Appliances & Global climate change

Increasing Consumer Participation in Reducing Greenhouse Gases

Prepared for the Pew Center on Global Climate Change

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Foreword *Eileen Claussen, President, Pew Center on Global Climate Change*

It makes a big difference which home appliances U.S. consumers buy. Residential electricity consumption — much of it from major home appliances — accounts for about one fifth of U.S. energy-related greenhouse gas emissions. New energy-efficient appliance models that use as little as half of the energy as their predecessors are available on the market.

Yet previous studies have shown little consumer response to the marketing of energy-efficient appliances. Although consumers stand to save money over time from smart appliance choices, energy-efficient products and programs to encourage their use have had limited success in the marketplace. This report prepared by Everett Shorey of Shorey Consulting, Inc. and Tom Eckman of the Northwest Power Planning Council takes a look at how consumers decide which major home appliances to buy, and suggests ways in which policy makers could encourage the use of energy-efficient products.

The authors draw upon previous experience from government and utility-run programs aimed at influencing consumers to purchase energy-efficient products. In doing so, they highlight the strengths and weaknesses of various approaches and analyze the economic and environmental ramifications of consumer purchases of appliances such as washers, refrigerators, and air conditioners. The authors find that a program's effect depends upon the particular consumer choice in question. The consumer may be considering an upgrade, early replacement, or retirement of an appliance. Each of these involves different economic tradeoffs, and thus different opportunities for policy intervention. The efficacy of a policy also depends upon where the consumer is in the process of purchasing an appliance. Different kinds of programs are required to get the attention of a consumer who is not even thinking about buying an appliance, as opposed to one who is doing research in *Consumer Reports*, or already out shopping in appliance stores. The authors find that future public policy and incentive programs will be most effective if they avoid a "one size fits all" approach, and instead adopt messages and communications mechanisms targeted at different categories of consumers, and different kinds of decisions.

This Pew Center report is the second in a series aimed at identifying practical solutions to address climate change. The Solutions series provides individuals and organizations with tools to evaluate and reduce their contributions to climate change.

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Executive Summary

Consumer purchases of major home appliances are an important aspect of the discussion about greenhouse gas reduction and global climate change for two reasons. First, major home appliances account for approximately one third of residential electricity consumption, a principal source of greenhouse gases. Second, appliance purchases give consumers a direct opportunity to affect greenhouse gas emissions. Absent other intervening factors, most consumers would probably wish to purchase appliances which save energy and money, and which are environmentally friendly. The questions for policy-makers revolve around what choices are available to consumers now, how consumers make their current choices, and how might it be practical to influence consumer choice.

This paper frames the policy issues by first focusing attention on the appliance categories that are purchased directly by consumers and that are significant consumers of electricity. Second, it analyzes the economic ramifications for consumers of their appliance purchase options. Finally, it reviews past attempts to influence consumer choice through public policy initiatives and suggests how new initiatives could be targeted more effectively. Further research is necessary in order to project how much energy would be conserved through any specific policy initiative.

The three areas of consumer choice that are potentially addressed through policy initiatives are *upgrades* to more efficient models of appliances when a consumer has already decided to make an appliance purchase; *retirements* of duplicate appliances; and *early replacements* of functioning appliances by newer and therefore more efficient ones. The first two of these consumer choices generally leave consumers economically better off if they purchase more efficient models. The economic and societal energy saving benefits of earlier than normal appliance replacements are generally positive as long as the consumer purchases an Energy Star® or higher-efficiency appliance or one meeting energy efficiency standards that are coming into effect in the next two or three years.

In the process of making any appliance purchase, individual consumers use different sources of information and have different interests, depending upon where they are in the purchasing process. Some consumers are actively engaged in researching and assessing appliances and intend to make an immediate purchase *(Buyers)*, others may be researching appliances but are hesitating over when to purchase *(Considerers)*, and still others are not interested in or receptive to information about appliances *(Satisfieds)*. The differences between these groups both create opportunities and present challenges to policy-makers and program designers who are attempting to alter consumer appliance purchasing behavior.

Past public policy and incentive programs have not differentiated their approaches and messages by where consumers are in the appliance purchase process. Future programs will be more effective if they adopt more targeted messages and communications mechanisms. Experience from these past programs has demonstrated several key issues:

- Well crafted programs including rebates, publicity, and assistance in disposing of old appliances appear to cause consumers to replace refrigerators before the end of the expected life of the appliance. It is likely that the refrigerator experience can be generalized to other appliances.
- There is little or no evidence that consumer tax credits are effective in influencing a significant number of consumers to change their purchasing behavior.
- Consumers seek information on appliances from many sources before they make a purchase and *Consumer Reports* is the most trusted source of information.
- Energy labels and the Energy Star® logo are, in themselves, insufficient to cause substantial change in consumer purchasing practices.

Recent programs in the Pacific Northwest and in the Northeast to promote the use of high-efficiency washing machines are providing an interesting model of success in influencing consumer behavior. These recent programs demonstrate several factors that should drive the development of any new consumer-oriented initiatives:

- It remains substantially easier to influence consumers who are actively engaged in appliance purchases (*Buyers* and some *Considerers*) than to influence the general public (*Satisfieds*).

- Retail appliance sales representatives have substantial influence on consumer choice. Incentives oriented to the retail sales representative coupled with simple sales tools can cause the sales representatives to influence consumer product selections.
- Direct financial incentives for consumers may not be necessary, especially when the consumer is already intending to purchase an appliance and the goal is to get the consumer to upgrade by purchasing a more efficient model.

Policy-makers must also craft any incentive programs in congruence with other public policy initiatives, especially minimum appliance energy efficiency standards. First, the minimum energy efficiency standard programs are the major public policy influence on manufacturers to raise the level of energy efficiency for their products. Without consideration of manufacturer intentions, it is possible that there will be no supply of more efficient products to meet any changes in demand caused by consumer-oriented public policy programs. Secondly, accelerating consumer purchases immediately in advance of a change in minimum standards could have the unintended effect of raising rather than lowering total societal energy consumption.

Based on these considerations, public policy programs could target each major appliance purchase decision using approaches and methods that have been successful in the past:

Decision	Target Group	Major Program Elements
Upgrade to More Efficient Appliance	*Buyers*	• Point-of-sale information including Energy Star® logos • Energy labels (on appliances) and data on energy use in electronic "catalogs" • Sales representative training and incentives
Avoid Postponement of Appliance Replacement	*Considerers*	• Point-of-sale information including Energy Star® logos • Easy-to-use cost and savings analyses, especially for potential online buyers • Sales representative training and incentives
Early Replacement	*Considerers* *Satisfieds*	• Mass communications Bill stuffers *Consumer Reports* • Cost and savings analyses • Rebates/Store Credits for appliance retirement
Appliance Retirement	All households	• Mass communications Bill stuffers *Consumer Reports* • Rebates • Pick-up and recycling programs

I. Introduction

The basic purpose of this paper is to analyze how consumers and public policy programs oriented towards individual consumers could affect appliance purchases and greenhouse gas production. It reviews an aspect of greenhouse gas mitigation that allows consumers to participate in programs that not only help to reduce energy consumption but also to improve their own financial position. Based on data from the U.S. Department of Energy (DOE), major home appliances account for approximately one third of the nation's residential energy consumption (equivalent to over 10 percent of total electricity consumption) and, thus, one third of the related greenhouse gas emissions. By purchasing more energy-efficient appliances, consumers have an opportunity to reduce greenhouse gas emissions directly.

Currently, consumers replace about 5 percent of refrigerators and 7 percent of washers annually (not counting those purchased for installation in new homes). If consumers can be induced to purchase appliances that are more efficient than basic units (upgrade) or to replace refrigerators or other appliances before the end of their useful lives (early replacement) with high-efficiency units, substantial savings in energy consumption and greenhouse gas emissions can be realized. Furthermore, approximately 15 percent of U.S. households have more than one refrigerator. Retiring some of these appliances would also help to reduce electricity consumption and greenhouse gas emissions.

The economics are generally attractive for consumers to upgrade to energy-efficient models when they replace old or broken appliances and can be reasonable, if not always optimal, for early replacements. However without public policy intervention, consumers are likely to remain unaware of potential cost savings and environmental benefits. They will tend to continue past patterns, not upgrading even when economically attractive and continuing to replace appliances only when they fail.

The purpose of this paper is to identify the major residential appliance stocks and their energy consumption; provide an overview of the normal appliance replacement patterns; discuss the programs that have been undertaken in the past to save energy and thereby reduce greenhouse gas emissions; and identify possible policies to encourage economically and environmentally beneficial early replacements, upgrades, and retirements of secondary, low-efficiency appliances. Public policy programs designed to encourage upgrades, early replacements, and retirements need to be targeted to the consumers actually making those decisions. Careful targeting will determine the types of messages that should be conveyed to consumer groups and how to convey those messages most effectively.

II. Changing Consumer Purchasing Behavior

To develop public policy for appliance purchases, policy-makers need to understand the following four issues:

- How much energy and greenhouse gas production could be affected?
- Which appliance categories offer the greatest potential for upgrades, high-efficiency early replacements or retirements?
- Which approaches have worked in the past and are likely to work in the future?
- What kinds of policies and programs are needed to change consumer decisions and increase upgrades, early replacements, and retirements of appliances?

Based on an understanding of these issues, policy-makers will be able to craft successful greenhouse gas reduction programs for consumer appliances.

The hypothesis is that, with the proper information and support, consumers will change their normal purchasing behavior so that they upgrade to more efficient products, replace old appliances early with high-efficiency models, and retire second refrigerators. In order to evaluate this hypothesis and to develop appropriate public policy to encourage upgrades, early replacements, and retirements, it is essential to understand how and why consumers purchase appliances and how those purchases might be influenced.

