multiplier. The decrease in energy expenditures is substantially larger than the increase in technology costs, resulting in an increase in the disposable income of individuals to spend on other things.

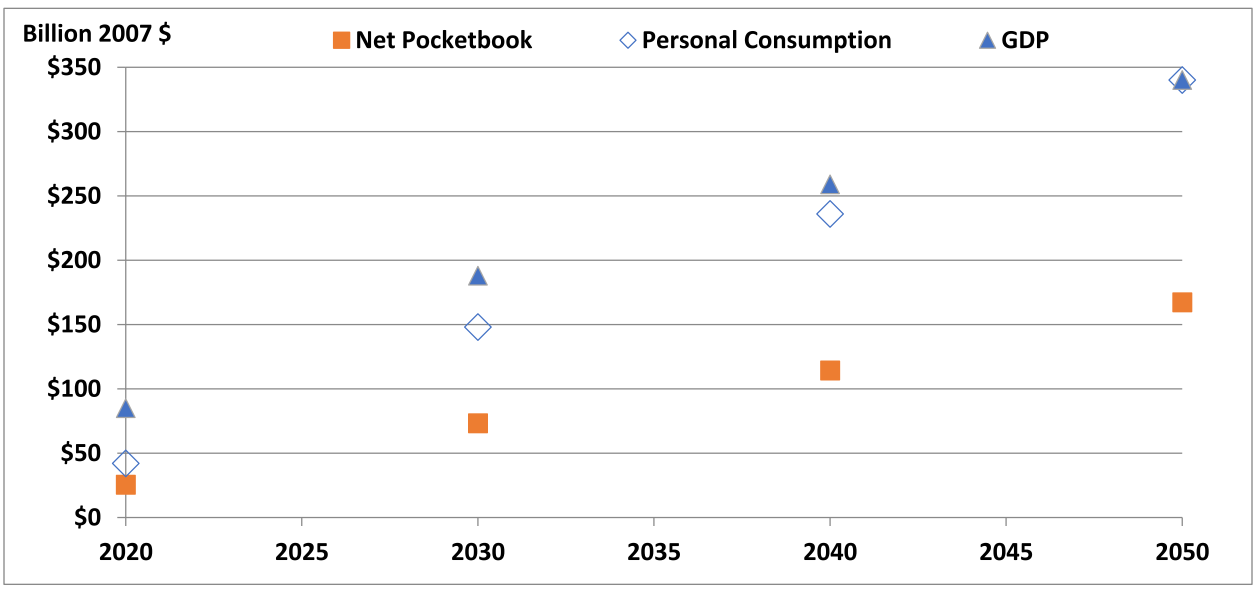
- The inclusion of energy efficient technologies in energy using durables increases the output of the firms that produce the technology.
- To the extent that the energy using products are consumer durables, they increase the disposable income that households have to do other things, such as buy other goods and services.
- To the extent that the energy using products are utilized as inputs in the production of other goods and service, like trucks used to deliver packages or vegetables, they lower the cost of those goods and services. In competitive markets, those costs are passed on to the consumer in the form of lower prices. This also increases the disposable income of the household to buy other goods and services.

The increase in economic activity resulting from spending on new technology and the increase in consumer disposable income flows through the economy, raising the income of the producers of the additional products that are purchased and increasing employment.

> Higher vehicle costs are projected to reduce household consumption slightly in the first few years of the rule implementation. Over time, fuel savings increase and the price of world oil decreases, which leads to lower prices economy-wide. As a result, household consumption increases over the long term.
>
> The fuel savings and lower world oil prices that result from this rule lead to lower prices economy-wide, even when the impact of higher vehicle costs is factored into this analysis. Lower prices allow for additional purchase of investment goods, which, in turn, lead to a larger capital stock. These price reductions also allow higher levels of government spending while improving U.S. competitiveness thus promoting increased exports relative to the growth driven increase in imports. As a result, GDP is expected to increase as a result of this rule.[127]

For example, in the recent regulatory proceeding that finalized the long-term fuel economy standard of 54.5 miles per gallon for 2025, the standard was projected to increase the size of the economy by over $100 billion, in 2010 dollars. This indirect benefit was equal to the direct consumer pocketbook benefit of the standard (Figure XI-1).

FIGURE XI-1: IMPACTS OF THE 2012-2016 CORPORATE AVERAGE FUEL ECONOMY RULE: SAVINGS AND INCREASES IN ECONOMIC ACTIVITY

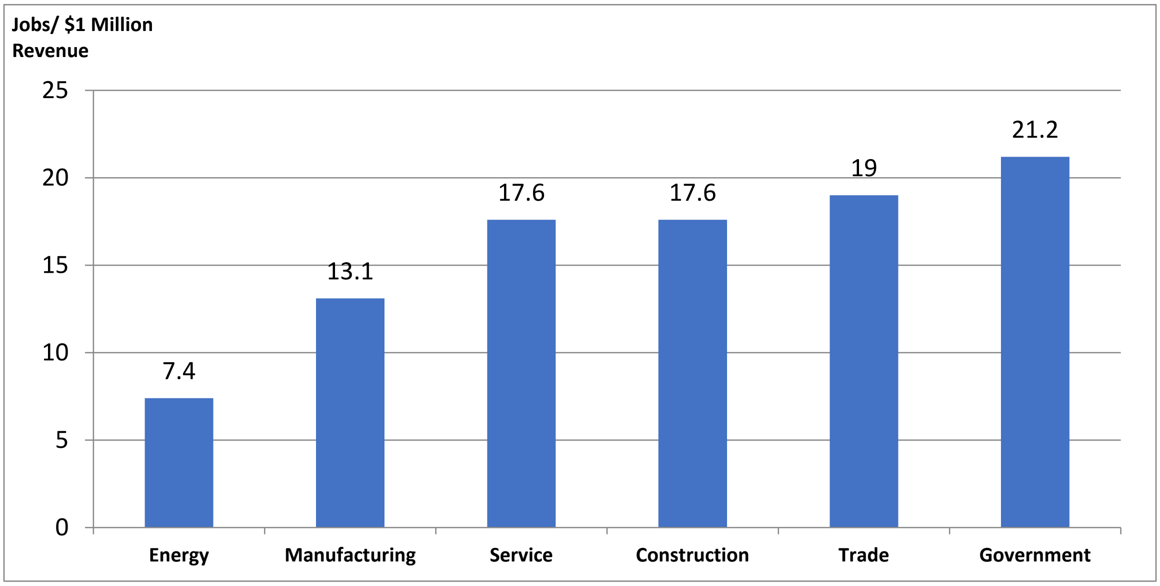


Source: Assessment and Standards Division Office of Transportation and Air Quality U.S. Environmental Protection Agency, Final Rulemaking to Establish Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average: Regulatory Impact Analysis, EPA-420-R-10-009, April 2010, Table 6-18. Docket EPA-HQ-OAR-2009-0472, *Memorandum: Economy Wide Impacts of Greenhouse Gas Tailpipe Standards,* March 4, 2012, Tables 1 and 2.

Figure XI-1 shows the relationship between the net pocketbook savings, increases in consumption and increases in GDP. Although the figure was estimated using standard econometric models of the economy, it was not included in the final published cost benefit analysis.[128] Another popular measure is to estimate jobs per dollar invested. In the electricity space, a comparative analysis of efficiency compared to generation found that efficiency created twice as many jobs per dollar spent on nuclear power and 50% more jobs than coal and gas generation.[129]

These large increases in economic activity lead to increases in employment. The effect is magnified by the fact that the non-energy sectors of the economy are substantially more labor intensive than energy production. As shown in Figure XI-2, the energy sector is less than half as labor intensive as the rest of the economy. This effect is compounded where energy is imported (as in the transportation sector). As consumers substitute away from energy, the goods and services they purchase stimulate economic and, disproportionately large, job growth.

FIGURE XI-2: LABOR INTENSITY OF KEY ECONOMIC SECTORS IN THE U.S.



Source: Rachel Gold, et al., *Appliance and Equipment Efficiency Standards: A Money Maker and Job Creator,* American Council for an Energy Efficient Economy, January 2011, p. 9, based on the IMPLAN Model, 2009.

The direct pocketbook savings of efficiency standards are the largest and most direct benefit of the standards, but this benefit has a second immediate and inevitable economic benefit. We have argued for at least a decade that the macroeconomic stimulus that results from shifting consumer spending from energy consumption to other goods and services is substantial. The academic literature supports the proposition that the higher multiplier on consumer disposable income results in an additional dollar of economic stimulus for each dollar of consumer savings.

This outcome reflects three effects. Direct and indirect growth comes from the economic activity (jobs) stimulated by the development and deployment of the energy saving technologies, which occurs directly in the new technologies and indirectly in the firms that supply new inputs for new technologies. Induced growth comes from the fact that the multiplier on energy spending is quite low compared to other activities. As disposable income is shifted from energy consumption to other goods and services, more economic activity is stimulated.

The literature on energy efficiency has a large body of research on the positive impact of reduced energy consumption on economic output. While the economic externalities of energy consumption originally entered the policy arena through the study of the negative recessionary impact of oil price shocks,[130] the positive impact of energy efficiency is becoming widely recognized and consistently modeled.[131] Importantly, the literature now goes well beyond the negative national security and environmental externalities, which are frequently noted in energy policy analysis. The macroeconomic effects of energy consumption and energy savings are important externalities of the efficiency gap.

The analyses cover a wide range of approaches. The qualitative analyses focus on very micro level impacts on individuals and utilities. For example, a recent analysis prepared for the OECD/IEA catalogued the varied positive impacts of energy efficiency, identifying over a dozen specific impacts, see Table XI-1. This list is replicated in several other qualitative analyses. Direct estimates of the non-economic benefits have been estimated at between 50% and 300% of the underlying energy bill savings.[132]

At a more macro and quantitative level, econometric models that use general flows of resources between economic activities have been used to assess the impact of increasing efficiency. In a sense, the coefficients in the macro models are representations of the relationships in the economy through which the micro level effects flow. No matter the level or approach, the evidence strongly supports the conclusion that there is a positive impact.

Figure XI-3 presents the conceptual framing that describes one of the more frequently used models – the REMI model, which has been repeatedly applied in the U.S. and Canada.

> Increasingly, research is showing that energy savings from energy efficiency improvements can deliver wider benefits across the whole economy such as increases in employment, GDP, trade balances, energy security, etc.…
>
> One way to look at the macroeconomic impacts is to separate them into:
>
> The cost and effects derived from investing in energy efficiency goods and services, and the effects derived from the energy savings (or reduced costs) from realizing an improvement in energy efficiency…
>
> Increased energy efficiency can lead to more competitive production for 'business consumers" or energy, while for final consumers increased efficiency mainly leads to a demand shift from energy consumption to other goods. For the consuming sectors, it is relatively straightforward to observe how investment in energy efficiency and energy savings can lead to increased spending and economic activity with second round effects such as employment, government revenue, and price effects (if other investment and spending is not crowded out). There are likely to be positive income effects, unless household wage demand increases as the labor supply becomes more competitive.[133]

REBOUND EFFECT[134]

The studies by regulatory agencies also include a rebound effect. That is, consumers use part of the increase in pocketbook disposable income to do things that consume energy. From the environmental or energy reduction point of view, this is a negative. Reducing energy consumption or emissions of pollutants is more than the simple improvement in efficiency suggests. From the consumer point of view, this is a positive, not a negative. That is, the fact that consumers use some of increased disposable income on energy indicates that they are using it to increase their utility.

TABLE XI-1: MULTIPLE BENEFITS OF ENERGY EFFICIENCY

Area of impact & Specific Benefits

- Economic
  - Provider Benefit & Infrastructure
- Energy Prices
  - Public Budgets
  - Energy Security
  - Macro-economic effects
- Social
  - Health
  - Affordability
  - Access
  - Development
  - Job Creation
  - Asset Values
  - Disposable Income
  - Productivity
- Environment
  - GHG Emissions
  - Resource Mgmt.
  - Air/Water Pollutants

Sources: Lisa Ryan and Nina Campbell, *Spreading the Net: The Multiple Benefits of Energy Efficiency Improvements* (International Energy Agency, Insight Series 2012), p. 25.

More Goods/Less Bads (in addition to waste & emission reduction)

Operation & Maintenance	Production
Engineering controls	Output
Cooling requirements	Performance
Facility reliability	Process cycles
Wear and tear	Product quality
Labor requirement	Production Reliability

Work Environment	Other
Protective equipment	Less liability
Lighting	Public image
Noise	Capital saving
Temperature controls	Space saving
Air quality	Worker Moral

Source: Ernst Worrell, et al., *Productivity Benefits of Industrial Energy Efficiency Measures*, U.S. EPA, December 4, 2001.

<u>Utility System</u>

Generation
Transmission
Distribution
Line Loss, Reserves
Credit & Collections
Demand Response
Price Effect
Reduced Risk
Avoided Regulatory Obligations & Costs
Reduced Terminations
Reduced Uncollectibles

<u>Participant</u>

Societal Risk & Security
Employment, Development
Productivity, Other economic
Health, Comfort, Bill Savings
O&M, Other resource Savings
Low Income Consumer Needs
Development
Employment
Property Values
Productivity

<u>Societal Non-energy</u>

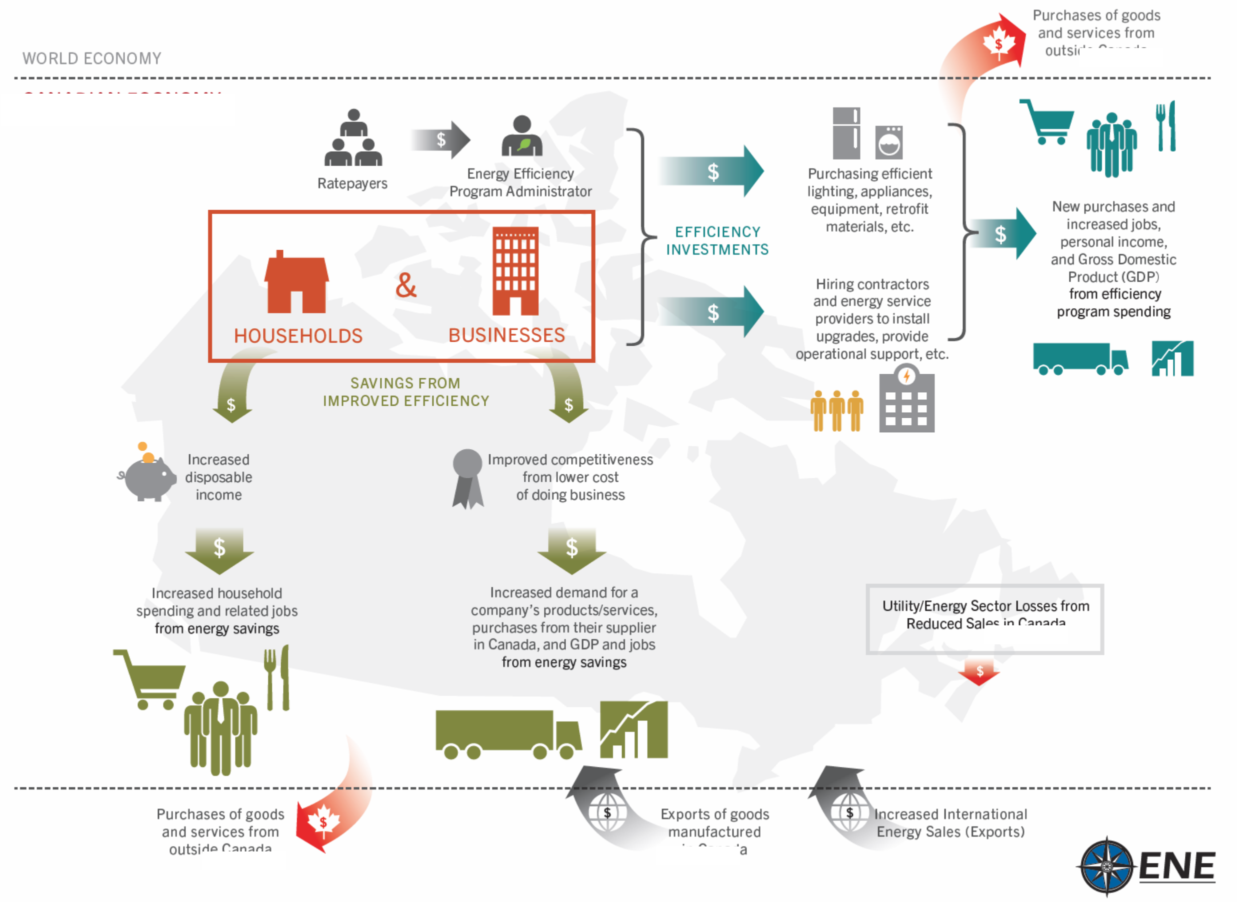
Electricity/Water Nexus
Air quality
Water Quantity & Quality
Coal Ash & Residuals

Source: James Lazar and Ken Colburn, *Recognizing the Full Value of Energy Efficiency* (Regulatory Analysis Project, September 2013), p. 6.

Benefit Type	Specific Benefit
Financial (other than energy cost savings)	Water and waste bill savings Reduced repaid and maintenance Increased resale value Improved durability
Comfort	Improved airflow Reduced drafts and temperature swings Better humidity control
Aesthetic	More attractive windows/appliances Less dust Reduced mold and water damage Protection of furnishings Dimmable lighting
Health & Safety	Improved respiratory health Reduced allergic reactions Lower fire/accident risk (from gas equipment)
Noise Reduction	Quieter equipment Less external noise intrusion
Education-related	Reduced transaction costs (knowing what to look for when purchasing equipment; ease of locating products) Persistence of savings Greater understanding of home operation
Convenience	Automatic thermostat controls] Easier filter changes Faster hot water delivery Less dusting and vacuuming
Other	Greater control over energy use/bills Reduced sick days Ease of selling home Enhanced pride Improved sense of environmental responsibility Enhanced peace of mind & responsibility for family well-being

Source: Jennifer Thorne Amann, 2006, *Valuation of Non-Energy Benefits to Determine Cost-Effectiveness of Whole-House Retrofit Programs: A Literature Review*, American Council for an Energy Efficient Economy, p. 8.

FIGURE XI-3: MACROECONOMIC IMPACT FROM INVESTING IN ENERGY EFFICIENCY



Source: ENE (Acadia Centre),

The rebound numbers (recently put at 10%, which is too high), are embedded in the analysis, and we have accepted them rather than recalculate benefits. Therefore, the rebound effect provides a small (at most 10%) "margin for error" in favor of the standards that will raise the economic benefit-cost ratio because the increase in utility has been incorrectly subtracted from the energy savings.

QUANTITATIVE ESTIMATES

In 2010, NHTSA noted one of the important externalities of reduced consumption, the downward pressure on prices, is a consumption externality. Derived from an auto standard, it provides a comprehensive discussion of the macroeconomic benefits that we find in all efforts to apply these models. "Lower prices allow for additional purchase of investment goods, which, in turn, lead to a larger capital stock. These price reductions also allow higher levels of government spending while improving U.S. competitiveness thus promoting increased exports relative to the growth driven increase in imports. As a result, GDP is expected to increase because of this rule.[135]

The EPA reviewed the literature on the macroeconomic impact of reduced energy consumption.[136] It ran econometric models driven by the pocketbook savings. The analysis models three effects on impacts of the rule that trigger adjustments in the economy – increased cost for vehicles, decreased consumption of gasoline, and a reduction in the price of petroleum. It does not model the impact of reduced pollutions (carbon and non-carbon) or other changes (like reduced fueling time). It found a very substantial multiplier effect increasing the GDP by just under 1%, or $340 billion, by 2050. Discounting the incremental growth of the economy at 3%, which is the discount rate used as the base case in this paper, the total is just under $100 billion and it is reached by 2030. This is slightly larger than the total consumer pocketbook savings.

> This combination of effects—price increases for vehicles and lower demand and world oil prices—would impact all sectors of the economy that use light-duty vehicles and fuels as intermediate inputs (e.g., delivery vehicles) to produce final goods. Households would also be impacted indirectly as consumers of final goods, and directly as consumers of fuels and light-duty vehicles.
>
> It is important to note, however, that these potential impacts do not represent additional benefits or costs from the regulation. Instead, they represent the effects on the U.S. economy as its direct benefits and costs are transmitted through changes in prices in the affected markets, including those for vehicles and their components, fuel, and the various resources used to supply them.[137]

These impacts, as discussed in the memo are an indirect effect of the rule, a genuine externality. This approach has become quite common with detailed analyses of energy efficiency across a range of activities (autos, appliances, buildings, industries),[138] sectors (e.g. energy, manufacturing, service, particularly as it impacts use of labor)[139] and with a variety of analytic approaches (qualitative, econometric).[140] These efforts to model the economic impact of energy efficiency have proliferated with different models[141] being applied to different geographic units, including states[142] and nations.[143] The results differ across studies because the models are different, the impact varies according to the size of the geographic unit studied and because the assumptions about the level and cost of energy savings differ. These differences are not an indication that the approach is wrong. On the contrary, all the analyses conclude that there will be increases in economic activity and employment. Given that there are different regions and different policies being evaluated, we should expect different results.

The intense interest in jobs since the financial meltdown represents the beginning of the period we refer to as "the present" for the adoptions of standards, regulatory analyses tend to estimate the job impact on the industry. While this narrow view of economic impacts misses the much broader macroeconomic view discussed above, it is notable that the impact on the industry that is the target of the standard tends to be positive in the mid- and long-term employment and output. This results in part from the indirect effect – shifting jobs to new technology production within the sector – and in part from the induced effect, since reducing the total (ownership plus operating) cost use goes down, tends to increase demand in the mid and long terms. The energy sector is less than half as labor intensive as the rest of the economy, so the ratio of job creation for efficiency, compared to other production option in electricity is also two to one.[144] This effect is compounded where energy is imported (as in the transportation sector). As consumers substitute away from energy, the goods and services they purchase stimulate economic and disproportionately large job growth.

The rule of thumb – an approximate doubling of the economic impact – that emerges in the literature reflects the observation on jobs.[145] Similarly, in a study of 52 examples of increases in industrial productivity, where benefit was monetized, the productivity savings were 1.25 times as large as the energy savings.[146] Macroeconomic models measuring the outcome in change in GDP yield a "respending" effect that clusters around 90%.[147]

In this analysis, we take a very cautious approach to estimating the induced macroeconomic benefits of efficiency. We apply the multiplier only to the net pocketbook savings. That is, we subtract the technology cost from the savings before we use the multiplier. This ensures that we do not double count the indirect effect, although that might have an induced multiplier effect of its own.

We also do not include a separate impact of the consumption externality, the effect that U.S. consumption has on lowering the market price of energy. In petroleum, this number is substantial. Agencies have estimated it, but not included it in their cost benefit analysis. Where they have presented the calculations, it is equal to about one-fifth of what we call the macroeconomic multiplier.[148] In the appliance sector, this effect has been model by considering the impact that reduced electricity demand has on the price of natural gas.[149]

We do not apply the multiplier to the value of environmental, public health and other externalities. Although these have been monetized in the traditional cost benefit analysis, that monetization does not generally include macroeconomic multipliers. Since it could be argued that these costs are reflected in the model coefficients that are a representation of empirically observed real world relationships, out of an abundance of caution we do not apply the multiplier to these benefits, which is the traditional approach.

Table XI-2 shows examples of the multiplier, with the GDP impact expressed as a multiplier of the value of net pocketbook savings. That is, we subtract costs from the estimated value of energy savings. This ensures we do not double count benefits.

TABLE XI-2: ESTIMATES OF MACROECONOMIC MULTIPLIERS AS A MULTIPLE OF NET POCKETBOOK SAVINGS

Modeler	Model Date	Policy Assessed	Region	GDP/$ of Net Savings	
				Base Case	Rebound Adjustment
Roland-Holst	DEAR	Computer Standard	California	1.8	2.0
ENE	REMI	Utility Efficiency	Northeast	2.2	2.4
Cadmus	REMI	Utility Efficiency	Wisconsin	2.5	2.8
Arcadia	REMI	Utility Efficiency	Canada	2.7	3.0

Sources:
David Roland-Holst, 2016, *Revised Standardized Regulatory Impact Assessment: Computers, Computer Monitors, and Signage Displays,* prepared for the California Energy Commission, June. ENE, *Energy Efficiency: Engine of Economic Growth: A Macroeconomic Modeling Assessment*, October 2008. Cadmus, 2015, *Focus on Energy, Economic Impacts 2011–2014*, December. Arcadia Center, 2014, *Energy Efficiency: Engine of Economic Growth in Canada: A Macroeconomic Modeling & Tax Revenue Impact Assessment,* October 30,

Since none of these studies take the rebound effect into account, which the regulatory impact analyses subtract from total benefits, we show a multiplier adjusted for the rebound effect. While we have chosen to add the rebound effect back into the pocketbook savings, we do not add it into the macroeconomic effect, since the rebound effect spends the money on consumption, meaning no change in the multiplier. To err on the side of caution, we assume the lowest value in the table and set the multiplier equal to the net pocketbook savings.

TRANSFER PAYMENTS AND ECONOMIC GROWTH

A debate over whether consumer pocketbook savings should be counted at all parallels the willingness to pay debate. It is possible to argue that the consumer pocketbook savings are just a transfer payment from energy producers to consumers and manufacturers of energy saving technology. As a transfer payment, they might not be considered a net gain for the economy or society.

We disagree with this on two grounds. First, transfers do matter. Manufacturers of energy-using consumer durables are quick to argue distributive effects when it comes to low income households, claiming incorrectly that it prices them out of the market. We think the distribution between consumers and energy suppliers does matter.

Second, if the transfers are not counted, but still recognized, then the macroeconomic effect becomes extremely important. Some uses of disposable income have much larger multipliers than others. Transferring wealth from energy producers to energy consumers has a substantial positive impact on economic growth that should be taken into account.

CONCLUSION

This categorization and recognition of the broad benefits is not unique to energy efficiency standards. For example, a recent National Academy of Sciences Transportation Research Board report prepared for the Transit Cooperative Research Program, entitled, *Practices for Evaluating the Economic Impacts and Benefits of Transit,* noted that "Because of shifting demands and constrained budgets, transit agencies have an increasing need to consistently and defensibly document the economic impacts and benefits of the services they provide."[150] The report identifies direct and indirect benefits that are akin to those discussed in this section.

> Two primary forms of economic analysis are discussed in this report:
>
> *Impacts on the economy* – most often referred to as "economic impacts" or "economic development impacts," which encompass effects on jobs and income: and
>
> *The economic valuation of broader societal benefits* – sometimes referred to as "social welfare," benefits which encompass the valuation of "non-user benefits" (affecting quality of life, environments, and productivity) in addition to user benefits….
>
> Economic impact = the study of the net change in economic activity (jobs, income, investment or value added) resulting from a project, event, or policy.
>
> Economic valuation of societal benefits = the social welfare value of prices ($) and non-prices (non-$) benefits associated with a project, policy or event. The non-priced benefits are assigned a valued based on revealed or stated preference methods. [151]

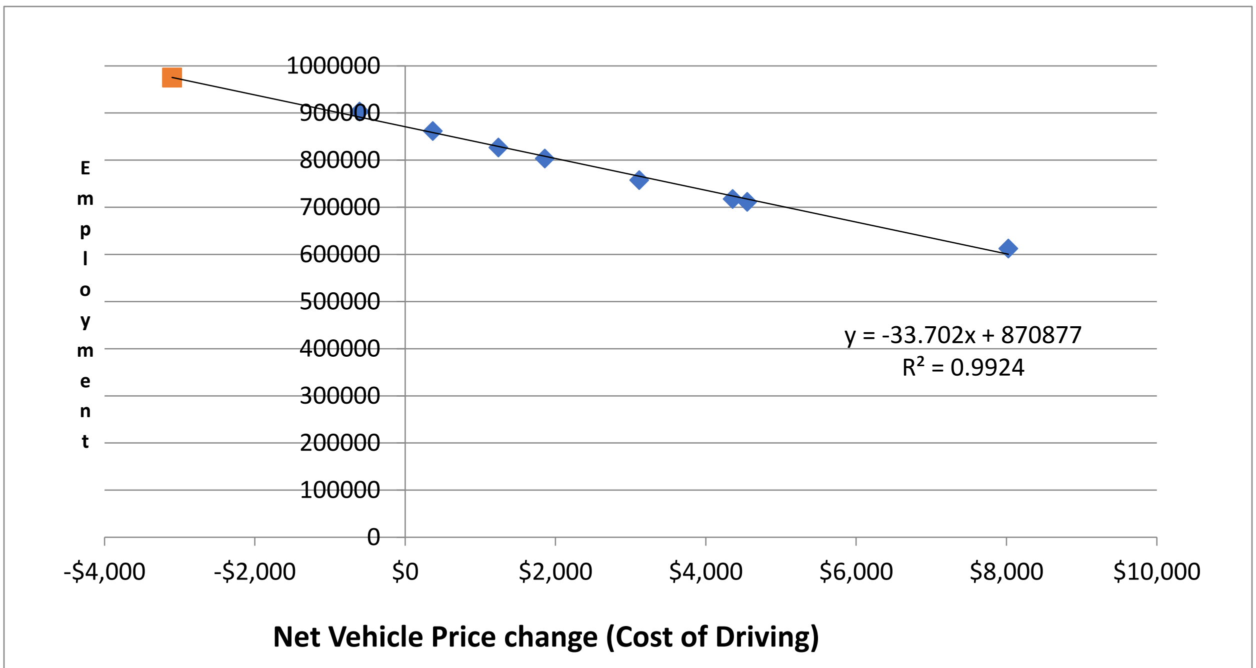
This quote includes all the impacts we have identified and the approach to valuing them. We agree they are the building blocks of a comprehensive and rigorous benefit-cost analysis.

EMPLOYMENT IMPACTS WHEN THE COST OF DRIVING DECLINES

A study by the Center for Automotive Research (CAR, Center for Automotive Research, The U.S. Automotive Market and Industry in 2025 (June 2011) recognized that changes in cost of driving impacts vehicle sales. That study estimated job losses because it vastly overestimated the increase in the initial cost of new fuel saving technologies, and it never considered the value of fuel savings to the consumer. We have shown that the cost of driving will decline. When it does so, sales increase.

The CAR study assumes that each 1 percent change in the "net price" of a vehicle (where net price is the cost of the vehicle minus the change in operating costs) – changes employment by at least 10,000 jobs. The CAR study focused on net cost increases, because of its erroneous assumptions. We find that higher fuel economy lowers the cost of driving and the net price of the vehicle, so it should lead to employment increases. (NHTSA-EPA, 2009; National Highway Traffic Safety Administration, Corporate Average Fuel Economy for MY 2012-MY 2016 Passenger Cars and Light Trucks, Preliminary Regulatory Analysis (Washington, D.C.: August, 2009). Table VII8c shows employment gains for the 5% scenario) As Figure XI-4 shows, using the jobs multiplier and our earlier estimate of the lowered cost of driving for cars, we project employment gains of 100,000. Trucks would increase the total substantially. Indirect jobs would equal or exceed the total within the auto industry through a general GDP multiplier.

FIGURE XI-4: EMPLOYMENT IMPACT OF LOWER COST OF DRIVING, CARS ONLY



Sources: Auto Industry Employment Multiplier from Center for Automotive Research, *The U.S. Automotive Market and Industry in 2025* (June 2011), Table 13. Net Price Change from EPA-NHTSA, Environmental Protection Agency & Department of Transportation: In the Matter of Notice of Upcoming Joint Rulemaking to Establish 2017 and Later Model Year Light Duty Vehicle GHG Emissions and CAFE Standards, Docket ID No. EPA-HQ-OAR-0799 Docket ID No. NHTSA-2010-0131, Table 2.

PART IV. MEDIUM AND HEAVY DUTY (WORK) TRUCKS

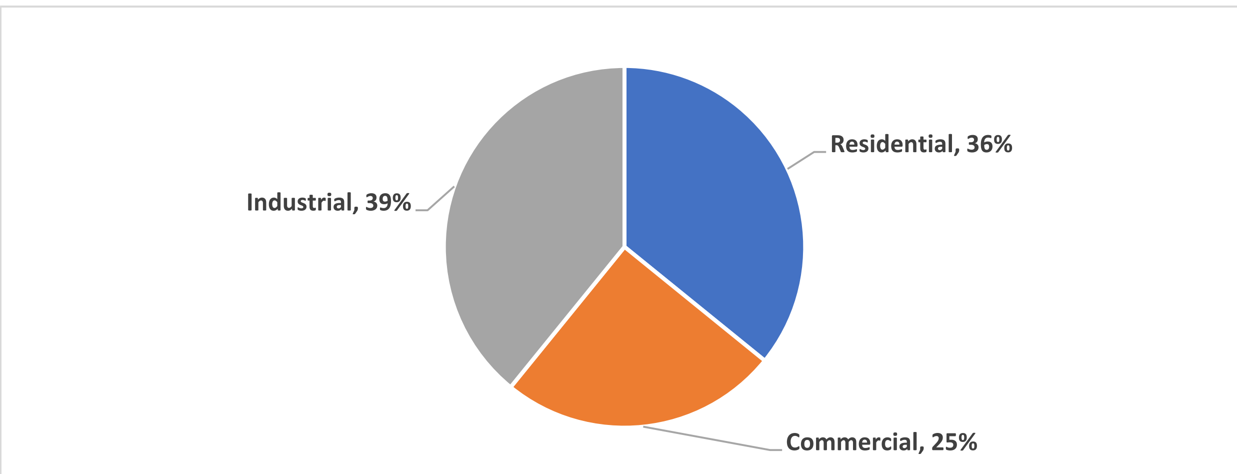
XII. THE CONSUMER STAKE IN THE FUEL USE OF HEAVY DUTY TRUCKS[152]

Over the past decade public opinion polling by the Consumer Federation of America and other organizations has revealed strong and widespread support for energy efficiency standards for consumer durables including automobiles and households appliances.[153] Because gasoline and electricity bills are such a large part of household annual expenses – currently about $1900 for gasoline and over $1400 for electricity, and $355 for natural gas[154] — it is not surprising that polls consistently elicit this support. Consumers clearly feel the pain in their pocketbooks and understand the economic impact of those energy costs on their household budgets.

Economic analysis has shown that there is a sound basis for consumer support of energy efficiency standards.[155] Although energy saving technologies require an investment, when they lower energy bills by more than their cost, the result is ultimately net savings to consumers.

While direct household expenditures on personal energy consumption are significant, they are only part of the consumer's expenditures on energy. Consumers also pay indirectly for the energy consumption in the commercial and industrial sectors through the prices of goods and services. As shown in Figure XII-1, the total residential energy consumption represents just over one-third of total national energy consumption. In other words, almost two thirds of the nation's energy consumption take place in the production and distribution of goods and services and the costs incurred are recovered in the prices of those goods and services.

FIGURE XII-1: ENERGY CONSUMPTION IN THE RESIDENTIAL, COMMERCIAL AND INDUSTRIAL SECTORS



Source: Energy Information Administration, *Monthly Energy Review: August 2015.*

Consumers recognize that when fuel prices rise, so does the cost of consumer goods due to the cost of transporting those goods. Conversely, because of competition, a reduction in transportation costs will result in lowering the cost of goods and services for consumers. Reducing the energy consumption of medium and heavy duty (work) trucks will reduce household expenditures by lowering the cost of all goods and services. Therefore, the rulemaking affecting heavy medium and heavy-duty truck fuel consumption deserves close scrutiny and support from consumers and consumer advocates. This section examines the costs of energy used by medium and heavy-duty trucks and the positive impact increased truck[156] fuel efficiency can have on America's households.

In this section we estimate the potential size of the indirect consumer expenditure. In the next section, we discuss the evidence that the costs are passed through to consumers. We also review survey evidence that shows the public understands the impact of transport costs on their pocketbooks and the role of truck fuel economy standards in alleviating the burden.

HOUSEHOLD EXPENDITURES FOR WORK TRUCK FUEL

Current

Expenditures for transportation fuels, whether direct or indirect, are the result of the amount of energy consumed and the price of that energy.

To estimate the potential consumer savings from improvements in the fuel economy of trucks, we first estimated the fuel used by the three main vehicle categories (household light duty, commercial light duty, and medium-heavy duty trucks). We undertake this analysis because different government agencies that analyze energy use slightly different categorizations of energy use by different types of vehicles, and we want to make clear how we arrived at our figures. However, because light duty vehicles, which make up the vast majority of household vehicles, are already covered by CAFE standards, we do not include them in this analysis. We have been careful not to double count light duty vehicle energy consumption in our estimate of indirect household expenditures on medium and heavy-duty transportation fuel.

Table XII-1 shows three different approaches to estimating household gasoline consumption. We used several data sources to build our estimate: EIA *Residential Consumption Survey,* the Department of Transportation's, *National Household Transportation Survey;* the Energy Information Administration's *Annual Energy Outlook*; the Bureau of Labor Statistics' Consumer Expenditure Survey; and the U.S. Department of Transportation's, *Bureau of Traffic Statistics.*

TABLE XII-1: THREE METHODOLOGIES FOR ESTIMATING THE INDIRECT, AGGREGATE, ANNUAL HOUSEHOLD CONSUMPTION OF TRANSPORTATION ENERGY

		Billion Gallons	
2009		**BLS/CE, EIA**	**NHTS/ EIABTS**
Household Gasoline		**100**	**96**
2010			
Household Gasoline	**Light Duty Short Axle**	**91**	**88**
Commercial Light Duty	**Light Duty Long Axle**	**36**	**36**
Medium & Heavy Duty	**2Axle-Six Wheel & Combination**	**43**	**45**

Method – BLS/EIA: ($per HH / $ per gallon) X No. HH; NHTS/EIA: (VMT/MPG)

Source: Bureau of Labor Statistics (BLS), *Consumer Expenditure Survey 2010,* Energy Information Administration (EIA), *Annual Energy Outlook, 2013,* Appendix A*;* Department of Transportation (DOT), *Bureau of Traffic Statistics (BTS) Data Base,* Tables 4-11 to 4-14. Department of Transportation, *National Household Transportation Survey, 2009 Price*: Energy Information Administration, *Petroleum Database;* Households, Bureau of the Census, *Statistical Abstract of the United States: 2012,* Table 59, 118 million households. *EIA, Monthly Energy Review,* miles per gallon, total gasoline and diesel on-highway supplies.

The 2009 calculation compares an estimate based on the Bureau of Labor Statistics Consumer Expenditure Survey to an estimate based on the National Household Transportation Survey, both for 2009. Using each of the estimates, we divided the household expenditure by the average price per gallon to arrive at the number of gallons per household. We then multiplied the household consumption by the total number of households. The National Household Transportation Survey estimates the total number of vehicle miles traveled by households. We divided this by the average miles per gallon of the light duty vehicle fleet to arrive at the amount of gasoline consumed. These two estimates are quite close.

The 2010 estimate is based on EIA data that identifies the amount of energy consumed by automobiles and light duty vehicles, medium duty vehicles and heavy-duty trucks. The EIA data does not separate out household and commercial use of light duty vehicles, so we used the *Consumer Expenditure Survey* from the Bureau of Labor Statistics to estimate the gasoline consumed by households. We subtracted this from the total for light duty vehicles, as reported in the *Annual Energy Outlook*, to determine the amount of energy consumed by light duty vehicles that is not consumed by households. We call this commercial light duty.

As shown in Table IX-1, this approach provides an estimate that is consistent with the Department of Transportation data, which categorizes vehicles by axle length and the number of tires. Again, the estimates are quite close, although they are lower than the estimate for 2009. There was a decrease in consumption between 2009 and 2010 in the aggregate consumption. The consistency of this data provides us with a substantial level of confidence in the amount of medium and heavy-duty truck fuel we use for our calculations.

Table XII-2 applies the BLS/EIA approach from Table IX-1 to the data for 2013 and 2014.[157] We prefer this approach since it can be updated easily. As a result, for 2013, we estimate 92 billion gallons of household gasoline consumption and 43 billion in work truck consumption. We reduce work freight truck consumption by 11% to account for exports of diesel, since their cost burden would not fall on consumers.

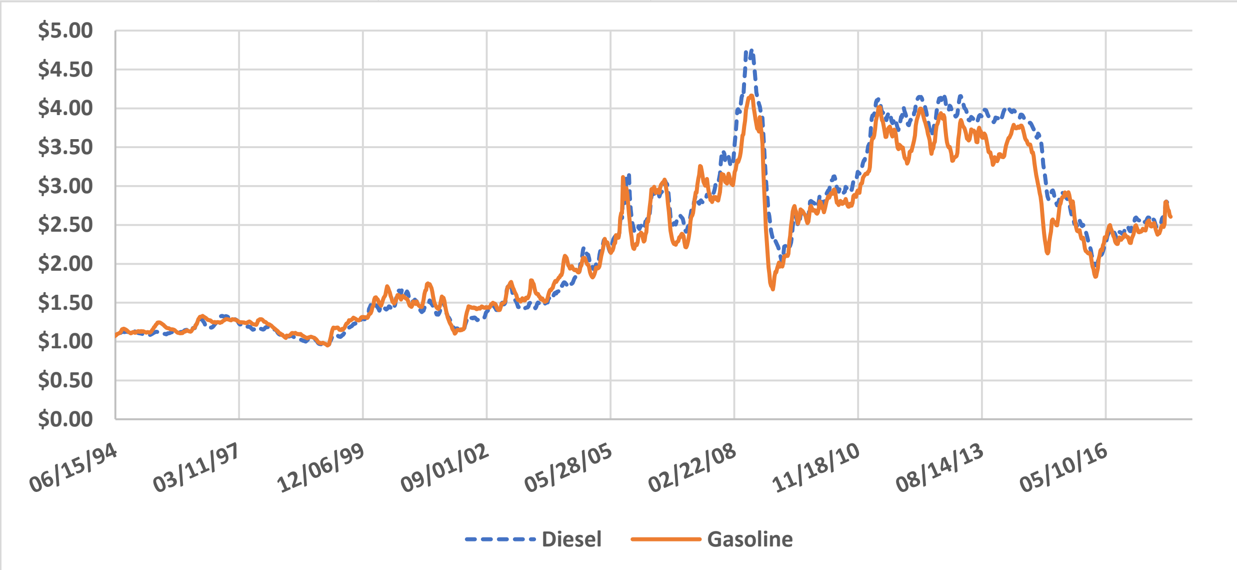
TABLE XII-2: HOUSEHOLD EXPENDITURES (BLS/EIA Method)

	Fuel	Consumptions Total Bil. Gal.	Per HH Gal.	$/gal.	Annual cost
2013					
Household Gasoline	**Gasoline**	**92**	**730**	**$3.58**	**$2,613**
Medium & Heavy Duty	**Diesel**	**43**	**300**	**$3.92**	**$1,176**
2014					
Household Gasoline	**Gasoline**	**93**	**730**	**$3.54**	**$2,511**
Medium & Heavy Duty	**Diesel**	**45**	**310**	**$3.82**	**$1,184**

Source: See Table II-1.

As shown in Figure XII-2, the prices of transportation fuels in recent years have been volatile while clearly trending upward. For a little over a decade, diesel fuel has cost more than gasoline. This confirms the conclusion we reached in our earlier analysis.[158] We estimate 730 direct gallons per household and 300 indirect gallons of diesel fuel consumption. Keeping in mind that diesel prices were 10% higher than gasoline prices in 2013, for every dollar that consumers spend on household gasoline, they spend about $0.47 on work truck transport fuel consumption. At an annual cost of nearly $1,200, households spend almost as much on freight truck fuel as they do on electricity.

FIGURE XII-2: FUEL PRICE (NOMINAL $/GALLON)



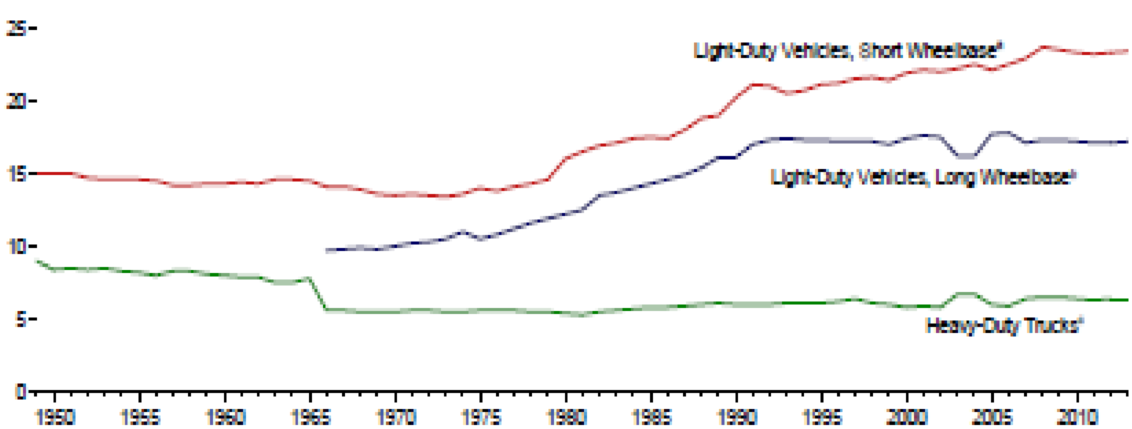
Source: EIA, Petroleum Price Database.

Future Household Expenditure Trends

Any cost/benefit analysis of a proposed standard must be forward looking and factor in expected costs at the time of implementation. The EIA projects lower prices for both gasoline and diesel in 2020, followed by a steady increase in prices to 2050. As large as current household spending is on transportation fuel used by medium and heavy-duty trucks, it will become even larger in the future. Going forward, the new CAFE requirements will lower the household impact of fuel costs associated with consumer and commercial light duty vehicles. On the other hand, without some controls, the burden on households due to medium and heavy-duty truck fuel costs will only increase both absolutely and relative to their direct expenditures on gasoline. Figure XII-3 shows that, historically, the fuel economy of medium-heavy duty trucks has not increased.

FIGURE XII-3: MOTOR ECONOMY 1949-2011 (MILES PER GALLON)

MPG



Source: U.S. Energy Information Administration, Monthly Energy Review, July 2015, page 17.

The most recent *Annual Energy Outlook* from the EIA, incorporating the new fuel economy standards for light duty vehicles and the much more modest standards for heavy duty trucks projects that this trend will continue. Over the next 30 years, light duty vehicle consumption is projected to decline by 20% as the standards become higher. With weak standards, work truck consumption is projected to increase by 43% as the economy grows.

Fuel consumption of light duty vehicles (and therefore household gasoline) is projected to decline because the increase in fuel economy is larger than the expected increase in miles driven.[159] Given the increase in consumption and prices (discussed below), work truck fuel expenditures are projected to grow from 47% of household gasoline consumption to 67%. The indirect burden on households will grow offsetting a significant part of the savings in direct fuel expenditures/

This analysis of the indirect cost burden that medium and heavy-duty trucks place on household budgets indicates that consumers have a big stake in the Phase II rule.

COMMERCIAL FUEL COSTS ARE PASSED THROUGH TO HOUSEHOLDS

A Cost of Doing Business

While we have calculated the size of fuel expenditures on a per household basis, we must ask, "do households actually pay these costs?" To a large degree, the answer is "Yes." These costs are just like any other commercial costs in the economy.

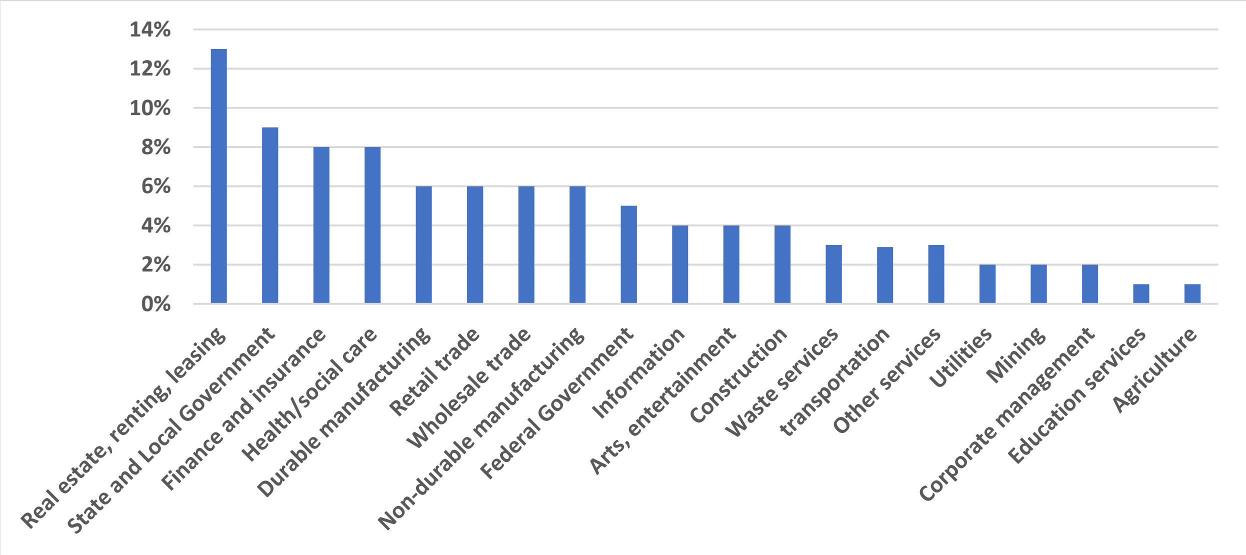
When a farmer pays for fertilizer or the delivery driver gets his paycheck, these business costs are recovered in the price of the related goods and services. The same is true with fuel costs. In fact, the Mid-Atlantic Freight Coalition confirms the pass-through of transportation costs in a report on how transportation and logistics consume a significant portion of household budgets. According to the report,

> "the freight logistics system costs nearly $4,500 per person, which is spent moving and warehousing goods. This $4,500 factor into the cost of every product we buy. Anything that industry or government can do to make the logistics system more efficient will return benefits in terms of lower cost and greater global competitiveness."[160]

Although this estimate of the size of the expenditure on freight logistics includes all transportation modes (truck, rail, barge, etc.) and all costs, (equipment, maintenance, salaries, etc.), it acknowledges the importance of transportation costs to the economy which includes truck fuel costs. In addition to the pass-through of these costs to consumers, there is the significant dependence on foreign sources for this fuel. Imported petroleum now makes up just under half (48%) of the total U.S. product supplied,[161] which is a drain on the U.S. economy.

While the recognition that transportation costs are paid for by consumers is obvious, the concept is reinforced by two observations: first, although transportation costs are a small part of the total economy (just under 3%), they are as large or larger, than several other sectors, including agriculture, mining, utilities and construction (see Figure XII-4). It is widely recognized that those costs are passed on to consumers.

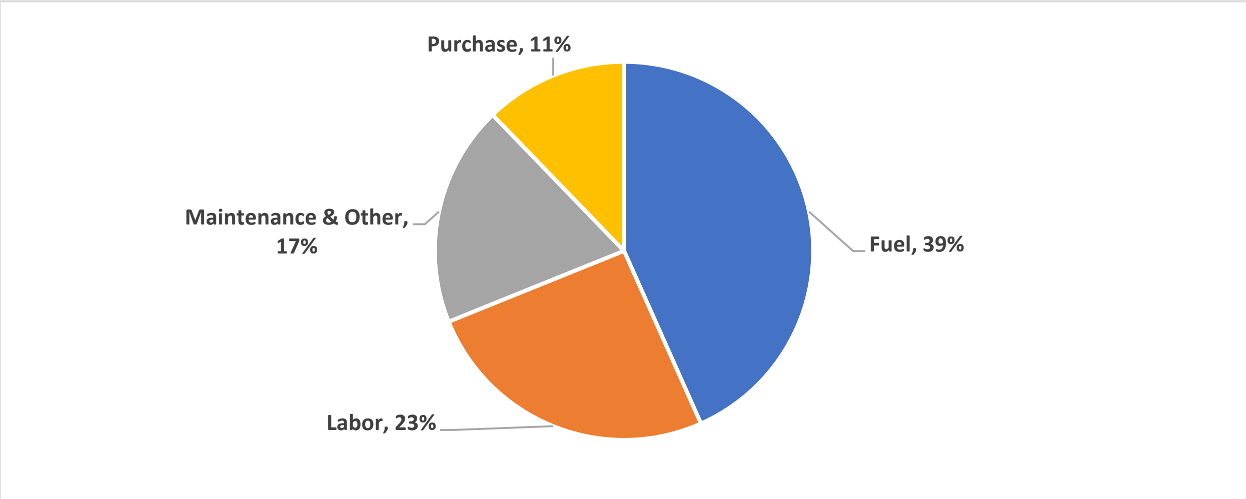
FIGURE XII-4: GROSS DOMESTIC PRODUCT BY SECTORS



Source: ***GDP by Industry*, http://en.wikipedia.org/wiki/Economy_of_the_United_States**

Second, fuel costs are the single largest component of transportation costs, representing over one-third of the total transportation costs (see Figure XII-5). Fuel costs are slightly larger than driver pay and three times as large as the cost of owning and insuring the truck. As transportation costs are passed through to consumers, fuel is the largest component of that pass-through. There is certainly no reason to believe that fuel costs are less likely to be recovered from consumers than drivers' wages or owners' capital costs.

FIGURE XII-5: AVERAGE TRUCK OPERATION COSTS



Source: EPA/NHTSA, Phase II RIA, p. 8-1

Econometric Models Demonstrate the Pass-Through Nature of Transportation Fuel Costs

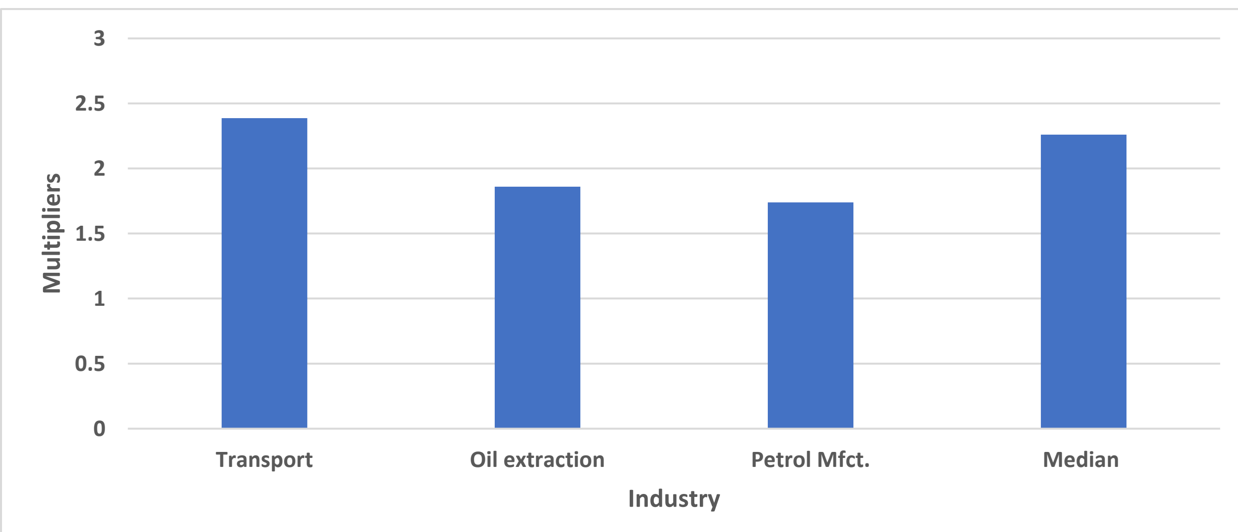
The economic reality of the flow through to consumers of transportation fuel costs is reflected in the way econometric models describe the growth of the economy. Such models are built on input/output tables, and transportation costs are a significant input in the models. In building these models, the pass-through of transportation costs is assumed, since transportation plays a fundamental role in the overall cost of production.

Transportation is an economic factor of production of goods and services, implying that relatively small changes can have substantial impacts on costs, locations and performance…

Transport also contributes to economic development through job creation and its derived economic activities. Accordingly, a large number of direct (freighters, managers, shippers) and indirect (insurance, finance, packaging, handling, travel agencies, transit operators) employment are associated with transport. Producers and consumers make economic decisions on products, markets, costs, location, prices which are themselves based on transport services, their availability, costs and capacity.[162]

The importance of transportation in these economic models is reflected in the high multiplier it is given. In order to build a model of the economy, analysts study the places where a sector purchases inputs and sells output. Typically, the more places that are touched by a sector, the larger its multiplier. Because most economic models are built on the flow of goods and services through the economy, they depend on the geographic scope and nature of activity within the economy being modeled. Transportation is generally seen as a central input to measuring broader economic activity. To further reinforce the impact of transportation costs on consumer pocketbooks, Figure XII-6 presents the sector multipliers for the state of California. Transportation has the 20th largest multiplier in a study of 60 California sectors. Not only is the transportation cost multiplier above average, but it is substantially larger than the multipliers related to petroleum production.

FIGURE XII-6: SECTOR MULTIPLIERS FOR THE CALIFORNIA ECONOMY



Source: California Economic Strategy Panel, *Using Multipliers to Measure Economic Impacts*, 2009, Table 1

In modeling the impact of higher fuel economy with these econometric models, it is important to understand certain market factors. As the cost of transportation declines, demand for transportation increases because the demand for goods and services increases due to their lower costs. In addition, as the population and economy grow, the need for commercial transportation increases as well. Nevertheless, the fuel savings from greater efficiency are much larger than the increase in consumption. The net effect is to reduce expenditures on fuel as a percent of total output. In fact, the reduction in energy consumption may be so large that the absolute level of consumption is lowered. This has a positive effect on the economy. We consume less petroleum products and more of other goods and services. Because those other goods and services have bigger multipliers, the economy expands. So, it is clear that the pass-through to consumers of truck fuel costs is important for both energy policy and economic policy.

XIII. POTENTIAL FUEL SAVINGS AND MARKET IMPERFECTOINS FOR MEDIUM AND HEAVY-DUTY TRUCKS

Above we showed that there was a broad consensus among the federal and state agencies and academic institutions that available technology could be added to light duty vehicles at an economic cost that makes them an attractive investment. There is an efficiency gap that policy can close in the light duty sector. The consensus around the potential for increased fuel economy and the results of recent increases in the standard in the light duty vehicle arena provide an important context for the heavy-duty truck rule. It is not surprising to find that the same is true of work trucks.

MEDIUM AND HEAVY-DUTY TRUCK TECHNOLOGY EFFICIENCY CURVES

The medium and heavy-duty truck sector is a much more complex product space than light duty vehicles, but in spite of the different types of vehicles, equipment configurations, and use patterns, a similar consensus has emerged with respect to medium and heavy-duty trucks. Expenditures on fuel efficient technology will be more than offset by savings in fuel costs.

Figure X-7, above, presented fuel savings in terms of percentage reduction (rather than gallons) for tractor trailers. Tractor trailers, defined as Class 8 trucks, are the most significant category of medium and heavy-duty trucks, accounting for 60-75 percent of the fuel consumption for medium and heavy-duty trucks. Therefore, throughout this analysis we focus attention on these vehicles.

Various studies predict that significant percentages of fuel reduction (10-20%) can be made with technology investments of $10,000-$20,000. In addition, substantial percentages of reduction (40-50%) can be made with investments of $40,000-$50,000.[163] This high reduction in fuel consumption is for Class 8 trucks, and other categories may not present equally rich fuel saving potential, but the potential is substantial in all classes of trucks.[164]

Compared to the figures for light duty vehicles, the cost of adding efficiency technologies to heavy duty trucks may appear large. However, heavy duty trucks are driven many more miles and fuel costs are between $100,000-$150,000 annually. Given the much larger number of miles driven per year of heavy duty trucks and the much lower mileage per gallon, as well as the higher cost of diesel, the average annual expenditure on fuel for heavy duty trucks is almost **<u>ten</u>** times the expenditure for light duty vehicles.[165] A ten percent reduction in fuel consumption will support a much larger investment in fuel saving technology.

These analyses leave little doubt that there is a significant amount of technology available that would lower the consumption of fuel in the medium and heavy-duty truck sectors at a very attractive cost. Consumer savings would be substantial. The next question is, why hasn't the marketplace witnessed these investments. With such large potential economic gains available, this section offers answers to two important questions based on the reviews of freight truck sector by several major research institutions:

- Why don't market forces drive these technologies into the vehicles?
- What policies can be implemented to achieve the economic gains?

We examined these questions at length in our comments supporting the recently adopted light duty vehicles efficiency standard.[166] The evidence on work trucks also provides a clear answer.

- The medium/heavy duty truck market exhibits significant market obstacles, barriers and imperfections that inhibit investment in energy saving technologies, and
- Performance standards are a very effective tool for overcoming these obstacles.

MARKET OBSTACLES, BARRIERS AND IMPERFECTIONS INHIBITING INVESTMENT

Externalities Lead to Underinvestment in Fuel Saving Technologies

As noted above, the indirect macroeconomic effects of energy efficiency do not enter into typical cost/benefit decisions about investing in energy efficient technologies. This is true in the work truck sector. While transportation companies capture some of the benefits in increased demand for their services, each company captures, at best, only a small part of the broader economic stimulus that reducing fuel consumption would cause. Therefore, such a benefit would be absent in each company's typical internal cost benefit analysis of fuel saving technology. This category of externalities has expanded recently well beyond the public goods aspect that was identified in traditional economic analysis to include information and learning, network effects and innovation process.

Similarly, U.S. consumption of transportation fuels is sufficiently large that a reduction in the quantity consumed has the effect of lowering the global (and therefore the national) price of crude oil. The public enjoys a large benefit, but the firms investing in efficiency receive only a small part of that total benefit because each individual firm receives a very small share of the total. This is called a consumption externality.[167]

In the freight truck sector, the link between efficiency induced fuel cost savings and positive economic impacts is particularly strong. Transportation is an important intermediate service. When truckers drive more, they are very likely to be carrying more goods or delivering more services, which means that the economy is expanding. Where the increase in truck freight results from a shift between transportation modes, it likely reflects the selection of a more efficient mode, which again indicates an improvement in the economy.

Imperfections in the Market

Since externalities cannot explain the failure of firms to invest in these attractive technologies, EPA shifts it attention to the other factors that inhibit investment (See Table XIII-1).

Not surprisingly, given the strong evidence of many factors that inhibit efficiency in the other sectors demonstrated in our earlier analysis,[168] we find strong support for similar factors in the medium and heavy-duty truck sector.

Table XIII-1: Performance Standards and Market Barriers to Efficiency in the Medium and Heavy-Duty Truck Sector

Nature of the Barrier	Effect on the Market	Impact of the Standard
Information Issues in the first sale market* Unavailable due to public good nature Complexity due to geography, driving styles, uses* Cost of gathering Cost of "redundant" production of Information	Inadequate or unreliable information about fuel saving technologies	Better information more readily available Public provision of information
Information Issues in the Secondary Market Compounded information problem Complexity due to geography, driving styles, uses* Different uses may affect mileage	Resale value inadequately rewards fuel saving technology Lack of incentive to invest in fuel economy in 1st sale market	Better information more readily available
*Split Incentives** Owner-Operator* Owner-Renter Tractor-Trailer Contract structure*	Owners emphasize different attributes Information does not overcome Coordination Problem	Alters the incentives Investment embedded in market Fosters coordination
Shrouded Attribute Lack of availability in bundles* Positional, "status" good	Bundles of attributes maximize other characteristics --durability, maintenance costs	Increased emphasis on shrouded attribute
Market power	Ability to choose operators, dulls market signals	Investment embedded in market, lower risk
Uncertainty Future savings, level and variance* Fuel price, performance, life, use, geography* Risk aversion, Option value Reliability	Savings are future, technology costs are current	Some market uncertainties removed Investment embedded in market, lower risk Hidden costs*
Adjustment & Transaction Costs Conservative approach to change, need to learn *& evaluate technology* Accelerated fleet turnover Training costs	Slows innovation Resistance to capital expenditure Resistance to increased cost	Experience with technology accelerates innovation Levels the playing field for investment
Endemic *Financial** Limited Access to Capital* Short payback, First Cost Bias* Time lag for retrofit*	Crowds out investment in efficiency Short payback period due to under-compensation of initial investment	Levels the playing field for investment Investment embedded in market, lower risk

PRIMARY SOURCES:

Bold = EPA-NHTSA, *Greenhouse Gas Emissions Standards and Fuel Economy Standards for Medium and Heavy-Duty Engines and Vehicles,* Federal Register 76(179), September 15, 2011, pp. 57315-57319.

***Italic* = Committee to Assess Fuel Economy for Medium and Heavy-Duty Vehicles, *Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles,* National Research Council, 2010.**

Underlined = Mike Roeth, et al., *Barriers to the Increased Adoption of Fuel Efficiency Technologies in the North American On--‐Road Freight Sector* Report for the International Council for Clean Transportation March 2013.

*** = Sanne Aarnink, Jasper Faber, Eelco den Boer, *Market Barriers to Increased Efficiency in the European On-road Freight Sector,* Delft, October 2012.**

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David Vernon and Alan Meier, "Identification And Quantification Of Principal---Agent Problem Affect Energy Efficiency Investments And Use Decisions In the Trucking Industry." *Energy Policy, 2012,* 49.

Haifeng Wang, et al., *Marginal Abatement Costs and Cost Effectiveness of Energy-Efficiency Measures,* London: International Maritime Organization (IMO), 2010.

Table XIII-1 shows the results of the analysis of the obstacles to investment in efficiency in the medium/heavy duty truck sector prepared by three major independent institutions. It also identifies the major documents upon which they rely. We also include the EPA/NHTSA Phase I analysis of the truck market, which has been vetted through litigation. In constructing this table, we use the same criteria as we applied in the analysis of *Performance Standards* – including empirical studies or summaries of the empirical literature from the past ten years. These studies support our findings in several important ways.

While some argue that there are no market barriers and imperfections to inhibit investment in energy saving technologies in the medium and heavy-duty truck sector,[169] the failure to make the previously cited investment in technologies, in spite of their clear benefits, indicates that there are significant inhibitors at work that have created an "efficiency gap."

In the Phase I analysis, EPA identified six broad categories of factors that have been offered as explanations for the failure of the truck market to pursue investment opportunities in fuel saving technologies that appear to be cost effective. The other major analyses identify these obstacles and several more, adding a great deal of detail. The findings from the medium and heavy-duty truck sector reinforce several of the key aspects of our earlier analysis.

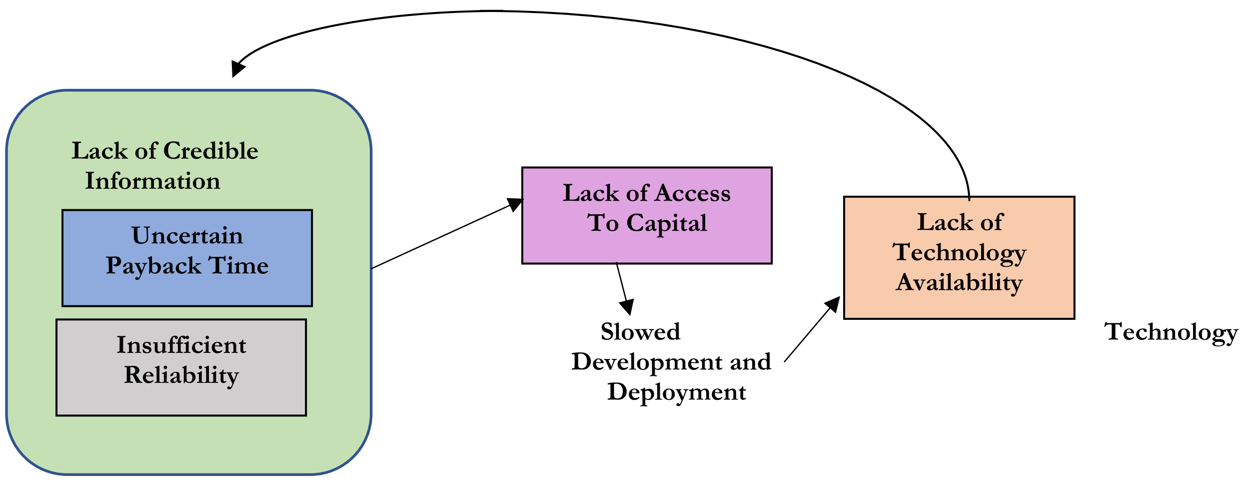
- The analysis involves commercial enterprises, which affirms the fact that economic motivation alone does not ensure optimum investment in efficiency.
- Many of the same factors are confirmed as important obstacles to energy saving investment on both the supply and the demand sides of the market.
- The supply and the demand sides interact and reinforce each other in a vicious circle. Policies that can break the circle are extremely attractive.
- The diffusion of innovation unfolds as a process in which the early challenge is to provide reliable, verifiable information to trigger the diffusion process. Experience allows the sharing of information later in the process, which creates different challenges.

The Environmental Protection Agency and the National Highway Traffic Safety Administration (EPA/NHTSA) examined the evidence that these barriers affect the truck market and summarized their conclusion as follows:

> On the other hand, the short payback period required by buyers of new trucks is a symptom that suggests some combination of uncertainty about future cost savings, transaction costs, and imperfectly functioning market. In addition, widespread uses of tractor-trailer combinations introduces the possibility that owners of trailers have weaker incentives than truck owners to adopt fuel-saving technology for their trailers…
>
> [B]ecause individual results of new technologies vary, new truck purchasers may find it difficult to identify or verify the effects of fuel saving technologies. Those who are risk averse are likely to avoid new technologies out of a concern over the possibility of inadequate returns on the investment, or with other impacts….
>
> Both baselines used project substantially less adoption than the agencies consider to be cost-effective. The agencies will continue to explore reasons for this slow adoption of cost-effective technologies.[170]

The report from the International Council on Clean Transportation summarized the supply-and demand side factors that inhibit innovation with a simple graph that depicts a recursive loop of factors that reinforce one another, as shown in Figure XIII-1. Given the thorough review by EPA/NHTSA, the NRC, and the International Council for Clean Transportation, as well as our own, suffice it to say that there is a significant energy efficiency gap in the medium and heavy-duty truck market and there is no reason to doubt the economic analysis of the potential benefits of closing that gap. In fact, the benefits have likely been underestimated, not only because the full value of externalities has not been included in the economic analyses, but also because the costs of implementing the standards have likely been overestimated.

FIGURE XIII-1: INTERACTION OF SUPPLY AND DEMAND SIDE FACTORS IN A RECURSIVE LOOP INHIBITING INVESTMENT IN EFFICIENCY



Source: Mike Roeth, et al., *Barriers to the Increased Adoption of Fuel Efficiency Technologies in the North American On---Road Freight Sector* Report for the International Council for Clean Transportation March 2013, p. 5.

XIV. THE WORK TRUCK RULES AS EFFECTIVE PERFORMANCE STANDARDS

PERFORMANCE STANDARDS AS A POLICY TOOL TO OVERCOME OBSTACLES TO INVESTMENT

These reviews of the literature on obstacles to investment in efficiency in the medium and heavy-duty truck sector also identify and discuss the ways that performance standards can improve the market performance. The regulatory analyses are required to consider alternatives. They do not conclude that the alternatives (like simple information programs) will have no impact, but that the alternatives do not address key obstacles effectively. As we showed in our *Performance Standards* paper, standards are attractive because they effectively address a wide range of obstacles.

We believe that one of the other major findings of our earlier analysis of fuel economy and performance standards applies in the medium/heavy duty truck sector as well. In order to effectively achieve the large net benefits, performance standards must be well-designed and carefully implemented. The following characteristics, which were critical for the success in the adoption of fuel economy standards for automobiles and light duty trucks, can successfully guide the development of performance for medium and heavy-duty trucks:

Long-Term: Setting a progressively rising standard that targets a high long-term goal over the course of a decade or more will foster and support a long-term perspective for the truck manufacturers, transportation companies and public, by reducing the marketplace risk of investing in new technologies. The long-term view gives the truck makers time to re-orient their thinking, retool their plants and help re-educate the transportation industry. It also gives the industry buying and using these trucks time to adjust.

Technology Neutral: Taking a technology neutral approach to a long-term standard unleashes competition around the standard that ensures that the industry will get a wide range of choices at that lowest cost possible.

Product Neutral: The new attribute-based approach to standards accommodates buyer preferences; it does not try to supplant them. This levels the playing field between truck makers and removes any pressure to push inappropriate vehicles into the market.

Responsive to industry needs: As was done in the light vehicle standards, establishing a long-term performance standard recognizes the need to keep the standards in touch with reality. The standards can be set at a moderately aggressive level that is clearly beneficial and achievable. With thoughtful cost estimates, consistent with the results of independent analyses of technology costs, a long-term performance standard will contribute to the significant reduction of the most significant cost in the transportation industry.

Responsive to consumer needs: The approach to standards should be consumer-friendly and facilitate compliance. The attribute-based approach ensures that the standards do not require radical changes in the available products or the product features that will be available to consumers. The setting of a coordinated national standard that lays out a steady rate of increase over a long-time period giving the market and the industry certainty and time to adapt to change.

Procompetitive: All of the above characteristics make the standards pro-competitive. Producers have strong incentives to compete around the standard to achieve them in the least cost manner, while targeting the market segments they prefer to serve.

In this section we evaluate the Phase II medium and heavy-duty truck rule proposed by EPA/NHTSA. We do so by applying the framework developed in Sections II-V. Moreover, because the Phase I rule is relatively recent and has been upheld by the courts, we focus primarily on the incremental additions to the analysis presented by EPA/NHTSA. We examine four areas that reflect the four sections above.

We begin with a discussion of the fuel savings benefits and the technology costs that must be incurred to achieve the reduction in fuel consumption. Although we recognize there are other economic costs and benefits, these make up the vast majority of the total costs and benefits. They are the most obvious consumer pocketbook benefits and costs. Because they are direct and not externalities, in a properly functioning market they would be reflected in the investment decisions that affect energy consumption. The analysis shows they are not, indicating significant market imperfections, obstacles and failures.

