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What Makes U.S. Energy Consumers Tick?

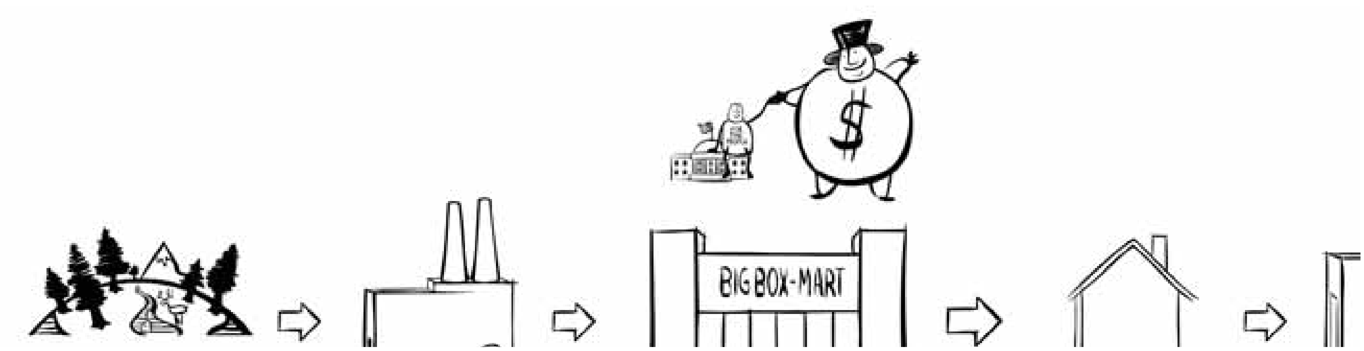
Harnessing the social sciences to answer that question can help lead the nation to an alternative—more efficient—energy future.

On October 6, 1997, during the run-up to the Kyoto Protocol negotiations in Japan later that year, President William J. Clinton described barriers to the adoption of energy-efficient technologies at a White House Conference on climate change. Saying that he was "plagued" by the example of the compact fluorescent light bulb in the reading lamp in his living room, he asked himself, "Why isn't every light bulb in the White House like this?"

The president then put his finger on a central question about consumer behavior, asking, "Why are we not all doing this? . . . we'd have to pay 60% more for the light bulb, but it would have three times the useful life. Therefore . . . we'd pay more up front, we'd save more money in the long run, and we'd use a whole lot less carbon. And why don't we do it? Why do we have any other kind of light bulbs in our homes? So when you get right down to it, now, this is where the rubber meets the road."

His remarks still resonate today. They highlight fundamental and persistent challenges in the United States to the use of energy efficiency as a potent tool for efforts to mitigate climate change, strengthen national energy security, and realize the economic benefits of a comprehensive, forward-thinking energy policy. These obstacles include individual and collective attitudes and behavior, household economics, and a paucity of readily available information on the benefits of energy-efficient consumer technologies. Understanding and managing such obstacles is the realm of the social sciences rather than technology and engineering, yet the social science of energy efficiency remains underappreciated by those who are best positioned to institute policies to promote energy efficiency as a solution to energy and climate problems.

Every president since Richard Nixon has devised a plan for changing the U.S. energy system, yet each one has failed to meet its objectives. The good news is that during the past four decades, the commercial availability of many advanced, efficient, and cleaner energy technologies has increased while their costs have fallen substantially. Partly as a result of the new technologies, the United States has steadily reduced the energy intensity of its economy. Nevertheless, it still ranks 134th among nations in the overall energy efficiency of its economy. Even among its industrialized economic competitors, the United States compares poorly in terms of energy intensity: According to data from the U.S. Energy Information Administration, it is about 38% more energy-intensive than Germany and Japan.



Countless careful studies of the energy system, including those from the National Academies and the President's Council of Advisors on Science and Technology, have provided a clear idea of the technologies needed to transition to a less carbon-intensive economy, yet the U.S. energy system of today looks much like the one of four decades ago. The Department of Energy (DOE), though tasked with funding and conducting "use-inspired" research, devotes little time or investment to studying how newly developed energy technologies ultimately succeed or fail in the marketplace and how they affect U.S. society.