Consumers can purchase appliances directly, typically for replacement at the end of the appliance's useful life or for home remodeling purposes. Consumers may also purchase appliances indirectly if they buy a new house that has appliances already. In this indirect situation, consumers do not usually have a substantial influence on the type or efficiency of the appliances supplied. Therefore, policies that focus on direct replacement and remodeling purchases are likely to be most effective in changing purchasing behavior.

In addition to replacing appliances and remodeling, consumers can retire extra, inefficient appliances they no longer need, especially refrigerators. The saturation level for refrigerators, for example, now exceeds 100 percent because some households maintain two operating refrigerators for extra capacity. This second refrigerator is usually older and less efficient than the primary one. Retiring the secondary refrigerator would yield an immediate reduction in electricity consumption, electric bills, and greenhouse gases.

III. Potential Electricity Savings and Greenhouse Gas Reduction

Potential savings in electricity consumption depend on the types of actions consumers take and the number of participating consumers. As noted previously, early replacements save electricity between the time of the replacement purchase and the time when ordinary replacement would have been necessary.[1] Upgrades save the incremental energy between a less efficient, base model and a more efficient, upgraded unit. Retirements save the total energy consumption of the product for its remaining life.

Retirement of second refrigerators shows the greatest potential savings of 1,500 gigawatt hours (GWh) of energy per year for each 1 percent of the refrigerator stock retired (See Table 1).[2] For each 1 percent of appliance owners who decide to replace an appliance early, the energy savings per year prior to "normal" replacement time can vary from 140 GWh to 780 GWh per year, depending on the product type. Upgrading to higher-efficiency room air conditioners saves 20 GWh per year for each percentage point of purchasers upgrading. Similarly, upgrades of washers and refrigerators to high-efficiency models save approximately 250 GWh per year over the expected life of the appliance.

Table 1

Potential Annual **Energy Savings** from Early Replacement, Upgrade, or Retirement

Appliance Type	Replaced with Average Model (GWh)	Replaced with High-Efficiency Model (GWh)	Upgraded (GWh)	Retired (GWh)
Washer	140	360	250	NA
Refrigerator	500	780	250	1,500
Room Air Conditioner	200	220	20	NA

Note: Per year for each 1 percent of appliance owners making a replacement, retirement or upgrade decision. A gigawatt hour (GWh) is an amount of energy that will power more than 1.1 million 100-watt lightbulbs for 1 year.

Source: U.S. Department of Energy and Association of Home Appliance Manufacturers.

There is no solid foundation for estimating the percentage of consumers who will change their purchasing decisions or choose to retire appliances in response to changes in energy prices, improvements in appliance efficiency, incentives, or other programs. During the recent DOE minimum appliance energy standard rulemakings no manufacturer volunteered a study on the relationships among retail prices, energy consumption, and appliance shipment levels.[3] A search of the academic literature and unpublished doctoral dissertations showed minimal analysis of these factors. Much of the available analysis derives from work by federally supported laboratories and other organizations that conduct energy consumption forecasting, including Lawrence Berkeley National Laboratory (LBL), Oak Ridge National Laboratory (ORNL) and the Electric Power Research Institute (EPRI).[4] However, these models do not establish reliable relationships among costs, energy consumption, and shipments and it is extremely difficult to validate their underlying data and assumptions.[5] Until additional research is available, policy-makers can only make educated estimates of the probable level of consumer response to an energy-efficient appliance incentive or education program.

The potential energy savings for each 1 percent change in total consumer decisions for early replacements with high-efficiency units, upgrades and retirements is 3,380 GWh per year. Successful programs have reached 2-10 percent of households above the normal size of the local appliance market.[6] A 5 percent incremental upgrade, early replacement and retirement rate would lead to 17,000 GWh annual reduction in electricity consumption and a 2.8 mmtce annual reduction in greenhouse gas emissions.

IV. Relevant Appliances, Market Size, and Annual Emissions

A typical household now has at least one refrigerator, range, washer, and dryer. Most households also have dishwashers.[7] In certain parts of the country and certain types of housing, consumers also have room air conditioners. All these use significant amounts of energy (See Table 2).[8] Other appliances in a home use equal or greater quantities of energy (such as water heaters, central heating and cooling systems) but, again, most of these units are bought and installed by contractors. The most promising opportunities for early appliance replacement are refrigerators, washers, and room air conditioners; refrigerators are also potential candidates for early retirement.

Table 2

Inventory of Appliances and Residential Electricity Consumption

Appliance Type	Inventory of Units (millions)	Saturation (percent of households)	Electricity Consumption Per Year (thousand GWh)	Annual Greenhouse Gas Emissions (million metric tons carbon equivalent)
Refrigerators	112	115	151	25
Ranges	100	101	34	6
Washer/Dryers	95	74	81	13
Dishwashers	45	52	40	7
Room Air Conditioners	42	41	52	9
Electricity Consumption – Major Home Appliances*			335	55
Total U.S. Residential Electricity Consumption			1,000	165
Total U.S. Electricity Consumption			3,000	495

Source: U.S. Department of Energy, Appliance Magazine, Association of Home Appliance Manufacturers.

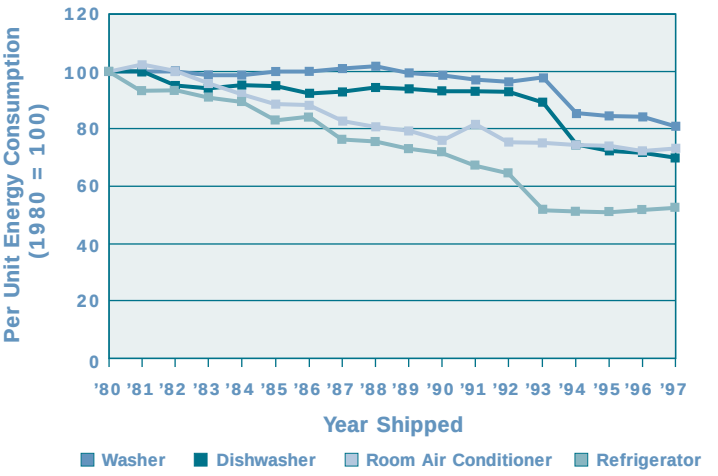
*Major home appliances comprise 33% of residential electricity consumption. The balance is made up of: space heating (14%), central air conditioning (10%), lighting (10%), water heating other than for appliances (8%), freezer (4%), television (3%), and other uses smaller than 1% (18%). Source: U.S. Department of Energy, Energy Information Administration, 1997 Residential Energy Consumption Survey (RECS).

Over the past fifteen years, the energy efficiency of appliances has improved so that replacing an old appliance with a new one of even average efficiency yields an energy saving of 15 percent for washers to 48 percent for refrigerators (See Figure 1).[9] Recent developments in washers and refrigerators yield even larger savings between older models and current high-efficiency ones.

Consumers shop for appliances for two principal reasons: to replace a failed or failing appliance or to remodel a kitchen or other room (including remodeling related to a move), (See Figure 2). Current appliance shipment data do not distinguish among appliance purchases for new construction, replacements, or remodeling. Shipments for use in new houses require approximately 1.3 million units.[10] The replacement and remodeling categories together represent over 80 percent of total appliance shipments. In these latter two cases, consumers typically have direct choice of appliance models and efficiency levels (See Table 3).

Figure 1

Change in **Energy Consumption** for Major Appliances

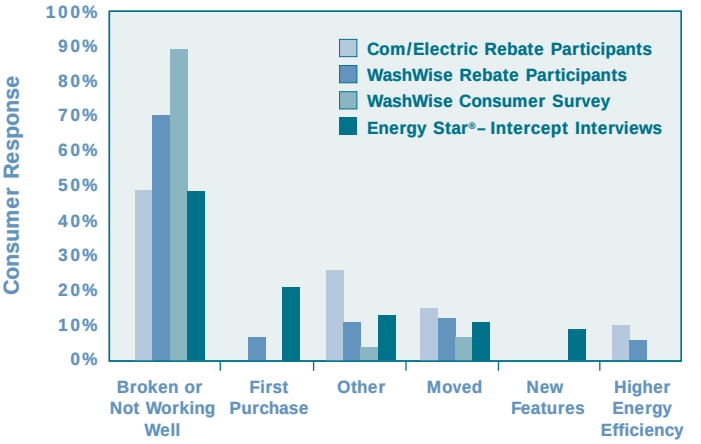


Source: Association of Home Appliance Manufacturers.

The average life of major home appliances reflects a range of time over which individual appliances will fail and will be replaced. The average life of washers is now 14 years. Refrigerators currently last on average about 19 years. This means that on average, 1/14th (7 percent) of the washers and 1/19th (5 percent) of refrigerators will fail each year.[11] For a household with several appliances, the likelihood of at least one appliance failing in a year is the sum of the individual expected failure rates. For example, a house with a washer and a refrigerator has roughly a 12 percent probability of having one or the other of these

Figure 2

Reasons for Appliance Purchase
Cited in Consumer Surveys



Source: Northeast Energy Efficiency Partnership and Northwest Energy Efficiency Alliance, Energy Star® Studies.

appliances fail. An average household with a washer, a dryer, a refrigerator, a stove, and a dishwasher may approach a 20 percent or greater probability of having at least one of the appliances fail in any year. As a consequence, 20 percent or more of U.S. households are in the appliance market every year.

Table 3

Replacement Portion of Appliance Shipments

Appliance Type	Total Shipments in a Typical Year (thousands)	Replacement & Remodeling (percent)	Replacement & Remodeling Shipments in a Typical Year (thousands)
Refrigerators	8,500	83	7,100
Washers	6,700	83	5,600
Dishwashers	5,000	85	4,250
Room Air Conditioners	4,000	88	3,500

Source: Appliance Magazine, U.S. Department of Commerce and Association of Home Appliance Manufacturers.