We next examine other, indirect benefits and costs. These are generally externalities that we would not expect producers and consumers to take into account in their decision making, but as important social costs and benefits, they should be taken into account in policymaking. Here we include macroeconomic considerations, including the rebound effect and public health effects. These benefits and costs increase the total value of the proposed rule significantly.

We then examine the explanation (theory) offered for why these costs and benefits have not been reflected in market transactions. Here we address both the issue of market imperfections and the pass-through of fuel costs.

Finally, we evaluate the overall design of the rule, according to the six criteria identified in the previous section. Because there are potentially large additional savings, we conclude with a section devoted to the question of whether the agencies have set the standards at a sufficiently high level.

KEY EXPLANATIONS

The Efficiency Gap and Discount Rates

In justifying the rule, the agencies begin by reprising the explanation offered in defense of the Phase I rule, pointing to five specific market failures and imperfections. They then review recent research and not only conclude that those five factors are still relevant, but they add several others that might come into play.

> In the HD Phase 1 rulemaking (which, in contrast to these proposed standards, did not apply to trailers), the agencies raised five hypotheses that might explain this energy efficiency gap or paradox: imperfect information in the new vehicle market; imperfect information in the resale market; principal-agent problems causing split incentives; uncertainty about future fuel cost savings; adjustment and transactions costs.

> All of the recent research identifies split incentives, or principal-agent problems, as a potential barrier to technology adoption. Uncertainty about future costs for fuel and maintenance, or about the reliability of new technology, also appears to be a significant obstacle that can slow the adoption of fuel-saving technologies… access to capital can be a significant challenge to smaller or independent businesses, and that price is always a concern to buyers… Other potentially important barriers to the adoption of measures that improve fuel efficiency may arise from ‘‘network externalities,’’ where the benefits to new users of a technology depend on how many others have already adopted it…. Some businesses that operate HDVs may also be concerned about the difficulty in locating repair facilities or replacement parts, such as single-wide tires… Manufacturers may be hesitant to offer technologies for which there is not strong demand, especially if the technologies require significant research and development expenses and other costs of bringing the technology to a market of uncertain demand… it can take years, and sometimes as much as a decade, for a specific technology to become available from all manufacturers..[171]

Clearly, the efficiency gap that the market has failed to close can be readily explained by market barriers, obstacles, imperfections and failure. EPA/NHTSA go a step farther in this analysis and draw out an important implication of the pervasive set of market imperfections, something we have been pointing out in these proceedings for several years. When market actors are laboring under the weight of significant market imperfections, calculating discounts rates on the basis of observed market behaviors reflects the totality of market factors, not simply consumer and producer preferences.

EPA/NHTSA stated this observation with respect to payback periods, but it applies equally to discount rates.

> In summary, the agencies recognize that businesses that operate HDVs are under competitive pressure to reduce operating costs, which should compel HDV buyers to identify and rapidly adopt cost-effective fuel-saving technologies…
>
> However, the short payback periods that buyers of new HDVs appear to require suggest that some combination of uncertainty about future cost savings, transactions costs, and imperfectly functioning markets impedes this process. Markets for both new and used HDVs may face these problems, although it is difficult to assess empirically the degree to which they actually do. Even if the benefits from widespread adoption of fuel-saving technologies exceed their costs, their use may remain limited or spread slowly because their early adopters bear a disproportionate share of those costs. In this case, the proposed standards may help to overcome such barriers by ensuring that these measures would be widely adopted.[172]

In 2008, we summarized the important role of supply side and market structural factors in affecting observed discount rates as follows; here we expand on that discussion.[173]

Pass-through

A second theoretical explanation that played an important part in the earlier analysis and was addressed by EPA/NHTSA is the question of the pass-through of cost savings to consumers.

> As a result of this proposed rulemaking, it is anticipated that trucking firms will experience fuel savings. Fuel savings lower the costs of transportation goods and services. In a competitive market, some of the fuel savings that initially accrue to trucking firms are likely to be passed along as lower transportation costs that, in turn, could result in lower prices for final goods and services. Some of the savings might also be retained by firms for investments or for distributions to firm owners. Again, how much accrues to customers versus firm owners will depend on the relative elasticities of supply and demand. Regardless, the savings will accrue to some segment of consumers: Either owners of trucking firms or the general public, and the effect will be increased spending by consumers in other sectors of the economy, creating jobs in a diverse set of sectors, including retail and service industries.[174]

The pass-through issue also turns up in another key aspect of the overall analysis, the rebound effect. The increase in consumption associated with the rebound effect occurs because consumers have more money to spend. The first effect is through the reduction of the cost of travel, but there is a second effect through the increase in disposable income available for other consumption.

> Elasticities with respect to fuel price and fuel cost can provide some insight into the magnitude of the HDV VMT rebound effect….
>
> Freight price elasticities measure the percent change in demand for freight in response to a percent change in freight prices, controlling for other variables that may influence freight demand such as GDP, the extent that goods are traded internationally, and road supply and capacity. This type of elasticity is only applicable to the HDV subcategory of freight trucks (*i.e.,* combination tractors and vocational vehicles that transport freight). One desirable attribute of such measures for purposes of this analysis is that they show the response of freight trucking activity to changes to trucking rates, including changes that result from fuel cost savings as well as increases in HDV technology costs. Freight price elasticities, however, are imperfect proxies for the rebound effect in freight trucks for a number of reasons. For example, in order to apply these elasticities, we must assume that our proposed rule's impact on fuel and vehicle costs is fully reflected in freight rates. This may not be the case if truck operators adjust their profit margins or other operational practices (*e.g.,* loading practices, truck driver's wages) instead of freight rates. It is not well understood how trucking firms respond to different types of cost changes (*e.g.,* changes to fuel costs versus labor costs).[175]

These observations make it clear that there is a significant level of pass-through of cost savings. Given the competitiveness of the trucking industry and its importance, we believe it is substantial. EPA/NHTSA conclude that there will be pass-through, but they do not provide an estimate. Their estimate of the rebound effect is moderate – 10% – based on a variety of factors. We have discussed this earlier. Given the very large economic benefits, the magnitude of the rebound effect does not significantly affect the bottom line of the analysis. Without specifying the precise level, it is clear that pass-through is significant and has important macroeconomic benefits.

THE ATTRIBUTES OF THE PHASE II RULE FOR WORK TRUCKS[176]

Long-Term: In economics, the view of time is defined by the extent to which the capital stock can be changed.[177] In the short-term it is fixed. In the long-term it can be extensively changed. In designing performance standards, the key issue is the cycle on which the design of consumer durables is refreshed or entirely redone. In the heavy-duty truck sector, EPA/NHTSA point out that the cycle can take as long as ten years. EPA/NHTSA see this as a fundamental constraint on the ability to set standards to require technologies to be included in vehicles.

> Under Alternative 3, the preferred alternative, the agencies propose to provide ten years of lead time for manufacturers to meet these 2027 standards, which the agencies believe is adequate to implement the technologies industry could use to meet the proposed standards. For some of the more advanced technologies production prototype parts are not yet available, although they are in the research stage with some demonstrations in actual vehicles. Additionally, even for the more developed technologies, phasing in more stringent standards over a longer timeframe may help manufacturers to ensure better reliability of the technology and to develop packages to work in a wide range of applications. Moving more quickly, however, as in Alternative 4, would lead to earlier and greater cumulative fuel savings and greenhouse gas reductions.[178]

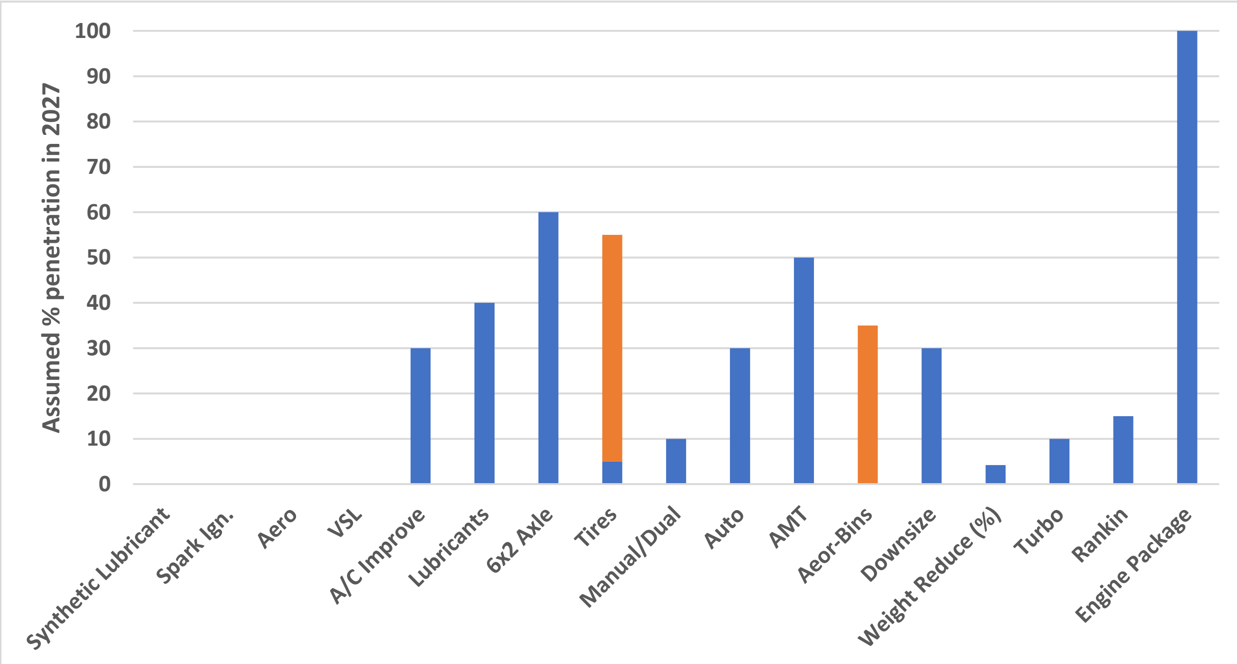
The agencies go through potential technologies one-by-one to assess the time frame in which they could be implemented and find several that have rather long periods. For example:

> The issue for heavy-duty vehicles is that the cab and/or passenger compartment is designed for a specific purpose such as accommodating an inline cylinder engine or allowing for clear visibility given the size of the vehicle. Consequently, a reduction in vehicle size and/or frontal area may not be realistic for some applications. This also may necessitate an expensive, ground-up vehicle redesign and, with a tractor model lifecycle of up to 10 years, may mean that a mid-cycle tractor design is not feasible. In addition, the frontal area is also defined by the shape behind the cab so reducing just the cab frontal area/size reduction may not be effective. Thus, this approach is something that may occur in a long-term timeframe of 10-15 years from today.[179]

While the long redesign cycle presents a challenge for standard setting, the 10-year time frame chosen by EPA/NHTSA represents a reasonable balance. It is hard to predict much beyond that period, but it gives the industry the opportunity to implement technologies. On the other hand, given the legislative mandates to maximize efficiency and reduce environmental harms to the extent feasible, the long cycle demands that the agencies actively monitor developments within the industry to see whether technologies have become feasible for the purpose of setting future standards. It also puts a spotlight on the importance of other policies, beyond standards, to speed the product cycle.

Technology Neutral: Technology neutrality leaves the choice of which technologies to utilize up to the manufacturers. The agencies achieve this outcome in two ways. They do not mandate any specific technology and they do not assume a very high level of penetration of many technologies. By relying on a variety of technologies that affect several of the key attributes of the vehicle that affect energy consumption, they create a rich palate of alternatives from which the manufacturers can choose to meet the standard (see Figure XIV-1).

FIGURE XIV-1: ADOPTION RATES FOR MAJOR CATEGORIES OF TECHNOLOGIES



Source: EPA/NHTSA, Phase II NOPR, Tables II-6 and III-10,

EPA/NHTSA assume a high penetration (over 50%) of a couple of the technologies based on their analysis of the market. However, even though they assume this high level to set the standard, manufacturers would not have to uniformly include the measures that EPA/NHTSA use to set the standard. They could meet the standard using a mix of other technologies, including many of those that were not used to set the standard. Given the level of the standard, there is a lot of head room for manufacturers to be innovative. The question that arises is not about whether the agencies have adhered to the principle of technological neutrality, they clearly have. The question is that in balancing the mandates of feasibility and maximizing energy savings and emissions reduction, they have given feasibility too much weight.

> For each category of HDVs, the standards would set performance targets that allow manufacturers to achieve reductions through a mix of different technologies and leave manufacturers free to choose any means of compliance.[180]

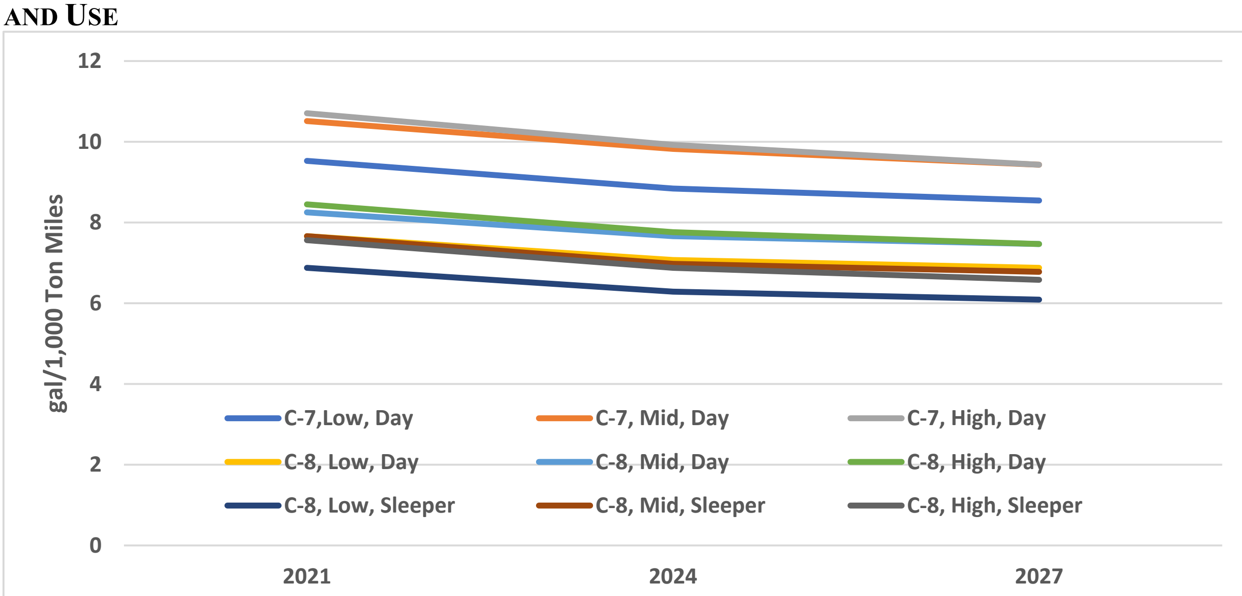
Product Neutral: The large amount of head room that EPA/NHTSA have left for manufacturers applies to alternative technologies across the board. Thus, entirely new approaches to meeting the standards are welcome and a small penetration of alternative engine types (Rankin and hybrid engines) factors into the level of the standards. In a sense, this is a step back from Phase I in which these alternatives were given additional credits as incentives to develop and deploy the technologies.

Responsive to industry needs: Above we noted that a fundamental constraint on setting standards is the refresh and redesign cycle of the product. As second constraint is the adoption cycle.[181] Given the amount of capital, the life of the product and its uses, the speed of adoption can vary substantially. Again, EPA/NHTSA evaluate specific technologies with respect to adoption cycles.

> As in Phase 1, we have chosen not to base the proposed standards on performance of VSLs because of concerns about how to set a realistic adoption rate that avoids unintended adverse impacts. Although we expect there will be some use of VSL, currently it is used when the fleet involved decides it is feasible and practicable and increases the overall efficiency of the freight system for that fleet operator. To date, the compliance data provided by manufacturers indicate that none of the tractor configurations include a tamper-proof VSL setting less than 65 mph. At this point the agencies are not in a position to determine in how many additional situations use of a VSL would result in similar benefits to overall efficiency or how many customers would be willing to accept a tamper-proof VSL setting. We are not able at this time to quantify the potential loss in utility due to the use of VSLs. Absent this information, we cannot make a determination regarding the reasonableness of setting a standard based on a particular VSL level. Therefore, the agencies are not premising the proposed standards on use of VSL, and instead would continue to rely on the industry to select VSL when circumstances are appropriate for its use. The agencies have not included either.[182]

The challenge of the adoption cycle reinforces the challenge of the product design cycle. Monitoring the development and adoption of technologies and using other policies to accelerate both are important activities to undertake. The agencies have outlined a list of key technologies that are already feasible or candidates for future inclusion in standards, as shown in Figure XIV-2.

FIGURE XIV-2: STANDARDS REFLECT TRACTOR TRAILER ATTRIBUTES: CLASS, CAB HEIGHT AND USE



Source: EPA/NHTSA, Phase II NOPR, Table III-1.

Responsive to consumer needs: In the general discussion of performance standards, we include the principle that standards should be attribute based as the key to this criterion. Consumers purchase and use durables for specific purposes. The attributes of the durables are extremely important. To the extent that agencies design standards to ensure consumers get the functionalities they need, the standards will be more effective. As in all cases, balance is necessary. Just as some consumers are more demanding, the agency may well conclude that those consumers are also more willing to pay for attributes, so higher levels of efficiency are feasible and practicable in the marketplace. Thus, whether or not the statute explicitly requires or defines specific attributes that should be considered, the agencies can and should take attribute based approaches under their general obligation to ensure standards are feasible and practicable.

EPA/NHTSA have certainly made that effort here. For example, as Figure XI-1, above, shows the target levels and development paths for the fuel consumption of tractor trailers taking their class, cab height and use into account. There is a 30% difference in targets across the nine categories and a 3% difference in the rate of improvement.

The challenge in balancing the consumer and producer interests is to recognize that standards that are too weak impose significant harm on consumers. They end up spending much more on freight transport than they should.

Procompetitive: Given the above description of the Phase II proposal, we conclude that it would be procompetitive. It would induce competition around the standard in which manufacturers would install those technologies in which they have an advantage, given the nature of their expertise and the customers they serve.

Well-designed performance standards that follow these principles command but they do not control. They ensure consumer needs are met while delivering energy savings and increasing consumer and total social welfare.

STRIKING THE BALANCE BETWEEN FUEL SAVINGS AND FEASIBILITY

In this section we examine the challenge of striking a balance between achieving the maximum energy savings/emissions reductions and the constraints of feasibility. Failing to achieve the maximum economically beneficial savings imposes a direct and significant harm on consumers – they are forced to pay too much for the goods and services that they consume. Mandating technologies that are infeasible will drive up costs and ultimately cause the performance standards to fail. These two considerations deserve equal weight, particularly in a sector where efficiency improvements have been largely flat, while the rest of the economy has been improving dramatically. The "burden of proof" established by the underlying statutes does not favor one concern over the other and leaves the agencies a great deal of discretion.

Throughout these comments we have identified the central tension in the otherwise excellent proposed rule. Did EPA/NHTSA leave too much energy savings on the table by underestimating the feasibility of adopting extremely beneficial technologies? EPA/NHTSA have said they are concerned that specific technologies cannot enter the market or cannot penetrate sufficiently to be allowed to influence the level of the standard, but they have not actually provided any evidence to support those conclusions. The fact that the industry has been a technological laggard for decades is an excuse, not an explanation.

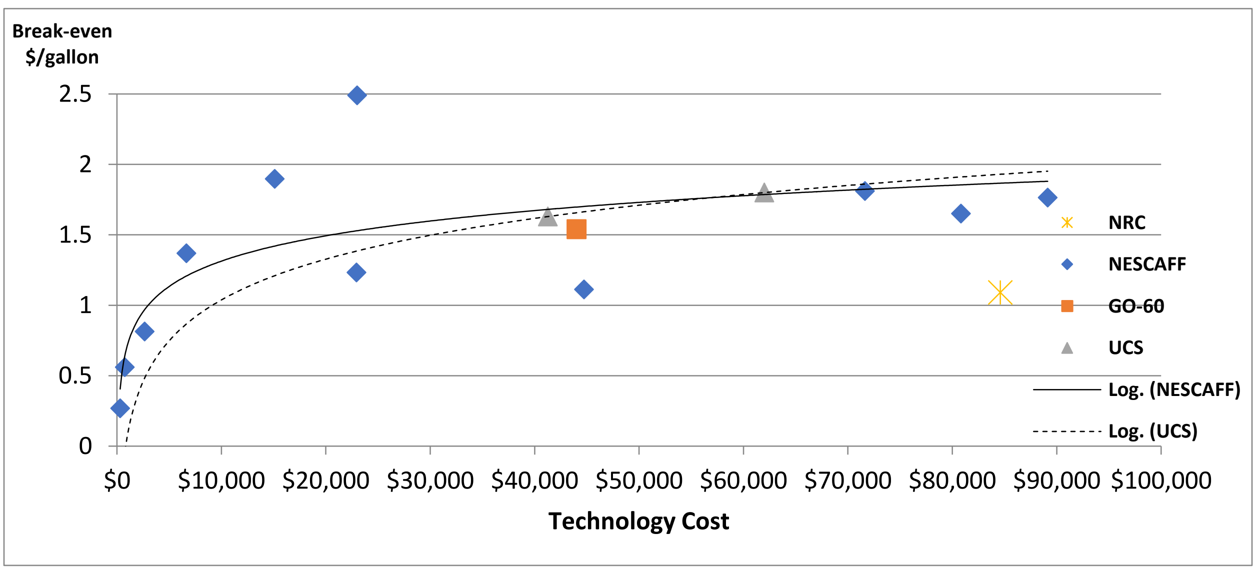
Two aggregate perspectives on the decision of the agencies to choose a relatively low level of energy savings – one internal, one external – shed light on this dilemma.

The analysis of technology cost curves in Section VII showed that there were many technology options that would deliver greater energy savings. If we consider two bundles, better engines or aerodynamics plus tires, the improvement would be 1.7 times as large. The ICCT is certainly correct in concluding that "if the US standards are going to require technology-forcing SuperTruck-like standards for tractors, it is more likely this would be in some future Phase 3 rulemaking for perhaps 2030 and beyond."

More importantly, with estimates of the technology costs and fuel savings in hand, the National Research Council report on medium and heavy-duty trucks simplifies the cost benefit analysis by focusing on the cost side and not making assumptions about fuel prices (See Figure XI-3). Instead of engaging in the uncertain and sometimes contentious exercise of projecting fuel costs over long periods, the National Research Council estimates the price per gallon that would be necessary to break even on an investment that incorporates technologies to reduce fuel consumption in medium and heavy-duty trucks, as noted in the discussion of OMB Circular-4.

NRC includes a discount rate, representing the time value of money, set at 7% to compare the estimated costs of saved fuel to projections for the future cost of fuel.[183] As shown in Figure XI-3 the NRC estimated that fuel prices would have to be just $1.09 per gallon for a very large investment in new technology to earn a 7% real rate of return. As actual fuel prices are currently over two and a half times this amount and expected to rise over time, the payout from these technologies would far exceed their cost.

FIGURE XI-3: COST PER GALLON BREAK-EVEN ANALYSIS FOR CLASS 8 TRUCKS



Sources: Northeast States Center for a Clear Air Future, International Council on Clean Transportation and Southwest Research Institute, *Reducing Heavy Duty Long Haul Combination Truck Fuel Consumption and* CO_2 *Emissions,* October *2009;* Don Air, *Delivering Jobs: The Economic Costs and Benefits of Improving the Fuel*

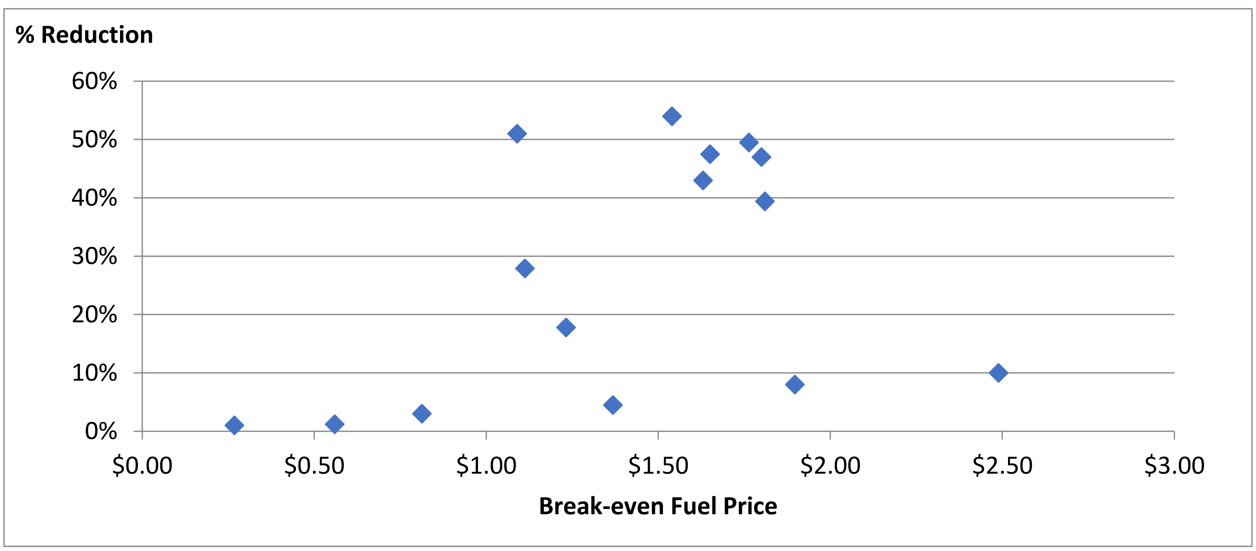
Economy of Heavy-Duty Vehicles, Union of Concerned Scientists, May 2010; Committee to Assess Fuel Economy for Medium and Heavy Duty Vehicles, *Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles*, National Research Council, 2010; Go 60 MPG, *Delivering the Goods: Saving Oil and Cutting Pollution from Heavy Duty Trucks.* A. Sidddiq Khan and Therese Langer, 2011, *Heavy Duty Vehicle Fuel Efficiency and Greenhouse Gas Emissions: The 2014-2019 Standards and a Pathway to the Next Phase,* American Council for an Energy Efficient Economy, December, 2011.

In Figure XI-3, we have also converted the results of several other recent studies to this break-even approach. While there are some differences among these studies, there is a clear consensus that large investments in increasing the fuel economy of medium and heavy-duty trucks are very attractive. All but one of the analyses show that investments in technology to improve fuel economy would earn more than the 7% discount rate at diesel prices of $2 and substantially more at higher gas prices. At a 3% discount rate, the breakeven price would be considerably lower. The analysis in Section VI suggests it could be as low as $0.70/gal.

EIA's projected diesel prices increase by 1.8% per year over the next 35 years to about $4.15 per gallon. This is over three times as fast as gasoline prices are projected to rise (.5%).

Figure XI-4 shows the size of potential fuel savings compared to technology costs. It suggests that a goal of cutting tractor trailer fuel consumption by 40 to 50 percent is economical in the long run. In order to cut fuel consumption in half, one must double the fuel economy of the vehicle.

FIGURE XI-4: TRACTOR TRAILERS: PERCENTAGE REDUCTION IN CONSUMPTION & BREAK-EVEN FUEL COSTS



Sources: Northeast States Center for a Clear Air Future, International Council on Clean Transportation and Southwest Research Institute, *Reducing Heavy Duty Long Haul Combination Truck Fuel Consumption and CO_2 Emissions,* October *2009;* Don Air, *Delivering Jobs: The Economic Costs and Benefits of Improving the Fuel Economy of Heavy-Duty Vehicles,* Union of Concerned Scientists, May 2010; Committee to Assess Fuel Economy for Medium and Heavy Duty Vehicles, *Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles,* National Research Council, 2010; Go 60 MPG, *Delivering the Goods: Saving Oil and Cutting Pollution from Heavy Duty Trucks.* A. Siddiq Khan and Therese Langer, 2011, *Heavy Duty Vehicle Fuel Efficiency and Greenhouse Gas Emissions: The 2014-2019 Standards and a Pathway to the Next Phase,* American Council for an Energy Efficient Economy, December.

This is exactly the target that was adopted for light duty vehicles in the 2012 CAFE rule. For example, if you reduce consumption by 50%, the breakeven cost of fuel is $1.50, which means that as long as fuel is more than $1.50, the cost of technology will be a money saver, around $1.00 at a 3% discount rate.

CONCLUSION

CFA has always argued that performance standards should be inframarginal, moving the industry toward its technological frontier, but not pressing the frontier outward and leaving room for competition to work its magic. We have called for benefit cost ratios of 2-to-1 based on consumer pocketbook economics (direct cost savings) as a cautiously aggressive but responsible approach. A benefit cost ratio of five-to-one, as is the case here, robs consumers of significant pocketbook cost savings. Therefore, we urge the agencies to provide a much more thorough, evidenced-based discussion of why so much cost-beneficial energy savings has been left untapped.

While the very large potential benefits lead us to call on the agencies to give a hard second look at the other factors that have led it to not push the industry harder, we believe that the huge efficiency gap also sends another strong message that should not be lost in the dickering over standard levels. The massive efficiency gap is testimony to a market that has performed abysmally for an extended period of time. We urge the agencies to seize the clear evidence on the failure of the medium/heavy duty truck market with respect to efficiency to transform the terrain of decision making in setting standards. As discussed above, they have moved in the right direction in at least half a dozen ways with the analysis of the proposed rule:

Discount rate: Recognizing real world consumer discount rate of 3% and market imperfections driving observed discount rate.

Efficiency Gap/Market Imperfection Analysis: Recognizing 30 years of empirical evidence demonstrating validity of efficiency gap explanation and identifying specific barriers, imperfections and obstacles that afflict specific markets.

Merging energy and environmental analysis: Recognizing major impact of fuel savings on assessment of rules.

Macroeconomic analysis: Reconciling important benefit of expansion of macro-economic activity resulting from greater fuel economy with realistic assessment of the rebound effect.

National security: Looking carefully at the impact of imports on national security and consumption externalities created by the large U.S. role in petroleum markets.

Effective design of standards: Designing standards that “command but do not control,” thereby unleashing forces of competition to ensure least cost implementation.

PART V.

APPLIANCE EFFICIENCY STANDARDS

XV. STANDARDS FOR TRADITIONAL HOUSEHOLD APPLIANCES

This Part presents evidence from the regulation of the energy consumption of household appliances. Appliance efficiency standards are excellent examples of "command-but-not-control" regulation that deliver large net benefits to consumers, the nation and the environment. The existence of an efficiency gap and the effect of well-designed performance standards apply in this space. Having made the general case for the existence of market imperfections and the effectiveness of performance standards as a response, we focus on specific features of appliances efficiency standards in this section. We begin with two broad issues. How much efficiency improvement is feasible and how much will it cost. We then turn to an example in the analysis of appliances to demonstrate the generality of the framework. We include it here, even though a negotiated regulation was overturned by the courts and DOE never issued a follow up final order, because it did conduct extensive analysis which demonstrates the precision of the benefit cost framework. Moreover, the failure of DOE to issue rules for furnaces underscores the importance of standards when the poor market performance of furnaces is compared to the much better performance of other appliances, as discussed below.

RESIDENTIAL APPLIANCES

Quantity

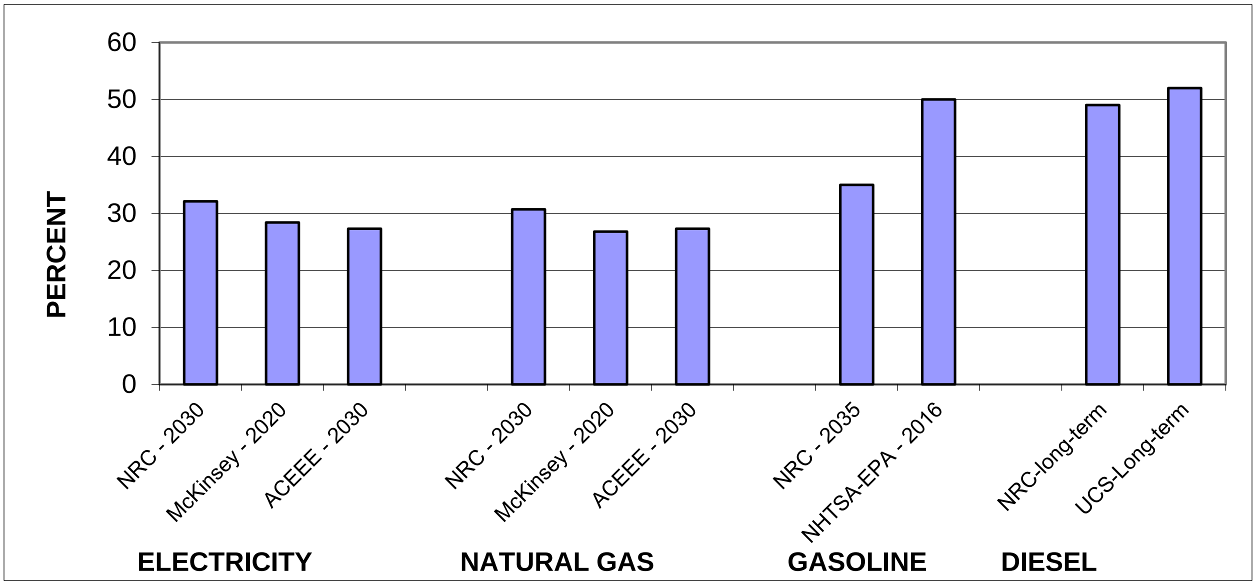
In comments filed in a proceeding that involved *Equipment Price Forecasting for Refrigerators, Refrigerator-freezers and Freezers*, CFA offered observations on the consumer benefits of more energy efficient appliances.

> CFA has been a party to numerous DOE rulemakings dealing with higher efficiency standards for home appliances, such as residential boilers and furnaces, air conditioners, water heaters, to name a few. We have long held that consumers benefit from more efficient products through lower energy costs. Incremental costs for efficiency improvements are paid back to the consumer in a reasonable amount of time—ultimately, the consumer saves money over the life of the product. For over eight years, CFA, working with its state and local affiliates, led a national public awareness campaign promoting increased consumer awareness of the economic, environmental and health benefits of energy efficient products and practices.[184]

Figure XV-1, updated from the comments filed in the appliance efficiency proceeding, shows that there is a large potential to reduce the consumption of each of the forms of energy consumed by most households (electricity, natural gas, gasoline, and diesel). In those comments, CFA pointed out that there was widespread agreement among the most prestigious national research institutions that the potential benefit of greater energy efficiency is substantial.

Figure XV-1 shows that a 20 to 30 percent reduction in consumption for energy sources consumed directly by households is technically feasible and economically practicable.

FIGURE XV-1: THE SIZE OF THE EFFICIENCY GAP ACROSS ENERGY MARKETS: TECHNICALLY FEASIBLE, ECONOMICALLY PRACTICABLE POTENTIAL ENERGY SAVINGS



Sources and Notes: Updated from: Cooper, Mark, 2011b, *Comments of the Consumer Federation of America, Equipment Price Forecasting for Refrigerators, Refrigerator-freezers and Freezers*, Re: Docket Number EE–2008–BT–STD–0012, March 24. Energy prices 2010 and projections from Energy Information Administration, *Annual Energy Outlook: 2013;* Electricity and natural gas savings based on Gold, Rachel, Laura, et. al., *Energy Efficiency in the American Clean Energy and Security Act of 2009: Impact of Current Provisions and Opportunities to Enhance the Legislation*, American Council for an Energy Efficient Economy, September 2009), McKinsey Global Energy and Material, *Unlocking Energy Efficiency in the U.S. Economy* (McKinsey & Company, 2009); National Research Council of the National Academies, *America's Energy Future: Technology and Transformation, Summary Edition* (Washington, D.C.: 2009). The NRC relies on a study by Lawrence Berkeley Laboratory for its assessment (Richard Brow, Sam Borgeson, Jon Koomey and Peter Biermayer, *U.S. Building-Sector Energy Efficiency Potential* (Lawrence Berkeley National Laboratory, September 2008). Gasoline based on: National Highway Traffic Safety Administration, *Corporate Average Fuel Economy for MY2012-MY 2016 Passenger Cars and Light Trucks, Preliminary Regulatory Impact Analysis*, Tables 1b, and 10. The 7 percent discount rate scenario is used for the total benefit = total cost scenario; NAS -2010, National Research Council of the National Academy of Science, *America's Energy Future* (Washington, D.C.: 2009), Tables 4.3, 4.4; MIT, 2008, Laboratory of Energy and the Environment, On the Road in 2035: Reducing Transportation's Petroleum Consumption and GHG Emissions Cambridge: July, 2008), Tables 7 and 8; EPA-NHTSA - 2010, Environmental Protection Agency Department of Transportation In the Matter of Notice of Upcoming Joint Rulemaking to Establish 2017 and Later Model Year Light Duty Vehicle GHG Emissions and CAFE Standards, Docket ID No. EPA-HQ-OAR-0799 Docket ID No. NHTSA-2010-0131, Table 2, CAR – 2011. Diesel based on: Northeast States Center for a Clear Air Future, International Council on Clean Transportation and Southwest Research Institute, *Reducing Heavy Duty Long Haul Combination Truck Fuel Consumption and CO_2 Emissions*, October *2009;* Don Air, *Delivering Jobs: The Economic Costs and Benefits of Improving the Fuel Economy of Heavy-Duty Vehicles*, Union of Concerned Scientists, May 2010; Committee to Assess Fuel Economy for Medium and Heavy Duty Vehicles, *Technologies and Approaches to Reducing the Fuel Consumption of Medium- and Heavy-Duty Vehicles*, National Research Council, 2010; Go 60 MPG, *Delivering the Goods: Saving Oil and Cutting Pollution from Heavy Duty Trucks.*

We summarized the analytic consensus as follows:

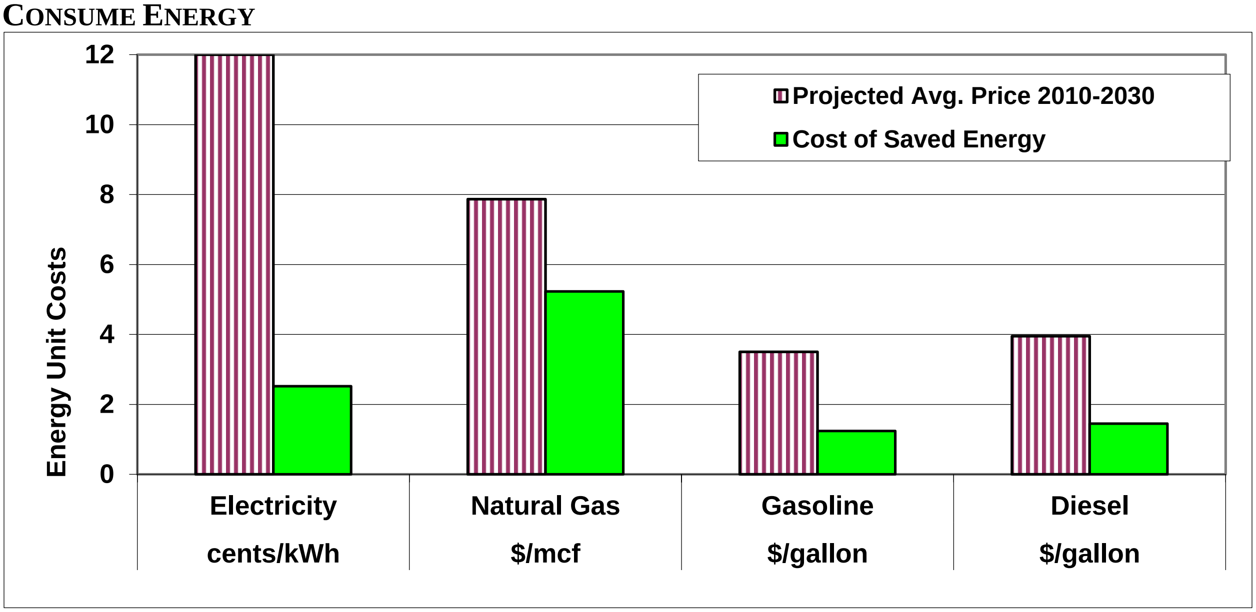
> In the past year, four major national research institutions have released reports that document the huge potential for investments in energy efficiency to lower consumers' bills and greenhouse gas emissions, creating a win-win for consumers and the

environment. The National Research Council of the National Academy of Sciences has estimated the potential reduction in electricity, natural gas and gasoline at approximately 30 percent, similar to the estimates of NHTSA/EPA. McKinsey and Company and the American Council for Energy Efficient Economy have reached a similar conclusion on electricity and natural gas. Across these three sectors, saving energy costs about one third of the price of producing it. With the publication of these studies, the question is no longer "Can efficiency make a major contribution to meeting the need for electricity in a carbon constrained environment?"

These studies demonstrate that it can.[185]

As shown in Figure XV-2, this potential energy savings can be achieved by including more energy efficient technologies in the consumer durables that use energy at a fraction of the cost of the energy consumption to consumers. Reduced energy consumption lowers the consumer energy bill much more than the cost of including the advanced technology to reduce the energy use of the durables. Simply put, it costs a lot less to save energy than to use it.

FIGURE XV-2: THE COST OF SAVING ENERGY IS MUCH LOWER THAN THE PRICE PAID TO CONSUME ENERGY



Source: See Figure XV-1, cost of saved energy is average of estimates across studies.

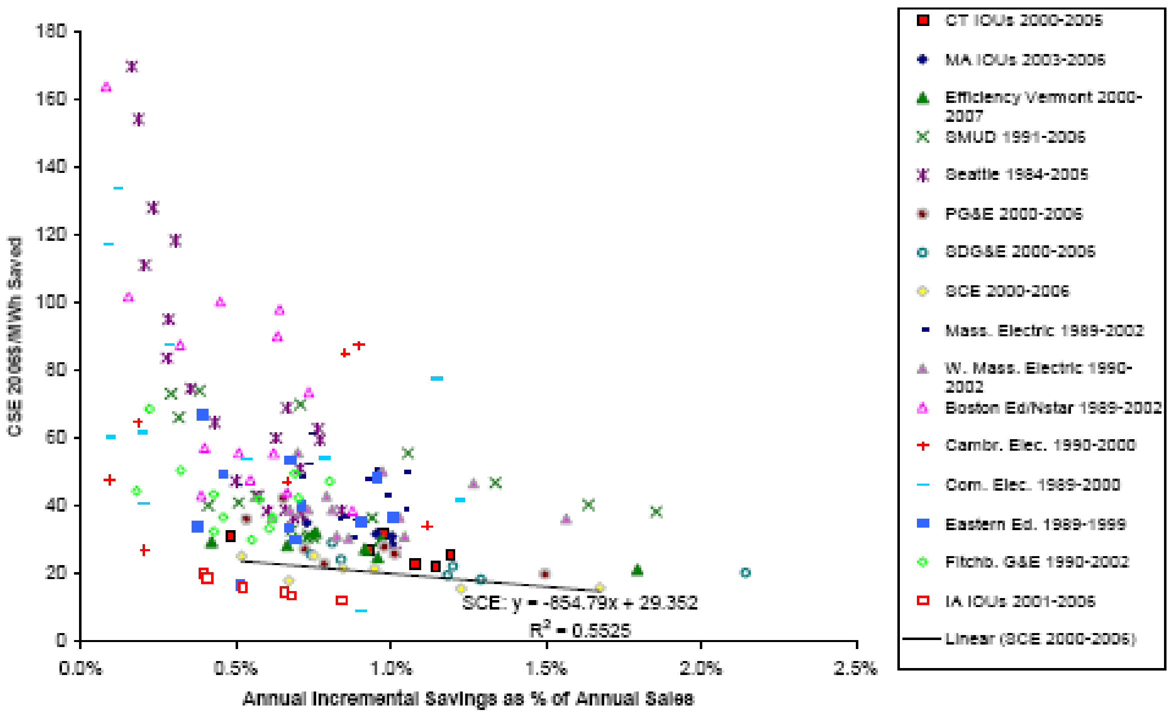
Cost

Engineering economic analyses provided the initial evidence for the efficiency gap. *Ex ante* analyses indicated that there would be substantial net benefits from including technologies to reduce energy consumption in consumer durables. As these policies were implemented *ex post* analyses were conducted to ascertain whether the *ex ante* expectations were borne out.

The most intense and detailed studies were conducted by utilities subject to regulation. Figure XV-3 shows the results of analyses of the cost of efficiency in sixteen states over various periods covering the last twenty years. The data points are the annual average results obtained in various years at various levels of energy savings. The graph demonstrates two points that are important for the current analysis.

- First, the vast majority of costs fall in the range of $20/MWh to $50/MWh (i.e. 2 to 5 Cents/kwh).
- Second, the higher the level of energy savings, the lower the level of costs. There is certainly no suggestion that costs will rise at high levels of efficiency.

FIGURE XV-3: UTILITY COST OF SAVED ENERGY (2006$/MWH) VS. INCREMENTAL ANNUAL SAVINGS AS A % OF SALES

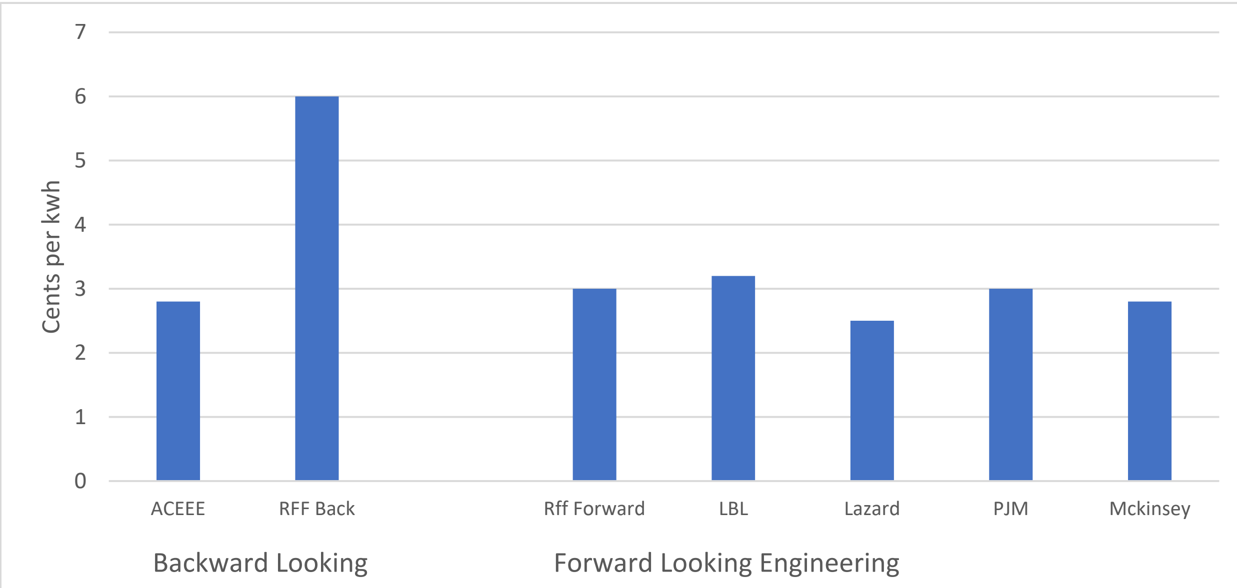


Source: Kenji Takahasi and David Nichols, "Sustainability and Costs of Increasing Efficiency Impact: Evidence from Experience to Date," *ACEEE Summer Study on Energy Efficient Buildings* (Washington, D.C., 2008), p. 8-363.

This analysis of the actual cost of saved energy is consistent with several other analyses that look back at what has been achieved by efficiency policy. As shown in Figure XV-4, several other efforts to look back at achieved costs reach similar conclusions, including estimates from Resources for the Future and the U.S. Department of Energy. The forward-looking estimates from research institutions like Lawrence Berkeley labs and McKinsey and Company are similar. In fact, utilities and Wall Street analysts use similar estimates.

The cost of technologies to reduce energy consumption are frequently converted to a simple measure of the cost of saved energy by dividing the investment cost (with appropriate discount rates and deflators) by the quantity of energy saved. These estimates of the cost of saved energy (COSE) enjoy a strong consensus. The quantity of energy that has been or can be saved is subject to more debate. The best empirical evidence is that at least 40% of the reduced electricity consumption in California can be attributed to its energy policies – appliance efficiency standards, building codes, and utility efficiency programs.[186] The recent study by Levinson mentioned in the introduction corroborates this finding using the same basic model. It shows that about 39% of the reduction could be attributed to California policies. However, it then goes on to challenge that finding by introducing a new set of variables, but that final analysis is fatally flawed and deserves to be given no weight.[187]

FIGURE XV-4: THE COST OF SAVED ELECTRICITY

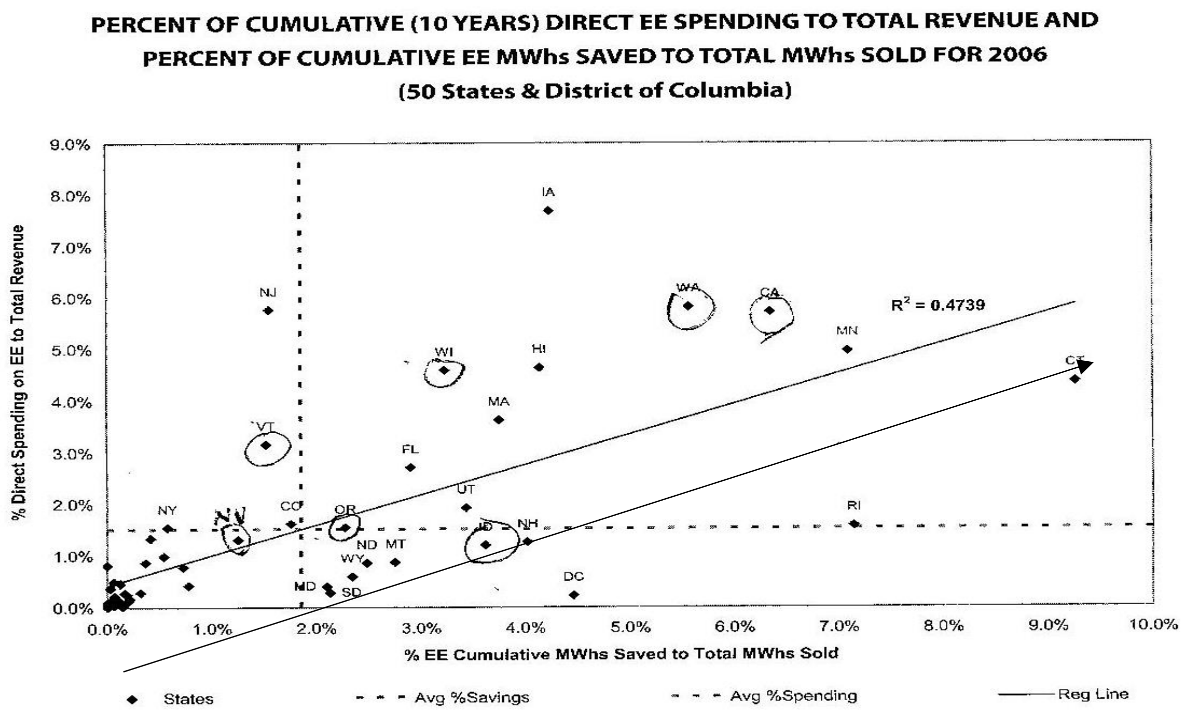


Source: Kenji Takahasi and David Nichols, "Sustainability and Costs of Increasing Efficiency Impact: Evidence from Experience to Date," *ACEEE Summer Study on Energy Efficient Buildings* (Washington, D.C., 2008), p. 8-363, McKinsey Global Energy and Material, *Unlocking Energy Efficiency in the U.S. Economy* (McKinsey & Company, 2009); National Research Council of the National Academies, *America's Energy Future: Technology and Transformation, Summary Edition* (Washington, D.C.: 2009). The NRC relies on a study by Lawrence Berkeley Laboratory for its assessment (Richard Brown, Sam Borgeson, Jon Koomey and Peter Biermayer, *U.S. Building-Sector Energy Efficiency Potential* (Lawrence Berkeley National Laboratory, September 2008).

All of the above analyses of the effect of energy policy arrive at the estimate indirectly, by trying to estimate the other factors that affected electricity consumption and attributing the unexplained variance to policy. However, as suggested by the analysis of price, the impact of some of the policies can be examined directly. In fact, the 2008 paper that estimated that policy accounted for 43% of the variance, showed a strong correlation between a ranking of energy efficiency programs,[188] and the level of electricity consumption.[189] The strong correlation between program ranking and the level of energy consumption is instructive but imprecise.[190] Efforts to directly assess the impact of policy instruments more precisely support the conclusion that policy matters.

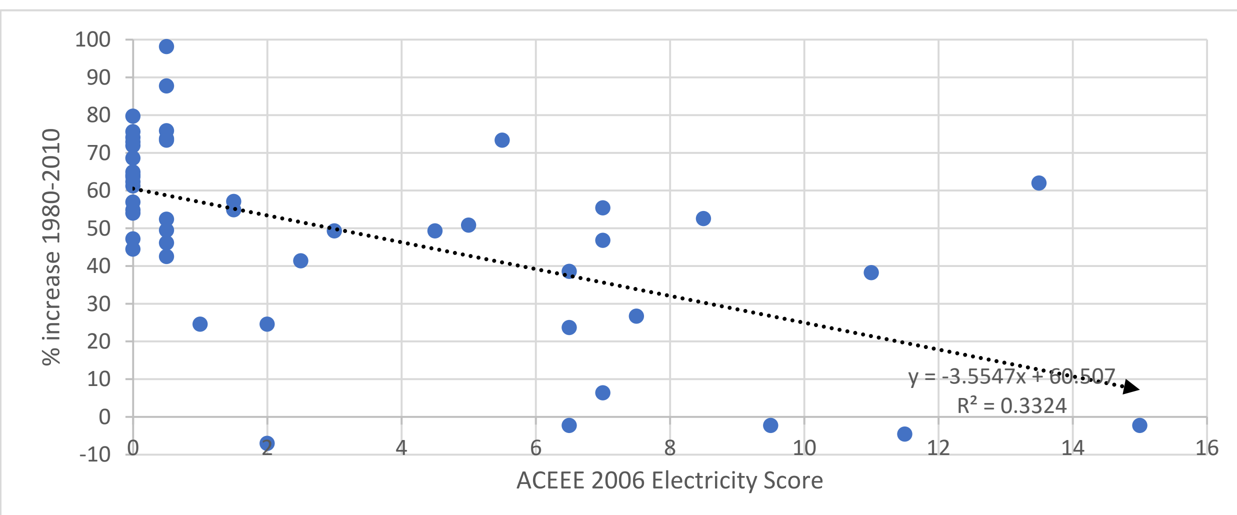
Charles Cicchetti examined the relationship between spending on utility energy efficiency programs and incremental savings attributed to those programs. As shown in the upper graph in Figure XV-5, he found a strong relationship, with spending explaining almost of half of the variance in energy savings. Figure XV-5 also identifies the states that equaled or exceeded California's performance on electricity growth over the past 30 years. Even in this elite group, policy effort matters.

FIGURE XV-5: UTILITY ENERGY EFFICIENCY SPENDING AND SAVINGS



Source: Charles Cicchetti, *Going Green and Getting Regulation Right*, Public Utilities Reports, 2009, p. 105.

ACEEE Spending 2006, EIA Consumption (contiguous, lower 48 states)



Source: U.S. EIA State Database; Eldridge, Maggie, et al. The State Energy Scorecard for 2006, American Council for and Energy Efficient Economy, June 1

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The lower graph uses the ACEEE 2006 spending (as in Kandel, Sheridan and McCAuliffe, 2008) as a proxy for long term effort at efficiency and correlates it with the growth of consumption over the 1980-2010 period. Again, the correlation is strong and significant.

If the policy accounts for 40% or more of the savings in growth of electricity consumption, over the long term that represents about a 20% reduction in electricity consumption. This is consistent with the engineering estimates cited in Section I.

GAS FURNACES

Market Imperfections as the Cause of Consumer Harm in the Market for Gas Furnaces[191]

A well-designed performance standard that raises the efficiency of gas furnaces will deliver benefits to consumers and the nation because it addresses important market imperfections that are difficult to correct with other policies.[192] Our extensive analysis of the literature and hundreds of studies has identified five broad categories and three dozen specific market imperfections. We described the specific market imperfections that affect the energy consumption of gas furnaces in Table XV-1.

The numerous, varied and significant market imperfections mean that weak, single purpose policies, like information programs, will not be effective. Stronger policies, like price increases (e.g. a gas guzzler tax), do not address many of the imperfections. Simply raising the price of natural gas may impose a great deal of cost on uses that do not suffer market imperfections, while the market imperfections in other markets sectors diminish the impact of prices.

We believe the proposed standards possess the key characteristic of effective performance standards. The levels of efficiency and products are widely available in the market. The lead time is more than adequate. The one unique characteristic of the standard is that the higher levels require a different technology (condensing furnaces) because the non-condensing furnaces simply cannot perform much better. The physics of the furnace require shifting to a new technology to achieve efficiencies above 90%. Manufacturers can implement the technology in different ways, however.

THE TRACK RECORD OF APPLIANCE ENERGY PERFORMANCE STANDARDS AND PRICES

Impact on Efficiency

The process of innovation and technological progress to lower the cost of energy savings over the implementation phase is strongly supported by the development of appliance efficiency standards.

1. For the past several decades, the retail price of appliances has been steadily falling while efficiency has been increasing.

2. Past retail price predictions made by the DOE analysis of efficiency standards, assuming constant price over time, have tended to overestimate retail prices.

3. The average incremental price to increase appliance efficiency has declined over time. DOE technical support documents have typically overestimated the incremental price and retail prices.

4. Changes in retail markups and economies of scale in production of more efficient appliances may have contributed to declines in prices of efficient appliances.[193]

TABLE XV-1: IMPERFECTIONS ADDRESSED BY STANDARDS

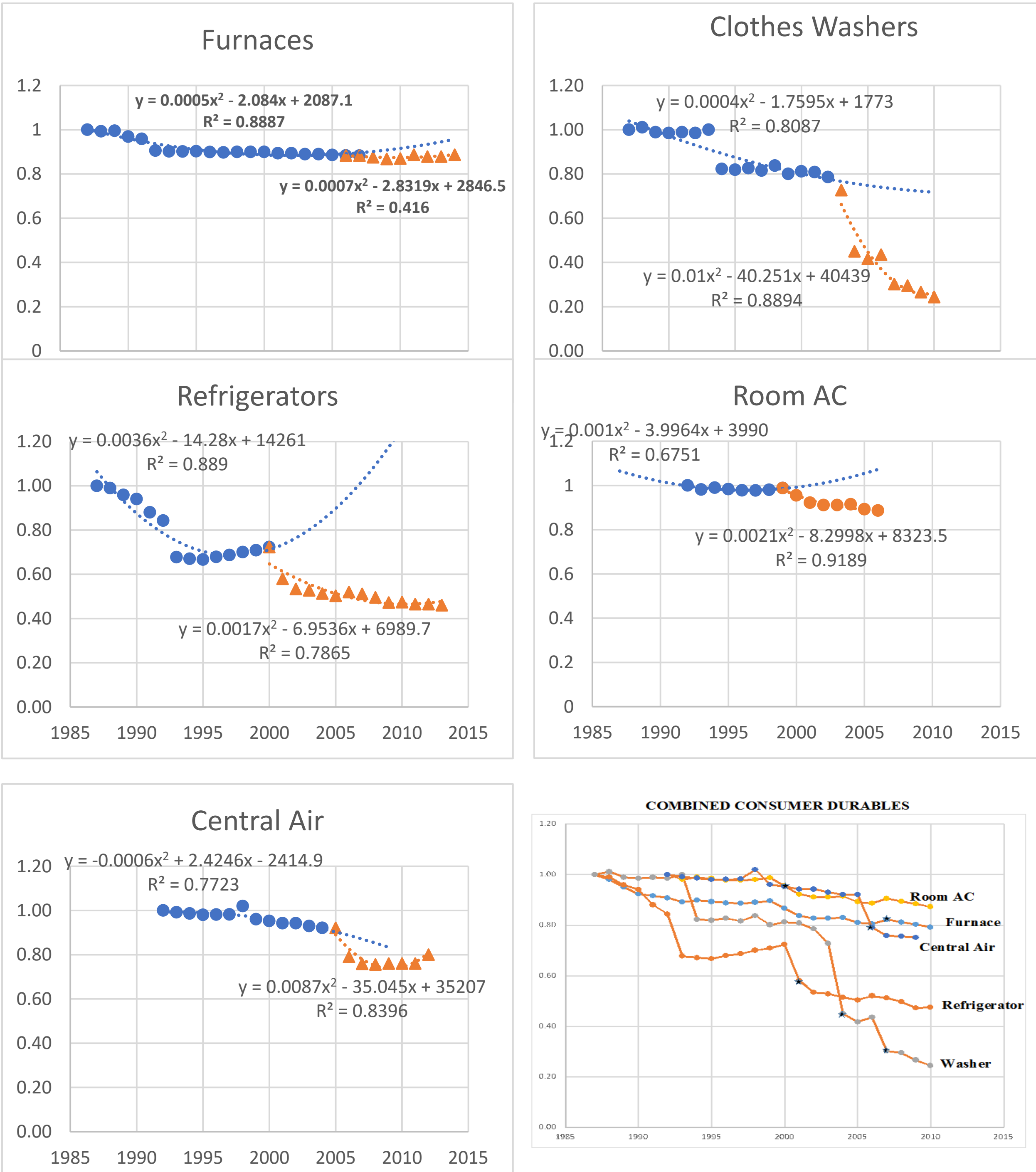
SOCIETAL FAILURES	**STRUCTURAL PROBLEMS**	**ENDEMIC FLAWS**	**TRANSACTION COSTS**	**BEHAVIORAL FACTORS**
Externalities	Scale/ fragmentation	Agency – split incentives	Sunk Costs	Motivation
Public Goods	Bundling	Lack of Capital	Risk	Calculation/ Discounting
Coordination	Utility profit incentives		Uncertainty	
Information	Installer skill		Imperfect Information	

The Gas Consumption of Furnaces is a Particularly Difficult Problem for the Marketplace to Solve.

Externalities: Ultimately, the benefit of reducing energy consumption has value beyond the benefit that each individual directly enjoys from reduced energy consumption (environmental, public health, and market processes like consumption externalities, learning by doing, coordination and network effects, a public goods problem).
Market Structure: Market characteristics can reduce the incentive to invest in economically beneficial technologies. Utilities profit from increased sales and have little incentive to promote conservation. The housing market, and therefore the furnace market, is fragmented. Financial practices reduce the appropriability of gains from efficiency investments. Quality installation of high efficiency products is challenging.
Agency: The builders and landlords make the key decisions about energy consumption by choosing the durables and the bundle of attributes that will be made available in the market, thereby constraining the range of energy consumption levels the consumer has to choose from. The supply-side interests are separate and different from the consumers' interests (split incentives problem).
Bundling and Access to Capital: Owners and landlords tend to focus on the primary product attributes and the first cost of the consumer durable, ignoring the life cycle cost (i.e. the total of acquisition and operating costs) since they do not pay the energy bills.
Risk: Moving efficiency into mass market products runs the risk of being underpriced by inefficient products. Learning new installations is challenging.
Imperfect Information: Installers lack information and skills with higher technologies in some situations. Consumers do not know how to calculate the economic benefit of long-lived durables or judge the quality of the installation.
Motivation/Calculation: Consumers frequently make replacement decisions under severe time constraints. Even if consumers are paying attention to energy use, it would be difficult for them to determine how much energy the devices use and the impact of reducing consumption based on long-term price predictions. The information is either not readily available or the transaction cost of obtaining it is high (information and transaction cost problems).

The track record of efficiency standards for household consumer durables is excellent. Figure XIV-1 shows the record of five consumer durables since the late 1980s. Data on the efficiency of these devices has been compiled since then and it covers the period in which natural gas prices were deregulated. Efficiency is measured as the decline in energy use compared to the base year, which is set equal to 1. The performance of the furnace market is quite deficient with respect to energy efficiency, which has had and continues to have the weakest standards by far.

Figure XV-6: Appliance Efficiency Standards and Trends (Base Year Efficiency = 1; △ = New Standard)



Sources: Nadel, Steven and Andrew deLaski, *Appliance Standards: Comparing Predicted and Observed Prices,* American Council for An Energy Efficient Economy, July 2013; *Steven* Nadel, Neal Elliott, and Therese Langer *Energy Efficiency in the United States:35 Years and Counting*, June 2015.

Examining the trends for individual consumer durables in Figure XIV-1 suggests three important observations. First, the implementation of standards improved the efficiency of the consumer durables. Second, furnaces have been far less efficient than they should have been, since the DOE has set and maintained weak standards. Third, after the initial implementation of a standard, the improvement levels off, suggesting that if engineering-economic analyses indicate that additional improvements in efficiency would benefit consumers, the standards should be strengthened on an ongoing basis.

Table XV-2 shows the results of econometric analysis of the data. The statistical analysis created (dummy) variables that identify each consumer durable and whether a standard was in place or not. We use the year to estimate the underlying trend. Table XIII-2 shows what is obvious to the naked eye in Figure XV-1: Stricter standards as set by DOE lead to measurable improvements in appliance efficiency. Table XV-2 shows that the observations that are obvious to the naked-eye in bivariate relationship in Figure XV-1 are statistically valid. We present two sets of models, one based on all years and one based on shorter, five-year periods before and after the standards are adopted.

TABLE XV-2: MULTIVARIATE ANALYSIS OF APPLIANCE STANDARDS

Variable	Statistic	5-years before/after				All Years			
		1	2	3		4	5	6	
Standard	β	-.1637	-.1386	-.1086		-.2260	-.1079	-.0803	-
	Std. Err.	(..0485)	(.0587)	(.0382)	(.0366)	(.0414)	(.0227)		
	p <	.000	.023	.007		.000	.010	.001	
Trend	β	NA	-.0053	-.0111		NA	- .0107	-.0135	
	Std. Err.		(.0081)	(.008)			(.0026)	(.0019)	
	p <		.51	.176			.000	.000	
Refrig	β	NA	NA	-.2775		NA	NA	-.2242	
	Std. Err.			(.0382)			(.0289)		
	p <			.000				.000	
Washer	β	NA	NA	-.2889		NA	NA	-.2144	
	Std. Err.			(.0561)			(.0391)		
	p <			.000				.000	
RoomAC β		NA	NA	.0478		NA	NA	-.0895	
	Std. Err.			(.0642)			(.0321)		
	p <			.383				.009	
CAC	β	NA	NA	-.0050		NA	NA	.0383	
	Std. Err.			(.0292)			(.0260)		
	p <			.864				.143	
R^2	.20	.21		.85		.29	.36	.75	

Statistics are Beta coefficient and robust standard errors.

We have built this analysis in the typical way that multivariate regression analysis is conducted. The dependent variable is energy consumption with the base year set equal to 1. Later years had lower values. We introduce a variable to represent the adoption of a standard. This variable (known as a dummy variable) takes the value of 1 in every year when the standard was in place and a value of zero when it was not. A negative number means that the years in which the standard was in force had lower levels of energy consumption. Similarly, the difference between appliances is handled with dummy variables. We include each appliance except furnaces, which shows how the other appliance performed compared to furnaces. Again, a negative number means that the other appliances had lower levels of energy consumption.

The impact of standards is statistically significant and quantitatively meaningful in all cases. The coefficient in column 6 (All Years, All Variables) indicates that the standard lowers the energy consumption by about 8%. This finding is highly statistically significant, with a probability level less than .0001. There is a very high probability that the effect observed is real. The underlying trend is also statistically significant, suggesting that the efficiency of these consumer durables was improving at the rate of 1.35% per year. Given that the engineering-economic analysis had justified the adoption of standards and that standards were effective in lowering energy consumption, this means the market trend was not sufficient to drive investment in efficiency to the optimal level. We include the variables for consumer durables other than furnaces, which means the Beta coefficient measures the performance compared to furnaces. Negative numbers indicate that the energy use declined more for the consumer durable other than for furnaces. Refrigerators, clothes washers and room air conditioners perform significantly better than furnaces. Central air conditioners show no statistically significant difference. Comparing the models with shorter terms to the all year model is consistent with the earlier observation. The impact of the standard is greater (almost 11% in column 3) because we have eliminated the out years where the effect of the standard has worn off. The impact of the trend is slightly smaller (1.1% per year) but the statistical significance is greatly affected by shortening the period because we truncate the trend.

Price

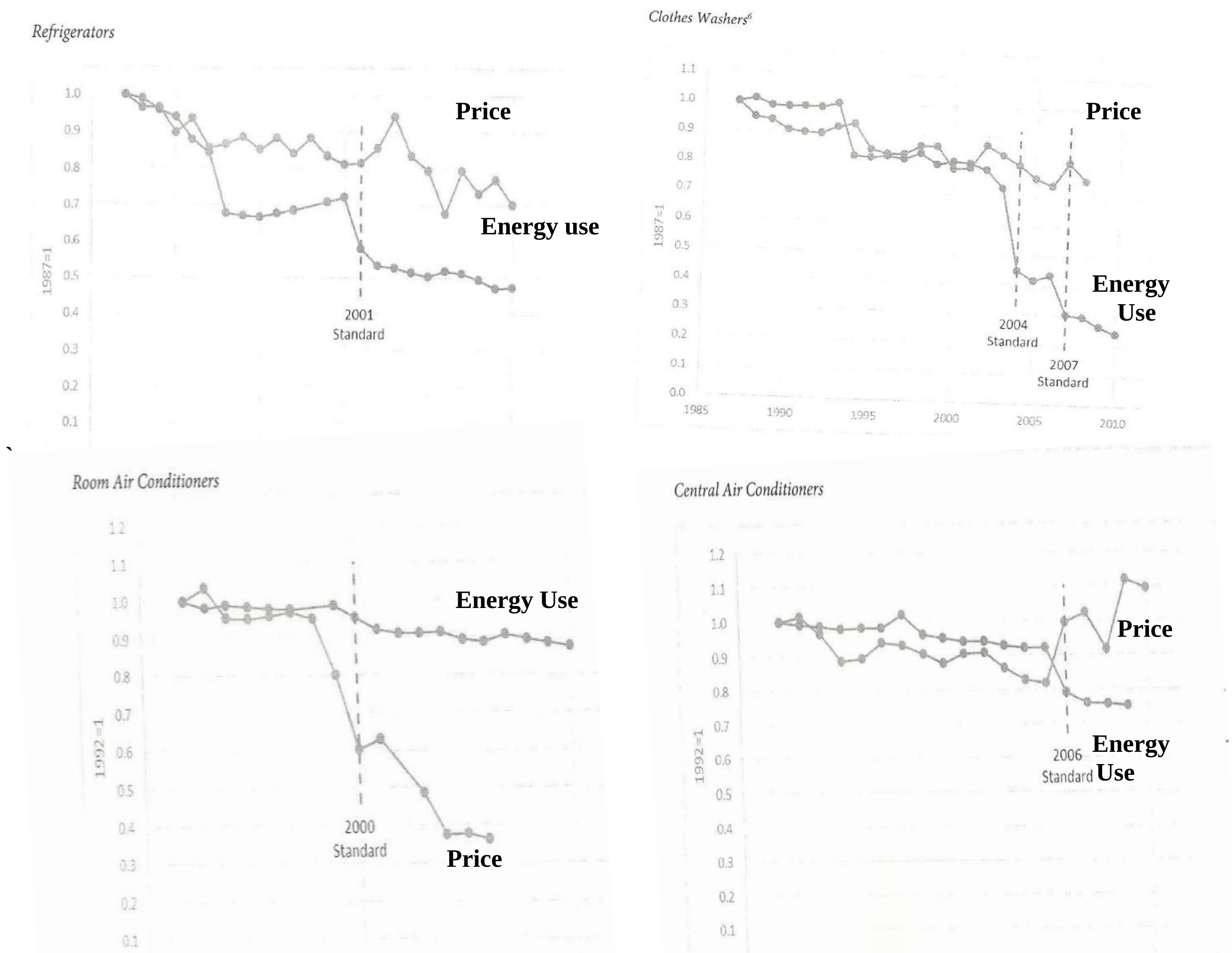
The engineering-economic analysis indicates that although the standards may increase the cost of the consumer durable, the reduction in energy expenditures is larger, resulting in a net benefit to consumers. We have also pointed to evidence that the costs of energy saving technologies tend to be smaller than the *ex-ante* analysis suggests because competition and other factors lower the cost. The experience of the implementation of standards for the household consumer durables is consistent with this interpretation (see Figure XV-2).

While the efficiency was increasing, the cost of the durables was not, as shown in Figure XV-7. There are five standards introduced for the four appliances in Figure XV-2. In three of the cases (refrigerators, clothes driers – second standard, and room air conditioners), there was a slight increase in price with the implementation of the standard, then a return to a pre-standard downward trend. In one case (clothes driers – first standard) there was no apparent change in the pricing pattern. In one case (central air conditioners) there was an upward trend.

We do not mean to suggest that the price increase was too big, compared to the engineering-economic analysis or that the standards lowered costs, although there are theories that would support such a rationale, (i.e. suppliers take the opportunity of having to upgrade energy efficiency through redesign to make other changes that they might not have made otherwise). However, this does indicate that the standards can be implemented without having a major, negative impact on the market.

The analysis of consumer durables also shows that there was no reduction in the quality or traits of the products. The functionalities were preserved while efficiency was enhanced at modest cost.

FIGURE XV-7: PRICE TRENDS AND STANDARDS



Source: Steven Nadel and Andrew deLaski, *Appliance Standards: Comparing Predicted and Observed Prices*, American Council for an Energy Efficient Economy, July 2013.