Furthermore, the vast majority of the DOE's investment in energy research, development, and demonstration has focused on supply-side technologies. Since 1985, the DOE has dedicated only 19% of its research, development, and demonstration (RD&D) spending to energy-efficient technologies, and nearly half of the total has gone to advanced vehicle technologies. The federal government has paid virtually no attention to the energy-related social sciences, yet the energy savings achievable through behavioral changes and the adoption of existing technologies are in many cases larger, cheaper, and more immediate than those achievable through further technology development, at least in the near term. More federal support for technological RD&D is certainly sorely needed, but those investments could be significantly leveraged through the application of social and behavioral research on technology acceptance and use.

Picking low-hanging fruit

Household energy consumption for space heating, appliances, lighting, and personal transportation is responsible for nearly 40% of carbon emissions in the United States. The potential benefits of greater energy efficiency in the household sector are large; a 2009 study by Thomas Dietz and colleagues found that annual greenhouse gas emissions from the residential sector could be reduced by 20% within 10 years by employing 17 types of behavioral interventions, such as weatherizing houses or properly maintaining vehicles and heating, ventilation, and air conditioning equipment. This level of reduction equates to 7.5% of total U.S. greenhouse gas emissions. The study did not assume 100% adoption of each intervention; rather, drawing on empirical data of adoption rates for previous health and environmental behavior interventions, the researchers estimated potential adoption rates ranging from 15% for carpooling to 90% for weatherization.

Notably, the analysis included only interventions that are currently and broadly available, are low- to no-cost, and do not require major lifestyle changes. Even greater reductions could be achieved through actions that require greater lifestyle adjustments, such as living closer to work or telecommuting, and through the adoption of novel technologies that are currently on the verge of mass-market penetration, such as heat-pump water heating and air conditioning.

The study also did not include the emissions savings achievable through federally mandated improvements in the energy efficiency of appliances and lighting use, such as the phase-out of inefficient light bulbs stipulated by Congress in the Energy Independence and Security Act of 2007. Indeed, the emissions savings achievable through new energy-efficiency regulations could equal those possible through behavioral interventions. Thus, changes in household behavior and advanced technology adoption, coupled with new government efficiency standards, could reduce household greenhouse gas emissions by 15% of total U.S. emissions within 10 years, with low costs or even positive financial returns to consumers.

Engaging consumers

Achieving these results will require developing more effective strategies to promote the adoption of energy-efficient technologies and practices. Up-front cost is a major barrier to the adoption of more-efficient technologies, and this consideration often outweighs the potential for long-term savings in consumer decisionmaking processes. On the behavioral side, barriers to household actions include existing regulations, infrastructure issues, limited consumer choice, and a lack of information about the energy (and cost) savings

Opposite and this page:
FREE RANGE STUDIOS, from *The Story of Stuff* Project (abridged),
Video animation, 5:00 minutes, 2007.

achievable through behavioral changes.

To overcome current barriers, behavioral interventions will need to be coupled with properly designed policies aimed at facilitating their adoption. Drawing on 30 years of social science research on consumer behavior and decision-making, the researchers who conducted the 2009 study developed six design principles for effective technology deployment programs.

First, outreach programs should focus on the actions and technologies that are likely to have the greatest impact; that is, those with the most technical potential and the greatest potential to change behaviors and attitudes among the largest number of individuals. Second, where applicable, the financial incentives must be sufficient to get people's attention. Third, an effective marketing campaign must be put into action. Fourth, credible and accessible information must be made available to the consumer. Fifth, participation in the program must be simple and easy. Finally, a trustworthy quality-control mechanism must be in place to ensure that products and services meet expectations.

It is instructive to compare two recent federal programs in light of their fidelity to these principles: the low-income weatherization assistance program and energy-efficiency tax credits funded by the 2009 American Reinvestment and Recovery Act (ARRA), and the 2009 vehicle trade-in program known as "Cash for Clunkers," which like ARRA was designed primarily as an economic stimulus measure.

Although serious questions remain about whether Cash for Clunkers achieved its stated policy goals in a cost-effective manner, there is little question that it was wildly popular: The initial $1 billion allocation was claimed within a month, and a supplemental $2 billion appropriation was used up shortly thereafter. Nearly 700,000 cars were scrapped in only two months. The program was successful in catalyzing public acceptance because it met the criteria listed above: The financial reward (a $3,500 to $4,500 rebate) was large and immediate; trustworthy information on the product was readily available; the program was publicized through an extensive, industry-financed marketing campaign; participation was easy, since car dealers handled most of the paperwork; and the product was of known quality.