V. Consumers Save Money through Early Replacements and Upgrades

A consumer's decision to replace an appliance early with a high-efficiency unit or to upgrade to a more efficient one has a significant economic component. In both instances, the consumer pays more up front but has lower energy costs over time.

The financial effects are simplest in an upgrade decision. In this case, the consumer pays a premium for a more efficient appliance. For example, a $550 basic refrigerator could have an annual energy cost of $60. A more efficient model with a purchase price of $660 could have an annual energy cost of $37.[12] The incremental purchase price for the consumer is $110 and the annual energy savings are $23. This yields a simple payback of 4.8 years and a net present value to the consumer of $78 at 6 percent interest before the effects of inflation.[13] A positive net present value means that consumers are better off even taking out a loan at the stated interest rate to buy the more efficient refrigerator and paying back the loan with the money saved in reduced energy bills.[14]

The economic consequences of early replacement are more complicated. A consumer replacing an appliance early makes the purchase before he or she ordinarily would have. In turn, the consumer receives the savings in energy costs from the time of the actual purchase to the time the new appliance would have been purchased if it had not been replaced early. For example, in the simplest case, a consumer with a 10-year old clothes washer purchasing a new washing machine for $420 could get one with $25 lower annual operating costs if he or she bought the average model available today. If the consumer's current washer would have failed in four more years, then the consumer would need to buy a new, more efficient washer at that time by paying the $420 purchase price. Therefore, the consumer gets $25 a year in energy savings for a total of $100 in savings over four years. In exchange he or she has to pay four years of extra interest on the accelerated purchase.[15] If the consumer financed the clothes washer purchase over 5 years at a real (net of inflation) interest rate of 6 percent, the interest on the purchase over 4 years would be approximately $65.[16] Thus, by replacing their clothes washer early the consumer saves roughly $35 ($100 - $65). However, if the consumer purchased a more efficient

Energy Star® model he or she might save $60 per year in energy cost, or $240 over the four years. The added cost of this more efficient model accrues $100 in interest payments (compared to the $65 in interest on the purchase of the standard model) and therefore results in a total savings of $140 — four times those achieved by the early replacement with a model of average efficiency.[17]

In order to produce net savings to society, the appliance that is being replaced early must also be retired from further service. If it is sold as a "used appliance" or donated to charity its electricity use will still generate greenhouse gas emissions. If it is retired, any remaining economic value it might have must be "written off" and could significantly reduce the economic benefits of early replacement. In addition, for refrigerators, freezers, and room air conditioners, the old appliances must not only be retired, but their refrigerants must be recovered. In many cases this accelerates in time the expenditure of an additional $25 to $75 for refrigerant recovery.

It is almost always the case that purchasing a higher-efficiency model when replacing an appliance early is a better economic option than replacement with models of just average efficiency. First, as shown above, just as for upgrades, higher-efficiency products, such as Energy Star® appliances, are more attractive for consumers as early replacement choices than are "typical" appliances. Second, early replacement with Energy Star® or other high-efficiency appliances is also more beneficial in terms of energy savings and greenhouse gas reduction. Finally, early replacement with high-efficiency models avoids a situation in which it is preferable to wait for a "normal" replacement cycle when the efficiency of all models will have improved.

VI. Changing Purchasing Patterns

While the economics of upgrades and early replacement of major home appliances with high-efficiency models are generally favorable, they are not always compelling. In order to produce a significant impact on electricity savings and greenhouse gas emissions, current consumer purchasing patterns must be altered. Without intervention of some sort, consumers are likely to continue making appliance purchase decisions in the same way and with the same results as they have in the past. To change consumer behavior, policy-makers need the answers to two questions:

- What decisions do consumers usually make when purchasing appliances?
- When is it practical to intervene to change consumer behavior?

The smaller the change the consumer must make in his or her purchasing behavior, the easier it will be to modify buying patterns. It is easier to encourage upgrades than early replacements or retirements because an upgrade involves the least deviation from typical consumer buying habits. When the consumer is already in an appliance store and has decided to purchase an appliance, channeling his or her decision towards a more efficient model requires intervention and influence but the consumer has already moved over the threshold of indifference. Influencing consumers to replace appliances early or to retire them requires overcoming the inherent inertia of the status quo.

A. Consumer Decisions: Upgrades, Early Replacements, and Retirements

The motivations for upgrade and early replacement decisions will be different from retirement decisions and will, therefore, require different programs and appeals for consumers to change their current behavior patterns. From the consumer's standpoint, the decision to upgrade or to replace an appliance early is significantly different from the decision to retire one. With upgrades and early replacements, the consumer is making an investment before it is absolutely necessary but is gaining a more efficient product. Some consumers also gain satisfaction from knowing that they are making a personal contribution to energy conservation

and greenhouse gas reduction. It will take different types of intervention appealing to different consumer desires in order to motivate consumers to retire a secondary but inefficient appliance, such as an extra refrigerator, if they do not already plan to replace it.

Consumer Decision Processes

Consumers generally shop for appliances when they are forced to. Unlike shopping for clothes or other fashion items, appliance shopping is rarely a leisure activity. The most pressing stimulus for buying a new appliance is a failed or irreparable one, or one that the consumer simply thinks would cost too much to repair. A large portion of room air conditioner sales, for example, occurs during the first hot week in June or July. Some consumers also face continuing and escalating repair bills; others have no immediate need to purchase an appliance. Consumer decisions about purchasing thus fall into three broad categories:[18]

- *Satisfied:* Not considering purchasing a new appliance;
- *Considering:* Beginning to think about purchasing a new appliance, and reviewing appliance options, models, and prices; and
- *Buying:* Searching for a retail outlet and making a purchase.

Changing consumer behavior to encourage early replacement and retirement of appliances will depend on understanding the motivations and constraints facing consumers at each stage in the decision-making process. Generally, consumers who are in the *Buying* mode are the most receptive to information and influence since they are planning to make a purchase, usually in a retail outlet. They are potential targets for public policy initiatives encouraging them to upgrade from a standard model to a more energy-efficient one. They could also be receptive to information on early replacement or retirement of *other* appliances, opening the option to use the retail channel as a means of influencing replacement and retirement decisions.

Considerers are only beginning to contemplate purchasing an appliance. They might be planning to remodel. They may be concerned about the age or repair status of a particular appliance in their home. They could be interested in reducing their energy consumption. They may be interested in reducing greenhouse gases. In all these circumstances, *Considerers* are becoming receptive to information about appliances but are far from committed to making a purchase.

In a sense, *Satisfied* consumers are the most ambitious targets for public policy initiatives. Absent any incentives or other influences, they are not likely to consider either early replacement or appliance retirement. Any early replacement purchases by consumers in this group represent a public policy induced net change in the appliance inventory, since *Buyers* and many *Considerers* were already planning to replace an appliance.

An individual consumer can be in all three of these purchasing categories at the same time. He could be an active buyer for a room air conditioner, beginning to consider replacing a washer, and perfectly satisfied with a dishwasher. That particular consumer could be highly receptive to information about prices, features and availability for room air conditioners and completely indifferent or hostile to promotional materials on the value of a newly developed dishwasher. Thus an individual consumer may need to be reached in different ways for each of his or her possible decisions.

A consumer's place in the purchasing categories will affect his or her openness to and interest in information on appliances. Particularly for major purchases, the consumer's research process is complicated, involving a combination of timing and attention. Consumers need to focus their attention on an issue, in this instance the features and benefits of a major home appliance, and the message about those features and benefits must permeate the clutter of information about other products and services.[19] The closer a consumer is to the actual purchase decision (*Buyers* and *Considerers*), the more receptive he or she will be to information about major home appliances. Similarly, in-store promotions only help change consumer behavior when consumers are in the appliance section of a retail store. Thus, in-store promotions and sales representatives are most relevant to *Buyers* and do not reach *Satisfieds*, who are not in the store considering an appliance. As *Satisfieds* move to becoming *Buyers*, the range and specificity of communications methods increases (See Table 4).

Table 4

Major Methods of Communicating with Consumers

	Buying Status		
Communication Method	**Satisfieds**	**Considerers**	**Buyers**
Mass Media	x	x	x
Utility Bills or Other Direct Mail	x	x	x
Articles and Consumer Magazines		x	x
In-store Promotions, Product Labels			x
Sales Person Influence			x

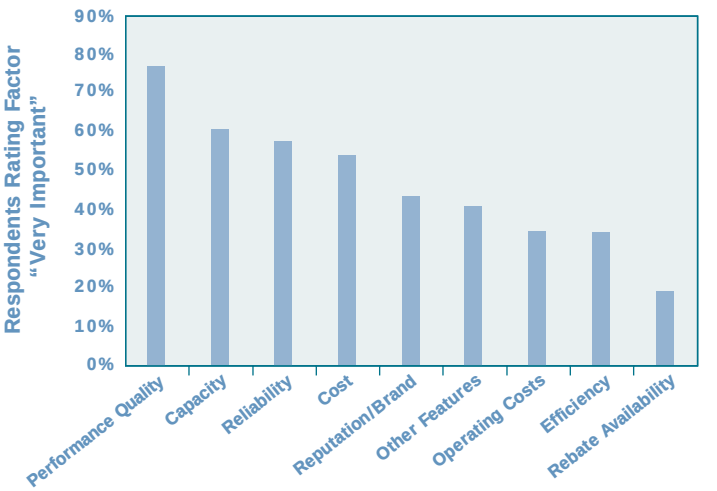
Influencing Consumer Decisions

The most effective public policy approaches will address issues of importance to consumers through media that consumers find relevant and credible. Several recent incentive programs and other public policy initiatives have included consumer surveys that address both the drivers of consumer appliance choice and the media they rely on to gather information for their appliance purchase decisions.

