Consumer Federation of America

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March 24, 2011

Ms. Brenda Edwards
U.S. Department of Energy
Building Technologies Program, Mailstop EE-2J
1000 Independence Ave., SW
Washington, DC 20585-0121

Re: Docket Number EE–2008–BT–STD–0012, Equipment Price Forecasting for Refrigerators, Refrigerator-freezers and Freezers

The Consumer Federation of America (CFA) appreciates the opportunity to comment, for record, on the above-captioned proceeding regarding the Department of Energy's (DOE or the agency) Notice of Data Availability (NODA) for equipment price forecasting in the case of the standards rulemaking for refrigerators, refrigerator-freezers and freezers.

As a matter of legal process and substance, the proposed rule that is the subject of the NODA should have been approved and issued as a final order on the basis of the hearing record months ago.

INTRODUCTION

Background on the Consumer Federation of America

Established in 1968, Consumer Federation of America (CFA) is an association of some 300 non-profit consumer groups that seeks to advance the consumer interest through research, advocacy and education.

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

CFA was a signatory to the consensus appliance agreement negotiated in 2010 which includes standards for refrigerators and freezers which this rule seeks to implement. We are deeply troubled that the Executive Branch has stood in the way of adoption of a compromise that was worked out by industry, consumer groups and environmentalists.

Outline of the Comments

After briefly commenting on the flaws in the administrative process that have resulted in the delay issuing the final rule, we will examine the two issues raised in the NODA. The NODA asked for comment on a specific aspect of its economic analysis – learning effects. We support the inclusion of learning effects in the economic analysis, but point out that there are many other important economic and non-economic effects of the order that the agency failed to, but should, incorporate.

We then turn to the question of consumer welfare analysis in the rulemaking, summarizing our analysis of market barriers to energy efficiency presented in Appendix A. Our economic analysis of appliance efficiency standards and efficiency standards in general has convinced us that there are substantial consumer welfare gains from such standards. The agency has identified a small subset of the reasons why consumers gain from technology neutral, precompetitive minimum performance standards. We show that there are a wide range of market obstacles, barriers and imperfections that result in an undervaluation of and underinvestment in energy efficiency in appliance markets. Note that we see this as a market problem, not simply a consumer problem. Consumer behaviors contribute to the problem, but producers do as well, as do market structure and transaction cost problems. The agency has defined the underlying market imperfections far too narrowly and rested the economic justification for the standards on far too small a base. We attach a lengthy analysis of market imperfections that lead to the failure of the market to provide the optimum level of energy efficiency and why standards are the best policy tool to address the diverse market imperfections.

I. PROCESS

The progress of this order has been afflicted by an unwarranted delay and the imposition of an unwarranted, if not illegal, interpretation of the statute.

Procedural Delay

The delay in issuing a final rule is harming the public and in violation of the statute and rules of due process.

- The standard proposed for refrigerators reflects the results of a consensus process in which industry and public interest groups hammered out a compromise.
- The order proposed a standard that is entirely consistent with the Congressional intent of the statute it is implementing.
- The administration has failed to comply with the statutory deadline for reasons that are inconsistent with the Congressional intent.
- The NODA points to an Executive Order that post-dates the statutory deadline and is being applied in a way that violates the Congressional intent of the underlying statute.

Thus, this rule, which enjoys widespread support because it is consumer-friendly, promotes the national interest and is well within the technical capability of the industry, needs to be liberated from the regulatory purgatory into which it has fallen.

Substance and process converge in the NODA. The statute requires the Department of Energy to balance seven factors in issuing standards to govern the energy consumption of refrigerators. If the Congress wanted one factor, like net economic benefit, to dictate the standard, it would have said so. The seven factors are: 1) the economic impact of the standard; 2) the net savings in operating costs; 3) the energy and/ or water, savings; 4) impact on the performance of the product; 5) the impact on competition; 6) the need for national energy and water conservation, and 7) other factors the Secretary considers relevant.

The Executive Order required executive branch agencies to ensure that their rules achieve maximum net benefit. Executive Orders cannot repeal the laws of the land. They can only interpret them. The term maximum net benefit could easily be interpreted to be consistent with the balancing that Congress ordered in this case. It cannot be used to pick one of those seven.

The contemporary zeal for regulatory reform needs to be balanced. Good rules that are delayed harm the public, just as much, perhaps even more, than bad rules that are allowed to go into effect. When broad consensus is built through a regulatory negotiation that involves the affected parties, that consensus should carry great weight and be a good indication that the proposed standard is in the public interest.

Indeed, the specific action by the Congress suggests that it intended exactly the opposite of what the Executive branch is doing. It specified a specific economic test which would indicate that the proposed standard is economically justified, but did not specify any economic test that would indicate it is not economically justified and explicitly stated that failure to pass the specific test was not dispositive of whether a standard is economically justified.