XVI. THE CASE FOR MINIMUM EFFICIENCY STANDARDS FOR COMPUTERS AND DISPLAYS

At the outset, it is important to recognize the consumer interest in the energy efficiency of household digital devices. Our analysis shows that the energy consumption of these devices has increased by 500% in the past decade, driven by both increasing penetration and use.[194] These devices are all a part of energy use known as MEL, 'miscellaneous electrical load'. This is the energy used to power the huge range of electronics in homes. It has been estimated that a typical American home has forty products that constantly draw power, and people often do not even know they are paying for this hidden energy consumption.[195] In California and across the nation, these devices have come to represent a significant electricity load and drag on consumer budgets, in the range of 5 to 7 percent of electricity bills.[196] Addressing the energy that is wasted in this way is akin to going after the low hanging fruit. The potential energy savings from computers alone, via technologies that are currently available is substantial, a reduction of one-third or more in their energy use.[197]

THE GROWING IMPORTANCE OF HOUSEHOLD DIGITAL DEVICES

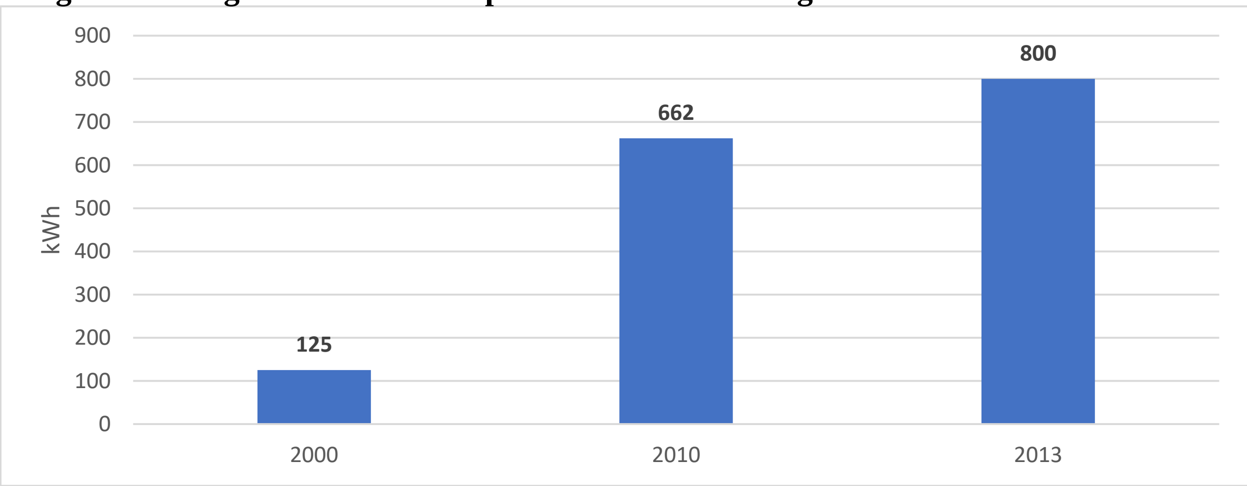
Over the past decade, policymakers at the federal and state levels have sharply increased the level and coverage of energy efficiency performance standards, using both legislation and regulation. The requirements to increase the energy efficiency have affected consumer durables, like automobiles, appliances, and buildings, and capital goods used by industry, like heavy-duty trucks, and electric motors. Major consumer durables like automobiles and HVAC equipment (heating and air conditioning) and capital goods, like medium and heavy-duty trucks receive the most attention in the energy policy process, and rightly so because of their large use of energy. However, the fastest growing component of national energy consumption is the appliance category, which includes a mix of appliances including lighting, televisions and consumer electronics.[198] Moreover, within this broad category, the fastest growing segment of home energy consumption involves what are known as household digital devices, which include computers, internet connectivity and video network devices. This section examines the growing importance and potential consumer benefits of adopting efficiency standards to cover these devices.

As shown in the top graph of Figure 1, the amount of electricity consumed by household digital devices increased more than five-fold between 2000 and 2010. Our estimate of the 2013 national average consumption of 800 kWh for household digital devices is based on the weighted average of the presence of those devices in households. That is, we multiply estimates of the number of households across the nation with the device by the average usage per household and divide by the total number of households.

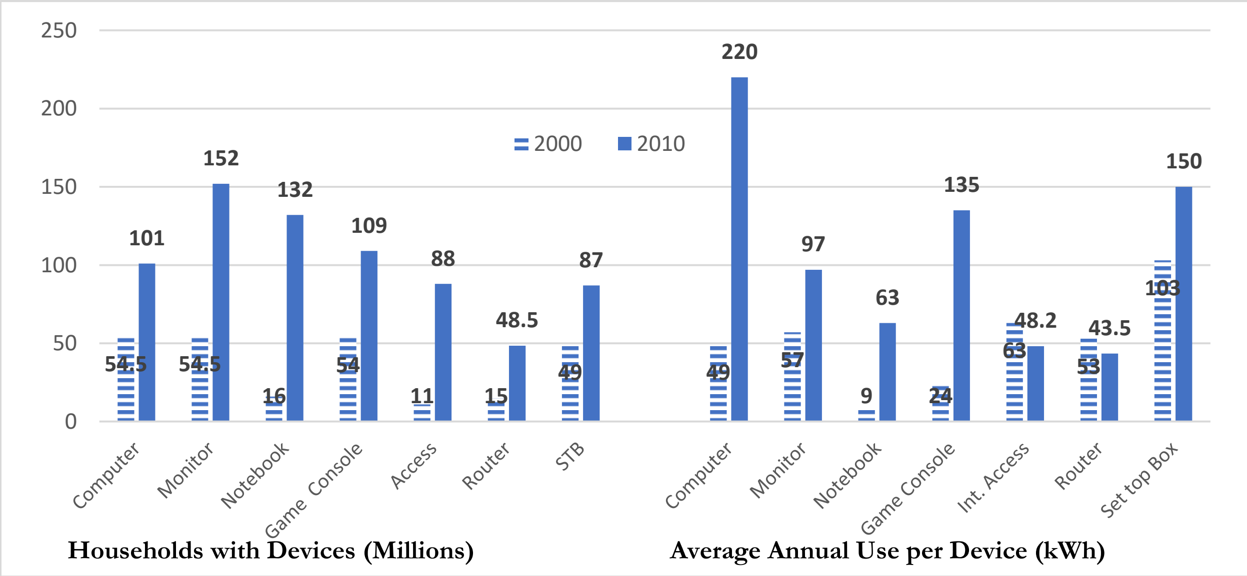
The increase in electricity use of these devices is driven both by increased penetration of the devices into households and increased use of those devices by households, as shown in the bottom graph of Figure XVI- 1. More households have more devices that they use more often for longer periods of time to accomplish tasks that consume more energy. Keeping in mind that in 2010 there were fewer than 120 million households, it is clear that these devices were not only approaching full saturation, but that some households had more than one device. Thus, in thinking about future levels of penetration, it may be more appropriate to think about some of these devices as personal rather than household.[199]

FIGURE XVI-1: INCREASING IMPACT OF DIGITAL DEVICES ON HOUSEHOLD ELECTRICITY USE

Weighted Average Annual Consumption of Households Digital Devices



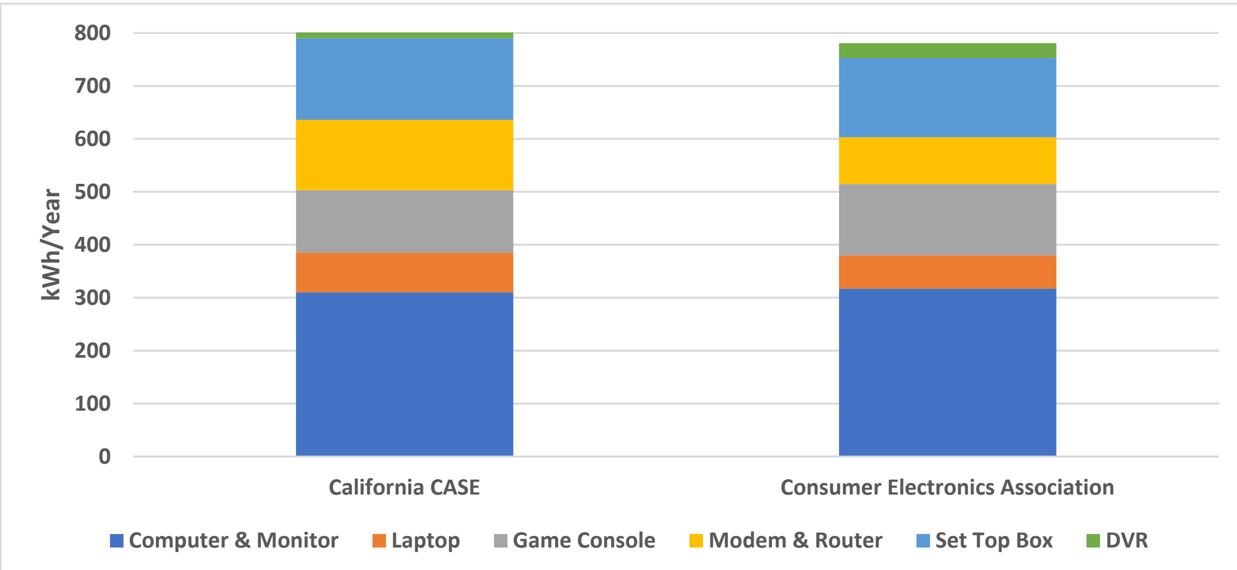
Penetration and Use of Computers, Game Consoles and Network Connectivity Devices



Source: Bryan Urban, Verena Tiefenbeck and Kurt Roth, *Energy Consumption of Consumer Electronics in U.S., Households: Final Report to the Consumer Electronics Association (CEA)*, Fraunhofer Center for Sustainable Energy Systems, December 2011. 2013 assumes one-third the average annual rate of growth since 2010 as occurred in 2000 to 2010. This reflects a slowing of growth in computer ownership and subscriptions to multichannel video service, with continued strong growth in broadband connectivity and gaming. Weighted

Figure XVI-2 presents a second way to describe household digital device electricity consumption. It shows the estimated electricity consumption of a household that has one of each of the devices – a computer with a monitor, a laptop, a modem with a router, a cable set top box and a DVR – and uses those devises at the average level. Given the penetration of these devices, this household would be the modal or "typical" household. Two estimates are shown, one from the California utilities, one from the Consumer Electronics Association. Both estimates of electricity consumption for this "typical" household, are quite close to 800 kWh. Of course, on a national average basis, some households do not have all of these devices, but some have more than one. Therefore, the weighted average seems reasonable.

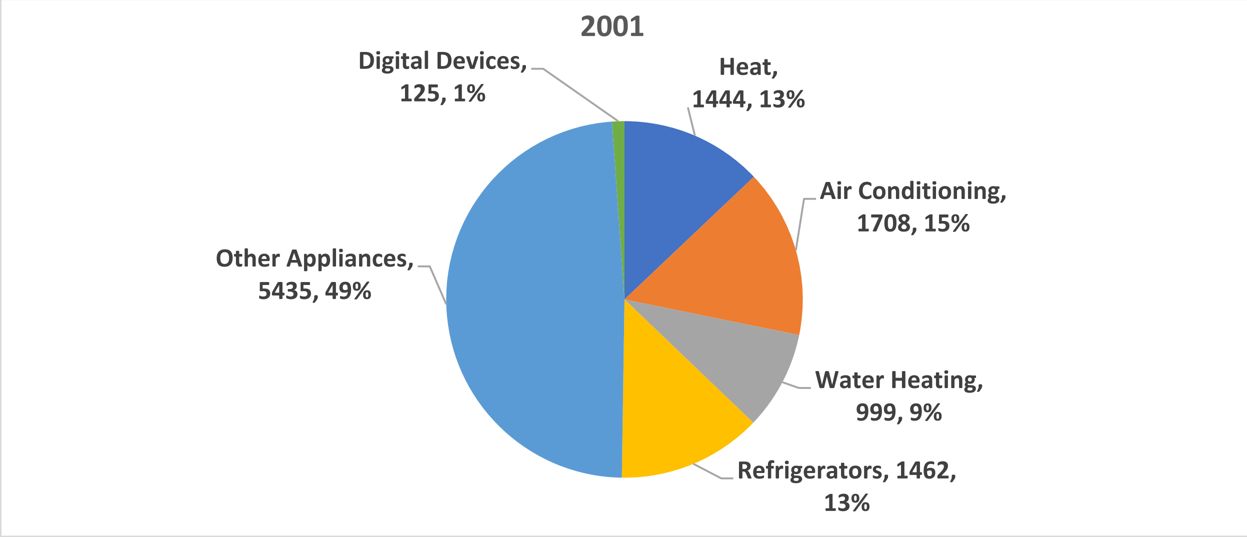
FIGURE XVI-2: ANNUAL CONSUMPTION OF A HOUSEHOLD WITH ONE OF EACH OF THE DEVICES

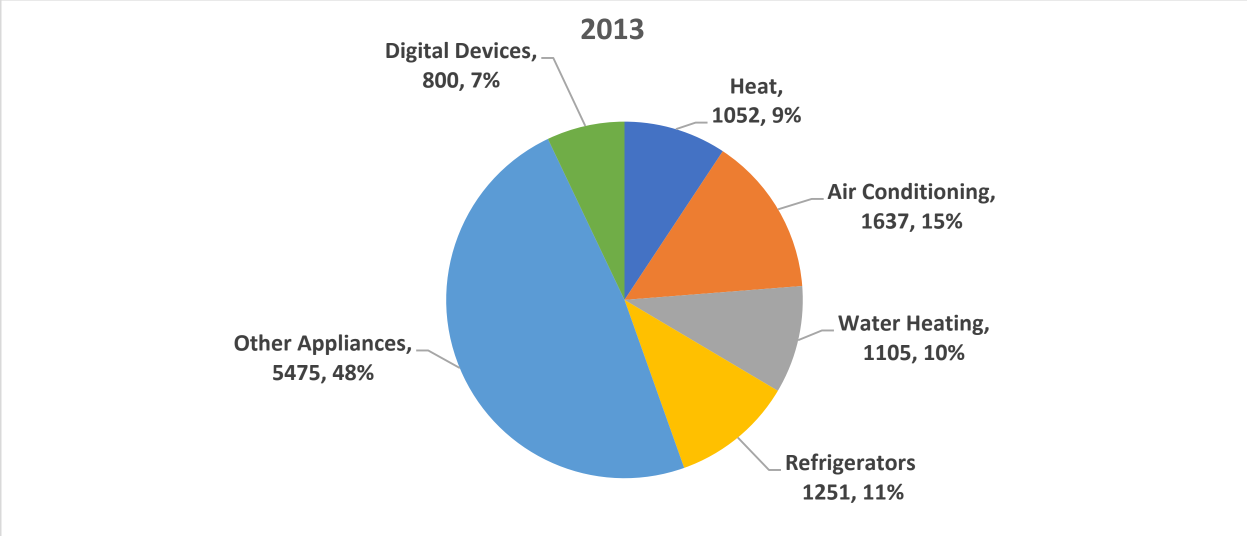


Source: Bryan Urban, Verena Tiefenbeck and Kurt Roth, *Energy Consumption of Consumer Electronics in U.S., Households: Final Report to the Consumer Electronics Association (CEA)*, Fraunhofer Center for Sustainable Energy Systems, December 2011. Pacific Gas and Electric et al., Codes and Standards Enhancement (CASE) Initiative for PY 2013, Title 20 Standard Development, docket #12-AAER-2A, July 29, 2013. The IOU CASE Reports cover, Computers, Set Top Boxes, Small Network Equipment and Game Consoles.

As shown in Figure 3, we estimate that on a national average basis, by 2013, household digital devices are not only the fastest growing source of demand for electricity, these consumer electronics devices also consumed about half as much energy as air conditioning and two-thirds as much as home refrigeration. Of course, air conditioning use is concentrated in specific regions while use of these consumer electronic devices is widespread across the country. The widely-dispersed nature of electricity consumption of household digital devices does not mean they should be ignored in consumer, energy or environmental policy. On the contrary, it makes it even more important to address the electricity consumption of household digital devices. Thus, household digital devices are one of the largest household users of electricity that have not been addressed by energy standards. While the rapid growth and dispersed nature of the use of these devices may have kept them off the radar screen of energy policy makers, it is clear that they are now an important driver of electricity consumption that deserves immediate and careful attention from decision makers with responsibility for energy policy.

FIGURE XVI- 3: NATIONAL WEIGHTED AVERAGE ELECTRICITY CONSUMPTION KWH/HOUSEHOLD
(Includes all households)





Sources and notes: The estimates of consumption by Household Digital Devices are subtracted from the "other appliance category." The 2009 RECS percentages of electricity consumption are adjusted to 2013, based on total electricity consumption in 2012. Residential Energy Consumption Survey (2001, 2009).

The Cause of the Efficiency Gap in Household Digital Devices

We have discussed the debate over the "efficiency gap" – the gap caused by the failure to make economically beneficial energy efficiency investments – and the role of performance standards as a policy response to close it in great detail. Many of the obstacles to investment in energy efficiency that we have identified apply to household digital devices. The electricity consumption of these devices is a particularly difficult problem for the marketplace to solve.

- The electricity consumption of these devices is not visible to consumers. The devices are purchased for their functionalities, which, given the dramatic increase in penetration and use, are highly desirable. The level of electricity consumption is not an attribute of the product to which consumers will pay much attention (a shrouded attribute problem).

- Even if consumers are paying attention to energy use, it would be difficult for them to determine how much energy the devices use and the impact of reducing consumption. The information is either not readily available (information problems) and/or the transaction cost of obtaining it is high (transaction cost problems) and/or the calculations are difficult for consumers to make given uncertainties about consumption and prices (behavioral and information problems).

- The manufacturers of the products make the key decisions about energy consumption and the bundle of attributes that will be made available in the market, thereby constraining the range of energy consumption levels the consumer has to choose from (principal agent problems).

- The manufacturers tend to focus on the primary product attributes and the first cost of the device, ignoring the life cycle cost (i.e. the total of acquisition and operating costs) since they do not pay the electricity bills. The manufacturers' interests are separate and different from the consumers' interests (split incentives problem).

- Ultimately, the benefit of reducing energy consumption has value beyond the benefit that each individual directly enjoys from reduced energy consumption (a public goods problem).

These characteristics make it highly unlikely that the marketplace will overcome these obstacles on its own to stimulate investment in energy efficiency increasing technologies. Simply providing consumers with more information about electricity consumption of the devices does not overcome the underlying problem on the demand side or the supply side.

Therefore, standards can play an important role. They address all four of the barriers identified.

- Standards put a floor under the level of energy consumption, without dictating which technologies can be utilized.
- Consumers do not have to master the economics of the level of energy consumption of the device.
- Because all manufacturers must abide by the same rule, there is less risk of adding the cost of the energy savings technology to the product.
- Producers who are better at adding technology at lower cost may benefit.
- Competition can be stimulated around the standard and may even go beyond it as the standard raises awareness.

Thus, the barriers are overcome to the level of the standard.

Our analysis shows that there is little doubt that the high electricity consumption of digital devices is the result of market imperfections. The paramount, but not the only, cause of the market failure with respect to the energy consumption of digital devices stems from the fact that, in this case, energy is what economists call a ‘shrouded attribute.’ It is part of a bundle of attributes. Computers provide valuable specific functionalities to consumers and the energy consumption of those devices is not directly relevant or visible to the consumer (a motivation/calculation problem). The energy consuming attributes are bundled into the device by the manufacturer (an agency problem). Since electricity bills are aggregates of a month of consumption across a large number of electricity consuming durables (an information problem), consumers do not see how much electricity any specific device uses (a calculation problem). Because the devices are plugged in, there is little, if any, market pressure to improve the energy efficiency of these devices (a market failure).

If manufacturers felt this market pressure, they would do a better job of investing in energy efficiency. The proof of that proposition comes from the performance of similar devices, where they do feel such pressures. In contrast to computers and laptops, which are generally plugged in, the energy consumption of tablets and smart phones—mobile devices that are used when not plugged in—is extremely important to manufacturers. Battery life is an essential feature of these devices, which means the manufacturers compete vigorously to reduce consumption and increase battery life. Consumers can easily assess the efficiency and performance of these devices. When they are forced to frequently charge them over and over again —they know it’s because a device is inefficient. Consumers can send a clear signal to manufacturers by not buying these inefficient devices or by expressing their dissatisfaction in reviews or direct communications. With these mobile devices that are used when they are not plugged in, manufacturers care a great deal about how efficient they are. Providing similar functions, these mobile devices consume one-tenth or less the electricity of the plugged-in devices.

Even if the amount of electricity used and its pocketbook impact were more visible and consumers were motivated and able to make the calculation, they still might not push the market to the optimal level of energy consumption because there are environmental externalities and economic social costs and benefits that are not likely to be reflected in the market transaction (an externality, public good and coordination problem).

EVALUATING THE CEC STAFF ANALYSIS AND PROPOSED STANDARD

Design of the Standards

With clear market imperfections giving rise to inefficiencies, the next question becomes: why is a performance standard a good policy? Exhibit 2 identifies the characteristics we have found to be associated with effective standards. We generally prefer performance standards because <u>they command, but they do not control</u> by setting a goal and allowing manufacturers flexibility to decide how to meet the goal.

Our analysis shows that performance standards work best when they address a clear market imperfection and are technology-neutral, product neutral and pro-competitive. The CEC proposal includes these elements. The standards establish a minimum level of efficiency but they do not dictate the technology. Standards work best when the manufacturers can design to meet the standard as they see fit. They will do so by choosing the least cost approach available to them. Different manufacturers will have different skill sets or different product lines and choose different technologies.

Performance standards like these give market certainty to stimulate adoption of cost effective energy saving technologies. Each manufacturer will set out to meet the standard in the most cost-effective way that it can without the fear that it will be undercut by cheap, inefficient products that do not meet the standard. Once standards are in place, the products will succeed or fail on the merits.

Standards must also be reasonable in relationship to what can be technologically accomplished. If they go too far, impose costs that are too large or require technologies that cannot be developed or delivered in the necessary time frame, they can do harm, rather than good. The CEC proposal clearly fulfills this criterion in a number of ways on both the supply and demand sides. It identifies products on the market that currently meet the standard, indicating that they are feasible. It recognizes important functionalities of the product that are either not affected by the standard or are accommodated by providing for adders that allow more energy consumption to deliver higher levels of functionality.

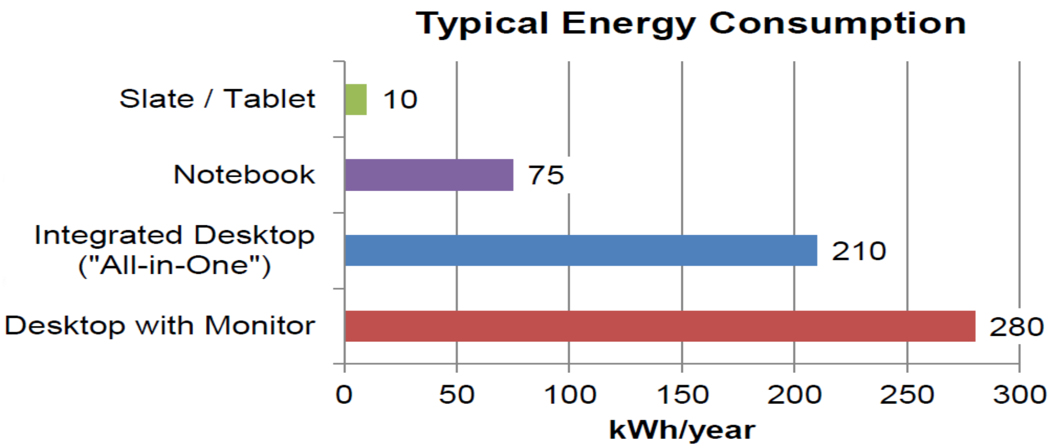
The proposed standards for computers focus on reducing energy consumption when the computer/display is not operating – i.e. in the off, sleep and idle modes. They also demonstrate “no regrets” approaches – such as setting defaults at the lowest level possible and automatic transitioning to lower levels of energy consumption when the computer is idle. This is a cautious approach which means the standards should not impair the ability of the computer to deliver the functionality that consumers want. This analysis provides strong evidence that the standard is technically feasible and not detrimental to consumers.

The targets set by these standards are moderate; if anything, they are cautiously forward looking but not very far, as the industry suggests that it needs more time to comply. It is clearly responsive to the design and build cycles of the products. This gives the industry an opportunity to plan more significant changes or a sequence of changes that eases the glide path to higher levels of efficiency. This is exactly the right way to kick off a standard for an important and dynamic product. It builds a framework that not only achieves near term gains but can provide a platform for future reductions in energy consumption

THE CEC PROPOSAL

Figure XVI-4 shows the dramatic difference between plugged in and mobile devices that provide similar functions. We offer this comparison to underscore the good job computer makers do when the market drives them to, not to suggest that they should put the same technology in all devices. However, it is likely that there are spillover and learning effects that will operate across devices that would facilitate and accelerate improvements in efficiency of plugged in devices once the manufacturers are motivated to improve efficiency by a standard.

FIGURE XVI-4: ANNUAL ENERGY CONSUMPTION OF KEY DIGITAL DEVICES



Source: NRDC Materials, CEC Staff Workshop, Computer, Computer Monitors, and Electronic Displays, TN #: 204158, April 15, 2015, p. 4.

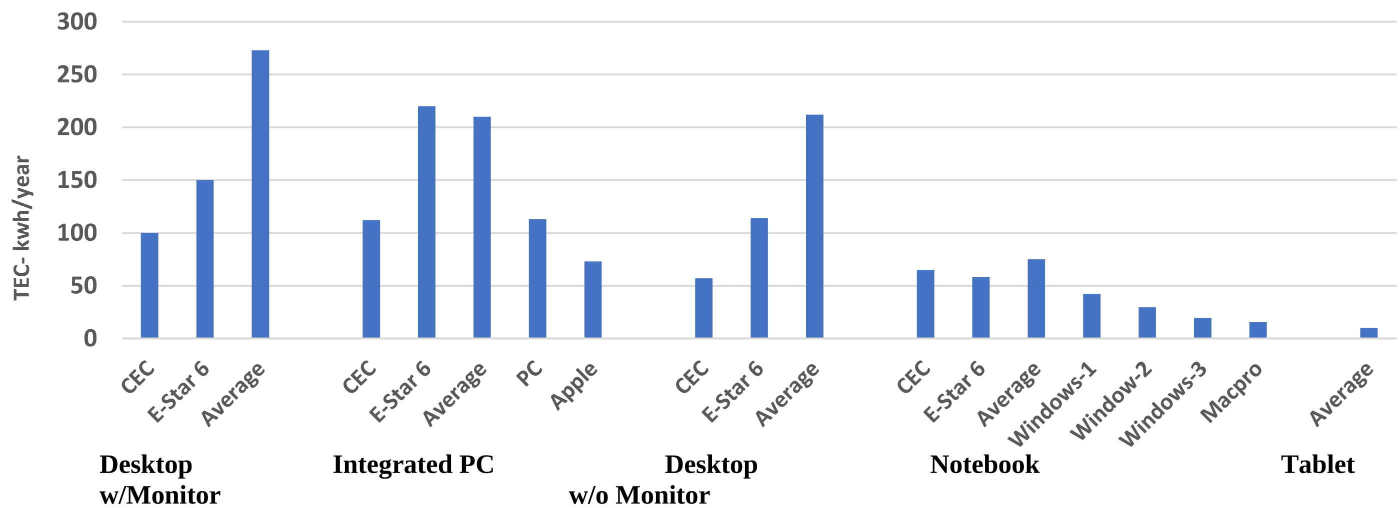
Figure XVI-5 locates the CEC proposal with respect to several important measures of where the market for computers and monitors is. It shows the CEC standard of "Typical Energy Consumption" compared to ENERGY STAR 6 levels, market averages and several examples of products available in the market. We will look at the terrain of the market in detail below. Here the important point is that the standard clearly is intended to significantly increase the energy efficiency of the devices. It is well beyond both the market average and ENERGY STAR. At the same time, there are specific products available that already meet the standard. In fact, a small but significant percentage of products in the market already meet the standard.

The standards focus on reducing energy consumption when the computer/display is not operating – i.e. in the off, sleep and idle modes. The comments also demonstrate "no regrets" approaches – such as setting defaults at the lowest level possible and automatic transitioning to lower levels of energy consumption when the computer is idle. This is a cautious approach which means the standards should not impair the ability of the computer to deliver the functionality that consumers want. This analysis provides strong evidence that the standard is technically feasible and not detrimental to consumers.

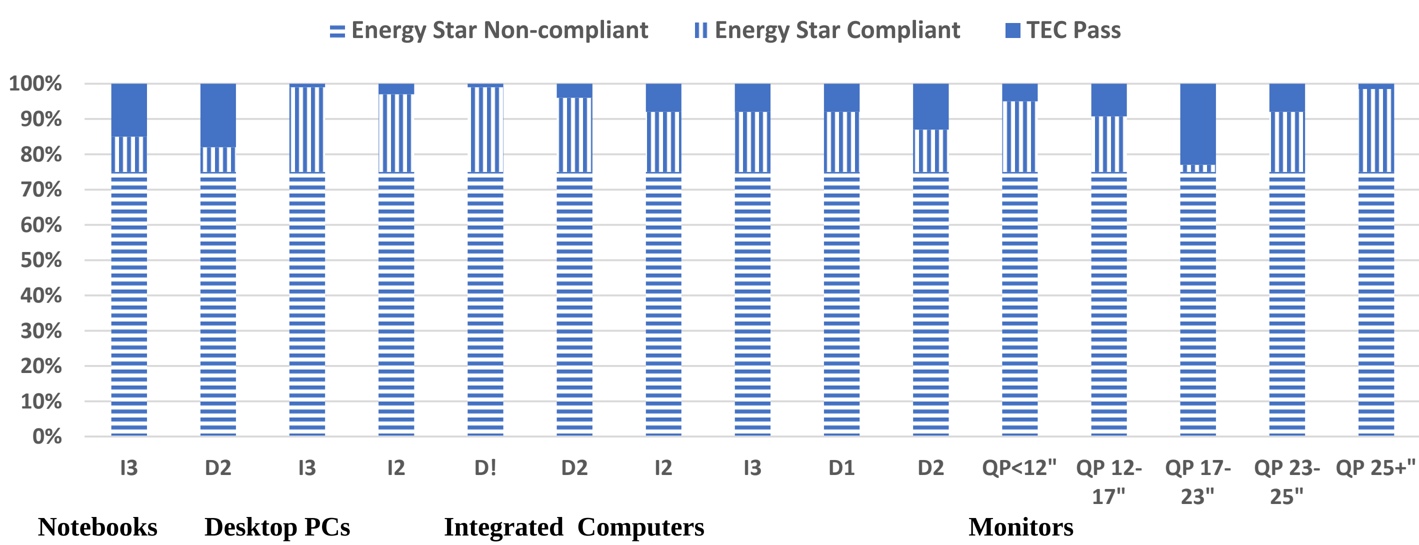
Based on the structure of the standard, its relationship to the current product market, and the benefit cost ratios, the proposed standards pass our test with flying colors on the most important of the characteristics. The benefits far exceed the costs, and they are product neutral, technology-neutral, and procompetitive. We also believe that they are responsive to consumer needs and industry needs, but these aspects deserve more attention. The targets set by these standards are moderate; if anything, our analysis suggests to us that the commission should go a little farther.

The standards are forward looking, but not very far, and the industry suggests that it needs more time to comply. This suggests to us that the judicious course for the CEC could well be to set standards that become progressively stronger over a number of design and build cycles. This gives the industry an opportunity to plan more significant changes or a sequence of changes that eases the glide path to higher levels of efficiency.

FIGURE XVI-5: TYPICAL ENERGY CONSUMPTIONS, VARIOUS DEVICE TYPES AND STANDARDS



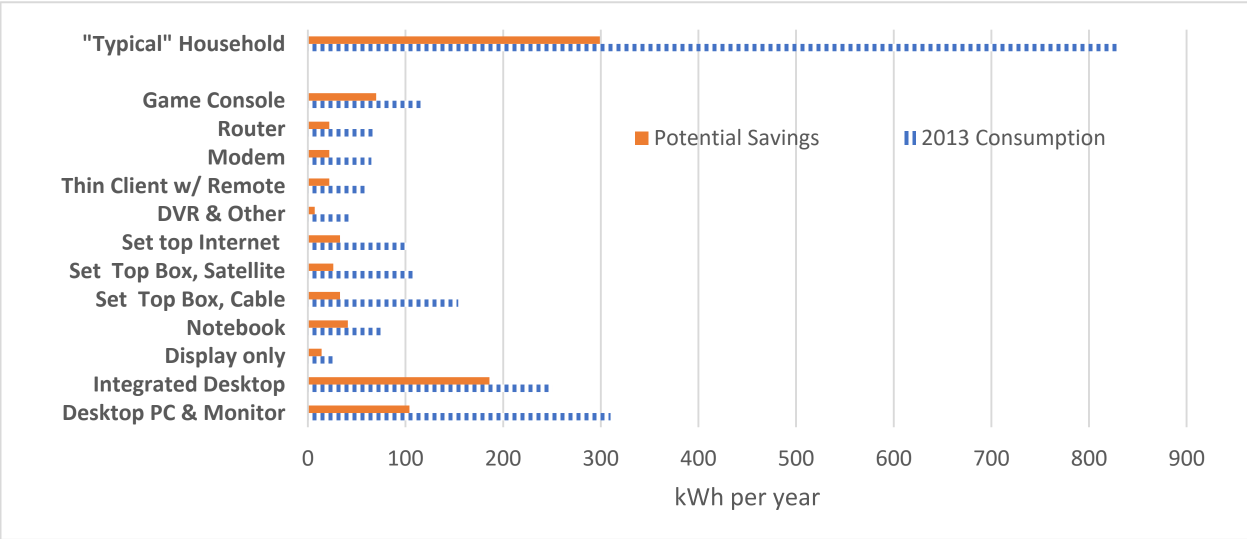
ENERGY STAR COMPLIANCE AND CEC TYPICAL ENERGY CONSUMPTION (TEC)



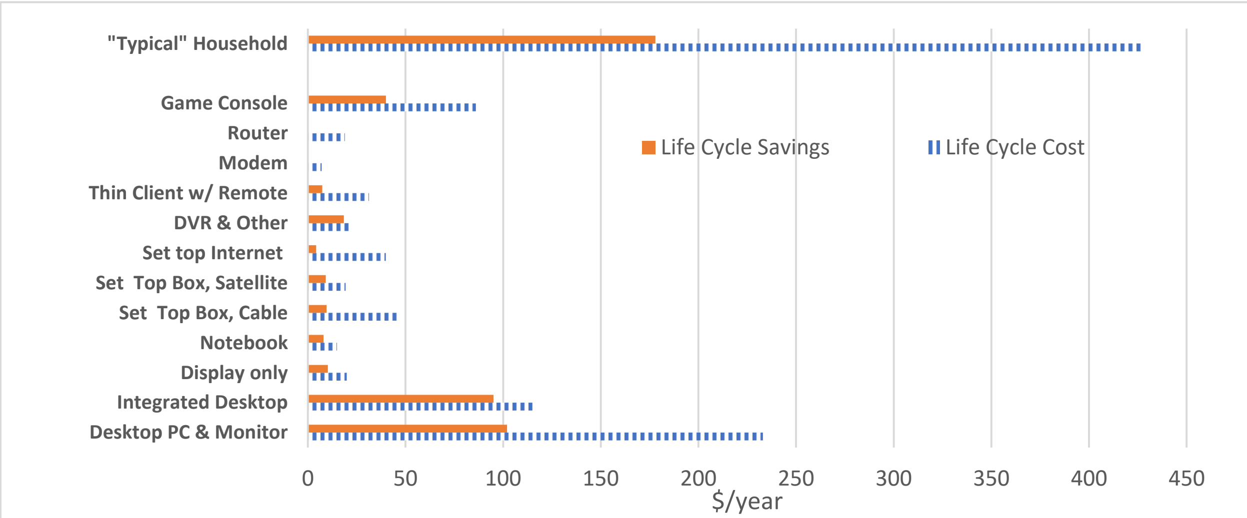
Source: Sources: Targets from CEC Staff Report, p. 22; Averages are current (2014), not baseline (2018), Desktop is CEC usage (Staff Report, p. 9), adjusted with NRDC (p. 4), Monitors are from CEC Staff Report (p.45), other averages from NRDC, pp. 4, 7, 8; E-Star 6 from ITI, Sheikh, pp. 11, 12, 13. ITI Technet Presentations, *California Energy Commission, Staff Workshop: Computers, Monitors and Signage Displays*, April 15, 2015, Donna Sadowy slides 9, 10; Mark Hollenbeck, slide 8. Donna Sadowy, Slide 7: ENERGY STAR products are today's best in class for energy performance; don't represent greater market. Jan. 2018 is very aggressive schedule – planning for 2018 products starts in 2016.

Recent analysis by the California investor-owned utilities (IOUs) demonstrates a substantial potential for electricity savings for these devices at a very attractive cost.[200] As shown in the top graph of Figure XVI-6, the typical household could save almost 300 kWh per year for the "one of each" set of devices. This is a reduction of more than one-third in electricity consumption.[201]

FIGURE XVI-6: COST AND BENEFITS OF IMPROVING EFFICIENCY OF DIGITAL DEVICES
Current Electricity Consumption and Potential Reductions



Life Cycle Costs and Benefits of Reducing Electricity Consumption



Source: Pacific Gas and Electric et al., Codes and Standards Enhancement (CASE) Initiative for PY 2013, Title 20 Standard Development, docket #12-AAER-2A, July 29, 2013. The IOU CASE Reports cover, Computers, Set Top Boxes, Small Network Equipment and Game Consoles.

We use the estimates prepared by the California IOUs since they are recent and provide a consistent analytic approach across appliances that is clearly defined and documented. A review of other estimates of potential energy savings and technology costs shows that these estimates are quite reasonable, even a bit on the cautious side. A number of studies put the potential for various devices in the range of 30 to 85 percent. Some mix behavioral and technology options, although it is frequently possible to achieve savings that are attributed to behavioral changes with technology where the extent of behavior modification is uncertain. Few of the studies estimate costs but those that do yield results that are similar to the utility studies [202] The bottom graph of Figure XVI-6 shows that for the "typical" households, the cost of achieving these improvements in energy efficiency would be much smaller than the value of the electricity saved. For each of the individual devices, the benefits exceed the costs. Using a 3% discount rate, the benefits are 2.4 times larger than the cost.

In short, the proposal submitted to the California Energy Commission by the IOUs for this important group of consumer durables, passes the consumer pocketbook test with flying colors.

Market Evidence Suggests that the Standard is Feasible

The fact that a substantial percentage of computers in the market (put at 10% to 25% by various industry commentors[203]) already meet the standard indicates that the standard is certainly feasible. The suggestion that the standard should be lowered to allow the vast majority of computers to pass, would rob consumers of substantial benefits.[204] The existence of a substantial number of models already in the market is one indication of the reasonableness of the standard.

Compared to portable devices, desktops consume much more energy, in large measure because they have not improved. "Battery-powered devices of similar capabilities and price have radically lower power use." The improvement required of the desktop PC is one-third of the current PC-Table gap and one-half of the current PC-portable gap for active and sleep modes.[205] For total consumption it requires the improvement of the desktop to be close to two-thirds of the PC-notebook gap[206] and total annual consumption.[207] As discussed above, we see this as the result of the shrouded nature of energy consumption in the desktop market and the resulting lack of market pressure to improve energy performance.

The level and trends of energy efficiency improvement across digital products gives another clear indication. Figure XVI-7, taken largely from evidence in this proceeding shows two factors that suggest much more could be accomplished for desktop computers.

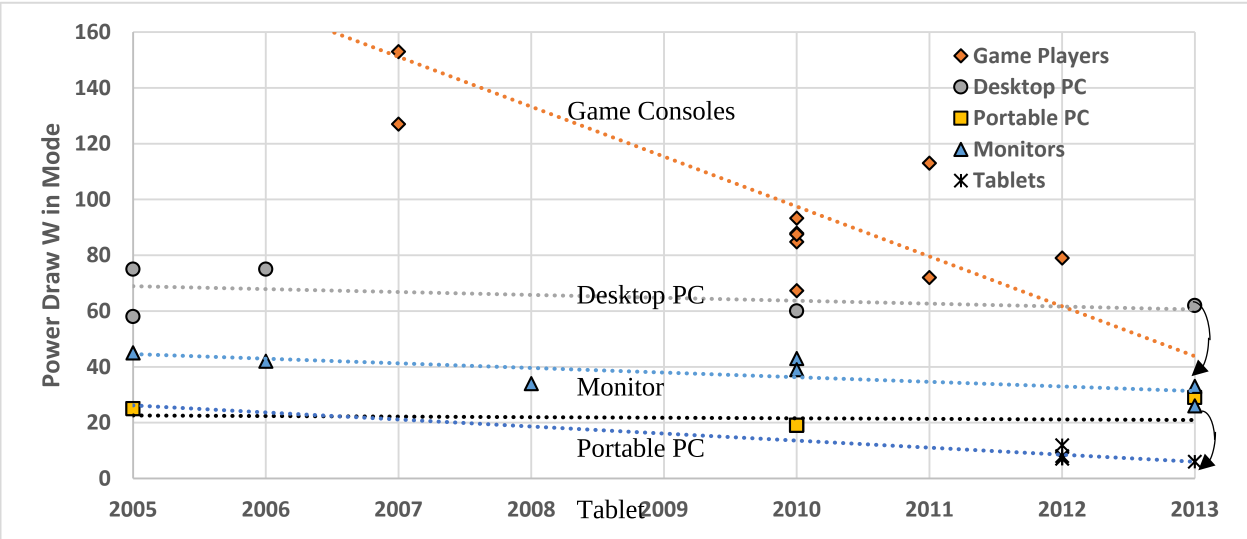
History Shows That Costs Will Fall, Rather Than Rise.

As noted in the CEC staff report, the cost projections are two to four times as high as the projections offered by the electric utility participants in the proceeding. Nevertheless, the industry offers cost projections that are orders of magnitude higher. These projections assume no learning, innovation or economies of scale. They are inconsistent with the history of the industry and the experience with regulation (see Figure XVI-8).

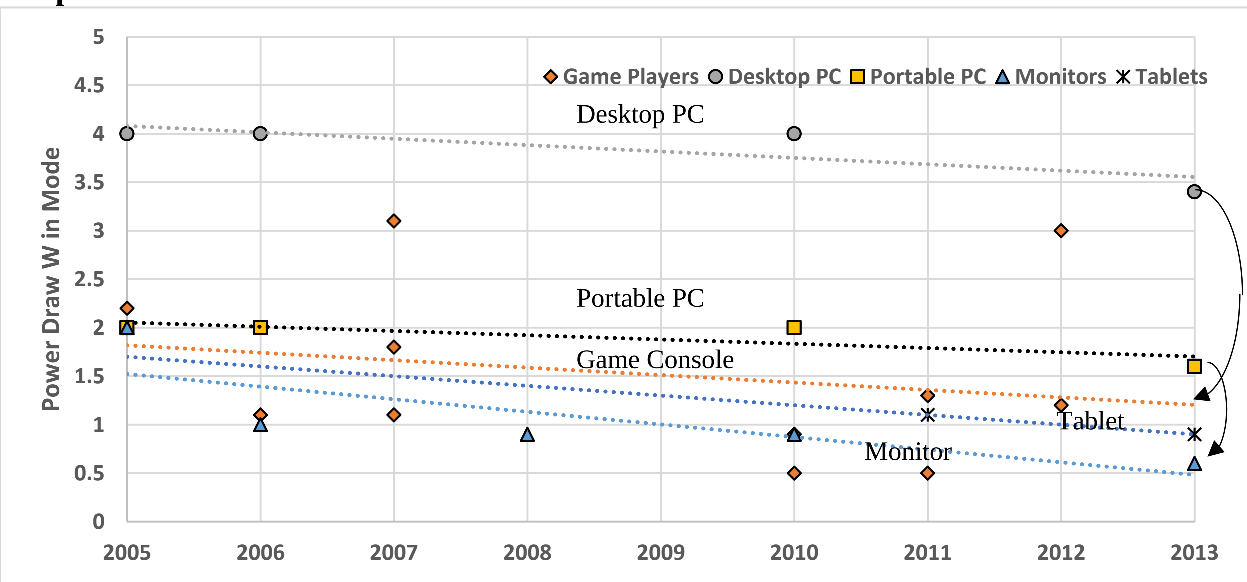
Historically, when it comes to standards, we have seen manufacturers line up in opposition, arguing that they impose unbearable or unconscionable costs on consumers – unbearable in the sense that they impose such high prices on consumers they will stop buying the devices or unconscionable in the sense that consumers will be forced to pay much more for a similar level of functionality or be forced to settle for devices that do not deliver the functionalities consumers want. However, history shows that the claims that standards will impose huge and unacceptable costs on consumers invariably proves false. Once the companies go to work to meet the standards in the least cost manner possible, their costs are one-third of the original estimates, and the benefits vastly exceed the costs.

FIGURE XVI-7: ENERGY USE BY VARIOUS DEVICES ACROSS TIME AND MODE

Active Mode

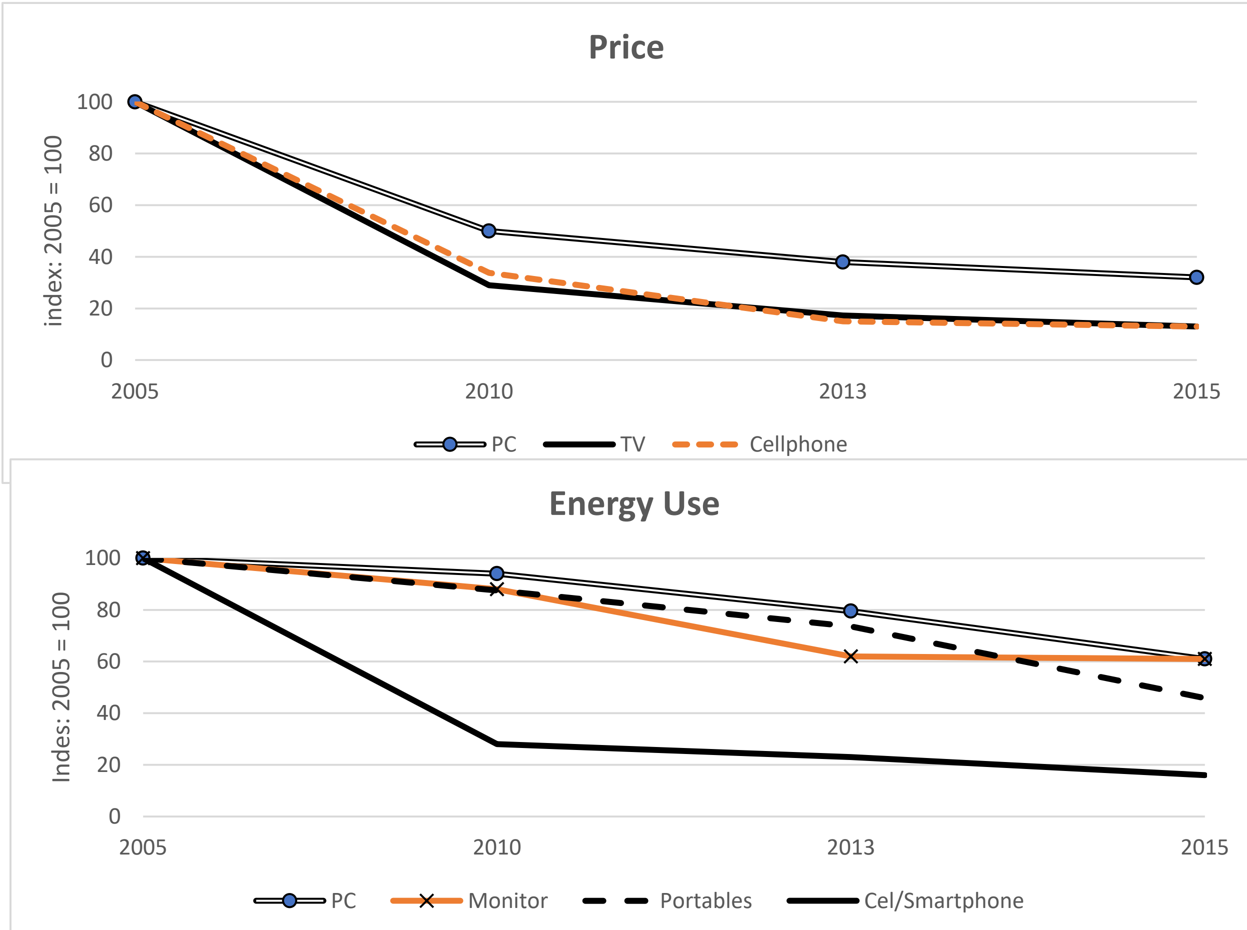


Sleep Mode



Sources: All data are from Bryan Urban, et al., *Energy Consomption of Consumer Electronics in U.S. Homes in 2013*, Fraunhoffer, USA, June 2014, pp. 32, 43, 56, 73, except game consoles, which is from A. Webb, et al., "Estimating the Energy Use of High Definition Games Consoles," *Energy Policy*, 61.

FIGURE XVI-8: PRICE AND ENERGY TRENDS FOR HOUSEHOLD DIGITAL DEVICES



Source: Price from the Bureau of Labor Statistics, *Consumer Price Index;* Energy Trends from Urban, et al., *Energy Consumption of Consumer Electronics in U.S. Homes*, Frauhofer, USA, June 2013. Longer term trends for the Cellphone/Smartphone from Annarita Paiano, Giovani Lagiots and Andrea Cataldo, "A Critical Analysis of the Sustainability of Mobile Phone Use, *Resource Conservation and Recycling,* 73 (2013) 161-171. Noah Horowitz, et al., *Cellular Phone: Advancements in Energy Efficiency and Opportunities for Energy Savings*, NRDC, October 2004.

REJECTION OF INDUSTRY OPPOSITION

Basic Criticism

The industry presentations and comments at the staff workshop reflect a number of misconceptions and misguided analyses that raise serious concern about the possibility for a meaningful dialogue as the regulatory process unfolds. The industry presentations demonstrate a fundamental misunderstanding of the purpose and function of a minimum performance standard. Table XVI-1 identifies the key points in the industry critique presented at the workshop and the alternative point of view presented by others. The industry comments express concern and criticize the CEC staff proposal in several ways.

(1) The proposal is criticized for writing rules that are deemed to be technically feasible and economically beneficial, even though they require a higher level of efficiency that is already observed in the market.

(2) The industry points out that many of the products now in the market do not comply with the standard that will go into effect in three years, suggesting that it, as consequence, the standard is infeasible.

(3) The industry demonstrates this non-compliance with reference to the compliance of the devices in the market with the current ENERGY STAR labelling program.

These criticisms are ill-founded and should not dissuade the Commission from issuing strong standards. Since the ENERGY STAR program plays such a prominent role in the industry comment, we begin with that point.

TABLE XVI-1: STAFF WORKSHOP COMMENTS

ISSUE AREA	INDUSTRY CRITIQUE	SUPPORTING CEC
ENERGY STAR & The Market	Not representative[1]	Underestimates use[13]
	Exceeds historical levels[2]	Technological progress[14]
	Drive out of Market[3]	Existing products in market[15]
Critique of the Standard	Uniform percentage gain[4]	Large potential savings[16]
	Technology Already in devices[5]	Technological progress[17]
	Cost benefit/Cost Model[6]	Benefits underestimates[18]
	Design cycle.2 year[7]	Technology available/software[19]
	Data Gotcha[8]	IOU, CLASP[20]
	Misleading Comparisons	Special Equipment[9]
	Adders too large[21]	
	Historic Improvement[10]	Contemporary Comparisons[22]
	Desktop to tablet[11]	Form Factor Comparison[23]
	Blaming Consumers[12]	Recognizing Consumer Limitation[24]

Sources: All citations are from presentations at the CEC Staff Workshop on Computer, Computer Monitors, and Electronic Displays, TN #: 204158, April 15, 2015. Industry Comments are individual authors in the ITI/Technet Computer Presentations. Non-industry comments are by individual organizations. Citations:

1 Sadowy, Sadowy, 7; Siekh, 5; Hollenbeck, 4,6.	**13 IOUs, 4, 5; NRDC, 2.9.**
2 Sadowy, 7, Sheikh, 11.	**14 NRDC, 5**
3 Sadowy, 7; Singh, 5.	**15 NRDC, 6.**
4 Singh, 2.	**16 IOUs, 6; NRDC, 5, Aggios, 7, 8.**
5 Singh, 5.	**17 NRDC, 6.**
6 Singh, 6; Siekh, 11.	**18 IOUs, 6; NRDC, 5, Aggios, 7, 8.**
7 Sadoway, 5, Verdun, oral	**19 IOUs, 4, 5; NRDC, 2.9.**
8 Sheikh, 14.	**20 Dewart, by reference to earlier IOU analysis**
9 Harkin, 4; Sadowy, 14.	**21 IOUs, 11; NRDC xx**
10 Harkin, 4	**22 NRDC, xx**
11 Additional Material,	**23 NRDC, 4.**
12 Harkin, 5.	**24 NRDC, xx (defaults)**

Standards v. Labels

The evidence presented at the staff workshop makes it clear to us that an information/labeling program is not enough to achieve the goals of California policy or to adequately promote the public interest because such a program is not designed to address the broad market imperfections we have identified in the market for efficiency of digital devices. The logic of a labeling program is to give consumers the information they need to make better choices and, presumably, demand more efficient appliances. If it does so, the efficiency gap should be reduced or disappear. In the case of computers, that has not happened. The ENERGY STAR levels of energy use are, themselves, well short of the level that could technically be achieved, based on the engineering/economic analysis. More importantly, after twenty years, the evidence shows that only a small fraction of computers sold in the marketplace are ENERGY STAR compliant. The labels have left a large segment of the market underperforming.

Unlike a performance standard, labelling might provide some pressure to improve the performance of some products, if it sends a strong enough market signal to incent the use of better technology, but it does not require all products to meet a standard. The evidence provided suggests that the ENERGY STAR program has not yielded broad improvements in market performance. The industry comments repeatedly state that ENERGY STAR does not reflect actual market performance.[208] Other data support this conclusion.[209]

The reason that the information program has failed is that the market imperfections are too profound. As discussed above, the market imperfections involve a great deal more than a lack of information. There is no reason to expect a labelling program to do the job of a performance standard under these conditions.

The ENERGY STAR labelling program suffers from several other flaws with respect to the goal of a standards approach. It is self-selected, unrepresentative, backward looking and not sales weighted. It does not present a picture of the market as it is, or more importantly, where the market is headed. The non-industry commenters point to the backward-looking problem of ENERGY STAR by pointing out rapid technological progress that has taken place since the ENERGY STAR levels of energy efficiency were last set.

Impact of a Standard

The fact that today many of the products in the market have been afflicted by a significant market imperfection and would not comply with the standard is not surprising. The analysis has identified a significant energy efficiency gap. This counterfactual non-compliance (counterfactual because the standards are not in effect) tells us little about the ability of the industry to comply. In fact, once the industry has an incentive to increase efficiency via a standard, it will seek and find the least cost ways to do so.

In setting a standard that is intended to move the market toward a more efficient outcome, the Commission could not possibly simply rely on the current market equilibrium, which is what the industry seems to want. It must set the standard at a higher level than observed in a significant number of products in the market if the technology allows it to do so.

Recognizing that such a standard will require the industry to devote resources to improving the efficiency of the devices and that consumers will ultimately bear the cost of that improvement; the Commission should write standards that are achievable at a cost that is justified. Most statutes that govern the writing of standards by regulatory bodies impose this obligation by requiring that the standards be technically feasible and economically practicable or cost-beneficial. In fact, if the Commission has identified levels of efficiency that are feasible and beneficial based on some existing products, it will have done exactly what it must to comply with the California law and promote the public interest. The evidence presented to the Commission shows that there are compliant products available in the market today. This suggests that the proposed standards are technically feasible and the potential benefits are large.

The non-industry commenters stress that the evidence supports the conclusion that the standard is technically feasible and cost beneficial, which is the legal standard. They also point to the rapid technological progress that has taken place since the ENERGY STAR 6 levels were set as evidence to support the technical feasibility of the standards. They also argue that the potential benefits have been underestimated because actual consumption of electricity is higher than assumed in the CEC analysis and the allowance for adders is too large or not necessary.

The stipulation that standards are technically feasible and economically beneficial guards against making erroneous assumptions about what the industry can accomplish. Ironically, the industry presentations make the opposite error. To demonstrate what they cannot do, or should not be asked to do, they offer a series of comparisons with the rate of change of a number of mature products that bear no relationship to new digital products.

Ironically, at the same time, they bristle when we make comparisons between digital devices, objecting to the observation that the energy efficiency of notebooks and tablets is vastly superior to that of plug-in devices. They misinterpret our use of that comparison.

When we point to the remarkable success of the equipment makers in improving the energy efficiency of tablets and smart phones, we do not do so to suggest that the same technologies can or should be used in computers or notebooks, although we suspect that there are spillovers that have not been exploited. Tablets teach us what the industry can do when it has strong incentives to improve energy efficiency. We believe that reducing or removing the market imperfections will unleash the same kind of innovation and investment that has led to the improvement in the energy efficiency of tablets.

Standards v. Consumer Behavior

The industry commenters also “blame” consumers for not operating their computers in the most efficient manner possible. This confuses the difference between behavioral policies and structural policies. Of course, we want consumers to behave in a responsible way. Irresponsible consumer behavior is not an excuse for irresponsible producer behavior. We want consumers to drive their cars intelligently, but even when they do, there is an immense amount of energy that can be saved by operating more energy efficient cars. The same is true for computers. Moreover, we must design standards on the basis of real world behavior, not hypothetical ideal behavior. To the extent we can help consumers to behave well by designing devices better (e.g. built in technologies and default settings), we should attribute those gains to the standard.

Computers and displays are overflowing with such opportunities, including default setting at the lowest level of energy consumptions necessary and automatic transitions to lower levels of energy consumption when possible.

High End Products

Industry has raised some questions about the ability of some (primarily high performance) models to consume less energy or to ramp up satisfactorily and still execute the desired functions. However, it is unclear whether this problem exists with the present design of devices and how difficult it would be to solve with new designs. Industry comments indicate a two-year design and build cycle, which, depending on when the standards are issued, what their level is, and when they go into effect, could be challenging if significant redesign is necessary.

The empirical evidence reviewed by the Commission and the anecdotal evidence presented at the workshop strongly support the proposition that the proposed standards are economically beneficial. The industry objects to this conclusion, presenting worst case scenarios, particularly for high end devices, claiming that they will be driven from the market. This argument is based on two assumptions that are generally not true. They assume that:

(1) the industry will be unable to control the cost increases necessary to meet the standard through innovation, and

(2) customers will be unwilling to pay the increase, even though these are high value uses.

The bottom line here is simple. The industry worries about high end devices because that is where they make the highest profit. We worry about low and mid-level devices because that is where consumers waste the most money on unnecessary energy consumption. There is every reason to believe that the high-end products will not be driven from the market, but will be supported by powerful market forces, i.e. the tendency of the industry to find the least cost solution while maintaining the functionality consumers want, the willingness to pay of consumers, and the foreclosure of sale of non-compliant products.

The CEC has continued to develop the standards in a direction that is consistent with these principles.

- The design and refresh cycle has been given more weight.
- The unique needs of consumers and demand in the marketplace has been recognized.
- The industry has come to support the standards.

These developments provide strong justification for our support of the process and our opposition to ill-considered legislative efforts that would have weakened the CEC's ability to arrive at a pro-consumer, pro-environment outcome that will also help the industry.

PART VII. FOUR DECADEES OF SUCCESSFUL ENERGY EFFICIENCY PERFORMANCE STANDARDS

XVII. THE BENEFIT-COST ANALYSIS OF FUEL ECONOMY STANDARDS

In this section, in laying out our comprehensive approach, we reject several arguments that would narrow the view of the benefits of efficiency standards because the externalities are real.

PARAMETERS OF THE ANALYSIS

In this analysis we rely primarily on agency economic analysis presented in the final regulatory impact/or environmental impact analyses. We accept the agencies' estimate of costs at a 3% discount rate, which even the critics seem to accept for purposes of estimating regulatory costs. Some of the historic studies were conducted with a higher discount rate and are difficult to convert to 3%. We report the original results, noting that the estimates would be more favorable at the lower discount rate. We accept the agencies' estimates of energy savings and the resulting reduction in emissions.

All values are converted to $2016, with BLS Consumer Price Index. All values are discounted at 3%, to the extent possible. For present and near future values, the Technical Support Documents and Federal Register notices provide the basic analysis so only a slight adjustment for the base case is necessary.

We show three metrics of performance, the benefit/cost ratio (b/c), the Internal Rate of Return (IRR), and the cost per gallon saved.

For studies of past (older) standards, analysts use actual market data on the energy consumption of the durable goods to calculate the annual savings. They then multiply by the average price of energy in each year (generally stated in constant, real terms) by the level of consumption.

Consumer pocketbook savings are the largest single benefit in all of these analyses. As argued above, when energy saving technology is added to energy using consumer durables or capital goods, the total amount of energy consumed declines. The decline in operating costs is larger than the capital cost increase, resulting in net pocketbook saving for consumers. As a general proposition, these benefits constitute the majority of the total benefits estimated by the agencies (two-thirds to four-fifths).

In light of the debate over pocketbook savings, the analysis that follows includes a "pure externalities" view of the cost benefit rules. This consists of two components (macroeconomic effects and environmental, public health and other externalities) that are very unlikely to be internalized in the private transaction of the manufacturer's sale of an energy using consumer durable. As noted above, one can argue that consumer pocketbook savings are an externality of environmental regulation. In this analysis, we treat it as a direct benefit in of the rule.

Although we identify these separate components of the benefits, we believe that the correct way to view the standards is to start with the consumer pocketbook savings and traditional externalities and recognize the additional macroeconomic stimulus created by adding new technology and lowering the total cost of owning and operating energy consuming durable goods.

We also show the effect of a 30% decline in compliance costs from the agency estimates. This is a very modest reduction compared to historical evidence. We include the rebound effect as a pocketbook benefit in the "adjusted" scenario, but we do not include it in the estimate of the macroeconomic benefits, which are based on the net pocketbook benefits as estimated by the agencies. We do not include a macroeconomic benefit for environmental/public health benefits. We do not show this scenario for studies that evaluate past performance, since these are intended to reflect the actual cost of the technology, which would include any progress.

Periods

The first period, past, stretches from the beginning of the standards program in the late 1970s as a response to the oil price shocks of that decade. It runs approximately three decades until the passage of the Energy Independence and Security Act of 2007. This Act reformed and rebooted energy efficiency programs dramatically. The reforms were aggressive and progressive in the technology sense. It is worth recalling that EISA was passed shortly after President Bush, hailing from an oil state, declared that America was suffering from an addiction to oil.

The second period, present, runs from the passage of EISA to the present. It embodies the most aggressive period of standards writing, in part as a response to EISA, in part as a response to a court ruling that found that the Department of Energy had failed to faithfully implement the statute governing energy conservation. This period included the launch of the National Program for motor vehicles, with its unprecedented interagency and federal-state cooperation.

The third period, near future, includes the standards that are under review and attack by the Trump Administration. This period includes the executive anti-regulatory orders as well as decisions by the EPA to reopen standards that had been formally concluded. The reconsideration of the final determination in regard the National Program is included in this period.

The fourth period, future, includes estimates of potential savings in all three areas on which we have focused – light duty vehicles, heavy duty vehicles and appliances. These would be put at risk due to the general constraint imposed by the administration, as well as specific rules that have been put under reconsideration.

We discuss the benefit cost characteristics of standards in chronological order because the nature of the underlying analysis differs across time and the policy implications are different. Present and future estimates involve more assumptions and projections, whereas backward looking evaluations measure what happened. Backward looking evaluations provide a check on future projections. In this Section, we discuss the past and present standards.

PAST STANDARDS

Light Duty Fuel Economy Standards

David Greene, a leading analyst of automotive fuel economy has prepared and placed in the record a groundbreaking study of the effect of fuel economy since the beginning of the CAFE program.[210] It is based on data from the Consumer Expenditure Survey conducted by the Bureau of Labor Statistics. It involves reported expenditures on gasoline and automobiles combined with estimates of national fuel prices and estimates of the cost of energy saving technology. The analysis is adjusted for inflation (results are stated in real, 2016 dollars). The only adjustment we have made in the analysis of past auto standards is to apportion the latter years of Greene's analysis (1980-2014) between pre-and post EISA and allocate model years 2008- 2011 to the post-EISA period.

The backward-looking evaluations of the broad impact of past standards are quite different than the technical support analyses that evaluate current and future standards, but they reach similar conclusions and support the methodology used for projections. The studies examine the units shipped, prices paid and the efficiency of specific products. They tend to use a higher discount rate than the one we use, but it is extremely difficult to adjust their findings, so we have only inflated the dollar amounts to state all costs and benefits in terms of 2016 dollars. The actual benefits would be higher with lower discount rates.

The top line of the TableXVIII-1 presents the results of that comprehensive evaluation of fuel economy improvements over the period from 1980 to 2014. To render the results of the backward -looking analysis comparable to the forward-looking analysis, we state all dollar amounts in 2015 dollars. We also estimate the implicit rate of return on the investment, i.e. we calculate the return on the average cost of technology yielded by the average savings over the life of the vehicle.

We also show the mid-point estimates (preferred or reference cases) for the agency analyses. Greene and Welch did not provide a mid-point. The range we show is for their estimated high and low cost of technology. They did caution that even the low cost attributed to technology they derived from the literature is probably too high.

We base the estimate of environmental externalities on Greene's estimate that the standards lowered consumption by 25-30%. We use 25% and assume that two-thirds of petroleum consumption was accounted for by light duty vehicles (consistent with our analysis in the discussion of work trucks). Over 30 years this means the standards saved about 20.5 billion barrels of oil. This is 17 times the value of environmental impacts estimated for the MY-2022-2025. This is consistent with the fact that the time period covered is ten times as long and the absolute value of the increase in mileage is greater. We set the value of environmental benefits for the earlier period (1980-2010) equal to 17 times the value claimed for 2022-2025.

The table presents the important costs and ratios in the following manner. The technology costs are given on the first line. Dividing the total costs by the amount of energy saved yields the cost of saved energy. That figure is "independent" of other assumptions about values. For the backward-looking analysis, the cost is about $0.58 per gallon. By historical and contemporary standards, this is a very low cost of saved energy.

The next line shows the traditional benefits calculated by the agencies. It shows the pocketbook savings first, then the environmental/public health benefits. In a typical pattern, the pocketbook savings are much larger than (3 times) the environmental benefits. The pocketbook savings have a large benefit cost ratio. The benefit cost ratios are greater than one on a standalone basis and combined the ratio is over 5.5-to-1. The internal rate of return (IRR) is very high.

TABLE XVII-1: EVALUATION OF ENERGY EFFICIENCY/EMISSION STANDARDS

Consumer Durable	Period (Source)	Cost & Benefit	2016$ Billion at 3% discount	b/c Ratio	IRR	Cost of Saved Energy $/Gal.	Enviromental Billion at 3%	b/c	Traditional Pocket + Enviro b/c	IRR	Pure Extern. Macro + Enviro b/c	IRR	Total Pocket+Extern b/c	IRR	Adjusted *Total b/c @ 70% of Cost*
Light Duty															
Past	1980-2014	TechCost	$499			$0.58									
	(Greene & Walsh)	Pocketbook	$2,121	4.25	13.88%		$697	1.40	5.65	18.72%					
	at 6% discount	Macroeconomic	$1,622	3.25							4.65	15.28%			
		Total Economic	$3,743	7.50	24.97%								8.90	29.66%	
Present	2008-2011	TechCost	$9			$1.11									
	(NHTSA, TSD)	Pocketbook	$27	3.00	9.31%		$6	0.67	3.67	11.80%					
		Macroeconomic	$18	2.00							2.67	8.10%			
		Total Economic	$45	5.00	16.50%								5.67	18.78%	*8.81*
	2012-2016	TechCost	62												
	(EPA/NHTSA, TSD)	Pocketbook	$182	2.94	9.06%		$41	0.66	3.60	11.55%					
		Macroeconomic	$120	1.94							2.60	7.07%			
		Total Economic	$302	4.87	16.05%								5.53	18.32%	*8.60*
Near Future	2017-2021	TechCost	$47			$0.88									
	(National	Pocketbook	$192	4.09	13.30%		$48	1.02	5.11	16.87%					
	Program)	Macroeconomic	$131	2.78							3.80	12.27%			
		Total Economic	$323	6.86	22.82%								7.88	26.25%	*12.24*
	2022-2025	TechCost	$36			$0.75									
	(EPA	Pocketbook	$92	2.56	7.56%		$41	1.14	3.69	11.88%					
	Determination.)	Macroeconomic	$56	1.56							2.69	8.12%			
		Total Economic	$148	4.11	13.39%								5.25	17.36%	*8.09*
Far Future	2025-2030	TechCost	$39												
	(ICCT Adapted)	Pocketbook	$117	3.00	9.31%		$52	1.33	4.33	14.05%					
		Macroeconomic	$78	2.00							3.33	9.01%			
Heavy Duty		Total Economic	$195	5.00	15.07%								4.59	15.07%	*7.27*
Trucks															
Present	Phase I	TechCost	$9			$1.07									
	(EPA, NHTSA)	Pocketbook	$56	6.22	19.35%		$6	0.67	6.89	22.94%					
		Macroeconomic	$47	5.22							5.89	18.28%			
		Total Economic	$103	11.44	35.76%								12.11	37.84%	*18.94*
Near Future	Phase II	TechCost	$29												
	(EPA, NHTSA	Pocketbook	$163	5.62	17.42%	$0.33	$66	2.28	7.90	24.67%					
	CFA Supporting)	Macroeconomic	$134	4.62							6.90	21.49%			
		Total Economic	$297	10.24	32.00%								12.52	39.13%	*19.34*
Far Future	Alt. 5 Increment	TechCost	$24												
	(EPA, NHTSA)	Pocketbook	$66	2.75	5.82%	$0.33	$27	1.13	3.88	11.71%					
		Macroeconomic	$42	1.75							2.88	6.95%			
		Total Economic	$108	4.50	11.74%								5.63	17.40%	*8.68*
Appliance						Billion $/									
						Quad									
Past	1988-2007	TechCost	$179			$2.29									
	(Meyers, et al.)	Pocketbook	$488	2.73	16.28		156	0.87	3.60	16.08%					
	3% to 2007	Macroeconomic	$309	1.73							2.60	15.26%			
	7% to 2040	Total Economic	$797	1.60	29.03								5.32	33.83%	*7.83*
Present	2007-2040	TechCost	$23												
	Light Bulbs	Pocketbook	$212	9.22	61.40		42	1.84	11.06	73.71%					
\	ACEEE	Macroeconomic	$189	8.22							10.06	54.70%			
\		Total Economic	$401	17.43	116.23								17.4	110.67%	*27.40*
	2007-2040	TechCost	$39												
	ACEEE assorted	Pocketbook	$166	4.26	27.65		33	0.85	5.11	33.63%					
		Macroeconomic	$127	3.26							4.11	20.36%			
		Total Economic	$293	7.51	49.97								7.51	47.76%	*11.81*
	2014-2044	TechCost	$26			$1.29									
	DOE TSD	Pocketbook	$62	2.38	13.53		11	0.42	2.81	19.69%					
	Refrigerator	Macroeconomic	$36	1.38							1.81	8.51%			
		Total Economic	$98	3.77	24.15								4.19	26.65%	*6.53*
Near Future	CFA Supported	TechCost	$56												
		Pocketbook	$370	6.61	20.15		18	0.32	6.93	23.94%					
		Macroeconomic	$314	5.61							5.93	16.42%			
		Total Economic	$684	12.21	49.97								12.54	79.76%	*19.65*
Far Future	ACEEE	TechCost	$202												
Appliances	(assume b/c=3,	Pocketbook	$607	3.00	18.42		121	0.60	3.60	22.29%					
	no water savings)	Macroeconomic	$405	2.00							2.60	15.28%	5.60	35.62%	*8.29*
		Total Economic	$1,012	5.00	32.86										

Sources and Notes

<u>Light Duty</u>

Past: This estimate is based on David Greene and Jilleah G. Welch, The Impact of Increased Fuel Economy for Light-Duty Vehicles on the Distribution of Income in the United States, Howard Baker Center for Public Policy, January 2017. A slight period of overlap between past and present is subtracted based on the NHTSA estimate of 208-2012.

Present: These are from the Technical Support Documents. Here we use the Federal Register Notice with the EPA economic analysis, since EPA separated out pocketbook (fuel) and other benefits. The inflator to bring the estimates to 2016 is 1.1.

2008-2011: https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/2006_friapublic.pdf
2012-2016: https://nepis.epa.gov/Exe/ZyPDF.cgi/P1006V2V.PDF?Dockey=P1006V2V.PDF
2017-2025: https://nepis.epa.gov/Exe/ZyPDF.cgi/P100F1E5.PDF?Dockey=P100F1E5.PDF

Near Future: These are from the Technical Support Documents in the mid-term review. TAR: https://nepis.epa.gov/Exe/ZyPDF.cgi/P100OXEO.PDF?Dockey=P100OXEO.PDF Final Determination:

Far Future: Light Duty Vehicles: This is based on a comparison of the ICCT projections for the five years between 2025-2030 to the analysis of the 2022-2025 period in the mid-term review. We use a 4.5% improvement scenario (the average of the ICCT 4% and 5% scenarios) because EPA discusses a 4.5% scenario for going forward in the mid-term review. The ICCT cost numbers are 10% higher and the savings rate 10% lower, compared to the EPA analysis, which seems reasonable given the movement up the supply curve for efficiency technology and the short period of time covered. ICCT: Nic Lutsey, et al., *Efficiency Technology and Cost Assessment of U.S. 2025-2030 Light Duty Vehicles*, March 2017.