The available research on consumer attitudes towards appliances indicates that price and specific product features such as performance/quality, capacity, and reliability are the principal factors affecting consumer appliance purchase decisions (See Figure 3).[20] In these surveys, consumers have placed less importance on operating costs and energy efficiency, despite the often attractive returns available from more efficient appliances. None of these surveys has been able to explain why. One possible explanation is that operating costs are relatively small in absolute magnitude and are difficult to disaggregate from other portions of the household utility bill. A second possibility is that consumers still do not understand the economic trade-offs between more and less efficient appliance models. A third explanation is that they simply care much more about product features relative to operating costs. Further research is needed to explain consumer preferences.

Figure 3

Survey Results from Incentive Programs and Other Studies



Factors Rated Very Important in Selecting an Appliance Model Average of Four Consumer Surveys

Source: Northeast Energy Efficiency Partnership, Northwest Energy Efficiency Alliance, Energy Star® and Arthur D. Little/AHAM studies.

Many consumer surveys conducted on appliances since the 1970s have included questions related to the consumer's intent to buy products at various prices and with various levels of incentives. In one recent study, 80 percent of retail appliance dealers surveyed said that less than half of consumers will pay an extra $100 for a "tumble wash" high-efficiency washer and that less than 30 percent of consumers

would pay an additional $200 for a tumble washer.[21] In a similar survey, 41 percent of consumers stated that they would pay no more for an appliance that cost $50 less per year to operate, 24 percent said they would pay $50 more, 23 percent said they would pay $100 more, and 5 percent said they would pay $200 or more.[22] Questions about a consumer's intent to buy are notoriously unreliable as predictors of consumer actions, often overstating consumer willingness to make purchases. However, these results tend to indicate that a significant rebate or incentive will be necessary to change consumer behavior either for upgrades or early replacements.

Consumers frequently gather information on appliances before they visit stores and make a purchase. In a recent survey of consumers considering energy-efficient appliances, approximately 64 percent of the respondents stated that they had done research before they visited a retail store.[23] Those same consumers stated that the showroom and personal contacts (such as past experience and friends) are their preferred sources of information, and other surveys have produced consistent results (See Table 5).[24]

Table 5

Preferred Sources of Consumer Advice

Source of Advice	Consumer Preference (5 = Most Valuable, 1 = Least Valuable)
Showroom	3.69
Personal Contact	3.41
Magazines	2.88
Newspapers	2.78
TV	2.09
Radio	1.55
Internet	1.54

Source: Brown & Whiting: *Consumer Attitudes Toward Energy-Efficient Appliances.*

Consumers also have clear views on the credibility of various information sources. *Consumer Reports* ranks highly in all surveys on consumer appliance purchasing, as do sales representatives at appliance retailers and utility sponsorship (See Table 6).[25]

Table 6

Credibility to Consumers of Information on Appliances

Source of Information	Credibility to Consumers (5 = Most Valuable, 1 = Least Valuable)
Consumer Reports	4.24
Energy Guide Label	3.70
Utility Company	3.65
Manufacturer	3.24
Sales Person	3.07
Environmental Protection Agency	2.95
Department of Energy	2.87
Articles or Stories in the Media	2.87
Product Advertisements	2.68

Source: Brown & Whiting: *Consumer Attitudes Toward Energy-Efficient Appliances.*

Interestingly, consumers indicate through focus groups and qualitative comments in the consumer surveys that they believe utility or other rebates place an implicit seal of approval on a new technology.[26]

Advertising through newspapers, television, and radio generally receives a low ranking both as a source of information and for credibility. This is significant because advertising may be one of the few ways to influence the decisions of *Satisfieds* and *Considerers*.

B. Consumer Decisions: Early Retirement

Consumers can decide to retire a secondary refrigerator or other appliance for various reasons. They may conclude that the cost of operating the appliance is not worth the benefit of extra capacity. The consumer's lifestyle may change so that extra capacity is no longer necessary. Or the consumer may make an altruistic decision to conserve energy. In the first instance, providing consumers with information on the true cost of operating a secondary, often old and inefficient refrigerator could persuade some consumers to retire their extra refrigerators. Otherwise, promoting appliance retirement will require appeals to environmental or energy concerns rather than education on the trade-offs between the current appliance and a more efficient newer one.

The authors found no research on the basis for consumer decisions to retire a secondary refrigerator or on the potential to influence those decisions. Homeowners with secondary refrigerators are not necessarily in the market for a new home appliance, so they are not exposed to the information sources available to *Buyers*. They are likely to draw on the same sources of information as *Considerers* and *Satisfieds*.

VII. Past Efforts to Influence Consumer Choices

Manufacturers, the federal government, state governments, and utilities have tried nearly every conceivable approach to encourage consumers to adopt new and more efficient technologies. Each group has provided financial incentives and education programs, with some limited infrastructure support.

Each group also has its own objectives. Manufacturers typically seek competitive advantage by introducing innovative, usually more profitable products. The federal government and state governments seek to promote either energy conservation or environmental improvement. Utility marketing programs originally promoted increased appliance saturation and fuel switching (e.g., gas water heaters for electric ones). With the advent of electricity generation capacity limitations, electric utilities embarked on demand side management (DSM) programs promoting energy conservation. The collective experiences of these various groups serve as a significant laboratory on how to influence consumer behavior.

The extent and quality of analysis on program effectiveness varies considerably among programs. Electric utilities have had to justify the effectiveness of their DSM programs to their regulators, so there is extensive analysis of the savings in energy and peak capacity requirements compared to DSM program costs. In 1982, Congress commissioned the General Accounting Office to assess the effectiveness of the federal energy conservation tax credit programs. However, both the DSM and federal tax credit studies focus on overall energy savings rather than combined administrative and incentive program costs. Very little substantive research exists on the link between incentives and change in purchasing behavior.

The danger of relying on past experience from any market promotion program is that a program's success or failure is related to a specific time and specific set of overall economic circumstances. An approach that seemed to have failed in the past may not fail in the future. Each type of market promotion program has a logical audience and probable target for changing purchasing behavior. By understanding the appropriate targets and objectives for any market promotion program, policy-makers can select a package of the most promising programs and estimate their likely effectiveness.

A. Financial Incentive Programs

Financial incentive programs come in two broad types: those designed to reduce the initial purchase price and those designed to reduce (or level) annual costs. *Initial Cost Reduction* programs feature rebates and tax credits. *Annual Cost Reduction or Leveling* programs feature low-interest loans, leasing, and inclusion on utility and other bills.

Initial Cost Reduction Programs

Rebates are a common thread throughout most new technology promotion programs. Manufacturers, utilities, and governments have all offered rebates at various times. For manufacturers, rebates are a form of short-term price discounting. Rebates have also been a staple of DSM and other programs sponsored by electric utilities. In 1992, there were 484 utility programs to promote efficient equipment and appliances. Of these programs, most (324) targeted water heaters (which are not usually purchased directly by consumers and are, therefore, not covered in this paper), followed by refrigeration (119). Only 17 of the refrigerator programs specifically provided incentives encouraging upgrades and 16 provided incentives for retirements; the others principally involved labeling and other forms of information and programs to collect and dispose of refrigerators without any associated incentives.[27] Most of the incentive programs involved some form of rebate, included related educational or promotional materials, and were sponsored by utilities with widely varying numbers of customers.

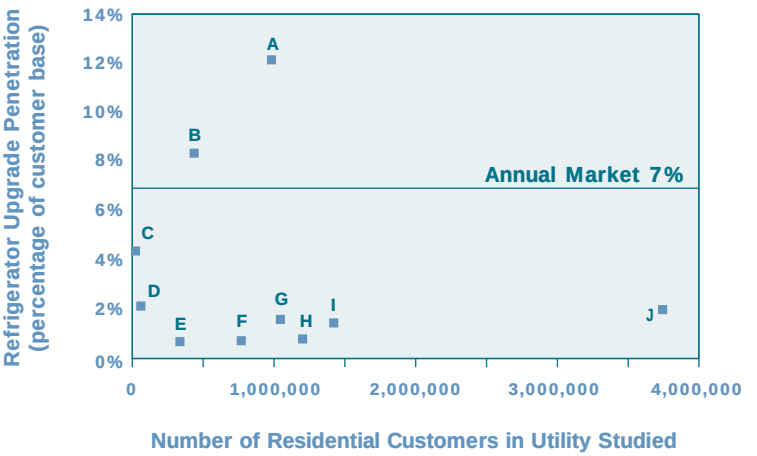
As a new effort analogous to the older DSM programs, several utility-centered coalitions have recently promoted energy-efficient washers, including the *WashWise* program from the Northwest Energy Efficiency Alliance; the Tumble Wash/Energy Star® program from the Northeast Energy Efficiency Partnerships; and California programs sponsored by Pacific Gas & Electric, San Diego Gas and Electric, Southern California Electric and Southern California Gas. However, unlike prior energy-efficient consumer rebate programs these more recent efforts have intentionally attempted to transform the market for resource-efficient washers. For example, the *WashWise* program carefully monitored the impact on market share of deliberate reductions in rebate amounts and concurrent changes in marketing activities to assess the persistence of sales of more resource efficient machines in the market. Over the course of less than two years the *WashWise* program was able to eliminate completely consumer rebates, yet still maintain market share.[28]

Governmental organizations have been less inclined to use rebates as a direct consumer subsidy because of the perceived difficulty in administering a rebate program directly to millions of consumers. The federal government supported a major market development program in the 1970s using tax credits for solar energy and energy conserving products. Rebates and tax credits for energy conservation appliances are not now in significant use at the federal or state levels although some programs do still exist such as tax credits for energy-efficient appliance purchases in Oregon. The Oregon tax credits are also one of the few programs that cover dishwashers in addition to other products.[29]