The phrase maximum net benefit can be considered one of the “other factors the secretary considers relevant, “ but it does not erase the six factors that are explicitly identified in the statue.

Moreover, if the phrase “net benefit” is interpreted narrowly as net economic benefit, it should take a comprehensive view of the economic effects of energy consumption and recognize the complex and dynamic processes that operate in the appliance market. The more weight the agency is going to put on a net economic benefit test, the more detailed and comprehensive its economic analysis must become.

Policy Framing: The Approach to Balancing

As a matter of law, Executive Orders cannot repeal acts of Congress. We believe that the executive branch should embrace the spirit, as well as the letter of the law. The Executive Order raises a fundamental issue about how agencies should balance numerous concerns. In particular, this statute calls for a balance between economics and the need for the nation to conserve energy. These are two extremely important goals that deserve to be balanced in decision making.

As a consumer organization, we tend to view these societal benefits as icing on the cake. We like to see proposed standards pass the consumer pocketbook test, which we apply first, and then point to societal benefits as an added gain. However, consumers have a strong interest in national energy security and a clean, healthy environment. Ultimately, the public bears the burden of policies that do not create national security or prevent environmental harm.

CFA has argued on the record in other proceedings that when Congress says "balance" it means "balance." Policies that demand results at either extreme – maximum net economic benefit that sacrifice substantial environmental gains or maximum environmental benefit that sacrifice substantial economic gains – do not represent balance. The public interest lies between these two extremes.

The issues raised in the NODA deserve careful attention, but this is neither the time nor the place to address them. Some of the issues belong at the start of the next round of rulemakings, where they can be vetted fully, rather than being inserted into an ongoing rulemaking at the eleventh hour. Some of the issues raised in the NODA should be dealt with in an OMB proceeding that involves general approaches to rulemaking, where the full implications of broad policy changes can be considered.

II. ECONOMIC ANALYSIS

LEARNING CURVES

In this regard, the proposal to take learning processes into account in estimating the cost of compliance with the standard is entirely appropriate, but it is not the only adjustment that should be made.

DOE certainly should take learning into account when it makes its projections of the cost of compliance with a standard.

The Executive Branch routinely does so when it writes other standards. For example, the Department of Transportation's National Highway Traffic Safety Administration (NHTSA) includes learning in its estimate of the cost of compliance with fuel economy standards.

Learning curves play an important part in the Department of Energy's Energy Information Administration *Annual Energy Outlook*, which is an extremely important policy document.

If the Department of Energy is going to rely heavily on maximum economic benefit to set appliance standards and then treat appliances differently, it will distort the decisions and choices that are made.

CONSUMER POCKETBOOK SAVINGS

In a comprehensive economic analysis, the agency must consider all of the costs and benefits. Learning curves clearly affect the cost side of the equation. Lower costs to comply with the standard would mean higher net benefits for consumers. However, in the original analysis, the agency also failed to quantify many other benefits. In particular, it failed to take into account a number of societal impacts that provide economic benefits directly to consumers.

Reduction in demand for the primary forms of energy used in the home has two important consumption externalities that directly affect the consumer pocketbook and therefore consumer welfare: peak load shaving and price suppression. Needless to say, we attach particular importance to these consumer pocketbook savings.

Peak load shaving: First, electricity is a form of energy that exhibits a peak load problem. Peaks of demand drive costs much higher at short periods. Reductions in demand have value beyond the average cost of electricity. The underlying analysis failed to quantify this benefit.

Natural gas price suppression: Second, natural gas is a depleting resource with many potential uses and relatively inelastic supply and demand. In the past decade, it has exhibited "hockey stick pricing," with dramatic increases for short periods of time. Whether recent increases in supply will change that remains to be seen. Under all circumstances, reductions in demand lower the average price substantially. The underlying analysis failed to quantify this benefit.

The combination of the failure to consider learning effects and the failure to include peak shaving and price suppression effects resulted in a severe underestimation of the consumer pocketbook, or welfare gains in original analysis.

By separating out consumer pocketbook savings from other benefits, we do not mean to suggest that consumer pocketbook savings are not good for the nation. However, since the economic analysis focused on the consumer pocketbook and the delay in issuing the rule was tied to a consumer pocketbook analysis, they deserve separate and special attention.

Societal Externalities

The original analysis failed to quantify important societal benefits as well.

Job creation: Lowering energy consumption puts more money in consumers' pockets. Consumer spending has a higher multiplier than energy sector spending. Therefore, we would expect the economy to produce more jobs when consumers spend less on energy. These benefits should be quantified and included in the economic analysis.

