Policy Options Targeting Decision Levers: An Approach for Shrinking the Residential Energy-Efficiency Gap[1]

Marilyn A. Brown and Jess Chandler, Georgia Institute of Technology
Melissa V. Lapsa, Oak Ridge National Laboratory

ABSTRACT

The model of bounded rationality offers valuable insights into consumer choices related to residential energy consumption. Many household energy decisions are highly dependent upon deliberation costs, an aversion to losses, and past experience. Thus, these three levers would appear to be valuable targets for policy intervention. In this paper, we examine three decision points where consumers make choices that can have significant bearing on their home energy use. For each decision point, we highlight a key decision lever and a policy that could improve the decision-making process. In particular, we describe (1) the mandatory disclosure of energy performance information as a means of reducing deliberation costs; (2) on-bill financing of energy-efficiency improvements to motivate going beyond loss aversion to choose the best alternative; and (3) smart meters with dynamic pricing that strengthens the link between actions and outcomes. While many design features of these three policies still need to be examined and optimized, experience to date – and their focus on important decision levers – suggests the potential for these policies to move residential energy behavior toward the expected choices of rational actors.

Introduction

For years, energy efficiency advocates have argued that bridging the energy-efficiency gap can save millions of dollars in energy consumption for consumers while improving quality of life and environmental conditions. Not doubting this premise, countless policies have been created and argued for on the basis of addressing barriers to energy efficiency. Many of these policies either provide general information or attempt to change the price of goods. Despite existing efforts, the energy-efficiency gap remains: contractors build inefficient homes that people are quick to buy; people rarely replace equipment or home materials with the most

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efficient, cost-effective technology; and we waste energy on things that are not in use. Much of this energy-efficiency gap can be attributed to how individuals make decisions.

In this paper, we provide background on decision making in the context of energy consumption, focusing on the bounded rationality model. Then, we examine three decision points where consumers make choices that can have significant bearing on their home energy consumption. For each decision point, we highlight a policy that could improve the decision-making process. In particular, we describe three federal policies that could help consumers make more informed energy use choices: mandatory disclosure of energy performance information; on-bill financing of energy-efficiency improvements; and smart meters with dynamic pricing. The effectiveness of these policies is suggested because they target important decision levers, illustrating that much more than monetary incentives are needed to change behavior. The results of a broader assessment of these policies in the context of their federal role is summarized in Table 1 with back-up information provided in Brown, et al. (2009).

Table 1. Summary Assessment of Three Policy Options

	Strengths	Weaknesses	Time Horizon*
Mandated Disclosure of Energy Performance Information	Appropriateness of the Federal Role, Broad Applicability, Technology Readiness, Cost-Effectiveness	Administrative Feasibility, Additionality	Medium to Long
On-Bill Financing of Energy-Efficiency Improvements	Appropriateness of the Federal Role, Broad Applicability, Technology Readiness, Significant Potential Benefits, Cost-Effectiveness	Administrative Feasibility	Short to Medium
Smart Meters with Dynamic Pricing	Broad Applicability, Significant Potential Benefits, Cost-Effectiveness, Additionality	Administrative Feasibility	Short

*Time horizons when significant energy savings begin: short (five years or less), medium (five to 10 years), and long (more than 10 years). Source: Brown, et al. (2009).

Background

If consumers were rational, adoption of energy-efficient technologies and practices would be commonplace because energy costs money, thereby reducing the potential for consumption of other goods; consumers would always choose the more efficient product with all other characteristics being equal. Because of consumer choices, suppliers would improve the efficiency of product offerings and the whole range of options and stock would become even more efficient over time – with demand pulling supply. This rational actor model remains popular in discussing the "energy-efficiency gap" and forecasting potential savings because it works for the aggregate market (Wilson and Dowlatabadi 2007). However, consumers are not rational, and "all else equal" choices typically do not exist, and their decisions are surrounded by uncertainty and risk.

