Evaluation Draft Technical) EPA–HQ–OAR–2015–0827; NHTSA–2016–
Assessment Report for Model Year) 0068; FRL–9949–54–OAR
2022–2025 Light Duty Vehicle GHG) Department Of Transportation
Emissions and CAFE Standards) RIN 2060–AS97; RIN 2127–AL76

Comments of the Consumer Federation of America

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THE CONSUMER FEDERATION OF AMERICA

The Consumer Federation of America[1] has participated in dozens, if not hundreds, of efficiency rulemakings, regulatory negotiations, and legislative hearings involving large and small energy using durables, ranging from automobiles to heavy duty trucks, air conditioners, furnaces, water heaters, computers, and light bulbs.[2] We have participated in every round of the rulemaking for fuel economy standards since the passage of the Energy Independence and Security Act, which rebooted and reformed the CAFE program. We appreciate the opportunity to share our views of the current state and future prospects for the National Program.

Our technical expertise is not in the design and production of these durables, it is in the design and implementation of minimum energy standards. We believe that knowing how to build an effective standard is at least as important to arriving at a successful outcome as knowing how to build a consumer durable. Moreover, we conduct extensive polling of public opinion, review the technical economic studies prepared by others and analyze evidence on the market performance of consumer products to determine whether there are significant potential consumer savings that would result from a higher standard.

In these comments we briefly discuss what we see as the key issues that should be addressed as the agencies move from the Technical Assessment Review (TAR) to the full mid-term evaluation and final rule for light duty vehicles in the model year (MY) 2022-2025 time frame In the Appendices we provide extensive documentation of these main points by

1) showing that we have raised these point throughout our involvement in the proceedings that led up to the TAR and similar proceedings dealing with minimum energy performance standards and

2) updating the extensive literature reviews that we have conducted to establish the validity of the approach we take in these comments.

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[1] 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.

[2] The CFA website (http://www.consumerfed.org/issues/energy) lists over 100 pieces of legislative testimony and regulatory comments in home energy and motor vehicles, most of which involve energy use and efficiency standards..

SUMMARY OF FINDINGS

1) Under the base case assumptions, consumers are the big winners, with total benefits (consumer pocketbook, environmental/public health, and macroeconomic stimulus) in the range of three to six times the costs.

- Three-fifths of those benefits are enjoyed as direct pocketbook cost savings resulting from a reduction in the total cost of driving.
- Payback periods are less than half of the life of the vehicles, and\
- Cash flow is positive in the first year of ownership.
- One way to summarize this outcome is to calculate the cost per gallon saved. EPA estimates that over 50 billion gallons of oil will be saved at a cost of $36 billion. That works out to just over $0.70 per gallon. Under NHTSA's base case assumption the cost is $1.30/gallon. Both are far less than even the low cost EIA price projections.

2) Low income consumers benefit more than the average consumer.

- Operating expenses are much more important in their total cost of driving.
- In buying used cars they capture a disproportionate share of the fuel savings embodied in resold cars.
- They tend to live in areas that are most affected by the environmental and public health impacts of driving.
- By the time the MY 2022 standards kick in, many of the new cars available for resale in the used car market will have higher mileage and lower operating costs than would have been the case without the reboot of CAFE.

3) The benefits of the National Program are still very strong, in spite of declining gasoline prices, because the minimum performance standards were extremely well designed. They are what we call a "command but not control" approach to regulation.

- They address numerous market imperfections.
- They do so in a manner that harnesses the power of capitalism and markets to meet the standard in the least cost manner possible.
- The new approach ensures consumers have choices in what to buy and automakers have freedom to select the technologies they know best to meet the standards.

4) Automakers have done an excellent job with the freedom they have.

- The auto market is setting records for sales, even as the fuel economy standard rises.
- Automakers are over-complying.
- Costs are coming down.
- Innovation is roaring.

5) Industry complaints about the standards are the typical handwringing, which has proven to be wrong time and again in the past.

- The attack on the National Program is based on a mixture of self-serving, unsubstantiated assumptions and false choices between efficiency and other attributes of vehicles.
- The current round of complaints uses costs that are between two and seven times of the agencies' estimates.
- Their analysis misrepresents what consumers want and ignores how much the billions of dollars they spend on advertising influences consumer behavior.
- The auto industry funded think tank attacks on the National Program are equally unconvincing. Six months ago their report identified a dozen things in the TAR. The 1200 pages of the TAR make it clear that the agencies have responded and still find a strongly positive outcome.

6) The automakers are also overstating the differences between the agencies and demanding a unified National Program in the hope that this would lower the standards.

- Both agencies find that the National Program is in the public interest under the both of the applicable statutes.
- Many of the differences between the agencies were transitional and will be eliminated before the MY2022 standards kick in.
- Analytic differences are "easy" to resolve. The two agencies (EPA and the California Air Resources Board) that support the current standard (or stronger) have made a better case.

7) The Zero Emission Vehicles (ZEV) standards adopted by nine states under Clean Air Act rules should not be weakened or undermined by the federal agencies.

For forty years the Clean Air Act has allowed California to adopt a different standard that the federal standard to deal with unique pollution problems. The states can choose between the two standards. States that account for about one third of the U.S. auto market have followed California.

- This approach is an example of American federalism at its best, allowing states to exhibit leadership and experiment with more aggressive approaches to national problems, while limiting the number of standards to two.
- The Clean Cars states adopted the Low Emission Vehicle Program (LEV), which was a huge success, in that it was a primary factor in bringing hybrids into the market.
- EPA and NHTSA expect gasoline engines to represent the overwhelming majority of vehicles automakers sell to comply with the standards.
- Automakers have vastly overstated the impact of sale of electric vehicles (EV) under the ZEV program and underestimated the prospects for EV sales.

RECOMMENDATIONS

Our review of the TAR and the reports and critiques that have been made public prior to the filing of formal comments leads us to make the following recommendations.

NHTSA's departure from the base case assumptions has not been well-justified and should be dropped, or treated as a minor sensitivity analysis. This applies to the shift in markup calculation and the dramatic reduction in vehicle miles traveled.

More broadly, NHTSA needs to abandon the artificial constraint it has place on technology in its model with the 3-year payback requirement. That figure was never correct. Consumers are willing to accept a five year payback. More importantly, the marketplace has moved away from short paybacks. It appears that the overwhelming majority of consumers, (90% according to an NADA spokesman), finance their vehicles. They do not walk into a dealership and pay cash up front. Leases now run an average of 68 months and vehicles are being held by owners more than five years. A payback constraint on technology, if one can be justified, should be five years.

Both agencies should estimate the indirect macroeconomic benefits of the rule.

Payback periods have been given far too much prominence because they embody and reflect market failures. They should not determine the inclusion of technology directly.

The impact of standards on low income households deserves continuing attention and analysis since it is frequently, and incorrectly, cited as a reason to weaken fuel economy standards.

Specific detailed examples and case studies of the dramatic increase in innovation stimulated by performance standards should developed.

The role of the Clean Cars Program in triggering the development of hybrid technology should be examined both as a backward look at how federalism under the Clean Air Act has worked and as a forward looking framework for the development of electric vehicles.

The agencies should continue to work, as they have in the past, to resolve and reconcile their differences over technologies, program design and costs. The richness of the analysis that comes from multiple agencies using different approaches should be seen not as a source of dissension and difference. The agencies must act to implement a National Program and their statutes afford them the flexibility to resolve their difference by using the highest, not lowest common denominator.

DESCRIPTION OF AND EXPLANATION FOR THE NATIONAL PLAN SUCCESS

1. CONSUMER BENEFITS OF THE STANDARD

As shown in Table 1, the topline results of the launch and early implementation of the National Program are quite simply, a very positive bottom line. Table 1 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 CO2 emissions and oil consumption). We add monthly cash flow analysis and cost per gallon saved, they are as more relevant to consumers.

There are clearly 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 1: CONSUMER POCKETBOOK IMPACTS

	Monthly			Cost per	Payback	Lifecycle savings		Total National ($, billion)	
	Cost	first year savings	Net	gallon saved	in years	Consumer	Total	Cost	Benefit
EPA									
	$16.07	$19.92	$3.85	$0.70	5-5.5	$1,620	$2,365	$36	$130
Mark-up (ICM)									
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 is 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 exceeds 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.

As positive as these evaluation are, CFA believes that a major benefit of the National Program has been omitted from the calculation. Driving is very close to a necessity in our society, given our sparsely populated continental economy and living patterns. Necessities have relatively low price elasticities and modest income elasticities. When the total cost of driving declines, consumers have more to spend on other goods and services.

At one level, the EPA/NHTSA analyses recognize this in the form of a rebound effect. As the cost of driving declines, consumers drive a little more, but they still have additional disposable income left over. The gasoline savings calculations are net of the rebound effect at the societal level, but not the individual level. If a consumer chooses to spend the economic savings on more gasoline, that constitutes a net benefit to the consumer in the form of increased utility. The multiplier effect of having more disposable income to spend on other goods and services depends on the nature of the activities that are increased and decreased. The primary area where activity is reduced is the petroleum sector, which has a particularly low multiplier.

Estimating the indirect macroeconomic effect of policy changes using general equilibrium input/output models is a common part of much policy analysis.[3] In 2012 EPA ran such a model to assess the effect of reducing gasoline consumption and increasing expenditure of automotive technology. It found that for every $1 of consumer pocketbook savings, there was an increase in GDP of about $0,80. It also showed a net increase in employment. These benefits could push the total benefits to almost six times the cost, as shown in Table 2.

TABLE 2: BENEFIT-COST RATIOS FOR EACH SOURCE OF BENEFIT

	Base Case Markup		NHTSA High Markup	
	EPA	NHTSA	EPA	NHTSA
Pocketbook	2.5	1.5	2.2	1.4
Environmental/Other	1.1	.7	1	.6
Macroeconomic	2.2	1.2	1.8	1.1
Total	5.8	3.4	5.0	3.1

Source: TAR, pp. ES-12. Macroeconomic based on EPQ.

2. LOW INCOME HOUSEHOLDS

Four years ago we explained why low income households are big winners from fuel economy standards and the EPA has looked at our arguments in the Technical Assessment Report. They found them to be supported by the empirical literature.[4]

Low income households make up a much smaller part of the new vehicle market than their share in the overall population. Therefore, 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. In the most recent consumer expenditure survey, low income households

[3] MEMORANDUM TO: Docket EPA-HQ-OAR-2009-0472, SUBJECT: Economy-Wide Impacts of Greenhouse Gas Tailpipe Standards; March 4, 2010 ; 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 are factored into this analysis. Lower prices allow for additional purchases of investment goods which, in turn, lead to a larger capital stock. These price reductions also allow higher levels of real 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.
Appendix H presents our discussion of this issue in the heavy duty truck rule and the performance standards paper.

[4] TAR, pp. 6-16 to 6-22.

spend about one-ninth as much on vehicle ownership as non-low income households but about one half as much of gasoline.[5]

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.

3. Well-Crafted Standards

We approach the setting of standards from a uniquely consumer point of view, always starting from three basic questions:[6]

- Will a standard save consumers money?
- Why is there an efficiency gap that appears to impose unnecessary costs on consumers?
- Why is a standard an appropriate policy?
- How can the standard be best designed to achieve the goal of lowering consumer cost?

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**, **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 3 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.

[5] Bureau of Labor Statistics, Consumer Expenditure Survey, June 2015.

[6] Appendix A provides examples form recent regulatory proceedings. Appendix B provides an overview of the conceptual framework based on the identification of numerous market imperfection. Appendix C identifies over 200 empirical studies from the past decade and a half that support the view the energy efficiency and climate change reflect significant market imperfection and market failure problems.

TABLE 3: IMPERFECTIONS POTENTIALLY ADDRESSED BY STANDARDS[1]

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]			
	Produce differentiation[19]			
	Incrementalism[30]			

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 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

4. 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.

5. Misleading Analysis from the Automakers

The AAM analysis makes a remarkable series of erroneous assumptions and misleading comparisons and claims.[7]

The analysis looks at only the costs of the standards and not the benefits.

The first slide (p. 2) claims that "only OEMs have real skin in the game." In fact, since the consumer pocketbook benefits exceed the technology costs by more than three-to-one, consumers have twice as much "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 six times as much "skin in the game" as the automakers. The claims ignore the fact that the agency analyses show that the total cost of driving declines (p. 35).