Heavy Duty Trucks:

Present: The first standard for heavy duty trucks adopted as a result of the Energy Independence and Security Act. Taken from the Technical Support Document: Phase I: https://nepis.epa.gov/Exe/ZyPDF.cgi/P100EG9C.PDF?Dockey=P100EG9C.PDF, In the Technical Assessment Report (TAR) and the Final Determination, EPA projects substantial cost reductions from the original Technical Support Document for the National Program. The current incremental cost estimate is almost 20% lower than the original incremental cost for 2022-2025. Taking a cautious approach for this analysis, we assume that the cost decline represents a 10% decline in the 2025 costs (assuming no cost overestimation in the 2017-2021).

Near Future These are from the Technical Support Documents: Phase II: https://www.gpo.gov/fdsys/pkg/FR-2016-10-25/pdf/2016-21203.pdf

Far Future: This is based on the Regulatory Impact Assessment of the Phase II Heavy Duty Truck Rule. We use the difference between the most stringent alternative considered and the final rule.

Appliances

Past: Stephen Meyers, James McMahon and Barbara Atkinson, *Realized and Projected Impact of U.S. Energy Efficiency Standards for Residential and Commercial Appliances*, LBNL, March, 2008. Converted from $2006 and a benefit cost ratio of 2.7-to-1 (p. 2). The study used a split discount rate, 3% for backward looking estimates and 7% for forward looking.

Present: (2008- 2014) is subtracted from the past. All adjustments to quantities are made to preserve the benefit cost ratios in the original.

Lowell Unger, et al., *Bending the Curve: Implementation of the Energy Independence and Security Act of 2007*, ACEEE, October 2015. Dollars inflated from 2013 to 2016. Discount rate adjusted from 5% to 3%. Costs are derived from net benefits and benefit cost ratio after adjustment to preserve the original benefit cost ratio.

Near Future: These are based on a small number of rules that were on the cusp of being adopted and have been delayed, for which CFA has taken action to secure the consumer benefits. , these estimates are for the 50% holdout scenario analyzed by Lawrence Berkeley National Laboratory (LBNL Report Impact of the EISA 2007 Energy Efficiency Standard on General Service Lamps (see Table 3: Representative Lamp Options and Properties), which was cited in our letter to DOE (Appliance Standards Awareness Project, et al., Docket No. EERE-2017-BT-NOA-0052, October 16, 2016). Small rules include portable air conditioners, uninterruptible power supplies, air compressors, commercial packaged boilers, ceiling fans and walk-in coolers and freezers.

Far Future: This is based on the ACEEE estimate that identifies opportunities for further increases in appliance efficiency consistent with the statutory mandates for updating standards (Appliances in general: http://aceee.org/research-report/a1604). They project dollar value savings. We inflate to 2016$ and discount the total. We assume the benefit cost ratio will be slightly lower than the near future ratio of 3-to-1 to estimate costs.

On the next line we show the macroeconomic externality and then the sum of the two externalities (macro + environmental). By definition, the macroeconomic benefits are lower than the pocketbook benefits, but they still dominate the pure externality case. The benefit cost ratio is over 4.6-to-1. The IRR is very high.

The next line shows the total economic benefit and then the total benefit adding the economic and environmental. The total benefit cost picture is very positive, at almost 9-to-1. The IRR is almost 30%. As noted above, we do not present an adjusted scenario, since the costs "are in the books" and already reflect learning.

While benefit cost analysis focuses on ratios and rates, dollars matter. The dollar values are extremely large, with consumer pocketbook savings of $2.1 trillion and macroeconomic benefits of $1.3 trillion. Traditional benefits are $2.8 billion and net benefits are $2.3 trillion. Including macroeconomic benefits, the total, net benefits almost reach $4 trillion. If the discount rate were adjusted to 3% for the entire analysis, the net benefits would likely be close to $6 trillion.

Dollar amounts matter a great deal to consumers. Greene's backward-looking analyses of the impact of fuel economy standards over three and a half decades of their existence, which is almost its entire operating life, is extremely important in the context of the current Determination. It provides a grounding for the forward-looking analyses. It shows that the forward-looking analyses are consistent with the past performance of the fuel economy standards, particularly when one focuses on the high end of the results, which Greene and Welch think is the estimate that better describes the standards in the past. Their best-case scenario is for average annual benefits is just over $400 per year for 35 years. The worst-case scenario is for benefits of just over $200 per year.

Appliances

On the first line of the appliance standards, we find costs of just under $180 billion, yielding a cost per quadrillion BTU of $2.29. By historical and contemporary standards, this is an extremely low cost.

Pocketbook benefits are about $490 billion and public health/environmental benefits are over $150 billion, yielding a traditional view of the benefit cost ratio of 3.6 and an IRR of 16%. Here we note that the public health/environmental benefits alone do not exceed the costs. But these are Department of Energy standards and public health/environmental benefits are not the animating goal. Energy savings are the primary goal.

Macroeconomic benefits are almost $310 billion, yielding total economic benefits of almost $800 billion. The pure externalities view has a benefit cost ratio of 2.6-to1, with an IRR over 15%. The full accounting for benefits and costs has a ratio over 5-to-1 and an IRR over 17.5%.

If the discount rate were adjusted, to 3% for the entire analysis, the total net benefits would exceed $1 trillion.

PRESENT

Light Duty Vehicles

The analysis of present standards relies on the agency's technical documents. We have adjusted the results to 2016 dollars. Because of the midterm review we divide the post-EISA standards into sub periods. We include the first two rounds of rulemakings in post-EISA period as present standards because they were not subject to the mid-term review. The Trump administration chose to include the 2021 standards for review. None of the agencies had done this separate analysis. We use the regulatory analysis as prepared here and adjust the future analysis for 2021 in the next section.

The two sets of standards issued after the passage of EISA have similar benefit cost ratios. The second set of standards issued under the National Program for model years 2017-2025, are much larger because they covered a longer period and raised standards higher. Given their similarity, we discuss them together.

Pocketbook benefits are over $200 billion, with a standalone benefit cost ratio of 3-to-1. Public health/environmental benefits are close to $50 billion, with a standalone benefit cost ratio of .66-to-1. The pure externalities view has a benefit cost ratio of 2.6-to-1. The full analysis has a benefit cost ratio of 5.5-to1 and an IRR over 18%.

These joint agency actions underscore the need to consider all benefits and costs that come from a rule, when those benefits and costs are inextricably linked, as the pocketbook and public health benefits are. Whether the policy and analysis launch from an energy, environmental or economic goal, it ends up in the same place because the co-benefits and co-costs are unavoidable. Standards are the least cost way to save energy or reduce pollution and they have the benefit of increasing consumer disposable income and stimulating economic growth. As a matter of public policy that seeks to promote the public interest under the statutes and executive branch guidance, the full impact is the correct target.

Work Trucks

In the present period we find the first rules governing work trucks. The analysis of work trucks in Table XVIII-1 shows that these rules are even more valuable to consumers and the nation than any other set of rules, past or present. Because work trucks had not been subject of efficiency/environmental regulation, the early standards yield relatively larger benefits at lower costs. This was the case with light duty standards as well.

The Phase I work truck rule has very low technology costs (less than $10 billion) for a cost per gallon of just under $1.10. This is less than half the current cost of diesel and less than one third of the projected cost over the life of the vehicles. It is a very attractive policy from this simple point of view.

It is equally attractive from the more complex benefit cost point of view. Pocketbook savings are over $55 billion with a benefit cost ratio over 6-to1. Public health/environmental impacts have a benefit cost ratio of .67-to-1, but the benefit cost ratio from the traditional point of view is almost 7-to-1 with an IRR of almost 23%. The pure externality point of view has a benefit cost ratio close to 6-to1. The full view has a benefit cost ratio above 12-to-1 with an IRR of almost 38%. With the exception of lightbulbs, discussed below, the work truck rule is the most attractive standard of all.

Appliances

Appliance standards in the present period are the most attractive standards in the past forty years. The technological revolution in lighting is the primary driver of this broad pattern of benefits. However, the other appliances also present positive benefit cost pictures. The only available analysis that enables us to make an estimate of cost per unit of saved energy put the figure at $1.29 per quad.

The pocketbook benefit cost ratios range from about 2.4-to-1 to more than 9-to-1. The traditional benefit cost ratios vary from just under 3-to-1 to over 11-to1. The pure externalities benefit cost ratios vary from just under 2-to-1, to over 10-to1. The full benefit cost ratios vary from just over 4-to-1 to over 17-to-1.

In the appliance area we also have significant standards at the state level. We have used computers and furnaces as examples earlier. The benefit cost ratios for computers support the general analysis above, as shown in Table XVII-2. All of the traditional (lifecycle) benefit cost ratios are greater than one. For the standards proposed, they are greater than two. In our focus on consumer pocketbook issues, we examine not only the lifecycle benefit cost ratio but also the flow of benefits and costs over time. A benefit cost ratio greater than two suggests that the break-even point comes less than halfway through the assumed product life. As can be seen in the exhibit, the payback periods are short, less than two years. This means that sometime in the second year the cash flow is positive. Moreover, given the product lives assumed, consumers will enjoy the positive cash flow for more than half of the product life. These standards are extremely consumer-friendly.

TABLE XVII-2: BENEFIT COST RATIO

Device	Product	Cost	Savings		Evaluation Metrics			Macroeconmic		Evaluation Total	
	Life		Annual	Lifecycle	b/c	IRR	Payback	Value	b/c	b/c	IRR
							years				
Desktop	5	$18	$12	$62	3.4	60%	1.45	$44	2%	5.8	113%
Monitor	6.6	$5	$4	$29	5.8	78%	1.13	$24	5%	10.6	146%
Bundle	6.2	$9	$7	$38	4.2	75%	1.21	$29	3%	7.4	136%
Notebook	4	$1	$1	$2	2	93%	1.74	$1	1%	3.0	199%

Source: CEC Staff Report, 2016, pp. 35, 82.

CONCLUSION

It is an understatement to say that the benefit cost analysis of the past forty-years of efficiency standards paints a very positive picture. To date, we see no significant drop off in any of the benefit cost measures. In all likelihood, this reflects the process of innovation and learning that well-crafted performance standards stimulate. In fact, since the present standards cover energy-using consumer durables for another couple of decades, the net benefits are likely to have been underestimated because costs will continue to decline. The adjusted scenarios put the benefit cost ratios above 8-to-1 and IRRs well above 20%.

XVIII. THE LONG-TERM SUCCESS OF ENERGY EFFICIENCY STANDARDS AND THE $2 TRILLION MISTAKE OF ABANDONING THEM

This Section presents an overview of the track record of energy efficiency performance standards discussed in the previous two sections. We begin with the broad sweep of the four decades of implementation of these standards for vehicles and appliances. Then we evaluate the harm of abandoning these successful programs by rolling back and freezing standards on the books, and turning away from the continuous process of increasing efficiency levels.

THE BROAD SWEEP OF STANDARDS

The full detail of the analysis was presented in Table XVII-1, here we take a simpler approach that highlights the current stakes. Table XVIII-1 focuses on economic benefits and costs in two broad periods, past and future. The top of the Table divides the analysis into past and present, with the dividing line being whether or not current standards have been placed at risk. The only adjustment we have made here is to move the benefits and costs for year 2021 into the at-risk period.

Past Standards

We will not repeat the backward-looking analyses here, but it is important to appreciate the magnitude of the benefits as background for understanding what is at stake going forward. The past efficiency standards yielded $2.5 trillion of pocketbook savings, with vehicles accounting for the majority of the total (four-fifths). We estimate $1.9 trillion of macroeconomic benefits. The total is almost $4.4 trillion, compared to costs of $0.6 trillion. Typically, the environmental benefit runs between a quarter and a half of the pocketbook benefits, so they tend to cover the costs. Thus, the total benefit to consumers and the nation is in the range of $5 trillion to $6 trillion, with the benefit cost ratio in the range of 7-to-1 to 9-to-1.

One can certainly argue that this huge burden of excess spending on energy would have been too much to bear. Things would have gotten so bad that the marketplace might have responded. That is exactly the point. The evidence on market imperfections makes it clear that the response would have been slow, more painful and far less effective.

FREEZE AND ROLLBACK

The threat of freeze and rollback of near term standards shows over almost $1.2 trillion in pocketbook and over $800 billion in macroeconomic. Here we see a shift with appliances equaling about three-fifths of the total. This reflects the fact that we have modeled two mid-term projections in the vehicle space that have a very well-established source, bur have not looked for much longer-term potential changes. There is certainly a great deal of potential, especially with the likely advance of electric vehicles, but we have not seen estimates that provide the kind of detail we need to do the type of benefit cost analysis on which this paper is based.

Therefore, we believe $2 trillion is a very conservative estimate of the loss that would be imposed by an abandonment or significant weakening of the standards program. Moreover, here as elsewhere, the public health/environmental benefits are likely to more than offset the costs, so the net savings are likely to be well over $ 2 trillion.

TABLE XVIII-1: FOUR DECADES OF ECONOMIC BENEFITS OF ENERGY EFFICIENCY STANDARDS AND THE MISTAKE OF ABANDONING STANDARDS

Period	Category	Vehicle	Appliance	Total
Past - Pre-EISA	Technology Cost	465	179	644
	Pocketbook Savings	2021	488	2509
	Macroconomic Benefits	1556	309	1865
	Total Economic Benefit	3577	797	4374
Recent - Post EISA	Technology Cost	71	49	120
not under review	Pocketbook Savings	209	24	233
	Macroconomic Benefits	138	325	463
	Total Economic Benefit	347	499	846
Total Past & Present	Technology Cost	536	228	764
Past & Present	Pocketbook Savings	2230	512	2742
	Macroconomic Benefits	1694	634	2328
	Total Economic Benefit	3924	1296	5220
Present - Under	Technology Cost	98	35	133
Threat of Freeze	Pocketbook Savings	308	113	421
and Rollback	Macroconomic Benefits	210	78	288
	Total Economic Benefit	518	191	709
Far Future	Technology Cost	63	202	265
	Pocketbook Savings	183	607	790
	Macroconomic Benefits	120	405	525
	Total Economic Benefit	303	1012	1315
Total				
Present & Future	Technology Cost	161	237	398
	Pocketbook Savings	491	720	1211
	Macroconomic Benefits	330	483	813
	Total Economic Benefit	821	1203	2024

Future Standards

As noted above, the agencies are required to look back, to see what standards are still needed, and forward to see if higher levels can be achieved. We have shown that the past standards are economically very attractive. The estimate of future potential in Table XVIII-1 for light duty vehicles, based on a study by the ICCT, suggests that there remain attractive opportunities to improve the fuel economy of light duty vehicles. The benefit cost ratios and IRRs are all as strong or stronger than in the past. The agencies should pursue these (as California has proposed). Failing to do so would push the harm imposed on society well past half a trillion dollars with losses exceeding benefit by more than five to one.

Work Trucks

The analysis of work trucks in Table XVIII-1 shows that these rules are even more valuable to consumers and the nation. Because work trucks had not been subject of efficiency/environmental regulation, the early standards yield relatively larger benefits at lower costs. This was the case with light duty standards as well.

Both phases of the heavy-duty truck rules yield among the highest benefit cost ratios and IRRs and lowest cost of saved energy of all the standards reviewed. The potential future standard for heavy duty trucks is taken from a level EPA/NHTSA ran for the Phase II rule but chose not to adopt as the standard. It shows declining net savings, but still has ratios that are strongly positive. There is no justification for lowering the Phase II standard; rather there appears to be room to raise these standards in the future, particularly as the process of implementation lowers costs.

A Closer Look at Vehicles

Freeze and Rollback

Given the main focus of this analysis is on vehicles, we examine the current period in greater detail. We drill down a bit more into the vehicle numbers in Table XVIII-2 we show the results that are included in Table XIV-1 along with benefit cost ratios and all the metric utilized early. The challenge is to parse out the costs and benefits from the early years of the National Program between those that are not being reconsidered (MY2017-2020) and those that are.

We have built an analysis of the freeze and rollback of standards based upon the Final Regulatory Impact Analysis (RIA) for the National Program. While some things have changed, the overall implications of the analysis are crystal clear. We have adjusted the value of fuel savings to reflect the decline in gasoline prices. We do so by calculating the dollar value of MY 2022-2025 in the National Program final RIA and comparing it to the value of fuel savings in the TAR. We assume the value of environmental/public health impact has not changed. We use the cost as stated in the RIA and account for the decline in costs by considering a scenario in which costs are 30% lower.

The Table distinguishes the two types of vehicles, the two separate policies (freeze and rollback), and we offer the three-individual views (traditional, pure externality, full benefits) and the benefit cost ratio calculated with and without the adjustment.

TABLE XVIII-2: THE NEGATIVE IMPACT OF FREEZING AND ROLLING BACK FUEL ECONOMY STANDARDS

Vehicle Type		Economic Values (Billion 2016 $)								b/c Ratios (All Loses)						Adjusted			Pure Externality	
		Cost	Lost	Lost	Lost	Lost	Lost			Pocket	Macro-	Total	Trad. = Pock + Env			(+.1*Reb./.7)			Billion $	b/c
		Saving	Pocket	Macro-	Total	Trad =	Trad +	Trad +		Book	Econ	Econ	Pock+	Pock +		Econ	Total			
			Book	Econ	Econ	Pock +	Macro	Macro +					Env	Env +						
						Env		.1* Reb.						Macro						
Light Duty																				
	Freeze &	69.4	145	75.6	220.6	211.5	287.1	295.8		-2.09	-1.09	-3.18	-3.05	-4.14		-4.54	-6.09		142	-2.05
	Rollback																			
	Freeze Only	52.1	91.9	39.8	131.7	146.7	186.5	195.2		-1.76	-0.76	-2.53	-2.82	-3.58		-3.61	-5.35		94.6	-1.82
Work Truck																				
	Freeze Only	29	163	134	297	229	363	371.7		-5.62	-4.62	-10.24	-7.90	-12.52		-14.63	-18.31		200	-9.85
Total																				
	Freeze &	98.4	308	209.6	517.6	440.5	650.1	658.8		-3.13	-2.13	-5.26	-4.48	-6.61		-7.51	-9.56		342	-4.97
	Rollback																			
	Freeze Only	81.1	254.9	173.8	428.7	375.7	549.5	558.2		-3.14	-2.14	-5.29	-4.63	-6.78		-7.55	-9.83		294.6	-5.19

Sources: EPA/NHTSA, *MY 2017 and Later – Regulatory Impact Analysis,* Tables 10-18 and 10-35 and *Final Determination,* Table ES-4.

For light duty vehicles we find that Freeze and Rollback and Freeze Only have severely negative impacts on consumers, the economy and the environment. They have substantial negative benefit cost ratios. Therefore, they violate the statute and the executive branch guidance. Since review of the standards for 2021 was not included in the mid-term review instituted by the National Program but the Trump Administration has signaled its intention to roll back those standards, we focus here on the freeze and roll back impact.

- The lost pocketbook benefits would be over $145 billion for the freeze and rollback and reduced economic growth would be over $75 billion (see Table XIV-2). The loss of $220 billion in benefits yields just under $70 billon in cost savings. In other words, the pocketbook benefit cost ratio is -2 to 1. The total economic cost benefit ratio is -3 to 1. The freeze only has a benefit cost ratio of -2.5 to 1.
- We have included for the purposes of this analysis the traditional industry approach, which is the sum of pocketbook and environmental benefits. Freeze and rollback has a substantial negative benefit cost ratio (-3 to 1), while freeze alone is almost as bad (-2.8 to 1)
- Taking cost reductions and the pocketbook value of the rebound effect into account, the benefit cost ratio is -4.5 to one. As noted above, the cost declines on which this scenario is based are already in evidence and the pocketbook value of the rebound effect is also correct, so this assessment of the economics is likely the best.
- Adding the lost environmental benefits to the adjusted economic benefits would put the negative benefit ratio close to -6 to 1 for freeze and rollback and -5 to 1 for freeze only. This is the best estimate of the impact of the attack on fuel economy standards.
- The pure externalities economics are also clearly negative. A policy of freeze (at 2021, without a rollback) only would have slightly less negative effects, but they would all be substantially negative. The policy change makes no sense either as economic policy or as externality policy.

Adding in the impact of work trucks makes matters much worse because work truck fuel economy has not been regulated much and the Phase II rule has very positive economic characteristics. In fact, because the work truck rule has such strong positive economic ratios, freezing out Phase II tends to dominate the analysis and the ratios converge around a common value. Again, since the Phase II rule was not written with a scheduled automatic review, the fact that the Trump Administration has put it on the table suggests a broader rollback of regulation. Therefore, again we focus on the Freeze and Rollback impacts.

- The analysis indicates over $300 billion in lost pocketbook savings and over $200 billion in lost macroeconomic growth for a total of half a trillion dollars of lost economic value.
- With cost savings technology less than $100 billion, the benefit cost ratio is -5 to 1.
- The traditional view of benefits (pocketbook plus environmental) indicates lost value of $440 billion and a benefit cost ratio of – 4.5 to 1.

- Adding in the macroeconomic benefit forgone pushes the total to over $650 billion, with a benefit cost ratio over -6.5 to 1.
- The "pure externality" view of the impact has a negative benefit cost ratio of almost -5 to 1.
- Finally, adjusting for the trend of declining costs, puts the benefit cost ratio in the range of -7.5 to -9.5 to one.

Freezing the standards at the 2021 level would rob consumers of over $90 billion in net savings and cost the economy $56 billion, for a total loss of almost $150 billion. Rolling back the standards would make matters worse. A rollback and freeze would:

- Rob consumers of net savings of over $4,500 per household,
- Prevent a reduction in operating costs of $150 billion,
- Undermine $150 billion of macroeconomic growth, and
- Forego over $50 billion in environmental, health and other benefits.
- The total of $350 billion of benefits foregone would yield automaker savings of only $50 billion, for a severely negative benefit cost ratio of 6-to-1.

For vehicles, economic benefits are about $800 billon. Public health/environmental benefits are another $200 billion, for a total of $1 trillion. Costs with historical and engineering based reduction going forward, would be about $100. The net benefits of $900 billon. However, historically, as shown in Table XVII-1, vehicle benefits were much larger than appliance benefits. In the future analysis appliance benefits appear to be much large than to the transportation savings. This is not because they are overestimated, but reflects a wide ranging, long term look at the future. For vehicles we have included two much nearer term (albeit future) standards

Therefore, this estimate of future savings for vehicles is likely to be very low. These include future benefits that do not extend far into the future. The projection of future benefits for appliances, which takes a long-term view, is significantly larger than vehicles (25%). Thus, a longer-term projection for vehicles would likely be at least $1 trillion and could be much larger.

Dollar Values

As noted earlier, the dollar values for households are as important as the billion and trillion-dollar policy aggregates. First, we focus on the mid-term review period. The TAR dollar results are presented in Table XII-2. For the typical household that purchases a vehicle with a 5-year auto loan and holds the vehicle for 10 years, the average annual savings is close to $300, discounted at 3%. A household that pays cash for the vehicle would realize almost $1650 of net savings.

Table XVIII-3 shows that there were differences between EPA and NHTSA in the estimates of costs and benefits. However, the topline results of the launch and early implementation of the National Program are quite simply, a very positive bottom line. Table XII-2 identifies key measures of the performance of the National Program projected for the

MY2022-2025 standards by both EPA and NHTSA from the consumer point of view. EPA and NHTSA focus on the lifecycle consumer savings, the payback period and total national benefits (in addition to reduction in CO_2 emissions and oil consumption). We add monthly cash flow analysis and cost per gallon saved as they are as more relevant to consumers.

While there are differences between the two agencies in their assessments as described below, we believe EPA's analysis, which stayed much closer to the original framework, is stronger and NHTSA will have to provide better justification for the changes it proposes to that methodology. We also believe the monthly cash flow analysis is more relevant to consumers and the cost per gallon saved is a simple measure of the consumer impact.

TABLE XVIII-3: CONSUMER POCKETBOOK IMPACTS OF FUEL ECONOMY STANDARDS

	Monthly			Cost per	Payback	Lifecycle savings		Total National ($, billion)	
	Cost	first year savings	Net	gallon saved	in years	Consumer	Total	Cost	Benefit
EPA									
Mark-up (ICM)	$16.07	$19.92	$3.85	$0.70	5-5.5	$1,620	$2,365	$36	$130
Retail Price Equivalent (RPE)	18.66	19.93	1.27	0.78	6	1,460	2,131	40	129
NHTSA									
Incremental Cost Mark-up (ICM)	18.00	25.10	6.90	1.18	6	800	1.168	89	175
Retail Price Equivalent (RPE)	20.00	24.79	4.79	1.29	6.5	600	876	79	178

Source: TAR, ES-11, ES-12 for cost/vehicle, total cost, total oil savings. First year cash flow and payback analysis are based on TAR 12-41 – 12-46, in which EPA presents year-by-year data for cash flows in the payback approach. The basic approach is applied to NHTSA first year VMT with direct calculation of savings, TAR 13-11 – 13-14. For the combined fleet, first year VMT is assumed to be 25% higher (increasing the first-year net benefit, but in the long-term NHTSA projections, survival weighted VMT is 20% lower, decreasing the lifecycle cost savings and increasing the cost per gallon saved).

- Notwithstanding the differences, the bottom line for both agencies is clear. The benefits of the program far exceed the costs.
- Cash flow benefits exceed costs incurred to reduce gasoline consumption early in the asset life (the first year).
- The cost per gallon saved is far below the projected cost of gasoline, even in the low-cost scenarios.
- Payback is less than half the asset life.
- There are substantial total savings measured at the consumer and national levels.

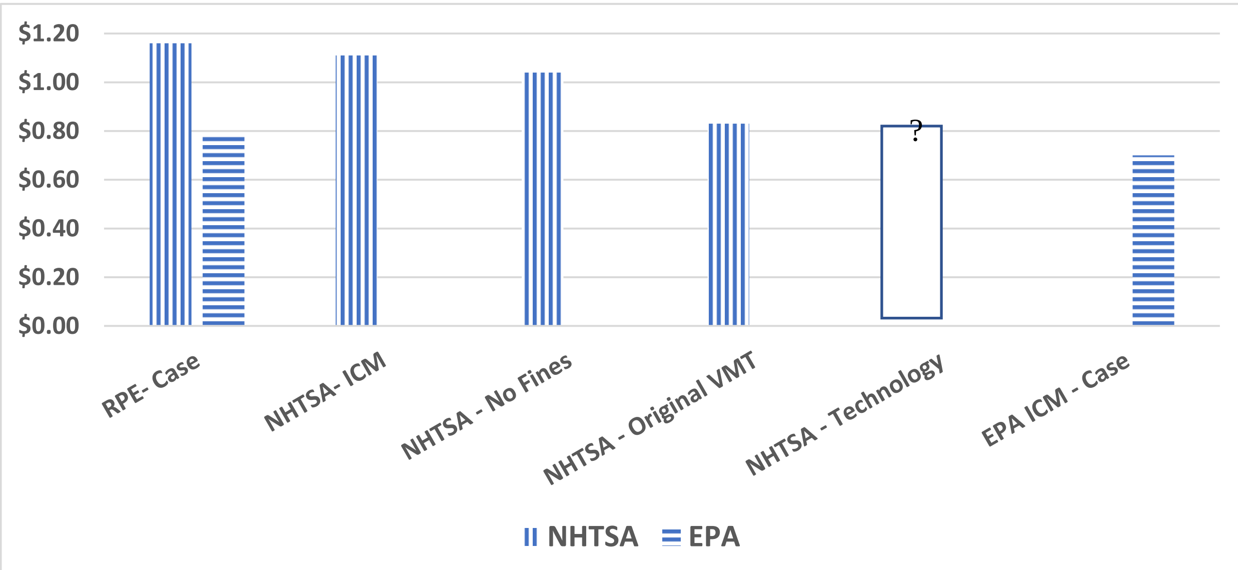
UNDERSTANDING THE DIFFERENCES BETWEEN THE AGENCIES

Although all the three agencies involved in the National Program generally agree that the standards are positive and point generally in the same direction. In fact, two of the three agencies (EPA and CARB) agree quite closely. NHTSA has headed in a tangential direction based questionable assumptions. Its analyses are properly treated by EPA as a "sensitivity" case.

EPA offers several analyses that allow us to begin to reconcile the differences between agencies, as suggested by Figure XVIII-1.

In our view NHTSA has gone off on a tangent from the other two agencies because of erroneous assumptions in its analysis. It increased the estimate of costs by unjustifiably raising the mark-up on fuel efficiency technologies and including fines paid in the cost. If lower cost technologies are available from compliant manufacturers, they will set the market clearing price and neither excessive profits nor fines will be recoverable in the market. It decreased the estimate of benefits by assuming a dramatic reduction of vehicle miles traveled, which it admits could well be a result of the great recession.

FIGURE XVIII-1: EXPLAINING THE DIFFERENCES BETWEEN THE EPA AND NHTSA BASED ON COST PER GALLON SAVED



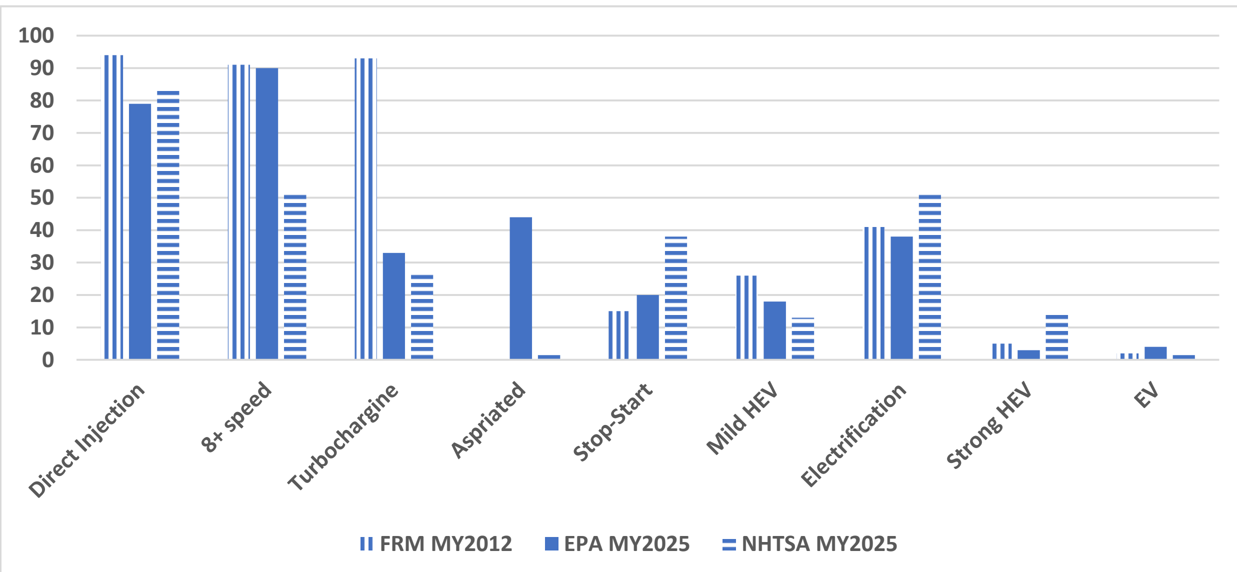
Source: ES-11 for costs, ES-12 for gallons saved and ES-9 for fines as a percent of base case costs. Assumes that fines and ICM are additive, which may overstate the cost reduction, since lower cost might enable some manufacturers to avoid fines.

NHTSA continues to impose the assumption that technologies included in vehicles must have a three-year payback.[211] That assumption was never justified, since consumers are willing to accept a five-year payback and, when all manufacturers face a similar constraint, there should be no disadvantage in meeting a higher constraint. Not only was the assumption never justified, but the changes in the market since 2012 have moved the market farther from the artificial constraint. Consumers are holding their vehicles longer and the majority of new car buyers are taking loans of five years or more. A five-year payback would be more appropriate, if such a constraint is needed, although NHTSA would be better off allowing technologies to enter the model in the order of least cost.

In one sense we should welcome differences in the penetration of technologies between manufacturers and across the fleet. This should indicate that different automakers are pursuing those technologies that suit them best and there are a lot of alternative pathways available. At the same time, extremely large differences might reflect the assumptions made by the modelers, rather than what is going in in the market. If there were little difference in the cost projections between the agencies this would not be a concern (since they are getting to the same place through different routes).

However, as shown in Figure XVIII-2, EPA and NHTSA have come up with different projections on technologies and costs and that immediately raises the question of whether the assumptions about technologies are driving the difference. Three differences stand out, the low level of penetration of 8-speed transmissions and high compression aspirated engines and the high level of penetration of strong hybrids in the NHTSA analysis. The agencies should examine and explain these differences as we move forward. We believe that EPA has presented the more convincing analysis on many of these points. We have also supported the general proposition that EPA is institutionally and legally better situated to take the lead where differences exist.

FIGURE XVIII-2: PENETRATION OF SPECIFIC TECHNOLOGIES INTO THE FLEET (IN PERCENT)



Source: TAR, pp. 12-35, 13-61-13-72.

APPLIANCES

Whereas the future impact of abandoning efficiency standards in the vehicle sector involves a small number of very large proceedings, the impact in the appliance space is more diffuse. There are many much smaller energy-suing durables. Much of the recent activity in writing the standards was the result of courts ordering the Department of Energy to comply with the statute that required frequent analysis of the state of efficiency to assess whether additional standards are in the public interest. There is a large role for the states, since the unoccupied field is left to the states. There are a variety of indirect ways that standards can be weakened or delayed.

Compared to the vehicle space, where two standards are being re-examined for the period for 2021-2025, the appliance efficiency space has several dozen standards that are teed up by the law at the federal and state level. Rather than parse through these individually, Table XVIII-1 above shows a very large estimate that covers a range of appliances and standards in a number of legal statuses (present being reconsidered and future that should be adopted.

Table XVIII-1 shows the economic evaluation of seven standards that CFA has been directly involved in defending. As noted earlier, lighting is a very large issue. Given the assault on lighting standards from DOE and the industry, these estimates are for the 50% holdout scenario analyzed by Lawrence Berkeley National Laboratory,[212] which was cited in our letter to DOE.[213] The General Service Lamp backstop standard has extremely high benefit cost ratios and a very low cost of saved energy. The six other standards identified (two of which have been saved, four of which are being litigated) much smaller and more typical of appliance standards in terms of size. While they are small, they have very positive benefit cost measures.

TABLE XVIII-1: RULES CFA HAS DEFENDED FROM DOE REPEAL OR ROLLBACK

Value	Pocket-book	Public Health	Macro-Economic	Pocket-book	Traditional Pocket. Pub.Hlth.	Pure Extern. Pub.Hlth.+ Macro	Full Benefit	Base Cost	Adjusted 70% of base
LED									
$ Billion	350	94	302	350	444	396	746	48	34
b/c Base				7.29	9.25	8.25	15.54		
b/c Adjusted				10.42	13.21	11.79	22.20		
Quads saved		47							
$/quad								1.021	0.71
6-Small									
$ Billion	19.8	11	11.7	19.8	30.8	22.7	42.5	8.1	5.67
b/c Base				2.44	3.80	2.80	5.25		
b/c Adjusted				3.49	5.43	4.00	7.50		
Quads saved		5.7							
$/quad								1.42	0.99

Sources and Notes: Given the assault on lighting standards from DOE and the industry, these estimates are for the 50% holdout scenario analyzed by Lawrence Berkeley National Laboratory (LBNL Report Impact of the EISA 2007 Energy Efficiency Standard on General Service Lamps (see Table 3: Representative Lamp Options and Properties), which was cited in our letter to DOE (Appliance Standards Awareness Project, et al., Docket No. EERE-2017-BT-NOA-0052, October 16, 2016). Small rules include portable air conditioners, uninterruptible power supplies, air compressors, commercial packaged boilers, ceiling fans and walk-in coolers and freezers. The latter two have now gone into force. Benefit cost estimates are from the relevant final regulatory analyses.

XIX. LOW INCOME CONSUMERS

CFA'S SEMINAL ANALYSIS

Automakers, dealers and flawed think tank analyses frequently claim that increases in fuel economy driven by performance standards force lower income households out of the market. We responded to the claims that higher fuel economy standards will harm low income households, which were emphasized by the National Association of Auto Dealers.[214] This rebuttal was part of the record and the object of the extensive analysis offered by Greene in the TAR proceeding.

We have argued that, since low income households are generally not in the new car market and operating costs are a much larger share of their cost of driving, the standards do not harm them. In the original analysis presented in comments on the National Program, we made two interrelated arguments.

First, we offered observations on how automakers manage the increasing cost of automobiles to keep them affordable.

- Over the past fifteen years, automakers have added three times as much value (and cost) with optional improvements in quality than mandatory (safety and environmental) improvements.
- The overall increase in MSRP tends to track closely to the increase in real disposable income.
- The cost increases that the long-term fuel economy standards will require over the next 15 years are well below the cost of quality improvement over the past 15 years.
- Unlike most other quality additions, fuel economy improvements deliver pocketbook savings to consumers.
- In today's market, fuel economy is a major determinant of vehicle quality that the market can easily absorb.
- Automakers adjust MSRP and discounts and auto financing in response to much larger changes in affordability.

Concerns about a negative impact of the standards on consumers and the auto market are unfounded, even in the case of low income consumers because they rest on faulty assumptions that are contradicted by the above analysis.

- When the costs of driving go down, vehicle ownership becomes more affordable, so output and employment in the industry will expand.
- Households with income below $20,000 made up approximately 22 percent of all households in 2010, but they accounted for only 2 percent of the money spent on new vehicles.
- Gasoline expenditures are a much bigger problem for these households. In 2010, households with incomes below $20,000 spent 7.3 times as much on gasoline as they spent on new car payments.

- Low-income households are much more involved in the used car market, in which we see an increase in supply of vehicles and lower prices as the standards accelerate the fleet turnover

The TAR recognized this argument, reviewed the literature and concluded that the evidence supported our point of view.[215]

> The 2013 Consumer Expenditure Survey data indicate that lower income households on average spent more in 2013 on gasoline ($2,154) than on vehicle ownerships ($670); in addition, they spent more on used vehicles ($362) than on new vehicles ($308). These results are analogous to those that Consumer Federation of America (CFA) provided in comments on the 2017-25 standards. CFA found that households with income less than $20,000 per year in 2010 accounted for 22 percent of households but only 2 percent of money spent on new vehicles; those households spent 7.3 times as much on gasoline as on new car payments.[43] These data suggest that lower income households are more affected by the impact of the rule on the used vehicle market than on the new vehicle market, and that they are more vulnerable to changes in fuel prices than they are to changes in vehicle prices.[216]

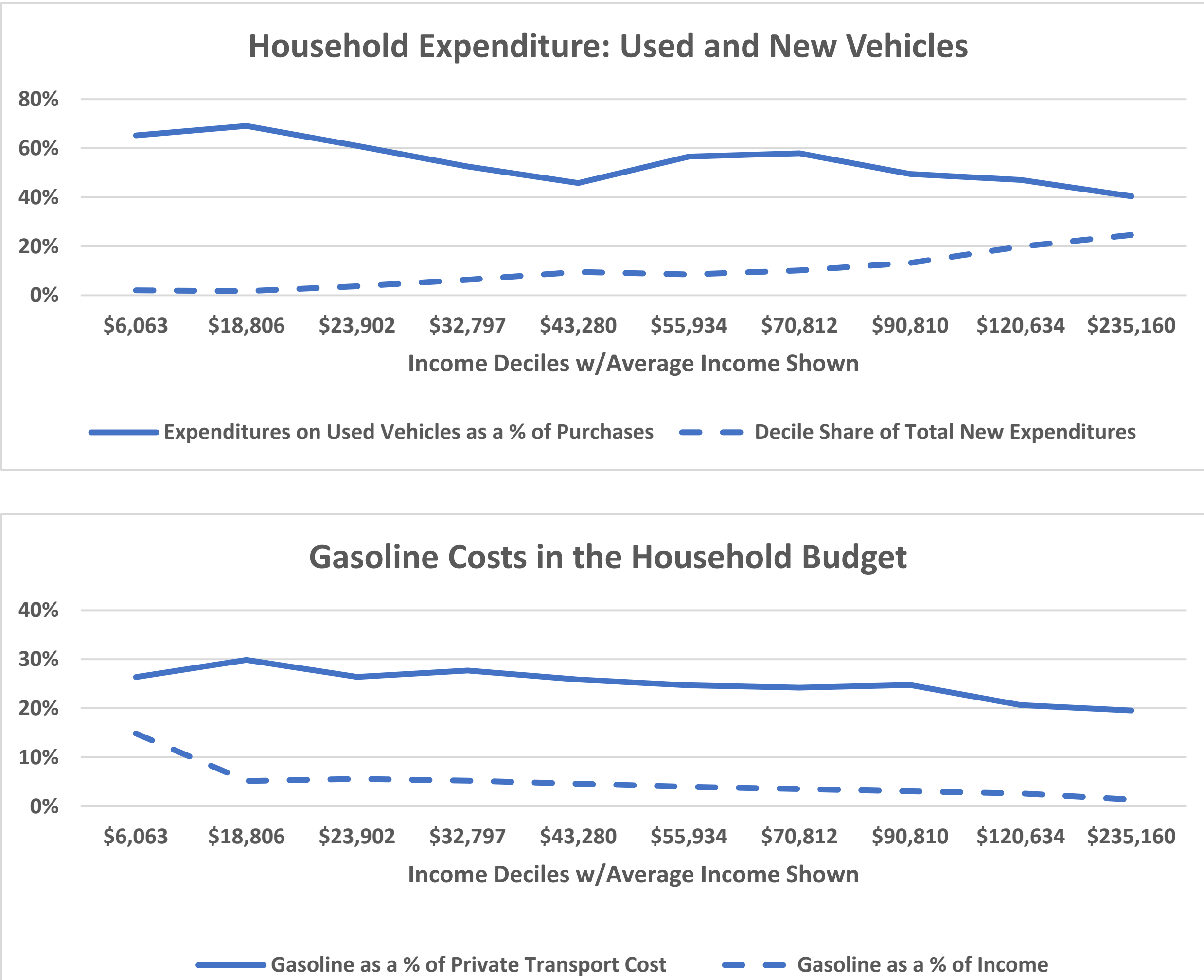
Since the issue receives such attention from the opponents of standards, it merits a reexamination and updating (see Figure XIX-1). Our argument can be summarized in three points. These are demonstrated in Figure 7 with data from the Consumer Expenditure Survey of 2015 broken down by deciles of income.

First, low income households make up a much smaller part of the new vehicle market than their share in the overall population. The upper graph of Figure XIX-1 shows that the two lowest income categories –bottom 20% of households -- account for less than 4% of the expenditures on new vehicles. The share of low income households in expenditures on used vehicles is above the national average. The percentage of used vehicle costs in total ownership costs declines steadily as income rises. Therefore, as shown in the lower graph, the operating cost of vehicles makes up a much larger part of their total cost of driving than the average household, and fuel economy standards reduce operating costs. The operating cost share of private transportation costs and household income decline steadily as income rises.

Second, because low income households buy used cars, they tend to benefit from the fact that the economic value of future fuel savings is only partially reflected in the resale price of used vehicles. Low income households get a disproportionate share of the operating cost reduction.

Third, low income households are likely to be disproportionate beneficiaries of the indirect benefits. Low income households are likely to suffer most from environmental and public health externalities associated with the operation of vehicles. They are likely to suffer most in a weak economy and benefit from policies that strengthen it. Therefore, they are likely to benefit most from reductions in those impacts.

FIGURE XIX-1: OWNERSHIP AND OPERATING COSTS ACROSS INCOME DECILES



Source: Bureau of Labor Statistics, Consumer Expenditure Survey, 2015.

The agencies also completely rebut a fundamentally flawed study by the Heritage Foundation. The study tries to claim, as all automaker inspired studies do, that dramatically increasing costs depress sales by raiding new car prices and hurt consumers, low income consumers in particular.

The study fails to take into account the shift to more expensive vehicles, a point we examine in the next Part. It fails to take into account that the trends started long before the National Program standards went into effect. It fails to note very diverse price paths in nations governed by a single standard. The agencies conclude, as we show in the next section that "vehicle standards alone do not seem to be driving price trends."

> The agencies point out the complexity in understanding the impact of standards on prices. The benefits of the standards for buyers of used vehicles will depend on two countervailing effects from the improvement in fuel economy: the increased cost of the used vehicles attributed to fuel-saving technologies, and the savings in fuel costs over time. Depreciation of new vehicle prices reduces the cost of the additional fuel economy

for used vehicle buyers. On the other hand, because older vehicles are used less on average than new vehicles, the fuel savings will accrue more slowly. On net, in this current Draft TAR, reduced up-front costs exceed the reduction in fuel savings so that the payback period is shorter for used cars than for new cars.[217]

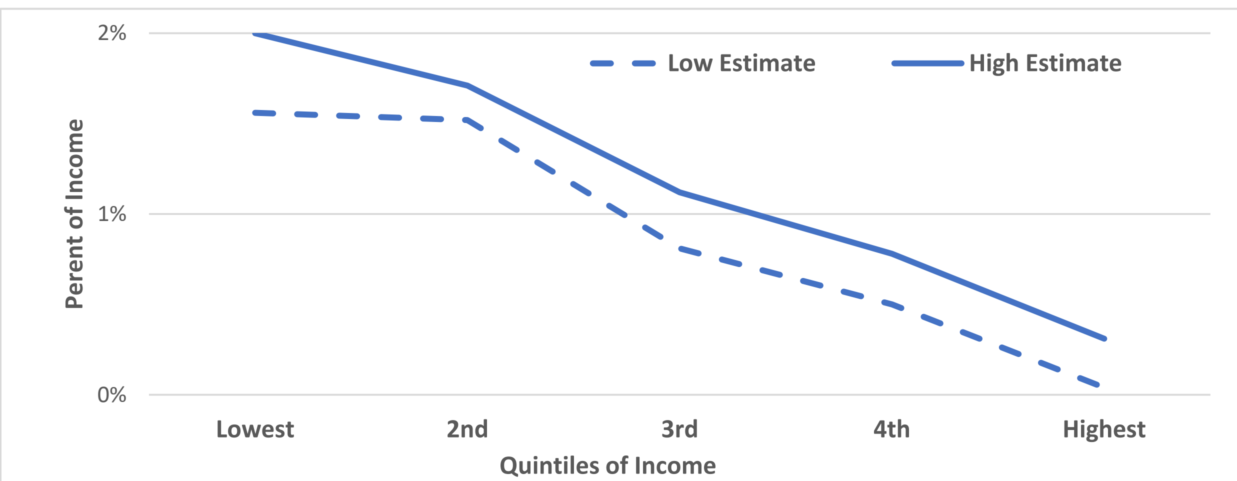
In short, contrary to the claim that standards hurt lower income household more than others, the empirical evidence suggests that market dynamics result in net benefits for lower income households more than others.

CONFIRMATION OF THE KEY CFA ARGUMENT

The study by Greene and Welch discussed above looks at this issue in greater detail than any previous study and strongly supports our conclusion. It factors in both market dynamics (price/cost relationships that favor low income households) **and** income dynamics. The income dynamic that benefits lower income households can be simply explained as follows. One must recognize that lower income households are more affected by operating costs than ownership costs and, with disproportionately lower incomes, receive disproportionately larger benefits, i.e. when benefits are expressed as a percentage of income.

The Greene and Welch study strongly supports our view, as shown in Figure XIX-2.

FIGURE XIX-2: PERCENTAGE OF INCOME SAVED DUE TO FUEL ECONOMY IMPROVEMENTS 1980-2014



Source: David Greene and Jilleah G. Welch, *The Impact of Increased Fuel Economy for Light-Duty Vehicles on the Distribution of Income in the United States*, Oak Ridge National Laboratory and the Energy Foundation, September 2016, p. 56.

Using the Consumer Expenditure Survey, the study can directly measure many of the key elements in our argument. Low income households are much less likely to buy new automobiles, so ownership costs are relatively less important than operating (primarily fuel costs). As more fuel-efficient vehicles pass through the used car market into the hands of lower income households, their operating cost expenditures decline. One of the big questions is “how much of the value of fuel savings is captured in the price of the used vehicle?” Based on a review of the literature and examination of the CES data, Greene and Welch find that about four-fifths of the value of fuel economy is passed on to low income purchasers of used vehicles. This finding is consistent with our conclusion that the auto market is imperfect with respect to fuel economy. Many of the imperfections that afflict the new car market would also affect the used car market.

The fact that lower income households receive a disproportionate share of the fuel savings interacts with the fact that operating costs are a larger part of their private transportation costs and the fact that they have lower income produce a powerful progressive effect of the program, as shown in Figure XIX-2. The two lowest quartiles (bottom 40%) enjoyed a reduction in household expenditures of 1.5% to 2% of income. The two middle income quartiles enjoyed a reduction in the range of 0.5% to 1%. The upper income quartile had the smallest net saving (0% to .3%).

WINNERS AND LOSERS

Another approach to studying the distributional impact on consumers that is particularly useful for examining the impact on the low-income population is a discussion of the number (%) of households that have pocketbook savings compared to those how see a net increase in the expenditures The DOE analysis of gas furnaces provides an opportunity to examine this approach.

The Overall Picture

Every efficiency standard will have different impacts on specific consumers. Consequently, there will be some consumers for whom the standards yield benefits that exceed costs, but for some consumers, costs will be greater than the benefits they derive. The fact that there can be both winners and losers from the adoption of a standard is always a source of concern to those who represent the consumer interest. However, the obverse is also true. The failure to adopt a standard when market imperfections have led to underinvestment in efficiency imposes unnecessary costs on some consumers. The relevant policy question is: how do those who would be helped by the standard compare to those would be hurt by the standard and/or the failure to adopt a standard?

In the case of a gas furnace efficiency standard set at 92% or higher, as shown in Exhibit 2, the winners exceed the losers by a wide margin. We identify two categories of winners:

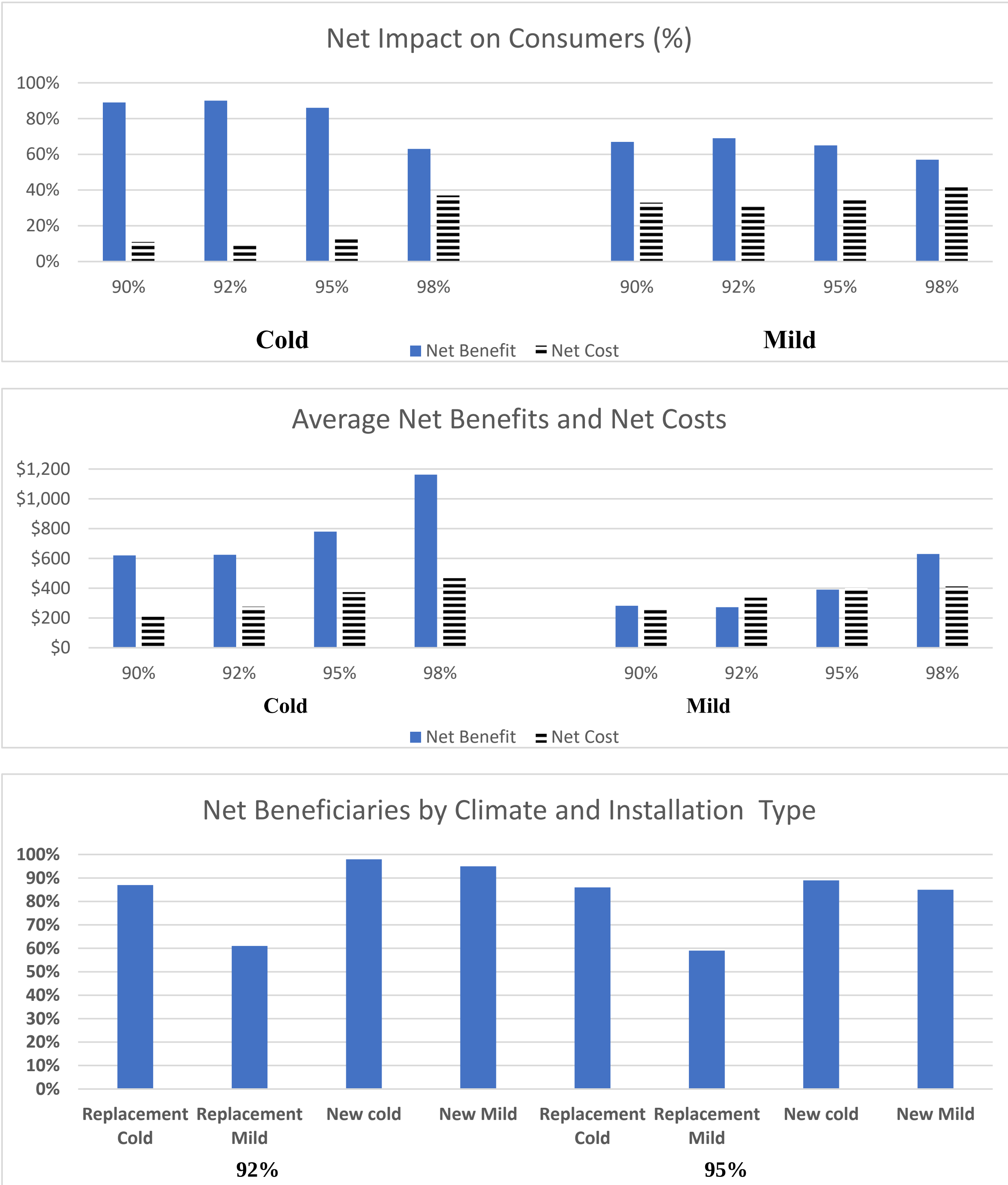
(1) those who enjoy a direct benefit in terms of pocketbook costs and

(2) those who break even in terms of pocketbook costs (beyond the 3% embedded in the analysis) and enjoy the other indirect benefits of the standard at zero net pocketbook cost.

One can even argue that some consumers who suffer small out of pocket losses but receive indirect benefits that are large enough to make them net winners could be considered winners. For this analysis we do not claim those consumers as net beneficiaries of the rule.

The upper graph in Figure XIX-3 identifies the percentage of households that are net winners from the higher efficiency furnace. The Figure shows that the number of net losers is

FIGURE XIX-3: FURNACES: CONSUMERS WITH NET BENEFITS AND NET COSTS: NATIONAL AVERAGE PERCENTAGES AND DOLLAR AMOUNTS



Source: U.S. Department of Energy, *Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Residential Furnaces*, February 10, 2015, pp. 8-37, 8-38; Energy Conservation Standards for Residential Furnaces; Proposed Rule, Federal Register, 10 CFR Part 430, (Vol. 80 Thursday, No. 48, March 12, 2015, Part III.

much smaller than the number of net winners in all circumstances. Generally, winners outnumber losers by 3 or 4 to 1. As shown in middle graph of Figure XIII-3, the economic analysis also shows that the winners gain more per household, on average, than the losers lose. Winners also substantially outnumber losers in both types of installation, replacement and new construction, as shown in the bottom graph of Figure XIX-3.

In all categories, the majority of households are winners. The winners and losers analysis provides evidence to support our concern about the impact on some groups of consumers. While winners outnumber losers in both cold and mild climates, the margin is much smaller in the mild climates. If the DOE could tailor the rule to specific circumstances, it could reduce the number of losers and increase the overall net benefit. That is the approach we have urged the DOE to continue to explore. But under no circumstances should it allow this concern to delay the rule. If the DOE solved the problem of targeting along the lines discussed below, the total net pocketbook benefit to consumers would be about 10% higher, bringing the pocketbook savings to over $19 billion. [218]

Having reduced the problem of net losses in certain circumstances, DOE could raise the standard in other circumstances. While the DOE estimates that a standard set at 95% AFUE would yield additional savings of $5 billion, some of the gains would not be achieved because of the exemption of small capacity furnaces. However, the $3 billion increase in net benefits resulting from the small furnace exemption would more than offset the lost benefits. Thus, the net benefits of a tailored standard would likely be considerably more than the $5 billion from the simple 92% standard.[219]

Low Income Consumers

As shown in Figure XIX-4, the conclusions reached about the benefits to consumers in general also apply to low income households. If anything, the fact that stands out for low income households is that the net dollar benefits are slightly larger and the net dollar costs slightly lower.

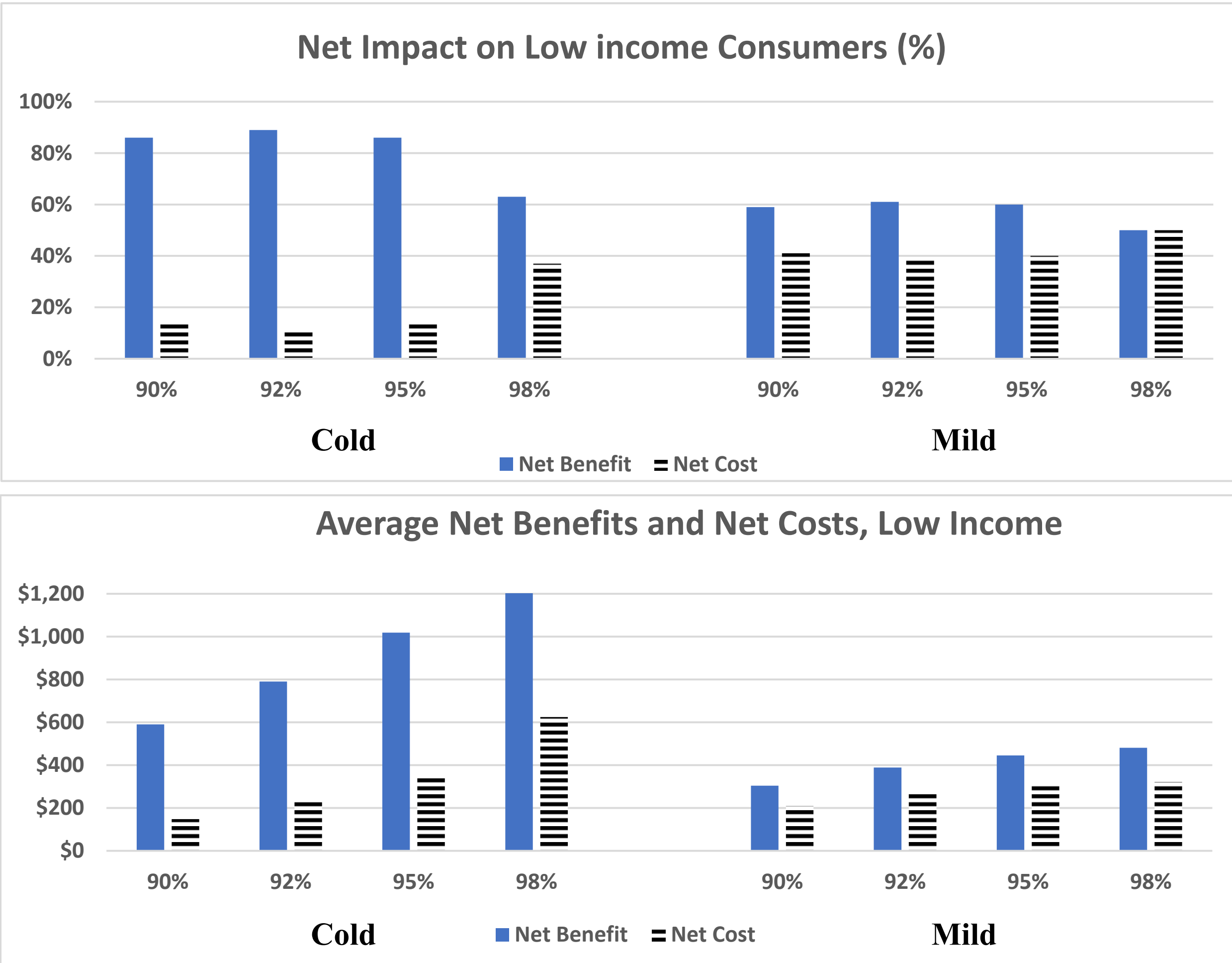
This may reflect the fact that low income households have lower efficiency furnaces to start with, so the energy savings from a higher standard are larger. There are other reasons that the standards are likely to benefit low income households more, or certainly ensure that they fare at least as well as others, which will be identified in the discussion of market imperfections below.

The analysis of market imperfections also reinforces the conclusion that low-income households will not be disproportionately harmed by raising the standard. If anything, they will benefit more than other groups.

While low income consumers occupy older housing with less efficient furnaces, they are also more likely to be renters, so the low-income segment suffers from a severe split incentives problem.[220] Landlords do not pay heating bills and they tend to keep first costs (of appliances) down. Therefore, they are more likely to underinvest in energy efficiency. Low income households would benefit more from a standard that makes the landlords do the right thing.

Landlords may also not be able to pass the costs of the more efficient appliances through to tenants. Their ability to do so may be restricted by the fact that the cost increase would apply to a small part of the rental market. There may also be rent eligibility formulas that limit the ability to increase rents to cover the costs of the more efficient equipment, or simply raising the rent would render their rentals less competitive. In addition, landlords may also realize that the incremental cost increase of a more efficient furnace spread out over the life of the product amounts to just a few dollars per month.

FIGURE XIX-4: LOW INCOME CONSUMERS WITH NET BENEFITS AND NET COSTS: PERCENTAGES AND DOLLAR AMOUNTS



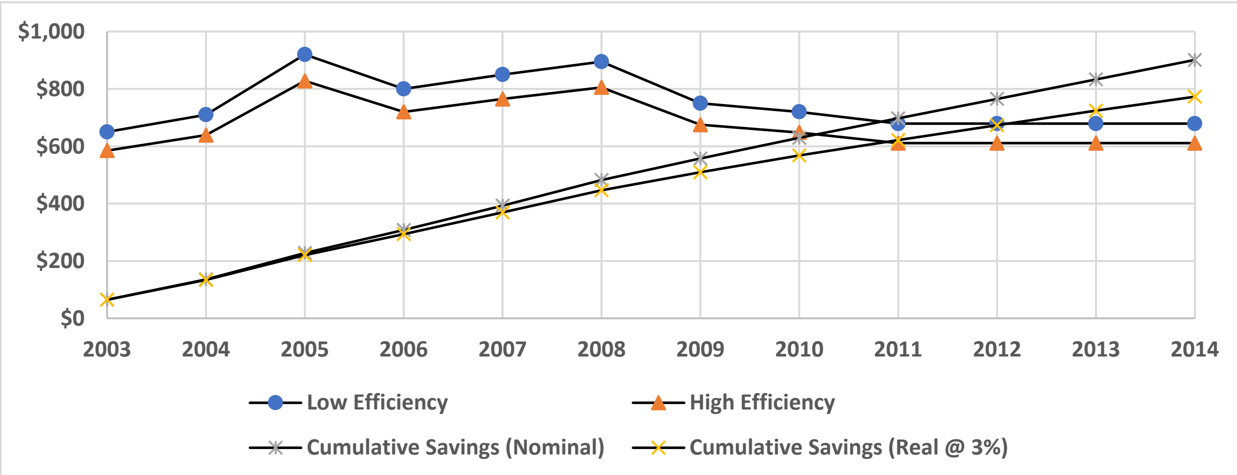
Source: U.S. Department of Energy, *Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Residential Furnaces,* February 10, 2015, pp. 8-37, 8-38.

Higher efficiency standards deliver a second consumer pocketbook benefit associated with the price of natural gas that has not been included in the DOE estimate and which benefits low income consumers in particular. Natural gas wellhead prices have been volatile over the past decade. The result is a significant fluctuation in monthly bills as the price changes are passed through to consumers (See Figure XIX-5).

This volatility makes it harder for households to manage their monthly budgets, particularly low and middle-income households for whom natural gas expenditures take a significant percentage of income. By consuming less gas, the burden of volatility is dampened.

The average bill over the 12-year period would have been reduced by about $75 and the standard deviation would have declined by about $9.

FIGURE XIX-5: WINTER HEATING EXPENDITURES AND SAVINGS FROM EARLY ADOPTION OF HIGHER EFFICIENCY



Source: Energy Information Administration

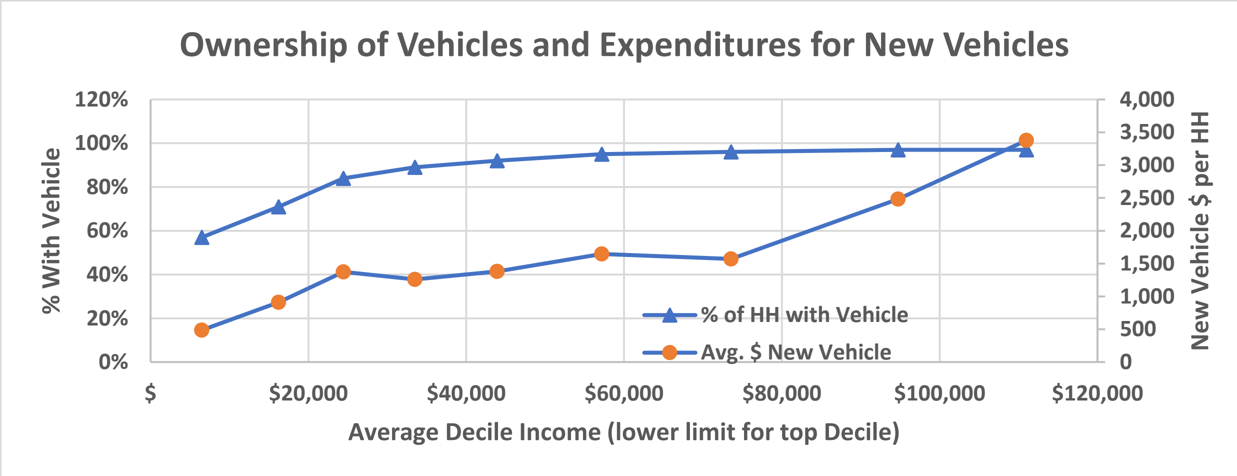
CONCLUSION: LOWER INCOME HOUSEHOLDS ENJOY MUCH LARGER BENEFITS FROM EFFICIENCY STANDARDS

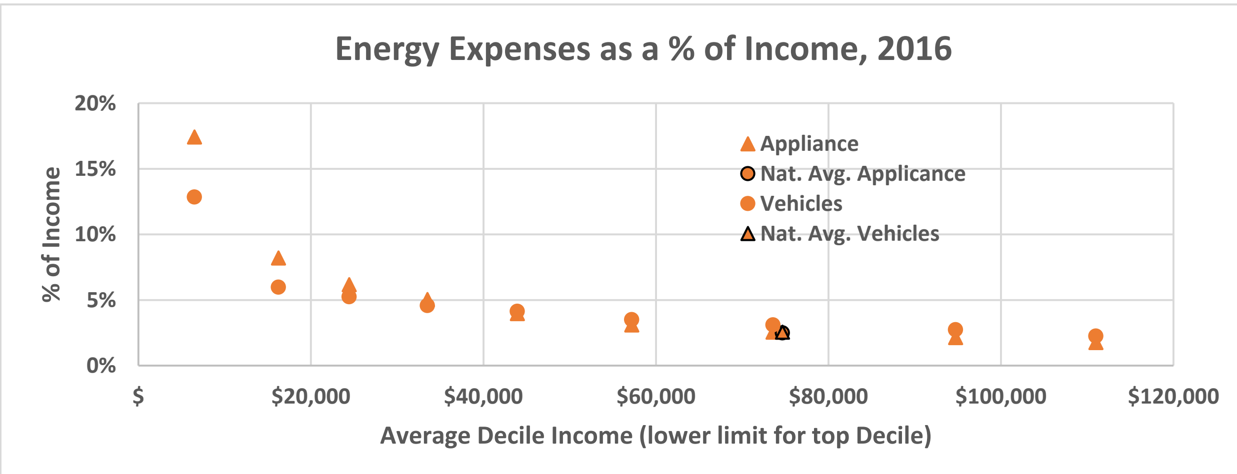
Because the companies incessantly repeat the unfounded claim that low income households are hurt by efficiency standards, we conclude this section with two general observations.

Having shown the much greater importance of operating costs in low income vehicle expenditures, we repeat an obvious conclusion we have stated before. The impact of fuel economy standards on low income households has little impact on the new vehicle market. As shown in the upper graph of Figure XIX-6, low income households are much less likely to own a vehicle. Over one-third of households with income below $12,000 own at least one vehicles. In contrast, fewer than one-tenth of households with incomes above $29,000 do not own a vehicle. Combining these two observations, we find that the bottom 20% of households account for only 4% of the new vehicle market. The lower graph shows the dramatic difference in the percentage of income spent on gasoline and home energy that powers appliances.

The second general observation that must be made with respect to low income households is that they also suffer disproportionately from environmental pollution.[221] They tend to live in areas that are most affected by pollution and have less resources to prevent, adapt or recover from the harms of pollution. They live closer to facilities that emit pollutants,[222] making them more vulnerable to the harmful effects of pollutant that have local and regional impacts,[223] live in housing that is less resistant to pollution.[224] They are more exposed and are more susceptible to suffer from pollution. This issue has been recognized for decades.[225]

FIGURE XIX-6: OWNERSHIP OF VEHICLES AND EXPENDITURES FOR NEW VEHICLES





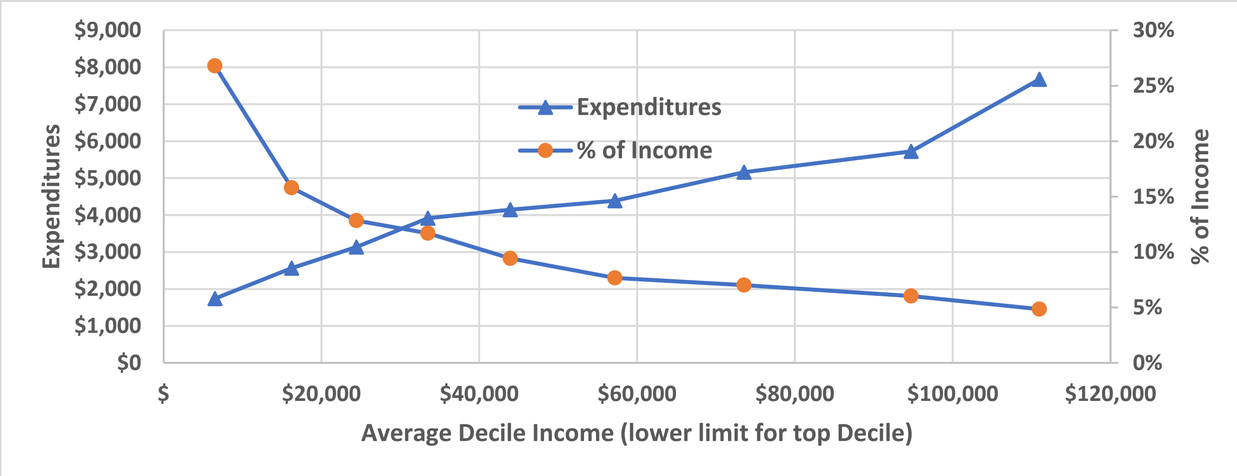
Source: Bureau of Labor Statistics, 2017, *Consumer Expenditure Survey; 2016, Deciles of Income.*

Figure XIX-7 uses health care expenditures from the *Consumer Expenditure Survey* to make this point in a similar fashion as above for gasoline expenditures. Lower income households have much less to spend on health care, but those expenditures account for a much larger share of their income.

This is certainly a very complex issue, but the evidence is overwhelming that lower income is associated with greater exposure to pollutants, which is associated with a higher incidence of the health problems associated with pollution. As one study put it,

> Census tracts in the lowest quartile of socioeconomic position, as measured by various indicators, were 10–100 times more likely to be high risk than those in the highest quartile. We observed substantial risk disparities for on-road, area, and non-road sources by socioeconomic measure and on-road and area sources by race. There was considerably less evidence of risk disparities from major source emissions.[226]

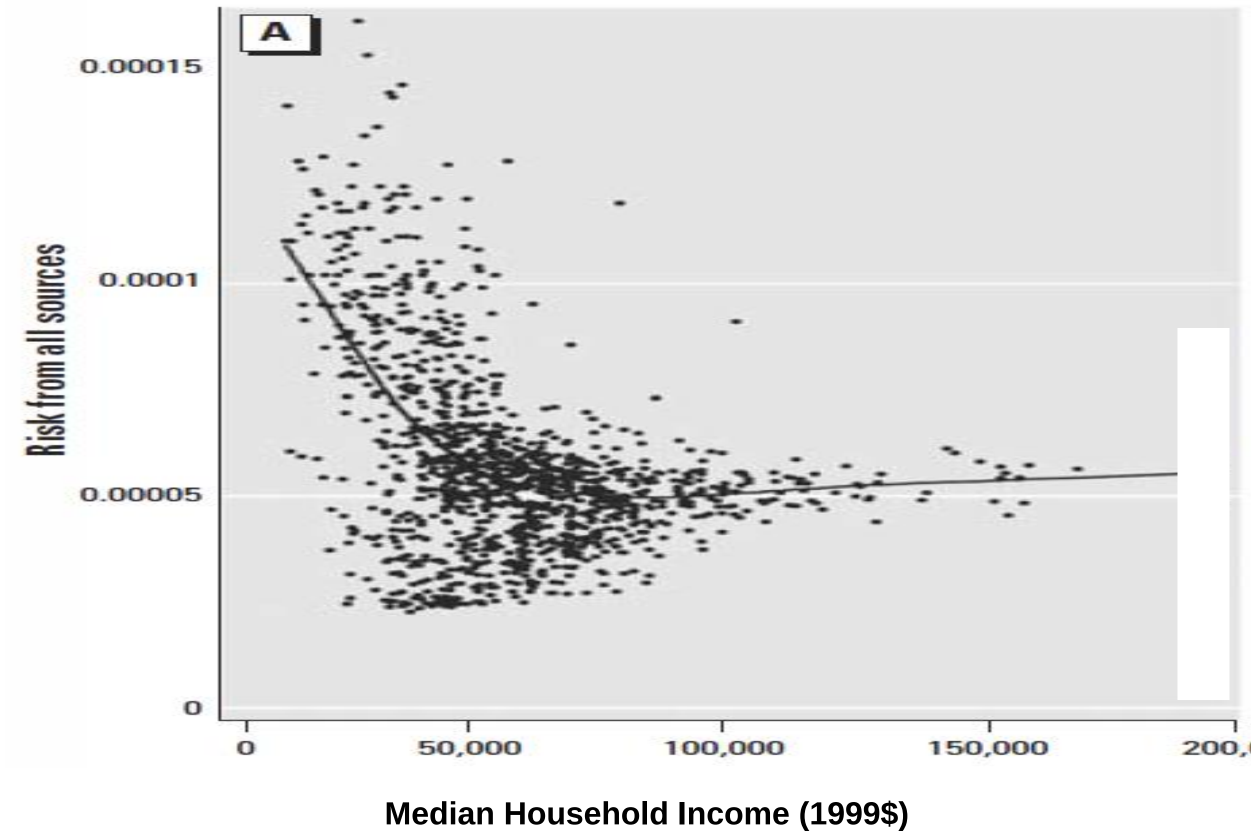
FIGURE XIX-7: HEALTH CARE EXPENDITURES AND INCOME, 2016



Source: Bureau of Labor Statistics, 2017, *Consumer Expenditure Survey; 2016, Deciles of Income.*

The graph of the data that underlies this conclusion, as shown in Figure XIX-8, is crystal clear. Simply put, living close to traffic and facilities that emit pollution raises the exposure to toxics and the risk and incidence of the related health effects.