Research in behavioral economics and psychology has shown that consumers actually are quite limited in their decision making; these limits require a different model of the individual – bounded rationality.[2] Individuals almost systematically: confuse known information for important information, seek confirmation, ignore relevant information, rely on norms, seek to keep the status quo, are averse to the possibility of losses, are creatures of habit, display intransitive preferences, and grossly discount the future, among other evidence of bounded rationality (Conlisk 1996; Wilson and Dowlatabadi 2007). Because of these limitations, a variety of principles could assist policy makers. People are: strongly influenced by peers and approval-seeking, habitual, motivated by non-monetary gain when doing "the right thing," wanting to avoid cognitive dissonance, loss-averse, unable to understand statistical information, and interested in owning their decisions (Dawnay and Shah, 2005). In this paper, we focus on the fact that decisions can be highly dependent upon the cost of evaluating alternatives (deliberation costs), an aversion to losses, and past experience that links actions with outcomes (Conlisk 1996). These three levers are a good place to discuss policy interventions; below, we describe these levers, ultimately conceptualizing them as deliberation costs, loss aversion, and connecting actions to outcomes.

Reducing Deliberation Costs

It is costly to evaluate all of the possible alternatives and futures for any particular decision. Individuals have been shown to reduce their deliberation costs by relying on heuristics, copying others, and defaulting to the status quo.

Relying on heuristics, or a simplified set of assumptions, allows people to make quick judgments based on just a few aspects, such as color, brand, or availability. Heuristics might rightly be referred to as biases or screening mechanisms. With durable goods purchasing experiments, a majority of consumers (58%) were found to rely on screening – getting rid of what they like least; far fewer relied on choice (12%) – picking what they like most, and the remainder used a combination of screening and then choosing (Shao, Lye and Rundle-Thiele 2008). For those consumers who care about energy consumption in their home purchase decision, having readily available information about home energy performance can simplify the decision – reducing the deliberation cost – by allowing screening.

Copying others reduces deliberation costs by offering an example of the good, action, or service in use. Copying reduces risks and uncertainty by making things more familiar. Besides making individuals more familiar with a particular good, this behavior is approval-seeking; copying is such a strong motivator of behavior that it is principle number one of behavioral economics (Dawnay and Shah 2005).

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[2] Volumes have been written on different models of the individual and decision making. While we look only at bounded rationality and behavioral economics here, we do not mean to say that issues of framing, attitudes, and social construction are not important. For a clear review of what several models mean to energy decision making, see Wilson and Dowlatabadi (2007).

Defaulting to the status quo means that individuals will not seek to move from their original position (Kahneman, Knetsch and Thaler 1991). For example, when given the choice, few customers switch electricity providers even if they might save money (Brennen 2007). Similarly, a significant risk premium for new energy-efficient materials was found to exist with consumers questioned about their willingness to pay for a more efficient apartment with different types of energy-efficient technology improvements, some new and some conventional (Farsi 2010). When appliances come with a 'default' setting, people will use that rather than making a calculated decision on how to set their appliances (McCalley 2006). In addition to default settings or choices, individuals have difficulty changing their own habits; habits can be thought of as an individual's default behavior (Dawnay and Shah 2005). Many residential energy actions are simply a function of repetitive behaviors (Brown and Macey, 1983).

Going Beyond Loss Aversion – Motivation to Choose the Best Alternative

As we said previously, there is an implicit incentive for avoiding waste of any good – more discretionary spending on other goods. However, this incentive only applies if the monetary savings are acknowledged and "worth it". In addition, much more powerful incentives than money appear when we acknowledge behavior. Individuals are very loss averse – this leads to an understatement of willingness to pay relative to individual willingness to accept (Kahneman, Knetsch and Thaler 1991). Loss aversion can also lead to the avoidance of future gain in order to keep what has already been obtained and grossly discount the future (Dawnay and Shah 2005). In addition, people may see non-monetary incentives as much more valuable – like matching up with their perceptions of 'self' and providing a sense of altruism. In some cases, monetary incentives may be offensive or counterproductive.

In this case, the traditional policy use of the term 'incentives' acts almost as a conceptual barrier to improving the incentives individual consumers see to choose more rational directions in their decision making. In order to avoid this very confusion, we think it is most appropriate to focus on the behavior of loss aversion.