In contrast, although the financial incentives for participation in ARRA-funded weatherization and energy efficiency tax credit programs are generous, these programs often suffer from poor marketing, delayed incentives, burdensome paperwork, and uncertain product quality.

Greater attention should be paid to addressing these barriers by applying existing behavioral and social science research to energy policy and by fostering new research on a number of critical questions. The most productive strategy will be to identify and promote the behaviors and technologies that can have the greatest impact on energy consumption and simultaneously to address the many barriers to these choices through major outreach campaigns. The failure to fulfill any of the six stated principles can block progress, yet many programs focus on satisfying only one or two tenets and thus do not gain much headway at the consumer level. As President Clinton suggested, simply providing consumers with pertinent information on energy savings, though important, is not sufficient to effect change.

Energy efficiency in transportation

Cash for Clunkers unintentionally illustrated the difficulty of achieving cost-effective emissions reductions through financial incentives. To be sure, a primary goal of the program was to rescue the U.S. auto industry, but a second policy objective was to improve the efficiency of the U.S. passenger fleet. Analyses of the results of the program by researchers from Stanford University and the University of California at Davis found that the program's cost was between $162 and $500 per ton of carbon dioxide emissions avoided. This range considerably exceeds the estimated $28 per ton carbon dioxide abatement cost of the cap-and-trade regime included in the painstakingly negotiated American Clean Energy and Security Act of 2009, as computed by the Congressional Budget Office. Research on incentivizing hybrid vehicle purchases suggests that reducing the program's cost to be comparable with other carbon-mitigation strategies on a per-ton basis would probably have required lowering the rebate to such an extent that it would have discouraged public participation.

Why don't vehicle purchasers simply demand greater fuel efficiency in the marketplace? Their resistance runs counter to rational economic thought, because the extra cost of efficiency technologies, such as hybrid gas-electric power trains, can be recouped over time through lifetime fuel savings, even without taking into account vehicle purchasing credits and other incentives. Barriers to greater acceptance include the difficulty of estimating fuel savings, the inherent complexity of the process of purchasing vehicles, and the many competing attributes that consumers look for in a vehicle, such as body styling, safety appliances, and luxury features.

A further barrier is the huge variability in fuel savings across hybrid vehicle models. Not all hybrids are the same. In many cases, the greater fuel efficiency of hybrid gas-electric engines has been used to boost engine horsepower rather than to improve fuel economy, as measured by miles traveled per gallon of gas. Dissatisfaction with the fuel economy of certain hybrid models, and a lack of understanding of the difference between fuel efficiency and fuel economy, may at least partially explain why only 35% of hybrid car owners buy another hybrid vehicle.

Compounding the problem, it does not appear that federal income tax incentives for purchasing cars that are more efficient have been effective, due to delayed and uncertain returns. A 2011 Harvard Kennedy School study of U.S. hybrid vehicle purchases found that the type of tax incentive offered was as important as the generosity of the incentive: sales tax waivers were associated with more than a tenfold increase in hybrid sales relative to income tax credits of similar value. Rising gasoline prices were associated with greater hybrid vehicle sales, but this effect operated almost entirely through vehicles with very high fuel economy, because "mild" hybrids, such as the Honda Civic, offered only marginal fuel economy improvements. Social preferences, most notably environmentalism, and access to high-occupancy vehicle lanes were also found to be significant factors in consumer adoption.

Social forces at work

Consumers often turn to trusted acquaintances, such as friends and neighbors, for information on the comparative benefits of energy-efficiency improvements. Social networks and early technology adopters are thus important mechanisms by which accurate information on energy efficiency is disseminated within neighborhoods and other social circles. To continue with the hybrid car example, social norms have proven essential to the diffusion of hybrid vehicle technology. Matthew Kahn at the University of California at Los Angeles has examined the effect of high concentrations of "green" voters in California counties on the ownership of "green" and "nongreen" vehicles. His regression analysis found that as the Green Party share of voters increased from 0% to 4%, the predicted count of registered Priuses per census tract increased from 2.2 to 46.2. Strikingly, only the Prius among hybrid cars showed such a large positive correlation with political affiliation. Kahn attributed this effect to social interactions and the perception of the Prius as the "greenest" vehicle to buy.