Above all, the beneficial effect of a reduction in the total cost of driving is hidden behind cost estimates that are 2 to 10 times higher than the agency estimates and benefits that are under estimated by 50 percent.[8]

The Alliance makes a series of erroneous and misleading comparisons.

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[7] 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)

[8] Appendix D provides evidence on the historic tendency of industry and regulators to overestimate the cost of implementing standards because they underestimate the ability of well-designed standards to unleash market forces to lower costs.

The Automakers present numerous nonsensical comparisons. For example, on the list of public concerns (p. 7), they note that terrorism, race relations and a weak economy are a greater concern to the public. 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 a bogus choice (p. 7) that assumes the global threat of climate change "requires government regulations… that raised the price on new cars… pricing new cars out of the reach of many American families," more respondents opt for more regulation (42% to 41%).

Similarly (p. 8), they point out that 69% of respondents want to encourage mobility, vs. 16% that want to discourage mobility. Since the standards lower the cost of driving (and have a rebound effect to increase driving), they obviously encourage mobility.

The Alliance asks loaded questions.

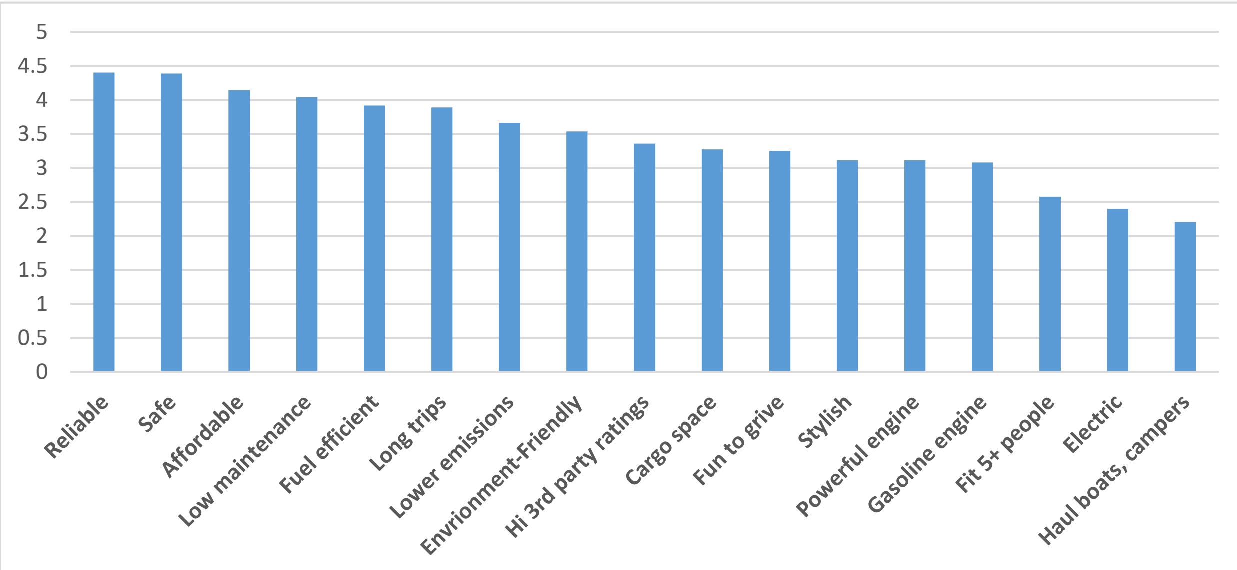
The key question on regulation reported by the AAM is extremely biased (p. 10). First, the question uses the laboratory standard of 54.5 miles per gallon, while EPA/NHTSA do all their economic analysis at the adjusted, real world mileage of about 42 MPG. Survey respondents live in the real world and 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 barrel bias, while 47% of the respondents said the target of 54.5 was too aggressive, 46% said it was about right or too lenient.

The public is not as enamored of gasoline powered muscle cars and trucks as the automakers claim.

If an EV and gasoline vehicle were matched on cost and travel length (p. 9), 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 1 shows, the analysis of desirable vehicle attributes shows that consumers want reliable, safe, affordable and low maintenance vehicles (p. 10). 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 1 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 (8^{th} and 9^{th}) than powerful engines (13^{th}) or engine type (gasoline power =14^{th}, electricity = 16^{th}). Fitting more than 5 people (15^{th}) or hauling boats and campers (ranks dead last) don't matter much. 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 means that EVs are on the early part of the adoption curve and there is a very strong basis to expect success.

FIGURE 1: 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)

The report from the School of Public and Environmental Affairs of Indiana University, which is supported by the automakers, raises many issues and questions about the fuel economy standards. As the Table 4 shows, the report should carry no weight with policymakers on procedural and substantive grounds.

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.

6. ONE NATIONAL PROGRAM

The automakers claim "there is no One National Plan" (ONP, p. 31-33). However, 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.

TABLE 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.

NHTSA has headed in a tangential direction based on 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 2.

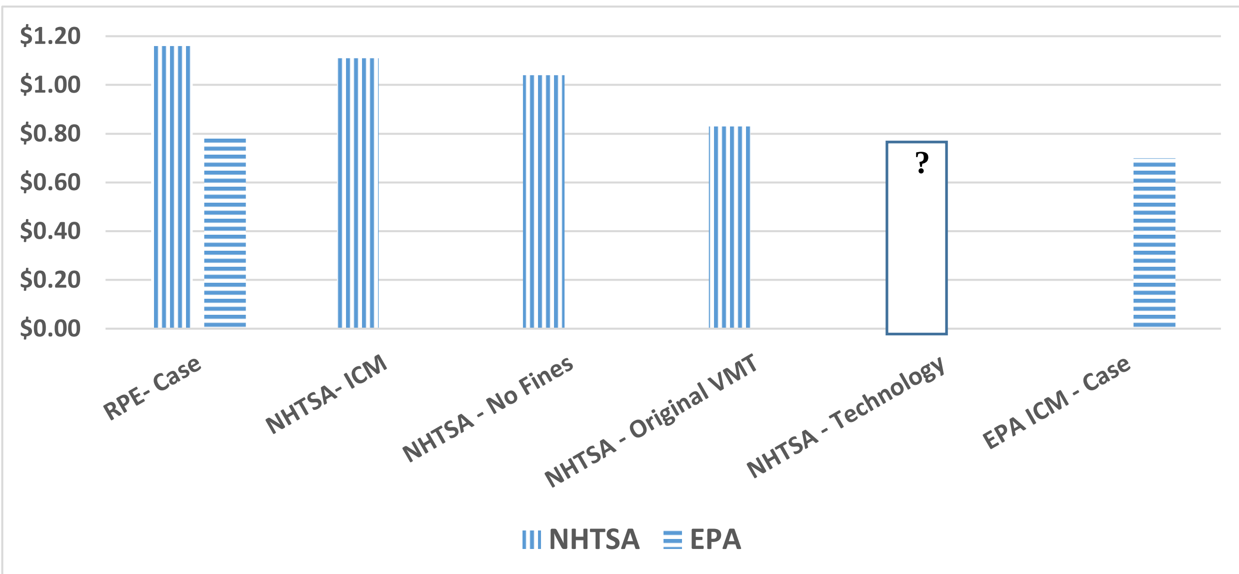
In our view NHTSA has gone off on a tangent from the other two agencies because of erroneous assumptions in its analysis. It increased the estimate of costs by unjustifiably raising the mark-up on fuel efficiency technologies and including fines paid in the cost. If lower cost technologies are available 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.

It continues to impose the assumption that technologies included in vehicles must have a three year payback.[9] That assumption was never justified, since consumers are willing to accept

[9] 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

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.

FIGURE 2: 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.

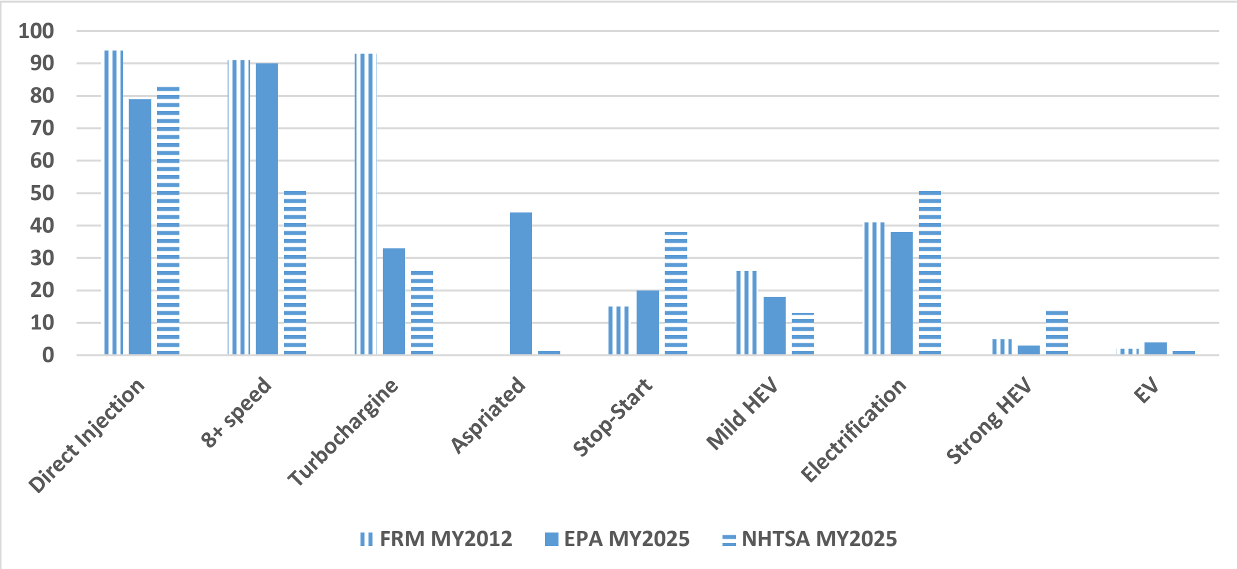
In one sense we should welcome differences in the penetration of technologies between manufacturers and across the fleet. This should indicate that different automakers are pursuing those technologies that suit them best and there are a lot of alternative pathways available. At the same time, extremely 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 3, 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

consumers and to reify them in the economic analysis, since they embody the market imperfections that the rules are intended to correct.

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 better institutionally and legal better situated to take the lead where differences cannot be resolved.[10]

FIGURE 3: PENETRATION OF SPECIFIC TECHNOLOGIES INTO THE FLEET (IN PERCENT)



Source: TAR, pp. 12-35, 13-61-13-72.

7. THE IMPORTANT ROLE OF THE CLEAN CARS (ZEV) PROGRAM

Our analysis shows that the main reason hybrids hit the market as early as they did (if indeed they ever would have) was California's low emission vehicle (LEV) program. The LEV program was designed to address the state's unique air quality problems, and adopted by a dozen other states for a variety of reasons, and incentivized automakers to develop and sell hybrids. Hybrids have now become best in class across a number of vehicle categories.

California's leadership role on emissions and fuel economy is federalism at its best: the state is a test-bed for automotive innovation, and we're seeing the emergence of some of the cleanest vehicles on the planet, at prices comparable to other mass market vehicles. The leadership of states to advance important public policy goals in the form of the Zero Emission Vehicle (ZEV) Program is again being resisted and attacked by the automakers.