Decision Experience – Linking Actions More Strongly with Outcomes

More experience with the actual result of a decision can improve future decisions. People tend to put greater weight on options grounded in the greatest personal experience – specifically options with which they have recent experience (Dawnay and Shah 2005).

Even when individuals have experience with making a particular decision, they may not have experience with the outcomes. Providing feedback can improve decision making by connecting decisions with outcomes. This is particularly apparent in energy and water consumption when we consider the once-monthly bill that summarizes thousands of individual decisions made over the course of weeks and long since forgotten by the time the bill arrives. Personalized information has been shown to be more effective than general information – while we "know" that some actions and goods are more efficient than others, we may not use the information if it doesn't describe our particular characteristics or meet our economic or environmental concerns (Benders et al. 2006).

Decision to Purchase

Making a decision to purchase a home is one that most individuals do not get much experience with in their lifetimes. Much market research goes into determining what people are searching for when they are selecting a home for purchase. However, this research tends to focus on information that is available to consumers and useful to real estate agents. Despite appearances, there is information available to prospective buyers that can be used to estimate performance, should one be so inclined (the home's age, square footage, type of heating system, and other attributes that are observable).

Policy to Reduce Deliberation Costs: Mandatory Disclosure of Home Energy Performance

The success of disclosure will require that the public understands and is comfortable with the material presented to them. Simple reporting methods as well as *public information or education campaigns* can help consumers interpret energy consumption and energy performance information disclosed to them. Consumers should be educated not only about the specific rating scheme, if one is created, but also on average consumption data, the benefits of greater efficiency, and the cost of retrofits. A case study in California demonstrated that consumer understanding of the meaning and usefulness of home energy performance data was a necessary prerequisite in most cases for consumer interest in home energy performance (Robert Mowris and Associates 2004).

Mandated disclosure policies are in place or under consideration in several jurisdictions both in the U.S. and abroad. Denmark and the Australian Capital Territory have had the most experience. Policies in place tend to have a normative perspective: "here is the home energy performance, and here is how it can be improved." Consumers may reject this information because they do not agree with the basis of improvement arguments – namely, payback time; it may be better to only provide an indication of the absolute and relative efficiency of the home at time of sale – rather than options for improving (Palm 2010). The policy form of mandated disclosure varies with two general types of information required at point of sale alone or in combination: energy usage history or energy performance rating based on an audit.

Montgomery County, Maryland, requires sellers to provide an energy-efficient retrofit guidebook and 12 months of energy usage information, where available, to buyers (Montgomery County 2008). Austin, Texas, requires energy audits before selling homes with a voluntary program for implementing cost effective upgrades; it also sets targets for audits of multifamily units. The voluntary upgrade program is run by Austin Energy with a spending cap of one percent of the home's value for upgrades with a simple payback of not more than seven years.

Denmark began requiring energy disclosure on new and resale residential and commercial buildings in 1997. The current Danish rating scheme includes a rating, plan for savings, and direct consumption information; ratings are required annually for large buildings and upon construction or point of sale for small buildings (Laustsen and Lorenzen 2003). Denmark has shown sustained success with its consistent message with a decrease in energy costs per home of almost 20% since 1997 (Miguez et al. 2006).

The point of influence of this policy mechanism is when a housing unit is being sold. Approximately five percent of the housing stock is sold each year, with turnover varying slightly by region. Thus, while the program is applicable to all existing homes; it will reach about one-quarter of the housing stock over five years. Individual housing unit turnover rates vary, and some housing units may never turn over; despite these limitations, a sustained disclosure program will reach most housing units by 20 years.

Because there is so little domestic experience with mandatory disclosure of home energy performance, there are several areas where additional social science research could be useful. What kind of information, by what media should be provided? When should the information be provided, by whom? Research on truth in lending, also dealing with disclosure, has shown that information affecting choice must be provided during shopping and not at contract signing because buyers are already committed by contract signing and cannot use the information to compare (Durken and Elliehausen 2002; Peterson 2003). Can comparable home energy performance be provided similarly to comparable home sales?