National energy security: Reduced energy consumption enhances national energy security. Moreover, the distinction between the types of energy consumed in the home (electricity and natural gas) and the broader question of national energy security, which focuses on petroleum consumption, is beginning to disappear. In the long-term, electric vehicles are likely to play a significant part in ending the nation's addiction to oil. Reducing demand for electricity in the home will free up electricity resources for use in the vehicle fleet. Reducing natural gas consumption in the home will free up natural gas for use in electricity generation and to a lesser extent natural gas powered vehicles. These benefits should be quantified and included in the economic analysis.

Environmental benefits: Reduced consumption of energy in the homes has environmental benefits. Electric generation facilities are major sources of pollutants and greenhouse gases. The mining and use of natural gas are also major sources of pollutants and greenhouse gases. Reducing consumption lowers emissions. Moreover, it is important to recognize that there is a chain of substitution. Substituting natural gas (which is freed up by efficiency) for coal provides a net environmental benefit. Substituting electricity for gasoline provides a net environmental benefit, especially when it is generated by renewable resources or natural gas. These benefits should be quantified and included in the analysis.

In separating out the societal benefits, we do not mean to imply that consumer pocketbooks do not see the impact of these benefits. Ultimately they do, but the effect is indirect. Lower national security costs or health care costs that result from reduced energy consumption will result in lower taxes and other burdens on consumers.

III. CONSUMER WELFARE GAINS AND MARKET IMPERFECTIONS

The discussion of the benefits that the agency has failed to quantify and include in its analysis points directly to the broad economic framework that the agency must apply in evaluating the proposed rule. Consumer pocketbook savings that result from consumption externalities and societal benefits in terms of improved national security and reduction of environmental harm are all classic externalities but for which it is widely recognized that markets fail to capture.

The NODA seeks comment on a critical issue in the cost benefit analysis of appliance performance standards.

> DOE also notes that the economics literature provides a wide ranging discussion of how consumers trade-off upfront costs against energy savings in the absence of government intervention … While DOE is not prepared at present to provide a fuller quantifiable framework for this discussion, DOE seeks comments on how to assess these issues.[1]

The NODA goes on to identify a problem that has frequently been noted in the academic literature and regulatory analysis.

> Much of this literature attempts of explain why consumers appear to undervalue energy efficiency improvement. There is evidence that consumers undervalue future energy savings as a result of (1) a lack of information, (2) a lack of sufficient savings to warrant delaying or altering purchases (e.g. an inefficient ventilation fan in a new building or the delayed replacement of a water pump), (3) inconsistent (e.g. excessively short-term) weighting of future energy cost savings relative to the available returns on other investments, (4) computational or other difficulties associated with the evaluation of relevant tradeoffs, and (5) a divergence in incentives (e.g. renter versus owner; builder versus purchaser).[2]

In order to assess these issues, DOE must have a comprehensive framework. DOE's list of causes of the failure of the market to invest fully in energy efficiency is a good start, but far from complete. Supply-side problems are totally ignored. Externalities are not mentioned.

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[1] Docket Number EE–2008–BT–STD–0012, Equipment Price Forecasting for Refrigerators, Refrigerator-freezers and Freezers, p. 9699

[2] Id., p. 9699

EMPIRICAL EVIDENCE OF THE EFFICIENCY GAP

Over a quarter of a century ago, policy analysts identified an "efficiency gap" based on the observation that engineering studies of energy efficiency technologies showed that the cost of including those technologies in consumer durables would yield savings that were far larger than the costs. As Exhibit 1 shows, the problem exists across a number of sectors. In the past year, four major national research institutions have released reports that document the huge potential for investments in energy efficiency to lower consumers' bills and greenhouse gas emissions, creating a win-win for consumers and the environment. The National Research Council of the National Academy of Sciences [3] has estimated the potential reduction in electricity, natural gas and gasoline at approximately 30 percent, similar to the estimates of NHTSA/EPA. McKinsey and Company[4] and the American Council for Energy Efficient Economy [5] have reached a similar conclusion on electricity and natural gas. Across these three sectors, saving energy costs about one third of the price of producing it. With the publication of these studies, the question is no longer "Can efficiency make a major contribution to meeting the need for electricity in a carbon constrained environment?" These studies demonstrate that it can, as the NRC put it:

> The deployment of existing energy-efficiency technologies is the nearest-term and lowest-cost option for moderating our nation's demand for energy, especially over the next decade… Many energy efficiency savings can be obtained almost immediately by deploying currently available technologies… The efficiency supply curves… demonstrate that many energy efficiency investments cost less than delivered electricity, natural gas, and liquid fuels, in some cases substantially less.[6]
>
> In a free-market economy, when the solution to an important problem is plentiful and cheap, one would expect that it would be widely adopted throughout society – If efficiency is such a bargain, why don't more people buy it? [7]

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[3] National Research Council of the National Academies, *America's Energy Future: Technology and Transformation, Summary Edition* (Washington, D.C.: 2009), p. 40. The NRC relies on a study by Lawrence Berkeley Laboratory for its assessment (Richard Brow, Sam Borgeson, Jon Koomey and Peter Biermayer, *U.S. Building-Sector Energy Efficiency Potential* (Lawrence Berkeley National Laboratory, September 2008).