The DSM refrigerator upgrade and retirement programs have had extremely varied rates of participation. One indicator of participation is the number of DSM rebates relative to normally expected sales of refrigerators. If the utility issues more rebates for energy-efficient appliances in a year than historical average annual appliance sales, the program is almost certainly influencing consumer behavior. However, the reverse is not true. A utility's DSM rebate program could influence the behavior of all rebate participants while remaining below the normal size of the local market. Of the ten clearly identifiable refrigerator upgrade rebate programs, Northern States Power and the Sacramento Municipal Utility District (SMUD) achieved penetration levels for refrigerator rebates well above the likely level of the local refrigerator market, indicating that they were achieving some level of early replacement (See Figure 4).[30] Otherwise, most rebate programs achieved penetrations at 1-2 percent of the customer base. Unfortunately, the analyses of DSM program effectiveness focused on energy savings and program costs rather than probing for cause and effect relationships between programs and consumer behavior. Similarly, Wisconsin Electric Power, Menasha (WI) Electric & Water

Figure 4

Penetration of Upgrade Refrigerator Rebates



A. Northern States Power
B. Sacramento Municipal Utility District
C. Salem (WA) Electric
D. Turlock Irrigation
E. Wisconsin Power & Light
F. Puget Power
G. San Diego Gas & Electric
H. Duke Power
I. Consumers Power
J. Southern California Edison

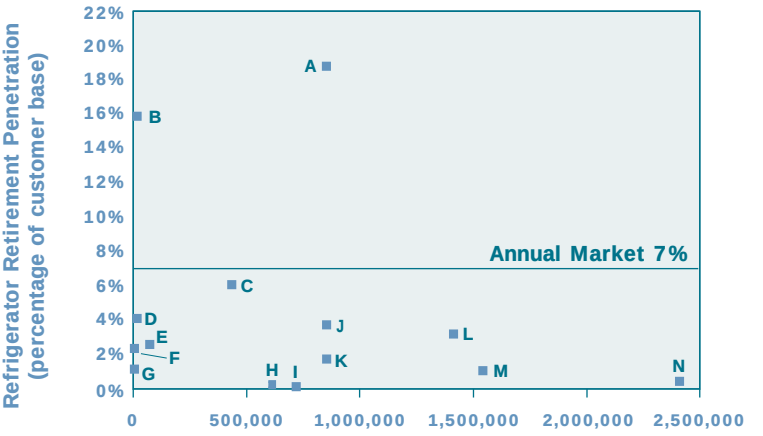
Source: U.S. Department of Energy, Energy Information Agency.

Note: The 7% annual market is the percentage nationwide of the customer base who replace refrigerators each year.

Utilities, and SMUD had retirement levels at or above the annual refrigerator market, also indicating some real retirements (See Figure 5).[31]

Figure 5

Penetration of **Refrigerator Retirements**



A. Wisconsin Electric Power
B. Menasha Electric & Water Utilities
C. Sacramento Municipal Utility District
D. Manitowoc Public Utilities
E. Green Mountain Power
F. Cedarburg Light & Water
G. New Holstein Public Utilities
H. Potomac Electric Power
I. New York State Electric & Gas
J. Massachusetts Electric
K. Jersey Central Power & Light
L. Consumers Power
M. Northeast Utilities
N. American Electric Power Company

Source: U.S. Department of Energy, Energy Information Agency.

Note: The 7% annual market is the percentage nationwide of the customer base who replace refrigerators each year.

The SMUD program is an example of an integrated approach designed to interest consumers and enlist retailer support. SMUD offered a large rebate ($175 in the early 1990s) to consumers purchasing high-efficiency refrigerators, erasing most of the first cost premium. In addition, SMUD paid retailers to pick up the consumer's old refrigerator when the retailer delivered the new one; SMUD then arranged for a recycling depot where the appliance retailer could return the used refrigerator at the end of the day's deliveries. Retailers were paid for an activity they traditionally performed for free and consumer purchases were subsidized. SMUD considered this to be a highly successful but very expensive program and the expense level caused SMUD to cancel it.[32]

In practice, this particular combination of SMUD programs probably appealed mostly to *Buyers* making upgrade decisions. SMUD does not report special outreach efforts to consumers who were not visiting appliance retailers. Furthermore, the nature of the recycling program's ties to new appliance delivery means it was unlikely to reach consumers making retirement decisions for secondary refrigerators. The programs may have prevented some consumers from keeping their old refrigerator (thus avoiding some electricity consumption from yet another secondary refrigerator) but the program is unlikely to have reduced substantially the number of existing refrigerators in use.

Two new programs have recently used consumer rebates to encourage the use of higher-efficiency clothes washers: the *WashWise* program in the Pacific Northwest and the Tumble Wash program in the Northeast. These two programs are comparable in the total number of rebates processed per month for markets of approximately equal size. The data on program effectiveness is better for the *WashWise* program since it has been in existence longer. That program appears to have doubled the market share for high-efficiency washers, starting with rebates of $130. Interestingly, those rebates were purposefully reduced in March 1998 to $75 and were eliminated in September 1998, but the trend toward purchasing high-efficiency washers has remained strong.[33] The utilities in the Northeast are offering rebates of $100 in Massachusetts and New Hampshire for any high-efficiency washer. Programs in Connecticut and Vermont are for consumers with electric water heaters and the program on Long Island, NY has rebate amounts varying by washer efficiency.

Early replacement programs are designed to get consumers to retire a functioning, but energy-inefficient appliance. Therefore, careful attention must be paid in the design and implementation of such programs to ensure that existing appliances are taken out of service. An old appliance "turn-in" program, modeled after the "halogen torchiere turn-in" events sponsored by the Northwest Energy Efficiency Alliance and local utilities is an example of a program design that might serve as a model.[34] At these events consumers are asked to "turn-in" standard halogen torchieres. In return the consumer receives a "store credit" toward the purchase of a new Energy Star® torchiere floor lamp. The old fixtures and lamps are then dismantled and recycled. This program design has two features worth noting. First, the "store credits" can be targeted at specific appliances. For example, such programs could avoid targeting appliances (e.g., refrigerators) where a new federal standard is scheduled to be implemented in less than a year and focus its attention on appliances (e.g., clothes washers) where a standard change is still several years away. Second, the "store credit" can serve as a substitute for the "salvage" value of the functioning appliance. This improves the economics of early replacement by offering a simple and clear "trade-in" value for the existing appliance while ensuring that it is taken out of service and properly recycled.

The U.S. Congress has used tax credits and other tax incentives to support a wide variety of new technologies and other capital investments. The most significant program relating to consumer

energy purchases was the Energy Tax Act of 1978 (P.L. 95-618). The Energy Tax Act authorized 15 percent tax credits for purchases up to $2,000 ($300 maximum credit) that increased the energy efficiency of a consumer's home. The Act also authorized 40 percent credits for the first $10,000 investment in renewable energy technologies installed in homes.[35]

Approximately 4-5 percent of all individual income tax returns in 1978 and 1979 claimed credits for energy conservation investments (3.5 million returns with credits in 1978 and 4.8 million returns in 1979). Average expenditures were just under $700 ($1,400 in 1999 equivalent dollars); total expenditures were $2.5 billion to $3.3 billion. A much smaller number of returns (40,000 in 1978 and 75,000 in 1979) claimed credits for investments in renewable energy sources. The average renewable source investment was $1,850 in 1978 and $2,500 in 1979. Given the magnitude of the number of returns claiming credits relative to the related industry sizes, it is extremely likely that there was a high proportion of homeowners who claimed tax credits for purchases they would have made without the tax credits.[36] The General Accounting Office (GAO) reviewed the Energy Tax Act credit program in 1982 and found all studies to that date generally inconclusive about the effectiveness of the credits.[37] In its report, the GAO concluded that no then current study demonstrated that tax credits had a significant effect on encouraging net incremental energy conservation purchases. Further evidence of the ambiguous impact of income tax credits on generating incremental improvements in consumer efficiency choices comes from a recent analysis of the sales of Energy Star® clothes washers and refrigerators in Oregon versus surrounding states. In Oregon there is a state income tax credit available for consumers who purchase these high-efficiency models. However, the market share of Energy Star® clothes washers and refrigerators in Oregon during 1999 was actually slightly lower than found in the adjoining state of Washington, which does not offer such credits.[38]

Cost Leveling

Experience with cost leveling programs has come primarily in the utility industry. These programs allow customers to purchase or lease new products — most often water heaters — and pay for them monthly through the utility bill. This approach has not been used recently to any major extent for refrigerators or other home appliances.[39]

B. Education and Communications Programs

There is a vast range of potential programs to educate consumers about high-efficiency and environmentally friendly appliances. Education and communication programs fall into four broad categories:

1. Product specific information, such as labels;
2. In-store education and promotion, including displays, brochures, and other written information, as well as sales representative recommendations;
3. Targeted mailings, including utility bill stuffers and other mailings to selected customer groups; and
4. Mass media communications through television, radio, and newspapers, including advertising, magazine articles, consumer reviews, and Internet sites.

Product Specific Programs: Labels

Product labeling programs are the longest running, continuous approach to promoting high-efficiency appliances. As a result of the Federal Trade Commission's Energy Guide labeling program initiated in the 1970s, all major home appliances now carry labels that show the projected operating cost and its cost relative to other appliances in the same class.[40] The program helps consumers make informed decisions about the appliances they buy. A second effect has been to achieve consistency in energy usage claims since the label information must be developed through standardized testing procedures. Manufacturers can only make energy consumption and conservation claims that are based on test procedures established by the Department of Energy and are consistent with the information on the Energy Guide label.