Decision to Renovate

Retrofitting a home is rarely done solely to improve energy efficiency. Even among homeowners who participated in a Home Performance with ENERGY STAR® retrofit program, the most important reason they gave for participating was "increase comfort", followed by replacing failing or old equipment (Knight, Lutzenhiser and Lutzenhiser 2006). However, certain choices made during the renovation can have great impact on the final efficiency of the home – especially those related to windows, insulation, and heating and cooling systems.

Policy to Go Beyond Risk Aversion: On-Bill Financing of Retrofits

Energy-efficiency investments could be encouraged in existing buildings by enabling State Energy Offices (SEOs) and utilities to offer on-bill financing to building owners. In the proposed financing scheme, the government, Federal or State, would provide seed money and program guidelines for revolving loans implemented through States. States would have the flexibility to determine their own program administrators and specific rules. However, State programs should include certified and bonded auditors and contractors competitively selected to promote quality and cost-competitiveness, and to ensure that monthly repayment obligations by consumers are less than the energy bill reductions from the energy savings.

A review of residential efficiency financing programs in the U.S. and Canada by Fuller (2008) identified 18 on-bill loan programs in operation across the country. Capital for these programs came from a variety of sources including lender funds, internal utility funds, and public benefits charges. The most common financing mechanism was an unsecured consumer loan (Fuller 2008, 37). This approach is quite distinct from the program design being proposed in this chapter, which would rely principally on Federal revenues passed through SEOs and utilities to individuals.

By designing the program to deliver monthly energy bill savings that exceed the monthly financing costs for the energy-efficiency improvements, participants realize an economic benefit, and any future building owner could view the arrangement as a net benefit. Failure of a customer to repay the obligation could result in disconnection (just as failure to pay utility bills can cause services to be terminated). The utilities would benefit if their financial incentives are aligned with helping their customers use energy more efficiently. Regulatory reform may be required in States where utility profits are tied strictly to sales of electricity and/or natural gas.

In the most general terms, such a financing program would be applicable to all existing dwellings and small businesses. Utilities, particularly those with a large customer base, can easily offer on-bill financing to their customers. Expanding services beyond the provision of gas or electricity to include energy-efficiency programs is a growing trend among utilities within the U.S. The use of DOE funds to enable on-bill financing is particularly important as a vehicle to allow municipal and rural cooperatives to participate, since they generally have less access to capital and would need more assistance in the initiation and design of such programs.

With some utilities adopting on-bill financing as a cost-effective resource without government intervention, reasons behind different perspectives of this type of program should be explored. How are utilities motivated for this type of program? Could other institutions, such as non-profits, mortgage lenders, or municipalities effectively administer on-bill financing programs? Similarly, the kinds of customers most likely to participate in an on-bill financing program are not well known; drivers of participation should be explored in further research.

Everyday Decisions

What might be deemed as reduced-risk choices, everyday energy decisions suffer from the same lack of information and decision simplifications as the riskier decisions of home purchase and retrofit. What is to be gained from turning out a light, turning off devices that would otherwise operate in continuous standby mode, and programming a thermostat? These questions are difficult for an individual to answer without feedback; however, the opportunity costs of taking such action might be obvious – you must actually turn off the light, and then turn it back on, an unplugged device might 'forget' a setting that must then be reselected, programming takes time and thought.

Policy to Link Actions with Outcomes: Smart Meters with Dynamic Pricing

Price-responsive demand – an attribute of efficiently functioning energy markets – requires "smart meters" as an enabling device, in combination with time-dependent rates. However, the public is largely confused about what constitutes a smart meter. The government could define and limit the use of the term "smart meter" to only be applied to those meters which record energy consumption hourly or more frequently and can interface with an in-home device or on-line tool. Such a definition is already being suggested to avoid confusion (TPUC 2008, 5). In addition, Federal technical and financial assistance could help develop dynamic and interactive metering practices beyond utility pilot programs.