FIGURE XIX-8: CANCER RISK FROM AIR TOXICS V. MEDIAN HOUSEHOLD INCOME



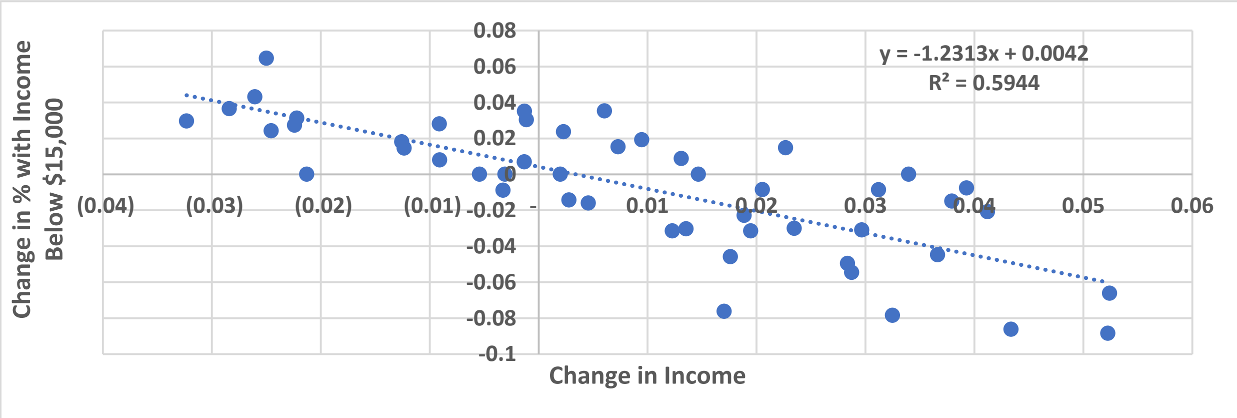
Sources: Buckley, Timothy J, Ronald White, 2005, Socioeconomic and Racial Disparities in Cancer Risk from Air Toxics in Maryland," *Environmental Health Perspectives*, July, p. 696.

It hardly seems necessary to make the point that the third outcome of efficiency standards, macroeconomic growth, would be to the benefit of low income households. Figure XIX-9 makes the point simply by showing there is a strong negative correlation between the change in income and the change in the percentage of households with incomes below several cutting points. We use nominal dollars, since deflating both the numerator and the denominator would not affect the correlation. In 2015, the $25,000 figure was categorized about 25% of the population as "low Income." The larger the group, the stronger the correlation, which makes sense since more of the total population is included in low income. The fact that the slope of the line is much steeper for the lowest income groups reinforces the conclusion that economic growth is good for low income households.

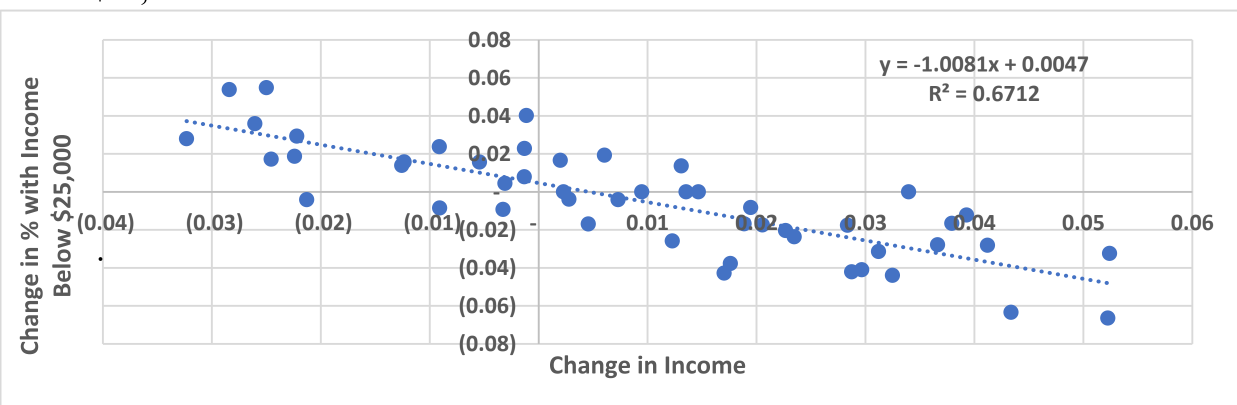
Looking at each of the measures of benefits of standards we find not only that low income household benefit more that others, but the disproportionately positive impact stretches well up into the income distribution. In fact, with significantly higher benefits relative to income stretching up to the range of $35,000 to $50,000 we can say that this is a lower and middle income issue. Freeze and rollback are a hidden tac on the bottom half of the income distribution.

FIGURE XIX-9: CHANGE IN HOUSEHOLD INCOME V. CHANGE IN % LOW INCOME GROUP

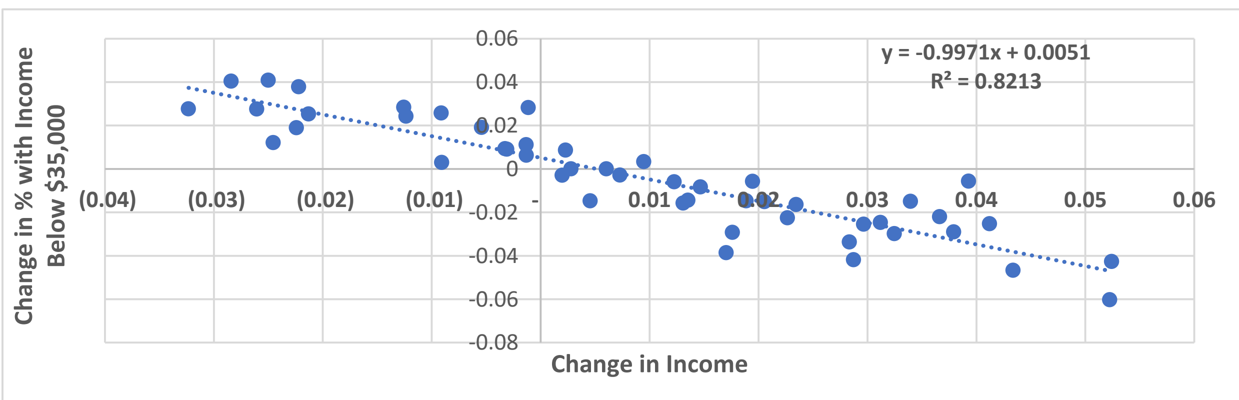
Below $15,000



Below $25,000



Below $35,000



Source: Bureaus of the Census, *Income and Poverty in the United States: 2015*, Table 3.

Thus, the two major output measures for standards that agencies traditionally rely on and the third we have added in this analysis all indicate that low income households benefit disproportionately by reducing energy consumption and pollution and increasing macroeconomic growth.

PART VIII.

AUTOMAKERS MEETING THE STANDARDS SET BY THE NATIONAL PROGRAM

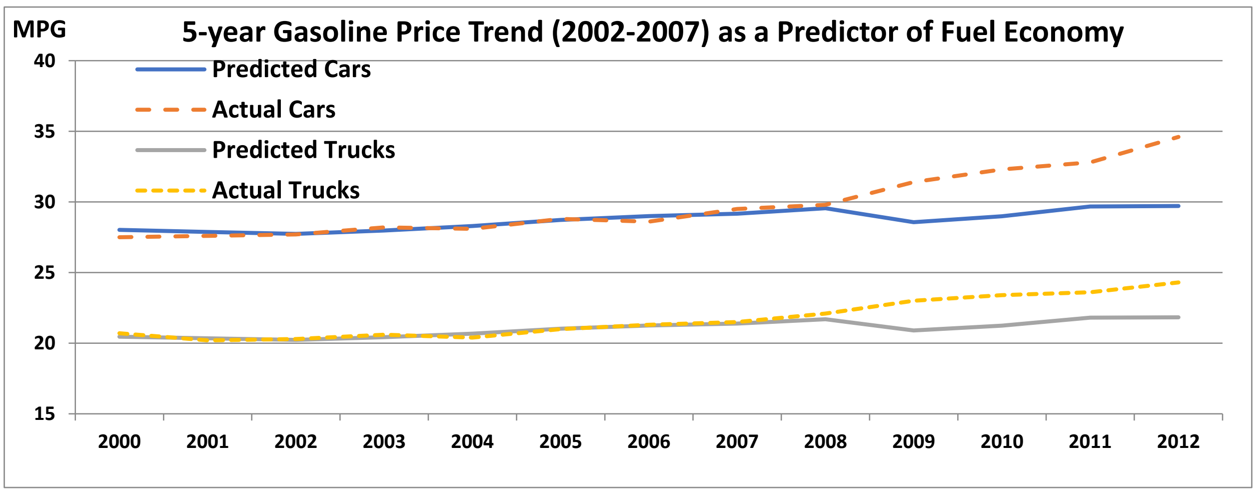
XX. A DEEP DIVE INTO THE NEW FUEL ECONOMY STANDARDS AND THE AUTO MARKET RESPONSE[227]

It is already clear that the market is dynamically adapting to the new standards on both the supply and the demand side. Automakers are delivering products that consumers want, and consumers are purchasing them in increasing numbers. The important role of the standards in triggering this market adaptation is also clear. This section examines several issues that inevitably arise with the acceptance and demand for more fuel-efficient vehicles. The following is an in-depth look at 3 key factors on the road to increased fuel efficiency: the role of gasoline prices, electric vehicles and four-cylinder engines.

GASOLINE PRICES

It is strikingly clear that the shift in fuel economy behavior coincided with the Congressional decision to reform and reinvigorate the fuel economy standards. However, there is an obvious question that will inevitably be raised: "Are not gasoline prices the actual cause of the change in behavior?" Figure XX-1 shows that while there is a correlation between gas prices and miles per gallon, standards have a strong correlation. Using the price of gasoline as the predictor of fuel economy, we find that prices dramatically under-predicted fuel economy in 2008 and later years. Therefore, other factors must be at work.

FIGURE XX-1: MILEAGE PREDICTED BY REAL GASOLINE PRICES V. ACTUAL MILEAGE



Sources: Environmental Protection Agency, Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2012, March 2012; Energy Information Administration, Petroleum Price.

The above analysis supports the hypothesis that the adoption of future standards played a larger role than gas prices. In fact, a statistical model that includes both the announcement of standards and gasoline prices accounts for over four-fifths of the variance in fuel economy and shows that standards have a statistically much larger effect.

A two-variable regression model explains four-fifths or more of the variance, with all the coefficients significant and no problem of co-linearity (See Table XX-1). In a multiple regression model, the coefficient on standards is much larger and more highly significant. This is the case whether we use a short period of price history (five years of rising prices from 2002-2007) or a long period (21 years of prices 1986-2007). Regressions were also run with lags on the gasoline price variable of two and three years. The results were similar, with the gasoline price effect weaker. Needless to say, if the data were extended to the present, the effect of standards would be much larger, as mileage has continued to improve while gasoline prices have fallen.

TABLE XX-1: EXPLAINING FUEL ECONOMY: STANDARDS ARE MORE IMPORTANT THAN PRICES

CARS					TRUCKS				
21-year	β Coff.	Sig.	β Coeff.	Sig.	21-year	β Coff.	Sig.	β Coeff.	Sig.
Standard	.8958	****	.6284	****	Standard	.8932	****	.7017	****
Price	na		.3500	***	Price	na		.2507	***
R^2	.79		.85		R^2	.73		.82	
5-year					5-year				
Standard	.8483	****	.6510	****	Standard	.8985	****	.7001	****
Price	na		.3900	*	Price	na		.3116	**
R^2	.72		.78		R^2	.81		.86	

Sig. Levels: **** <.0001, *** <.001, ** <.01, <.1

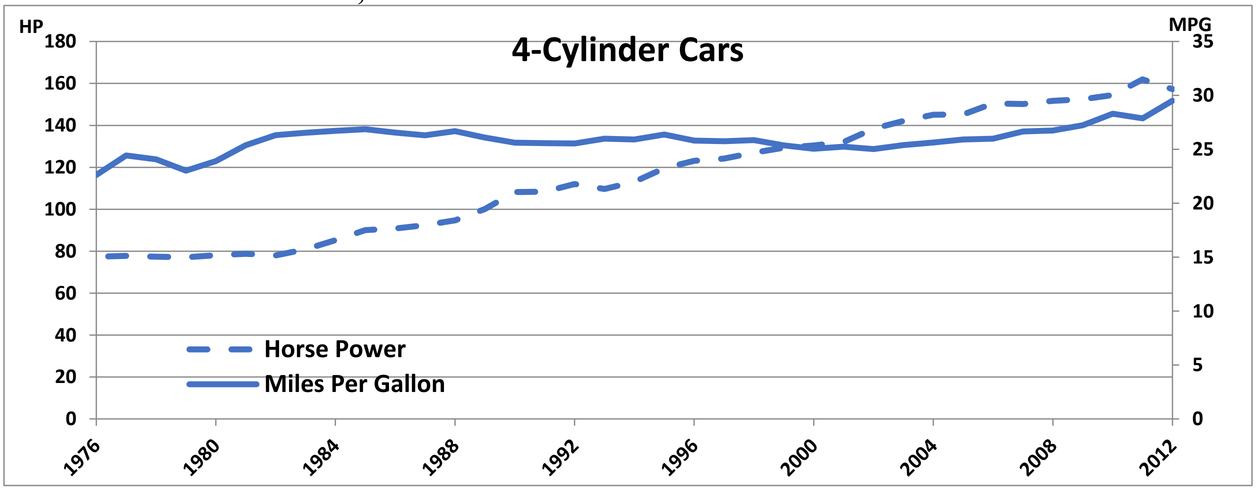
FOUR-CYLINDER ENGINES: EFFICIENT, POPULAR

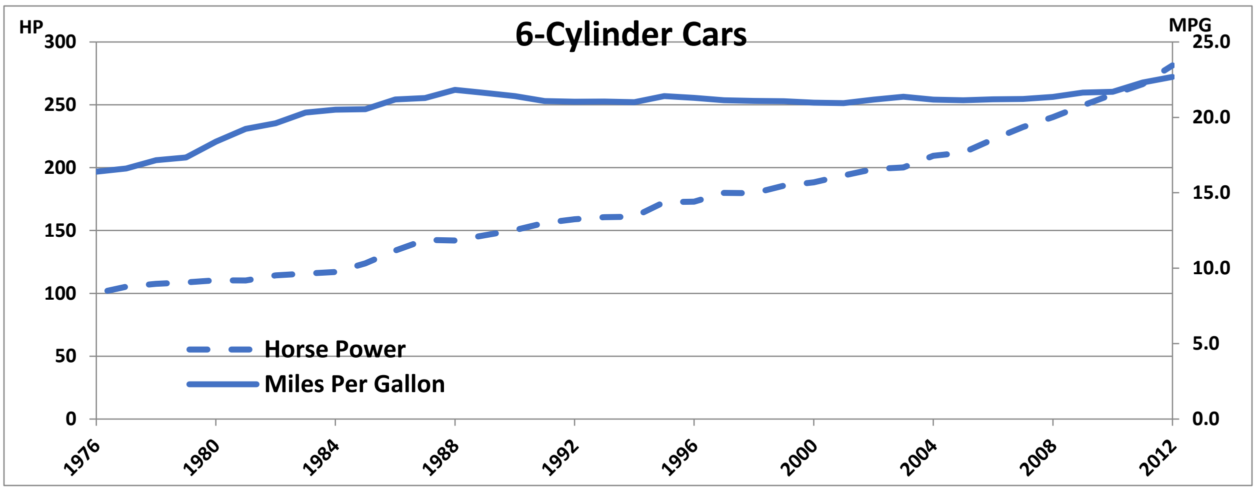
Analyzing sales of vehicles with four-cylinder engines also support this view of the market. The increase began in 2004, but showed a dramatic jump in 2008. One thing that is particularly noteworthy about this chart is that the increase in popularity of four-cylinder engines came after a significant decline in the popularity of 4-cylinder engines from 1987-2004. During that period, manufacturers offered more and more six and eight-cylinder engines focusing on the perceived need for power and speed. Four-cylinder engines now account for four-fifths of all car and SUV sales.

The recent increase in popularity of four-cylinder engines is due to manufacturers building more power into smaller, more efficient engines. As shown in Figure XX-2, the improving performance of four-cylinder engines was an important factor in increasing their market share. Four-cylinder engines get much higher gasoline mileage than engines with more cylinders, but in recent years they have been delivering high fuel economy with more horsepower. In contrast to four-cylinder engines, six-cylinder engines have been increasing their horsepower, while holding fuel economy steady. These trends reflect the efforts of the auto industry to keep options available for consumers while increasing overall fuel economy. They also reflect the fact that one of the major reforms enacted by Congress was to require future standards be attribute based. NHTSA chose the size (footprint) of the vehicle, which means larger vehicles have lower standards. Therefore, a wider range of vehicles that meet the vehicle-specific standard is available in the market.

Other technologies have penetrated rapidly. Four speed transmissions have all but disappeared from cars and SUVs.

FIGURE XX-2: CYLINDERS, HORSE POWER AND MILEAGE FOR CARS





Sources: Environmental Protection Agency, *Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2012,* March 2012**.**

Between 2004 and 2010, the percentage of all cars sold that had 6-cylinders dropped from 41% to 26%, while the percentage of 4-cylinder cars increases from 50% to 67%. In the SUV category, the percentage of 8-cylinder SUVs dropped from 32% to 14% while the percentage of 6-cylinder SUVs increased from 11% to 30%.

For new cars, average fuel economy increased by 4 mpg between 2004 and 2010. Three-quarters of that (3 mpg) was due to the increase in the fuel economy of the vehicles. One-quarter (1 mpg) was due to the shift from six-cylinder to four-cylinder cars.

For SUVs, average fuel economy increased by 4.75 mpg between 2004 and 2010. Of that, 2.75 mpg was due to the increase in the fuel economy of the vehicles and 2 mpg was due to the sharp decline in 8-cylinder market share and the sharp rise in 4-cylinder market share (likely people shifting from 8 to 6 and from 6 to 4).

Table XX-2 presents a statistical analysis that captures the shift in auto market behavior. Our earlier econometric analysis and the analysis of others show that consumer behavior reflected this quickly but that auto makers were slow to notice or understand it and react to the changing market.[228]

- **FIGURE XIV-2: CYLINDERS, HORSE POWER AND MILEAGE FOR CARS** 27% (21) of the "all-new" vehicles introduced in 2017 actually cost less than their 2011 version and got 1-10 MPG better fuel economy.
- When calculating 5 years of fuel costs, nearly half of these 2017 vehicles cost less to buy and fuel than their 2011 counterparts.
- 58 of the 79 vehicles increased in price, however;
- 15% (12 of 79) had fuel savings that offset the entire price increase;
- 52% (41 of 79) had fuel savings that offset the increased cost of fuel economy technology;
- 6% (5 of 79) were more expensive in 2017 but their fuel economy stayed the same or decreased from 2011.
- Looking at the cost/benefit average for these 79 all-new models—the added cost of fuel economy averaged $320 per vehicle and will save the buyer an average of $946 putting $626 back into consumer pocketbooks.
- 70 percent of the "all-new" 2017 vehicles had a CAFE-compliant trim, compared to 41 percent of the "all-new" 2015 vehicles.
- A record breaking 6 vehicles are compliant all the way to MY 2025.
- In looking at all of the 2017 models, "gas guzzlers" getting below 14 MPG is a miniscule 0.4% in 2017, down from 8.5% in 2011.
- A record 78% of the "all-new" light duty trucks had a CAFE compliant trim for 2017. Percentage-wise, trucks beat cars for CAFE compliance in 2017.
- 15 of the 17 manufacturers improved their CAFE compliance rate from 2015 to 2017.
- Comparing the sales figures for 2016 SUVs and light duty trucks with the 2011 models, those that increased the fuel efficiency by over 10% sold nearly 20% more vehicles than those with a less than 10% increase in fuel efficiency.

These statistics (with the exception of the 2016 SUV/truck data) clearly indicate that the car companies are fully capable of meeting the CAFE standards and they are able to do so with great savings for consumers. Rolling back the standards at this point would not only hurt America's already financially beleaguered consumers, but they would hamper vehicle sales and put U.S. car companies at a distinct competitive disadvantage to the Asian carmakers who will meet the standards. As has been proven during the first 5 years of the reinvigorated standards program, automotive engineers are fully capable of meeting the very standards agreed to in 2012 and consumers save money in the process. Rolling back the standard would be costly, counterproductive, and harmful to America's competitive position in the now global auto marketplace.

The substantial empirical record before the agencies supports continuing the National Program at the levels established in the 2012 final rule. If anything, the evidence suggests a strengthening, not weakening of the standards. A rollback and freeze are illegal and uneconomic, likely costing the nation $500 billion dollars. The damage done to the process of standard setting would double the losses, if the attack on regulation prevents the continuous upgrading of standards.

The National Program has been extremely successful because it implements the changes enacted in EISA in a manner that harnesses market forces to yield consumer pocketbook savings, macroeconomic growth and other public benefits. This is exactly the way the executive branch orders and OMB circulars have guided federal agencies. It takes a "command-but-not-control" approach to build a performance standard that embodies six principles,

As our historical analysis showed, the industry has responded as market theory and past experience predicts, a process that is observable at both the macro and micro levels.

- The industry has found lower cost ways of complying with the standards than originally thought.
- The mix of technologies likely to be chosen has shifted due to different speeds of development in knowledge and cost.
- One of the most popular approaches to meeting the standards, the Atkinson-2 engine was not even considered in the initial analysis and would never have been applied widely, but for the standards.
- There is no evidence that the costs of compliance are disrupting the auto market in any way and consumers are having no difficulty in finding the vehicles that they prefer at prices that are affordable.

In closing, a rollback of the MY 2021 fuel economy standard and/or a freeze of the MY 2022-2025 standards is simply not justified. The voluminous record has already established that the benefits far outweigh the costs; consumers and the economy would be greatly harmed if the standards were to be pulled back. Consumers value fuel economy and the automakers have shown they can meet the standards.

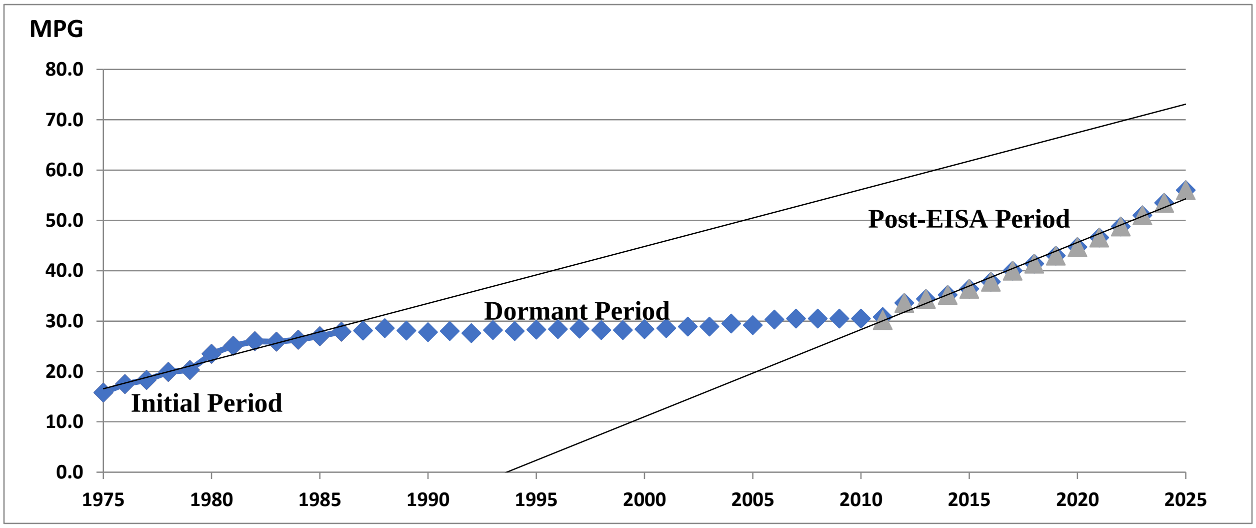
The Proposed Standards are Well Within the Reach of The Industry[229]

In Section VII we showed that the standards chosen were quite moderate, given the broad consensus on technology costs. There are two historical perspectives that also suggest the proposed standards are moderate and achievable.

As shown in Figure XX-3, the current proposal not only restarted the process just about as quickly as the law allowed, but it sets the U.S. on a path to doubling the fuel economy of new vehicles that is consistent with what was accomplished in the first decade of the program.

Globalization of the auto industry means it is no longer possible to be a successful automaker without being able to compete globally. Figure XX-4 shows the proposed standards in relation to the standards in place in other automobile producing and consuming nations. The proposed standard brings U.S. standards up to international levels.

FIGURE XX-3: U.S. MPG HISTORICAL AND PROPOSED: THE RATE OF INCREASE IS STEADY AND CONSISTENT WITH PAST EFFORTS TO IMPROVE FUEL ECONOMY



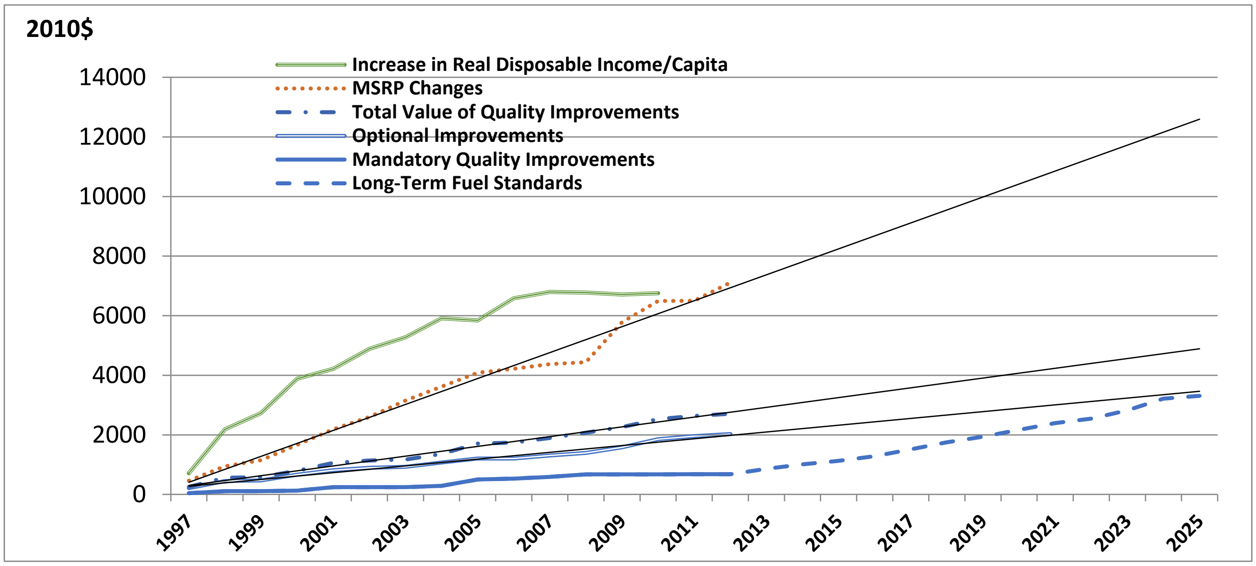
Sources: EIA, Light Duty Automotive Technology, Carbon dioxide Emissions, and Fuel Economy Trends: 1975 Through 2009, November 2009, Table; Office of Regulatory Analysis and Evaluation, Regulatory Impact Analysis, Corporate Average Fuel Economy,2011, 2012-2016, 2017-2025.

FIGURE XX-4: COMPARISON OF PROPOSED U.S. AND INTERNATIONAL STANDARDS

Source: Feng An, Robert Early and Lucia Green-Weiskel, Global Overview of Fuel Economy and Motor Vehicle Emission Standards: Policy Options and Perspectives for International Cooperation (The innovations Center for Energy and Transportation, United Nations Commission on Sustainable Development, May 2011, Background Paper No. 3).

The standards also reduce the supply-side risk of introducing new fuel savings technologies and triggers competition around fuel economy. Automakers know they can sell quality. As shown in Figure XX-5, according to statistics compiled by the Bureau of Labor Statistics, which is responsible for the Producer Price Index,

FIGURE XX-5: THE INDUSTRY ROUTINELY MAKES COSTLY QUALITY IMPROVEMENTS (Bureau of Labor Statistics Analysis of Quality Changes for Vehicles)



Source: Bureau of Labor Statistics, Quality Changes for Motor Vehicles, various years; Consumer Price Index Data base; Sources: Office of Regulatory Analysis and Evaluation, *Regulatory Impact Analysis, Corporate Average Fuel Economy*, 2011, 2012-2016, 2017-2025.

- over the past fifteen years, automakers have added three times as much value (and cost) with optional improvements in quality than with mandatory (safety and environmental) improvements.
- The overall increase in MSRP tends to track closely to the increase in real disposable income.
- The cost increases that the long-term standards will require over the next 15 years are well below the cost of quality improvements over the past 15 years.
- Unlike most other quality additions, fuel economy improvements deliver pocketbook savings to consumers.
- In today's market, fuel economy is a major determinant of vehicle quality that the market can easily absorb.
- Automakers adjust MSRP and discounts and auto financing in response to much larger changes in affordability.

XXI. A 2017 ANALYSIS OF CONSUMER SAVINGS AND AUTOMAKER PROGRESS ON THE ROAD TO 2025 CAFE STANDARDS[230]

INTRODUCTION

This Section evaluates the direct consumer savings, and automaker progress, associated with the 2025 CAFE standards. It is in response to current efforts by certain members of Congress and the current Administration to roll back those standards. The rationale for the rollback is that it costs too much to comply with the standards and, as a result, vehicle prices will increase, thus dissuading consumers from buying new cars. The fact is, rolling back the standards would not only cause great harm to consumer pocketbooks, but, because of consumer demand for fuel efficiency, would also harm sales.

Public opinion surveys, including one recently conducted by the Consumer Federation of America, demonstrate unquestionably that consumers want more fuel-efficient vehicles and that they strongly support standards requiring them. Consumers understand that gasoline costs are a major household expenditure and improvements in vehicle fuel economy puts money directly back into their pocketbooks. Furthermore, while gas prices are currently low, they understand the cyclical nature and volatility of those prices.

Our analysis shows that Congress and the Administration would be making a serious mistake in rolling back the standards. Not only would the impact be immediately felt by already financially strapped Americans, but it would put the U.S. car companies at a distinct disadvantage, both nationally and globally, in competing with the Asian manufacturers, who are quite capable of complying with the standards. As this section will demonstrate, not only do fuel economy standards pay off in lower ownership and operating costs, but the carmakers are fully capable of meeting the standards at a reasonable cost, and improving fuel economy improves sales.

NEARLY HALF OF "ALL-NEW" 2017 VEHICLES COST LESS TO BUY AND FUEL THAN THEIR 2011 COUNTERPARTS:

25% of the 2017 All-New Vehicles Cost Less Than Their 2011 Counterparts and Got Better Fuel Economy: Manufacturers have the greatest opportunity to improve vehicle fuel economy when they introduce a truly new vehicle.[231] For this analysis, we compared the cost and fuel economy of 19 of the 27 "all-new" 2017 models which had a 2011 version, the year before the current standard was put in place.[232] These 19 models included 79 different EPA designated engine/drive train/transmission/MPG configurations (or what are called "trims") (see Table XXI-1). When we compared the cost difference between the "all-new" 2017 models and their 2011 version, after factoring in inflation, 21 or 27% actually went down in price, yet every one of these vehicles saw a 1 to 10 MPG increase. Vehicles that improved their fuel economy while going down in price ranged from the Subaru Impreza and GMC Acadia to the Mercedes E Series, clearly demonstrating that improvements in fuel economy do not have to generate higher prices.

Table XXI-1: 2011 vs. 2017 "All-New" Price Comparison (Accounting for Inflation)		
	"All-New" Trims[123]	**Percent of "All-New Trims"**
Total "All-New" Vehicles with 2011 Counterpart	79	100%
2011 Vehicles Which Were LESS Expensive in 2017 Dollars and Had Higher MPG	21	27%
2011 Vehicles Which Were MORE Expensive in 2017, Who's Fuel[4] Savings Offset the Entire Price Increase	12	15%
2011 Vehicles Which Were MORE Expensive in 2017, Whose Fuel[4] Savings Offset the $100/MPG Cost of Fuel Economy Technology[5]	41	52%
2011 Vehicles Which Were MORE Expensive in 2017, Who's Fuel Economy Stayed the Same or Decreased	5	6%

[1]Inflation was calculated using BLS average inflation numbers from 2011-2016.

[2]Average "All-New" Vehicle Price from the New Car Cost Guide.

Fuel Savings Exceeded Fuel Economy Technology Costs for 94% of All-New 2017 Models: Annual vehicle price increases (less inflation) cover many different improvements such as new safety technology, convenience items, design changes, as well as upgraded fuel economy technology. By separating out the cost of fuel economy improvements from these other costs, we were able to get a more accurate look at the impact of the standards on consumer pocketbooks. Overall, for 74 of the 79 vehicles (94%), the added cost of new fuel-efficient technology was far exceeded by the resulting fuel cost savings over the first 5 years of ownership.

Even if the Price of the Vehicle Goes Up, Fuel Economy Savings Can Offset the Increase: For 12 of the 58 vehicles whose cost went up, the savings in fuel costs exceeded the entire price increase for that vehicle, even though only part of that increase can be attributed to fuel efficiency (See Table XXI-2).

Each mile per gallon of improvement is estimated to cost about $100 in improved fuel economy technology.[233] For 41 of the 58 vehicles whose cost went up, the savings in fuel costs outweighed the cost of the fuel economy technology. Finally, for the few vehicles whose fuel economy stayed the same or actually decreased, all experienced an increase in price.

OVERALL, FUEL ECONOMY IMPROVEMENTS FAR EXCEED THEIR COST, AND PARTIALLY OFFSET THE COST OF OTHER IMPROVEMENTS

The average "all-new" vehicle increased in price from $37,808[234] in 2011 to $39,723 in 2017, (4.8%). Their increase in fuel economy went from an average of 21.0 to 24.2 MPG, (13.2%). Considering that every mile per gallon of improvement costs about $100, the average cost of these improvements was $320. However, this fuel economy increase saved owners of these "all-new" vehicles an average of $946 in gas costs over 5 years. The difference between the cost of these improvements and their benefit provided consumers with an average savings of $626 over 5 years in gasoline costs. These savings go directly into consumer pocketbooks and back into the economy or offset about 40% of the non-fuel efficiency technology component of the average price increase of "all-new" cars from 2011-2017.

Table XXI- 2: 2011 & 2017 Average "All-New" Vehicle Price and Fuel Economy (Accounting for Inflation)			
Year	**Ave. "All-New" Vehicle Price[1][2]**	**Ave. Fuel Economy of "All-New" Vehicles[3]**	**Gas Cost for 5 Years[4]**
2011 Price in 2017 Dollars	$37,808	21.0	$7,567
2017 Price	$39,723	24.2	$6,621
Change in Price	$1,915	3.2	-$946
% Change	4.8%	13.2%	-14.3%
COST: $100 per MPG Increase for Fuel Economy Technology[5]	-$320		
BENEFIT: Gas Savings Due to Fuel Efficient Technology	$946		
SAVINGS: Average Savings for "All-New" Car Buyers	$626		

[1]Inflation was calculated using BLS average inflation numbers from 2011-2016 averaging 1.4% per year.

[2]Average "All-New" Vehicle Price is from the New Car Cost Guide for the 79 vehicles.

[3]Average Fuel Economy of 79 "All-New" Vehicles is based on EPA combined mileage estimates.

[4]Gas costs from AAA $2.27 (7/19/17) and driving an average of 14,000 miles per year.

[5] CFA bases its estimate of the cost of fuel economy on a review of the literature including historical, market-based and engineering studies, as described in Appendix B.

CAFE Compliance among "All-New" Vehicles Show Manufacturers are on Their Way to 2025 Compliance

The introduction of "all-new" vehicles is the best barometer of a manufacturer's ability to comply with CAFE standards. Changing the fuel economy of existing vehicles is difficult, as the vehicle is already designed and is being manufactured to its original specifications. With "all-new" vehicles, manufacturers can incorporate their latest fuel-saving technologies (See Table XXI-3).

In comparing the CAFE compliance of "all-new" models introduced in 2015, 2016 and 2017, there was a significantly higher percentage of CAFE-compliant vehicles in 2017. In fact, 70 percent of the "all-new" 2017 vehicles had a CAFE-compliant trim, compared to 41 percent of the "all-new" 2015 vehicles. Particularly noteworthy was the fact that 78% of the "all-new" light duty trucks had a CAFE compliant trim for 2017. Interestingly, percentage-wise, trucks beat cars for CAFE compliance in 2017.

Table XXI-3: Percentage of CAFE Compliant Vehicles Among "All-New" Models (2015-2017)			
	2015	**2016**	**2017**
Total "All-New" Vehicles	34	32	27
Total CAFE Compliant	14 (41%)	19 (60%)	19 (70%)
Percentage of CAFE Compliant Vehicles Among "All-New" Model Cars			**2015-2017**
	2015	**2016**	**2017**
Total "All-New" Cars	19	19	18
Total CAFE Compliant	8 (42%)	15 (80%)	12 (67%)
Percentage of CAFE Compliant Vehicles Among "All-New" Model Trucks			**2015-2017**
	2015	**2016**	**2017**
Total "All-New" Trucks	15	13	9
Total CAFE Compliant	6 (40%)	5 (40%)	7 (78%)

MANY MODELS EXCEED CURRENT YEAR CAFE REQUIREMENTS–SOME COMPLYING TO 2025

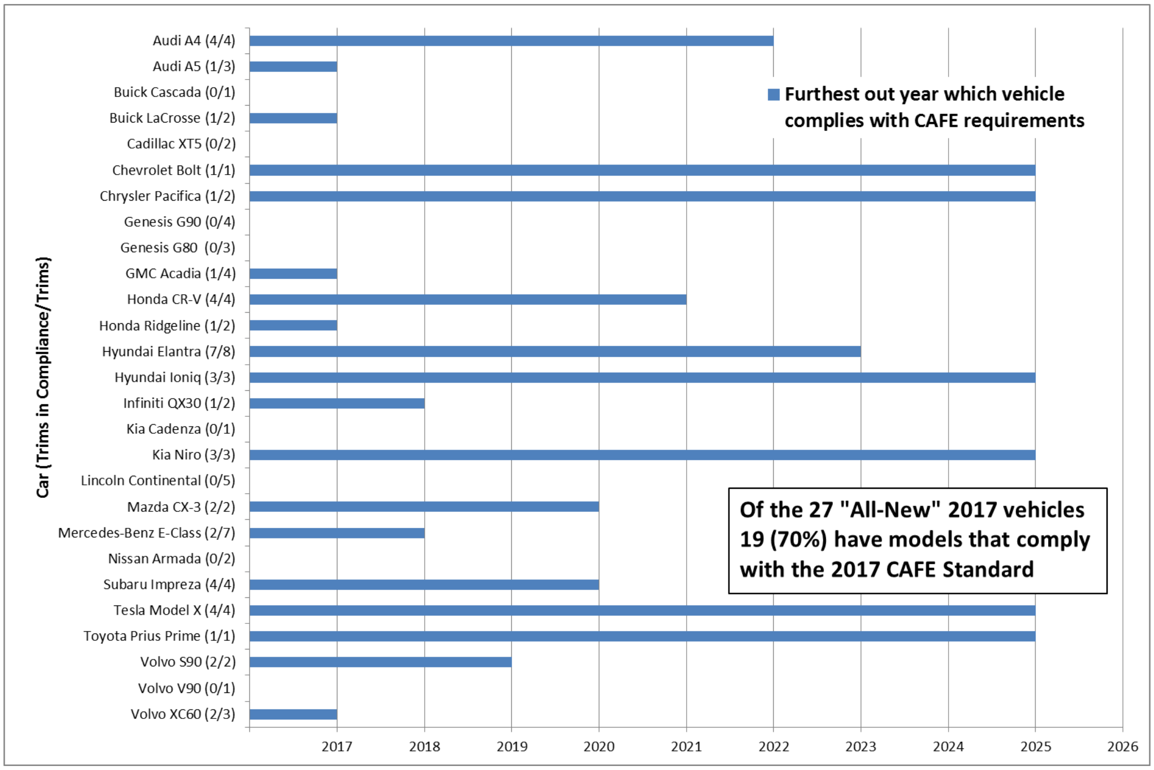
In reviewing the "all-new" vehicles, we also determined how many years into the future each model would comply with the *gradual increase* in CAFE requirements. Current vehicles that meet CAFE requirements for future years indicate that manufacturers are actually "ahead of the game" in terms of compliance.

About 70% (19) of the 27 "all-new" vehicles for 2017 had models which met, at the minimum, the 2017 CAFE standard. In fact, from 2015-2017, the majority of these compliant cars actually exceeded the minimums required for that year. Table XXI-4 and Figure XXI-1 show that 6 of the 2017 vehicles are already CAFE compliant with the 2025 standard—a record number.

Table XXI-4: Among th3e "All-New" 2017 Vehicles− How Many Will Continue Their CAFE Compliance Until:

	2015	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
2015	14	10 (71%)	8 (57%)	6 (43%)	5 (36%)	3 (21%)	3 (21%)	2 (14%)	0	0	0
2016	-	19	18 (95%)	18 (95%)	15 (79%)	14 (74%)	11 (58%)	7 (37%)	6 (32%)	4 (21%)	2 (11%)
2017	-	-	19	14 (74%)	11 (58%)	10 (53%)	8 (42%)	8 (42%)	7 (37%)	6 (32%)	6 (32%)

FIGURE XXI-1"ALL-NEW" 2017 VEHICLES AND THEIR CAFE COMPLIANCE



What is particularly remarkable is the improvements in CAFE compliance by each of the manufacturers (see Figure XXI-2). 14 of the 17 major manufacturers improved the percent of their vehicles that were CAFE compliant from 2015 to 2017. (Tesla at 100% compliance matched its 2015 compliance.) While Ford and Fiat Chrysler lost ground, many of the other manufacturers actually doubled the percent of CAFE compliant vehicles.

GAS GUZZLERS DECLINE SIGNIFICANTLY IN 2017 - VEHICLES GETTING OVER 30 MPG STAYS STEADY

Fuel economy progress is going well. In looking at all of the 2017 models, “gas guzzlers” getting below 14 MPG are a miniscule 0.4% in 2017, down from 8.5% in 2011. At the other end, there was a small increase in vehicles getting over 38 MPG, going from 4% last year to 4.3% in 2017. (Table XXI-5)

FIGURE XXI-2: PERCENT OF 2015 AND 2017 VEHICLE TRIMS THAT WERE CAFE COMPLIANT BY MANUFACTURER

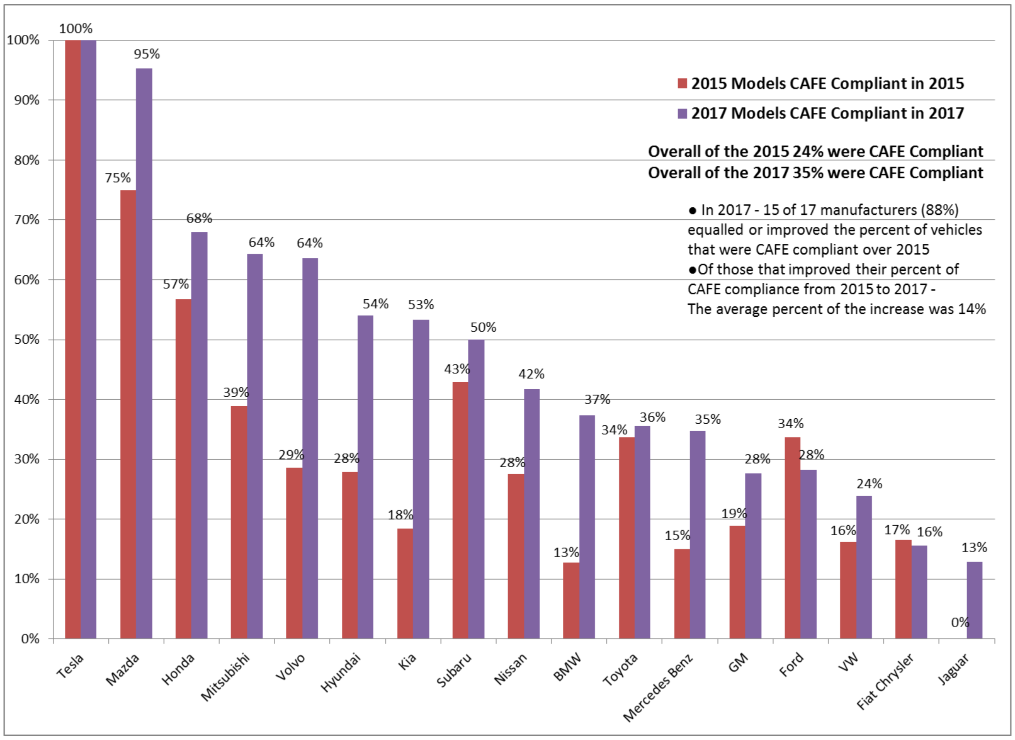


TABLE XXI-5: ON THE ROAD TO 40 MPG BY 2025: CARMAKERS DEMONSTRATE SIGNIFICANT PROGRESS

EPA Grade	MPG	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
10	38+	0.4%	0.2%	0.2%	0.2%	0.6%	1.0%	1.1%	2.9%	3.1%	3.0%	4.0%	4.3%
9	31-37	0.7%	0.4%	0.8%	1.1%	2.1%	3.2%	4.7%	6.4%	8.5%	8.7%	9.3%	8.8%
Over 30MPG		**1.1%**	**0.6%**	**1.0%**	**1.3%**	**2.7%**	**4.2%**	**5.8%**	**9.3%**	**11.6%**	**11.7%**	**13.4%**	**13.0%**
8	27-30	2.4%	3.0%	3.5%	4.4%	7.3%	7.8%	9.2%	12.0%	14.8%	16.5%	17.3%	15.8%
7	23-26	10.3%	10.2%	12.8%	12.4%	18.9%	18.3%	20.4%	25.0%	24.1%	23.8%	25.4%	27.1%
Acceptable		**12.7%**	**14.4%**	**18.3%**	**19.3%**	**31.6%**	**34.5%**	**41.2%**	**45.3%**	**50.5%**	**52.0%**	**56.1%**	**55.9%**
6	22	10.4%	10.4%	7.2%	11.7%	8.4%	8.0%	7.0%	7.7%	6.1%	8.0%	7.5%	7.7%
5	19-21	28.2%	26.5%	28.5%	27.6%	29.2%	30.4%	26.9%	26.5%	24.3%	22.2%	21.8%	21.1%
4	17-18	14.7%	13.7%	14.9%	12.5%	13.8%	12.5%	11.3%	9.4%	10.6%	11.7%	10.7%	10.5%
3	15-16	24.4%	24.6%	16.6%	15.6%	11.4%	10.3%	9.8%	6.7%	6.1%	4.7%	3.7%	4.5%
2	13-14	5.0%	5.9%	9.9%	8.2%	6.7%	6.8%	7.8%	3.0%	2.4%	1.4%	0.3%	0.4%
1	0-12	3.5%	5.2%	5.7%	6.4%	1.7%	1.7%	1.8%	0.4%	0.0%	0.0%	0.0%	0.0%
Poor		**86.2%**	**86.3%**	**82.8%**	**82.0%**	**71.2%**	**69.7%**	**64.6%**	**53.7%**	**49.5%**	**48.0%**	**43.9%**	**44.1%**
# of Trims[1]		**1076**	**1184**	**1198**	**1182**	**1101**	**1053**	**901**	**1057**	**1091**	**1194**	**1094**	**1097**

[1]We did not include large passenger vans or exotic vehicles.

SUVS, CROSSOVERS AND PICKUPS WITH HIGHER MPG INCREASES SELL BETTER

A key concern among U.S. automakers is the impact of fuel economy standards on sales. Rolling back the standards, they say, is necessary to maintain sales. Our analysis specifically demonstrates just the opposite.

SUVs, pickups and crossovers, whose MPGs (miles per gallon) increased by over 10% between 2011 to 2016, had a 59% increase in sales. On the other hand, those same vehicles with less than a 10% increase in MPGs from 2011 to 2016 experienced only a 41% increase in sales, almost 20% less. (See Tale XV-6) This analysis completely debunks automaker claims that consumers don't value good gas mileage. Clearly, the more improvement in MPG, the better the sales. NOTE: 2011 was the year prior to when the current CAFE requirements went into effect.

Table XXI-6: SUVs, Crossovers, Light Trucks - 2011-2016

Percent Increase in MPG 2011 - 2016	Number of Vehicles	2011 Average Sales Per Model	2016 Average Sales Per Model	Average Change in Sales (Units)	2011 - 2016 Average % Change in Sales
10% or More	29	95,143	150,828	55,685	59%
Under 10%	37	63,423	89,696	26,273	41%

Mileage figures from EPA and Sales from Auto News

The Toyota RAV4, which increased by 10 MPG from 2011 to 2016 and saw a sales increase of almost 220,000 or a 166% increase in annual vehicle sales. Meanwhile, the GMC Terrain which had a 1 MPG decrease saw only a 6% increase in sales from 2011 to 2016. And even though consumers are increasingly choosing crossover models over sedans, the typical crossover now gets 10% better gas mileage than in 2011, thanks to fuel economy standards which are currently under threat of a rollback.

CONCLUSION

Not only do consumers want more fuel efficiency, but this data and analysis make it abundantly clear that manufacturers are fully capable of meeting the current standard and that fuel economy helps sales. This should be no surprise, because the standard was specifically designed to help manufacturers meet the challenges they face with improving fuel efficiency. The current standards are not "one-size fits all" and were specifically crafted to respect the differing vehicle mixes among manufacturers as well as consumer choice. Acknowledging the fuel economy challenges inherent in larger vehicles, the standard incorporates two separate calculations, one for cars and one for light trucks, SUVs, and most crossovers. Furthermore, within those calculations, a sliding scale further reduces the requirements on larger vehicles. Finally, automakers meet requirements on an average basis across their entire fleet, which means that not all of the manufacturer's models have to meet a given year's target. This enables automakers to produce a mix of vehicles in response to consumer demand. The result: the standards have helped create a much more efficient U.S. auto fleet while preserving both manufacturer and consumer choice on size, weight and performance.

It is also evident that increased fuel economy plays an important role in vehicle sales. That was made clear in the mid 2000's when auto dealer lots were filled with gas guzzlers they simply couldn't sell, resulting in government bailouts for the industry. Rolling back the standards today would not only hurt U.S. automakers as the Asian companies roar ahead with vehicles in compliance, but would be a big blow to American pocketbooks, especially as gas prices rise in the future.

XXII. CFA'S ELECTRIC VEHICLE ANALYSIS[235]

THE BENEFIT OF TECHNOLOGY NEUTRAL, PRODUCT NEUTRAL LONG-TERM STANDARDS

CFA first introduced the analysis of electric vehicles into the hearing record in our 2012 comments on the National Program and we have updated that analysis regularly inside and outside of the record. At the time, we used the innovation diffusion adoption framework to argue that electric vehicles were headed towards sales of millions by the end of the period covered by the mid-term review. At the time those projections were seen as extremely aggressive. Today, given the stated plans of automakers worldwide, they are reasonable, even timid. We tie this marketplace development to the standards through their "command-but-not-control" approach. Being product and technology neutral, they allowed the automakers to go where they were best suited to comply with the standards.

Taking a long term, product and technology neutral approach unleashes competition around the standard that ensures that consumers get a wide range of choice at that lowest cost possible, given the level of the standard. There will soon be hundreds of models of electric and hybrid vehicles using four different approaches to electric powertrains (hybrid, plug-in, hybrid plug-in, and extended range EVs), offered across the full range of vehicles driven by American consumers (compact, mid-size family sedans, large cars, SUVs, pickups), by half a dozen mass market oriented automakers. At the same time, the fuel economy of the petroleum powered engines can be dramatically improved at consumer-friendly costs and it will continue to be the primary power source in the light duty fleet for decades.

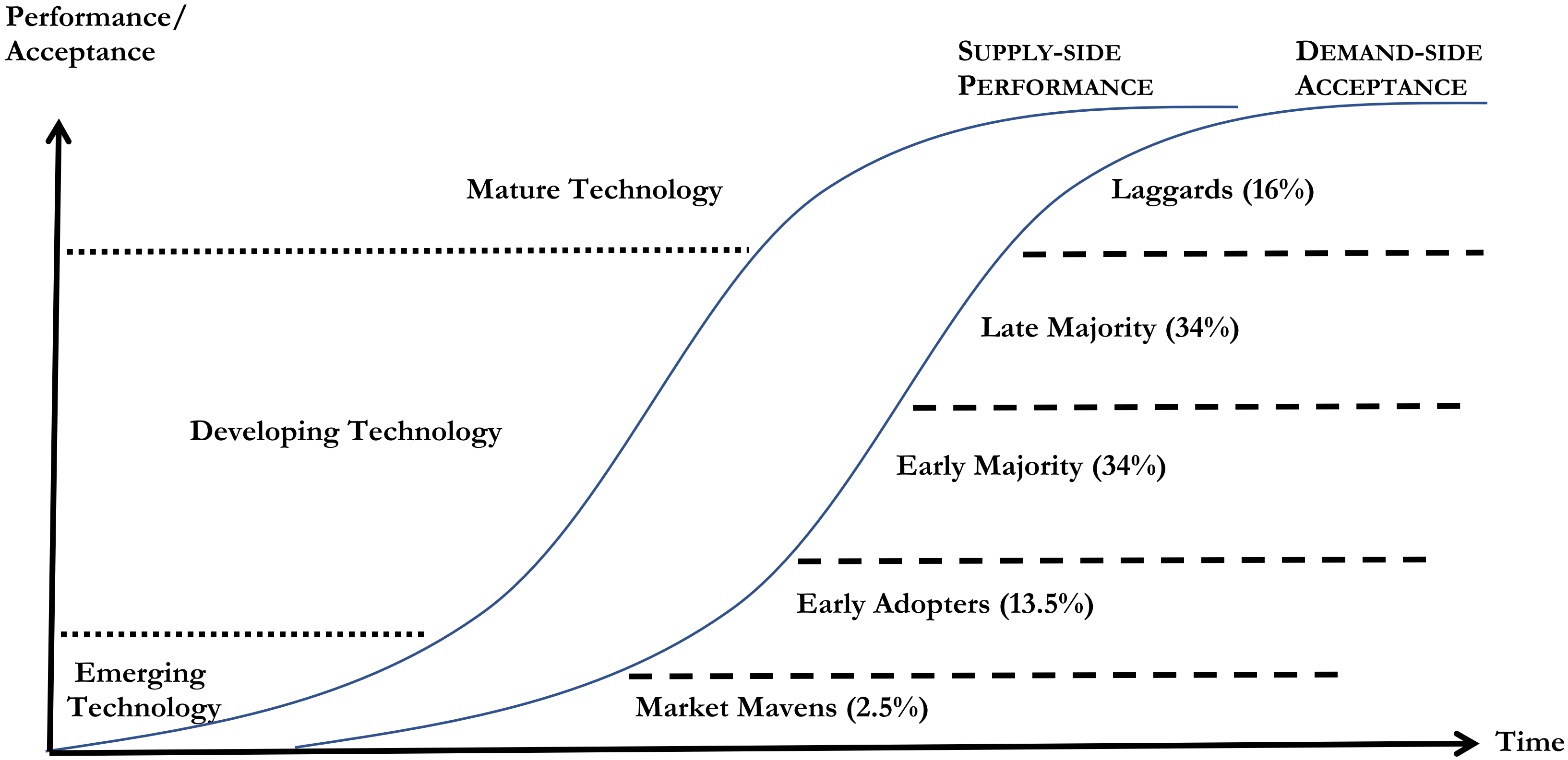
Today, automakers offer 30 models of electric vehicles. All of the major, mass market automakers are offering electrics using different approaches to power including hybrid, plug ins, hybrid plug in and extended range plug in, and they sell hundreds of thousands of units in the U.S. They are offering vehicles across the full range of models that consumers drive – compacts, sedans, large cars, SUVs and pickups. J.D. Powers and Associates project that there will be 159 models by 2016 and that electric vehicles will account for almost 10% of the market.[236]

U.S. automakers were in the rear guard of the hybrid revolution and the failure of the industry to recognize the need to innovate proved to be catastrophic. A failure to recognize the importance of electric vehicles could again be disastrous. Analysts project that the global plug in electric market will grow over ten times as quickly as the total light duty market over the next decade.[237] U.S. automakers need to be in the vanguard of the electric vehicle market to be competitive in the global auto market and the ZEV program is a proven way to ensure that they are.

THE PROCESS OF ADOPTING NEW TECHNOLOGIES

The electric vehicle likely represents the most profound change currently in the automobile. Its introduction is a function of new technology, and its adoption will be a function of consumer acceptance of this new technology. Time is a critical variable in analyzing the adoption of new technologies. The adoption of innovative products goes through a series of stages that starts out with small numbers and accelerates before peaking and leveling off. The result is a classic "S curve," as shown in Figure XXII-1.

FIGURE XXII-1: THE INTERACTION OF SUPPLY AND DEMAND IN THE CREATION/DIFFUSION OF INNOVATIVE TECHNOLOGIES



Sources: Mark Cooper, *Energy Efficiency Performance Standards: The Cornerstone of Consumer-Friendly Energy Policy* (Consumer Federation of America, October 2013, p. 50)derived from Mahajan, Vijay, Eitan Muller and Frank M. Bass,1990, "New Product Diffusion Models in Marketing: A Review and Directions of Research," *Journal of Marketing,* 54; Rick Brown, "Managing the "S" Curve of Innovation," 1992, *Journal of Consumer Marketing;* Fenn, Jackie, 1995, *When to Leap on the Hype Cycle,* Gartner Group; Paul Gilder and Gerard J. Tellis, 1997, "Will it Ever Fly? Modeling the Takeoff of Really New Consumer Durables," *Marketing Science,* 16: 3, "Growing, Growing Gone: Cascades, Diffusion, and Turning Points in the Product Life Cycle," *Marketing Science,* 23: 2 (2004); Kohli, Rajeev Donald R. Lehman and Jae Pae, 1999,"Extent and Impact of Incubation Time in New Product Diffusion, *Journal of Product Innovation Management,* 16; Osawa, Yshitaka and Kumiko Miazaki, 2006, "An Empirical Analysis of the Valley of Death: Large Scale R&D Project Performance in a Japanese Diversified Company," *Asian Journal of Technology Innovation,* 14:2; Sood, Ashish, et al., 2012, "Predicting the Path of Technological Innovation: SAW vs. Moore, Bass, Gompertz and Jryder," *Marketing Science,* 31: 6; Gartner, 2013, ***Interpreting Technology Hype.***

This classical view of innovation adoption highlights several important characteristics in the electric vehicle market. Products do not spring into the market and immediately achieve large market shares. It takes time on both the supply and demand sides. On the supply-side, there is a significant period of development of a product before it is brought to market as well as continued development as it is adopted. On the demand side, the small number of very early purchases frequently looks like a "niche" market, comprised of "mavens and innovators," who have unique characteristics. Early adopters are often opinion leaders and are perceived as "ahead of the curve." These opinion leaders serve as resources for the early majority. They tend to be more mainstream than "innovators" and provide legitimacy and broader appeal for the product. This is the product's takeoff period. It is also important to recognize that not all products penetrate 100% of the market, nor is it necessary for them to do so to be profitable.

ELECTRIC VEHICLES ARE OFF TO A FASTER START THAN HYBRIDS

Applying this process of adoption to answer the question "How are electric vehicles doing?" Electric vehicles can be divided into two broad categories: hybrids and other electric vehicles (plug in hybrids and battery electrics). The distinction is important, not only because the technologies are different, but also because hybrids were introduced into the market over a decade ago, while other electric vehicles were significantly introduced only about three years ago.

There are three types of electric powered vehicles on which the auto market is focused at present that can be distinguished by two characteristics, whether they have gasoline engines and whether the batteries can be recharged by being plugged in.

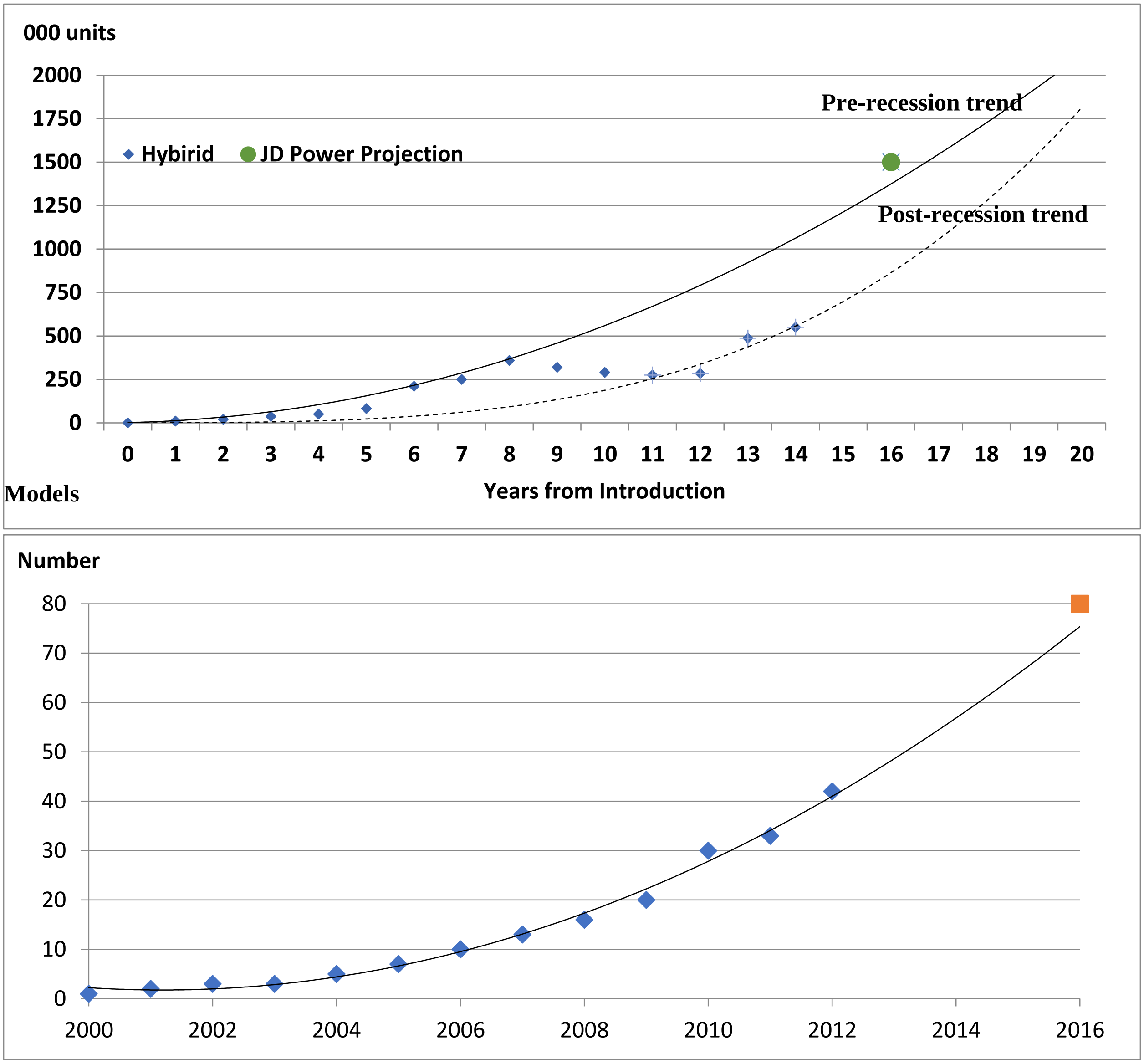
		Plug-in Capacity	
		No	Yes
Gasoline	No		All electric vehicle
	Yes	Hybrid	Plug-in Hybrid

Hybrids, like the Prius, entered the market in significant numbers over a decade ago. Plug-in hybrids and all electric vehicles entered the market in significant numbers about a decade after the hybrids. For the purposes of innovation diffusion analysis, since the time of market entry is important, we group the latter two as other electric vehicles.

After more than a decade of development and marketing, hybrids are an example of one of the most successful, radically different products introduced in the past two decades. Figure XXII-2 shows the sales history and the number of models. Both graphs include a projection from JD Power. The adoption of hybrids appears to have followed a non-linear growth pattern, especially after the initial phase of adoption. The sale of hybrids accelerated after year five and only the recession slowed them down. Their sales have now recovered. The number of models available has increased along with sales, and JD Power projects a sharp increase in the next few years. Putting models in the showrooms is critically important to driving sales, particularly as hybrids infiltrate the types of vehicles consumers are purchasing. The hybrid is now well past the developmental phase on the supply side and well into the early adoption phase on the demand side.

FIGURE XVII-2: HYBRID SALES AND PROJECTIONS

Sales

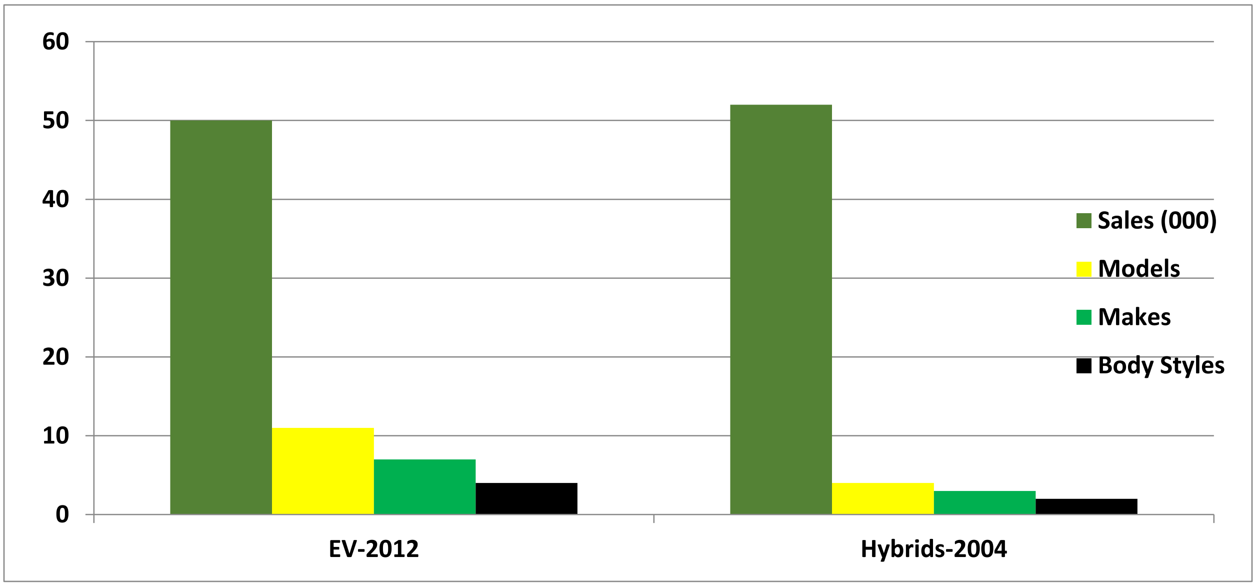


Sources: J.D. Power, ,Mike Omotoso, *Global Alternative Fuel Light Vehicle Sales Forecast,* April 2010; J.D. Power and Associates - 2, *Despite Rising Fuel Prices, the Outlook for "Green" vehicles Remains Limited for the Foreseeable Future,* April 27, 2011,

Early Adoption

Introduced in 2000, the sales of hybrid vehicles (vehicles with dual power sources, typically electric and gas) have increased significantly since their introduction. Today, every manufacturer except Mazda offers a number of hybrid options in a variety of vehicle sizes. As the chart below shows, during their first four years, sales of EVs have outpaced the now popular hybrids. Figure XXII-3 shows that the roll out of models for EVs is matching or exceeding that of hybrids.

FIGURE XXII-3: EARLY DEVELOPMENT, MODELS, MAKES AND BODY TYPES: HYBRIDS V. NON-HYBRID ELECTRIC VEHICLES



Source: Updated from Jack Gillis and Mark Cooper, *The Fuel Economy of 2013 Vehicles: A Fast Start toward the Goal of 54.5mpg in 2025* (Consumer Federation of America, April 2013). Based on Rudi Halbirght, Max Dunn, *Case Study: The Toyota Prius, Lessons in Marketing Eco-Friendly Products*, March3, 2010; http://www.hybridcars.com/hybrid-sales-dashboard/... Various years; J.D. Power, ,Mike Omotoso, *Global Alternative Fuel Light Vehicle Sales Forecast*, April 2010; J.D. Power and Associates - 2, *Despite Rising Fuel Prices, the Outlook for "Green" vehicles Remains Limited for the Foreseeable Future,* April 27, 29011, The Boston consulting Group, *The Comeback of the electric Car? How Real, How Soon, and What Must Happen Next?,* June 2011, Exhibit 5, from the "steady pace Scenario;" Electric drive vehicle sales figures (U.S. Market) - EV sales, http://www.electricdrive.org/index.php?ht=d/sp/i/20952/pid/20952.

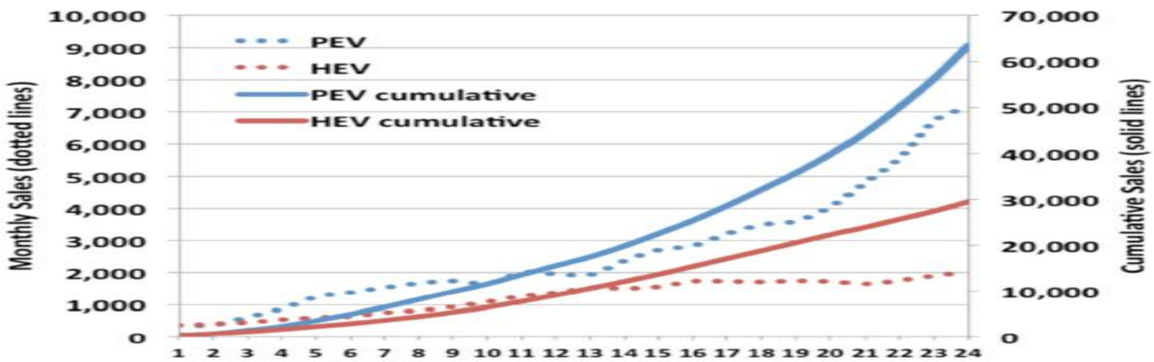
While there is speculation that consumers are not ready for electric vehicles, there has been a sharp increase in sales. Compared to the pattern for hybrids through their first three years, the electrics are doing quite well, as shown in Figure XXII-4. In fact, they have reached higher sales than hybrids did in their first three years. If electric vehicles follow a standard and expected nonlinear pattern, there will be large numbers on the road within a decade. If electric vehicles follow a standard and expected nonlinear pattern, there will be large numbers on the road within a decade.