Consumer Federation of America surveys show that consumers – especially young adults—are increasingly interested in buying electric vehicles and the more people know about

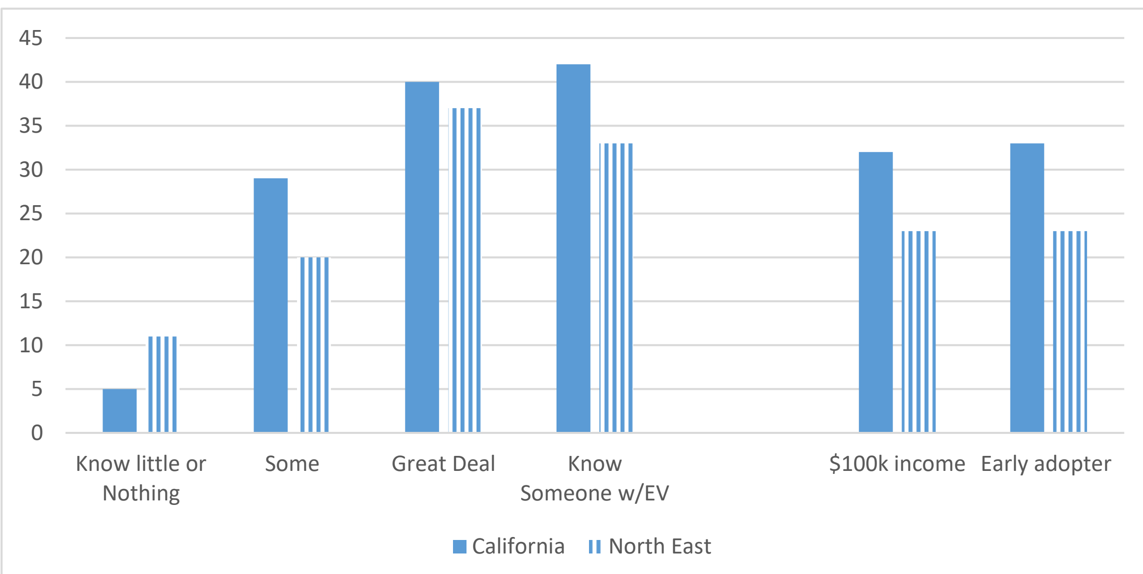
[10] Appendix F argues that the intersection of the "efficiency gap" and climate change create an urgent need for vigorous policy action. Appendix G outlines our thinking about the legal and institutional factors that affect the agencies' ability to undertake those vigorous actions.

EVs, the more interested they are. Interest has increased over the past year, despite persistent low gas prices. This year, 13 car companies are offering at least one electric option.

Neither EPA nor NHTSA expect gasoline engines to dominate the compliance strategies of auto makers and both project EVs playing a very small role in the National Program.   We have argued that the public opinion response and automaker interest in a new technology that is rapidly evolving toward attributes that will attract consumers is bright (see Appendix I).

Figure 4, taken from the AAM shows the important role of knowledge that we have found in our surveys. Those will little knowledge are unlikely to consider buying an EV, that the willingness to consider EVs grows dramatically with knowledge, to about two fifths. Moreover, knowledge and some experience (knowing someone with an EV) are equal in impact. We also know that over a quarter of young people and almost a third of those with incomes above $100k express interest. Early adopters express a similar level of interest. In our view, with a new technology at a currently low level of penetration and targets for adoption well below the level of expressed interest, this constitutes an encouraging field of interest for automakers to till.

FIGURE 4: LIKELY TO CONSIDER BUYING AN EV IN THE NEXT TWO YEARS



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. 19. 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)

APPENDIX A:

DEFINITION AND APPLICATION OF THE PERFORMANCE STANDARD CRITERIA

This Appendix contains examples of the framework as we have presented and applied it in various energy policy contexts and proceedings.

PRESENTATION TO THE CALIFORNIA ENERGY ACADEMY

***Energy Efficiency Performance Standards: The Cornerstone of Consumer-Friendly Energy Policy*, October 2013. *Energy Efficiency Performance Standards: Driving Consumer and Energy Savings in California*, Mark Cooper, Director of Research, California Energy Commission's Energy Academy, February 20, 2014, slide 22.**

> **Performance Standards**: 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. Key principles for the design of performance standards to ensure they are effective include the following.

- **Long-Term:** Setting an increasingly rigorous standard over a number of years that covers several redesign periods fosters and supports a long-term perspective. The long term view lowers the risk and allows producers to retool their plants and provides time to re-educate the consumer.
- **Product Neutral:** Attribute based standards accommodate consumer preferences and allow producers flexibility in meeting the overall standard.
- **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 choices at that lowest cost possible, given the level of the standard.
- **Responsive to industry needs:** The standards must recognize the need to keep the target levels in touch with reality. The goals should be progressive and moderately aggressive, set at a level that is clearly beneficial and achievable.
- **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.
- **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.

LIGHT DUTY VEHICLES

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.

The proposed rule recognizes the need to keep the standards 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 proposed 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 Benefit of Technology Neutral, Product Neutral Long-Term Standards
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.

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.

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.

HEAVY DUTY TRUCKS

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.

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.

Phase II: EPA/NHTSA point out that the cycle can take as long as ten years. They see this as a fundamental constraint on the ability to set standards to require technologies to be included. 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. 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: Taking a technology neutral approach to a long term standard unleashes competition around that ensures that the industry will get a wide range of choices at that lowest cost possible.

Phase II: 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. 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.

Product Neutral: 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.

Phase II: 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. 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: 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.

Phase II: The adoption cycle is also a constraint on the speed of penetration of technologies into the market. 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. 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.

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 criteria. 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.

Phase II: 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. EPA/NHTSA have certainly made that effort here. For example, 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.

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.

Phase II: 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.

COMPUTERS

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.

THE IMPORTANT ROLE OF STANDARDS

The strongly positive cost benefit analysis that supports including energy saving technologies in these household digital devices, always raises the question:

- Why hasn't the marketplace driven this result?

The answer to this question is well-known:

- The market for energy efficiency suffers from numerous obstacles, barriers and imperfections that inhibit the investment in energy efficiency technologies.

We have examined 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 in a recent report. 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.

California's role in moving the nation forward in setting standards for these devices is also appropriate for a number of reasons.

- California is a large enough market to get the attention of the product manufacturers.
- Not only is the California economy large even on a global scale, but Silicon Valley in Northern California has a special place in the digital revolution, so it is likely to get the broad attention of policy makers.
- Given the experience of the past quarter of a century, there is a great deal of experience with this type of standards setting process in California.
- The fact that the California IOUs have conducted extensive analysis and proposed a set of standards that achieves significant savings reflects this history and bodes well for the process.

Given the highly positive cost benefit analysis and the demonstration that there are numerous technologies available that could meet or beat the standard, the proposed levels are a good starting point, but just a starting point. In our review of the literature, we identified a number of characteristics that make performance standards effective in responding to the market barriers and imperfections that inhibit investment in efficiency. The proposed initial levels of the standards would capture many of the characteristics.

GAS FURNACES

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,J uly 10, 2015, p. 23

A. Market Imperfections as the Cause of Consumer Harm in the Market for Gas Furnaces

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. Our extensive analysis of several literatures and hundreds of studies has identified five broad categories and three dozen specific market imperfections. The upper graph of Exhibit 9 identifies the broad categories and specific types of market failures that our analysis shows performance standards are adept at addressing. We described the specific market imperfections that affect the energy consumption of gas furnaces in the lower section of Exhibit 9.

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 diminishes the impact of prices.

EXHIBIT 9: IMPERFECTIONS ADDRESSED BY STANDARDS: HIGHLIGHTING FACTORS AFFECTING DIGITAL DEVICES

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

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).

C. WELL-DESIGNED PERFORMANCE STANDARDS

We believe the proposed standards possess these characteristics. 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.

APPENDIX B
CONCEPTUAL SPECIFICATION OF MARKET IMPERFECTIONS

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

The effort to create a unified National Program to improve fuel economy and reduce greenhouse gas emissions ties together two major fields of energy policy and research. Over the past several decades, these areas have been the subject of a great deal of conceptual and empirical analysis. These are summarized in the following tables.

EFFICIENCY

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 **Economics of information**	**Split Incentives (3)** **Imperfect & Asymmetric Information (4)**
Add bounded rationality & broader concept of transaction cost	**Transaction cost economics**	**Adverse Selection (5)** **Hidden Costs (7)**
Add biases, error and decision heuristics	**Behavioral Economics**	**Bounded Rationality (6)** **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, analysing 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; analysing 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.

<u>Clusters</u>
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

Inconsistent quality of installation (sizing, sealing and charging, code compliance and enforcement) and improper use eliminates savings

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

Incumbent Support
Industry structure
Inadequate supply chain
Monopoly power

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

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

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.

APPENDIX C

EMPIRICAL EVIDENCE SUPPORTING THE MARKET IMPERFECTION AND POLICY ANALYSIS

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

This Appendix presents an update of sources and citations from our review of the empirical literatures that supports the existence of an "efficiency gap" that is caused by a number of market imperfections and demonstrates the close parallel in the climate change literature. analysis in this Chapter. We present the sources in alphabetical order, with each source having a number. The numbers from the tables correspond to the numbers in the source list. The numbering enables us to assign each source to a specific market imperfection or policy conclusion. Many of the sources are multifaceted, so they appear several times.

The citations are presented next. Lower case letters refer to citation from the efficiency gap literature. Uppercase letters refer to citations from the climate change literature. Here we use the short form citation to identify the source in the alphabetical list. We have tried to extract quotes that bear directly on the area they are listed.

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,

1 Acemoglu, Daron, et al., 2012, *"The Environment and Dedicated Technical Change," American Economic Review, 102(1*)
2 Allcott, Hunt and Nathan Wozny, 2011, *Gasoline Prices, Fuel Economy and the Energy Paradox?",* MIT, Working Paper.
3 Allcott, Hunt, 2010, *Beliefs and Consumer Choice,* November.
4 Andersson, Henrik, et al. 2013, "Willingness to Pay and Sensitivity to Time Framing: A Theoretical Analysis and an Application on Car Safety," *Environ Resource Econ*, 56.
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Citations

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 Dechezlloprete, 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
OVERESTIMATION OF COSTS IN REGULATORY PROCEEDINGS

***Energy Efficiency Performance Standards: The Cornerstone of Consumer-Friendly Energy Policy*, October 2013, pp. 28-32.**

While the aggregate data in Exhibit III-1 appear to suggest a very strong downward trend, the data for individual utilities suggest a moderate downward trend. Exhibit III-1 shows the trend line for one individual utility. The trend is very slightly negative. The authors suggest that declining costs for higher levels of efficiency can be explained by economies of scale, learning and synergies in technologies. As utilities do more of the cost effective measures, costs decline. Also, if technical potential is much higher than achievable savings, economies of scale and scope and learning could pull more measures in and lower costs. This explanation introduces an important area of analysis in the "energy gap" debate – learning curves.

Policies to reduce the efficiency gap, like performance standards, will improve market performance. 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 above that 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.

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.

> 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 efficiency appliances.[11]

> 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 cost. 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.[12]

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).

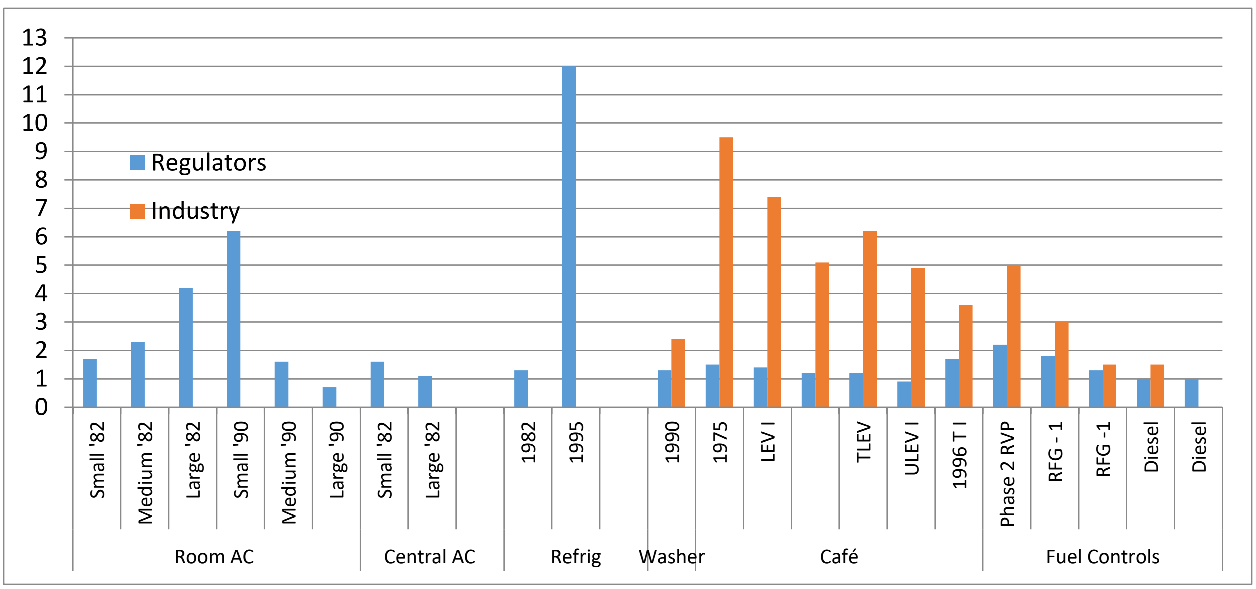
> The European car industry is highly dynamic and innovative. Its R&D expenditures are well above average in Europe's manufacturing sector. Among the most important drivers of innovation are consumer demand (for comfort, safety and fuel economy), international competition, and environmental objectives 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…

[11] Dale, et. al., 2009, p. 1.
[12] Sperling, et al., 2004, p.p. 10-15.