In an intriguing 2007 survey of hybrid vehicle owners that deals a blow to economic rationality, Ken Kurani and Thomas Turrentine of the University of California at Davis found not a single household that analyzed its fuel costs in a systematic way, and almost none that factored gasoline costs into the household budget. The high fuel economy of the hybrids purchased by these households signified some other important value. The researchers found that some buyers of highly efficient vehicles were attracted by the new technology, others by the environmental benefits or a sense of "living lighter," but that potential financial savings motivated none.

In light of these observations, does providing consumers with increased information actually enable people to make more-informed decisions about energy efficiency? Here, the main issues are informational overload (too much information can lead to analytic paralysis) and the structural obstacles that consumers face in adopting new highly efficient technologies. More research is needed on how to design information to be easily understood, how to disseminate this information through trusted sources, and where well-designed information has the highest impact.

There also is the question of who should provide the information. A developing area of interest is the potential role of service providers, including realtors, mortgage agents, and service technicians, in educating households on opportunities to improve building efficiency, either during the home purchasing process or during large renovations or additions.

From the consumer standpoint, technology adoption is affected not only by price but also by payback time: What annual return in energy savings do consumers require before they will use a technology? Because this rate is profoundly affected by social norms and behavioral considerations, social science research can provide guidelines on how to reduce it so the up-front cost of energy efficiency becomes less of a deterrent.

More research is also needed on the "rebound" effect, in

To overcome current barriers, behavioral interventions will need to be coupled with properly designed policies aimed at facilitating their adoption.

ANTHONY DISCENZA, *Drift*, Video, 15:00 minutes, 2003. Courtesy of Catharine Clark Gallery, San Francisco.

CHRIS JORDAN, *Midway: Message from the Gyre* [176], Ultrachrome inkjet print, 26.5 x 31.5 inches, 2009.

which the energy savings from efficiency improvements are partially offset by corresponding increases in energy use. Two types of rebound, direct and indirect, have been observed. Direct rebound refers to situations in which more-efficient energy technologies lead to increased use of those same technologies. One example is when households use the financial savings from more efficient home heating equipment to heat their home to a greater extent. Indirect rebound refers to cases where the savings from efficiency gains are used to purchase other energy-intensive goods and services, either at the individual level or because of increased economic activity across society.

In theory, the rebound effect can be quite large, as can happen, for example, if drivers of hybrid vehicles find that they can now drive twice as far on the same gallon of gasoline (a case of direct rebound). In practice, direct rebound effects rarely approach the savings from energy-efficiency improvements: For air conditioning, space heating, and transportation, the effect is generally in the range of 10 to 30%, whereas for lighting and appliances, it typically is less than 20%.

Indirect rebound is often more difficult to measure, but in some cases it may exceed the magnitude of direct rebound. It should be kept in mind, however, that to the extent that indirect rebound effects are coupled to increased economic activity or standards of living, they are not necessarily an undesirable phenomenon, partuclarly for economically-disadvantaged populations. Nevertheless, there is interest among researchers in exploring ways to reduce rebound. For example, what would discourage drivers from responding to increased fuel economy by driving more miles? Would a gradually escalating gas tax be as effective as suggested by current models, or is there an effective upper limit to vehicle use that eliminates the need to create financial disincentives for increased energy use?

Major challenges remain

Reducing the energy intensity of the U.S. economy is a huge undertaking that will certainly require strong and committed leadership. Political will to devise ambitious and strategic energy policy is feeble, resistance from some interests is formidable, and the public does not appear to pay much attention to energy policy. Compared with current knowledge about the technological options, there is only a rough understanding of how society shapes the energy system, and how the system, in turn, affects society. In the United States, local leadership as well as public and corporate support for major energy policy changes have enabled some local and state governments to enact strategic and dramatic changes in policy. Similar successes have occurred in other countries.

A report from the American Academy of Arts and Sciences, *Beyond Technology: Strengthening Energy Policy through Social Science*, issued in 2011, concluded that the social sciences could promote energy efficiency and other advanced energy technologies through better-informed energy policy decisions. The report highlighted several existing social science tools that could be used immediately to make energy policy and programs more effective, and the study committee also raised critical questions that still need to be examined rigorously. Questions included the following: Where large up-front financial barriers to the adoption of energy-efficient technologies exist, what policies most effectively persuade consumers to adopt those technologies? Which policies do so most cost-effectively? Numerous jurisdictions around the country have experimented with policies to reduce or eliminate upfront financial barriers, but which of these are the most successful and why? How can governments and utilities effectively market energy-efficiency programs?