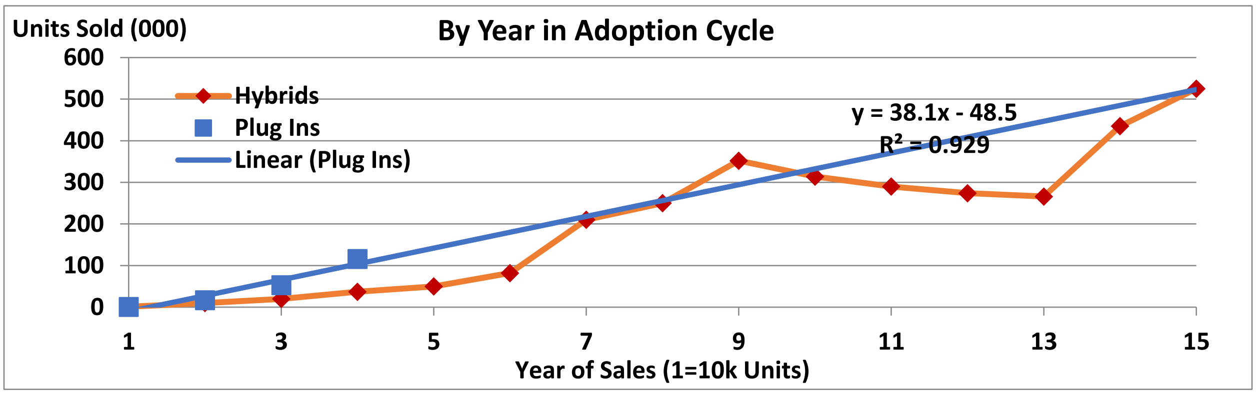
Number of Electric Models Keeps Increasing

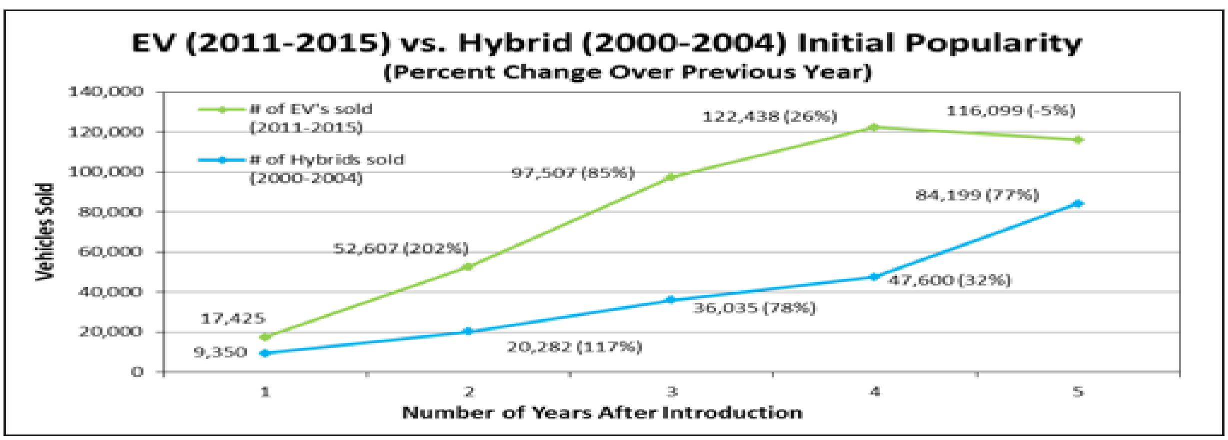
While lower gas prices may have dampened EV sales a bit in 2015, carmakers have increased their efforts to offer new, longer-range, and lower-priced EVs. This year, 13 car companies offer at least one electric option. Volkswagen is offering four models, while Ford, BMW, and Mercedes-Benz each offer three models. Of the major automakers, only Honda, Subaru, and Mazda do not currently offer an EV option.

FIGURE XXII- 4: HYBRID ADOPTION COMPARED TO PLUG IN ELECTRIC VEHICLE ADOPTION

Early Months







Source: Updated from Jack Gillis and Mark Cooper, *The Fuel Economy of 2013 Vehicles: A Fast Start toward the Goal of 54.5mpg in 2025* (Consumer Federation of America, April 2013). Based on Rudi Halbirght, Max Dunn, *Case Study: The Toyota Prius, Lessons in Marketing Eco-Friendly Products*, March3, 2010; http://www.hybridcars.com/hybrid-sales-dashboard/... Various years; J.D. Power, ,Mike Omotoso, *Global Alternative Fuel Light Vehicle Sales Forecast*, April 2010; J.D. Power and Associates - 2, *Despite Rising Fuel Prices, the Outlook for "Green" vehicles Remains Limited for the Foreseeable Future,* April 27, 29011, The Boston consulting Group, *The Comeback of the electric Car? How Real, How Soon, and What Must Happen Next?,* June 2011, Exhibit 5, from the "steady pace Scenario;" Electric drive vehicle sales figures (U.S. Market) - EV sales, http://www.electricdrive.org/index.php?ht=d/sp/i/20952/pid/20952., http://en.wikipedia.org/wiki/File:DoE_EV_Everywhere_Blueprint_p5.png

As both carmakers and their suppliers make large investments in battery technology, there will be a record number of new models introduced in 2017. Table XXII-1 shows a near steady increase in the number of EVs being offered over the past 6 years. Just six years ago there were only three EVs on the market. By 2016, there were 25 models on the market. Based on manufacturer projections, 31 different models should be available in 2017. Between BMW, Chevrolet, Hyundai, Mercedes-Benz, Tesla, and Volvo, six all-new EVs will be added including the much-anticipated Tesla Model 3, which already has over 400,000 pre-orders. The number of pre-orders for the new Tesla is higher than for any other car ever introduced.

TABLE XXII-1: NUMBER OF ELECTRIC VEHICLES AVAILABLE BY YEAR

Year	Plug-in Hybrids	Battery Operated EV's	Total Electric Vehicles
2011	1	2	3
2012	4	4	8
2013	8	8	16
2014	10	8	18
2015	8	8	16
2016	12	13	25
2017*	15	16	31

*Projected

EV Ranges Are Matching Household Driving Patterns

"Range anxiety" is a term that describes consumer concern about the possibility of an EV running out of electricity at a bad time. The good news is that – according to a study conducted by Consumers Union and the Union of Concerned Scientists in 2015 – about 70 percent of Americans drive less than 60 miles a day, which is within the range of most EVs. As Table XXII-2 below indicates, 13 of the 25 2016 models – that is, 52 percent – have a range of over 60 miles. Four models – or 16 percent – get over 100 miles on a single charge; these include the BMW i3, Nissan Leaf SV/SL, Tesla Model S, and Tesla Model X. (Note: Table 2 considers vehicles' range using battery power only. Plug-in hybrids will have a longer range under gasoline power.)

TABLE XXII-2: THE RANGE OF ELECTRIC VEHICLES AMONG 2016 MODELS

Using Battery Only	
Range in Miles	2016
0-30	11
31-60	1
61-100	9
101-150	2
151-200	0
201+	2
Total	25

EVs Are Increasingly Price Competitive

In 2016, it is expected that Americans will buy over 17.1 million cars and light trucks, with an average price of $33,560. Today's EVs have become price competitive. While EVs do vary widely in price – from $23,000 for a Mitsubishi i-MiEV to over $136,000 for a BMW i8 – there are a number of vehicles whose prices are similar to those of the gas-powered version of the cars (see Table XXII-3).

TABLE XXII-3: COST COMPARISON OF EVS TO THEIR GAS-POWERED COUNTERPART

Manufacturer	Vehicle	Price (MSRP)[5] [6]	Annual Cost for Fuel[7] [8]
Fiat	500 Lounge HB (Gas)	$19,856	$1,340
	500e (Electric)	$25,126	$522
	Difference	**$5,270**	**-$818**
Ford	Focus Titanium HB (Gas)	$22,073	$1,090
	Focus Electric (Electric)	$23,050	$576
	Difference	**$977**	**-$514**
Kia	Soul + (Gas)	$18,195	$1,257
	Soul EV (Electric)	$25,577	$576
	Difference	**$7,382**	**-$681**
Smart	ForTwo Proxy (Gas)	$18,480	$1,116
	ForTwo ED (Electric)	$18,500	$576
	Difference	**$20**	**-$540**
Volkswagen	Golf SE HB (Gas)	$24,217	$1,127
	e-Golf (Electric)	$21,685	$522
	Difference	**-$2,532**	**-$605**

Notes

[1] Includes $7,500 tax credit.

[2] Includes $7,500 tax credit. Currently, the tax credit only applies to the first 200,000 vehicle models. If the credit is not changed and these pre-orders hold, then have of these people will not get the $7500 tax credit.

[3] J.D. Power and LMC Automotive

[4] Kelley Blue Book

[5] Prices from the New Car Cost Guide

[6] Electric price includes $7,500 federal tax credit, typical level 2 power connector price of $600, and an estimated $750 for home installation of a 240 Volt receptacle.

[7]Based on typical driving of 15,000 miles per year.

[8] Cost of fuel for electrics is based on a national average of $0.12 kWh (according to EIA), and cost for gas is based on national $2.18 for regular and $2.68 for premium (according to AAA)

In looking at the typical cost of an electric vehicle, we conducted a one-to-one comparison for those EVs with a gas-powered version of the same vehicle. While some manufacturers, including Fiat and Kia, do charge significantly more for their EVs, others – including Ford, Smart and Volkswagen – have priced electric and gas-powered versions of the same model similarly.

To compare the costs between EVs and their gas-powered counterparts, we considered the $7,500 federal tax credit currently offered, added the estimated cost of purchasing a Level 2 connection device and a 240-volt circuit for home charging. The connection charges are estimates, and could be mitigated by rebates from local utility companies or local tax credits. For example, Gulf Power in Pensacola, Florida, offers a $750 credit toward the costs of upgrading a home to accept a level 2 charger. Austin (TX) Energy will rebate 50 percent of the cost up to $1500 and many states offer tax credits. If longer charge times are acceptable, then Level 1 charging equipment comes free with the vehicle and simply plugs in to a regular electric outlet, requiring no additional investment.

KNOWLEDGE AFFECTS CONSUMER INTEREST IN EVS

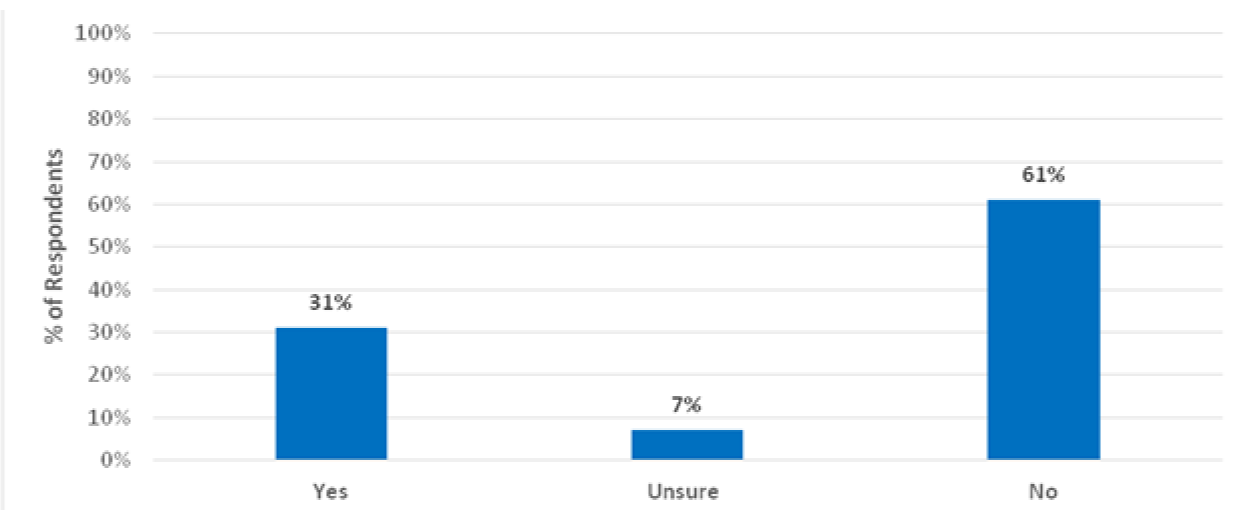
For the past two years CFA has conducted surveys addressing consumer knowledge of and attitudes toward electric vehicles.

The 2015 Survey

Overall Interest in Purchasing an EV

Overall, a surprising percentage of respondents are interested in purchasing an EV, as shown in Figure XXII-5. This interest provides a catalyst for manufacturers to aggressively promote EVs and improve their designs.

FIGURE XXII-5: THE NEXT TIME YOU BUY OR LEASE A CAR, WILL YOU CONSIDER AN ELECTRIC VEHICLE?

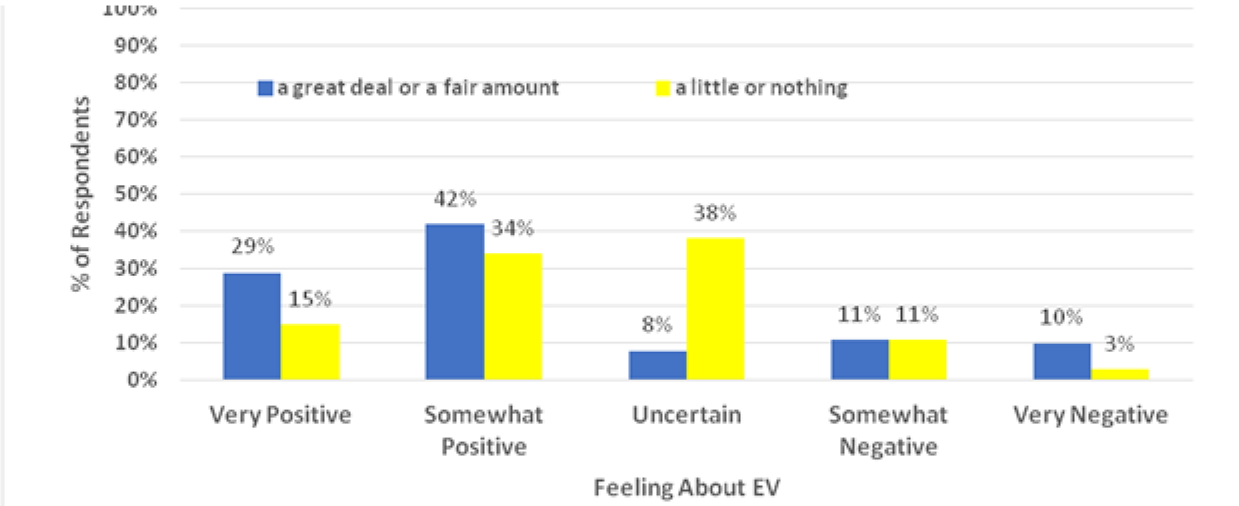


Source: Consumer Federation of America survey conducted by ORC International by cell phone and landline on August 20-23, 2015.

How Does Knowledge about EVs Affect Attitudes Towards Them?

As Figure XXII-6 shows, there is a correlation between consumer knowledge about EVs and their attitude towards them. While 71 percent of those that know about EVs have a "Very Positive" or "Positive" attitude about EVs, it is important to note that there is a remarkably high "Very Positive" or "Positive" attitude (49 percent) among respondents who indicated that they knew little or nothing about EVs. While knowledgeable consumers have a more positive attitude towards EVs, there is a general attractiveness of EVs among consumers regardless of their EV knowledge.

FIGURE XXII-6: DO YOU HAVE A POSITIVE OR NEGATIVE VIEW OF ELECTRIC VEHICLES?



Source: Consumer Federation of America survey conducted by ORC International by cell phone and landline on August 20-23, 2015.

The Impact of EV Knowledge on Potential Purchase Behavior

In further analyzing consumers' overall interest in buying an EV, we compared purchase desire between respondents more and less knowledgeable about EVs (see Figure XXII-7). We found a significant correlation between consumer understanding of EVs and their potential to purchase one. For consumers who understand "a great deal" or a "fair amount" about EVs, intention to purchase was much higher. This is strong evidence of the benefits for manufacturers who invest in promoting their EVs. Automakers are among the largest advertisers in the country; directing some of this investment towards EVs will clearly pay off in increased consumer purchases. Clearly, there is a benefit to consumers learning more about EVs.

The 2016 Survey

According to a second survey on EVs conducted in 2016, consumer interest in purchasing an electric vehicle (EVs) has increased in the past year, and this interest is greatest among young adults. CFA also found that the number of EV choices on the market is increasing, while electric vehicle prices are becoming competitive with gas-powered vehicles. Overall, sales of EVs have significantly outpaced the sales of hybrids in their first years on the market. 2016 sales of EVs outpaced 2015.

FIGURE XXII-7: CONSIDERING AN EV BY KNOWLEDGE

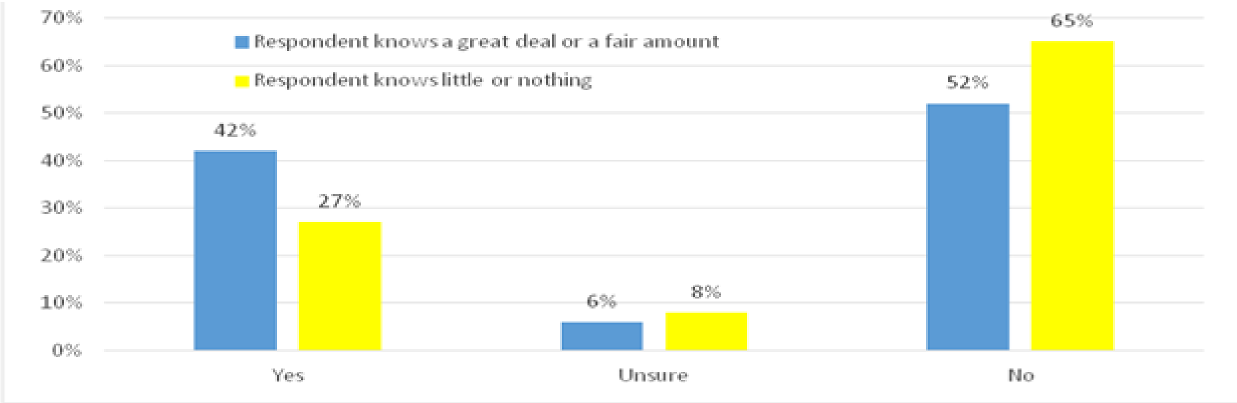
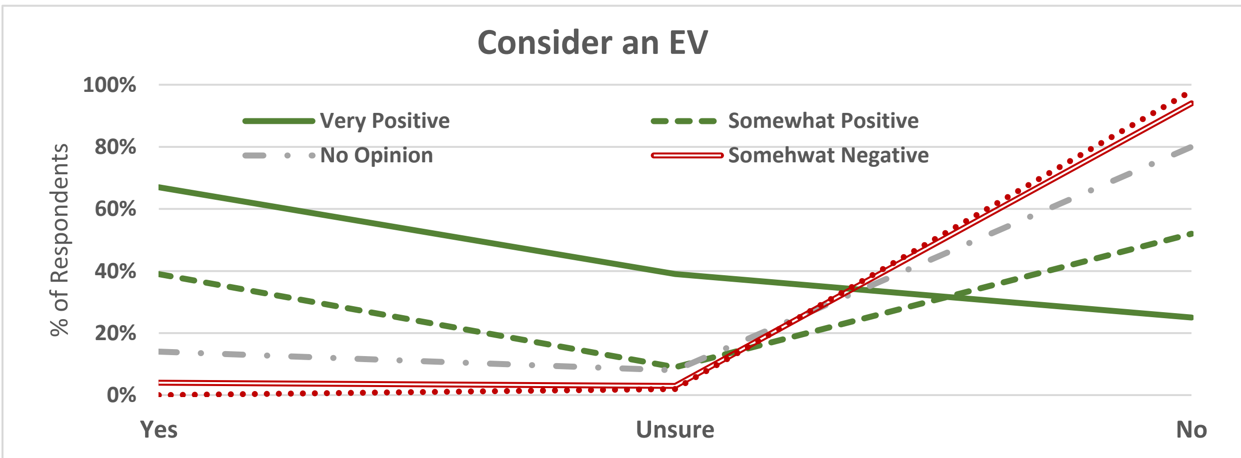
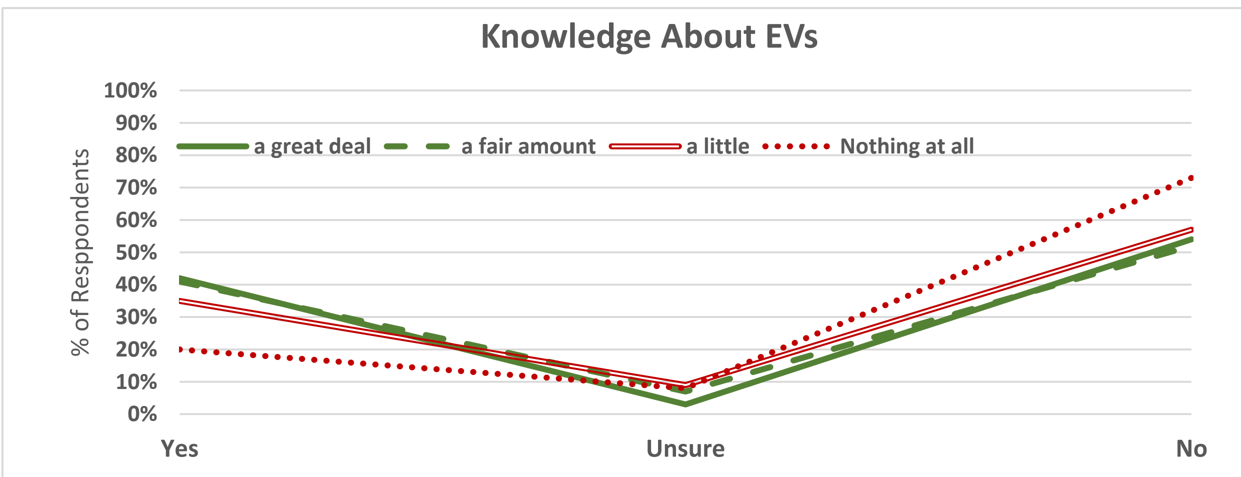


FIGURE XXII-8: WILLINGNESS TO CONSIDER PURCHASING AN ELECTRONIC VEHICLE





Source: Consumer Federation of America survey conducted by ORC International by cell phone and landline on August 20-23, 2015.

The survey revealed growing interest in purchasing an electric vehicle, rising from 31 percent in 2015 to 36 percent in 2016. Among different age groups, young adults (18-34) are most interested, with a full 50 percent saying they would consider buying an electric vehicle.

The more consumers say they know about EVs, the greater their interest in purchasing one. Among survey respondents who consider themselves very knowledgeable about electric vehicles, 55 percent are interested in buying an EV. Among those who say they have no knowledge of EVs, only 22 percent are interested in buying one.

The survey also asked consumers, "The next time you buy or lease a car, would you consider an electric vehicle if it costs the same as a gas-powered car, has lower operating and maintenance costs, has a 200-mile range between charges, and can recharge in less than an hour?" In response to this question, 57 percent said they would be interested in purchasing this EV. For those who say they know a lot about EVs, the figure was 62 percent. And for young adults, the figure was 70 percent. As the younger buyers enter the market, more attractive EVs are made available, and consumers learn more about these vehicles, interest in purchasing them is likely to grow significantly.

This survey question approximates the kind of vehicle that is expected to be available for consumer purchase in the very near future. The upcoming Chevrolet Bolt ($30,000) and Tesla Model 3 ($27,500) are expected to arrive on the market in 2017, and will match the criteria outlined in the question, with charging estimates via DC Fast Charge of one to two hours.

APPENDIX A:
DETAIL ON EXECUTIVE ORDERS AND OMB GUIDANCE ON APPROACHES TO RULEMAKING

	Reagan (12291)	Clinton (12866)	Bush (OMB-Circular A-4)	Obama (13563)
Overall Goal	General Requirements. In promulgating new regulations, reviewing existing regulations, and developing legislative proposals concerning regulation, all agencies, to the extent permitted by law, shall adhere to the following requirements:	The Regulatory Philosophy. Federal agencies should promulgate only such regulations as are required by law, are necessary to interpret the law, or are made necessary by compelling public need,	A statement of the need for the regulatory action: Agencies should explain whether the action is intended to address a market failure or to promote some other goal, such as improving governmental processes, protecting privacy, or combating discrimination. If the action is compelled by statute or judicial directive, agencies should describe the specific authority and the extent of discretion permitted.	Our regulatory system must protect public health, welfare, safety, and our environment while promoting economic growth, innovation, competitiveness, and job creation. As stated in that Executive Order and to the extent permitted by law, each agency must
Transparency	In order to implement Section 2 of this Order, each agency shall, in connection with every major rule, prepare, and to the extent permitted by law consider, a Regulatory Impact Analysis. Such Analyses may be combined with any Regulatory Flexibility Analyses performed under 5 U.S.C. 603 and 604. Except as provided in Section 8 of this Order, agencies shall prepare Regulatory Impact Analyses of major rules and transmit them, along with all notices.	Each agency shall draft its regulations to be simple and easy to understand, with the goal of minimizing the potential for uncertainty and litigation arising from such uncertainty.	The agency should add notes to the bottom of the tables that enable readers to interpret the information in the tables correctly. For example, when there is significant uncertainty to estimates, a caveat describing the nature of the uncertainty should be provided in the notes. A good regulatory analysis is designed to inform the public and other parts of the Government (as well as the agency conducting the analysis) of the effects of alternative actions. Regulatory analysis sometimes will show that a proposed action is misguided, but it can also demonstrate that well-conceived actions are reasonable and justified.	It must ensure that regulations are accessible, consistent, written in plain language, and easy to understand. It must measure, and seek to improve, the actual results of regulatory requirements. It must promote predictability and reduce uncertainty
Scientific Basis	Administrative decisions shall be based on adequate information concerning the need for and consequences of proposed government action;	Each agency shall base its decisions on the best reasonably obtainable scientific, technical, economic, and other information concerning the need for, and consequences of, the intended regulation.	The agency should use the best reasonably obtainable scientific, technical, economic, and other information to quantify the likely benefits and costs of each regulatory alternative. Presenting benefits and costs in physical units in addition to monetary units will improve the transparency of the analysis.	In applying these principles, each agency is directed to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible. It must be based on the best available science.

Consultation	Wherever feasible, agencies shall seek views of appropriate State, local, and tribal officials before imposing regulatory requirements that might significantly or uniquely affect those governmental entities. Each agency shall assess the effects of Federal regulations on State, local, and tribal governments, including specifically the availability of resources to carry out those mandates, and seek to minimize those burdens that uniquely or significantly affect such governmental entities, consistent with achieving regulatory objectives. In addition, as appropriate, agencies shall seek to harmonize Federal regulatory actions with related State, local, and tribal regulatory and other governmental functions.	seek out the opinions of those who will be affected by the regulation as well as the views of those individuals and organizations who may not be affected but have special knowledge or insight into the regulatory issues. Consultation can be useful in ensuring that your analysis addresses all of the relevant issues and that you have access to all pertinent data. Early consultation can be especially helpful. You should not limit consultation to the final stages of your analytical efforts.	It must allow for public participation and an open exchange of ideas.
Benefit Cost Analysis Principles			
Regulatory action shall not be undertaken unless the potential benefits to society from the regulation outweigh the potential costs to society;	Each agency shall assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs.	Regulatory analysis is a tool regulatory agencies use to anticipate and evaluate the likely consequences of rules. It provides a formal way of organizing the evidence on the key effects good and bad of the various alternatives that should be considered in developing regulations. The motivation is to (1) learn if the benefits of an action are likely to justify the costs or (2) discover which of various possible alternatives would be the most cost-effective.	propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify);
Agencies shall set regulatory priorities with the aim of maximizing the aggregate net benefits to society, taking into account the condition of the particular industries affected by regulations, the condition of the national economy, and other regulatory actions contemplated for the future.	[I]n choosing among alternative regulatory approaches, agencies should select those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity), unless a statute requires another regulatory approach.	At a minimum, agencies should compare, with their preferred option, a more stringent and less stringent alternative, and assess the benefits and costs of the three possibilities, with careful consideration of which achieves the greatest net benefits.	It must identify and use the best, most innovative, and least burdensome tools for achieving regulatory ends.
Unless covered by the description required under paragraph (4) of this subsection, an explanation of any legal reasons why the rule cannot be based on the requirements set forth in Section 2 of this Order.	In deciding whether and how to regulate, agencies should assess all costs and benefits of available regulatory alternatives, including the alternative of not regulating. Costs and benefits shall be understood to include both quantifiable measures (to the fullest extent that these can be usefully estimated) and qualitative measures of costs and benefits that are difficult to quantify, but nevertheless essential to consider	When quantification of a particular benefit or cost is not possible, it should be described qualitatively. The analysis of these alternatives may also consider, where relevant and appropriate, values such as equity, human dignity, fairness, potential distributive impacts, privacy, and personal freedom.	It must take into account benefits and costs, both quantitative and qualitative. Where appropriate and permitted by law, each agency may consider (and discuss qualitatively) values that are difficult or impossible to quantify, including equity, human dignity, fairness, and distributive impacts.

To permit each proposed major rule to be analyzed in light of the requirements stated in Section 2 of this Order, each preliminary and final Regulatory Impact Analysis shall contain the following information… A description of the potential benefits of the rule, including any beneficial effects that cannot be quantified in monetary terms, and the identification of those likely to receive the benefits	Each agency shall identify the problem that it intends to address (including, where applicable, the failures of private markets or public institutions that warrant new agency action) as well as assess the significance of that problem.	After identifying a set of potential regulatory approaches, the agency should conduct a benefit-cost analysis that estimates the benefits and costs associated with each alternative approach. The benefits and costs should be quantified and monetized to the extent possible, and presented in both physical units (e.g., number of illnesses avoided) and monetary terms.	Where appropriate and permitted by law, each agency may consider (and discuss qualitatively) values that are difficult or impossible to quantify, including equity, human dignity, fairness, and distributive impacts.
Regulatory Design			
Regulatory objectives shall be chosen to maximize the net benefits to society; Among alternative approaches to any given regulatory objective, the alternative involving the least net cost to society shall be chosen; and	When an agency determines that a regulation is the best available method of achieving the regulatory objective, it shall design its regulations in the most cost-effective manner to achieve the regulatory objective.	*Benefits and costs*. Agencies should identify the potential benefits and costs for each alternative and its timing. Once an agency identifies the least burdensome tool for achieving its regulatory objective, measuring the incremental benefits and costs of successively more stringent regulatory alternatives will allow an agency to identify the alternative that maximizes net benefits.	select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity);
A description of the potential costs of the rule, including any adverse effects that cannot be quantified in monetary terms, and the identification of those likely to bear the costs; A determination of the potential net benefits of the rule, including an evaluation of effects that cannot be quantified in monetary terms;	Each agency shall identify and assess alternative forms of regulation and shall, to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt. Each agency shall examine whether existing regulations (or other law) have created, or contributed to, the problem that a new regulation is intended to correct and whether those regulations (or other law) should be modified to achieve the intended goal of regulation more effectively. In setting regulatory priorities, each agency shall consider, to the extent reasonable, the degree and nature of the risks posed by various substances or activities within its jurisdiction.	To the extent feasible, agencies should specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt. It may be useful to identify the benefits and costs in the following manner: Benefits and costs that can be monetized, and their timing; Benefits and costs that can be quantified, but not monetized, and their timing; Benefits and costs that cannot be quantified. Whenever you report the benefits and costs of alternative options, you should present both total and incremental benefits and costs. In addition to the direct benefits and costs of each alternative, the list should include any important ancillary benefits and countervailing risks. Distributional effects. Transfer payments.	to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt; and

A description of alternative approaches that could substantially achieve the same regulatory goal at lower cost, together with an analysis of this potential benefit and costs and a brief explanation of the legal reasons why such alternatives, if proposed, could not be adopted; and	In doing so, each agency shall consider incentives for innovation, consistency, predictability, the costs of enforcement and compliance (to the government, regulated entities, and the public), flexibility, distributive impacts, and equity. Each agency shall identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public.	The agency should consider a range of potentially effective and reasonably feasible regulatory alternatives. The relevant alternatives might involve different approaches, with distinct advantages and disadvantages. In considering which alternatives to discuss, an agency should reasonably explore which approaches are feasible and plausible ways of meeting the regulatory objective. An agency should give particular attention to identifying and assessing flexible regulatory approaches, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public.	identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public.
	Each agency shall avoid regulations that are inconsistent, incompatible, or duplicative with its other regulations or those of other Federal agencies. Each agency shall tailor its regulations to impose the least burden on society, including individuals, businesses of differing sizes, and other entities (including small communities and governmental entities), consistent with obtaining the regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations. Each agency shall identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public.	The Presumption Against Economic Regulation: Government actions can be unintentionally harmful, and even useful regulations can impede market efficiency. For this reason, there is a presumption against certain types of regulatory action. price controls in competitive markets; production or sales quotas in competitive markets; • mandatory uniform quality standards for goods or services if the potential problem can be adequately dealt with through voluntary standards or by disclosing information of the hazard to buyers or users; or controls on entry into employment or production, except (a) where indispensable to protect health and safety or (b) to manage the use of common property resources.	tailor its regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations;

TABLE III-2: DETAILED ANALYTIC STEPS IN OMB CIRCULAR A-4

Define the Baseline: The baseline represents the agency's best assessment of what the world would be like absent the action. To specify the baseline, the agency may need to consider a wide range of factors and should incorporate the agency's best forecast of how the world will change in the future, with particular attention to factors that affect the expected benefits and costs of the rule. evolution of the market, changes in external factors affecting expected benefits and costs, changes in regulations promulgated by the agency or other government entities, and the degree of compliance by regulated entities with other regulations.

Set the Time Horizon of Analysis: When choosing the appropriate time horizon for estimating benefits and costs, agencies should consider how long the regulation being analyzed is likely to have economic effects. The time frame for the analysis should cover a period long enough to encompass all the important benefits and costs likely to result from the rule.

Quantify and Monetize the Benefits and Costs:

Willingness to Pay: This value is typically and most easily measured in terms of the amount of money the individual would pay ("willingness to pay" (WTP)) or require as compensation ("willingness to accept" (WTA)), so that the individual is indifferent between the current state of the world (baseline), on the one hand, and the consequences of the regulatory alternative along with the monetary payment, on the other hand. To the extent possible, agencies should estimate people's valuations of benefits and costs using revealed preference studies based on actual behavior. To the extent possible, agencies should estimate people's valuations of benefits and costs using revealed preference studies based on actual behavior.

Full Range of Effects: Agencies should include the following effects, where relevant, in their analysis and provide estimates of their monetary values: Private-sector compliance costs and savings; Government administrative costs and savings; Gains or losses in consumers' or producers' surpluses; Discomfort or inconvenience benefits and costs; and Gains or losses of time in work, leisure, and/or commuting/travel settings.

Evaluate Non-quantified and Non-monetized Benefits and Costs: Sound quantitative estimates of benefits and costs, where feasible, are preferable to qualitative descriptions of benefits and costs because they help decision-makers to understand the magnitudes of the effects of alternative actions and compare across different types of consequences.

Breakeven analysis. When quantification and monetization are not possible, many agencies have found it both useful and informative to engage in threshold or "breakeven" analysis. This approach answers the question, "How large would the value of the non-quantified benefits have to be for the rule to yield positive net benefits?"

Cost-effectiveness analysis. Cost-effectiveness analysis (CEA) can provide a helpful way to identify options that achieve the most effective use of the available resources (without requiring monetization of all of the relevant benefits and costs). Generally, cost-effectiveness analysis is designed to compare a set of regulatory actions with the same primary outcome (e.g., an increase in the acres of wetlands protected) or multiple outcomes that can be integrated into a single numerical index (e.g., units of health improvement).

Characterize uncertainty in benefits, costs, and net benefits: In developing an uncertainty analysis, agencies should follow these steps: *Specify potential scenarios*. *Calculate the benefits and costs associated with each scenario. Construct a range of values. Assign probabilities and calculate expected values*.

Alternative regulatory approaches. At a minimum, one or more tables should generally be used to report the benefits and costs of both the agency's preferred option and at least one alternative that is less stringent (i.e., lower cost) and one alternative that is more stringent (i.e., higher cost). For each of the regulatory alternatives, the agency should calculate benefits and costs relative to a common baseline.

Rank qualitative impacts. The agency should categorize or rank the qualitative effects in terms of their importance (e.g., certainty, likely magnitude, and reversibility). The agency should distinguish the effects that are likely to be significant enough to warrant serious consideration by decision-makers from those that are likely to be minor.

APPENDIX B:
ANNOTATED TABLES FOR EFFICIENCY GAP SECTION IV

LBNL Market Barriers to Energy Efficiency

Barriers[1]	Market Failures	Transaction Cost[2]	Behavioral factors[16]
Misplaced incentives	Externalities	Sunk costs[3]	Custom[17]
Agency[4]	Mis-pricing[20]	Lifetime[5]	Values[18] & Commitment[19]
Capital Illiquidity[8]	Public Goods[22]	Risk[6] & Uncertainty[7]	Social group & status[21]
Bundling	Basic research[23]	Asymmetric Info.[9]	Psychological Prospect[24]
Multi-attribute	Information	Imperfect Info.[10]	Ability to process info[27]
Gold Plating[11]	(Learning by Doing)[25]	Availability	Bounded rationality[26]
Inseparability[13]	Imperfect Competition/	Cost[12]	
Regulation	Market Power[28]	Accuracy	
Price Distortion[14]			
Chain of Barriers			
Disaggregated Mkt.[15]			

William H. Golove and Joseph H. Eto, *Market Barriers to Energy Efficiency: A Critical Reappraisal of the Rationale for Public Policies to Promote Energy Efficiency;*

1) Six market barriers were initially identified: 1) misplaced incentives, 2) lack of access to financing, 3) flaws in market structure, 4) mis-pricing imposed by regulation, 5) decision influenced by custom, and 6) lack of information or misinformation. Subsequently a seventh barrier, referred to as "gold plating," was added to the taxonomy (9).
2) Neo-classical economics generally relies on the assumption of frictionless transactions in which no costs are associated with the transaction itself. In other words, the costs of such activities as collecting and analyzing information; negotiating with potential suppliers, partners, and customers; and assuming risk are assumed to be nonexistent or insignificant. This assumption has been increasingly challenged in recent years. The insights developed through these challenges represent an important new way to evaluate aspects of various market failures (especially those associated with imperfect information). Transaction cost economics examines the implications of evidence suggesting that transaction costs are not insignificant but, in fact, constitute a primary explanation for the particular form taken by many economic institutions and contractual relations (22).
3) Transaction cost economics also offers support for claims that the illiquidity of certain investments leads to higher interest rates being required by investors in those investments (23).
4) Misplaced, or split, incentives are transactions or exchanges where the economic benefits of energy conservation do not accrue to the person who is trying to conserve (9).
5) Thus, as the rated lifetime of equipment increases, the uncertainty and the value of future benefits will be discounted significantly. The irreversibility of most energy efficiency investments is said to increase the cost of such investments because secondary markets do not exist or are not well-developed for most types of efficient equipment. This argument contends that illiquidity results in an option value to delaying investment in energy efficiency, which multiplies the necessary return from such investments (16)
6) If a consumer wishes to purchase an energy-efficient piece of equipment, its efficiency should reduce the risk to the lender (by improving the borrower's net cash flow, one component of credit-worthiness5) and should, but does not, reduce the interest rate, according to the proponents of the theory of market barriers. (p.10). Potential investors, it is argued, will increase their discount rates to account for this uncertainty or risk because they are unable to diversify it away. The capital asset pricing model (CAPM) is invoked to make this point (16).
7) Perfect information includes knowledge of the future, including, for example, future energy prices. Because the future is unknowable, uncertainty and risk are imposed on many transactions. The extent to which these unresolvable uncertainties affect the value of energy efficiency is one of the central questions in the market barriers debate. Of course, inability to predict the future is not unique to energy service markets. What is unique is the inability to diversify the risks associated with future uncertainty to the same extent that is available in other markets (20).
8) In practice, we observe that some potential borrowers, for example low-income individuals and small business owners, are frequently unable to borrow at any price as the result of their economic status or "credit-worthiness." This lack of access to capital inhibits investments in energy efficiency by these classes of consumers (10).
9) Finally, Williamson (1985) argues that the key issue surrounding information is not its public goods character, but rather its asymmetric distribution combined with the tendency of those who have it to use it opportunistically (23).
10) [K]nowledge of current and future prices, technological options and developments, and all other factors that might influence the economics of a particular investment. Economists acknowledge that these conditions are frequently not and in some cases can never be met. A series of information market failures have been identified as inhibiting investments in energy efficiency: (1) the lack of information, (2) the cost of information, (3) the accuracy of information, and (4) the ability to use or act upon information (20).
11) The notion of "gold plating" emerged from research suggesting that energy efficiency is frequently coupled with other costly features and is not available separately (11).
12) Even when information is potentially available, it frequently is expensive to acquire, requiring time, money or both (20).
13) Inseparability of features refers specifically to cases where availability is inhibited by technological limitations. There may be direct tradeoffs between energy efficiency and other desirable features of a product. In contrast to gold plating where the consumer must purchase more features than are desired, the inseparability of features demands purchases of lower levels of features than desired. (2)
14) The regulation barrier referred to mis-pricing energy forms (such as electricity and natural gas) whose price was set administratively by regulatory bodies (11).
15) On the cost-side of the equation, the critics contend that, among other things, information and search costs have typically been ignored or underestimated in engineering/economic analyses. Time and/or money may be spent: acquiring new information (search costs), installing new equipment, training operators and maintenance technicians, or supporting increased maintenance that may be associated with the energy

efficient equipment (p.16). [T]he class, itself, consists of a distribution of consumers: some could economically purchase additional efficiency, while others will find the new level of efficiency is not cost effective (13).

16) Discounted cash-flow, cost-benefit, and social welfare analyses use price as the complete measure of value although in very different ways; behavioral scientists, on the other hand, have argued that a number of "noneconomic" variables contribute significantly to consumer decision making (17).

17) [C]ustom and information have evolved significantly during the market barrier debate (11).

18) In the language of (economic) utility theory, the profitability of energy efficiency investments is but one attribute consumers evaluate in making the investment. The value placed on these other attributes may, in some cases, outweigh the importance of the economic return on investment (19).

19) [P]sychological considerations such as commitment and motivation play a key role in consumer decisions about energy efficiency investments (17).

20) Externalities refer to costs or benefits associated with a particular economic activity or transaction that do not accrue to the participants in the activity (18).

21) Other factors, such as membership in social groups, status considerations, and expressions of personal values play key roles in consumer decision-making (17). In order for a market to function effectively, all parties to an exchange or transaction must have equal bargaining power. In the event of unequal bargaining positions, we would expect that self-interest would lead to the exploitation of bargaining advantages (19).

22) Public goods are said to represent a market failure. It has been generally acknowledged by economists and efficiency advocates that public good market failures affect the energy services market. (19) [T]he creation of information is limited because information has public good qualities. That is, there may be limits to the creator's ability to capture the full benefits of the sale or transfer of information, in part because of the low cost of subsequent reproduction and distribution of the information, thus reducing the incentive to create information that might otherwise have significant value (20).

23) Investment in basic research in believed to be subject to this shortcoming; because the information created as a result of such research may not be protected by patent or other property right, the producer of the information may be unable to capture the value of his/her creation (19).

24) Important theoretical refinements to this concept, known as prospect theory, have been developed by Tversky and Kahneman (1981, 1986). This theory contends that individuals do not make decisions by maximizing prospective utility, but rather in terms of difference from an initial reference point. In addition, it is argued that individuals value equal gains and losses from this reference point differently, weighing losses more heavily than gains (21).

25) The information created by the adoption of a new technology by a given firm also has the characteristics of a public good. To the extent that this information is known by competitors, the risk associated with the subsequent adoption of this same technology may be reduced, yet the value inherent in this reduced risk cannot be captured by its creator (19).

26) This work is consistent with the notion of bounded rationality in economic theory. In contrast to the standard economic assumption that all decision makers are perfectly informed and have the absolute intention and ability to make decisions that maximize their own welfare, bounded rationality emphasizes limitations to rational decision making that are imposed by constraints on a decision maker's attention, resources, and ability to process information. It assumes that economic actors intend to be rational, but are only able to exercise their rationality to a limited extent (p.21).

27) Finally, individuals and firms are limited in their ability to use — store, retrieve, and analyze — information. Given the quantity and complexity of information pertinent to energy efficiency investment decisions, this condition has received much consideration in the market barriers debate (20).

28) This barrier suggests that certain powerful firms may be able to inhibit the introduction by competitors of energy-efficient, cost-effective products (10).

RFF Market and Behavioral Failures Relevant to Energy Efficiency

Societal Failures	***Structural Failures***	***Potential Behavioral Failures***[11]
Energy Market Failures	Capital Market Failures	Prospect theory[12]
Environmental Externalities[1]	Liquidity constraints[5]	Bounded rationality[13]
Energy Security	Information problems[6]	Heuristic decision making[14]
Innovation market failures	Lack of information[7]	Information[15]
Research and development spillovers[2]	Asymmetric info. >	
Learning-by-doing spillovers[3]	Adverse selection[8]	
Learning-by-using[4]	Principal-agent problems[9]	
	Average-cost electricity pricing[10]	

Source: Kenneth Gillingham, Richard G. Newell, and Karen Palmer, *Energy Efficiency Economics and Policy* (Resources for the Future, April 2009)

1) Externalities: the common theme in energy market failures is that energy prices do not reflect the true marginal social cost of energy consumption, either through environmental externalities, average cost pricing, or national security (9).

2) R&D spillovers may lead to underinvestment in energy-efficient technology innovation due to the public good nature of knowledge, whereby individual firms are unable to fully capture the benefits from their innovation efforts, which instead accrue partly to other firms and consumers (11).

3) Learning-by-doing (LBD) refers to the empirical observation that as cumulative production of new technologies increases, the cost of production tends to decline as the firm learns from experience how to reduce its costs (Arrow 1962). LBD may be associated with a market failure if the learning creates knowledge that spills over to other firms in the industry, lowering the costs for others without compensation.

4) Positive externalities associated with learning-by-using can exist where the adopter of a new energy-efficient product creates knowledge about the product through its use, and others freely benefit from the information generated about the existence, characteristics, and performance of the product (12).

5) Capital: Some purchasers of equipment may choose the less energy-efficient product due to lack of access to credit, resulting in underinvestment in energy efficiency and reflected in an implicit discount rate that is above typical market levels (13).

6) Information: Specific information problems cited include consumers' lack of information about the availability of and savings from energy-efficient products, asymmetric information, principal-agent or split-incentive problems, and externalities associated with learning-by-using (11).

7) Lack of information and asymmetric information are often given as reasons why consumers systematically underinvest in energy efficiency. The idea is that consumers often lack sufficient information about the difference in future operating costs between more-efficient and less-efficient goods necessary to make proper investment decisions (11).

8) Asymmetric information, where one party involved in a transaction has more information than another, may lead to adverse selection (11).

9) Agency: The principal-agent or split-incentive problem describes a situation where one party (the agent), such as a builder or landlord, decides the level of energy efficiency in a building, while a second party (the principal), such as the purchaser or tenant, pays the energy bills. When the principal has incomplete information about the energy efficiency of the building, the first party may not be able to recoup the costs of energy efficiency investments in the purchase price or rent charged for the building. The agent will then underinvest in energy efficiency relative to the social optimum, creating a market failure (12).

10) Prices faced by consumers in electricity markets also may not reflect marginal social costs due to the common use of average-cost pricing under utility regulation. Average-cost pricing could lead to under- or overuse of electricity relative to the economic optimum (10).

11) Systematic biases in consumer decision making that lead to underinvestment in energy efficiency relative to the cost-minimizing level are also often included among market barriers. (8); The behavioral economics literature has drawn attention to several systematic biases in consumer decision making that may be relevant to decisions regarding investment in energy efficiency. Similar insights can be gained from the literature on energy decision-making in psychology and sociology. The evidence that consumer decisions are not always perfectly rational is quite strong, beginning with Tversky and Kahneman's research indicating that both sophisticated and naïve respondents will consistently violate axioms of rational choice in certain situations (15).

12) The welfare change from gains and losses is evaluated with respect to a reference point, usually the status quo. In addition, consumers are risk averse with respect to gains and risk seeking with respect to losses, so that the welfare change is much greater from a loss than from an expected gain of the same magnitude (Kahneman and Tversky 1979). This can lead to loss aversion, anchoring, status quo bias, and other anomalous behavior (16).

13) Bounded rationality suggests that consumers are rational, but face cognitive constraints in processing information that lead to deviation from rationality in certain circumstances (16); Assessing the future savings requires forming expectations of future energy prices, changes in other operating costs related to the energy use (e.g., pollution charges), intensity of use of the product, and equipment lifetime. Comparing these expected future cash flows to the initial cost requires discounting the future cash flows to present values (3).

14) Heuristic decision-making is related closely to bounded rationality and encompasses a variety of decision strategies that differ in some critical way from conventional utility maximization in order to reduce the cognitive burden of decision-making. Tversky (1972) develops the theory of elimination-by-aspects," wherein consumers use a sequential decision-making process where they first narrow their full choice set to a smaller set by eliminating products that do not have some desired feature or aspect (e.g., cost above a certain level), and then they optimize among the smaller choice set, possibly after eliminating further products. (16) For example, for decisions regarding energy-efficient investments consumers tend to use a simple payback measure where the total investment cost is divided by the future savings calculated by using the energy price today, rather than the price at the time of the savings— effectively ignoring future increases in real fuel prices (p. 17). The salience effect may influence energy efficiency decisions, potentially contributing to an overemphasis on the initial cost of an energy-efficient purchase, leading to an underinvestment in energy efficiency. This may be related to evidence suggesting that decision makers are more sensitive to up-front investment costs than energy operating costs, although this evidence may also be the result of inappropriate measures of expectations of future energy use and prices (17).

15) Alternatively, information problems may occur when there are behavioral failures, so that consumers are not appropriately taking future reductions in energy costs into account in making present investments in energy efficiency (12).

UNIDO Barriers to Industrial Energy Efficiency

	Perspectives	**Barriers**
	Orthodox Economics	**Risk (1)**
		Access to capital (2)
Add information costs & opportunism		
	Agency theory	**Split Incentives (3)**
	Economics of information	**Imperfect & Asymmetric Information (4)**
Add bounded rationality &	**Transaction cost economics**	**Adverse Selection (5)**
broader concept of transaction cost		**Hidden Costs (7)**
Add biases, error and	**Behavioral Economics**	**Bounded Rationality (6)**
decision heuristics		**Inertia & Status Quo Bias (8)**
		Routine (9)

Steve Sorrell, Alexandra Mallett & Sheridan Nye. *Barriers to industrial energy efficiency, A literature review,* United Nations Industrial Development Organization, Vienna, 2011, Figure 3.1 & Section 3.

(1) Risk: The short paybacks required for energy efficiency investments may represent a rational response to risk. This could be because energy efficiency investments represent a higher technical or financial risk than other types of investment, or that business and market uncertainty encourages short time horizons.

(2) Access to capital: If an organization has insufficient capital through internal funds, and has difficulty raising additional funds through borrowing or share issues, energy efficient investments may be prevented from going ahead. Investment could also be inhibited by internal capital budgeting procedures, investment appraisal rules and the short-term incentives of energy management staff.

(3) Split incentives: Energy efficiency opportunities are likely to be foregone if actors cannot appropriate the benefits of the investment. Wide applicability… Landlord-tenant problems may arise in the industrial, public and commercial sectors through the leasing of buildings and office space. The purchaser may have a strong incentive to minimize capital costs, but may not be accountable for running costs…. maintenance staff may have a strong incentive to minimize capital costs and/or to get failed equipment working again as soon as possible, but may have no incentive to minimize running costs. If individual departments within an organization are not accountable for their energy use they will have no incentive to improve energy efficiency.

(4) Imperfect information: Lack of information on energy efficiency opportunities may lead to cost-effective opportunities being missed. In some cases, imperfect information may lead to inefficient products driving efficient products out of the market. Information on: the level and pattern of current energy consumption and comparison with relevant benchmarks; specific opportunities, such as the retrofit of thermal insulation; and the energy consumption of new and refurbished buildings, process plant and purchased equipment, allowing choice between efficient and inefficient options.

Asymmetric information exists where the supplier of a good or service holds relevant information, but is unable or unwilling to transfer this information to prospective buyers.

(5) Asymmetric information may lead to the adverse selection of energy inefficient goods.

(6) Hidden costs Engineering-economic analyses may fail to account for either the reduction in utility associated with energy efficient technologies, or the additional costs associated with them. As a consequence, the studies may overestimate energy efficiency potential. Examples of hidden costs include overhead costs for management, disruptions to production, staff replacement and training, and the costs associated with gathering, analyzing and applying information.

General overhead costs of energy management: employing specialist people (e.g., energy manager); energy information systems (including: gathering of energy consumption data; maintaining sub metering systems; analyzing data and correcting for influencing factors; identifying faults; etc.); energy auditing;

Costs involved in individual technology decisions: i) identifying opportunities; ii) detailed investigation and design; iii) formal investment appraisal; formal procedures for seeking approval of capital expenditures; specification and tendering for capital works to manufacturers and contractors additional staff costs for maintenance; replacement, early retirement, or retraining of staff; disruptions and inconvenience;

Loss of utility associated with energy efficient: problems with safety, noise, working conditions, service quality etc. (e.g., lighting levels); extra maintenance, lower reliability,

(7) Bounded rationality: Owing to constraints on time, attention, and the ability to process information, individuals do not make decisions in the manner assumed in economic models. As a consequence, they may neglect opportunities for improving energy efficiency, even when given good information and appropriate incentive consumers do not attempt to maximise their utility or producers their profits.

(8) Inertia and the status quo bias: Routines can be surprisingly persistent and entrenched. … This type of problem has been labeled *inertia* within the energy efficiency literature and identified as a relevant explanatory variable for the efficiency gap

(9) Routines as a response to bounded rationality the use of formal capital budgeting tools within investment decision-making. Other types of rules and routines which may impact on energy efficiency include: operating procedures (such as leaving equipment running or on standby); safety and maintenance procedures; relationships with particular suppliers; design criteria; specification and procurement procedures; equipment replacement routines and so on.

MCKINSEY AND COMPANY MARKET BARRIERS TO HOME ENERGY EFFICIENCY

Kckinsey Category	McKinsey Nature	McKinsey Description	Cluster
Behavioral	Awareness	Low priority, Preference for other attributes	CD, RLA
Availability	Availability	Restricted procurement, 1st cost focus	CD
Behavioral	Awareness	Shop for price and features	RD
Behavioral	Awareness	Limited understanding of use and savings	CEPB, EH, GB, RLA
Behavioral	Custom & Habit	Little attention at time of sale	NH
Behavioral	Custom & Habit	Underestimation of plug load	RD
Behavioral	Custom & Habit	Aversion to change	CI,
Behavioral	Custom & Habit	CFLS perceived as inferior	RLA
Behavioral	Hurdle	Payback-Hurdle, 28% discount rate	CEPB
Behavioral	Hurdle	Payback-Hurdle,40% discount rate	EH
Behavioral	Use	Improper use and maintenance	CEPB, EH, RD
Behavioral	Awareness	Not accountable for efficiency	CI
Availability	Capital	Competing use of capital	EH, GB, RLA, CI
Structural	Agency	Tenant pays, builder ignores	CEPB, EH, RD
Availability	Availability	Lack of contractors	EH
Availability	Availability	Lack of availability in area	NH
Availability	Availability	Lack of demand => lack of R&D	RD
Availability	Availability	Emergency replacement	RLA
Availability	Bundling	Efficiency bundled with other features	RLA
Structural	Owner Transfer	Lack of premium at time of sale	CD, NH, NPB, RLA
Structural	Owner Transfer	Limits payback to occupancy period	EH
Structural	Transaction	Lack of information	NPB
Structural	Transaction	Disruption during improvement process	EH
Structural	Transaction	Difficult to identify efficient devices	RD
Behavioral	Risk/Uncertainty	Business failure risk	CEPB
Behavioral	Risk/Uncertainty	Lack of reliability	CI
Structural	Transaction	Research, procurement and preparation	EH, GB, RLA

SOURCE:
McKinsey and Company, *Unlocking Energy Efficiency in the U.S. Economy,* July 2009, Tables 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, Exhibits 14, 15, 16, 19, 21, 24, 26, 27, 29, 30.

Clusters
CD = Commercial Devices;
CEPB = Commercial Existing Private Buildings;
CI = Commercial Infrastructure;
EH = Existing Homes;
GB = Government Buildings;
NH = New Homes;
NPB = New Private Commercial Buildings;
RD = Residential Devices;
RLA = Residential Lighting and Appliances

McKinsey Categories Defined:

Structural. These barriers arise when the market of environment makes investing in energy efficiency less possible or beneficial, preventing measures that would be NPV-positive from being attractive to an end-user:

Agency issues energy efficiency less possible or beneficial, preventing a measure that would be NPV misaligned between economic actors, primarily between landlord and tenant These barriers arise when the market or environment makes investing in (split incentives), in which energy bills and capital rights are

Ownership transfer issues, in which the current owner cannot capture the full duration of benefits, thus requiring assurance they can capture a portion of the future value upon transfer sufficient to justify upfront investment; this issue also affects builders and buyers… Because developers do not receive the future energy savings from efficient buildings and are often unaware or uncertain of the market premium energy efficient building can command, developers have little financial incentive to invest in energy efficiency above the required minimum.

"Transaction" barriers, a set of hidden "costs" that are not generally monetizable, associated with energy efficiency investment; for example, the investment of time to research and implement a new measure High transaction barriers arise as consumers incur significant time "costs" in researching, identifying, and procuring efficiency upgrades

Pricing distortions, including regulatory barriers that prevent savings from materializing for users of energy-savings devices.

Behavioral: These barriers explain why an end-user who is structurally able to capture a financial benefit still decides not to

Risk and uncertainty over the certainty and durability of measures and their savings generates an unfamiliar level of concern for the decision maker. Many operators are risk averse and put a premium on reliability; they may not be inclined to pursue energy efficiency activities for fear of disrupting essential services.

Lack of awareness, or low attention, on the part of end-users and decision makers in firms regarding details of current energy consumption patterns, potential savings, and measures to capture those savings. Homeowners typically do not understand their home energy consumption and are unaware of energy-saving measures.

Custom and habit, which can create inertia of "default choices" that must be overcome. Enduring lifestyle disruptions during the improvement process. End-users retain preconceived and often inaccurate ideas about differences in functionality that limit the acceptance of certain products.

Elevated hurdle rates, which translate into end-users seeking rapid pay back of investments - typically within 2 to 3 years. This expectation equates to a discount rate of 40 percent for investments in energy efficiency, inconsistent with the 7-percent discount rate they implicitly use when purchasing electricity (as embodied by the energy provider's cost of capital). It is beyond the scope of this report to evaluate the appropriate risk-adjusted hurdle rate for specific end-users, though it seems clear that the hurdle rates of energy delivery and energy efficiency are significantly different.

Availability: These barriers prevent adoption even for end-users who would choose to capture energy efficiency opportunities if they could

Adverse bundling or "gold plating," situations in which the energy efficient characteristic of a measure is bundled with premium features, or is not available in devices with desirable features of higher priority, and is therefore not selected

Capital constraints and access to capital, both access to credit for consumers and firms and (in industry and commerce) competition for resources internally within balance-sheet constraints. Energy efficiency projects may compete for capital with core business projects.

Product (and service) availability in the supply chain; energy efficient devices may not be widely stocked or available through customary purchasing channels, or skilled service personnel may not be available in a particular market

CONCEPTUAL SPECIFICATION FOR THE CLIMATE CHANGE ANALYSIS

Resources for The Future

EXTERNALITIES
Knowledge Externalities that are not captured by markets, a, *a*
Research and Development b
Importance of learning by searching c
Deployment: Importance of learning by doing c
Economics of Scale/returns to scale d
Network effects d

MARKET STRUCTURE:
Cost Structures: Long investment cycles, increasing returns to scale, network effects e, j, *b*
Challenge of creating new markets: Undifferentiated product i
Lack of competition hinders innovation *h*
Regulatory Risk g, j, *g, j, k, l, x*
Carbon tax level and permanence g
Fiscal policy *g*

ENDEMIC
Principle agent *w*
Shot-term view, g, i
Incomplete markets i

TRANSACTION COST
Uncertainty: as a cause of underinvestment *b, d, e,*
High risk premia on new technologies
Information: Value of information *d, f, r, s*
Sunk costs and embedded infrastructure

POLITICAL POWER
Monopolistic structures and lack of competition *u*

INERTIA:
Cost of Inertia 1

POLICY
Lack of leadership, *x*
Statutory, *k, l, o, p*

Oak Ridge

Causes of Carbon Lock-In

Business Innovation Risk/Cost Effectiveness and Fiscal Barriers
Technical risk
Volatile Energy Prices
Market risk
High up-front costs

Transaction Costs
Inadequate workforce/infrastructure
Misinformation
Imperfect information
Lack of specialized
Inadequate validation
Volatile Energy Prices

Policy Obstacles – Regulatory/ Statutory barriers
Unfavorable policy environment
Unfavorable regulation
Uncertain Regulations
Burdensome Permitting
Uncertain/Unfavorable fiscal policy
Misplaced incentives

Incumbent Support
Industry structure
Inadequate supply chain
Monopoly power

Sources:

Lower case letters (a) from Raymond J. Kopp and William A Pizer, *Assessing U.S. Climate Policy Options* (Washington, D.C.: November 2007)

Italicized Letters (a) are from Marylin A. Brown, et al., *Carbon Lock-In: Barriers to Deploying Climate Mitigation Technologies,* Oak ridge National Laboratory, January 2008.

a) Public Goods: Similarly, rationales for public support of technology demonstration projects tend to point to the… inability of private firms to capture the rewards for rewards for designing and constructing first-of-a-kind facilities. (p. 120)

(b) R&D tends to be underprovided in a competitive market because its benefits are often widely distributed and difficult to capture by individual firms…. economics literature on R&D points to the difficulty firms face in capturing all the benefits from their investments in innovation, which tend to spill over to other technology producers and users.. (pp. 118-120); In addition, by virtue of its critical role in the higher education system, public R&D funding will continue to be important in training researchers and engineers with the skill necessary to work in either the public or private sector to product GHG-reducing technology innovations (p. 120) … Generic public funding for research tends to receive widespread support based on significant positive spillovers that are often associated with the generation of new knowledge. (p. 136).

(c) Another potential rationale involves spillover effects that he process of so-called "learning-by-doing" – a term that describes the tendency for production costs to fall as manufacturers gain production experience." (p. 136)

(d) Network Effects: Network effects provide a motivation for deployment policies aimed at improving coordination and planning – and where appropriate, developing compatibility standards – in situations that involve interrelated technologies, particularly within large integrated systems (for example, energy productions, transmission, and distribution networks). Setting standards in a network context may reduce excess inertia (for example, the so-called chicken-and-egg problems with alternative fuel vehicles), while simultaneously reducing search and coordination costs, but standard scan also reduce the diversity of technology options offered and may impede innovation over time. (p. 137)

(e) Similarly, rationales for public support of technology demonstration projects tend to point to the large expense; high degree of technical, market and regulatory risk; and inability of private firms to capture the rewards for rewards for designing and constructing first-of-a-kind facilities. (p. 120)

(f) Finally, incomplete insurance markets may provide a rationale for liability protection or other policies for certain technology options (for example, long-term CO2 storage). (p. 137)

(g) Regulatory risk: Similarly, rationales for public support of technology demonstration projects tend to point to the… high degree of technical, market and regulatory risk. The problem of private-sector under investment in technology innovation may be exacerbated in the climate context where the energy assets involved are often very-long lives and where the incentives for bringing forward new technology rest heavily on domestic and international policies rather than natural market forces. Put another way, the development of climate-friendly technologies has little market value absent a sustained, credible government commitment to reducing GHG emissions. (p. 120)

(h) The mismatch between near-term technology investment and long-term needs is likely to be even greater in situation where the magnitude of desired GHG reductions can be expected to increase over time. If more stringent emissions constraint will eventually be needed, society will benefit from near-term R&D to lower the cost of achieving those reductions in the future. (p. 120)."

(i) Finally, incomplete insurance markets may provide a rationale for liability protection or other policies for certain technology options (for example, long-term CO2 storage, (p.137)."

(j) The problem of private-sector under investment in technology innovation may be exacerbated in the climate context where the energy assets involved are often very-long lives and where the incentives for bringing forward new technology rest heavily on domestic and international policies rather than natural market forces… "Put another way, the development of climate-friendly technologies has little market value absent a sustained, credible government commitment to reducing GHG emissions (p.12).

Cost-Effectiveness Barriers

a) External Benefits and Costs: External benefits of GHG-reducing technologies that the owners of the technologies are unable to appropriate (e.g., GHG emission reductions from substitutes for high GWP gases and carbon sequestration).

b) External costs associated with technologies using fossil fuels (e.g., GHG emissions and health effects from small particles) making it difficult for higher priced, GHG-reducing technologies to compete.

c) High Costs: High up-front costs associated with the production and purchase of many low carbon technologies; high operations and maintenance costs typical of first-of-a-kind technologies; high cost of financing and limited access to credit especially by low-income households and small businesses.

d) Technical Risks: Risks associated with unproven technology when there is insufficient validation of technology performance. Confounded by high capital cost, high labor/operating cost, excessive downtime, lack of standardization, and lack of engineering, procurement and construction capacity, all of which create an environment of uncertainty.

e) Market Risks: Low demand typical of emerging technologies including lack of long-term product purchase agreements; uncertainties associated with the cost of a new product vis-à-vis its competitors and the possibility that a superior product could emerge; rising prices for product inputs including energy feedstocks; lack of indemnification.

f) Lack of Specialized Knowledge: Inadequate workforce competence; cost of developing a knowledge base for available workforce; inadequate reference knowledge for decision makers.

Fiscal Barriers

g) Unfavorable Fiscal Policy: Distortionary tax subsidies that favor conventional energy sources and high levels of energy consumption; fiscal policies that slow the pace of capital stock turnover; state and local variability in fiscal policies such as tax incentives and property tax policies. Also includes various unfavorable tariffs set by the public sector and utilities (e.g., import tariffs for ethanol and standby charges for distributed generators) as well as unfavorable electricity pricing policies and rate recovery mechanisms.

h) Fiscal Uncertainty Short-duration tax policies that lead to uncertain fiscal incentives, such as production tax credits; uncertain future costs for GHG emissions.

Regulatory Barriers

i) Unfavorable Regulatory Policies: Distortionary regulations that favor conventional energy sources and discourage technological innovation, including certain power plant regulations, rules impacting the use of combined heat and power, parts of the federal fuel economy standards for cars and trucks, and certain codes and standards regulating the buildings industry; burdensome and underdeveloped regulations and permitting processes; poor land use planning that promotes sprawl.

j) Regulatory Uncertainty: Uncertainty about future regulations of greenhouse gases; uncertainty about the disposal of spent nuclear fuels; uncertain siting regulations for off-shore wind; lack of codes and standards; uncertainty regarding possible future GHG regulations.

Statutory Barriers

k) Unfavorable Statutory Policies: Lack of modern and enforceable building codes; state laws that prevent energy saving performance contracting.

l) Statutory Uncertainty: Uncertainty about future statutes including renewable and energy efficiency portfolio standards; unclear property rights relative to surface injection of CO_2, subsurface ownership of CO_2 and methane, and wind energy.

Intellectual Property Barriers

m) High Intellectual Property

n) Transaction Costs: High transaction costs for patent filing and enforcement, conflicting views of a patent's value, and systemic problems at the USPTO

o) Anti-competitive Patent Practices Techniques such as patent warehousing, suppression, and blocking.

p) Weak International Patent Protection: Inconsistent or nonexistent patent protection in developing countries and emerging markets.

q) University, Industry, Government Perceptions: Conflicting goals of universities, national laboratories, and industry concerning CRADAs and technology commercialization.