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.[13]

Exhibit III-4, 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.[14] 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."[15]

EXHIBIT III-4: 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.**

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

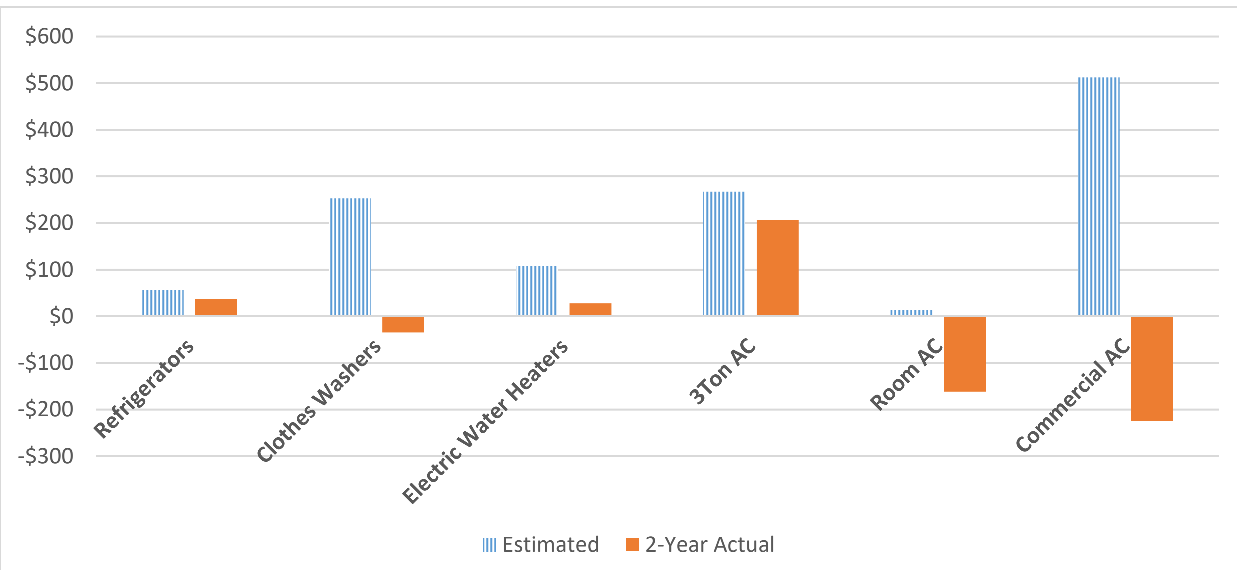
[13] Kuik, 2006,
[14] Hwang, and Peak, 2006.
[15] Harrington, 2006, p. 3.

response. A simulation of the cost of the 2008 increase in fuel economy standards found that a technologically static response was 3 times more costly 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.[16]

A recent analysis of major appliance standards adopted after the turn of the century shows a similar and even stronger pattern (see Exhibit III-5). Estimated cost increases are far too high. There may be a number of factors that produce this result, beyond an upward bias in the original estimate and learning in the implementation, including pricing and marketing strategies. Sperling et al, 2004, emphasized the adaptation of producers in the analysis of auto fuel economy standards.

EXHIBIT III-5: ESTIMATED AND ACTUAL COST INCREASES ASSOCIATED WITH RECENT STANDARDS FOR MAJOR APPLIANCES



Source: 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.

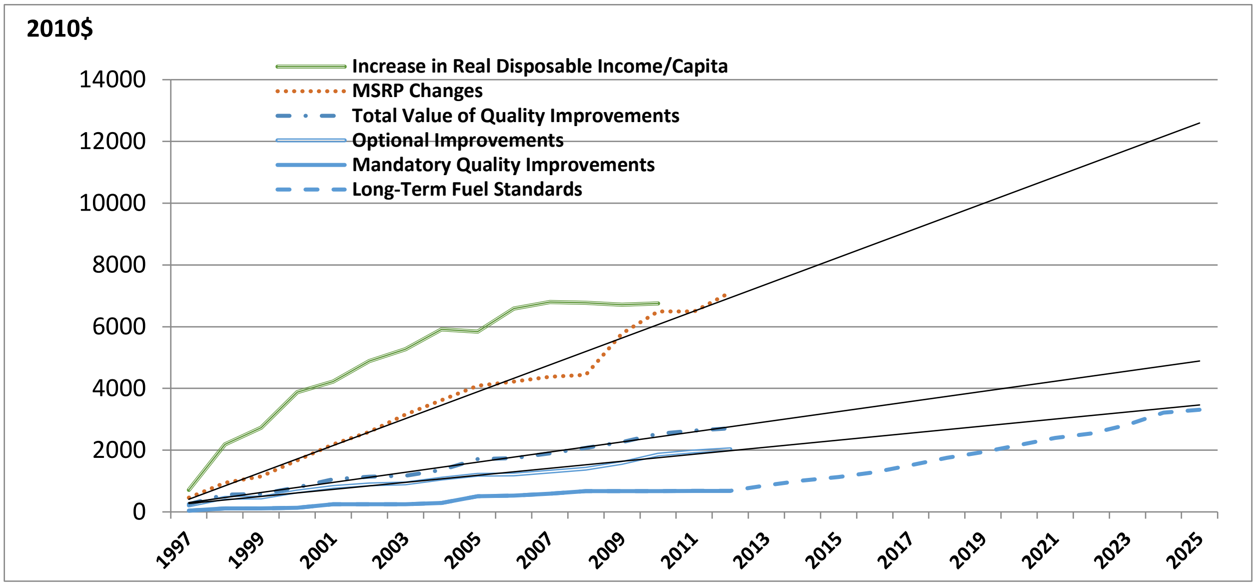
As shown in Exhibit III-6, in comments on the light duty truck and auto standards, CFA presented a historical analysis of cost increases associated with mandates that reflects the ability and strategy of producers to keep cost increases within the broad limits of industry practices.

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

[16] Whitefoot, et al., 2012, pp. 1…5.

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.

EXHIBIT III-6: GRADUAL IMPROVEMENT IN FUEL ECONOMY CAUSES A SLOW AND STEADY PRICE INCREASE WHILE THE INDUSTRY HAS HANDLED 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.

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.[17]

[17] Worrell, et al., 2003, p. 1081.

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,J uly 10, 2015, PP. 26-31

D. THE TRACK RECORD OF APPLIANCE ENERGY PERFORMANCE STANDARDS

1. Impact on Efficiency

The track record of efficiency standards for household consumer durables is excellent and the performance of the furnace market is quite deficient with respect to energy efficiency. Exhibit 11 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.

Examining the trends for individual consumer durables in Exhibit 11 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, as we have noted, DOE has set weak standards.

Third, after the initial implementation of a standard, the improvement levels off, suggesting that if engineering-economic analysis indicates that improvements in efficiency would benefit consumers, the standards should be strengthened on an ongoing basis.

Exhibit 12 shows the results of econometric analysis of the data underlying Exhibit 11. It shows that what is obvious to the naked eye in the bivariate relationships in Exhibit 11 (stricter standards as set by DOE lead to measurable improvements in appliance efficiency) are statistically valid when rigorous controls are introduced into multivariate regression analysis.

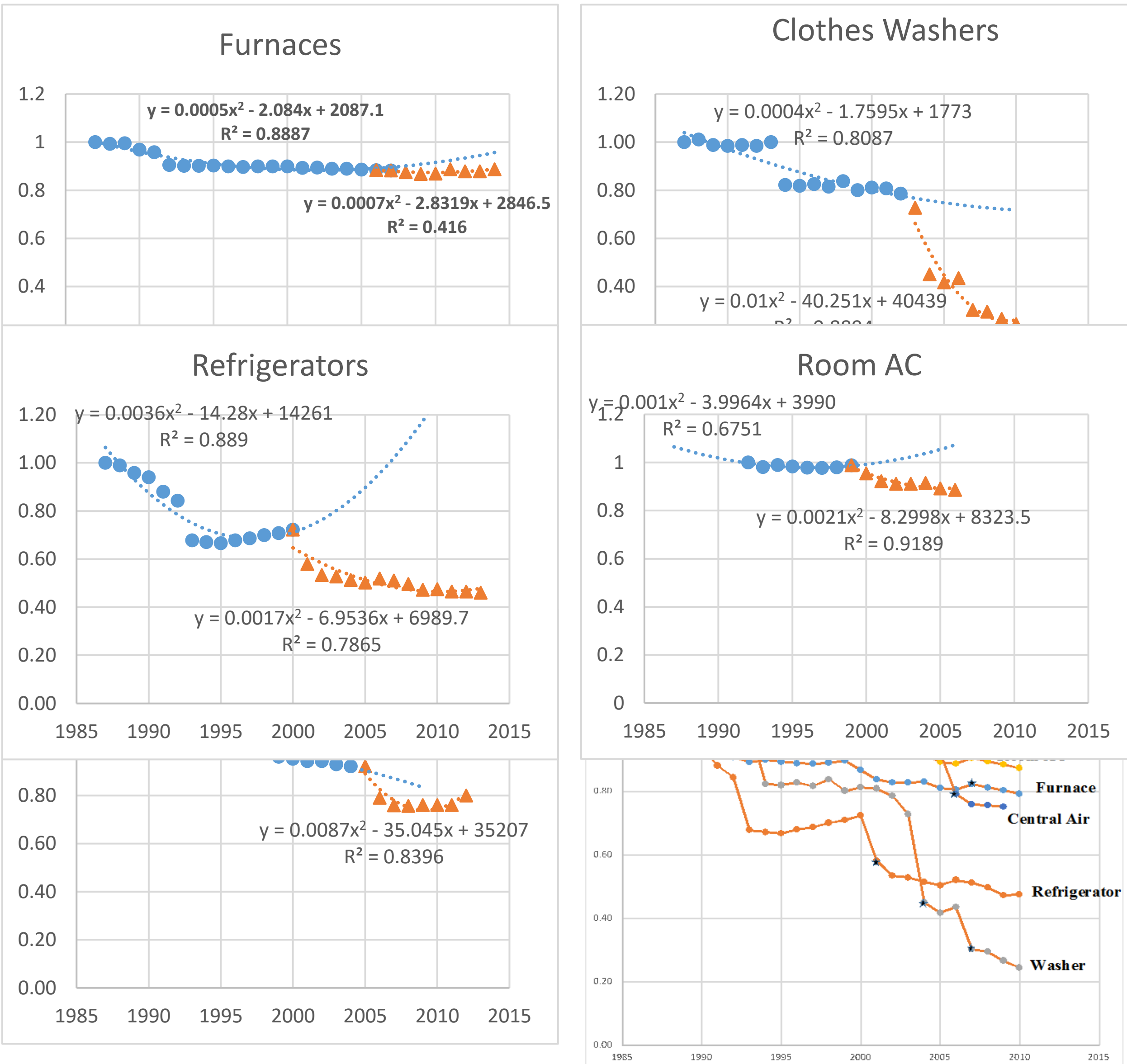
We have built this analysis in the typical way that multivariate regression analysis is conducted. The dependent variable is energy consumption with the base year set equal to 1. Later years had lower values.

We measure the trend of efficiency improvements (the market driven year-by-year improvements) by including the year as trend term.

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 appliances performed compared to furnaces. Again, a negative number means that the other appliances had lower levels of energy consumption.