Existing social science knowledge can help formulate marketing campaigns that take into account intrinsic and extrinsic motivations, personally relevant and nontechnical information, social norms and relationships, and technologies that are accommodated by pervasive routines and lifestyles. Still other energy policies, however, suffer from a lack of social science research about their effectiveness. Although jurisdictions around the country have adopted building standards for energy efficiency, few data are available about how well they are enforced. The nation relies increasingly on voluntary industry standards, such as LEED and Energy Star, but far too little is known about who participates in the programs, how to improve participation rates, and whether the programs deliver the kinds of returns they promise.

Indeed, scientific investigation of people, firms, institutions, and behavior can help generate better understanding of how to reduce the energy intensity of the nation's economy. To this end, the President's Council of Advisors on Science and Technology, reporting in 2010 on its in-depth examination of the U.S. energy innovation system, recommended that the DOE and the National Science Foundation launch an interdisciplinary social science research program to address the nontechnical barriers to cleaner and more efficient energy technologies. The National Academies' study *America's Climate Choices*, published in 2011, also recommended establishing an integrative, interdisciplinary research enterprise that includes the social sciences.

Charting an agenda

The American Academy's *Beyond Technology* report presents a preliminary social science research agenda to understand the societal and institutional challenges to achieving an alternative energy future, recognize the pioneering work in this area, and identify knowledge gaps. The agenda is grouped into three clusters. The first grouping, comprising individual behavior, decisionmaking, and technology acceptance, includes questions such as: How does the private sector market products, and what is the applicability for products with social benefits? How are energy-related norms and behaviors influenced by social networks? What are the effective and ineffective strategies for engaging the consumer in pricing strategies (such as time-of-use electric billing, which charges higher rates during peak energy-use periods and lower rates during off-peak periods) that contribute to more efficient energy use?

The second grouping asks how to incorporate behavior into policy analysis: How do people actually use and respond to household technologies such as smart meters, and how does this response differ from what models assume? What behavioral changes have the most economic and technical potential?

The third cluster of research questions relates to policy development and regulations. Key questions include: How do jurisdictional conflicts (especially between state and federal policies) impede public/private partnerships? What is the relative effectiveness of existing energy policies? How does the United States compare with other countries? Ongoing work at the American Academy is highlighting these research needs and tackling some of the most pressing questions.

Striving for consilience

As a bottom line, the reason for fortifying the link between energy policy development and the social sciences boils down to two crucial observations. First, although transforming the energy system could provide vast social benefits, achieving large reductions in the energy intensity of the U.S. economy will require significant societal changes. The nation can change not only its sources of energy but also how energy is used, delivered, priced, and regulated. The social and behavioral sciences can illuminate much about how social processes might help shape—and drive—that change. Second, the social sciences can help in overcoming barriers to taking sensible steps to change the system in the near term, a classic example being the "efficiency paradox," in which residential and business consumers choose not to make improvements in energy efficiency that would in fact bring rapid financial benefits.

In his book *Consilience*, published in 1998, the biologist E. O. Wilson posited that most real-world problems exist at the intersection of different disciplines: "Only fluency across boundaries will provide a clear picture of the world as it really is, not as seen through the lens of ideologies and religious dogmas or commanded by myopic response to immediate need." Energy problems—perhaps most clearly in the case of climate change—are excellent examples. Indeed, as the President's Council of Advisors on Science and Technology, the National Academies, and the American Academy have all recognized, truly interdisciplinary research on the U.S. energy system is long past due. Many observers are now asking how to create green jobs, how to better compete in the global marketplace, and how policy hinders or helps the innovation enterprise. But research funding to answer such questions in a rigorous way is essentially nonexistent. At present, there are few obvious federal sources of support for social science or interdisciplinary research on energy, nor are there abundant private resources.

As the United States struggles to responsibly address massive energy-related challenges, including climate change, energy poverty, energy security, and imperatives for economic growth, it will be necessary to balance intellectual and financial investment in the physical and natural sciences and engineering with a commitment to the social sciences. The consilience of all available intellectual resources is necessary if the nation is to achieve an alternative energy future better suited to current and future needs.

Recommended reading

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