Other Barriers

r) Incomplete and Imperfect Information: Lack of information about technology performance – especially trusted information; bundled benefits and decision-making complexities;

s) High cost of gathering and processing information; misinformation and myths; lack of sociotechnical learning; and lack of stakeholders and constituents

t) Infrastructure Limitations: Inadequate critical infrastructure – including electric transmission capabilities and long-term nuclear fuel storage facilities; shortage of complementary technologies that encourage investment or broaden the market for GHG-reducing technologies; insufficient supply and distribution channels; lack of O&M facilities and other supply chain shortfalls

u) Industry Structure: Natural monopoly in utilities disenabling small-scale competition

v) Industry fragmentation slowing technological change, complicating coordination, and limiting investment capital.

w) Misplaced Incentives: Misplaced incentives when the buyer/owner is not the consumer/user (e.g., landlords and tenants in the rental market and speculative construction in the buildings industry) – also known as the principal-agent problem.

x) Policy Uncertainty: Uncertainty about future environmental and other policies; lack of leadership

APPENDIX C:
EMPIRICAL EVIDENCE SUPPORTING THE MARKET IMPERFECTION AND POLICY ANALYSIS

Schools of Thought/ Imperfection	Efficiency	Climate
<u>Traditional</u>		
Externalities		
Public goods & Bads	28, 55, a, b	24,132, 177, 197, ZL
Basic research/Stock of Knowledge		46, 37, N
Network effects	127,.ak	134, I
Learning-by-doing & Using	47, i	134, 105,120, 153 E
Localization		101, 153, 182, H
Industry Structure	122, 127, 163, 167	
Imperfect Competition		
Concentration	16, m	
Barriers to entry		
Scale	39, r	
Cost structure		44, 106, 134, I
Switching costs	165, t	
Technology	136, w	
R&D		90, 143, 15, E
Investment		
Marketing		
Bundling: Multi-attribute	162, 21, 116, z	
Cost-Price		
Limit impact of price	74, 116,, ac	
Sluggish Demand/Fragmented Mkt.		82, 97, 110, W
Limited payback	74, 165, ae	
<u>Behavioral</u>	117,133,144,149,159,173	
Motivation & Values	6, 10, h	39, ZM
Influence & Commitment		
Custom	145, 146	
Social group & status	6, h	97, ZN
Perception	13, al	
Bounded Vision/Attention	1,162, k	
Prospect/ Risk Aversion	151,165, l	
Calculation.		78, Z
Bounded rationality	10, 75, d, o	
Limited ability to process info	4, q	
Heuristic decision making	95, s	
Discounting difficulty	47,95,96,113,136, v	

Schools of Thought/ Imperfections	Efficiency	Climate
<u>Transaction Cost/ Institutional</u>		
Search and Information	88, 108	
Imperfect information	10, 100, n	19, 62, 90, U
Availability	10, 185, d	
Accuracy		
Search cost	41, 185, u	
Bargaining		
Risk & Uncertainty	32, 33, 165, t	42, 83, 103, 180, 188, R
Liability		
Enforcement		
Fuel Price		82, 134.
Sunk costs		83
Hidden cost	185, ab	106
High Risk Premia		106, T
Incomplete Markets		82, 97, 179
<u>Endemic Imperfections</u>		
Asymmetric Info		
Agency	72, 163, 185, c, ad	83, 193, Q
Adverse selection	41, e	79, 44, X
Perverse incentives	167, f	
Lack of capital		
<u>Political Power & Policy</u>		
Monopoly/lack of competition		101, 155, 187, 188, ZB
Incumbent power		182, ZA
Institutional support	167, af	
Inertia	136, ag	83, 1, 69, 106, M, V
Regulation	al	
Price	41, 88, 121, ah	
Aggregate, Avg.-cost	95, ai	
Allocating fuel price volatility		82, 98, 203, O
Permitting		
Lack of commitment	108, aj	83, 110, 156, 181,

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a. Macroeconomic: Edelstein and Killian, 2009, p. 13, [T]he cumulative effects on real consumption associated with energy price shocks are quantitatively important. We showed that the responses of real consumption aggregates are too large to reflect the effects of unanticipated change in discretionary income alone. Our analysis suggests that the excess response can be attributed to shifts in precautionary savings and to changes in the operating costs of energy using durables.

b. Committee On Health, Environmental, And Other External Costs And Benefits Of Energy Production And Consumption, **2011,** p. I, [D]espite energy's many benefits, most of which are reflected in energy market prices, the production, distribution, and use of energy also cause negative effects. Beneficial or negative effects that are not reflected in energy market prices are termed "external effects" by economists. In the absence of government intervention, external effects associated with energy production and use are generally not taken into account in decision making. When prices do not adequately reflect them, the monetary value assigned to benefits or adverse effects (referred to as damages) are "hidden" in the sense that government and other decision makers, such as electric utility managers, may not recognize the full costs of their actions. When market failures like this occur, there may be a case for government interventions in the form of regulations, taxes, fees, tradable permits, or other instruments that will motivate such recognition.

c. UNIDO, 2011, p. 19, Asymmetric information exists where the supplier of a good or service holds relevant information, but is unable or unwilling to transfer this information to prospective buyers. The extent to which asymmetric information leads to market failure will depend upon the nature of the good or service…. In contrast to energy commodities, energy efficiency may only be considered a search good when the energy consumption of a product is clearly and unambiguously labelled and when the performance in use is insensitive to installation, operation and maintenance conditions. But for many goods, the information on energy consumption may be missing, ambiguous or hidden, and the search costs will be relatively high. In the absence of standardised performance measures or rating schemes, it may be difficult to compare the performance of competing products. Taken together, these features tend to make energy efficiency closer to a *credence good* and hence more subject to market failure. Thus, to the extent that energy supply and energy efficiency represent different means of delivering the same level of energy service, the latter is likely to be disadvantaged relative to the former. The result is likely to be overconsumption of energy and under-consumption of energy efficiency.

d. Alcott, 2011, p. 1, Results show that beliefs are both highly noisy, consistent with imperfect information and bounded computational capacity, and systematically biased in manner symptomatic of "MPG illusion;" Alcott and Wozny, 2010.

e. Davis, 2010, p. 1; Extensive analysis of U.S. and global markets support the conclusion that this is an important impediment to greater energy efficiency of consumer durables. "The results show that, controlling for household income and other household characteristics, renters are significantly less likely to have energy efficient refrigerators, clothes washers and dishwashers."

f. UNIDO, 2011, p. 19, In some circumstances, asymmetric information in energy service markets may lead to the adverse selection of energy inefficient goods. Take housing as an example. In a perfect market, the resale value of a house would reflect the discounted value of energy efficiency investments. But asymmetric information at the point of sale tends to prevent this. Buyers have difficulty in recognising the potential energy savings and rarely account for this when making a price offer. Estate agents have greater resources than buyers, but similarly neglect energy efficiency when valuing a house. Since the operating costs of a house affect the ability of a borrower to repay the mortgage, they should be reflected in mortgage qualifications. Again, they are not. In all cases, one party (e.g., the builder or the seller) may have the relevant information, but transaction costs impede the transfer of that information to the potential purchaser. The result may be to discourage house builders from constructing energy efficient houses, or to discourage homeowners from making energy efficiency improvements since they will not be able to capture the additional costs in the sale price.

g. Ozaki and Sevastyanove, 2009.

h. Claudy and O'Dricoll, 2008, p. 11, "A growing body of literature around energy conservation contends that investment into energy efficiency measure is often motivated by "conviction" rather than "economics." Behavioral factors, including attitudes and values, explain a greater amount of variation in proenvironmental behaviour and provide valuable insights for policy makers and analysts."

i. Desroches, 2011, p. 1, Costs and prices generally fall in relations to cumulative production, a phenomenon known as experience and modeled as a fairly robust empirical experience curve… These experience curves… incorporated into recent energy conservation standards… impact on the national modeling can be significant, often increasing the net present value of potential standard levels… These results imply that past energy conservation standards analyses may have undervalued the economic benefits of potential standard levels.

j. UNIDO, 2011, p. iii, If an organization has insufficient capital through internal funds, and has difficulty raising additional funds through borrowing or share issues, energy efficient investments may be prevented from going ahead. Investment could also be inhibited by internal capital budgeting procedures, investment appraisal rules and the short-term incentives of energy management staff.

k. Alcott, 2009, p. 1. "I provide evidence to suggest that at least some of this effect is because consumers' attention is malleable and non-durable." UNIDO, pp. viii, Owing to constraints on time, attention, and the ability to process information, individuals do not make decisions in the manner assumed in economic models. As a consequence, they may neglect opportunities for improving energy efficiency, even when given good information and appropriate incentive consumers do not attempt to maximise their utility or producers their profits.

l. Sardiano, 2007, p. 1417, Decision making process to invest in energy efficiency improvement, like other investments, is a function of the behavior of individual or of various actors within the industrial firm. In this context, managerial attitudes toward energy conservation are also important factors… [E]nergy efficiency measures are often overlooked by management because it is not a core business activity and it is thus not worth much attention.

m. Blumstein, 2013, p. 5, [T]he existence of market power dampens the responsiveness of suppliers of goods or services to consumer demand, as actors in a monopolistic or oligopolistic setting can more or less set prices and quality attributes.

n. Atari, et. al., 2010, p. 1. For a sample of 15 activities, participants underestimated energy use and savings by a factor of 2.8 on average, with small overestimates for lower-energy activities and large, underestimates for high-energy activities.

o. Green, German and Delucchi, 2009, p. 203; "The uncertainty/loss aversion model of consumers' fuel economy decision making implies that consumers will undervalue expected future fuel savings to roughly the same degree as manufacturers' perception that consumers demand short payback periods."

p. UNIDO, 2011, p. iii, Lack of information on energy efficiency opportunities may lead to cost-effective opportunities being missed. In some cases, imperfect information may lead to inefficient products driving efficient products out of the market. Information on: the level and pattern of current energy consumption and comparison with relevant benchmarks; specific opportunities, such as the retrofit of thermal insulation; and the energy consumption of new and refurbished buildings, process plant and purchased equipment, allowing choice between efficient and inefficient options.

q. Atari, et. al., 2010, p. 1. For a sample of 15 activities, participants underestimated energy use and savings by a factor of 2.8 on average, with small overestimates for lower-energy activities and large, underestimates for high-energy activities."

r. Montalvo, 2007, p. S10, Due to the size of investment and longevity or production processes it is very likely that the diffusion of new processes will occur in an incremental way.

s. Ito, 2010, p. 1, Evidence from laboratory experiments suggests that consumers facing such price schedules may respond to average price as a heuristic. I empirically test this prediction using field data.

t. Sardianou, 2007, p. 1419, Our empirical results also confirm that organizational constraints and human related factors can be thought of as barriers in incorporating the energy saving technology in incorporating the energy saving technology in the existing production process.

u. Sardianou, 2007, p. 1419, Having limited information with regard to energy conservation opportunities and their profitability is considered an obstacle…. Other possible barriers include lack of documentation of energy data.

v. Kurani and Turrentine, 2004, p. 1, One effect of limited knowledge is that when consumers buy a vehicle, they do not have the basic building blocks of knowledge to make an economically rational decision. When offered a choice to pay more for better fuel economy, most households were unable to estimate potential savings, particularly over periods of time greater than one month. In the absence of such calculations, many households were overly optimistic about potential fuel savings, wanting and thinking they could recover an investment of several thousand dollars in a couple of years.

w. Montalvo, 2007, p. A10, Finally, firms face the challenge of technological risk. The gains promised by new technologies have yet to materialize, a situation that contrasts strongly with the perceived reliability of the current, familiar operating process. In the literature on technology management it has been established that adoption or development of new production processes implies the capacity to integrate new knowledge and large organizational change.

x. UNIDO, 2011, p. iii, The short paybacks required for energy efficiency investments may represent a rational response to risk. This could be because energy efficiency investments represent a higher technical or financial risk than other types of investment, or that business and market uncertainty encourages short time horizons.

y. Montalvo, 2007, p. s10, Closely related to these technological opportunities are the firm and sector level capabilities to actually adopt new technologies. It has been reported that insufficient availability of expertise in clear production (eco-design) the current training and clean technology capacity building at the sector level and the insufficient understanding and experience in cleaner production project development and implementation, play a role in the adoption of new cleaner production processes. These factors can be expected to become even more critical at the level of small- and medium sized enterprises..

z. Gabaix and Laibson, 2005, p. 1; "We show that information shrouding flourishes even in highly competitive markets, even in markets with costless advertising, and even when the shrouding generation allocational inefficiencies." Hosain and Morgan, Brown, Hossain and Morgan

aa. Sallee, 2012, "The possibility of rational inattention has two key implications. First, if consumers rationally ignore energy efficiency, this could explain the energy paradox. In equilibrium, firms will underprovide energy efficiency if consumers ignore it. If true, this would qualitatively change the interpretation of empirical work on the energy paradox. Most empirical work tests for the rationality of consumer choice across goods that are actually sold in the market. If rational inattention leads to an inefficiency set of *product offerings* (emphasis added), consumer might choose rationally among goods in equilibrium but a paradox still exists. Second, if consumers are rationally inattentive to energy efficiency, this could provide direct justification for regulatory standards and "no tech policies, such as the Energy Star Label System."

ab. UNIDO, 2011, p. iii, Hidden costs Engineering-economic analyses may fail to account for either the reduction in utility associated with energy efficient technologies, or the additional costs associated with them. As a consequence, the studies may overestimate energy efficiency potential. Examples of hidden costs include overhead costs for management, disruptions to production, staff replacement and training, and the costs associated with gathering, analyzing and applying information. General overhead costs of energy management: employing specialist people (e.g., energy manager); energy information systems (including: gathering of energy consumption data; maintaining sub metering systems; analyzing data and correcting for influencing factors; identifying faults; etc.); energy auditing; Costs involved in individual technology decisions: i) identifying opportunities; ii) detailed investigation and design; iii) formal investment appraisal; formal procedures for seeking approval of capital expenditures; specification and tendering for capital works to manufacturers and contractors additional staff costs for maintenance; replacement, early retirement, or retraining of staff; disruptions and inconvenience; Loss of utility associated with energy efficient: problems with safety, noise, working conditions, service quality etc. (e.g., lighting levels); extra maintenance, lower reliability.

ac. Li, Timmins and von Haefen, 2009, "we are able to decompose the effects of gasoline prices on the evolution of the vehicle fleet into changes arising from the inflow of new vehicles and the outflow of used vehicles. We find that gasoline prices have statistically significant effects on both channels, but their combined effects results in only modest impacts on fleet fuel economy. The short-run and long-run elasticities of fleet fuel economy with respect to gasoline prices are estimated at 0.022 and 0.204 in 2005. "

ad. Committee to Assess Fuel Economy, 2010, p. 2, The [Medium and Heavy Duty] truck world is more complicated. There are literally thousands of different configurations of vehicle including bucket trucks, pickup trucks, garbage trucks, delivery vehicles, and long-haul trailers. Their duty cycles vary greatly… the party responsible for the final truck configuration is often not well defined.

ae. Sardianou, 2007, p. 1419, The lack of access to capital (76%) and the slow rate of return (74%) of energy savings investments are categorized as barriers.

af. UNIDO, 2011, p. iii, Routines as a response to bounded rationality the use of formal capital budgeting tools within investment decision-making. Other types of rules and routines which may impact on energy efficiency include: operating procedures (such as leaving equipment running or on standby); safety and maintenance procedures; relationships with particular suppliers; design criteria; specification and procurement procedures; equipment replacement routines and so on.

ag. Montalvo, 2007, A11, organization capabilities refer to the firm's endowments and capabilities to carry out innovation… When the knowledge is not present in the firm adoption will depend on the firm's capacity to overcome shill lock-in, and to unlearn and acquire new skills. UNIDO, Inertia and the status quo bias: Routines can be surprisingly persistent and entrenched. … This type of problem has been labeled inertia within the energy efficiency literature and identified as a relevant explanatory variable for the efficiency gap.

ah. Sardianou, 2007, p. 1419, Uncertainty about future energy prices (62%) is also characterized as a barrier [leading] to the postponement of energy efficiency measures.

ai. Ito, 2010, p. 1, I find strong evidence that consumers respond to average price rather than marginal or expected marginal price.

aj. UNIDO, 2011, p. 67, The government does not give financial incentives to improve energy efficiency, Lack of coordination between different government agencies, Lack of enforcement of government regulations, There is a lack of coordination between external organizations; Sardianou, 2007, p. 1402, [B]ureaucratic procedure to get government financial support is a barrier to energy efficiency improvements for the majority (80%) of industries.

aj. Consumers Union, 2012, p. 8, "this suggests that many consumers are misinformed about the program

ak. Lutzenheiser, et al., (2001, cited in Blumstein, 2013), p. viii, The commercial building "industry" is in fact a series of linked industries arrayed along a "value chain" or "value stream" where each loosely coupled link contributes value to a material building in process. Each link, while aware of the other links in the process, is a somewhat separate social world with its own logic, language, actors, interests, and regulatory demands. For the most part "upstream" actors constrain the choices and actions of "downstream" actors.

al. Jessoe and Rapson, 2013, p. 34, These results confirm the practical importance of one of economics' most ubiquitous assumptions – that decision makers have perfect information. Indeed, the absence of perfect information is likely to cause substantial efficiency loses both in this setting and others in which quantity is also infrequently or partially observed by decision makers.

CLIMATE CHANGE ANALYSIS

A Walz, Schleich and Ragwitz, 2011, p. 16, Power prices, however, are not found to drive patent activity. Hence power prices alone would likely not be sufficient to spur innovation activities in wind and arguably also other, currently less cost-efficient renewable technologies.

B The stability and long-term vision of policy target setting are important policy style variables, which contribute to the legitimacy of technology and provide guidance of search…

C Calel and Dechezloprete, 2012, p. 1. "[M]ore refined estimates that combine matching methods with different-in-difference provide evidence that the EU ETS has not impacted the direction of technological change. This finding appears to be robust to a number of stability and sensitivity checks. While we cannot completely rule out the possibility that the EU ETS has impacted only large companies for which suitable unregulated comparators cannot be found, our findings suggest that the EU ETS so far has had at best a very limited impact on low-carbon technological change.

E Massetti and Nicita, 2010, p. 17, We find that a [carbon] stabilization policy together with an R&D policy targeted at the only energy sector is significantly less costly than the stabilization policy alone. We find that energy R&D does not crowd-out non-energy R&D, and thanks to intersectoral spillovers, the policy induced increase in energy efficiency R&D spills over to the non-energy sector, contributing to knowledge accumulation and the reduction of knowledge externalities.

G Qui and Anadon, pp. 782, The size of the wind farm is another significant factor in all specifications… indicate that a doubling in wind farm size could lead to price reductions of about 8.9%.

H Qui and Anadon, pp. 782, Localization rate is a significant factor in all specifications… indicate that a doubling of localization rate was associated with reductions in wind electricity price ranging from 10.9% to 11,4%.

I de Cian and Massimo, 2011, p. 123, Uncertainty and irreversibility are two features of climate change that contribute to shape the decision-making process. Technology cost uncertainty can depress the incentive to invest. The risk of underinvestment is even more severe considering that energy infrastructure has a slow turnover. Capital irreversibility and uncertainty heighten the risk of locking into existing fossil-fuel-based technologies. Additional investments are sunk costs that increase the opportunity cost of acting now… The result is reinforced when uncertain costs have a large variance, showing that investments decrease with risk. Jamasb and Nicita, (2007, p 8) R&D activity can be subject to three main types of market failure namely indivisibility, uncertainty and externalities.

K Gross, et al. 2012, p. 18, In the energy sector, such "network externalities" rise for example in the physical structures of large scale high voltage alternating current (AC) power grids themselves (themselves a reminders of early energy planners' desire to locate power stations close to the source of coal) which now provides a cost advantage to large scale centralized station over distributed alternatives.

M Grimaud and Lafforgue, 2008, p. 1…20,The main results of the paper are the following: i) both a carbon tax and a green research subsidy contribute to climate change mitigation; ii) R&D subsidies have a large impact on the consumption, and then social welfare, as compared to the carbon tax alone; IV) those subsidies allow to spare the earlier generations who are, on the other hand, penalized by a carbon tax….In a second-best world, a carbon tax used alone leads to a higher social cost (with respect to first-best) than a research policy alone;

N Jamasb and Kohler, 2007, p. 9, Information technology and pharmaceuticals, for example, are both characterized by high degrees of innovation, with rapid technological change financed by private investment amounting typically to 10-20% of sector turnover. This is in dramatic contrast with power generation, where a small number of fundamentals technologies have dominated for almost a century and private sector RD&D has fallen sharply with privatization of energy industries to the point where it is under 0.4% of turnover.

O Gross, et al., 2012, p. 14, Capital intensive, zero fuel cost power stations like wind farms, need to cover their long run average costs—namely the cost of capital. They can neither actively affect/set marginal power prices nor respond to power price changes, except to curtail output, which does not save costs (as there are no fuel cost to save), but does lose revenue. However, carbon prices only affect the marginal price of fuel and power. We should therefore expect that an emissions trading scheme will encourage fuel switching from coal to gas, and efficiency first and renewable energy (or indeed nuclear) investment last. This is exactly what we have seen in reality.

Q Gross, 210, p. 802, "A range of factors that relate to the amount and quality of information about technology costs and risks available to policymakers and market participants are relevant when considering incentives and investment in new technologies: Policymakers may have relatively poor information about costs for emerging technologies. 'Appraisal optimism' (where technology/project developers under estimate the cost of unproven technology/systems) is a common feature in the development of new technologies. When providing cost data to policymakers technology developers or equipment suppliers may also have incentives to up or play down costs and potential according to circumstances. Where new or unproven technologies are being utilized for the first time, information about costs may be limited for all concerned... There may be an 'option value' to potential investors in waiting (delaying investment) where there is poor information and high levels of technology and market risk. The first conclusion is that policymaking in the energy area needs new tools of analysis that can deal with the market risks associated with policy design… In particular, policymakers need to be mindful of the role of revenue risk as well as cost risk in the business case for investment.

R Fuss and Szolgayosva, 2010, p.2938, We find that the uncertainty associated with the technological progress of renewable energy technologies leads to a postponement of investment. Even the simultaneous inclusion of stochastic fossil fuel prices in the same model does not make renewable energy competitive compared to fossil-fuel-fired technology in the short run based on the data used. This implies that policymakers have to intervene if renewable energy is supposed to get diffused more quickly. Otherwise, old fossil-fuel-fired equipment will be refurbished or replaced by fossil-fuel-fired capacity again, which enforces the lock-in of the current system into unsustainable electricity generation..

T Gross, Blyth and Heponstall, 2012, p. 802.The first conclusion is that policymaking in the energy area needs new tools of analysis that can deal with the market risks associated with policy design… In particular, policymakers need to be mindful of the role of revenue risk as well as cost risk in the business case for investment.

U Horbach, 2007, p. 172, Environmental management tools help to reduce the information deficits to detect cost savings (especially material and energy savings) that are an important driving force of environmental innovation.

V Weyant, 2011, p. 677, The infrastructure for producing, distributing, and promoting the industries' current products require large investments that have already been incurred.

W Jamasb and Kohler, 2007, Thus, the 'market pull' forces reach deep into the innovation chain…This is in contrast with power generation, where a small number fundamental and private sector RD&D has fallen sharply with privatization of energy industries. technologies have dominated for almost a century and private RD&D has fallen sharply with privatization... In turn, market pull measures are devised to promote technical change by creating demand and developing the market for new technologies.

X Weyant, 2011, p. 675, The situation can develop from several different types of market failure, including poor or asymmetric information available to purchasers, limits on individual's ability to make rational decisions because of time or skill constraints, principle agent incongruities... and lack of financing opportunities.

Z Green, 2010, p. 6, The rational economic consumer considers fuel saving over the full life of a vehicle, discounting future fuel savings to present value. This requires the consumer to know how long the vehicle will remain in operation; he distances to be traveled in each future year, the reduction in the rate of fuel consumptions, and the future price of fuel…. The consumer must also estimate the fuel economy that will be achieved in real world driving based on the official estimate. Finally, the consumer must know how to make a discounted present value calculation, or must know how to obtain one… The utility-maximizing rational consumer has fixed preferences, possesses all complete and accurate information about all relevant alternatives, and has all the cognitive skills necessary to evaluate the alternatives. These are strict requirements indeed….

ZA Nicolli and Vona, p. 1, Our empirical results are consistent with predictions of political-economy models of environmental policies as lobbying, income and to a less extent, inequality have expected effects on policy. The brown lobbying power, proxied by entry barriers in the energy sector, has negative influence on the policy indicators even when taking into account endogeneity in its effect. The results are also robust to dynamic model specifications and to the exclusion of groups of countries

ZB Weyant, 2011, p. 677, Further complicating matters, existing companies in energy-related industries --- those that produce energy, those that manufacture the equipment that produces, converts and uses energy, and those that distribute energy – can have substantial incentives to delay the introduction of new technologies. This can happen if their current technologies are more profitable than the new ones that might be (or have been) invented, or if they are in explicitly (oil and gas) or implicitly (electric generation equipment producers and automakers) oligopolistic structured, or if they are imperfectly regulated (electric and gas utilities). The incentive arises partly because the infrastructure for producing, distributing, and promoting the industries' current products require large investments that have already been incurred.

ZC Horbach, 2008, p. 172, An environmentally oriented research policy has not only to regard traditional instruments like the improvement of the technological capabilities of a firm but also the coordination with soft environmental policy instruments like the introduction of environmental management systems.

ZE Wilson, et al., p. 781, The institutions emphasized in our analytic framework are twofold: the propensity of entrepreneurs to invest in risky innovation activities with uncertain pay-offs; and shared expectation around an innovation's future trajectory. Other important and related institutions include law, markets and public policy. Public resources are invested directly into specific innovation stages, or are used to leverage private sector resources through regulatory or market incentives structured by public policy…. New technologies successfully diffuse as a function of their relative advantage over incumbent technologies. For energy technologies, this can be measured by the difference in cost and performance of energy service provision in terms of quality, versatility, environmental impact and so on. Many of these attributes of relative advantage can be shaped by public policy as well as the other elements of the innovation system.

ZF Walz, Schleich and Ragwitz, 2011, p. 5, The specific advantage of feed-in tariffs is seen in lower transaction costs and reduced risk perception for investors and innovators, which are extremely important especially for new entrants and for financial institutions.

ZH Walz, Schleich and Ragwitz, 2011, p. 16, Our econometric analyses also imply that the existence of targets for renewables/wind and a stable policy support environment are associated with higher patent activity.

ZLMaxim, 2014, 284, Measuring the sustainability of the energy sector has evolved around three main dimensions: environmental, economic and social.

ZMCroson, 2014, 336, This literature has often discussed how traditional policy instruments (like taxes), or traditional methods (like cost-benefit analysis), can be affected by behavioral concerns, including taxes crowding out public good contributions or the impact of hyperbolic discounting or reference dependent preferences on environmental policy. This research which integrates human limitations into environmental economics is refreshing, and shows great promise. Scholars, policy makers and politicians have enthusiastically embraced this research. One reason may be the increasing awareness of environmental problems, and of the evident difficulty in solving these problems using traditional instruments. Another reason may be the low cost of many behavioral interventions. An additional, more concealed, reason may be a general distrust in the market system and classical economics by individuals in these positions.

ZO Cordes and Schwesinger, 2014, passim, Proposition 1. Preference acquisition processes based upon social learning can override a technology's relative cost and/or hedonistic disadvantages and therefore lead to its diffusion in a population of interacting adopters…Proposition 2. If a dedicated cultural rolemodel takes effect in consumers' preference learning during certain critical time spans or "windows of opportunity", it can persistently promote the diffusion of a green technology…Proposition 3. State regulation that temporarily creates a niche for a green technology by preventing competitive impacts of other technologies can help decreasing its cost or hedonistic disadvantages by gaining adopters in the niche market. Subsequently, a technology can be able to diffuse further even after the removal of this kind of governmental protection… Proposition 4. Environmental policy instruments that comprise the promotion of "green preferences" via social learning in combination with measures to lower relative cost disadvantages can be expected to be more efficient and effective as to the fostering of a green technology's diffusion in a population of interacting adopters.

ZP Spence, et al., 2015, 550, We show that, although cost is likely to be a significant reason for many people to take up DSM measures, those concerned about energy costs are actually less likely to accept DSM. Notably, individuals concerned about climate change are more likely to be accepting. A significant proportion of people, particularly those concerned about affordability, indicated unwillingness or concerns about sharing energy data, a necessity for many forms of DSM. We conclude substantial public engagement and further policy development is required for widespread DSM implementation.

ZQ Zinaman, 2015, pp. 113…125, Rapid cost reductions—for example, of photovoltaic modules—have changed the economic landscape for what is feasible. Yet established asset bases, and their supporting business models and regulatory frameworks, still retain significant inertia in most power systems. These longstanding financial and institutional ''legacy'' arrangements promote incremental change…Whether the trends outlined in Section II are ''headwinds'' or ''tailwinds'' will depend on the orientation set by decisionmakers for their power systems. Policymakers and regulators can choose to let these external forces determine how power systems unfold, or they can promote policies and build regulatory and finance frameworks that drive the transformation toward a desired vision. As a final organizing principle, early and frequent stakeholder engagement will encourage the emergence of modern power systems that accommodate a broad set of interests and best serve citizens and energy customers.

ZR Zinaman, 2015, passim, Trends: Ten Trends: Renewable energy cost reductions, Innovations in data, intelligence, and system optimization, Energy security, reliability, and resilience goals, Evolving customer engagement, Bifurcated energy demands, Increased interactions with other sectors, Local and global environmental concerns over air emissions, Energy access imperatives, Increasingly diverse participation in power markets, Revenue and investment challenges. Power Sector Finance: Regulations on commercial banking risk, Risk-premium environment for investments, Interest rates on government bonds, Capital availability from development authorities, Tax structures, Credit rating of electric utilities, Price and availability of inputs, Market structure and valuation constructs, Policy and regulatory environment.

ZS Fratzscher, 2015, p. III, Utilities are experiencing an unprecedented change in their operating environment, which requires a broad reinvention of business models. Historically, a centralized and grid-connected power generation structure positioned utilities in the center of the power system, with a culture focused on regulators and mandates rather than innovation and customer service expectations. This utility business model is now profoundly questioned by the accelerated deployment of distributed energy resources and smart grid technologies, as well as profound changes in market economics and regulatory frameworks. This is a global trend, to which utilities and regulators around the world seek to find adequate solutions.

ZT Eichman, Joshua D., 2013, p.353 Three renewable deployment strategies are explored including all wind, all solar photovoltaic, and 50/50 mixture. Initially, wind is the preferred candidate from a cost and required installed capacity perspective; however, as the penetration increases excess wind generation encourages installation of solar. The 50/50 case becomes more cost competitive at high renewable penetrations (greater than 32.4%) and provides the highest system-wide capacity factor and CO2 reduction potential. Results highlight the value of optimizing the renewable deployment strategy to minimize costs and emphasize the importance of considering capacity factor and curtailment when representing the true cost of installing renewables.

ZU Yun Yang, Yun, Shijie Zhang, and Yunhan Xiao, 2015, p. 433, The introduction of energy distribution networks and/or storages has significant and similar effects on optimal system configuration and can improve the system's economic efficiency because of the elimination of some of the strong coupling relation between demands and generators.

ZZ Friebe, 2014, pp. 223-224, In fact, our qualitative results underline that in emerging markets Feed-in-Tariffs combined with guaranteed grid access are even more important than in industrialized countries. Both mechanisms considerably reduce comparatively high investment risk, which is typical for emerging countries… Our results show that in emerging markets – in addition to technology-specific factors – generic influencing factors such as transparency and legal security for international private sector organizations must be considered. We add to the (renewable) energy policy literature, which focuses on policy formulation, by emphasizing these implementation factors for emerging markets.

ZAA Green, German and Delucchi, 2009, p. 203; This suggests that increasing fuel prices may not be the most effective policy for increasing the application of technologies to increase passenger and light truck fuel economy. This view is supported by the similar levels of technology applied to U.S. and European passenger cars in the 1990s, despite fuel prices roughly three times higher in Europe. It is also circumstantially supported by the adoption by governments around the world of regulatory standard for light-duty vehicle fuel economy and carbon dioxide emissions.

ZAD Lizal, 2014, p. 114, Producers could, however, withhold part of production facilities (i.e., apply a capacity cutting strategy) and thereby push more expensive production facilities to satisfy demand for electricity. This behavior could lead to a higher price determined through a uniform price auction. Using the case of the England and Wales wholesale electricity market we empirically analyze whether producers indeed did apply a capacity cutting strategy. For this purpose we examine the bidding behavior of producers during high- and low-demand trading periods within a trading day. We find statistical evidence for the presence of capacity cutting by several producers, which is consistent with the regulatory authority's reports.

APPENDIX D:
BEHAVIORAL CONSTRUCTS AND COGNITIVE BIASES

Name	Description
Theoretical Causes/Construct	
Bounded rationality	limits on optimization and rationality
Prospect theory	
Mental accounting	
Adaptive bias	basing decisions on limited information and biasing them based on the costs of being wrong.
Attribute substitution	making a complex, difficult judgment by unconsciously substituting it by an easier judgment[114]
Attribution theory	
Salience	
Naïve realism	
Cognitive dissonance, and related:	
Impression management	
Self-perception theory	
Heuristics in judgment and decision making, including:	
Availability heuristic	estimating what is more likely by what is more available in memory, which is biased toward vivid, unusual, or emotionally charged examples[50]
Representativeness heuristic	judging probabilities on the basis of resemblance[50]
Affect heuristic	basing a decision on an emotional reaction rather than a calculation of risks and benefits[115]
Some theories of emotion such as:	
Two-factor theory of emotion	
Somatic markers hypothesis	
Introspection illusion	
Misinterpretations or misuse of statistics; innumeracy.	
Specific Behavioral Effects https://en.wikipedia.org/wiki/List_of_cognitive_biases	
Ambiguity effect	The tendency to avoid options for which missing information makes the probability seem "unknown".[10]
Anchoring or focalism	The tendency to rely too heavily, or "anchor", on one trait or piece of information when making decisions (usually the first piece of information acquired on that subject)[11][12]
Anthropomorphism or personification	The tendency to characterize animals, objects, and abstract concepts as possessing human-like traits, emotions, and intentions.[13]
Attentional bias	The tendency of our perception to be affected by our recurring thoughts.[14]
Automation bias	The tendency to depend excessively on automated systems which can lead to erroneous automated information overriding correct decisions.[15]

Availability heuristic	The tendency to overestimate the likelihood of events with greater "availability" in memory, which can be influenced by how recent the memories are or how unusual or emotionally charged they may be.[16]
Availability cascade	A self-reinforcing process in which a collective belief gains more and more plausibility through its increasing repetition in public discourse (or "repeat something long enough and it will become true").[17]
Backfire effect	The reaction to disconfirming evidence by strengthening one's previous beliefs.[18] cf. Continued influence effect.
Bandwagon effect	The tendency to do (or believe) things because many other people do (or believe) the same. Related to groupthink and herd behavior.[19]
Base rate fallacy or Base rate neglect	The tendency to ignore base rate information (generic, general information) and focus on specific information (information only pertaining to a certain case).[20]
Belief bias	An effect where someone's evaluation of the logical strength of an argument is biased by the believability of the conclusion.[21]
Ben Franklin effect	A person who has performed a favor for someone is more likely to do another favor for that person than they would be if they had *received* a favor from that person.
Berkson's paradox	The tendency to misinterpret statistical experiments involving conditional probabilities.
Bias blind spot	The tendency to see oneself as less biased than other people, or to be able to identify more cognitive biases in others than in oneself.[22]
Cheerleader effect	The tendency for people to appear more attractive in a group than in isolation.[23]
Choice-supportive bias	The tendency to remember one's choices as better than they actually were.[24]
Clustering illusion	The tendency to overestimate the importance of small runs, streaks, or clusters in large samples of random data (that is, seeing phantom patterns).[12]
Confirmation bias	The tendency to search for, interpret, focus on and remember information in a way that confirms one's preconceptions.[25]
Congruence bias	The tendency to test hypotheses exclusively through direct testing, instead of testing possible alternative hypotheses.[12]
Conjunction fallacy	The tendency to assume that specific conditions are more probable than general ones.[26]
Conservatism (belief revision)	The tendency to revise one's belief insufficiently when presented with new evidence.[5][27][28]
Continued influence effect	The tendency to believe previously learned misinformation even after it has been corrected. Misinformation can still influence inferences one generates after a correction has occurred.[29] cf. *Backfire effect*
Contrast effect	The enhancement or reduction of a certain perception's stimuli when compared with a recently observed, contrasting object.[30]
Courtesy bias	The tendency to give an opinion that is more socially correct than one's true opinion, so as to avoid offending anyone.[31]
Curse of knowledge	When better-informed people find it extremely difficult to think about problems from the perspective of lesser-informed people.[32]
Declinism	The belief that a society or institution is tending towards decline. Particularly, it is the predisposition to view the past favourably (rosy retrospection) and future negatively.[33]
Decoy effect	Preferences for either option A or B change in favor of option B when option C is presented, which is similar to option B but in no way better.
Denomination effect	The tendency to spend more money when it is denominated in small amounts (e.g., coins) rather than large amounts (e.g., bills).[34]
Disposition effect	The tendency to sell an asset that has accumulated in value and resist selling an asset that has declined in value.

Distinction bias	The tendency to view two options as more dissimilar when evaluating them simultaneously than when evaluating them separately.[35]
Dunning–Kruger effect	The tendency for unskilled individuals to overestimate their own ability and the tendency for experts to underestimate their own ability.[36]
Duration neglect	The neglect of the duration of an episode in determining its value
Empathy gap	The tendency to underestimate the influence or strength of feelings, in either oneself or others.
Endowment effect	The tendency for people to demand much more to give up an object than they would be willing to pay to acquire it.[37]
Exaggerated expectation	Based on the estimates, real-world evidence turns out to be less extreme than our expectations (conditionally inverse of the conservatism bias).[*unreliable source?*][5][38]
Experimenter's or expectation bias	The tendency for experimenters to believe, certify, and publish data that agree with their expectations for the outcome of an experiment, and to disbelieve, discard, or downgrade the corresponding weightings for data that appear to conflict with those expectations.[39]
Focusing effect	The tendency to place too much importance on one aspect of an event.[40]
Forer effect or Barnum effect	The observation that individuals will give high accuracy ratings to descriptions of their personality that supposedly are tailored specifically for them, but are in fact vague and general enough to apply to a wide range of people. This effect can provide a partial explanation for the widespread acceptance of some beliefs and practices, such as astrology, fortune telling, graphology, and some types of personality tests.
Framing effect	Drawing different conclusions from the same information, depending on how that information is presented
Frequency illusion	The illusion in which a word, a name, or other thing that has recently come to one's attention suddenly seems to appear with improbable frequency shortly afterwards (not to be confused with the recency illusion or selection bias).[41] This illusion may explain some examples of the Baader-Meinhof Phenomenon, when someone repeatedly notices a newly learned word or phrase shortly after learning it.
Functional fixedness	Limits a person to using an object only in the way it is traditionally used.
Gambler's fallacy	The tendency to think that future probabilities are altered by past events, when in reality they are unchanged. The fallacy arises from an erroneous conceptualization of thelaw of large numbers. For example, "I've flipped heads with this coin five times consecutively, so the chance of tails coming out on the sixth flip is much greater than heads."
Hard–easy effect	Based on a specific level of task difficulty, the confidence in judgments is too conservative and not extreme enough[5][42][43][44]
Hindsight bias	Sometimes called the "I-knew-it-all-along" effect, the tendency to see past events as being predictable[45] at the time those events happened.
Hostile attribution bias	The "hostile attribution bias" is the tendency to interpret others' behaviors as having hostile intent, even when the behavior is ambiguous or benign.
Hot-hand fallacy	The "hot-hand fallacy" (also known as the "hot hand phenomenon" or "hot hand") is the fallacious belief that a person who has experienced success with a random event has a greater chance of further success in additional attempts.
Hyperbolic discounting	Discounting is the tendency for people to have a stronger preference for more immediate payoffs relative to later payoffs. Hyperbolic discounting leads to choices that are inconsistent over time – people make choices today that their future selves would prefer not to have made, despite using the same reasoning.[46] Also known as current moment bias, present-bias, and related to Dynamic inconsistency.
Identifiable victim effect	The tendency to respond more strongly to a single identified person at risk than to a large group of people at risk.[47]

IKEA effect	The tendency for people to place a disproportionately high value on objects that they partially assembled themselves, such as furniture from IKEA, regardless of the quality of the end result.
Illusion of control	The tendency to overestimate one's degree of influence over other external events.[48]
Illusion of validity	Belief that furtherly acquired information generates additional relevant data for predictions, even when it evidently does not.[49]
Illusory correlation	Inaccurately perceiving a relationship between two unrelated events.[50][51]
Illusory truth effect	A tendency to believe that a statement is true if it is easier to process, or if it has been stated multiple times, regardless of its actual veracity. These are specific cases oftruthiness.
Impact bias	The tendency to overestimate the length or the intensity of the impact of future feeling states.[52]
Information bias	The tendency to seek information even when it cannot affect action.[53]
Insensitivity to sample size	The tendency to under-expect variation in small samples.
Irrational escalation	The phenomenon where people justify increased investment in a decision, based on the cumulative prior investment, despite new evidence suggesting that the decision was probably wrong. Also known as the sunk cost fallacy.
Law of the instrument	An over-reliance on a familiar tool or methods, ignoring or under-valuing alternative approaches. "If all you have is a hammer, everything looks like a nail."
Less-is-better effect	The tendency to prefer a smaller set to a larger set judged separately, but not jointly.
Look-elsewhere effect	An apparently statistically significant observation may have actually arisen by chance because of the size of the parameter space to be searched.
Loss aversion	The disutility of giving up an object is greater than the utility associated with acquiring it.[54] (see also Sunk cost effects and endowment effect).
Mere exposure effect	The tendency to express undue liking for things merely because of familiarity with them.[55]
Money illusion	The tendency to concentrate on the nominal value (face value) of money rather than its value in terms of purchasing power.[56]
Moral credential effect	The tendency of a track record of non-prejudice to increase subsequent prejudice.
Negativity bias or Negativity effect	Psychological phenomenon by which humans have a greater recall of unpleasant memories compared with positive memories.[57][58] (see also actor-observer bias, group attribution error, positivity effect, and negativity effect).[59]
Neglect of probability	The tendency to completely disregard probability when making a decision under uncertainty.[60]
Normalcy bias	The refusal to plan for, or react to, a disaster which has never happened before.
Not invented here	Aversion to contact with or use of products, research, standards, or knowledge developed outside a group. Related to IKEA effect.
Observer-expectancy effect	When a researcher expects a given result and therefore unconsciously manipulates an experiment or misinterprets data in order to find it (see also subject-expectancy effect).
Omission bias	The tendency to judge harmful actions as worse, or less moral, than equally harmful omissions (inactions).[61]
Optimism bias	The tendency to be over-optimistic, overestimating favorable and pleasing outcomes (see also wishful thinking, valence effect, positive outcome bias).[62][63]
Ostrich effect	Ignoring an obvious (negative) situation.
Outcome bias	The tendency to judge a decision by its eventual outcome instead of based on the quality of the decision at the time it was made.
Overconfidence effect	Excessive confidence in one's own answers to questions. For example, for certain types of questions, answers that people rate as "99% certain" turn out to be wrong 40% of the time.[5][64][65][66]

Pareidolia	A vague and random stimulus (often an image or sound) is perceived as significant, e.g., seeing images of animals or faces in clouds, the man in the moon, and hearing non-existent hidden messages on records played in reverse.
Pessimism bias	The tendency for some people, especially those suffering from depression, to overestimate the likelihood of negative things happening to them.
Planning fallacy	The tendency to underestimate task-completion times.[52]
Post-purchase rationalization	The tendency to persuade oneself through rational argument that a purchase was good value.
Pro-innovation bias	The tendency to have an excessive optimism towards an invention or innovation's usefulness throughout society, while often failing to identify its limitations and weaknesses.
Projection bias	The tendency to overestimate how much our future selves share one's current preferences, thoughts and values, thus leading to sub-optimal choices.[67][68][58]
Pseudocertainty effect	The tendency to make risk-averse choices if the expected outcome is positive, but make risk-seeking choices to avoid negative outcomes.[69]
Reactance	The urge to do the opposite of what someone wants you to do out of a need to resist a perceived attempt to constrain your freedom of choice (see also Reverse psychology).
Reactive devaluation	Devaluing proposals only because they purportedly originated with an adversary.
Recency illusion	The illusion that a word or language usage is a recent innovation when it is in fact long-established (see also frequency illusion).
Regressive bias	A certain state of mind wherein high values and high likelihoods are overestimated while low values and low likelihoods are underestimated.[5][70][71][*unreliable source?*]
Restraint bias	The tendency to overestimate one's ability to show restraint in the face of temptation.
Rhyme as reason effect	Rhyming statements are perceived as more truthful. A famous example being used in the O.J Simpson trial with the defense's use of the phrase "If the gloves don't fit, then you must acquit."
Risk compensation / Peltzman effect	The tendency to take greater risks when perceived safety increases.
Selective perception	The tendency for expectations to affect perception.
Semmelweis reflex	The tendency to reject new evidence that contradicts a paradigm.[28]
Sexual overperception bias / sexual underperception bias	The tendency to over-/underestimate sexual interest of another person in oneself.
Social comparison bias	The tendency, when making hiring decisions, to favour potential candidates who don't compete with one's own particular strengths.[72]
Social desirability bias	The tendency to over-report socially desirable characteristics or behaviours in oneself and under-report socially undesirable characteristics or behaviours.[73]
Status quo bias	The tendency to like things to stay relatively the same (see also loss aversion, endowment effect, and system justification).[74][75]
Stereotyping	Expecting a member of a group to have certain characteristics without having actual information about that individual.
Subadditivity effect	The tendency to judge probability of the whole to be less than the probabilities of the parts.[76]
Subjective validation	Perception that something is true if a subject's belief demands it to be true. Also assigns perceived connections between coincidences.

Surrogation	Losing sight of the strategic construct that a measure is intended to represent, and subsequently acting as though the measure is the construct of interest.
Survivorship bias	Concentrating on the people or things that "survived" some process and inadvertently overlooking those that didn't because of their lack of visibility.
Time-saving bias	Underestimations of the time that could be saved (or lost) when increasing (or decreasing) from a relatively low speed and overestimations of the time that could be saved (or lost) when increasing (or decreasing) from a relatively high speed.
Third-person effect	Belief that mass communicated media messages have a greater effect on others than on themselves.
Triviality / Parkinson's Law of	The tendency to give disproportionate weight to trivial issues. Also known as bikeshedding, this bias explains why an organization may avoid specialized or complex subjects, such as the design of a nuclear reactor, and instead focus on something easy to grasp or rewarding to the average participant, such as the design of an adjacent bike shed.[77]
Unit bias	The tendency to want to finish a given unit of a task or an item. Strong effects on the consumption of food in particular.[78]
Weber–Fechner law	Difficulty in comparing small differences in large quantities.
Well travelled road effect	Underestimation of the duration taken to traverse oft-traveled routes and overestimation of the duration taken to traverse less familiar routes.
Zero-risk bias	Preference for reducing a small risk to zero over a greater reduction in a larger risk.
Zero-sum bias	A bias whereby a situation is incorrectly perceived to be like a zero-sum game (i.e., one person gains at the expense of another).

Social biases[edit]

Actor-observer bias	The tendency for explanations of other individuals' behaviors to overemphasize the influence of their personality and underemphasize the influence of their situation (see also Fundamental attribution error), and for explanations of one's own behaviors to do the opposite (that is, to overemphasize the influence of our situation and underemphasize the influence of our own personality).
Authority bias	The tendency to attribute greater accuracy to the opinion of an authority figure (unrelated to its content) and be more influenced by that opinion.[79]
Defensive attribution hypothesis	Attributing more blame to a harm-doer as the outcome becomes more severe or as personal or situational similarity to the victim increases.
Egocentric bias	Occurs when people claim more responsibility for themselves for the results of a joint action than an outside observer would credit them with.
Extrinsic incentives bias	An exception to the *fundamental attribution error*, when people view others as having (situational) extrinsic motivations and (dispositional) intrinsic motivations for oneself
False consensus effect	The tendency for people to overestimate the degree to which others agree with them.[80]
Forer effect (aka Barnum effect)	The tendency to give high accuracy ratings to descriptions of their personality that supposedly are tailored specifically for them, but are in fact vague and general enough to apply to a wide range of people. For example, horoscopes.
Fundamental attribution error	The tendency for people to over-emphasize personality-based explanations for behaviors observed in others while under-emphasizing the role and power of situational influences on the same behavior[58] (see also actor-observer bias, group attribution error, positivity effect, and negativity effect).[59]
Group attribution error	The biased belief that the characteristics of an individual group member are reflective of the group as a whole or the tendency to assume that group decision outcomes reflect the preferences of group members, even when information is available that clearly suggests otherwise.

Halo effect	The tendency for a person's positive or negative traits to "spill over" from one personality area to another in others' perceptions of them (see also physical attractiveness stereotype).[81]
Illusion of asymmetric insight	People perceive their knowledge of their peers to surpass their peers' knowledge of them.[82]
Illusion of external agency	When people view self-generated preferences as instead being caused by insightful, effective and benevolent agents
Illusion of transparency	People overestimate others' ability to know them, and they also overestimate their ability to know others.
Illusory superiority	Overestimating one's desirable qualities, and underestimating undesirable qualities, relative to other people. (Also known as "Lake Wobegon effect", "better-than-average effect", or "superiority bias".)[83]
Ingroup bias	The tendency for people to give preferential treatment to others they perceive to be members of their own groups.
Just-world hypothesis	The tendency for people to want to believe that the world is fundamentally just, causing them to rationalize an otherwise inexplicable injustice as deserved by the victim(s).
Moral luck	The tendency for people to ascribe greater or lesser moral standing based on the outcome of an event.
Naïve cynicism	Expecting more *egocentric bias* in others than in oneself.
Naïve realism	The belief that we see reality as it really is – objectively and without bias; that the facts are plain for all to see; that rational people will agree with us; and that those who don't are either uninformed, lazy, irrational, or biased.
Outgroup homogeneity bias	Individuals see members of their own group as being relatively more varied than members of other groups.[84]
Self-serving bias	The tendency to claim more responsibility for successes than failures. It may also manifest itself as a tendency for people to evaluate ambiguous information in a way beneficial to their interests (see also group-serving bias).[85]
Shared information bias	Known as the tendency for group members to spend more time and energy discussing information that all members are already familiar with (i.e., shared information), and less time and energy discussing information that only some members are aware of (i.e., unshared information).[86]
Sociability bias of language	The disproportionally higher representation of words related to social interactions, in comparison to words related to physical or mental aspects of behavior, in most languages. This bias attributed to nature of language as a tool facilitating human interactions. When verbal descriptors of human behavior are used as a source of information, sociability bias of such descriptors emerges in factor-analytic studies as a factor related to pro-social behavior (for example, of Extraversion factor in the Big Five personality traits [58]
System justification	The tendency to defend and bolster the status quo. Existing social, economic, and political arrangements tend to be preferred, and alternatives disparaged, sometimes even at the expense of individual and collective self-interest. (See also status quo bias.)
Trait ascription bias	The tendency for people to view themselves as relatively variable in terms of personality, behavior, and mood while viewing others as much more predictable.
Ultimate attribution error	Similar to the fundamental attribution error, in this error a person is likely to make an internal attribution to an entire group instead of the individuals within the group.
Worse-than-average effect	A tendency to believe ourselves to be worse than others at tasks which are difficult.[87]

Memory errors and biases[edit]

Bizarreness effect	Bizarre material is better remembered than common material.
Choice-supportive bias	In a self-justifying manner retroactively ascribing one's choices to be more informed than they were when they were made.
Change bias	After an investment of effort in producing change, remembering one's past performance as more difficult than it actually was[88][*unreliable source?*]
Childhood amnesia	The retention of few memories from before the age of four.

Conservatism or Regressive bias	Tendency to remember high values and high likelihoods/probabilities/frequencies as lower than they actually were and low ones as higher than they actually were. Based on the evidence, memories are not extreme enough[70][71]
Consistency bias	Incorrectly remembering one's past attitudes and behaviour as resembling present attitudes and behaviour.[89]
Context effect	That cognition and memory are dependent on context, such that out-of-context memories are more difficult to retrieve than in-context memories (e.g., recall time and accuracy for a work-related memory will be lower at home, and vice versa)
Cross-race effect	The tendency for people of one race to have difficulty identifying members of a race other than their own.
Cryptomnesia	A form of *misattribution* where a memory is mistaken for imagination, because there is no subjective experience of it being a memory.[88]
Egocentric bias	Recalling the past in a self-serving manner, e.g., remembering one's exam grades as being better than they were, or remembering a caught fish as bigger than it really was.
Fading affect bias	A bias in which the emotion associated with unpleasant memories fades more quickly than the emotion associated with positive events.[90]
False memory	A form of *misattribution* where imagination is mistaken for a memory.
Generation effect (Self-generation effect)	That self-generated information is remembered best. For instance, people are better able to recall memories of statements that they have generated than similar statements generated by others.
Google effect	The tendency to forget information that can be found readily online by using Internet search engines.
Hindsight bias	The inclination to see past events as being more predictable than they actually were; also called the "I-knew-it-all-along" effect.
Humor effect	That humorous items are more easily remembered than non-humorous ones, which might be explained by the distinctiveness of humor, the increased cognitive processing time to understand the humor, or the emotional arousal caused by the humor.[91]
Illusion of truth effect	That people are more likely to identify as true statements those they have previously heard (even if they cannot consciously remember having heard them), regardless of the actual validity of the statement. In other words, a person is more likely to believe a familiar statement than an unfamiliar one.
Illusory correlation	Inaccurately remembering a relationship between two events.[5][51]
Lag effect	The phenomenon whereby learning is greater when studying is spread out over time, as opposed to studying the same amount of time in a single session. See alsospacing effect.
Leveling and sharpening	Memory distortions introduced by the loss of details in a recollection over time, often concurrent with sharpening or selective recollection of certain details that take on exaggerated significance in relation to the details or aspects of the experience lost through leveling. Both biases may be reinforced over time, and by repeated recollection or re-telling of a memory.[92]
Levels-of-processing effect	That different methods of encoding information into memory have different levels of effectiveness.[93]
List-length effect	A smaller percentage of items are remembered in a longer list, but as the length of the list increases, the absolute number of items remembered increases as well.[94][*further explanation needed*]
Misinformation effect	Memory becoming less accurate because of interference from post-event information.[95]
Modality effect	That memory recall is higher for the last items of a list when the list items were received via speech than when they were received through writing.
Mood-congruent memory bias	The improved recall of information congruent with one's current mood.
Next-in-line effect	That a person in a group has diminished recall for the words of others who spoke immediately before himself, if they take turns speaking.[96]
Part-list cueing effect	That being shown some items from a list and later retrieving one item causes it to become harder to retrieve the other items.[97]

Peak-end rule	That people seem to perceive not the sum of an experience but the average of how it was at its peak (e.g., pleasant or unpleasant) and how it ended.
Persistence	The unwanted recurrence of memories of a traumatic event.[*citation needed*]
Picture superiority effect	The notion that concepts that are learned by viewing pictures are more easily and frequently recalled than are concepts that are learned by viewing their written word form counterparts.[98][99][100][101][102][103]
Positivity effect	That older adults favor positive over negative information in their memories.
Primacy effect, recency effect & serial position effect	That items near the end of a sequence are the easiest to recall, followed by the items at the beginning of a sequence; items in the middle are the least likely to be remembered.[104]
Processing difficulty effect	That information that takes longer to read and is thought about more (processed with more difficulty) is more easily remembered.[105]
Reminiscence bump	The recalling of more personal events from adolescence and early adulthood than personal events from other lifetime periods[106]
Rosy retrospection	The remembering of the past as having been better than it really was.
Self-relevance effect	That memories relating to the self are better recalled than similar information relating to others.
Source confusion	Confusing episodic memories with other information, creating distorted memories.[107]
Spacing effect	That information is better recalled if exposure to it is repeated over a long span of time rather than a short one.
Spotlight effect	The tendency to overestimate the amount that other people notice your appearance or behavior.
Stereotypical bias	Memory distorted towards stereotypes (e.g., racial or gender), e.g., "black-sounding" names being misremembered as names of criminals.[88][*unreliable source?*]
Suffix effect	Diminishment of the recency effect because a sound item is appended to the list that the subject is *not* required to recall.[108][109]
Suggestibility	A form of misattribution where ideas suggested by a questioner are mistaken for memory.
Telescoping effect	The tendency to displace recent events backward in time and remote events forward in time, so that recent events appear more remote, and remote events, more recent.
Testing effect	The fact that you more easily remember information you have read by rewriting it instead of rereading it.[110]
Tip of the tongue phenomenon	When a subject is able to recall parts of an item, or related information, but is frustratingly unable to recall the whole item. This is thought to be an instance of "blocking" where multiple similar memories are being recalled and interfere with each other.[88]
Travis Syndrome	Overestimating the significance of the present.[111] It is related to the enlightenment Idea of Progress and chronological snobbery with possibly an appeal to novelty logical fallacy being part of the bias.
Verbatim effect	That the "gist" of what someone has said is better remembered than the verbatim wording.[112] This is because memories are representations, not exact copies.
Von Restorff effect	That an item that sticks out is more likely to be remembered than other items[113]
Zeigarnik effect	That uncompleted or interrupted tasks are remembered better than completed ones.

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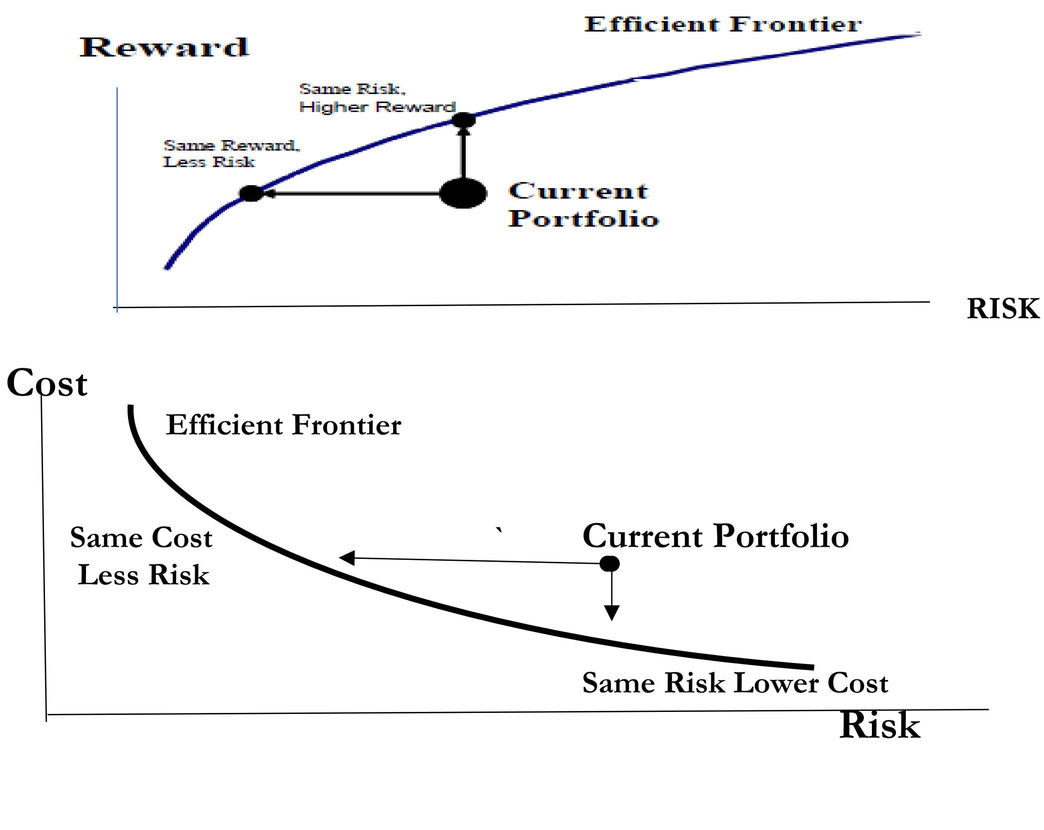
APPENDIX E
A RISK – HEDGING VIEW OF THE PROPOSED FUEL ECONOMY STANDARDS
(CFA National Program Comments, Technical Appendix)

In this section, we present a different approach to making that risk assessment. We apply the principles of financial market theory that have been used for over half a century to the proposition of risk hedging in portfolio analysis. Risk analysis allows the decision maker to hedge by creating a portfolio that balances more and less risky assets. In addition to providing a framework of assessing the prudence of the investment in fuel saving technology, the analysis also sheds light on the change in the decision making environment that has created more demand for fuel savings technologies.

Theoretical Background

Financial market theory provides a framework for evaluating the trade-off between performance and risk that has been adapted to the analysis of energy resource acquisition in the electricity sector. The top graph in Figure E-1 presents the basic approach, as a publication from the National Regulatory Research Institute.[238] Investors want to be on the efficient frontier, where risk and reward are balanced. They can improve their expected returns if they can increase their reward without increasing their risk, or they can lower their risk without reducing their reward.

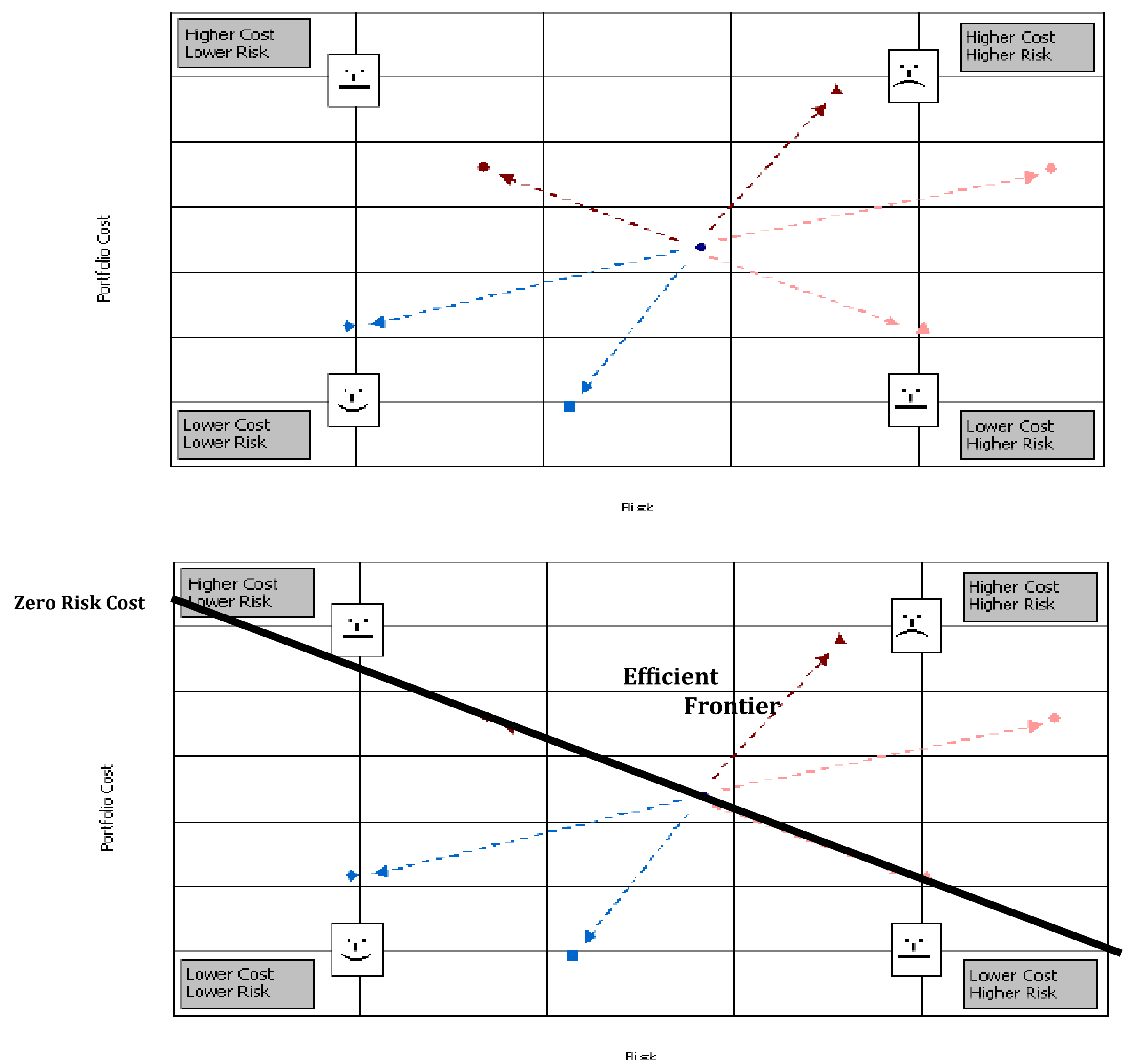
FIGURE E-1: RISK/REWARD, COST/RISK ANALYSIS



Source: Ken Costello, *Making the Most of Alternative Generation Technologies: A Perspective on Fuel Diversity*, (NRRI, March 3, 2005), p. 12, upper graph.

In applying this framework to the evaluation of energy options, analysts frequently plot cost against risk.[239] The lower graph in Figure E-2 shows the cost/risk frontier. In the financial literature, risk is measured by the standard deviation of the reward (the Beta).[240]Options that would move the portfolio toward the efficiency frontier should be adopted since they embody lower cost and/or risk.[241] The upper graph in Figure E-2 describes movement in each direction from the initial point. The lower graph in Figure E-2, introduces the efficient frontier by identifying the risk free cost, which is defined as the highest price that is likely to occur, if everything goes wrong.

FIGURE E-2: MAPPING THE TERRAIN OF INVESTMENT DECISIONS



Source: Jansen, J.C., L.W. M. Beurskens, and X, van Tilburg, 2006, *Application o Portfolio analysis to the Dutch Generating Mix*, ECN, February, 2006

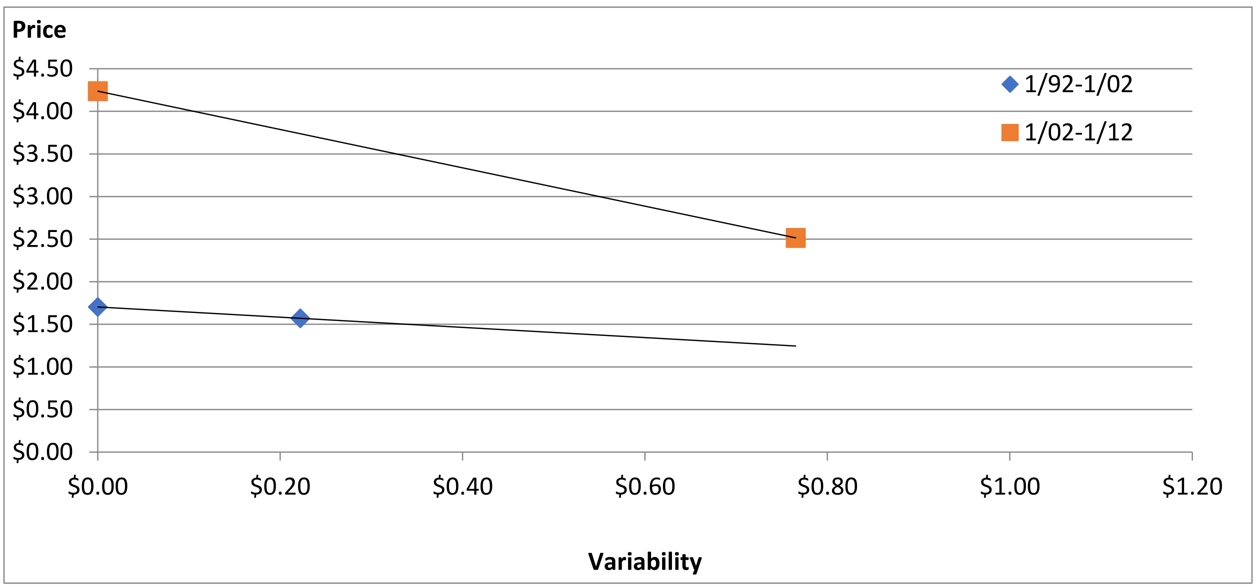
Risk and Price in the Past Two Decades of the Gasoline Market

Figure E-5 places the track record of gasoline prices into the risk-cost framework. By contrasting the January 1992-January 2002 period with the January 2002- January 2012 period we gain insight into the transformation of the role of gasoline costs in the auto market that we have discussed above.

We estimate the risk associated with gasoline prices as the rolling average of the 30-day standard deviation of the price. We use the highest cost in the decade as the zero-risk price. We plot the average prices at the average standard deviation to identify the risk-price frontier.

Three changes occurred between the two decades. The average price increased by 67 percent between the two decades. The highest price increased by 170 percent. Variability of price increased by 250 percent. As we have noted, consumers face a severe challenge, with an average expenditure increase of $750. Monthly variability of $50 and a highest price increase resulting in over $150 higher monthly expenditures.

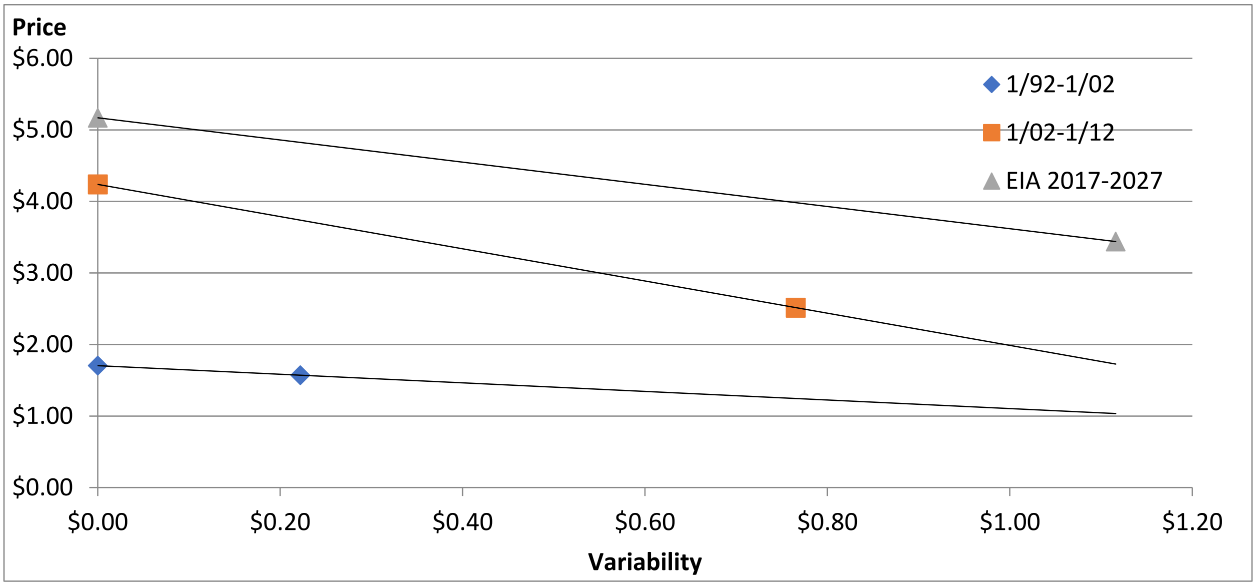
FIGURE E-5: THE TRACK RECORD OF GASOLINE PRICES (2009$/GALLON)



Source: Energy Information Administration, Petroleum data base, gasoline prices.

Figure E-6 plots the projected prices used in the analysis by NHTSA-EPA along with the past two decades. Since we do not have daily price projections, we have used the high, middle and low estimates for a decade (2017 -2027) to calculate the variability and the average. The graph suggests that the near future is projected to resemble the recent past, which is reasonable. However, with current prices higher than average prices projected for the next decade, the future price projection strikes us as too low. Indeed, the EIA has increased its price projections by $0.30 per gallon.[242]

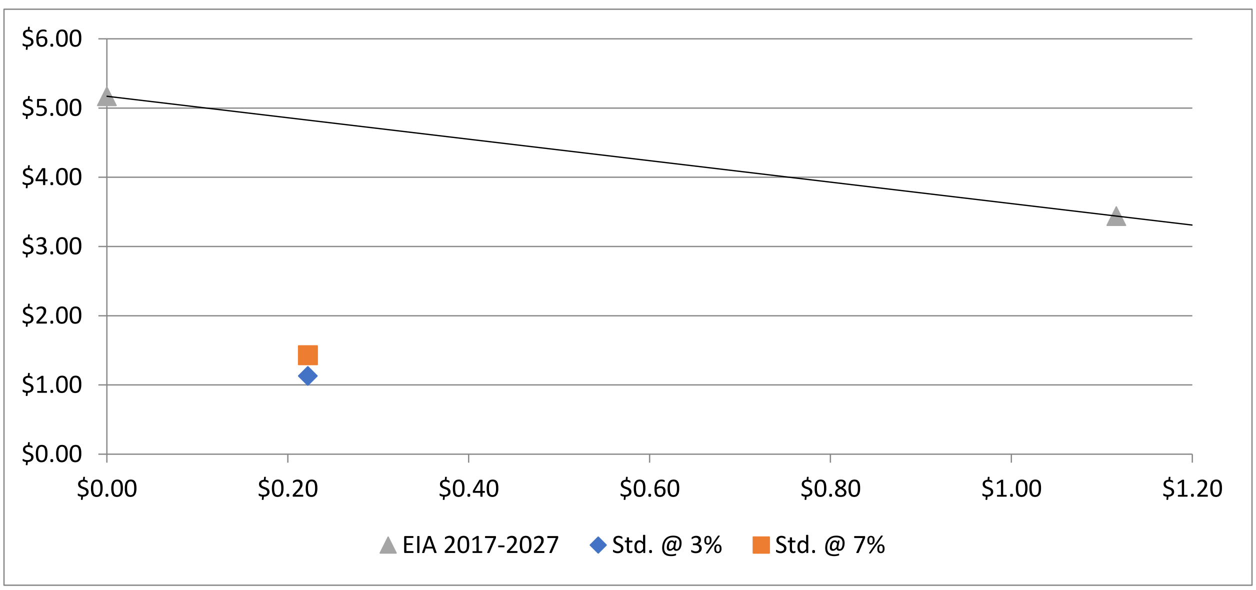
FIGURE E-6: PAST AND PROJECTED GASOLINE PRICES AND VARIABILITY



Source: Energy Information Administration, Petroleum data base, gasoline prices. Source: Office of Regulatory Analysis and Evaluation National Center for Statistics and Analysis, *Preliminary Regulatory Impact Analysis Corporate Average Fuel Economy for MY 2017-MY 2025, Passenger Cars and Light Trucks,* November 2011, Table X-12-1.

The primary purpose of this analysis is to gain insight into whether spending money on higher fuel economy is a good investment. Having identified the risk-price frontier, we need to convert the cost of fuel economy into a cost per gallon equivalent (see Figure E-7). We know the projected average cost of the technology and we have estimates of variability in terms of both

FIGURE E-7: RISK HEDGING EVALUATION OF THE PROPOSED STANDARDS



Source: Energy Information Administration, Petroleum data base, gasoline prices. Source: Office of Regulatory Analysis and Evaluation National Center for Statistics and Analysis, *Preliminary Regulatory Impact Analysis Corporate Average Fuel Economy for MY 2017-MY 2025, Passenger Cars and Light Trucks,* November 2011, Table X-12-1.

cost and effectiveness. We can divide these by the number of gallons saved to arrive at an investment cost per gallon. This is known as the cost of saved energy (see Attachment c). In this analysis we still must discount the benefits, since future saved gallons have less value than current saved gallons. Figure F-7 shows both 3% and 7% discount rates.

The resulting cost estimates are quite low, in the range of $1.15 to $1.45 per gallon. Fuel economy would appear to be a very good investment. This conclusion is consistent with the Monte Carlo experiment findings. Given that the estimated cost of saved gasoline is about two standard deviations below the mean, there is a greater than 97 percent chance that the investment will be positive (i.e. the cost of gasoline will exceed the cost of saved gasoline)

APPENDIX F:
VEHICLE AND PRICE CHANGES AMONG "ALL-NEW" MODELS 2011 TO 2017

The following information was used to analyze the performance of "all-new" vehicles in the 2017 fleet with their 2011 counterparts. 2011 was the year before the current standard was implemented. The 2011 vehicle pricing was adjusted for inflation in order to fairly compare price changes with the 2017 models. There were 27 "all new" models in 2017. For 19 of those models, there was a corresponding vehicle available in 2011. Those are the vehicles we were able to compare. Among the 19 models, there were 79 different trim configurations each having a separate cost and MPG rating. Using current gas prices and assuming 14,000 miles driven in a typical year, the savings from increased fuel economy was determined for all 79 different trim configurations.