[4] McKinsey Global Energy and Material, *Unlocking Energy Efficiency in the U.S. Economy* (McKinsey & Company, 2009), p. iii.

[5] Gold, Rachel, et. al., Energy Efficiency in the American Clean Energy and Security Act of 2009: Impact of Current Provisions and Opportunities to Enhance the Legislation (American Council for an Energy Efficient Economy, September 2009), p. iii.

[6] NRC, Energy Future, p. 40. McKinsey, Unlocking, p. iii, expresses a similar sentiment: "Energy efficiency offers a vast, low-cost energy resource for the U.S. economy – but only if the nation can craft a comprehensive and innovative approach to unlock it. Significant and persistent barriers will need to be addressed at multiple levels to stimulate demand for energy efficiency and manage its delivery across more than 100 million buildings and literally billions of devices. If executed at scale, a holistic approach would yield gross energy savings worth more than $1.2 trillion, well above the $520 billion needed through 2020 for upfront investment in efficiency measures (not including program costs)." Gold, Energy Efficiency, p. iii, expresses a similar sentiment: "When analyses ignore the readily available benefits from energy efficiency, they distort how energy and climate legislation, such as ACES, could affect American consumers and the U.S. economy. Experience in the states that have energy efficiency programs demonstrates that efficiency is the quickest and most effective way to reduce energy usage and address climate change… improving the energy efficiency provisions in ACES… provides significant additional consumer savings and carbon reductions and creates more jobs… This analysis estimates that, by 2030, including these improvements can save American consumers an average of $832 per household; create over 1 million jobs; reduce carbon dioxide by over 900 MMT; and avoid the need for 512 medium sized coal-fired power plants."

[7] McKinsey, Unlocking, p. 2. "The reasons to focus on energy efficiency are as simple as the questions are puzzling: If the economics of energy efficiency are so compelling and the technology is available and proven, why has the U.S. economy not captured more of the energy efficiency available to it, particularly given the progression of efforts at federal and state levels, by government and non-government entities alike, over the past three decades? In other words, by what means could the United States realize a much greater portion of the energy efficiency available to it?"

The answer to the question is well-known – energy markets are imperfect, riddled with barriers and obstacles to efficiency, especially the market for electricity, and market imperfections lead to market failures. [8]

The terminology applied to describe the failure of energy markets to achieve the level of energy efficiency one would expect from a theoretically efficient market has proliferated as concern over this problem has grown. The existence of this "efficiency gap" is explained with terms like barriers, obstacles, challenges, imperfections, and failures. These terms are often applied differently by different authors, but, when all is said and done, there is substantial consensus on the challenges energy efficiency faces in the building sector, where appliances are the primary users of energy.

MARKET IMPERFECTIONS

The analysis of market imperfections in the attached paper is grounded in a brief review of the general literature on market structure, conduct and performance in which we identify six broad categories of market imperfections. Three of these are prominent in what we call traditional/neoclassical analysis – societal, market structure and power. Three of these are grounded in what we call new institutional analysis – endemic flaws, transaction costs and behavioral economics.

As described in great detail in that attached study, economists and policy analysts with very different perspectives have identified a couple dozen causes of market failure when it comes to energy efficiency. In our analysis, we have grouped these into five broad areas –

- **Societal issues where important values are not well reflected in market transactions:** e.g. consumption and production externalities, national security values and environmental impacts.
- **Structural conditions that result in inefficient outcomes:** scale problems, bundling of multi-attribute products, product cycles, lack of availability, lack of experience with new products.

Golove, William H. and Joseph H. Eto, *Market Barriers to Energy Efficiency: A Critical Reappraisal of the Rationale for Public Policies to Promote Energy Efficiency, p. 6,* "These ideas were often expressed as questions about the existence and magnitude of an efficiency gap. The efficiency gap, a phrase now widely used in the energy-efficiency literature, refers to the difference between levels of investment in energy efficiency that appear to be cost effective based on engineering-economic analysis and the (lower) levels actually occurring."