EXHIBIT 11: APPLIANCE EFFICIENCY STANDARDS AND TRENDS
(BASE YEAR EFFICIENCY = 1; ▲ = NEW STANDARD)



Source: Nadel, Steven and Andrew deLaski, *Appliance Standards: Comparing Predicted and Observed Prices*, American Council for An Energy Efficient Economy, July 2013; Nadel, Steven, Neal Elliott, and Therese Langer *Energy Efficiency in the United States:35 Years and Counting,* June 2015

EXHIBIT 12: MULTIVARIATE ANALYSIS OF STANDARDS

Variable	Statistic	5-years before/after			All Year			
		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 Beta coefficient and robust standard errors.

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.

Comparing the models with shorter terms to the all year models 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.

2. Price

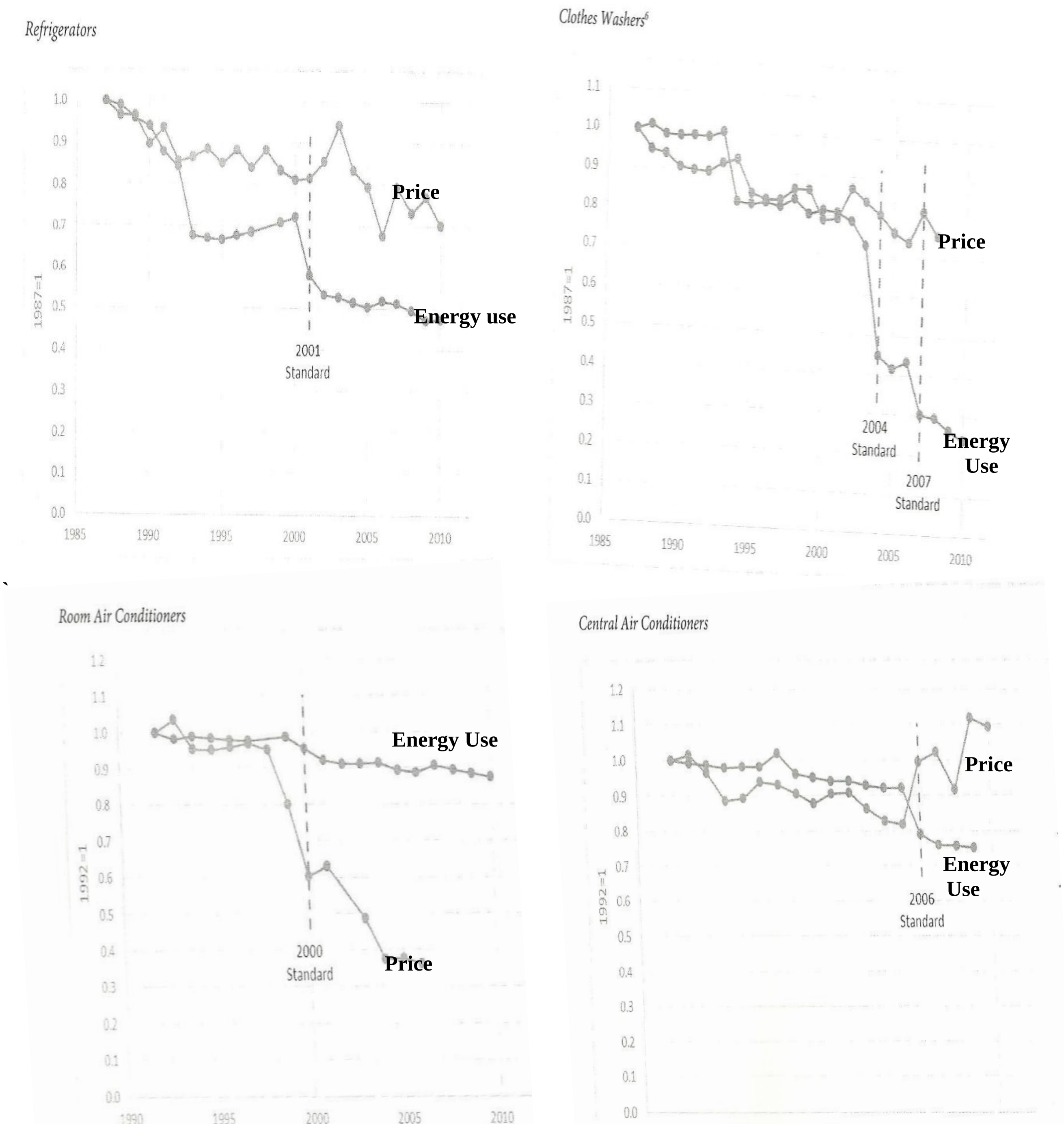
The engineering-economic analysis indicates that although the standards may increase the cost of the consumer durable, the reduction in energy expenditures is larger, resulting in a net benefit to consumers. We have also pointed to evidence that the costs of energy saving technologies tends to be smaller 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.

While the efficiency was increasing, the cost of the durables was not, as shown in Exhibit 13. There are five standards introduce for the four appliances in Exhibit 13. In three of the cases – refrigerators, clothes dryers (second standard) and room air conditioners – there was a slight increase with the implementation of the standard, then a return to pre-standard downward trend. In one case – clothes dryers (first standard) – there was no apparent change in the pricing pattern. In one case (central air conditioners) there was an upward trend, which may be explained by a surge in metal prices during that period.

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 suggestion, (i.e. suppliers take the opportunity of having to upgrade energy efficiency through redesign to make other changes that they might not have made). 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.[18]

[18] Nadel, Steven and Andrew deLaski, *Appliance Standards: Comparing Predicted and Observed Prices,* American Council for An Energy Efficient Economy, July 2013; Consumer Federation of America, Performance Standards.

EXHIBIT 13: PRICE TRENDS AND STANDARDS



Source: Nadel, Steven and Andrew deLaski, *Appliance Standards: Comparing Predicted and Observed Prices*, American Council for An Energy Efficient Economy, July 2013;

APPENDIX E
DISCOUNT RATES AND PAYBACK PERIODS AS MARKET OUTCOMES

***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**

While the calculation of payback periods is a frequent measure of the economics of an investment, it is only one measure of the consumer impact and it suffers from significant limitations, particularly when it is interpreted as a constraint on behavior.

NHTSA discovers that there are fuel savings technologies that pay for themselves, but have not been moved into the vehicle fleet. Since this cannot be explained by the externalities market failure, there must be other market failures operating.

> *If some fraction of fuel economy improvements (as perceived and valued by vehicle purchasers) is large enough to exceed the increased vehicle cost (and result in an increase in vehicle sales), then what would be the nature of the market failure such that those levels of fuel economy would not exist but for a CAFE mandate? To better understand this issue, NHTSA seeks comment on the following question: What evidence or data exists that indicate the extent to which consumers undervalue fuel economy improvement? Under what circumstances is it reasonable to expect that a mandated increase in fuel economy would lead to an increase in sales?*

NHTSA's pro-industry view of the world blames the market failure on the consumer, when, in fact, the problem is the automakers. This is one of several reasons that NHTSA's reliance on auto industry plans and data and the extreme efforts to which it goes to "protect" the automakers from discomfort are misplaced.

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 Exhibit A-5).

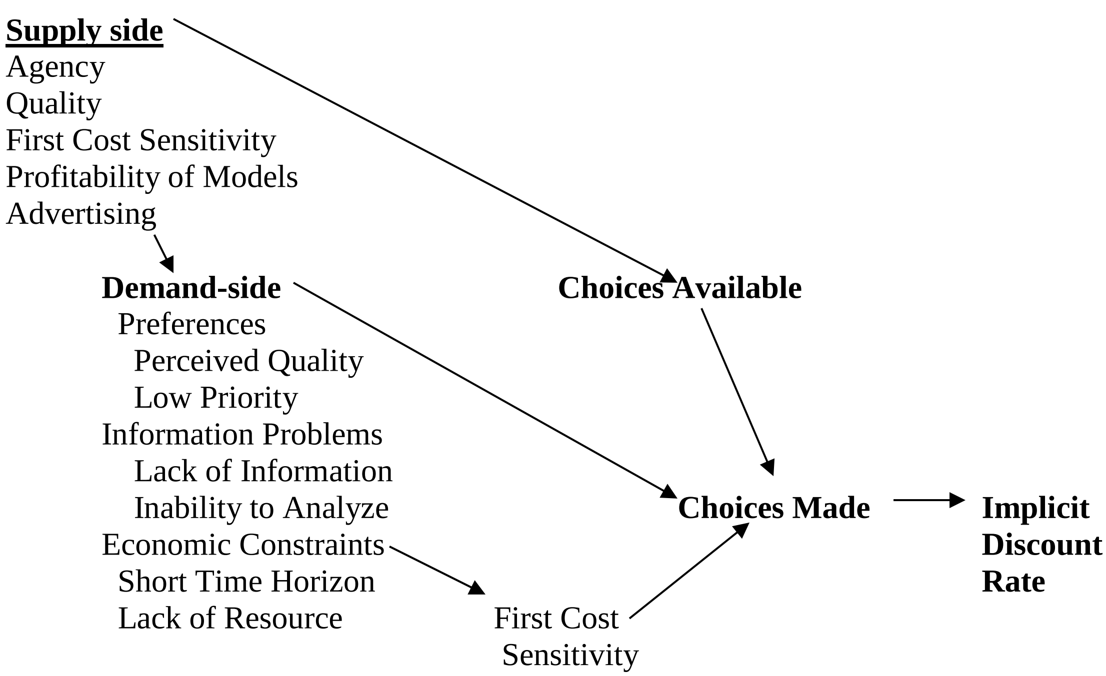
Failing to recognize the imperfections on the supply-side leads NHTSA to an over reliance on automaker product plans. Thus, it is a much better representation of reality to say that the auto market undervalues fuel economy. The problem is not just the consumer. Indeed, the automakers may be a bigger 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.

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.

Exhibit A-5:
Imperfections in the Auto Market



Even when they do consider efficiency investments, they may not find the more efficient vehicles to be available in the marketplace.

We view the apparent high discount rate attributed to consumers as the result of other factors not the root cause of the demand-side problem. 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.

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.

***Energy Efficiency Performance Standards: The Cornerstone of Consumer-Friendly Energy Policy*, October 2013**

The Discount Rate

The market exhibits a high "implicit" discount rate for energy efficiency, which we interpret as the result of the many barriers and imperfections that retard investment in efficiency enhancing technology.[19] There are several aspects of the high discount rate that deserve separate attention. 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. In other word, 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. Analysis of market imperfections explains the implicitly high discount rate as the result of market imperfections, not consumer preferences.

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,[20] procrastinating consumer,[21] who responds to average, not marginal prices.[22] The consumer is heavily influenced by social pressures,[23] with discount rates that vary depending on a number of factors[24] and has difficulty making calculations.[25] 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

[19] In one recent example, Mon, 2014, finds an implicit discount rate for light bulbs of 100%
[20] See e.g., Arbuthnott, Dolter, 2013, p.7; Qui, Colson and Grebitus, 2014, p. 216,
[21] See e.g., Lilemo, 2014, The effect of procrastination
[22] See e.g., Ito, 2014, p. 537,
[23] See e.g., Axsen, Orlebar and Skippon, 2013, 96,
[24] See e.g., While the sensitivity to a range of socio-economic factors is to be expected, other variation is surprising (e.g. Enzler and Meir, 2014), Andersson, Henrik, et al., 2013, 437.
[25] See e.g., Kurani and Turrentine, 2004, p. 1,

agency problem).[26] Bundles of attributes are decided by producers in circumstances in which the consumer cannot disentangle attributes (the shrouded attributes problem.)[27]

Firms suffer similar problems. We find organizational structure matters a great deal[28] in routine bound,[29] resource strapped organizations[30] confronted with conflicting incentives[31] and a great deal of uncertainty about market formation for new technologies.[32] Knowledge and skill to implement new technologies is lacking[33] and firms have little incentive to create it because of the difficulty of capturing the full value.[34] Public policy efforts to address these problems have been weak and inconsistent.[35] 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.[36]

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[26] See e.g., Davis, 2010, p. 1; Lutzenheiser, et al., 2001, cited in Blumstein, 2013, p. viii,
[27] Bundles and Shrouded attributes xx
[28] See e.g., Inoue, 2013, 162, our finding shows that the organisational and managerial factors of firms are important in examining environmental R&D.
[29] See e.g., Montaveloalo, 2007, A11
[30] See e.g., Sorrel, Mallet and Nye, 2011, p. iii,
[31] Sardianou, 2007, p. 1417,
[32] See e.g., Montaveloalo, 2007, p. A10,.
[33] See e.g., Horbach, 2007, p. 172,
[34] See e.g., de Cian and Massimo, 2011, p. 123, Jamasb and Nicita, (2007, p 8
[35] See e.g., Sorrel, Mallet and Nye, 2011, p. 67, Sardianou, 2007, p. 1402,
[36] See e.g., Fuss and Szolgayosva, 2010, p.2938,

