

Narrowing the US energy efficiency gap

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The energy-efficiency gap has puzzled researchers and policy makers for decades (1). Changes in behavior and the use of efficient technologies could substantially reduce energy consumption, yielding strong financial returns. However, householders, business managers, and government officials fail to take advantage of the opportunity. Attari et al. (2) reveal important features of the gap by an innovative analysis of how US householders think about energy.

Looking into the Gap

Why would householders not take advantage of energy savings that bring substantial economic rewards? Attari et al. (2) deploy an insight from the literature on risk perception to provide one answer. People form quantitative judgments about risk not through precise calculations but by using heuristics and biases. One of the strongest of these biases is the anchoring effect in which a well-known base point, such as a 100-W light bulb running for 1 h, serves as the basis for making estimates of other quantities, such as the amount of energy involved in line-drying clothes or changing thermostat settings. Attari et al. (2) asked respondents to estimate the energy used per hour by nine appliances and the amount of savings from six household actions, using the 100-W bulb as a comparison point. On average, people substantially underestimate overall energy use and savings potential, but they overestimate at the low end of the energy use/savings range and very substantially underestimate the amount used/saved at the high end of the range [see also Kempton et al. (3), Stern (4), and Carrico et al. (5)]. Householders seem to make insufficient adjustments away from the anchor point. Put differently, the variation in energy use/savings reported by most people is very much compressed compared with the actual variation. Perceptions of auto fuel savings, the energy costs of transporting goods, and the energy costs of beverage containers follow much the same pattern. On average, respondents underestimate the impacts of the most effective auto efficiency action considered (tune ups). They also, on average, do not accurately rank the inefficiency of trucks as a transport mode or the high-energy costs of glass bottles.

This is an important clue to the efficiency gap. Consider the householder who decides to reduce her energy consumption.

It is unlikely she will know an accessible and trustworthy source of information on what to do. Her best judgment will yield ratings across actions like those assessed by Attari et al. (2). If she resembles the average respondent, she will underestimate potential savings by a factor of nearly three, mostly as a result of not seeing the full impacts of the most effective steps that she might take. For example, she may not make a distinction between line-drying clothes and adjusting clothes washer temperature settings, but the latter action saves more than two times

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as much energy per load of wash than the former. The probable result is that she will save much less energy than she might if she used more accurate information in making decisions.

For each respondent, Attari et al. (2) created a regression model that uses actual values to predict estimated energy use/savings. They found considerable variation across respondents in both slopes and intercepts. Two factors are consistently related to individual efficiency estimates. One is numeracy, which has been shown in previous research to compensate for the anchoring bias, an interesting but not surprising effect. They also find that respondents who believe that humans can cause significant harm to the environment had more accurate estimates. It may be that these beliefs are a surrogate for general awareness of environmental issues and thus for factual knowledge that ameliorates the anchoring effect. Equally intriguing are the findings regarding what does not consistently affect the accuracy of estimates: self-reported energy use and a wide variety of social characteristics including political views, car and home ownership, age, sex, income, and education. Underestimates of energy use/savings seem to permeate all sectors of American society.

Bridging the Gap

Encouraging energy savings through behavioral change and adoption of more efficient equipment is widely acknowledged

as a win-win policy (6). Behaviorally realistic estimates show that well-designed policies could reduce US household greenhouse gas emissions by more than 20%, equivalent to more than 7% of total US emissions (7) or 44% of the emissions reduction target identified by President Obama in 2009 (8). However, many efforts to promote household energy efficiency are not based on an understanding of how householders think about and make decisions regarding energy efficiency (9). Bridging the efficiency gap requires policy design principles grounded in research in the social, behavioral, and decision sciences (10). The study by Attari et al. (2) is an exemplar of the kind of research that we need.

One obvious implication of their work is the need to provide information about the actual impacts of energy savings actions. Such information must be clear, in a form that is useful for decision making, and from a trusted source. The literature on eco-labeling can inform clear communications (11, 12). We know less about how to provide information in a context that makes it useful for decision making or about what sources are trusted. For example, providing information in utility bills provides access when a householder is thinking about energy costs, but we do not know how that modality would influence trust.

Attari et al. (2) inform us about householder perceptions of energy use/savings, but they do not have data on decisions made or actual consumption. It is plausible to argue that householders may take a few minor steps, and feeling that they have done their part, end up consuming more by being profligate about other aspects of consumption. However, it is equally plausible that a few initial steps lead to a sense of accomplishment and a reorientation in consumption, with large reductions after initial smaller steps. Only empirical analysis can sort through alternative hypotheses about how environmentally significant consumption unfolds. Unfortunately, very little investment has been made in high-quality datasets that would allow the analyses that we need to understand decisions and actual consumption. If energy efficiency is to be

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a serious component of future energy and climate policy, these investments are essential.

The efficiency gap is not limited to households. Small businesses, corporate managers, and government officials underinvest in energy savings as well. Underestimates of how much energy may be saved and especially, overestimates of the impact of the least-effective actions and underestimates of the impact of the most effective actions probably plague these settings. Organizational culture and routines undoubtedly complicate both beliefs about efficiency and decision making. Analysis of these organizational heuristics and biases could lead to more effective efficiency policy.

Understanding the Gap

Integrative theories of environmental decision making by individuals and households are emerging (13, 14). The social psychological literature has emphasized explaining why individuals differ in making environmentally consequential decisions but has given less attention to decision processes. The literature that Attari et al. (2) engage is a perfect complement in that it emphasizes decision processes. However, it has paid less attention to the factors that cause variation across individuals in decision making. Thus, a synthesis of the two approaches would likely yield a much more robust and useful understanding, one that builds on but moves beyond the standard rational choice model. It is intriguing that one of the strongest predictors of individual accuracy

in estimating energy use/savings, general beliefs about the potential of human action to harm the environment, is at the heart of one leading social psychological theory of environmental concern (15, 16).