[8] McKinsey, Unlocking, p. viii, "The highly compelling nature of energy efficiency raises the question of why the economy has not already captured this potential, since it is so large and attractive. In fact, much progress has been made over the past few decades throughout the U.S., with even greater results in select regions and applications. Since 1980, energy consumption per unit of floor space has decreased 11 percent in residential and 21 percent in commercial sectors, while industrial energy consumption per real dollar of GDP output has decreased 41 percent. As impressive as the gains have been, however, an even greater potential remains due to multiple and persistent barriers present at both the individual opportunity level and overall system level. By their nature, energy efficiency measures typically require a substantial upfront investment in exchange for savings that accrue over the lifetime of the deployed measures. Additionally, efficiency potential is highly fragmented, spread across more than 100 million locations and billions of devices used in residential, commercial, and industrial settings. This dispersion ensures that efficiency is the highest priority for virtually no one. Finally, measuring and verifying energy not consumed is by its nature difficult. Fundamentally, these attributes of energy efficiency give rise to specific barriers that require opportunity-specific solution strategies and suggest components of an overarching strategy."

- **Endemic tendencies of economic relationships that undermine key market functions:** e.g. agency issues (e.g. landlord-tenant, builder-buyer), asymmetric information, first cost sensitivity.
- **Transaction costs create frictions that impose costs and constrain exchange:** e.g. sunk costs, new product risk & uncertainty, imperfect information.
- **Behavioral, psychological and other human traits that bound "maximizing" actions,** e.g. motivation, difficulty of calculation and discounting (projecting future energy consumption and prices).

While a lengthy list of potential market imperfections can be derived from the general literature, (as described in Exhibit 2), they can also be seen in the long standing debate over the "energy efficiency gap." This literature is the focal point of our analysis. Exhibit 3 presents summaries of the arguments from two very different perspectives – Lawrence Berkeley Labs and Resources for the Future. They may differ in detail and policy recommendations, but they identify a common set of problems.

STANDARDS AS A RESPONSE TO MARKET IMPERFECTIONS

Performance standards that are technology neutral and procompetitive are an ideal way to address all of these imperfections, as long as the level chose is within the frontier of what is economically practicable and technologically feasible. Private sector firms compete around those standards in the marketplace, developing the technologies they think will meet the standard at the lowest price. This competition produces new goods and keeps the cost down. Declining out of pocket energy expenditures allows consumers to spend more resources on other goods and services, which grows the economy.

The following market imperfections that cause the appliance market to provide less efficiency than it should are addressed by performance standards:

SOCIETAL FAILURES	ENDEMIC FLAWS	TRANSACTION COSTS
Externalities	Agency	Sunk Costs, Risk
Information as a public good	Asymmetric Information	Risk & Uncertainty
	Moral Hazard	Imperfect Information

STRUCTURAL PROBLEMS	BEHAVIORAL FACTORS
Scale issues	Motivation
Bundling	Calculation/Discounting
Cost Structure	
Product Cycle	
Availability	

Energy efficiency standards are the most effective way to correct the undervaluation of energy efficiency in the residential market. Raising minimum efficiency standards lowers the supply-side risk of investing in more efficient technologies for appliance manufacturers and helps new products get to scale more quickly. They address critical gaps in the valuation of, information about, and motivation to adopt energy saving technologies.

PUBLIC SUPPORT

The Consumer Federation of America has recently conducted a national random sample public opinion poll on home energy consumption and minimum efficiency standards. My analysis of the results is attached to this testimony as Appendix B. We find that the public overwhelmingly recognizes the benefits of energy efficiency in the home and supports energy efficiency standards.

Specifically, we found:

- Nearly all Americans (95%) think it "beneficial for appliances like refrigerators, clothes washers, and air conditioners to become more energy efficient," with 78% believing this increased efficiency to be "very beneficial."
- Nearly all Americans (96%) think improved appliance efficiency is important for personal financial reasons – "lowering your electric bills" – with 80% considering this to be very important. However, large majorities also believe improved appliance efficiency to be important for environmental reasons – because it reduces the nation's consumption of electricity "to reduce air pollution" (92% important, 77% very important) and "to reduce greenhouse gas emissions" (84% important, 66% very important).
- Substantial majorities also favor improved energy efficiency of appliances even when this increases the purchase price of appliances. This support predictably varies with the payback period: 3 years (79% favor, 35% favor strongly), 5 years (73% favor, 32% favor strongly), and 10 years (60% favor, 29% favor strongly).
- Only about two-thirds of Americans (68%) are aware that the "government requires new appliances like refrigerators, clothes washers, and air conditioners to meet minimum energy standards."
- Respondents who are aware of the minimum standards are more likely to support then (74% to 64%).
- But nearly three-quarters of Americans (72%) support "the government setting minimum energy efficiency standards for appliances," with strong support from 28%.