APPENDIX F
THE INTERSECTION OF MARKET FAILURE AND MASSIVE EXTERNALITIES

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,

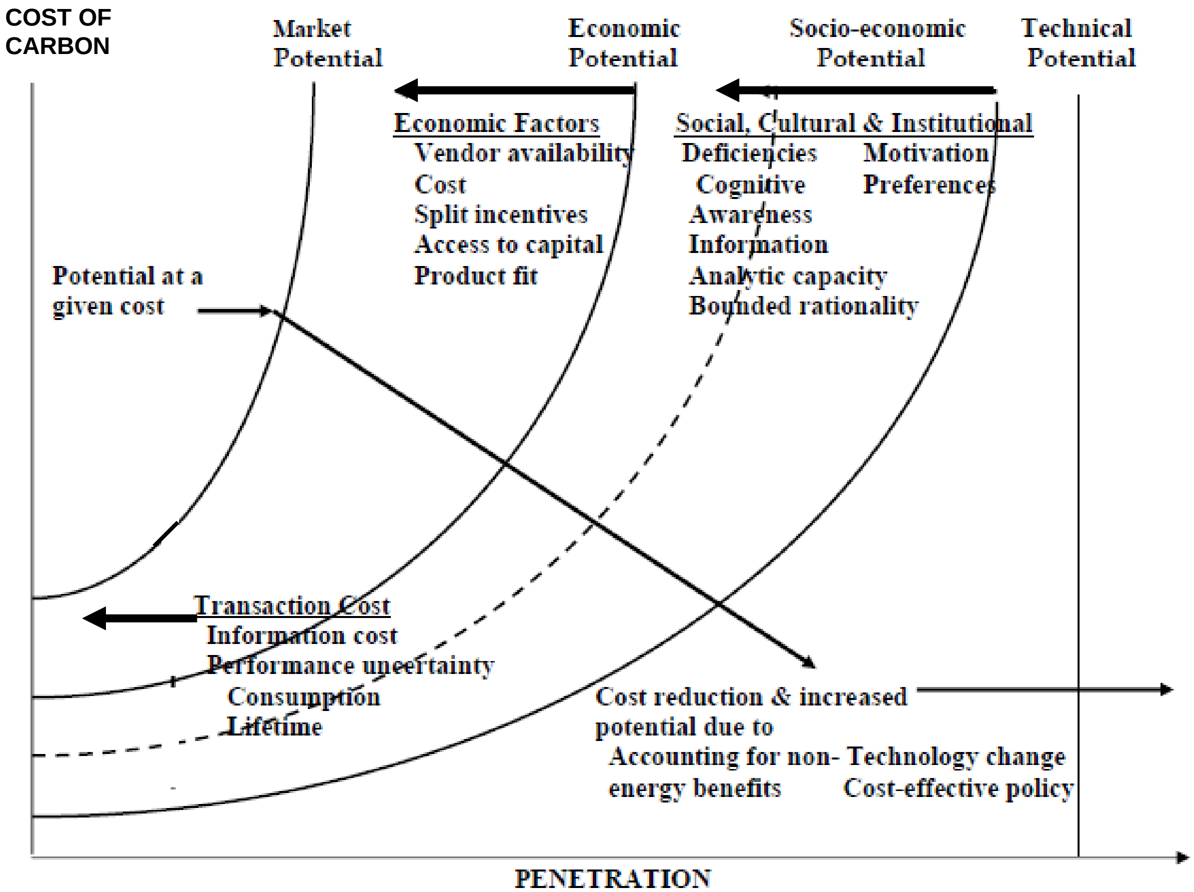
The LBL Framework

A 2004 report to the California Energy Commission from Lawrence Berkeley laboratory captures much of the above discussion of market failure in the form of technology penetration frontiers (See Exhibit III-3). 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 analysis cites in its 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 exhibit identifies all of the major categories of market imperfections, barriers, obstacles, etc. discussed above – 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. Thus, this presentation arrays the market structure analysis presented in Exhibit III-1 in a technology investment framework.

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. Another set of factors moves consumer along the frontiers. A higher price on carbon, or a lower cost to reduce carbon would move investment up the frontier.

EXHIBIT III-6: PENETRATION OF MITIGATION TECHNOLOGIES: A CONCEPTUAL FRAMEWORK



Source: 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.

***Energy Efficiency Performance Standards: The Cornerstone of Consumer-Friendly Energy Policy*, October 2013, pp. 60-64.**

D. 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 reflected 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."[37]

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.[38]

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 Exhibit V-5.

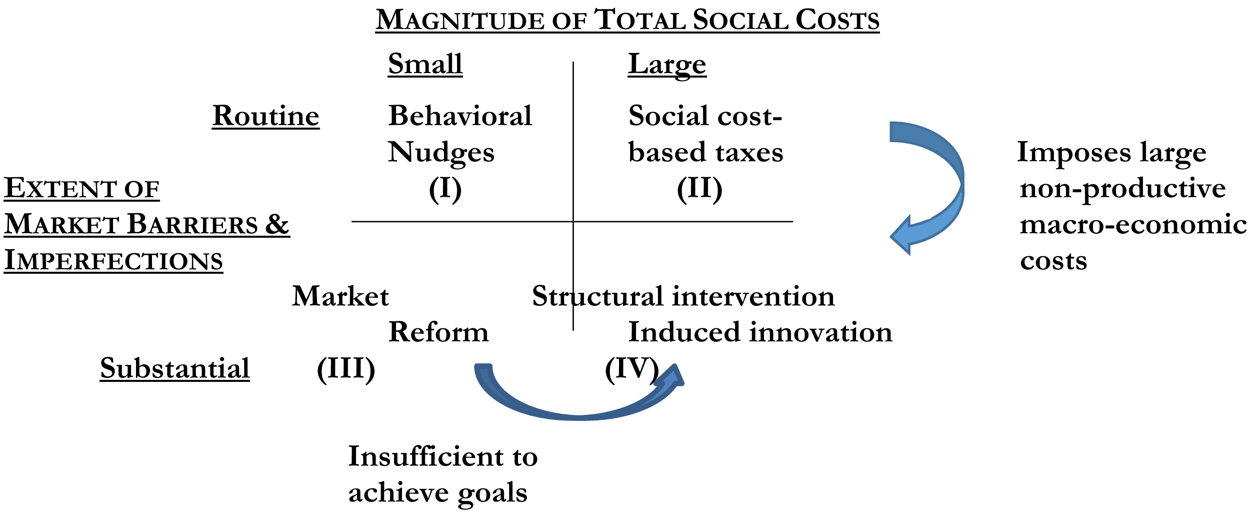
If market imperfections are routine and the social costs of poor market performance are small (cell I), modest policies like behavioral nudges may be an adequate response. If market imperfections are small and costs are large (cell II), then price signals might be sufficient to deal with the externalities. 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.

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

[37] Gross, et al., 012.
[38] Acemoglu, et al, 2012, pp. 132.

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.

EXHIBIT V-5: TYPOLOGY OF POLICY CHALLENGES AND RESPONSES



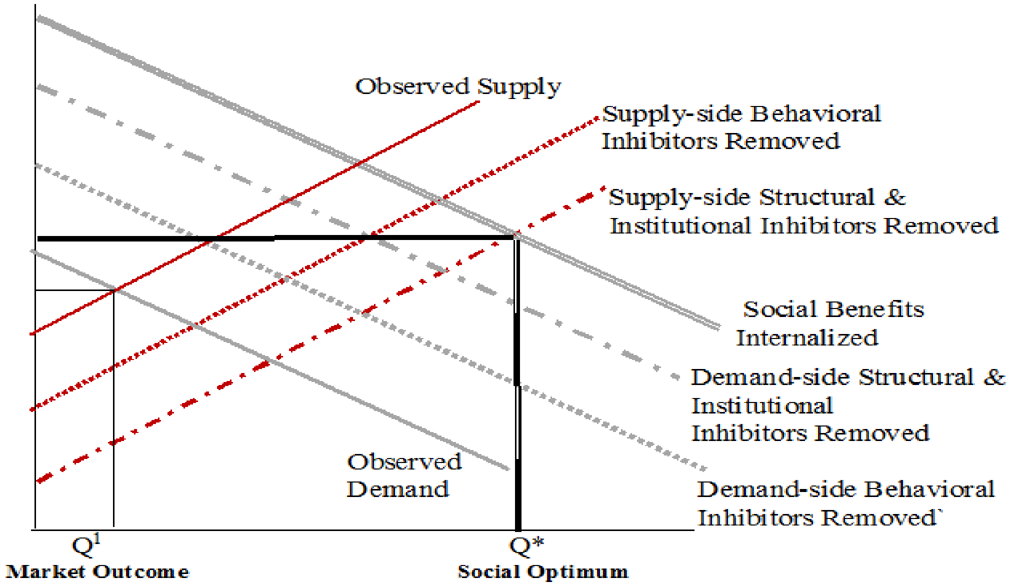
THE WELFARE ECONOMICS OF VIGOROUS POLICY ACTION (UPDATE)

The following 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 she starts by identifying the benefit of capturing positive externalities, the opposite of the typical approach that launches from negative externalities. She models behavioral barriers that reduce consumer purchases of a good that has a positive externality, i.e. the efficiency gap problem. In the upper graph of Figure IX-1, we add market structural and new institutional barriers to the behavioral factors that drive consumer purchases farther from the social optimum. We have constructed the graph to generally reflect the magnitude of effects suggested by the earlier 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.

FIGURE IX-1: TWO VIEWS OF MARKET IMPERFECTIONS AND POLICY RESPONSES

Welfare Economics: Induced Supply and Demand Shift to Increase Social Welfare



In the large distance between the actual equilibrium and the equilibrium that reflects the removal of all barriers, the lower graph of Figure IX-1 also reflects the fact that climate change 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. Climate change involves very large impacts and a great deal of uncertainty, in part due to the very long time frame of analysis. This raises a host of questions about the discount rate, as discussed below. These characteristics interact to argue for a precautionary principle that supports greater reduction in emissions and the adoption of overlapping policy instruments.

APPENDIX G
RECONCILING THE INSTITUTIONAL AND LEGAL DIFFERENCES OF A COMPLEX ECONOMIC AND ENVIRONMENTAL CHALLENGE

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

E. Establishing a Long-Term Vision for Enhanced Fuel Economy

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 requires more lead time than that. At the same time, NHTSA cannot set standards for more than five years. In contrast to this narrow window through which Congress allows NHTSA to set fuel economy, the Congress is considering very long term time frames for legislating climate change policy – setting 10, 20 and 40 year targets.

Tailpipe Emission Standards Should be the Focal Point of Policy

From a policy perspective, it is critically important that the Clean Air Act's framing of the standard envisions, 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 presented in Section II 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 Exhibit I-13).

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.