In a recent extension of the labeling concept, the Department of Energy and the Environmental Protection Agency have developed an Energy Star® labeling program that serves as a seal of approval for high-efficiency products. With the Energy Star® label, consumers know that they are purchasing an efficient product without having to research energy consumption data for all similar products. Currently, washers, dishwashers, refrigerators, and room air conditioners are eligible to receive Energy Star® labels.[41]

In reviews of the Energy Star® programs, approximately 75 percent of consumers claimed to have been aware of the Energy Guide label and found it to be "moderately to somewhat useful."[42] The labeling program has also influenced manufacturers to change the overall composition of their product mix toward more efficient appliances. Recent research indicates that the presence of the labeling program is associated with an increased rate of energy efficiency innovation in appliances.[43]

Unfortunately, the Energy Guide labeling program has not kept pace with the advent of electronic commerce. While "online" purchases of major home appliances do not as yet represent a major share of sales, research has shown consumers do use the Internet to do comparison shopping.[44] To aid in their search for energy-efficient appliances, the Environmental Protection Agency does provide the brand, model number, energy efficiency, and a limited amount of other information for Energy Star® compliant clothes washers, refrigerators, dishwashers, and room air conditioners on its website. However, none of three major online retailers' websites visited by the authors provided the Energy Guide information for the appliances listed.[45] These sites also did not permit a consumer to use "energy efficiency" or Energy Star® as a selection or comparison criteria. Given the apparent impact that the Energy Guide labeling program (and by implication the Energy Star® program) has had, it would appear that the inclusion of this information on "electronic" showrooms would also be highly beneficial.

In-Store Education Programs

Manufacturers frequently seek ways to train in-store sales staff of appliance and other retailers about new and innovative products as a means of improving new product acceptance. Appliance retailers, in turn, seek ways both to excite their in-store sales staff and to give them something to talk about other than price. The challenge is to reach the many salespeople who are on the floor selling appliances nationwide. So far, only manufacturers have focused extensively on training in-store appliance sales representatives to sell high-efficiency appliances and promote early replacement and retirement. Other groups have provided salespeople with information on energy savings and cost/saving comparisons. For example, sales representatives report that the Energy Guide label provides an ice-breaker for conversations about appliances, making it easier to talk with consumers about energy.[46] As an additional approach for enlisting the

assistance of retailers, the *WashWise* program has provided rebates to the retailers payable to the floor sales staff in order to encourage the sales staff to promote more efficient appliances.[47] The *WashWise* retailer program was designed to function within the standard "sales incentive" structures operating in each store or chain, rather than as an "outside" incentive. This approach was selected in an attempt to institutionalize incentives for salespeople.[48]

In-store appliance sales staff only come into contact with *Buyers* and some *Considerers*. Therefore, they will be most effective in encouraging upgrade decisions and increasing the number of *Considerers* who actually purchase new more efficient appliances.

Targeted Marketing: Bill Stuffers

Utilities have frequently used direct mail (i.e., "bill stuffers") to publicize energy conservation, efficient appliances, and other marketing programs. Since the utility sends a bill to each customer monthly anyway, and this billing pays the postage and basic handling costs of a direct mail campaign, the monthly bill is a low-cost means of advertising. Further, consumers believe that products and services advertised in the utility bill are at least implicitly endorsed by the utility so that the utility's credibility can be transferred to a new product or technology.[49]

One potential advantage of direct mail is that it reaches *Satisfieds* and *Considerers* as well as *Buyers*. Therefore, the use of bill stuffers and other direct mailings could help encourage early replacement or appliance retirement by consumers who are not currently visiting an appliance store and shopping for an appliance. Bill stuffers could be preferable to other direct mail mechanisms because of the low cost.

Mass Communications

Mass communication provides the greatest opportunity to reach potential customers who are not currently shopping for or considering appliances. There are two basic approaches to mass communication: advertising and public relations. In advertising (either paid or public service announcements), the sponsor controls the content of the message but there is no implicit or explicit credibility provided by third parties. In other forms of public relations, such as magazine articles, the publisher determines the content and provides an implicit endorsement of the message.

The major disadvantage of mass media advertising is cost versus effectiveness. Sustained advertising campaigns covering national audiences can easily cost tens to hundreds of millions of dollars. While public service announcements are available for free on television and radio, the timing and targeting of these announcements are under the broadcaster's control. Public service announcements may not run frequently enough or provide the necessary coverage to influence consumer behavior significantly.

One public relations venue of special significance for home appliances is *Consumer Reports*. No other publication or information source has the same visibility and credibility with appliance consumers. (See Table 5, *supra*.) Obtaining coverage and endorsement by *Consumer Reports* adds significant credibility to any effort promoting early replacement or retirement of appliances.

Finding an appropriate and cost-effective balance of advertising and public relations will be critical in order to reach *Considerers* and *Satisfieds*. This will require enlisting manufacturers in advertising a public policy program as well as using free media and public relations opportunities wisely.

C. New Program Approaches

The WashWise *retailer incentive is one example of possible new programs that build on past experience to create targeted public policy approaches.* The incentive payments to retail sales staffs are designed to get dealers involved in educating consumers to overcome consumer hesitancy in purchasing a high-efficiency washer. In a recent set of business school case analyses on high-efficiency appliances, one student team suggested an increasing level of rebates for each appliance a consumer replaced early in order to encourage multiple replacements by consumers.[50] If the federal government chose to use tax incentives to promote the purchase of higher-efficiency appliances, it could give the appliance manufacturers or retailers tax credits and allow them to use those credits to pay for consumer or dealer rebates. The challenge for policy-makers is to understand the limitations of past programs and to create new programs that are targeted effectively to specific consumer decisions.

VIII. Effects of Public Policy Programs on Manufacturers

Actual consumer purchases depend on both what the consumer wishes to do (demand) and what products are available to purchase (supply). Unless manufacturers produce high-efficiency products, consumers cannot purchase them. Similarly, if manufacturers cease to produce low-efficiency products, then consumers will be forced to buy more efficient units. In the most obvious situation, minimum appliance efficiency standards have caused manufacturers to cease producing lower-efficiency products and forced consumers to purchase models more efficient than traditional ones. Therefore, public policy programs oriented towards manufacturers can also have a major effect on consumer behavior.

While it is clearly the case that, over the past twenty years, manufacturers have increased the average efficiency levels of the appliances they produce, the causes of this change are complex. Minimum efficiency standards have played a role as have competitive considerations, consumer demand, public policy programs oriented towards consumers, and other public policy programs oriented towards manufacturers. It is beyond the scope of this study to assess the relative importance of these various factors in influencing design and production decisions by manufacturers. Whenever public policy programs oriented towards consumers are developed, they should consider both whether manufacturers will be in a position to supply appropriate products and whether they reinforce, duplicate or contradict other manufacturer-oriented programs. For example, in the recent agreement on revisions to the federal standards for clothes washers there are provisions that seek to institute "production tax credits" for manufacturers who produce models exceeding, that is, more efficient than, the proposed new standards. The agreement also calls for upgrades to the Energy Star® specifications both to simplify the identification of the models that would qualify for the tax credit and to continue consumer marketing of products that exceed the minimum federal standards (See Box 1).

Box 1

Industry and Energy Efficiency Advocates Agree on New Clothes Washer Standards

On May 23, 2000, appliance manufacturers, energy efficiency advocates, and DOE officials announced a landmark agreement on revisions to the minimum efficiency standards for clothes washers. The agreement, which covers appliance efficiency standards as well as related incentives and information programs, culminated months of negotiations between appliance manufacturers and a broad coalition of public interest advocates. The agreement includes joint recommendations for: 1) efficiency standard levels and implementation dates, 2) Energy Star® program specifications, 3) federal tax credits for manufacturers and 4) energy and water use performance disclosure/reporting.

Standard Levels and Implementation Dates:

The agreement, if adopted by DOE, will increase the minimum efficiency requirements for clothes washers sold in this country over the current standards that became effective in 1994. The agreement calls for a 22.5 percent improvement effective January 1, 2004 followed by a 35 percent improvement beginning January 1, 2007.

Energy Star® Specifications:

The agreement calls upon DOE to set the minimum efficiency levels for clothes washers to qualify for the Energy Star® label in 2001 at 35 percent above the current standard and raise it to 42.5 percent above the current standard in 2004. It also calls upon DOE to increase the minimum efficiency levels for refrigerators and freezers to qualify for the Energy Star® label to 10 percent above the new federal standard that takes effect July 1, 2001, and to raise this to 15 percent better than the 2001 standard in 2004.

Federal Tax Credits:

Parties to the agreement support legislation that would provide federal income tax credits for manufacturers producing clothes washers complying with the new standards prior to its effective date. In addition, manufacturers could receive tax credits for producing Energy Star® compliant refrigerators and freezers. On July 26, 2000 this legislation was introduced in both the House and Senate in the form of *"The Resource Efficient Appliance Incentives Act"* (Senate Bill 2939 and House Bill 4977).

Performance Disclosure and Reporting:

The standard establishes the minimum energy efficiency of new clothes washers, but will not regulate the amount of water that can be used by the machines. However, manufacturers agreed to disclose the energy efficiency and water consumption of all clothes washers that qualify for the tax credit/Energy Star® sold beginning sometime in 2001. The Association of Home Appliance Manufacturers (AHAM) will also report the sales weighted average energy efficiency and water consumption of all machines sold beginning in 2002 and each machine's water factor beginning in 2007. (A machine's water factor is the total amount of water used in a normal cycle.)

DOE estimates that the new agreement will save just over 5 quadrillion Btu (British thermal units) of energy (enough electricity to light 16 million U.S. homes for 25 years) and reduce water use by some 10.5 trillion gallons over a 25-year period. As a result of these energy savings, greenhouse gas emissions will be reduced by 80 million metric tons per year — an amount equal to that produced by nearly 4 million cars.

Parties to the agreement include the Association of Home Appliance Manufacturers, Alliance Laundry Systems, Amana, Asko, Frigidaire, General Electric Appliances, Maytag, Miele, Fisher & Paykel, Whirlpool, the Natural Resources Defense Council, American Council for an Energy-Efficient Economy, the Alliance to Save Energy, Northwest Power Planning Council, the City of Austin, Texas, Pacific Gas and Electric Company, the Appliance Standards Awareness Project, and the California Energy Commission.