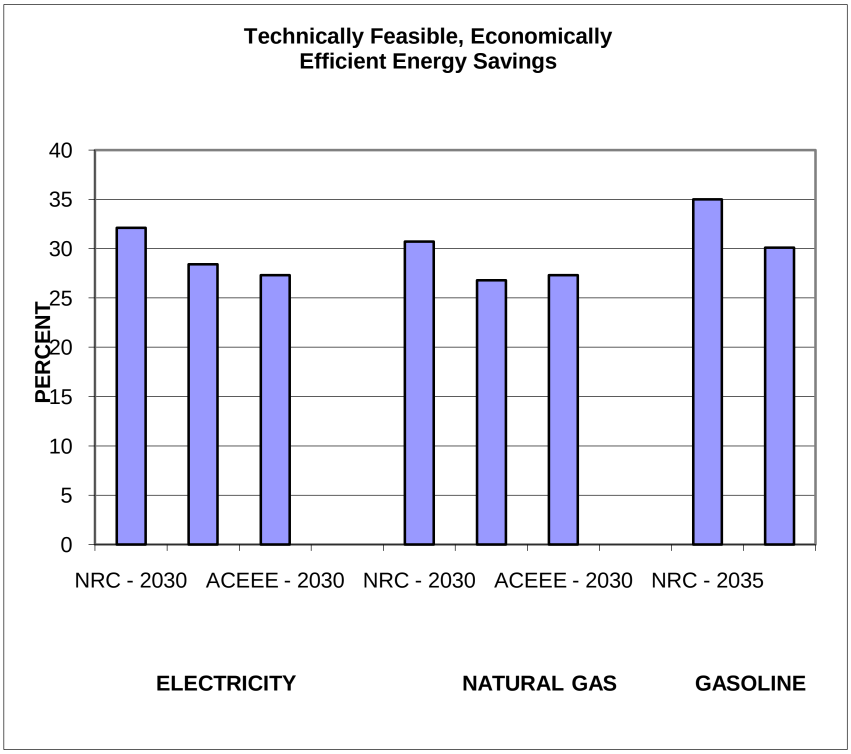
We believe this is very compelling data that demonstrate clearly consumer desire and support for cost-effective energy efficient products and appliance efficiency standards.

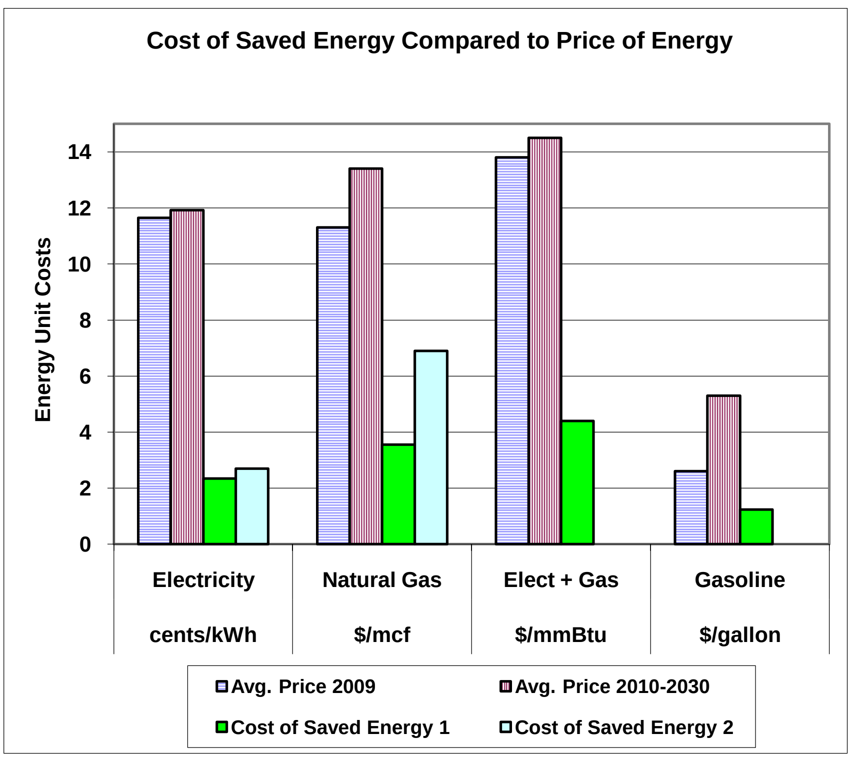
In closing, Consumer Federation of America appreciates the opportunity to provide our comments on learning effects and consumer welfare in addition to our broader energy efficiency analyses and public opinion findings as they relate to this Notice of Data Availability. We hope that the Department will find them helpful.