EXHIBIT I-13: 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

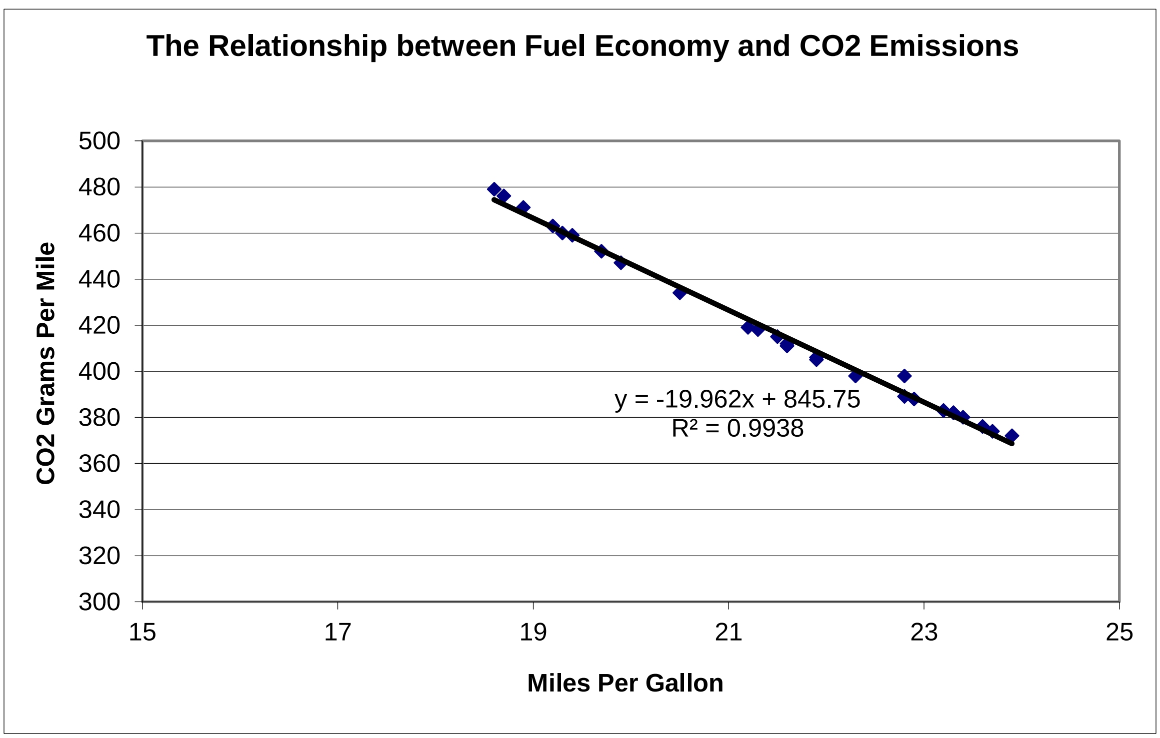
Third, the economic constraint under which NHTSA operates is more restrictive than EPA's. NHTSA is bound to do what is "economically practicable," while EPA must consider cost. NHTSA has interpreted its mandate under the statute to be largely constrained by what the industry's capabilities are. It hesitates 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. 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 the outputs of these two governing what can be done undermines the ability of the agency to write rules that are in the public interest. 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, and thus allows the industry to continue with its poor performance. EPA is not bound by this practice.

Fifth, 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.

Finally, because there is a direct physical relationship between the amount of greenhouse gasses a vehicle emits and the amount of gasoline it uses, by fulfilling its obligation to protect the public health and welfare under the Clean Air Act, EPA 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.

Exhibit I-14 shows data on fuel economy and greenhouse gas emissions for autos sold in the U.S. in 2006-2009. 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.

EXHIBIT I-14: 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.

APPENDIX H:
MACROECONOMIC STIMULUS EFFECTS OF FUEL ECONOMY IMPROVEMENTS

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, p. 21

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.

- 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.

***Energy Efficiency Performance Standards: The Cornerstone of Consumer-Friendly Energy Policy*, October 2013, pp. 34-37.**

D. MACROECONOMIC BENEFITS OF PERFORMANCE STANDARDS

These discussions of the non-energy benefits are framed in terms of the benefits to the individual. Another significant potential benefit is in the macroeconomic multiplier effect of reduced energy expenditures. 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 macroeconomic impact of energy policy has taken on great significance in the current round of decision making for two reasons.

- With the economy mired in recession, every policy is evaluated for its ability to stimulate growth and create jobs.

- Because climate policy requires a demand shift in economic activity, its impact on growth and job is extremely important.

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 have three economic effects from the point of view of the economy.

- 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.

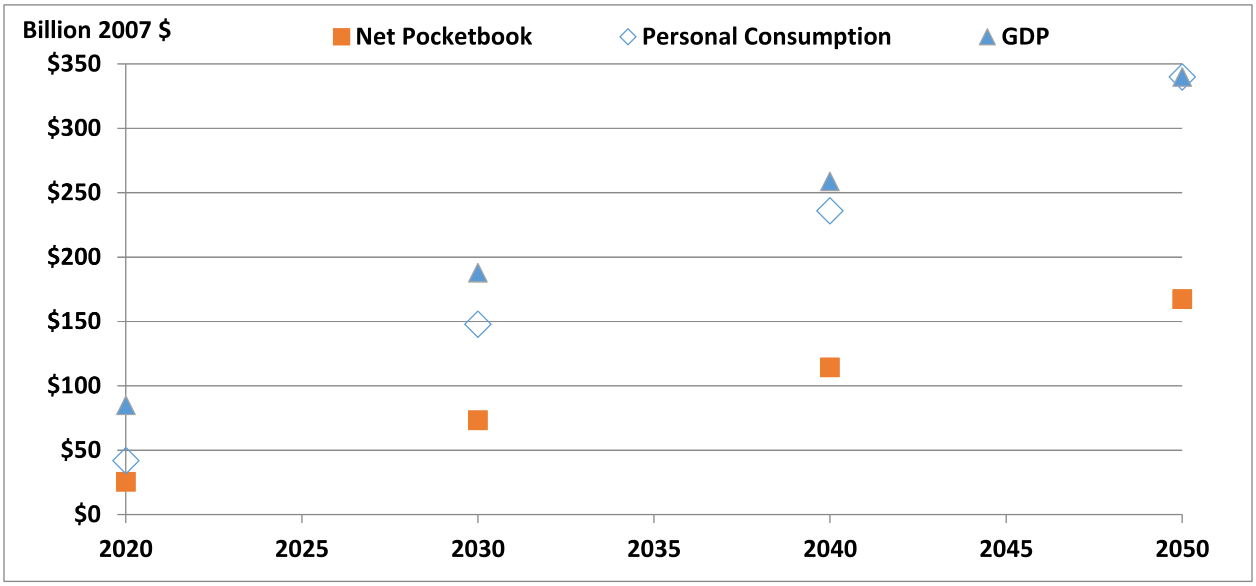
The increase in economic activity resulting from spending on new technology and the increase in consumer disposable income flows through the economy, raising the income of the producers of the additional products that are purchased and increasing employment.

> 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 are 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.[39]

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 (see Exhibit II-9).

[39] U.S. EPA, 2010, pp. 3-4.

Exhibit III-9: Impacts of the 2012-2016 Corporate Average Fuel Economy Rule: Savings and Increase s in Economic Activity



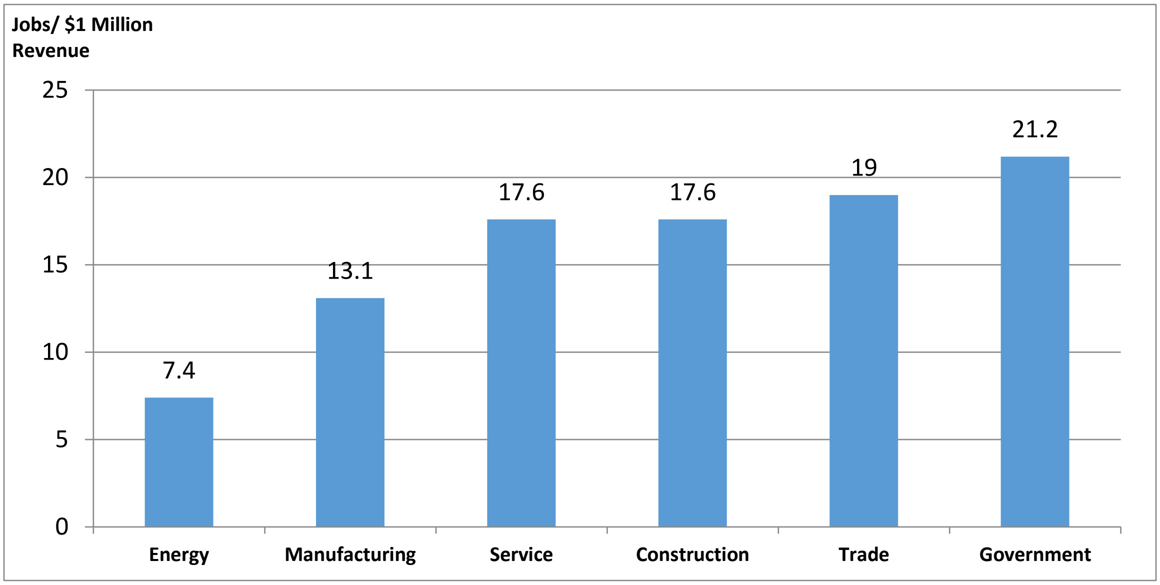
Source: Assessment and Standards Division Office of Transportation and Air Quality U.S. Environmental Protection Agency, Final Rulemaking to Establish Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average: Regulatory Impact Analysis, EPA-420-R-10-009, April 2010, Table 6-18.
Docket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

Exhibit III-9 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.[40] 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.[41]

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 Exhibit III-10, 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.

[40] Cooper, 2011a, CFA, 2012, pp. 53-54.
[41] Wei, Patadia and Kammen, 2010; Anair, and Hall, 2010; Gold, et al., 2011; Roland-Holst, 2008.

EXHIBIT III-10: LABOR INTENSITY OF KEY ECONOMIC SECTOR 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.

These efforts to model the economic impact of energy efficiency have proliferated with different models[42] being applied to different geographic units, including states[43] and nations.[44] 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 of 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.

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[42] For example, EPA, 2010, IGEM; Gold, 2011, IMPLAN, Howland and Murrow and NYSERDA 2011, REMI),

[43] For example, New York (NYSERDA, 2011), New England (Howland and Murrow), California (Roalnd Holst, 2008)

[44] For example, U.S. (Gold,, 2011, EPA, 2010, Warr, Ayres and Williams, 2009) and UK (Cambridge Center, 2006). Warr, Ayres and Williams, 2009, note recent studies on Asian economies, Korea, Canada and Spain,

APPENDIX I
CFA SURVEYS AND ANALYSES DEALING WITH ELECTRIC VEHICLES

KNOWLEDGE AFFECTS CONSUMER INTEREST IN EVS, NEW EV GUIDE TO ADDRESS INFO GAP

Washington, DC October 2015 --In a survey released today by the Consumer Federation of America (CFA), most Americans (54 percent) have a positive view of electric vehicles (EVs). While 33 percent of the respondents had no opinion, only 13 percent had a negative view of EVs. More significantly, almost one-third (31 percent) say they will consider buying an EV in their next car purchase even though, at this early stage, only one percent of vehicles sold are EVs. “While the current market penetration of EVs is small, there are currently 12 automakers currently offering a wide variety of EVs, so these consumers already have choices,” said Jack Gillis, CFA’s Director of Public Affairs and author, *The Car Book* and the new *Snapshot Guide to Electric Vehicles* (see more below).

Not surprisingly, the survey revealed that the more Americans know about EVs, the more likely they are to consider this purchase. However, only a little over a quarter of respondents say they know a great deal (6 percent) or a fair amount (21 percent) about EVs at this early stage of EV marketing and sales. “Clearly, there is a tremendous opportunity for EV sellers to take advantage of this interest as long as they engage in the same effective marketing that has moved millions of gas powered vehicles,” said Mark Cooper, CFA’s Director of Research.

“Our research shows a clear, statistically significant, correlation between knowledge about EVs and positive attitudes towards EVs. The more one knows about EVs, the more positively one feels about these vehicles,” said Cooper.

“Furthermore, there is a statistically significant correlation between positive attitudes about EVs and a willingness to purchase them—those who feel positively about EVs are more likely to consider purchasing one,” said Cooper.

About the EV Guide

“As the auto and tech industries pour millions and millions into the refinement of EVs, the American consumer is poised to bring those EVs home and plug them in,” said Gillis. Research demonstrates not only a strong general interest in EVs, but a correlation of that interest with EV knowledge. In order to improve consumer understanding of EVs, CFA’s Jack Gillis, author of *The Car Book*, is releasing *The Car Book’s Snapshot Guide to Electric Vehicles* available on the ConsumerFed.org website for no charge.