While the agreement is subject to a final rulemaking by DOE, it is expected that the joint recommendations by manufacturers and efficiency advocates will be accepted and written into the final standards. DOE expects to publish the proposed clothes washer standards in the Federal Register this fall and issue the final rule by the end of 2000.

Box 1 continued

Summary of Industry and Energy Efficiency Advocates Agreement on Clothes Washer Standards

Joint Recommendation	Clothes Washers	Refrigerator/Freezers
New Standard		
January 1, 2004	22.5% Improvement (MEF 1.04)	Not Applicable
January 1, 2007	35% Improvement (MEF 1.26)	Not Applicable
Energy Star® Efficiency Levels		
January 1, 2001	35% Improvement (MEF 1.26)	10% Improvement
January 1, 2004	42.5% Improvement (MEF 1.42)	15% Improvement
Tax Credit		
Through December 31, 2003	35% Improvement (MEF 1.26) – $50/unit	10% Improvement – $50/unit
Through December 31, 2006	42.5% Improvement (MEF 1.42) changing to 45% (MEF 1.5) on January 1, 2004 – $100/unit	15% Improvement – $100/unit

Note: MEF = Modified Energy Factor and is a measure of the energy efficiency of a clothes washer. MEF measures the cubic feet/kilo-watt-hour of energy use per normal laundry cycle. The higher the MEF, the more efficient the machine.

IX. Conclusions

Public policy programs can help change consumer behavior around appliance purchases. An upgrade program can build on the successes of similar programs sponsored by utilities and others for refrigerators, room air conditioners, clothes washers, and dishwashers, among other appliances. A refrigerator retirement program can build on the recycling programs initiated in the 1980s while focusing more carefully on actual retirements. Few programs have focused on assuring that *Considerers* actually buy appliances rather than deferring the purchase and continuing to use the older, less efficient one. Similarly, few programs have focused on early replacement separate from upgrades. Finally, all programs must ensure that any current appliances are removed from use in order to reduce total societal energy consumption and greenhouse gas production. New public policy initiatives can be developed which target each of these consumer decisions and which are congruent with emerging minimum appliance efficiency standards and other current programs oriented towards manufacturers.

A. Upgrade Programs: *Buyers* and *Considerers*

Upgrade programs have demonstrated success at increasing purchases of more efficient refrigerators, room air conditioners, washers, and other consumer products. These programs have generally offered incentives of $20 to $150 to consumers who purchase appliances that are 10-35 percent more efficient than the appliance models that meet the minimum efficiency standards at the time of the incentive. These programs also typically have been publicized by both utilities and retailers. At their best, they have had a significant effect on the local marketplace, sometimes doubling the local market share held by high-efficiency appliances. The *WashWise* and Tumble Wash and the SMUD refrigerator programs are good models for a successful upgrade program targeting *Buyers*. These programs were designed to maximize the use of the existing sales chain, but alter its existing incentive structure to promote the sale of more energy-efficient appliances.

A program to encourage *Considerers* not to postpone an appliance purchase could use many of the same program elements as one focused towards *Buyers*. Since many *Considerers* are already in appliance stores, it would be relatively straightforward to develop a program to help appliance sales

representatives encourage these consumers to purchase now. The recent incentives in the *WashWise* program provide a useful example of the power gained with active retailer cooperation. Such a program would clearly be in the interests of appliance retailers, whose sales would increase. In order to maximize the potential for energy savings (and to spread the typically high fixed cost of marketing over more savings), replacement programs should always operate in conjunction with an upgrade program so that consumers can be guided to higher-efficiency appliance purchases.

B. Early Replacement: *Satisfieds* and *Considerers*

The most difficult set of programs to design and implement with significant results would focus on Satisfieds and Considerers to encourage early replacement of appliances with high-efficiency models. Not only are the economic benefits of early replacement with higher-efficiency models less clear-cut, but the *Satisfieds* and *Considerers* are also the least receptive to information about purchasing appliances and the most expensive to reach. An early replacement program targeted to these groups will need to rely on mass media communications and other approaches with high credibility (such as government agencies, utilities and *Consumer Reports*) and with sufficient frequency and cleverness to break through the overall advertising clutter. While some form of consumer incentive may be necessary, the major hurdle is not consumer economics but the consumer's indifference and inattention to appliance efficiency. For success, a respected organization will need to take a strong lead to coordinate a consistent, compelling, and memorable message that catches the attention of consumers. This message will need active support at the retail level to ensure that consumers who are considering early replacement actually make a high-efficiency purchase.

A public policy program oriented towards high-efficiency early replacements must also be designed in conjunction with any anticipated changes in minimum appliance efficiency standards or other changes in appliances that could make models available in a few years much more efficient than high-efficiency products currently in the marketplace. From a societal standpoint, consumers contribute more to the environment and energy conservation if they delay replacement until the more efficient models come into the market. Since new energy efficiency standards come into effect on predictable and relatively long cycles, it should be possible to craft programs that avoid any unanticipated effects of early replacements immediately prior to new standards.

C. Retirement

To date, most refrigerator retirement incentives have not distinguished between true retirements and disposal of a surplus refrigerator once a new one is purchased. While a surplus disposal program may help encourage early replacement by subsidizing all replacements, this may not be the best approach since past recycling programs have free rider rates exceeding 60 percent of participants.[51] Narrowing the target segment served by a retirement program is likely to reduce retailer interest if such a program is unavailable to most purchasers of a new appliance. Retailer influence and publicity could be partially replaced by utility mailings and aggressive publicity from *Consumer Reports* and other highly credible mass circulation journals. Even with this support, however, a retirement program is unlikely to attain the same penetration rates achieved by the best recycling programs.

Public policy programs could, thus, target each major replacement decision as well as early retirements using approaches and methods that have been successful in the past (See Table 7). The total potential energy savings from these programs will depend on the length of time the program runs and on how long it would take for the appliance to fail without replacement or retirement.

Table 7

Potential **Public Policy Programs** and Target Consumer Decisions

Decision	Target Group	Major Program Elements
Upgrade to More Efficient Appliance	*Buyers*	• Point-of-sale information including Energy Star® logos • Energy labels (on appliances) and data on energy use in electronic "catalogs" • Sales representative training and incentives
Limit Loss of Potential *Buyers*	*Considerers*	• Point-of-sale information including Energy Star® logos • Easy-to-use cost and savings analyses, especially for potential online buyers • Sales representative training and incentives
Early Replacement	*Considerers* *Satisfieds*	• Mass communications Bill stuffers *Consumer Reports* • Cost and savings analyses • Rebates/Store Credits for appliance retirement
Appliance Retirement	All households	• Mass communications Bill stuffers *Consumer Reports* • Rebates • Pick-up and recycling programs

Endnotes

1. Care must be taken to ensure that the efficiency of the replacement appliance is not significantly below the efficiency of the appliance that would have been purchased on a normal replacement cycle, or it is possible that more energy will be saved by waiting for the normal replacement cycle. This is particularly true if efficiency levels are improving rapidly due to technological advances and/or changes in minimum standards.

2. Technical Support Documents from U.S. Department of Energy as filings for minimum appliance efficiency standard rulemakings (U.S. Department of Energy — July 1995 for Refrigerators, October 1997 for Room Air Conditioners and October 1998 for Washers). This calculation is based on the difference in energy consumption between the average unit in the housing inventory versus a current basic unit or a high-efficiency unit times 1 percent of the inventory of appliances for early replacements and retirements and 1 percent of appliance purchases for upgrades.

3. Personal requests by the author (E. Shorey) to the appliance companies while serving as a consultant to the Association of Home Appliance Manufacturers on rulemaking matters.

4. Lawrence Berkeley Laboratory developed a Residential Energy Model (REM) based in part on earlier energy forecasting work done at Oak Ridge National Laboratory. At the same time, the Electric Power Research Institute developed the Residential Energy End-Use Planning System (REEPS) model. The purpose of both REM and REEPS is to forecast energy consumption by fuel type, region, customer type, and end use. To accomplish this energy forecasting objective, these models need to incorporate projections of the overall efficiency level and fuel type used by home appliances through some sort of consumer choice algorithm. Given the dominance of the inventory of appliances at any given time relative to the number of appliances sold annually (approximately 10+ units in the inventory to every unit sold annually), energy consumption forecasting models can achieve useful accuracy with only modest accuracy in appliance shipment estimates. While these models are not explicitly developed to forecast the relationships between appliance prices, energy consumption, and product shipments, the efficiency levels of home appliances are important factors in projecting energy consumption. Therefore, the developers of these models have attempted to develop and validate both their overall accuracy (the relationship between forecasted and actual energy consumption) and the accuracy and validity of key component elements such as energy efficiency and consumption levels of home appliances.

5. The difficulty in validating appliance shipment forecasting models is due to the absence of reliable retail price data on appliance purchases. This difficulty is also due to the inability to link price data with specific models sold and with the presence of incentive, promotional, and other programs. Appliances are sold through many different retail outlets with wide variations in selling prices to end users. First, there are no consistent sources measuring retail transactions so that the price variations are not well tracked. Second, the variation in prices between retailers for the same model can be significant relative to the incentive amount of many programs. Without good retail price data, it is virtually impossible to measure the relationships between prices, energy costs, other features, and purchase volumes.

6. See Figures 4 and 5.

7. Association of Home Appliance Manufacturers, *Home Appliance Saturation and Length of First Ownership Study,* May 1996; U.S. Bureau of the Census, *American Housing Survey for the United States in 1995;* Appliance Magazine, *22nd Portrait of the U.S. Appliance Industry,* September, 1999.

8. Site electricity consumption weighted by electric percentage of total units. The proposed annual greenhouse gas limitation for the United States under the Kyoto Protocol is approximately 1,500 mmtce.