Sincerely,

Mark Cooper
Director of Research

EXHIBIT 1:
THE EFFICIENCY GAP ACROSS ENERGY MARKETS





Sources and Notes:
Gold, Rachel, Laura, et. al., *Energy Efficiency in the American Clean Energy and Security Act of 2009: Impact of Current Provisions and Opportunities to Enhance the Legislation*, American Council for an Energy Efficient Economy, September 2009),
McKinsey Global Energy and Material, *Unlocking Energy Efficiency in the U.S. Economy* (McKinsey & Company, 2009).
National Highway Traffic Safety Administration, *Corporate Average Fuel Economy for MY2012-MY 2016 Passenger Cars and Light Trucks, Preliminary Regulatory Impact Analysis*, Tables 1b, and 10. The 7 percent discount rate scenario is used for the total benefit = total cost scenario.
National Research Council of the National Academies, *America's Energy Future: Technology and Transformation, Summary Edition* (Washington, D.C.: 2009). The NRC relies on a study by Lawrence Berkeley Laboratory for its assessment (Richard Brow, Sam Borgeson, Jon Koomey and Peter Biermayer, *U.S. Building-Sector Energy Efficiency Potential* (Lawrence Berkeley National Laboratory, September 2008).
2009 average prices are from the Energy Information Administration, Short-Term Outlook, while 2010-2030 Prices are from the *Annual Energy Outlook: 2009. Adjusted.*

EXHIBIT 2: COMPREHENSIVE LIST OF IMPERFECTIONS THAT CAUSE MARKETS TO FAIL

TRADITIONAL AND INDUSTRIAL ORGANIZATION ECONOMICS
NEW INSTITUTIONAL AND BEHAVIORAL ECONOMICS

INDUSTRY STRUCTURE

- Imperfect Competition
  - Concentration
  - Barriers to Entry
  - Scale
  - Vertical Leverage
  - Collusion
- ICE problems
  - Price discrimination
  - Entry barrier
  - Bargaining
- Technology
  - R&D
  - Investment
- Marketing
  - Bundling: Multi-attribute
  - Product Differentiation
  - Gold Plating
  - Inseparability
  - Purchase Method
  - Advertising
- Cost-Price
  - Level
  - Structure
    - Product cycle
    - Disaggregated/ fragmented Mkt.
  - Ownership
    - Control
      - Transfer
        - Limited payback
        - Lack of premium
- Elasticity
  - Own-price
  - Cross-price
  - Income
- Availability
  - Backward bending supply
  - Lack
  - Emergency replacement
  - Poor Quality
- Regulation
  - Price Distortion Avg-cost
  - Permitting
  - Other Distortions

SOCIETAL FLAWS

- Traditional Externalities
  - Positive
  - Negative
  - Public Goods
    - Basic research
    - Information
      - Learning-by-doing
      - Learning-by-using
- Network Effects
  - Direct
    - User
    - Nonuser
  - Indirect
  - Cross platform
- Innovation Economics
  - General Purpose Tech.
  - Producer surplus
  - Consumer surplus
  - Prosumers
  - Productivity
  - Applications
- Non-economicValues

POWER

- Legal Framework
  - Property
  - Contract
- Policy
  - Taxation
  - Subsidies
  - Protectionism
  - Trade
- Antitrust Enforcement
- *Toward Structure*
  - Market Dominance
    - Merger
  - Toward Behavior
- Regulatory Capture

ENDEMIC IMPERFECTIONS

- Asymmetric Information
  - Agency
  - Moral Hazard
  - Adverse Selection
- Perverse Incentives
- Conflict of Interest
- Inequality
  - Physical Capital
    - Maldistribution
    - Insufficiency
  - Human Capital
    - Health
    - Education
- Macroeconomic Imbalances
  - Income/ Demand
- Insufficiency
  - Investment
- Instability

TRANSACTION COST

- Search and Information
  - Imperfect Information
    - Availability
    - Accuracy
    - Search Cost
- Bargaining
  - Risk & Uncertainty
    - Technology
    - Marketplace
    - Policy
    - Financial
    - Liability
- Enforcement
  - Switching costs
  - Sunk costs
  - Monitoring Costs

BEHAVIORAL BASICS

- Motivation Values & Commitment
  - Bounded Selfishness/wants
    - Morality
    - Fairness/reciprocity
    - Altruism
    - Preference
    - Custom
    - Social group & status
- Perception
  - Bounded Vision/Attention
    - Prospect
      - Framing
      - Loss Avoidance
      - Status Quo
      - Salience
    - Self-fulfilling Prophesy
    - Social Influence
      - Awareness
      - Attention
      - Low priority
- Calculation
  - Bounded rationality
    - Ability to process info
      - Low Probability Events
      - Long-Term
      - Small Outcomes
- Execution
  - Bounded Willpower
    - Improper use
    - Improper maintenance

Exhibit 3: Market Imperfections and the Efficiency Gap

LBL Market Failure Analysis

Barriers[1]
- Misplaced incentives
  - Agency[4]
- Capital
  - Illiquidity[8]
- Bundling
  - Multi-attribute
    - Gold Plating[11]
    - Inseparability[13]
- Regulation
  - Price Distortion[14]
- Chain of Barriers
  - Disaggregated Mkt.[15]