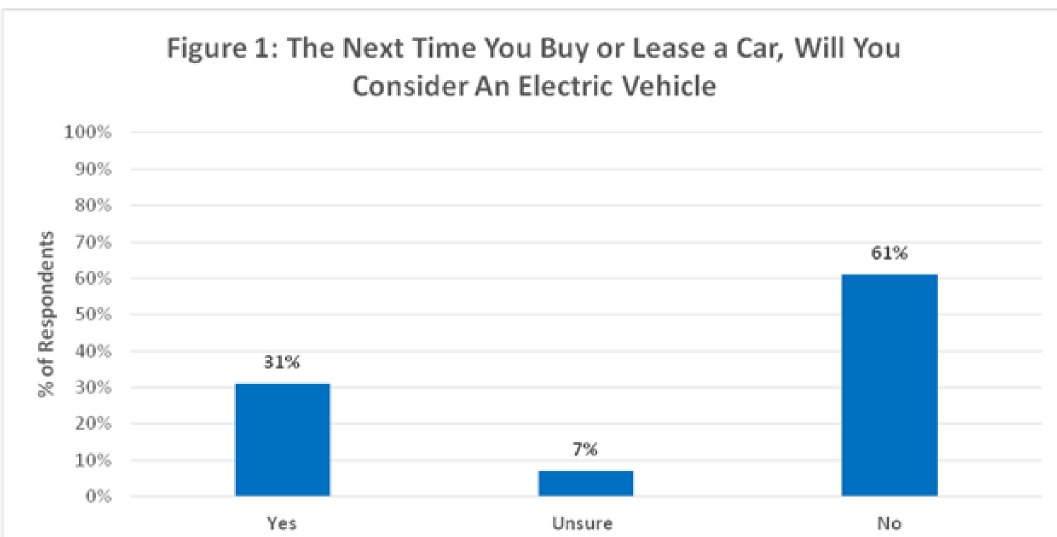
“Our goal is to expose the public to the options available and thereby increase interest in learning more about these vehicles. With battery prices coming down, disruptive innovators like Tesla and Apple entering the EV market, and consumers looking for ways to reduce their dependence on the gas pump, there is no question that EVs are poised to become the next big thing in the automotive marketplace,” said Gillis. *The Snapshot Guide to Electric Vehicles* provides an overview of the key features of the 2016 model EVs allowing consumers to readily compare the mileage, range, and charging types available among the new models. The guide is designed to improve consumer knowledge and understanding of EVs as well as provide a comparative road map to the choices available for 2016. The free guide is available online here.

In addition to the main findings of the survey, the data shows that wealthier respondents and those with more education said they knew more about EVs and were more likely to express an intention to purchase. Males state more knowledge, and older respondents and males were more likely to express the intent to purchase. "These demographic correlations are typical of new product adoption and portend a positive future for the EV market," said Cooper.

The following charts depict the major findings in the CFA survey. The survey was conducted for CFA by ORC International by cell phone and landline on August 20-23, 2015, using a representative sample of 1009 adult Americans. The survey's margin of error is plus or minus three percentage points.

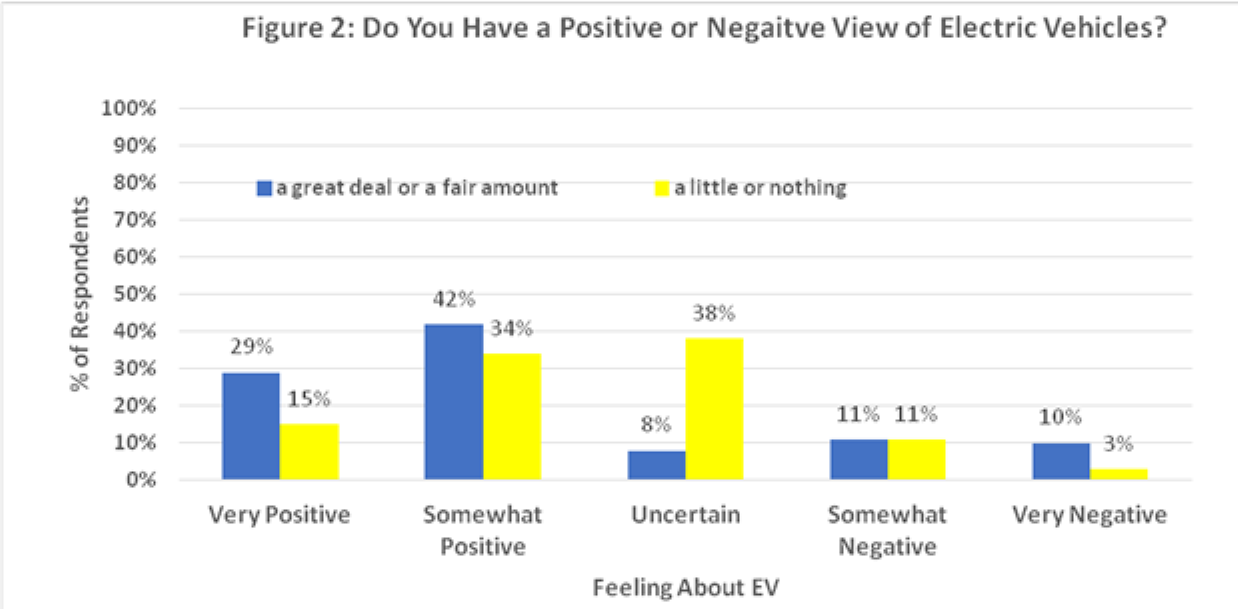
Overall Interest in Purchasing an EV

Overall, a surprising percentage of respondents are interested in purchasing an EV. This interest provides a catalyst for manufacturers to aggressively promote EVs and improve their designs.



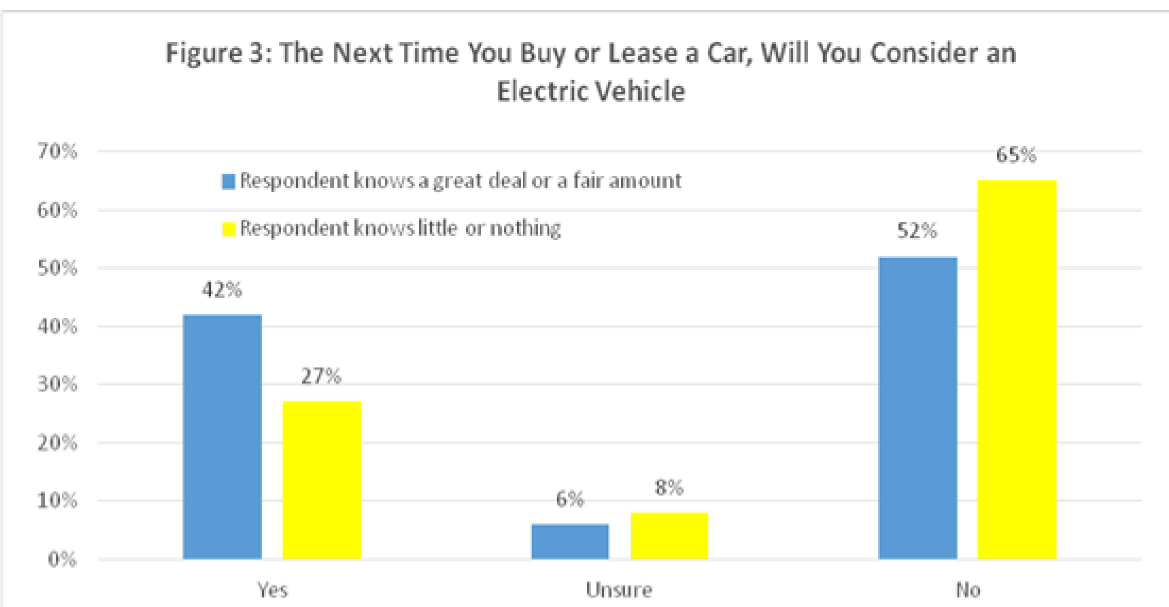
How Does Knowledge about EVs Affect Attitudes Towards Them?

As Figure 2 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.



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. 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.



New Data Shows Consumer Interest in Electric Vehicles Is Growing

Prices Are Down; Number of Models Is Up; Free New Guide to EVs Available as Year over Year Sales Increase

Washington, D.C. — Consumer interest in purchasing an electric vehicle (EVs) has increased in the past year, and this interest is greatest among young adults. That's according to the Consumer Federation of America's second annual survey on EVs. 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. Currently, 2016 sales of EVs are on track to outpace 2015.

"Consumer interest in buying electric vehicles is growing at the same time these vehicles are becoming more available and more attractive," said Jack Gillis, CFA Director of Public Affairs and author of *The Car Book*. "It does not surprise us that electric vehicle sales have grown more rapidly in their first four years than did those of hybrid vehicles," he added.

For the second year, CFA commissioned ORC International to conduct a national survey on consumer attitudes toward EVs. A representative sample of 1,007 adult Americans was surveyed by cell phone and landline in late August. The survey's margin of error is plus or minus three percentage points.

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," said CFA's Gillis.

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)[i] and Tesla Model 3 ($27,500)[ii] 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.

Consumer Guide to EVs Updated

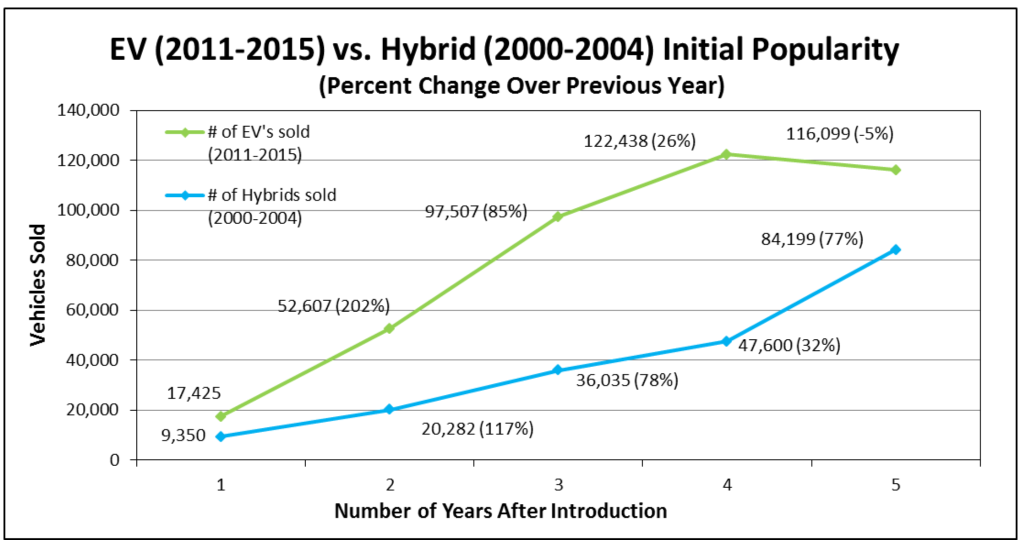
Because research demonstrates a correlation of interest in EVs with knowledge of EVs, CFA has updated its EV guide in order to improve consumer understanding of EVs. *The Car Book's Snapshot Guide to Electric Vehicles* is available for free on the ConsumerFed.org website.

"Our goal is to expose the public to the options available, and thereby increase interest in learning more about electric vehicles. With batteries becoming more efficient, an increasing number of choices entering the market, and prices becoming more affordable, there is no question that EVs are poised to disrupt the automotive marketplace," said Gillis.

The Snapshot Guide to Electric Vehicles provides an overview of the key features of 2017 model EVs, allowing consumers to readily compare the mileage, range, and charging types available among new models. The guide is designed to improve consumer knowledge and understanding of EVs, while providing a comparative road map to the choices available for 2016.

Electric Vehicles Are Off to a Faster Start than Hybrids

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.



"Consumers understand that low gas prices will not last forever, and these early adoption numbers for electric vehicles signal significant future growth in the market," said Dr. Mark Cooper, CFA's Director of Research.

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.

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 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, 33 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 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

"We doubt that automakers would be spending billions of dollars on EVs if they did not think they could sell them to consumers," said Cooper.

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 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 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, [iii] with an average price of $33,560[iv]. 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 3).

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.

Table 3: Cost Comparison of EV's to Their Gas Powered Counterpart			
Manufacturer	**Vehicle**	**Price (MSRP)**[v vi]	**Annual Cost for Fuel**[vii viii]
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**

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.

[i] Includes $7,500 tax credit.
[ii] 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.
[iii] J.D. Power and LMC Automotive
[iv] Kelley Blue Book
[v] Prices from the New Car Cost Guide
[vi] 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.
[vii]Based on typical driving of 15,000 miles per year.
[viii] 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).