Environmentally significant consumption also opens important ground for testing theories and concepts from the heuristics and biases literature. The health and safety risks usually studied sometimes involve daily behaviors (e.g., smoking and wearing a seatbelt), but the consequences are usually cognitively remote (e.g., health years later and the low probability/high consequence auto accident). In contrast, most environmentally significant actions are both part of daily life and have consequences as immediate as the next utility bill or stop at the gas station. The difference in time horizons and cognitive availability provides a rich testbed for further exploration of theory, concepts, and methods. Further, the differences in consumption patterns across nations and even within nations allows comparative analysis to reveal the factors in cognition that are context specific and those that are widespread or even universal.

Providing information in the hopes of changing beliefs and, ultimately, behavior is a common avenue of policy intervention. However, before walking that path, it would be prudent to understand how easy it will be to make progress. After political beliefs are formed, there is a strong tendency for individuals to accept information consistent with views already held and reject contradictory views (17, 18). It is not clear how this finding would apply to views about

a more neutral topic like energy use/savings. Undoubtedly, trust in the source of new information is important. That, in turn, raises the topic of social learning on networks (19)—the degree to which accurate and inaccurate beliefs about energy savings spreads through social networks. These networks may matter for households. They are certainly important in understanding the actions of large and small organizations and policy networks.

Attari et al. (2) reveal a key piece of the energy efficiency puzzle in the US—underestimation of what might be achieved. Their results should lead to clearer thinking about efficiency policy, and certainly provide sufficient evidence to begin policy experiments. Such experiments, designed to provide householders with accurate and trustworthy information on their energy use and energy savings choices and honed to local circumstances across the US, could help narrow the efficiency gap even as we learn to craft more effective policy. Relatively modest investments could yield substantial returns if social and behavioral insights are built into program design (9, 10). However, even more importantly, by initiating a link between the social psychological literature on environmentally significant consumption and the risk perception literature, they point the way to a more synthetic theory of environmental decision making.

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- Jaffe AB, Stavins RN (1994) The energy-efficiency gap: What does it mean? *Energy Policy* 22:804–810.
- Attari SZ, DeKay ML, Davidson CI, de Bruin WB (2010) Public perceptions of energy consumption and savings. *Proc Natl Acad Sci USA* 107:16054–16059.
- Kempton W, Harris C, Keith J, Weihl J (1985) Do customers know "what works" in energy conservation? *Marriage Fam Rev* 9:116–133.
- Stern PC (1986) Blind spots in policy analysis: What economics doesn't say about energy use. *J Policy Anal Manage* 5:200–227.
- Carrico AR, Padgett P, Vandenberg MP, Gilligan J, Wallston KA (2009) Costly myths: An analysis of idling beliefs and behavior in personal motor vehicles. *Energy Policy* 37:2881–2888.
- US National Research Council Panel on Limiting the Magnitude of Climate Change (2010) *Limiting the Magnitude of Climate Change* (National Academy Press, Washington, DC).
- Dietz T, Gardner GT, Gilligan J, Stern PC, Vandenberg MP (2009) Household actions can provide a behavioral wedge to rapidly reduce US carbon emissions. *Proc Natl Acad Sci USA* 106:18452–18456.
- Obama B (2009) Remarks by the President at the Morning Plenary Session of the United Nations Climate Change Conference. Available at <http://www.whitehouse.gov/the-press-office/remarks-president-morning-plenary-session-united-nations-climate-change-conference>. Accessed August 11, 2010.
- Vandenberg MP, Stern PC, Gardner GT, Dietz T, Gilligan JM (2010) Implementing the behavioral wedge: Designing and adopting effective carbon emissions reduction programs. *Environ Law Rev* 40:10547–10554.
- Stern PC, Gardner GT, Vandenberg MP, Dietz T, Gilligan JM (2010) Design principles for carbon emissions reduction programs. *Environ Sci Technol* 44:4847–4848.
- Thøgersen J (2002) Promoting "green" consumer behavior with eco-labels. *New Tools for Environmental Protection*, eds Dietz T, Stern PC (National Academy Press, Washington, DC), pp 83–104.
- US National Research Council Committee on Sustainable Products and Services (2010) *Certifiably Sustainable? The Role of Third-Party Certification Systems: Report of a Workshop* (National Academy Press, Washington, DC).
- Wilson C, Dowlatabadi H (2007) Models of decision making and residential energy use. *Annu Rev Environ Resour* 32:169–203.
- Stern PC (2008) Environmentally significant behavior in the home. *The Cambridge Handbook of Psychology and Economic Behaviour*, ed Lewis A (Cambridge University Press, Cambridge, UK), pp 363–382.
- Dunlap RE, Van Liere KD, Mertig AD, Jones RE (2002) Measuring endorsement of the new ecological paradigm: A revised NEP scale. *Soc Sci Q* 56:425–442.
- Stern PC, Dietz T, Guagnano GA (1995) The new environmental paradigm in social psychological perspective. *Environ Behav* 27:723–745.
- Lord CG, Ross L, Lepper MR (1979) Biased assimilation and attitude polarization: The effects of prior theories on subsequently considered evidence. *J Pers Soc Psychol* 37:2098–2109.
- Munro GD, et al. (2002) Biased assimilation of sociopolitical arguments: Evaluating the 1996 U.S. presidential debate. *Basic Appl Soc Psych* 24:15–26.
- Henry AD (2009) The challenge of learning for sustainability: A prolegomenon to theory. *Hum Ecol Rev* 16:131–140.