Transaction Cost[2]
- Sunk costs[3]
- Lifetime[5]
- Risk[6] & Uncertainty[7]
- Asymmetric Info.[9]
- Imperfect Info.[10]
  - Availability
- Cost[12]
- Accuracy

Behavioral (noneconomic) factors[16]
- Custom[17]
- Values[18] & Commitment[19]
- Social group & status[21]
- Psychological
  - Prospect[24]
- Bounded rationality[26]
  - Ability to process info[27]

Market Failures
- Externalities
- Mis-pricing[20]
- Public Goods[22]
- Basic research[23]
- Information (Learning by Doing)[25]
- Imperfect Competition/Market Power[28]

Resources for the Future: Potential Market Failures

Type of Failure	Potential Market Failures
Societal	Environmental Externalities[A]
	Energy Security
	Public Goods[a]
	Innovation market failures
	R& D underinvestment[B, b]
	Learning-by-doing spillovers[C, c]
	Learning-by-using[D]
	Network Effects[d]
Endemic	Capital Market Failures
	Liquidity constraints[E, e]
	Information problems[F]
	Asymmetric info [H]
	Adverse selection[H]
	Principal-agent problems[L]
Regulatory Policy [h, k]	Average-cost pricing[J]
	Uncertainty[i]
	Liability[h, j]
Transaction Costs	Lack of Information[G]
	Asset lives [i, k]
	Incomplete Markets[g]
Structure	Scale economies[f]
	Investment horizon[h]
Behavioral[K]	Prospect theory [L]
	Bounded rationality[M]
	Heuristic decisionmaking[N]
	Information[O]

Sources and Notes:

Numbers: Golove, William H. and Joseph H. Eto, *Market Barriers to Energy Efficiency: A Critical Reappraisal of the Rationale for Public Policies to Promote Energy Efficiency;*

capital letters are from Kenneth Gillingham, Richard G. Newell, and Karen Palmer, *Energy Efficiency Economics and Policy* April 2009);

lower case letters are from Raymond J. Kopp and William A Pizer, *Assessing U.S. Climate Policy Options* (Washington, D.C.: November 2007)

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 (p.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 (p. 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 (p. 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 (p. 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 (p. 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 (p. 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 (p. 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 (p. 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 (p. 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 (p. 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 (p.11).

12) Even when information is potentially available, it frequently is expensive to acquire, requiring time, money or both (p. 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. (p.12)

14) The regulation barrier referred to mis-pricing energy forms (such as electricity and natural gas) whose price was set administratively by regulatory bodies (p. 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 (p. 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 (p. 17).

17) [C]ustom and information have evolved significantly during the market barrier debate (p. 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 (p. 19).

19) [P]sychological considerations such as commitment and motivation play a key role in consumer decisions about energy efficiency investments (p. 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 (p. 18).

21) Other factors, such as membership in social groups, status considerations, and expressions of personal values play key roles in consumer decision-making (p.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 (p. 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. (p. 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 (p. 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 (p. 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 (p.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 (p. 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 (p. 20).

28) This barrier suggests that certain powerful firms may be able to inhibit the introduction by competitors of energy-efficient, cost-effective products (p. 10).

A) 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 (p. 9).

B) 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 (p. 11).

C) 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.

D) Learning by Using: 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 (p. 12).

E) 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 (p. 13).

F) 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 (p. 11).

G) 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 (p. 11).

H) Asymmetric information, where one party involved in a transaction has more information than another, may lead to adverse selection (p. 11).

I) 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 (p. 12).

J) 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 (p. 10).

K) Behavioral: 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. (p. 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 (p. 15).

L) 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 (p. 16).

M) Bounded rationality suggests that consumers are rational, but face cognitive constraints in processing information that lead to deviation from rationality in certain circumstances (p. 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 (p. 3).

N) 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. (p. 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 (p. 17).

O) 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 (p. 12).

a) Public Goods:, Many technologies have competing or multiplicative (rather than additive) impact. The most compelling economics typically reside with the first abatement options in the analytical sequence. Pursuing energy efficiency in electric power, for example, has the potential to reduce the number of new coal-fired power plants needed (p. xx); The mismatch between near-term technology investment and long-term needs is likely to be even greater in a 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. 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 markets 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)

(e) 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; (p.120).

(f) 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)

(g) Finally, incomplete insurance markets may provide a rationale for liability protection or other policies for certain technology options (for example, long-term CO_2 storage). (p. 137)

(h) 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)

g) “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).”

h) “Finally, incomplete insurance markets may provide a rationale for liability protection or other policies for certain technology options (for example, long-term CO_2 storage, [.137).”

(i)“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).”