The term "time variant pricing" refers to any dynamic pricing scheme; these may be designed as peak and off-peak pricing, real time pricing, or critical peak pricing structures. The simplest form of time variant pricing is achieved by setting a higher "peak" rate and a lower "off-peak" rate; this does not exactly match the variability in the wholesale price, but it does provide a signal to customers that power is more expensive during peak periods, such as summer afternoons in most of the country. Research suggests that critical peak pricing is the most effective; however, time of use (TOU) rates and peak time rebates (PTR) when supplemented by enabling technologies such as smart meters can also reduce peak demand significantly (Faruqui and Sergici 2009).[3]

[3] An analysis of pilot programs showed savings of three percent to six percent using TOU rates alone with savings of 13 to 20% if they were designed as critical peak rates (Faruqui and Sergici 2009).

Effective smart meters have been developed and are already in place in some areas. In 2008, 6.7 million smart meters were being used, compared to just less than one million in 2006. Still, 95% of installed meters are common technology – old-style meters (FERC 2008). Further R&D is ongoing and should bring the cost of smart meters down further and improve the human-meter interface.

Rate design is an important ingredient of success, and rates offered should be tailored to the region and customers. There are several pilots of various pricing schemes and display types ongoing across the U.S., including a large pilot program in Washington, DC, called Power Cents DC, which involves 1,200 customers over two years and is nearly halfway complete (Faruqui and Sergici 2009). Sustained meaningful pricing structures are important because the long-run price elasticity is estimated to have a mean of -0.9, ranging from -0.7 to -1.4, while the mean estimate of short-run price elasticity is -0.3, ranging from -0.2 to -0.6 (EPRI 2008).

Smart meters are applicable to all residential customers of electricity and piped fuels. Residents who get fuel delivered to tanks face a different sort of demand response pressure, and they are faced with filling the tank. This is a similar situation to many prepayment options that have shown energy savings. Nevertheless, some customers will be able to respond more than others. Special populations could see real increases in their bills, and should be carefully identified to prevent harm. Renters who do not see or pay their bill separately from their rent may not have an incentive to respond. Low-income or low-use consumers may not have any reductions to make. Homebound individuals especially those relying on "always on" equipment may be able to make reductions, especially involving comfort levels, but they could have health consequences.

Because they provide price signals and energy consumption feedback, smart meters and demand response programs can both provide actionable incentives and increase experience with decisions related to every day energy use. There remain open questions on what information is best to display to consumers, in what units, and at what frequency. Answering these questions can improve the degree of decision-making support when these mechanisms are more widespread.

Summary

In this paper, we have shown three decision points and three levers related to residential energy consumption. For each decision lever, we have identified a policy option that has the potential to improve decision making by reducing deliberation costs, minimizing the probability of loss, or strengthening the link between actions and their consequences. Table 1 provides an overview.

These policy options are presented as ways to improve decision making; this means they are intended to move behavior towards the expected choices of a rational actor. As mentioned throughout this paper, there are still open questions on the specifics of these policy options – mostly regarding precision on what information, people, or timing should be involved. Social science research is needed to further explore these policy options while keeping the principles of behavioral economics in mind.

Table 1. Policies to improve residential energy decision-making by decision lever*

Decision Lever / Policy Option	Reducing Deliberation Costs	Minimizing the Likelihood of Losses	Linking Actions More Strongly to Outcomes
Mandatory disclosure of home energy performance	**Allows energy information to be included in purchase decision with less cognitive demand than a list of home features**	More efficient homes will save money	Over time, consistent performance information might make its way into the vernacular.
On-bill financing		More efficient homes will save money **Reduced upfront costs allows consideration of full implications of material or equipment selection**	
Smart meters with dynamic pricing	Provides near immediate feedback	Avoiding wasted energy use saves money	**Provides conditioning information to relate decision actions to money or energy used/saved**

*The bold cells are the principal decision lever targeted by a policy option.

Future research needs to address the array of additional decision levers that influence consumer and household choices, including the role of branding and other heuristics as well as issues of design, style, aesthetics and comfort. Such decision levers, including the three examined here, undoubtedly operate differently across market segments, and they will be more or less important depending on structural features of the marketplace. For example, the impact of decision levers may be overwhelmed by the principal-agent problem or lack of geographic access to energy-efficient products. These contextual issues provide a fruitful focus for further research on decision levers and policy design.

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