9. Association of Home Appliance Manufacturers, *Shipment Statistics, 2000,* Provided by e-mail to E. Shorey.

10. U.S. Department of Commerce, Census Bureau reports C20 — Housing Starts and C22 — Housing Completions.

11. Appliance Magazine, *22nd Portrait of the U.S. Appliance Industry,* September 1999; USDOE "Life Cycle Cost Spreadsheet, January, 2000" and "National Energy Savings Two-Tier Shipments/NES Spreadsheet", February, 2000. Available at http://www.eren.doe.gov/buildings/codes_standards/applbrf/clwasher.html, Association of Home Appliance Manufacturers, personal communications by authors.

12. Sample values derived from Hakim, S.H., and I. Turiel, *Cost-Efficiency Analysis in Support of the Energy Conservation Standards for Refrigerator/Freezers,* Lawrence Berkeley Laboratories (undated). These sample values are expressed in constant 1992 dollars and omit any effects from inflation.

13. A simple payback is "the amount of time in months or years required for an investment to recover its non-discounted initial capital cost as a result of savings from that investment." Net Present Value is "the total present value of an investment; [NPV] takes into account all discounted costs and savings over the full life cycle of the investment, measures the profitability of an investment and allows alternate investments to be compared objectively." U.S. Department of Energy, *Financing Energy Efficiency in Buildings,* Rebuild America Guide Series, May 1998.

14. The discussion of net present value is intuitively clearer if the consumer is thought to take out a loan for the added price and use the energy savings to pay the loan back. The general argument is the same if the consumer pays cash and uses the energy savings for other investments or purchases.

15. This example assumes that any subsequent replacements either take place at the same time or that the life of the new appliance is long enough so that the present value of any second replacement timing differences are minimal. Given the long expected lives of major home appliances (14-16 years or more for washers), this assumption of inconsequential second replacements will have no practical effects on the economic analysis.

16. For the purposes of analyzing the impacts of appliance regulations on consumer purchases, the Department of Energy is currently proposing a 6 percent real after-tax rate of return as the consumer's cost of money. Other commentators have suggested that rates of approximately 2 percent are more appropriate. U.S. Department of Energy, *Preliminary Technical Support Document: Energy Efficiency Standards for Consumer Products: Clothes Washers,* Docket No. EE-RM-94-403, October 1998, pp. 7-21, and comments by Dr. David B. Goldstein, Natural Resources Defense Council, 12 February 1999, pp. 6-7. Real after-tax discount rates include the cost (or alternative investment opportunity) available to consumers after correction for the effects of inflation and taxes.

17. In addition to their greater energy savings, Energy Star® clothes washers generally use substantially less water thus reducing a consumer's water and wastewater bills. Analysis based on data contained in U.S. DOE "Life Cycle Cost Spreadsheet," January 2000, available at http://www.eren.doe.gov/buildings/codes_standards/applbrf/clwasher.html.

18. The basic concept of "bounded rationality" and satisficing behavior was developed by Herbert A. Simon and others. The notion is that individuals have neither the time nor the information to evaluate all options for any decision. Individuals bound the options they consider to those that appear relevant at the time and settle on the first satisfactory choice they find. As a corollary result, individuals who are overwhelmed with potential decisions will filter information that is not relevant to decisions of current importance.

19. Hiam, Alexander and Charles D. Schewe, *The Portable MBA in Marketing,* John Wiley & Sons, 1998, p. 190; Batra, Rajeer, John G. Myers and David A. Aaker, *Advertising Management,* Prentice Hall, 1995, p. 234.

20. Lawrence Berkeley Laboratory, *Draft Report on Consumer Research for Clothes Washers,* 27 March 1998, p.5; Hewitt, D., J. Pratt, and G. Smith, *A Second Wash Wise Market Evaluation Report,* Pacific Energy Associates, July 1998, p.19; Brown & Whiting, *Consumer Attitudes Towards Energy-Efficient Appliances,* Volumes I and II, 1996, Table 10; Shorey, E., R. Topping, and J. Brewda, *The Financial Impacts of DOE Top Loading Horizontal Axis Washer Standards on U.S. Washing Machine Manufacturers: Report to the Association of Home Appliance Manufacturers Horizontal Axis Task Force,* Arthur D. Little, Inc., August 1991, p. 26.

21. Barbagallo, L., and T. Ledyard, *Market Assessment for Tumble Wash Clothes Washers and Other Energy Star® Appliances,* RLW Analytics, August 1998, p. 21.

22. Hewitt, Pratt, & Smith, *A Second Wash Wise Market Evaluation Report,* p. 20.

23. Brown & Whiting, *Consumer Attitudes Towards Energy-Efficient Appliances,* Table 18.

24. *Ibid*., Table 19; Hewitt, Pratt & Smith, *A Second Wash Wise Market Evaluation Report,* p. 21.

25. Brown & Whiting, *Consumer Attitudes Towards Energy-Efficient Appliances,* Table 20.

26. *Ibid.*, p. 20.

27. Blevins, R.P., and B.A. Miller, *1992 Survey of Demand-Side Management Programs,* EPRI TR-102193, Electric Power Research Institute, May 1993, pp. 4-2, 4-3.

28. Hewitt, Pratt & Smith, *A Second Wash Wise Market Evaluation Report,* p.1; Gardner, Margie and Bronfman, Ben, Northwest Energy Efficiency Alliance, personal communication to T. Eckman, (May 10, 2000).

29. The Oregon tax credit program covers "premium appliances," solar, geothermal and fuel cell systems. See http://www.energy.state.or.us/res/tax/taxcdt.htm.

30. Blevins & Miller, *1992 Survey of Demand-Side Management Programs,* pp. 4-16 to 4-137.

31. *Ibid.*

32. Author's (E. Shorey) interview with Warren Lindleaf, Demand Side Specialist at Sacramento Municipal Utility District, December 1999. Information on the other three high performing programs is not available.

33. Hewitt, Pratt & Smith, *A Second Wash Wise Market Evaluation Report,* p. 35; Barbagallo & Ledyard, *Market Assessment for Tumble Wash Clothes Washers and Other Energy Star® Appliances,* p. 35.

34. Pacific Consulting Service and Shel Feldman Management Consultants, *Northwest Energy Efficiency Alliance Market Progress Evaluation Report on the Energy Star® Residential Lighting Fixtures Program*. No. 2 (August 1999). p. A.5.

35. Note that these amounts reflect expenditures in the late 1970s. The equivalent of a $2,000 purchase in 1980 is approximately $4,000 in 1999.

36. Author's (E. Shorey) calculation of implicit materials usage by taxpayers claiming credits versus apparent consumption of insulation and other energy conservation materials.

37. United States General Accounting Office, *Studies on the Effectiveness of Energy Tax Incentives Are Inconclusive,* EMD-82-80, 11 March 1982; United States General Accounting Office, *The Business Energy Investment Credit for Solar and Wind Energy Systems,* GAO/RCED-83-8, 7 March 1983, p. ii.

38. Eckman, Tom. *Memorandum Regarding State Level Penetration of Energy Star® Appliances in 1999*. July 12, 2000.

39. Blevins & Miller, *1992 Survey of Demand-Side Management Programs,* pp. 4-9 to 4-10

40. Authorized by 16 CFR Part 305.

41. The Energy Star® program is described in the EPA website www.epa.gov/appdstar/estar/.

42. Brown & Whiting, *Consumer Attitudes Towards Energy-Efficient Appliances,* Table 13.

43. Newell, Richard G., Adam B. Jaffe, and Robert N. Stavins, *The Induced Innovation Hypothesis and Energy-Saving Technological Change, Working Paper* 6437, National Bureau of Economic Research, March 1998. Essentially the same material can be found in "Discussion Paper 98-12" (Revised), *Quarterly Journal of Economics,* August 1998, pp. 941-975 and Newell, Richard G., *Environmental Policy and Technological Change: The Effects of Economic Incentives and Direct Regulation on Energy-saving Innovation,* Doctoral Thesis, Harvard University, May 1997.

44. Ernst & Young, LLP. *The Second Annual Ernst & Young Internet Shopping Study — The Digital Channel Continues to Gather Steam.* January 1999, pp. 9-10.

45. The sites visited included Sears, "The largest appliance site online" (www2.Sears.com), Circuit City (www.circuitcity.com) and the Microsoft Network E-shop (eshop.MSN.com). Both Sears and Circuit City are Energy Star® Partners. This oversight is particularly obvious for Sears because it was the "Energy Star® Retail Partner of the Year" for 2000.

46. Brown & Whiting, *Sales Staff Approach toward Selling Energy-Efficient Appliances,* 10-12 March 1997, pp. 16-18.

47. Hewitt, Pratt & Smith, Pacific Energy Associates, Inc., *WashWise/Energy Star® Resource-Efficient Clothes Washer Program,* Market Progress Evaluation #3, 30 April 1999, p. 6.

48. Gordon, Lois; ECOS Consulting, personal communication to T. Eckman, (March 1999).

49. Brown & Whiting, *Consumers Attitudes Toward Energy-Efficient Appliances, Focus Groups Conducted in Los Angeles, CA and Washington, DC,* March 1997 and December 1996.

50. Unpublished presentations by students in Industry and Strategic Decision Analysis, The Center for Business & Public Policy, The George Washington University, 26 April 1999. Course sponsored jointly by the Association of Home Appliance Manufacturers, US Department of Energy and The George Washington University.

51. Slide presentation by Violette, D.M., and M.L. Goldberg, XENERGY, Inc., "Residential Program Evaluation", reproduced in Michigan Evaluation Working Group, *Evaluation of Consumers Power Company's REDUCE THE U$E Programs,* 21 July 1994, Slide RES-10. Free riders are customers who receive the rebate even though they would have retired their refrigerators anyway.

notes