Vehicle Price Change From 2011 to 2017 Compared to Gas Savings Due to Increased Fuel Efficiency

Division	Model	Trim	2011 Price in 2017 Dollars[12]	2017 Price	Change in Price	Change in MPG[3]	Cost of FE Tech ($100/ MPG)[4]	Change in 5 Yr. Gas Costs[5]	Price Difference Plus Gas Savings	FE Tech Cost Plus Gas Savings
GMC	Acadia FWD	2011 - SL [3.6, V6, A(A6)] 2017 - SL [2.5, I4, A(A6)]	$34,005	$29,070	-$4,935	4	$400	-$1,474	-$6,409	-$1,074
GMC	Acadia FWD	2011 - SLE [3.6, V6, A(A6)] 2017 - SLE-1 [2.5, I4, A(A6)]	$36,809	$32,450	-$4,359	4	$400	-$1,474	-$5,832	-$1,074
GMC	Acadia AWD	2011 - SLE [3.6, V6, A(A6)] 2017 - SLE-1 [3.6, V6, A(A6)]	$38,945	$34,450	-$4,495	1	$100	-$424	-$4,918	-$324
Honda	Ridgeline 4WD	2011 - RTS [3.5, V6, A(A5)] 2017 - RTS [3.5, V6, A(A6)]	$33,754	$31,515	-$2,239	5	$500	-$2,152	-$4,392	-$1,652
GMC	Acadia FWD	2011 - SLT [3.6, V6, A(A6)] 2017 - SLT-1 [2.5, I4, A(A6)]	$40,782	$38,350	-$2,432	4	$400	-$1,474	-$3,905	-$1,074
Honda	Ridgeline 4WD	2011 - RT [3.5, V6, A(A5)] 2017 - RT [3.5, V6, A(A6)]	$30,865	$29,475	-$1,390	5	$500	-$2,152	-$3,543	-$1,652
Honda	Ridgeline 4WD	2011 - RTL [3.5, V6, A(A5)] 2017 - RTL [3.5, V6, A(A6)]	$36,825	$35,580	-$1,245	4	$400	-$1,804	-$3,049	-$1,404
Subaru	Impreza Wagon	2011 - 2.5i Premium [2.5, I4, A(S4)] 2017 - Premium [2.0, I4, A(AV-S7)]	$20,287	$19,895	-$392	10	$1,000	-$2,287	-$2,679	-$1,287
Subaru	Impreza AWD	2011 - 2.5i [2.5, I4, A(S4)] 2017 - Base [2.0, I4, A(AV-S7)]	$19,753	$19,395	-$358	10	$1,000	-$2,287	-$2,645	-$1,287
Mercedes	E-Series	2011 - E 350 4MATIC [3.5, V6, A(A5)] 2017 - 300 4MATIC [2.0, I4, A(A9)]	$55,429	$54,650	-$779	5	$500	-$1,765	-$2,545	-$1,265
Cadillac	SRX/XT5 AWD	2011 - Luxury [3.0, V6, A(S6)] 2017 - Luxury [3.6, V6, A(S8)]	$49,229	$47,390	-$1,839	2	$200	-$807	-$2,646	-$607
Hyundai	Elantra	2011 – Touring SE [2.0, I4, A(A4)] 2017 - Eco [1.4, I4, A(AM7)]	$21,675	$20,650	-$1,025	9	$900	-$1,592	-$2,617	-$692
Chrysler	T&C/Pacifica	2011 - Touring [3.6, V6, A(A6)] 2017 - Touring [3.6, V6, A(A9)]	$32,211	$30,495	-$1,716	2	$200	-$732	-$2,448	-$532
GMC	Acadia AWD	2011 - SLT [3.6, V6, A(A6)] 2017 - SLT-1 [3.6, V6, A(A6)]	$42,918	$41,450	-$1,468	1	$100	-$424	-$1,891	-$324
GMC	Acadia AWD	2011 - Denali [3.6, V6, A(A6)] 2017 - Denali [3.6, V6, A(A6)]	$48,295	$46,920	-$1,375	1	$100	-$424	-$1,799	-$324

Hyundai	Elantra	2011 - Touring SE [2.0, I4, M(M5)] 2017 - Value Edition [2.0, I4, A(S6)]	$20,821	$20,250	-$571	6	$600	-$1,161	-$1,732	-$561
GMC	Acadia FWD	2011 - Denali [3.6, V6, A(A6)] 2017 - Denali [3.6, V6, A(A6)]	$46,159	$44,920	-$1,239	1	$100	-$424	-$1,663	-$324
Mercedes	E-Series	2011 - E 350 Coupe [3.5, V6, A(A5)] 2017 - 300 [2.0, I4, A(A9)]	$52,172	$52,150	-$22	5	$500	-$1,610	-$1,632	-$1,110
Mercedes	E-Series	2011 - E 550 [5.5, V8, A(A7)] 2017 - 550 (coupe) [4.7, V8, A(A7)]	$60,983	$60,650	-$333	3	$300	-$1,278	-$1,611	-$978
Mercedes	E-Series	2011 - E 550 (CONVERTIBLE) [5.5, V8, A(A7)] 2017 - 550 (convertible) [4.7, V8, A(A7)]	$69,206	$69,100	-$106	3	$300	-$1,421	-$1,527	-$1,121
Hyundai	Elantra	2011 - GLS [1.8, I4, A(A6)] 2017 - SE [2.0, I4, A(S6)]	$18,241	$18,150	-$91	1	$100	-$152	-$244	-$52
Subaru	Impreza Wagon	2011 - 2.5i Premium [2.5, I4, A(S4)] 2017 - Premium [2.0, I4, A(AV-S7)]	$21,355	$21,695	$340	10	$1,000	-$2,287	-$1,947	-$1,287
Subaru	Impreza AWD	2011 - 2.5i [2.5, I4, A(S4)] 2017 - Base [2.0, I4, A(AV-S7)]	$20,821	$21,195	$374	10	$1,000	-$2,287	-$1,913	-$1,287
Mazda	CX-9 2WD	2011 - Sport [3.7, V6, A(S6)] 2017 - Sport [2.5, I4, A(S6)]	$31,116	$31,520	$404	5	$500	-$1,765	-$1,362	-$1,265
Division	**Model**	**Trim**	**2011 Price in 2017 Dollars[12]**	**2017 Price**	**Change in Price**	**Change in MPG[3]**	**Cost of FE Tech ($100/ MPG)[4]**	**Change in 5 Yr. Gas Costs[5]**	**Price Difference Plus Gas Savings**	**FE Tech Cost Plus Gas Savings**
Volvo	XC60 FWD	2011 - 3.2 R [3.2, V6, A(S6)] 2017 - T5 Inscription [2.0, I4, A(S8)]	$40,637	$40,950	$313	5	$500	-$1,474	-$1,162	-$974
Volvo	XC60 AWD	2011 - 3.2 R [3.2, V6, A(S6)] 2017 - T5 Inscription [2.0, I4, A(S8)]	$42,773	$42,950	$177	3	$300	-$1,050	-$873	-$750
Mazda	CX-9 4WD	2011 - Sport [3.7, V6, A(S6)] 2017 - Sport [2.5, I4, A(S6)]	$32,601	$33,320	$719	4	$400	-$1,474	-$754	-$1,074
Honda	CR-V 4WD	2011 - EX-L [2.4, I4, A(A5)] 2017 - EX-L [1.5, I4, A(AV)]	$29,792	$30,495	$703	6	$600	-$1,448	-$745	-$848
Honda	CR-V 2WD	2011 - EX [2.4, I4, A(A5)] 2017 - EX [1.5, I4, A(AV)]	$28,457	$29,195	$738	6	$600	-$1,342	-$604	-$742
Chrysler	T&C/Pacifica	2011 - Touring L [3.6, V6, A(A6)] 2017 - Touring L [3.6, V6, A(A9)]	$34,347	$34,495	$148	2	$200	-$732	-$584	-$532
Honda	CR-V 4WD	2011 - EX [2.4, I4, A(A5)] 2017 - EX-L [1.5, I4, A(AV)]	$26,962	$27,995	$1,033	6	$600	-$1,448	-$415	-$848
Honda	CR-V 2WD	2011 - EX-L [2.4, I4, A(A5)] 2017 - EX [1.5, I4, A(AV)]	$25,627	$26,695	$1,068	6	$600	-$1,342	-$273	-$742
Honda	CR-V 2WD	2011 - LX [2.4, I4, A(A5)] 2017 - LX [2.4, I4, A(AV)]	$23,170	$24,045	$875	4	$400	-$958	-$84	-$558
Mazda	CX-9 2WD	2011 - Touring [3.7, V6, A(S6)] 2017 - Touring [2.5, I4, A(S6)]	$33,167	$35,970	$2,803	5	$500	-$1,765	$1,038	-$1,265
Mazda	CX-9 2WD	2011 - Grand Touring [3.7, V6, A(S6)] 2017 - Grand Touring [2.5, I4, A(S6)]	$35,399	$40,470	$5,071	5	$500	-$1,765	$3,306	-$1,265
Buick	Lacrosse	2011 - CXS [3.6, V6, A(A6)] 2017 - Premium [3.6, V6, A(S8)]	$36,061	$41,065	$5,004	5	$500	-$1,610	$3,394	-$1,110
Buick	Lacrosse	2011 - CXL [3.6, V6, A(A6)] 2017 - Essence [3.6, V6, A(S8)]	$31,565	$38,665	$7,100	5	$500	-$1,610	$5,490	-$1,110
Mazda	CX-9 4WD	2011 - Touring [3.7, V6, A(S6)] 2017 - Touring [2.5, I4, A(S6)]	$34,651	$37,770	$3,119	4	$400	-$1,474	$1,645	-$1,074
Mazda	CX-9 4WD	2011 - Grand Touring [2.5, I4, A(S6)] 2017 - Grand Touring [3.7, V6, A(S6)]	$36,883	$42,270	$5,387	4	$400	-$1,474	$3,913	-$1,074
Volvo	XC60 FWD	2011 - 3.2 [3.2, V6, A(S6)] 2017 - T5 Dynamic [2.0, I4, A(S8)]	$34,603	$40,950	$6,347	5	$500	-$1,474	$4,872	-$974
Volvo	XC60 AWD	2011 - T6 [3.0, V6, A(S6)] 2017 - T6 Inscription [2.0, I4, A(S8)]	$41,011	$46,350	$5,339	3	$300	-$1,156	$4,183	-$856

Division	Model	Trim	2011 Price in 2017 Dollars[12]	2017 Price	Change in Price	Change in MPG[3]	Cost of FE Tech ($100/ MPG)[4]	Change in 5 Yr. Gas Costs[5]	Price Difference Plus Gas Savings	FE Tech Cost Plus Gas Savings
Volvo	XC60 AWD	2011 - T6 R [3.0, V6, A(S6)] 2017 - T6 R-Design [2.0, I4, A(S8)]	$44,375	$51,000	$6,625	3	$300	-$1,156	$5,469	-$856
Volvo	S80/S90 FWD	2011 - 3.2 [3.2, V6, A(S6)] 2017 - T5 Momentum [2.0, I4, A(S8)]	$39,463	$46,950	$7,487	5	$500	-$1,355	$6,132	-$855
Volvo	S80/S90 AWD	2011 - T6 [3.0, V6, A(S6)] 2017 - T6 Momentum [2.0, I4, A(S8)]	$43,468	$52,950	$9,482	4	$400	-$1,227	$8,256	-$827
Volvo	XC60 AWD	2011 - 3.2 [3.2, V6, A(S6)] 2017 - T5 Dynamic [2.0, I4, A(S8)]	$36,739	$42,950	$6,211	3	$300	-$1,050	$5,161	-$750
Hyundai	Equus/G90	2011 - Signature [4.6, V8, A(A6)] 2017 - Premium [3.3, V6, A(S8)]	$61,944	$68,100	$6,156	2	$200	-$894	$5,262	-$694
Nissan	Armada AWD	2011 - SV [5.6, V8, A(A5)] 2017 - SV [5.6, V8, A(S7)]	$46,469	$47,800	$1,331	1	$100	-$767	$565	-$667
Nissan	Armada AWD	2011 - SL [5.6, V8, A(A5)] 2017 - SL [5.6, V8, A(S7)]	$48,744	$52,550	$3,806	1	$100	-$767	$3,040	-$667
Nissan	Armada AWD	2011 - Platinum [5.6, V8, A(A5)] 2017 - Platinum [5.6, V8, A(S7)]	$56,487	$60,490	$4,003	1	$100	-$767	$3,237	-$667
Honda	CR-V 4WD	2011 - LX [2.4, I4, A(A5)] 2017 - LX [2.4, I4, A(AV)]	$23,170	$25,345	$2,175	4	$400	-$1,037	$1,138	-$637
Cadillac	SRX/XT5 AWD	2011 - Premium [3.0, V6, A(S6)] 2017 - Premium Luxury [3.6, V6, A(S8)]	$51,841	$54,390	$2,549	2	$200	-$807	$1,742	-$607
Nissan	Armada 2WD	2011 - SL [5.6, V8, A(A5)] 2017 - SL [5.6, V8, A(S7)]	$45,753	$49,650	$3,897	1	$100	-$671	$3,226	-$571
Nissan	Armada 2WD	2011 - Platinum [5.6, V8, A(A5)] 2017 - Platinum [5.6, V8, A(S7)]	$53,496	$57,590	$4,094	1	$100	-$671	$3,423	-$571
Nissan	Armada 2WD	2011 - SV [5.6, V8, A(A5)] 2017 - SV [5.6, V8, A(S7)]	$40,488	$44,900	$4,412	1	$100	-$671	$3,741	-$571
Cadillac	SRX/XT5 FWD	2011 - Performance [3.0, V6, A(S6)] 2017 - Premium Luxury [3.6, V6, A(S8)]	$45,337	$51,895	$6,558	2	$200	-$732	$5,827	-$532
Cadillac	SRX/XT5 FWD	2011 - Base [3.0, V6, A(S6)] 2017 - Base [3.6, V6, A(S8)]	$36,130	$38,995	$2,865	2	$200	-$732	$2,133	-$532
Cadillac	SRX/XT5 FWD	2011 - Luxury [3.0, V6, A(S6)] 2017 - Luxury [3.6, V6, A(S8)]	$40,862	$44,895	$4,033	2	$200	-$732	$3,302	-$532
Chrysler	T&C/Pacifica	2011 - Limited [3.6, V6, A(A6)] 2017 - Limited [3.6, V6, A(A9)]	$41,289	$42,495	$1,206	2	$200	-$732	$474	-$532
Audi	A4 Quattro	2011 - Prestige [2.0, I4, A(S8)] 2017 - Prestige [2.0, I4, A(AM-S7)]	$45,646	$48,000	$2,354	3	$300	-$745	$1,608	-$445
Audi	A4 Quattro	2011 - Premium [2.0, I4, A(S8)] 2017 - Premium [2.0, I4, A(AM-S7)]	$36,462	$39,400	$2,938	3	$300	-$745	$2,193	-$445
Audi	A4 Quattro	2011 - Premium Plus [2.0, I4, A(AM-S7)] 2017 - Premium Plus [2.0, I4, A(S8)]	$40,093	$43,200	$3,107	3	$300	-$745	$2,362	-$445
Audi	A4	2011 - Premium [2.0, I4, A(AV)] 2017 - Premium [2.0, I4, A(AM-S7)]	$34,123	$34,900	$777	3	$300	-$690	$87	-$390
Audi	A4	2011 - Premium Plus [2.0, I4, A(AV)] 2017 - Premium Plus [2.0, I4, A(AM-S7)]	$37,807	$41,100	$3,293	3	$300	-$690	$2,603	-$390
Hyundai	Equus/G90	2011 - Ultimate [4.6, V8, A(A6)] 2017 - Ultimate [5.0, V8, A(S8)]	$68,886	$69,700	$814	1	$100	-$471	$343	-$371
Buick	Lacrosse	2011 - CX [2.4, I4, A(S6)] 2017 - Preferred [3.6, V6, A(S8)]	$28,831	$36,065	$7,234	2	$200	-$560	$6,674	-$360
Lincoln	MKS/Continental FWD	2011 - FWD [3.7, V6, A(S6)] 2017 - Premiere [3.7, V6, A(S6)]	$44,076	$44,560	$484	1	$100	-$424	$60	-$324

Audi	A4 Quattro	2011 - Prestige [2.0, I4, M(M6)] 2017 - Prestige [2.0, I4, M(M6)]	$44,269	$48,000	$3,731	2	$200	-$477	$3,254	-$277
Audi	A4 Quattro	2011 - Premium [2.0, I4, M(M6)] 2017 - Premium[2.0, I4, M(M6)]	$35,084	$39,400	$4,316	2	$200	-$477	$3,839	-$277
Audi	A4 Quattro	2011 - Premium Plus [2.0, I4, M(M6)] 2017 - Premium Plus[2.0, I4, M(M6)]	$38,715	$43,200	$4,485	2	$200	-$477	$4,008	-$277
Hyundai	Genesis/G80	2011 - V6 [3.8, V6, A(A6)] 2017 - 3.8L V6 [3.8, V6, A(S8)]	$35,244	$41,400	$6,156	1	$100	-$348	$5,808	-$248
Audi	A5 Quattro	2011 - Premium [2.0, I4, A(S8)] 2017 - Sport [2.0, I4, A(S8)]	$40,360	$42,200	$1,840	1	$100	-$268	$1,572	-$168
Audi	A5 Quattro	2011 - Premium [2.0, I4, M(M6)] 2017 - Sport [2.0, I4, M(M6)]	$38,982	$41,200	$2,218	1	$100	-$248	$1,970	-$148
Division	**Model**	**Trim**	**2011 Price in 2017 Dollars[1,2]**	**2017 Price**	**Change in Price**	**Change in MPG[3]**	**Cost of FE Tech ($100/ MPG)[4]**	**Change in 5 Yr. Gas Costs[5]**	**Price Difference Plus Gas Savings**	**FE Tech Cost Plus Gas Savings**
Hyundai	Elantra	2011 - Touring GLS [2.0, I4, A(A4)] 2017 - GT [2.0, I4, A(S6)]	$18,364	$19,800	$1,436	1	$100	-$229	$1,206	-$129
Hyundai	Elantra	2011 - Touring GLS [2.0, I4, M(M5)] 2017 - GT [2.0, I4, M(M6)]	$17,083	$18,800	$1,717	1	$100	-$229	$1,488	-$129
Audi	A5 Cabriolet Quattro	2011 - Premium [2.0, I4, A(S8)] 2017 - Sport [2.0, I4, A(AM-S7)]	$47,195	$48,600	$1,405	0	$0	$0	$1,405	$0
Hyundai	Elantra	2011 - Limited [1.8, I4, A(A6)] 2017 - Limited [2.0, I4, A(S6)]	$21,339	$22,350	$1,011	0	$0	$0	$1,011	$0
Lincoln	MKS/Continental AWD	2011 - AWD [3.7, V6, A(S6)] 2017 - Premiere [3.7, V6, A(S6)]	$46,095	$46,560	$465	0	$0	$0	$465	$0
Hyundai	Elantra	2011 - GLS [1.8, I4, M(M6)] 2017 - SE [2.0, I4, M(M6)]	$15,838	$17,150	$1,312	-3	$0	$520	$1,832	$520
Hyundai	Genesis/G80	2011 - V8 [4.6, V8, A(A6)] 2017 - 5.0L V8 [5.0, V8, A(S8)]	$45,924	$54,550	$8,626	-2	$0	$894	$9,520	$894

[1]Inflation was calculated using BLS average inflation numbers from 2011-2016.

[2]Vehicle Price is from the New Car Cost Guide.

[3]Fuel Economy of Vehicles is from the EPA.

[4]CFA bases its estimate of the cost of fuel economy on a review of the literature including historical, market-based and engineering studies, as described in Appendix B.

[5]Gas costs based on driving the vehicle 14,000 miles per year for 5 years and using gas prices from AAA (7/10/17).

2011 Vehicles Which Were Less Expensive in 2017 Dollars and Had Higher MPG

2011 Vehicles Which Were More Expensive in 2017, but Who's Fuel Savings Offset the Entire Price Increase

2011 Vehicles Which Were More Expensive in 2017, but Who's Fuel[4] Savings Offset the $100 per MPG Cost of Fuel Efficient Technology

2011 Vehicles Which Were More Expensive in 2017 and Whose Fuel Economy Stayed the Same or Decreased

ENDNOTES

[1] Congressional Budget Office Cost Estimate, 2017, 2017 Reconciliation Recommendations of the Senate Committee on Finance, November 26.

[2] In announcing NAHB opposition to the House Tax bill, (NAHB Now, 2017, NAHB Opposes Tax Reform Plan, October 28, the NAHB declared, "By sharply reducing the number of taxpayers who would itemize, what's left is a tax bill that essentially eviscerates the mortgage interest deduction and strips the tax code of its most vital homeownership tax benefit. This tax blueprint will harm home values, act as a tax on existing home owners and force many younger, aspiring home buyers out of the market" An early analysis of the mortgage deduction had offered the $1 trillion figure, Judson, Rick, 2013, "NAHB Chairman's Letter: NAHB Weighs in on Congressional Housing Issues," Builder, August 13, Eliminating the mortgage interest deduction would have a devastating impact on individual homeowners, the housing industry, and the economy. It would impose a large tax increase on millions of middle-class homeowners, weaken demand for housing, cost the economy hundreds of thousands of jobs, drive down home values, and erode household wealth. It could even push the housing sector back into recession. Every 1 percent decline in home prices reduces household net worth by about $180 billion nationwide; a 6 percent drop in home values would wipe out $1 trillion in household wealth. Lower home values also would shrink the tax base of local communities and force more homeowners underwater.

[3] Tax Foundation, 2017, Understanding JCT's New Distributional Tables for the Senate's Tax Cuts and Jobs Act, November 16.

[4] The executive branch guidance is contained in three executive orders, E.O. 13771, 13777, 13783, along with OMB Guidance on E.O. 13777; Department of Energy 2017, In the matter of Request for Information on Reducing Regulation and Controlling Regulatory Costs, before the Department of Energy, E.O. 13771, 13777, 13783, July 14, 2017 (Hereafter DOE Notice); Department of Transportation, 2017, Office of the Secretary of Transportation, *In Re Notification of Regulatory Review: 14 CFR Chapters I, II, and III, 23 CFR, Chapters I, II, and III, 46 CFR Chapter II, 48 CFR Chapter 12, 49 CFR Chapters I, II, III, V, VI, VII, VIII, X, and XI,* Docket No. DOT–OST–2017–0069, October 2, 2017. (hereafter, DOT Notice)

[5] The Energy Policy and Conservation Act of 1975 (EPCA) (Pub.L. 94–163, 89 Stat. 871, enacted December 22, 1975) is a United States Act of Congress that responded to the 1973 oil crisis by creating a comprehensive approach to federal energy policy. The primary goals of EPCA are to increase energy production and supply, reduce energy demand, provide energy efficiency, and give the executive branch additional powers to respond to disruptions in energy supply.[1] Most notably, EPCA established the Strategic Petroleum Reserve, the Energy Conservation Program for Consumer Products, and Corporate Average Fuel Economy regulations. https://en.wikipedia.org/wiki/Energy_Policy_and_Conservation_Act

[6]The Clean Air Act (1965) and the first round of strengthening amendments Environmental Protection Agency, Clean Air Act Amendments of 1977, Major amendments were added to the Clean Air Act in 1977 (1977 CAAA). The 1977 Amendments primarily concerned provisions for the Prevention of Significant Deterioration (PSD) of air quality in areas attaining the NAAQS. The 1977 CAAA also contained requirements pertaining to sources in non-attainment areas for NAAQS. A non-attainment area is a geographic area that does not meet one or more of the federal air quality standards. Both of these 1977 CAAA established major permit review requirements to ensure attainment and maintenance of the NAAQS

[7] See Part III.

[8] The Consumer Federation of America (CFA) has argued this throughout its regulatory interventions, starting with fuel economy standards (Comments and Technical Appendices of the Consumer Federation of America, Re: National Highway Traffic Safety Administration Notice of Proposed Rulemaking; Docket No. NHTSA 2008-0089, RIN 2127-AK29; Average Fuel Economy Standards, Passenger Cars and Light Trucks; Model Years 2011-2015, July 1, 2008 (hereafter CFA NHTSA, 2008)) and ending, most recently and explicitly in comments on EPA's final determination in the National Program for light duty vehicles (CFA NHTSA/EPA Comments, 2017).

[9] The Consumer Federation of America is an association of more than 250 nonprofit consumer groups that was established in 1968 to advance the consumer interest through research, advocacy, and education.

[10] The CFA website (http://consumerfed.org/issues/energy/) provides links to 140 pieces of testimony and reports published in the past ten years dealing with the efficiency of energy-using consumer durables divided roughly equally between appliances and vehicles.

[11] Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022-2025, Environmental

Protection Agency, California Air Resources Board, National Highway Traffic Safety Administration, EPA-420-D-16-900, July 2016.

[12] Environmental Protection Agency 40 CFR Parts 85, 86, and 600, Department of Transportation National Highway Traffic Safety Administration 49 CFR Parts 523, 531, 533. et al. and 600, 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards; Final Rule Final Rulemaking for 2017-2025 Light-Duty Vehicle Greenhouse Gas, Emission Standards and Corporate, Average Fuel Economy Standards, October 15, 2012.

[13] Comments of the Consumer Federation of America, Notice of Intent to Prepare an Environmental Impact Statement; Request for Scoping Comments, before the National Highway Transportation Safety Administration, Department of Transportation, Docket No. NHTSA-2017-0069, September 25, 2017 (hereafter, CFA NHTSA EIS Comments).

[14] Comments of the Consumer Federation of America, *In the Matter of Proposed Determination on the Appropriateness of the Model Year 2022-2025 Light-Duty Vehicle Greenhouse Gas Emissions Standards under the Midterm Evaluation, before the Environmental Protection Agency*, EPA-HQ-OAR-2015-0827, December 30, 2016 (hereafter CFA Determination Comments).

[15] Comments of the Consumer Federation of America, *Evaluation Draft Technical Assessment Report for Model Year 2022–2025 Light Duty Vehicle GHG) Department of Transportation Emissions and CAFE Standards*, EPA– HQ–OAR–2015–0827; NHTSA–2016 0068; FRL–9949–54–OAR RIN 2060–AS97; RIN 2127–AL76, September 26, 2016 (hereafter CFA TAR Comments).

[16] Comments of the Consumer Federation of America, *in the Matter of Transportation Infrastructure: Notice of Review of Policy, Guidance and Regulation, before the Department of Transportation*, Docket No. Ost-2017-0057, July 24, 2017 (hereafter, CFA DOT Infrastructure Comments).

[17] Comments of the Consumer Federation of America on *the California Air Resources Board Mid-Term Review*, before the California Air Resources Board, March 24, 2017 (here after, CFA CARB Comments).

[18] Statement of Jack Gillis, U.S. Environmental Protection Agency on the Reconsideration of the Final Determination of the Mid-term Evaluation of Greenhouse Gas Emissions Standards for Model Years 2022-2025 Light-duty Vehicles, Environmental Protection Public Hearing, Washington DC, September 6, 2017 (hereafter CFA EPA Reconsideration Testimony).

[19] Testimony of Dr. Mark Cooper on Midterm Review and an Update on the Corporate Average Fuel Economy Program and Greenhouse Gas Emissions Standards for Motor Vehicles, Before the Committee on Energy and Commerce Subcommittee on Commerce, Manufacturing, and Trade, Subcommittee on Energy and Power, U.S. House of Representatives, September 22, 2016 (hereafter, CFA Mid-term Congressional Testimony).

[20] Comments of the Consumer Federation of America, before the Environmental Protection Agency, Department of Transportation, National Highway Traffic Safety Administration, Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium and Heavy-Duty Engines and Vehicles, Phase 2; Proposed Rule, 40 CFR Parts 9, 22, 85, et al., 49 CFR Parts 512, 523, 534, et al., October 1, 2015; Comments of the Consumer Federation of America, Re: Department of Transportation Notice of Intent to Prepare an Environmental Impact Statement for New Medium- and Heavy-duty Vehicle Fuel Economy Standards— Docket No.: NHTSA-2014-0074, August 8, 2014.

[21] Mark Cooper, *Paying the Freight*, Consumer Federation of America, attached to CFA Comments *Re: Department of Transportation Notice of Intent to Prepare an Environmental Impact Statement for New Medium- and Heavy-duty Vehicle Fuel Economy Standards*— August 8, 2014. All citations are to Version 2.0, August 2015.

[22] Consumer Federation of America, 2015, Comments on Notice of Proposed Rulemaking for Energy Conservation Standards for Residential Boilers, Docket Number EERE–2012–BT–STD– 0047/RIN 1904–AC88: July 1; Consumer Federation of America, 2017, Comments on Direct Final Rule and Proposed Rule for Residential Central Air Conditioners and Heat Pumps, Docket Number EERE–2014–BT–STD–0048/RIN 1904–AD37, April 26; Consumer Federation of America, 2017, Comments on Request for Information for Test Procedures for Room Air Conditioners, Docket Number EERE–2017–BT–TP–0012, September 5; March 18, 2010 Honorable Cathy Zoi Assistant Secretary for Energy Efficiency and Renewable Energy U.S. Department of Energy 1000 Independence Ave, SW Washington, DC 20585-0121 Re: Water heater energy conservation standards docket: EERE-2006-BT-STD-0129 and RIN 1904–AA90; Comments of the Consumer Federation of America before the Department of Energy, In the matter of Request for Information on Reducing Regulation and Controlling Regulatory Costs, before the Department of Energy, E.O. 13771, 13777, 13783, July 14, 2017, and Joint Comments of the Consumer Federation of America, National Consumer Law Center, Massachusetts Union of Public Housing Tenants and Texas Ratepayers' Organization to Save Energy, before the U.S. Department of

Energy Building Technologies Program, RE: Notice of Proposed Rulemaking for Energy Conservation Standards for Residential Furnaces, July 10, 2015.

[23] Comments of the Consumer Federation of America, 2017, Comments on "Energy Conservation Program: General Service Incandescent Lamps and Other Incandescent Lamps Request for Data," Docket Number: EERE- 2017–BT–NOA–0052, October 16.

[24] Consumer Federation of America, 2017, Comments on Docket Number EERE–2015–BT–STD–0008/RIN 1904–AD52: Direct Final Rule, Dedicated-Purpose Pool Pumps, May 5; Consumer Federation of America, 2012, Comments on Notice of Proposed Rulemaking for Battery Chargers and External Power Supplies, Docket Number EERE-2008-BT-STD-0005, July 16; Consumer Federation of America, 2011, Comment on Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Determination, of Set-Top Boxes and Network Equipment as a Covered Consumer Product) Docket No. EERE-2010-BT-DET-0040, RIN 1904-AC52 September 22.

[25] Consumer Federation of America, et al., 2016, October, Comments of Consumer Federation of America, Consumers Union, Consumer Action and Consumer Federation of California, Proposed Regulations for Computers, Computer Monitors, and Electronic Displays, CEC Docket Number: 14-AAER-02, October 24, 2016, Consumer Federation of America, et al., 2016, May, Comments of the Consumer Federation of America, Consumers Union, Consumer Action and Consumer Federation of California on Proposed Efficiency Standards for Computers, Computer Monitors and Signage Displays, Submitted to the California Energy Commission, Docket Number: 14-AAER-02, May 23, 2016, Xxx(energy Academy, 2016, computers) Mark Cooper, 2015, "Energy Efficiency Performance Standards: Driving Consumer and Energy Savings in California," *California Energy Commission Workshop on Computer Standards*, April 15, 2015, Consumer Federation of America, et al., 2015, "Comments of Consumer Federation of America, Consumers Union, Consumer Action and Consumer Federation of California," *Computers, Computer Monitors, and Electronic Displays,* before the California Energy Commission, Docket Number: 14-AAER-02, May 29, 2015,

[26] Consumer Federation of America, 2017, Comments and Letter to Commissioner McAllister California Energy Commission, Phase II Pre-rulemaking for general service lamps (GSL) Docket No. 17-AAER-07, June 16, September 18.

[27] Mark Cooper, 2011, Testimony of Dr. Mark Cooper Director of Research on Appliance Efficiency Standards Legislation, Before the Senate Energy and Natural Resources Committee, March 10.

[28] Mark Cooper, 2014, *Energy Efficiency Performance Standards: Driving Consumer and Energy Savings in California.* Presentation at the California Energy Commission's Energy Academy, February 20.

[29] CFA DOT Infrastructure Comments.

[30] Comments of the Consumer Federation of America, *Proposed Rulemaking to Establish Emission Standards and Corporate Average Fuel Economy Standards Environmental Protection Agency Light-Duty Vehicle Greenhouse Gas) 40 CFR Parts 86 and 600; Department of Transportation 49 CFR Parts 531,633, 537, et al.,* November 27, 2009, pp. 2-3. (hereafter CFA National Program, 2009)

[31] Environmental Protection Agency, California Air Resources Board, National Highway Traffic Safety Administration, *Draft Technical Assessment Report: Midterm Evaluation of Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards for Model Years 2022-2025,* July 2016, p. 1-3, (hereafter, TAR).

[32] CFA, National Program, 2009.

[33] At the time of the filing in New Mexico, CFA issued a report entitled, A Consumer Analysis of the Adoption of the California Clean Cars Program in Other States, November 2007.

[34] Cooper, 2017, *The Political Economy of Electricity*, Chapter 5.

[35] *Why the Environmental Protection Agency Should Grant a Clean Air Act Waiver to California For Its Advanced Clean Cars Program,* Statement of Dr. Mark N. Cooper, Director of Research, Consumer Federation of America (CFA) to the Environmental Protection Agency, Pubic Hearing, September 19, 2012.

[36] Mark Cooper, *Energy Efficiency Performance Standards: Driving Consumer and Energy Savings in California.* Presentation at the California Energy Commission's Energy Academy, February 20, 2014 (hereafter, Performance Standards, 2014); *Energy Efficiency Performance Standards: The Cornerstone of Consumer-Friendly Energy Policy*, Consumer Federation of America, October, 2013.

[37] Mark Cooper, *Rising Gasoline Prices And Record Household Expenditures: Will Policymakers Get Serious About Ending Our "Addiction To Oil" By Supporting A 60 Mile Per Gallon Standard?,* Consumer Federation of America, May 16, 2011.

[38] 82 Fed. Reg. 24582 (May 30, 2017). While the RFI is narrowly styled in terms of infrastructure projects, the notice makes it clear that comments will broadly impact the DOT thinking on regulatory reform. (p. 26735), In

EO 13771 and EO 13777, President Trump directed agencies to further scrutinize their regulations. The review described in this notice will supplement the Department's periodic regulatory review and its activities under EO 13771 and EO 13777. Unlike those activities, this request for input is narrowly focused on identifying and addressing impediments to the completion of transportation infrastructure projects. The comments that DOT receives in response to this notice will inform those other, broader activities." We believe it is important for the agency to have the broad terrain of regulatory reform in view.

[39]Id., Acknowledging the Superior Force of the Law and Executive Orders in force.

[40] Office of Management and Budget, *Memorandum For: Regulatory Policy Officers at Executive Departments and Agencies and Managing and Executive Directors of Certain Agencies and Commissions,* May 5, 2017, states "Agencies should continue to comply with all applicable laws and requirements. In addition, EO 12866 remains the primary governing EO regarding regulatory planning and review. Accordingly, among other requirements, except where prohibited by law, agencies must continue to assess and consider both the benefits and costs of regulatory actions, including deregulatory actions, when making regulatory decisions, and issue regulations only upon a reasoned determination that benefits justify costs."

[41] *The Administrative Procedure Act* (APA), Pub.L. 79–404, 60 Stat. 237, establishes the nature of judicial oversight over rulemaking agencies (https://en.wikipedia.org/wiki/Administrative_Procedure_Act_(United_States). The APA requires that in order to set aside agency action not subject to formal trial-like procedures, the court must conclude that the regulation is "arbitrary and capricious, an abuse of discretion, or otherwise not in accordance with the law." However, Congress may further limit the scope of judicial review of agency actions by including such language in the organic statute. To set aside formal rulemaking or formal adjudication whose procedures are trial-like, a different standard of review allows courts to question agency actions more strongly. For these more formal actions, agency decisions must be supported by "substantial evidence" after the court reads the "whole record", which can be thousands of pages long. Unlike arbitrary and capricious review, substantial evidence review gives the courts leeway to consider whether an agency's factual and policy determinations were warranted in light of all the information before the agency at the time of decision. Accordingly, arbitrary and capricious review is understood to be more deferential to agencies than substantial evidence review. Arbitrary and capricious review allows agency decisions to stand as long as an agency can give a reasonable explanation for its decision based on the information it had at the time. In contrast, the courts tend to look much harder at decisions resulting from trial-like procedures because those agency procedures resemble actual trial-court procedures, but Article III of the Constitution reserves the judicial powers for actual courts. Accordingly, courts are strict under the substantial evidence standard when agencies acts like courts because being strict gives courts final say, preventing agencies from using too much judicial power in violation of separation of powers.

[42] Results of over a dozen national random sample public opinion polls are among the 140 pieces of research to be found at the CFA website (http://consumerfed.org/issues/energy/).

[43] Republican presidents signed the legislation that created the fuel economy program in 1976 and then reformed it in 2007. The laws passed both houses of Congress with large majorities. In fact, eight of the nine major pieces of legislation that effect the energy efficiency of consumer durables were signed by Republican presidents. Both the House and the Senate have voted overwhelmingly in favor of these laws (14 times in all) with over 85 percent voting in favor.

[44] Performance Standards, 2014*;* See Mark Cooper, 2017, *The Political Economy of Electricity: Progressive Capitalism and the Struggle to Build a Sustainable Power Sector*, (Praeger), Chapter 7 and Appendix II for a more recent comprehensive review.

[45] We have identified these characteristics in the study of standards in a broad range of goods including light duty vehicles, heavy duty trucks, gas furnaces and computers. The key characteristics of "command but not control" regulation extend to policies that create institutional arrangement as discussed in Cooper, 2017.

46 Comments of the Consumer Federation of America, Proposed Rulemaking to Establish light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards, Environmental Protection Agency, 40 CFR Parts 86 and 600; Department of Transportation, 49 CFR Parts 531,633, 537, et al., November 28, 2009, Appendix F. Energy Efficiency Performance Standards: The Cornerstone of Consumer-Friendly Energy Policy, October 2013, pp. 60-64 and Cooper, Performance Standards, 2014; Mark Cooper, 2017, The Political Economy of Electricity: Progressive Capitalism and the Struggle to Build a Sustainable Power Sector, (Praeger), Chapter 7.

47 Mary and Robert Raymond Professor of Economics at Stanford University, and the George P. Shultz Senior Fellow in Economics at Stanford University's Hoover Institution.

[48] He was a member of the President's Council of Economic Advisors during the George H. W. Bush Administration and Senior Economist at the Council of Economic Advisors during the Ford and Carter Administrations.

[49] John, B. Taylor, *Economics* (Houghton Mifflin, 11998, pp. 410, 896.

[50] W. Kip Viscusi, John M. Vernon and Joseph E. Harrington, Jr., *Economics of Regulation and Antitrust* (MIT, 2001).

[51] Id., pp. 28-29.

[52] Office of Management and Budget, Memorandum For: Regulatory Policy Officers at Executive Departments and Agencies and Managing and Executive Directors of Certain Agencies and Commissions, May 5, 2017.

[53] Viscusi, Vernon, and Harrington, 2000, pp. 2-3.

[54] Cooper, *Performance Standards*, reviews the different approaches in the appliance, building, light duty and climate change literatures.   Sanne Aarnink, Jasper Faber, Eelco den Boer, *Market Barriers to Increased Efficiency in the European On-road Freight Sector*, Delft, October 2012, introduce these distinctions for the medium/heavy duty truck sector.

[55] Framework developed in Comments of the Consumer Federation of America, *Proposed Rulemaking to Establish Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards*, Environmental Protection Agency 40 CFR Parts 86 and 600, Department of Transportation 49 CFR Parts 531,633, 537, et al., November 28, 2009. Most recent update, including climate change literature available in Mark Cooper, 2017, The Political Economy of Electricity: Progressive Capitalism and the Struggle to Build a Sustainable Power Sector, (Praeger), Chapter 7 and Appendix II for a more recent comprehensive review.

[56] In terms of the structure-conduct-performance paradigm, the awards to critics of the neoclassical model can be sorted as follows – Basic Conditions: End of Value-free Economics, Sen, 1998; New Institutional/ Transaction Cost: Coase, 1992; North, 1993; Fogel, 1993; Williamson, 2009; Ostrom, 2009 Endemic Flaws: Stiglitz, 2001; Spence, 2001; Market Structure: Krugman, 2008, Heckman, 2008; Tirole 2014; Deaton, 2015; Conduct: Behavioral Akerloff, 2001; Kahneman, 2002; Smith, 2002; Shiller, 2013; Thaler, 2017; Strategic Behavior: Nash Jr., 1994; Selton, 1994; Harsanyi, 1994.

[57] See Appendix B for annotated versions of these tables.

[58] William H. Golove and Joseph H. Eto, Market Barriers to Energy Efficiency: A Critical Reappraisal of the Rationale for Public Policies to Promote Energy Efficiency, (Lawrence Berkeley Laboratory, 1996)/

[59] Golov and Eto, 1996, p. iv.

[60] There has recently been a dramatic re-commitment to publicly-sponsored energy efficiency and a substantial increase in allocated resources; Sanstad, Alan H., W. Michael Haneman, and Maximillion Auffhammer, 2006, "End-Use Energy Efficiency in a "Post-Carbon California Economy," in *Managing Greenhouse Gas Emissions in California*. The California Climate Change Center at UC Berkeley, p. 6-5.

[61] Golove and Ito, 1996, p. x.

[62] Golove and Eto, p. 22.

[63] Golove and Eto, p. 23.

[64] Golove and Eto, p. 23.

[65] Golove and Eto, p. 20.

[66] Kenneth Gillingham, Richard G. Newell, and Karen Palmer, *Energy Efficiency Economics and Policy* (Resources for the Future, April 2009), p. 7.

[67] Id., p. 8.

[68] Gross, Robert, et al., 2012, On Picking Winners: The Need for Targeted Support for Renewable Energy, Imperial College London, October.

[69] Acemoglu, Daron, et al., 2012, "The Environment and Dedicated Technical Change," American Economic Review, 102(1), p. 132.

[70] W. Kip Viscusi, John M. Vernon and Joseph E. Harrington, Jr., *Economics of Regulation and Antitrust* (MIT, 2001), pp. 35-37.

[71] Luke Stewart, 2010, *The Impact of Regulation on Innovation in the United States: A Cross-Industry Literature Review*, Institute of Medicien Committee on Patient Safety and Health IT, June.

[72] Institute for European Environmental Policy, Review of Costs and Benefits of Energy Savings: Task 1 Report 'Energy Savings 2030, May 2013 IEER, pp. 4…6.

[73] Performance Standards, 2014, slide 22.

[74] Comments of Consumer Groups on Proposed Rule 2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards, Docket Nos.EPA-HQ-OAR-2010-0799; FRL-9495-2NHTSA–2010–0131, February 13, 2012, pp. 9-12. (hereafter CFA National Program, 2012).

[75] Howarth, Richard B. and Alan H. Sanstad, 2007, "Discount Rates and Energy Efficiency," Contemporary Economic Policy, 13, p. 108.

[76] Howarth, Richard B. and Bo Anderson, "Market Barriers to Energy Efficiency," *Energy Economics,* 15 (1993), p. 265.

[77] Burtraw, Dallas and Matt Woerman, 2013, "Economic ideas for a complex climate policy regime," *Energy Economics,* 40.

[78], de la Rue du Can, Stephane, et al., 2014, "Design of incentive programs for accelerating penetration of energy-efficient appliances," *Energy Policy*, Energy Policy, 72, 2014, p. 5.

79 de la Rue du Can, et al., 2014,

[80] Thinking about the NEXT FIVE YEARS, how concerned, personally, are you about the following issues? Please use a scale of 1 to 5, where 1 means no concern and 5 means great concern. (1) No concern (1), (2), (3), (4), (5) Great concern (5), DON'T KNOW (99)

Gasoline prices

U.S. dependency on Mid-Eastern oil

[81] How important is it to you that the country reduces its consumption of oil? Is it . . . Very important, (2) Somewhat important, (3) A little important, (4) Not at all important 99 DON'T KNOW

[82] How important is it to you, in order to limit oil consumption that the fuel economy of motor vehicles increases? Is it. . Very important, (2) Somewhat important, (3) A little important, (4) Not at all important 99 DON'T KNOW

[83] Do you support or oppose the federal government requiring auto companies to increase the fuel economy of the vehicles they manufacture? Would you say you… (1) Support strongly, (2) Support somewhat, (3) Oppose somewhat, (4) Oppose strongly 99 DON'T KNOW

[84] The federal government has recently required automobile manufacturers to increase the fuel economy of their motor vehicle fleets from an average of 25 miles per gallon today to 35 miles per gallon by 2016. Do you think the government should increase this standard to an average of 60 miles per gallon by 2025? YES, 02) NO, 99) DON'T KNOW

[85] Now suppose increases in the fuel economy of motor vehicles increased their purchase price but reduced the cost of using them. If these price increases were offset by reduced gasoline costs over the following time periods, would you favor or oppose these fuel economy increases?

Would you favor strongly, favor somewhat, oppose somewhat or oppose strongly?

(1) Favor strongly, (2) Favor somewhat, (3) Oppose somewhat, (4) Oppose strongly 99 DON'T KNOW, 3 years, 5 years, 10 years

[86] The survey was conducted for CFA by ORC International, which interviewed a representative sample of 1,008 American adults by landline or phone on July 13-16. The margin of error for the survey is plus or minus three percentage points.

[87] 7 Reasons Why the Trump Administration Won't Put the Brakes on Fuel Economy Standards, November 14, 2016

[88] The shift is statistically significant (Chi Square $p < .000$).

[89] Because there are so few who do not think fuel economy is not important, the confidence interval around the average is very large, but the difference between those who think it is important and those who do not is statistically significant because it is so large. The relationship between importance and expected fuel economy is highly statistically significant ($p < .0000$) and quantitatively meaningful, with the importance of fuel economy explaining 8% of the variance in expected fuel economy

[90] The statistically significant factors explain 37% of the variance in next vehicle fuel economy. The standardized beta coefficients are as follows:

Current mpg	.49***
Importance of fuel economy	.18***
Pickup	-.1**
Subcompact Compact	.08*
Large Sedan	-.07*
Gender (Male=2)	-.07*
Income	-.07*

Given that these background and basic attitudes do not take into account many other factors that affect fuel economy, like the number of cylinders, the transmission, etc., the amount of explained variance is substantial.

[91] Mitch Bainwol, President and CEO, Alliance of Automobile Manufacturers, Consumers & Fuel Economy, CAR Management Briefing Seminars, Traverse City, Michigan, August 2016, The winter related question, specific to the North East, has been discarded. It would rank 12th of 18, low in California, high in New England)

[92] Id., p. 2.

[93] Id., p. 35.

[94] Id., p. 7.
[95] Id., p. 7.
[96] Id., p. 8.
[97] Id., p. 10.
[98] Id., p. 9).
[40] Id., p. 10.
[100] Home energy consumption and appliances efficiency standards have acquired another link to gasoline consumption. As concern about gasoline expenditures continues and climate grows, electric vehicles have become a focal point for efforts to reduce oil consumption. Reducing electricity consumption in the home could free up electricity for use in the vehicle fleet, thereby allowing the U.S. to meet its national energy policy goals without putting excess pressure on the electricity sector.
[101] OMB Circular A-4, pp. 33-34. The 7 percent rate is an estimate of the average before-tax rate of return to private capital in the U.S. economy. It is a broad measure that reflects the returns to real estate and small business capital as well as corporate capital. It approximates the opportunity cost of capital, and it is the appropriate discount rate whenever the main effect of a regulation is to displace or alter the use of capital in the private sector. OMB revised Circular A-94 in 1992 after extensive internal review and public comment. In a recent analysis, OMB found that the average rate of return to capital remains near the 7 percent rate estimated in 1992. Circular A-94 also recommends using other discount rates to show the sensitivity of the estimates to the discount rate assumption… The effects of regulation do not always fall exclusively or primarily on the allocation of capital. When regulation primarily and directly affects private consumption (e.g., through higher consumer prices for goods and services), a lower discount rate is appropriate. The alternative most often used is sometimes called the social rate of time preference. This simply means the rate at which a society discounts future consumption flows to their present value. If we take the rate that the average saver uses to discount future consumption as our measure of the social rate of time preference, then the real rate of return on long-term government debt may provide a fair approximation. Over the last thirty years, this rate has averaged around 3 percent in real terms on a pre-tax basis. For example, the yield on 10-year Treasury notes has averaged 8.1 percent since 1973 while the average annual rate of change in the CPI over this period has been 5.0 percent, implying a real 10-year rate of 3.1 percent. For regulatory analysis, you should provide estimates of net benefits using both 3 percent and 7 percent.
[102] OMB Circular A-4. pp. 35-36. Similar issues affect health impacts, "When future benefits or costs are health-related, some have questioned whether discounting is appropriate, since the rationale for discounting money may not appear to apply to health" (p. 34).
[103] Grayer, Ted and W. Kip Viscusi, 2012, *Overriding Consumer Preferences with Energy Regulation,* Mercatus Center.
[104] See Appendix B for extensive citations for the following discussion.
[105] Stern Paul C., "Blind Spots in Policy Analysis: What Economics Does Not Say about Energy Use," *Journal of Policy Analysis and Management,"*5:2 (1986), p. 209.
[106] Thomas G. Poder and Jie He, 2017, Willingness to pay for a cleaner car: The case of car pollution in Quebec and France, Energy 130; Susan Rose-Ackerman, 2011, Putting Cost-Benefit Analysis in Its Place: Rethinking Regulatory Review, Yale Law School Legal Scholarship Repository.; Lisa Heinzerling, Frank Ackerman, 2002, Pricing the Priceless: Cost-Benefit Analysis of Environmental Protection, 150 U. Pa. L. Rev. 1553.
[107] Benjamin Leard, et al., 2017, How Much Do Consumers Value Fuel Economy and Performance? Evidence from Technology Adoption, Brookings Institution, June;
[108]Leard, et al., 2017, p. 27, put it as follows, "Moreover, this conclusion does not account for potential induced innovation caused by tighter standards, market failures associated with insufficient market incentives for innovation, market failures associated with imperfect competition (such as the possible underprovision of fuel economy), and interactions between new and used vehicle markets. Finally, the conclusion does not account for transitional dynamics.
[109]For example, a similar sentiment is expressed by one critique of willingness-to-pay studies in healthcare (Joaquin F. Mould Quevedo, et al., "The Willingness-to-Pay Concept in Question," Rev. Sauide Publica: 43(2), as follows: "[M]ost of these investigations still do not differentiate the economic factors that might be distorting the market, centering the investigation on a hypothetical aggregate demand when whoever defines the price and amount offered of a particular medication or medial intervention in the health sector generally comes from the supply-side.
[110] Leard, et al., p. p. 29.

[111] Wilkinson, Nick, 2008, *An Introduction to Behavioral Economics,* New York: Palgrave, p. 212, reflecting Table 5.1.
[112] American Action Forum, *Regulatory* Rodeo.
[113] National Academy of Sciences analyses have played a large part in the estimation of vehicle technology costs.
[114] Performance Standards, 2013, pp. 28-32.
[115] Larry Dale, et al., "Retrospective Evaluation of Appliance Price Trends," *Energy Policy* 37, 2009. p. 1.
[116] Sperling, Dan et al., 2004, Analysis of Auto Industry and Consumer Responses to Regulation and Technological Change and Customization of Consumer Response Models in Support of AB 1493 Rulemaking, Institute of Transportation Studies, UC Davis, June 1, pp. 10-15.
[117] Kuik, On, 2006, *Environmental Innovation Dynamics in the Automotive Industry:* Project Assessing Innovation Dynamics Induced by Environmental Policy. November 3.
[118] Hwang, Roland and Matt Peak, 2006, *Innovation and Regulation in the Automobiles Sector: Lessons Learned and Implicit on for California CO_2 Standards,* April.
[119] Harrington, Winston, 2006, *Grading Estimates of the Benefits and Costs of Federal Regulation: A Review of Reviews,* Resources for the Future, September, p. 3.
[120] Whitefoot, Kate, Meredith Fowler and Steven Skerlos, 2012, *Product Design Response to Industrial Policy: Evaluating Fuel Economy Standards Using an Engineering Model of Endogenous Product Design,* Energy Institute at Haas, May, pp. 1…5.
[121] Worrell, et al., 2003, p. 1081.
[122] Steven Nadel and Andrew Delaski, *Appliance Stnadards: Comparing Predicted and Observed Prices,* American Council for an Energy Efficient Economy and Appliance Standards Awareness Project, July 2013.
[123] Worrell, Ernst, et al., 2003, "Productivity Benefits of Industrial Energy Efficiency Measures," Energy, 28(11): This examination shows that including productivity benefits explicitly in the modeling parameters would double the cost-effective potential for energy efficiency improvement, compared to an analysis excluding those benefits. (p 1)
[124] Larry Dale, et al., 2009.
[125] David Greene and Jilleah G. Welch, The Impact of Increased Fuel Economy for Light-Duty Vehicles on the Distribution of Income in the United States, Oak Ridge National Laboratory and the Energy Foundation, September 2016, pp. 60- 62; David Greene and Jilleah G. Welch, *The Impact of Increased Fuel Economy for Light-Duty Vehicles on the Distribution of Income in* the *United States*: *A Retrospective and Prospective Analysis,* Oak Ridge National Laboratory and the Energy Foundation, March 2017, section 5.2.
[126] Taylor, 1998, p. 898.
[127] U.S. EPA, 2010, pp. 3-4.
[128] Cooper, Mark, 2011a, *Comments of Consumer Federation of America and Consumer Groups, Proposed Rule 2017 and Later Model Year,* Docket Nos. Light-Duty Vehicle Greenhouse Gas Emissions, EPA-HQ-OAR-2010-0799; FRL-9495-2 and Corporate Average Fuel Economy Standards, NHTSA–2010–0131, February 13.
[129] Wie, Max Shana Patadia and Daniel Kammen, 2010, "Putting Renewables and Energy Efficiency to work: How Many Jobs Can the Clean Energy Industry Generate in the US?", *Energy Policy,* 38; Anair, Don and Jamie Hall, 2010, *Delivering Jobs: The Economic Costs and Benefits of Improving the Fuel Economy Heavy-Duty Vehicles,* Union of Concerned Scientists, May; Gold, Rachel, et al., 2011, *Appliance and Equipment Efficiency Standards: A Money Maker and Job Creator,* American Council for an Energy Efficient Economy, January; Roland-Holst, David, 2008, *Energy Efficiency, Innovation, and Job Creation in California,* Center for Energy, Resources, and Economic Sustainability, October.
[130] James D. Hamilton, "Causes and Consequences of the Oil Shock of 2007–08," *Brookings Papers on Economic Activity* Spring; Warr, Benjamin S, Robert U. Ayres, and Eric Williams, 2009, *Increase Supplies, Increase Efficiency: Evidence of Causality Between the Quantity and Quality of Energy Consumption and Economic Growth.* 2009/22/EPS.ISIC, Faculty & Research Working Paper. INSEAD.
[131] In addition to the recent U.S. analysis by U.S. EPA/NHTSA, 2011, see Jamie Howland, et al., 2009, *Energy Efficiency: Engine of Economic Growth.* Rockport, ME: Environment Northeast; and New York State Energy Research & Development Authority, 2011, *Macro-Economic Impact Analysis of New York's Energy Efficiency Programs: Using REMI Software.* Albany NY: NYSERDA, August 4; Holmes Ingrid and Rohan Mohanty, 2012, *The Macroeconomic Benefits of Energy Efficiency: The Case for Pubic Action,* E3G, April; Cambridge Centre for Climate Change Mitigation Research, 2006, *The Macro-Economic Rebound Effect and the UK Economy.* Cambridge, U.K.: Cambridge Econometrics and Policy Studies Institute, May; and Lisa, Ryan, and Nina Campbell, 2012, *Spreading the Net: The Multiple Benefits of Energy Efficiency Improvements.* Insight Series. Paris, France: International Energy Agency, for a general global review.

[132] James Lazar and Ken Colburn, *Recognizing the Full Value of Energy Efficiency* (Regulatory Analysis Project, September 2013).

[133] Ryan, and Campbell, 2012, *Spreading the Net: The Multiple Benefits of Energy Efficiency Improvements.* Insight Series. Paris, France: International Energy Agency, pp. 1…2 …3.

[134] Barker, Terry, Paul Eakins and Tim Foxon, 2007, "The Macro-economic Rebound Effect in the UK Economy," *Energy Policy,* 35; Cambridge Centre for Climate Mitigation Research, 2006, *The Macro-economic Rebound Effect and the UK Economy,* Cambridge Econometrics and Policy Studies Institute, May 15; Goldstein, David, Sierra Martines and Robin Roy, *Are there Rebound Effects from Energy Efficiency? An Empirical Analysis, Internal Consistency and Solutions*, Electric Policy.com.; Nadel, Steven, 2012, *The Rebound Effect: Large or Small,* American Council For An Energy Efficient Economy, August.; Bornstein, Severin, 2013, *A Microeconomic Framework for Evaluating Energy Efficiency Rebound and Some Implications,* Energy Institute at HAAS, May.

[135] U.S. EPA, 2010, pp. 3-4.

[136] Memorandum To: Docket EPA-HQ-OAR-2009-0472, Subject: Economy-Wide Impacts of Greenhouse Gas Tailpipe Standards, March 4, 2010.

[137] Id., p. 1.

[138] The IEER review of studies lists seven studies covering the residential building and the industrial sectors covering a handful of European nations in 2010-2013. The effects studies were primarily employment, cost of saved energy and competitiveness. Worrel, et al., identified 70 industrial case studies, with 52 that monetized the benefits.

[139] Max Wei, Shana Patadia, and Daniel Kammen, 2010, "Putting Renewables and Energy Efficiency to Work: How Many Jobs Can the Clean Energy Industry Generate in the US?" *Energy Policy* 38.

[140] Ryan and Campbell, identify a dozen partial equilibrium models that have been applied to regions within nations, individual nations, groups of nations and the global economy. The effects analyze include GDP, employment by sector, public budgets, trade, distribution, and investment.

[141] For example, EPA, 2010, IGEM; Rachel Gold, et al., 2011, *Appliance and Equipment Efficiency Standards: A Money Maker and Job Creator*, American Council for an Energy Efficient Economy, January 2011, p. 9, based on the IMPLAN Model, 2009. Howland and Murrow and NYSERDA 2011, REMI).

[142] For example, New York (NYSERDA, 2011), New England (Howland and Murrow), California (David Roland-Holst, 2016)

[143] For example, U.S. (Gold,, 2011, EPA, 2010, Warr, Ayres and Williams, 2009) and UK (Cambridge Center, 2006), note recent studies on Asian economies, Korea, Canada and Spain,

[144] Wei, Patadia, and Kammen, 2010, Gold, et al., 2011.

[145] ACEEE, "In our experience modeling efficiency investments, we find that re-spending the energy savings typically creates an equivalent number of jobs as implementing the investment." (p. 2)

[146] Worrell, et al., p. 5.

[147] Ryan and Campbell, p. 5., Howland, et al., 2009.

[148] EPA, 2012-2016,

[149] Wiser, Bolinger and St. Clair, 2005.

[150] National Academy of Sciences Transportation Research Board report prepared for the Transit Cooperative Research Program, *Practices for Evaluating the Economic Impacts and Benefits of Transit* 2017, forward. This example is particularly appropriate since infrastructure spending and projects, on which transit would be an important area, appear to be widely supported because of the benefits they deliver to individuals and the economy

[151] Id., pp. 3… 10.

[152] Comments of the Consumer Federation of America**,** Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium and Heavy-Duty Engines and Vehicles Phase 2; Proposed Rule, Environmental Protection Agency, Department of Transportation, National Highway Traffic Safety Administration, 40 CFR Parts 9, 22, 85, et al., 49 CFR Parts 512, 523, 534, et al., October 1, 2015. (hereafter, CFA Heavy-0Duty, 2015)

[153] Performance Standards, *2013.*

[154] Based on Bureaus of Labor statistics, *Consumer Expenditure Survey,* for 2013 and 2013-2014

[155] See Section XII.

[156] For the purposes of simplicity, in this paper, we will refer to medium and heavy-duty trucks as 'work trucks'.

[157] We estimate 2014 based on total products supplied and average price for the year, assuming a 1% increase in the number of households and constant consumption per household. This is consistent with the difference between

the 2013 Consumer Expenditure Survey and the mid-year 2014 Consumer Expenditure Survey. While price is down 3% between 2014 and 2013, expenditures are down 1.5% in the year July 2013-July 2014. By the end of the year we would expect the increase in consumption stimulated by declining prices to be offset by the decrease in consumption reflecting more fuel-efficient vehicles and the underlying trend. For diesel, we divide the total expenditures by the estimated number of households.

[158] Mark Cooper and Jack Gillis, *Paying the Freight: The Consumer Benefits of Increasing the Fuel Economy of Medium and Heavy-Duty Trucks,* Consumer Federation of America, February 2014.

[159] Population growth will increase vehicles on the road and overall miles driven.

[160] Mid-America Freight Coalition "The Economic Importance of Freight," p. 2.

[161] EIA, *Monthly Energy Review,* August 2015, Table 3.1.

[162] Transportation and Economic Development Authors: Dr. Jean-Paul Rodriguez and Dr. Theo Notteboom, http://people.hofstra.edu/geotrans/eng/ch7en/conc7en/ch7c1en.html. A regional analysis reinforces this observation, Oregon, Transportation, Plan Update, Transportation and the Economy Manufacturing is dependent on transportation to receive raw materials and to deliver its products. Manufacturing is usually a highly competitive activity. Unless an area has other low-cost attributes, high transportation costs will cause manufacturers to leave or avoid that area.

[163] It is important to note that a 50% fuel consumption decrease is equal to a 100% increase in fuel economy. In other words, when the fuel economy doubles, the fuel consumption is cut in half.

[164] For example, the American Council for an Energy Efficient Economy estimates potential fuel savings from two phases of technology improvement at between 30% and 46% for heavy duty pickups and vans and Class 8 trucks respectively, http://aceee.org/files/pdf/fact-sheet/hd-oil-reduction.pdf. There are many opportunities to reduce fuel consumption that have been studied recently. See for example, Ben Sharpe and Nigel Clark, Trailer Technologies for Increased Heavy-Duty Vehicle Efficiency, Technical, Market, and Policy Considerations, International Council on Clean Transportation, June 2013; Donald W. Stanton, Systematic Development of Highly Efficient and Clean Engines to Meet Future Commercial Vehicle Greenhouse Gas Regulations, Safe International, 2013-01-2421, September 2013; TA Engineering, DOE SuperTruck Program Benefits Analysis, December 20, 2012. It should also be noted that the cost analyses are being updated and, reflecting the findings in Cooper, 2013, the actual costs are likely to be lower than early estimates.

[165] Energy Information Administration, Monthly Energy Review for fuel consumption, of 4126 gallons per heavy duty truck and 460 gallons per light duty vehicle in 2011. Diesel was over 7% more expensive than gasoline.

[166] CFA National Program, 2012.

[167] CFA National Program, 2012.

[168] Performance Standards. 2013.

[169] Id., examines the arguments in detail.

[170] EPA-NHTSA, Greenhouse Gas Emissions Standards and Fuel Economy Standards for Medium and Heavy-Duty Engines and Vehicles, Federal Register 76(179), September 15, 2011, p. 57319.

[171] EPA/NHTSA, NPRM, p. 4043.

[172] EPA/NHTSA, NPRM, pp. 40437-40438.

[173] To underscore the fact that we have been pushing for the agencies to recognize this important reality of the efficiency gap, this discussion is taken directly from our 2009 light duty comments (CFA NHTSA, 2009, 2008)..

[174] EPA/NHTSA, NPRM, p. 40482

[175] EPA/NHTSA, NPRM, p. 40450, 40451.

[176] Mark Cooper, Jack Gillis. Comments of the Consumer Federation of America, before the Environmental Protection Agency, Department of Transportation, National Highway Traffic Safety Administration, Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium and Phase 2; Proposed Rule, 40 CFR Parts 9, 22, 85, et al 49 CFR Parts 512, 523, 534, et al., October 1, 2015, Technical Appendix, pp. 28, 31.

[177] John B. Taylor, *Economics*, Houghton Mifflin, 2nd Ed., glossary.

[178] EPA/NHTSA, p. 40154.

[179] EPA/NHTSA, PHASE II RIA, p. 2-16.

[180] EPA/NHTSA, PHASE II NOPR, p. 40143.

[181] Performance Standards, 2013 showed the important role that adoption, in the form of diffusion curves, plays in the analysis of the efficiency gap and the design and evaluation of standards.

[182] EPA/NHTSA, PHASE II RIA, p. 2-89.

[183] The discount rate also refers to the interest rate used in discounted cash flow (DCF) analysis to determine the present value of future cash flows… takes into account not just the time value of money, but also the risk or uncertainty of future cash flows; inv*estopedia.com/terms/d/***discountrate***.asp*
[184] CFA, 2011c, p. 1.
[185] CFA, 2011c, p. 7.
[186] Kandel, Shieridan and McCAuliffe, 2008, p. 10. This study addresses the research need identified by Sudarshan and Anant, 2008. Some results are closer to 50%, which is consistent with Bernstein, 2003.
[187] The analysis that includes the additional variables is methodologically flawed, statistically inferior, and substantively meaningless. The introduction of 26 regional variables wreaks havoc on the analysis.

- It adds almost nothing to the explained variance.
- It renders the key analytic variables on which the most of the paper focuses (climate and income) statistically insignificant (half of the variables are not even larger than their standard errors).
- It reverses the sign of the climate variables.

With a large number of cases (32,000), when a small number of variables has this large effect on the variables already in the equation, there must be a severe colinearity problem. Kandel, Sheridan and McAuliffe (2008) identified this problem in explaining why they did not introduce state-specific dummy variables. Yet, the Levinson study presents no analysis of the magnitude and meaning of colinearity.

- It does not show the coefficients and statistics for the newly introduced variables.
- It does not show results for regressions with the 26 variables alone or in combination with an analytically meaningful subset of variables.
- It apparently shifts away from robust standard errors, which are most important when there is a colinearity problem.
- It provides no statistical tests to assess the impact of colinearity.

Given these statistical characteristics and problems, it is certain that the model without the regional variables is a better model (more parsimonious and statistically efficient). There are other methodological problems with the paper. It singles out California because it has held electricity consumption per capita flat over a thirty-year period. Yet, there are six other states that have done the same thing. These other states are included in the comparison group, when they belong in the treatment group. Moving these six states from the comparison to the treatment group increases the growth of consumption of the comparison group by 15 percentage points (unweighted average). That these six states belong in the treatment group is demonstrated by the fact that their average ACEEE score on electricity programs is twice as high as the remainder of the comparison group. The average score for these six is almost 15, which is much closer to California's score of 19, than the score of the remainder of the comparison group, which is 7.
[188] Eldridge, 2007
[189] Kandel, Shieridan and McCAuliffe, 2008.
[190] In fact, the authors did not calculate correlation coefficients. Moreover, the graph uses total energy consumption, which is vulnerable to criticism, since it is the change in consumption that matters.
[191] Joint Comments of the Consumer Federation of America, National Consumer Law Center, Massachusetts Union of Public Housing Tenants and Texas Ratepayers' Organization to Save Energy, before the U.S. Department of Energy Building Technologies Program, RE: Notice of Proposed Rulemaking for Energy Conservation Standards for Residential Furnaces, July 10, 2015, p. 23.
[192] Comments of Consumer Federation of America, Consumers Union, Consumer Action and Consumer Federation of California, Docket Number: 14-AAER-02, Project Title: Computer, Computer Monitors, and Electronic Displays. TN #: 20385333, Date: 5/29/2015, pp. 27-29, is another recent example of the framework applied to an important category of household appliances.
[193] Dale, et. al., 2009, p. 1.
[194] See CFA analysis, Attachment A, Figure 1 and accompanying text.
[195] http://standby.lbl.gov/, *http://www.washingtonpost.com/news/energy-environment/wp/2015/02/06/your-home-is-full-of-devices-that-never-turn-off-and-theyre-costing-you-a-lot-of-money/*
[196] See CFA analysis, Attachment A, Figure 3 and accompanying text.
[197] See CFA analysis, Attachment A, Figure 4 and accompanying text.
[198] U.S. Energy Information Administration, Heating and cooling no longer majority of U.S. home energy use, March 7, 2013, http://www.eia.gov/todayinenergy/detail.cfm?id=10271

[199] The analogy here might be the comparison with wireline telephone subscriptions, which topped out at about 170 million (approximately 1.5 per household), while wireless subscriptions now exceed 330 million (more than one per person).

[200] Pacific Gas and Electric et al., *Codes and Standards Enhancement (CASE) Initiative for PY 2013, Title 20 Standard Development,* Docket #12-AAER-2A, July 29, 2013.

[201] A voluntary agreement has been reached for set top boxes that will achieve some of the potential savings.

[202]– see, e.g., Morris E. Jones, Jr., Belle W.Y. Wei, and Donald L. Hung, "Laptop Energy-Savings Opportunities based on User Behaviors," *Energy Efficiency,* 2013 (6); Won Young Park, Amol Phadke, and Nihar Shah, "Efficiency Improvement Opportunities of Personal Computer Monitors: Implications for Mark Transformation Programs," *Energy Efficiency,* (2013(6);Eric Hitting, Kimberly A. Mullins and Ines L. Azevedo, "Electricity Consumption and Energy Savings in the United States, Energy Efficiency, March, 31, 2012; Steven Lanzisera, Bruce Nordman, and Richard E. Brown, "Data Network Equipment Energy Use and Savings Potential in Buildings," *Energy Efficiency,* 2012 (5); Catherine Mercier and Laura Moorfield, *Commercial Office Plug Load Savings and Assessment: Final Report,* Ecova, July 2011; McKinsey Global Energy and Materials, *Unlocking Energy Efficiency in the U.S. Economy,* McKinsey and Company, 2009.

[203] The Local OEMs put the figure at 25%; ITI presenter used lower figures.

[204] LOEM at 8.

[205] Based on Exhibit 4.

[206] Based on the Staff analysis at p. 35.

[207] The estimates assume a 30% reduction in energy consumption, with the first two estimates based on the data underlying the Exhibit, the third is based on the NRDC (p. 4) data.

[208] CEC Workshop Comments, Sadowy, p. 5; Shiekh, p. 10.

[209] Fiona Brocklehurst and Jonathan Wood, Energy Consumption of Computers in the Chinese Market," CLASP, October 9, 2014, Energy Consumption of Gaming computers in the US, CLASP, October 30, 2014.

[210] David Greene and Jilleah G. Welch, *The Impact of Increased Fuel Economy for Light-Duty Vehicles on the Distribution of Income in the United States,* Oak Ridge National Laboratory and the Energy Foundation, September 2016.

[211] Appendix E explains why concepts like the discount rate and payback periods are market characteristics, reflecting the full array of market imperfections and failures. Therefore, it is a mistake to attribute them solely to consumers and to reify them in the economic analysis, since they embody the market imperfections that the rules are intended to correct.

[212] LBNL, 2016, Report Impact of the EISA 2007 Energy Efficiency Standard on General Service Lamps (see Table 3: Representative Lamp Options and Properties),

[213] Appliance Standards Awareness Project, et al., Docket No. EERE-2017-BT-NOA-0052, October 16, 2016.

[214] CFA responded to these claims in *Top 10 Reasons Consumers Want 54.5 MPG by 2025,* May 22, 2012, as well as in comments on the proposed Rule, 2012.

[215] TAR, pp. 6-16 to 6-22.

[216] Id., p. 6-17.

[217] Id., pp. 6-18, 6-19.

[218] The shift from 92% to 95% increases consumer pocketbook benefits by $5billion, but the 95% standard applies to less than 100% of the households. Assuming the net losers are eliminated in mild climates, one-third of those with net costs would be eliminated, saving about $370 of net costs per household. (TSD 2015, p. 3-38). This would apply to roughly 16% of total shipments. (TSD 2015, p. 7-3). Over twenty years, that is about 8 million units shipped, bringing the total reduction in net costs to almost $3 billion.

[219] DOE, NOPR 2015, p. 13576.

[220] Myers, Erica, "Asymmetric Information in residential Rental Markets: Implications for the energy efficiency gap." Energy Institute Haas School of Business, University of California, Working Paper WP 246, February 2015, cited in Building Technologies Office, Impact of Standards on Low Income Renters, eere.energy.gov; Larry Dale, Transcript of the Public Meeting, Energy Conservation Standards for Residential Furnaces, April 13, 2015, pp. 9-14.

[221] Miranda, Maie Lynn, 2011, "Making the Environmental Justice Grade: The Relative Burden of Air Pollution in the United States," Int. J. Environ. Res. Public Health,8(6).

[222] Morello-Frosch, R. and B.M. Jesdale, 2006, "Separate and unequal: residential segregation and estimated cancer risks associated with ambient air toxics in U.S. Metropolitan areas," Environ. *Health Perspect.* 114(3); Fleischman, Lesley and Marcus Franklin, 2017, *Fume Across the Fence Line,* Clean Air, November.

[223] Deguen, S. and D. Zmirou-Navier, 2010, "Social inequalities resulting from health risks related to ambient air quality – a European review," *Eur J Public Health* (1); Katz, Cheryl, 2012, "People in Poor Neighborhoods Breathe More Hazardous Particles," *Scientific American,* November 1.

[224] Shrubole, C., et al., 2016, "Impacts of energy efficiency retrofitting measures on indoor $PM_{2.5}$ concentrations across different income groups in England: a modelling study," *Advances Building Energy Research,* 10(1).

[225] Faiz, Asif, Christopher S. Weaver and Michael P. Walsh, 1996, Air Pollution from Motor Vehicles: Standards and Technologies for Controlling Emissions, The World Bank.

[226] Buckley, Timothy J, Ronald White, 2005, Socioeconomic and Racial Disparities in Cancer Risk from Air Toxics in Maryland," *Environmental Health Perspectives*, July, p. 693. While this study was at the census track level in Maryland, other studies reach similar finding in metropolitan areas across the nation. See, for example, "Segregation and Black/White Differences in Exposure to Air Toxics in 1990," Lopez, Russ, 2002, *Environmental Health Perspectives*, 110, April., Three factors, Black/White poverty levels, percent employed in manufacturing, and degree of segregation as measured by the dissimilarity index, collectively explain over half the variation in the net difference score for exposure to air toxics in large U.S. metropolitan areas. Other potential factors, including overall income inequality, relative political power, and local variation in environmental regulation (*64*), may also affect net difference scores and should be included in future research.... The results here show that Blacks are more likely than Whites to live in census tracts with higher total modeled air toxics concentrations, partly because they are more likely than Whites to live in poverty, and poverty itself may be a risk factor for living in a poor-quality environment.

[227] Comments of the Consumer Federation of America on the California Air Resources Board *Mid-Term Review,* before the California Air Resources Board, Attachment II: On The Road To 54 MPG, A Progress Report on Achievability, March 24, 2017.

[228] 2010 Models Don't Make The Fuel Economy Grade: New Labels Can Increase Automaker Mileage Performance The Same Way the Crash Test Results Improved Safety Performance, September 15, 2010, http://www.consumerfed.org/pdfs/New-Fuel-Economy-Grades-PR-9-15-10.pdf, Stuck in Neutral:: America's Failure to Improve Motor Vehicle Fuel Efficiency, 1996-2005, November 2006 http://www.consumerfed.org/pdfs/CAFE_and_Auto_Sales.pdf, Still Stuck in Neutral: America's Continued Failure to Improve Motor Vehicle Fuel Economy A Look at the Changes in Top Selling Models 2005-2007, July 2007, http://www.consumerfed.org/elements/www.consumerfed.org/file/Still_Stuck.pdf.

[229] Comments of the Consumer Federation of America, *Notice of Intent to Prepare an Environmental Impact Statement; Request for Scoping Comments*, before the National Highway Transportation Safety Administration, Department of Transportation, Docket No. NHTSA-2017-0069, September 25, 2017.

[230] Comments of the Consumer Federation of America, in the Matter of Transportation Infrastructure: Notice of Review of Policy, Guidance and Regulation, Before the Department of Transportation, Docket No. OST-2017-0057, Appendix B, July 24, 2017.

[231]Each year only about 10 percent of the fleet is made up of truly "all-new" vehicles. Typically, when a new model is introduced, that vehicle essentially stays the same for 5-6 years. This is called a "model series" and while there may be some style and feature changes during a model's series, the mechanics of the vehicle generally stay the same

[232] There were 27 all new vehicles introduced in 2017, 19 of them had a previous version available in 2011. These 19 vehicles were the ones we included in this analysis.

[233] CFA bases its estimate of the cost of fuel economy on a review of the literature including historical, market-based and engineering studies.

[234] 2017 Dollars

[235] Comments of the Consumer Federation of America, On the Proposed National Program, Technical Appendix, pp. 31-32.

[236] J.D. Power and Associates, Despite Rising Fuel Prices, the Outlook for "Green" vehicles Remains Limited for the Foreseeable Future, April 27, 29011.

[237] Dave Hurst and John Gartner, *Electric Vehicle Market Forecasts* (Navigant, 2013).

[238] Costello, 2005.

[239] Jansen Beurskens, and Tiburg, 2006, p. 13 argue for a risk-cost frontier.

[240] The **Standard deviation** is a widely used measurement of variability or diversity used in statistics and probability theory. It shows how much variation or "dispersion" there is from the "average" (mean, or expected/budgeted value). A low standard deviation indicates that the data points tend to be very close to the mean, whereas high standard deviation indicates that the data are spread out over a large range of values.

[241] Jansen Beurskens, and Tiburg, 2006, Appendix, p. 59, ""the question of whether a tool could be develop for gauging the impact of incremental technology deployment… the use of a (sort of) Sharpe ratio, showing the tangent of the direction a certain portfolio at (or to the right of) the efficient frontier would move into by incremental use of a certain technology."

[242] Energy Information Administration, *Early Release of the Annual Energy Outlook: 2012*, January, 2012.