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A Hearing To

Inform Committee Members about the role of the Department of Energy's research programs in developing technologies and standards to enable deployment of net-zero energy buildings, support sustainability in domestic industries and highlight R&D areas which need continued attention to achieve the goals of the DOE net-zero energy buildings program and beyond.

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Summary

This testimony responds to an invitation from the House Energy and Environment Subcommittee of the Committee on Science and Technology to inform Committee Members about the role of the Department of Energy's research programs in:

- developing technologies and standards to enable deployment of net-zero energy buildings,
- support sustainability in domestic industries, and
- highlight R&D areas which need continued attention to achieve the goals of the DOE net-zero energy buildings program and beyond.

This testimony specifically addresses the need for increased research support to investigate and apply insights from the social and behavioral sciences. As discussed in this testimony, insights from the social and behavioral sciences offer an important opportunity to enable a significantly greater level of energy savings in buildings, industry, the residential sector, and transportation. More specifically, social science insights can help maximize potential technology-based savings; improve decision making; and reveal social, behavioral, and cultural means of motivating and facilitating smart energy behaviors.

Without the development and application of insights from the social and behavioral sciences, energy efficiency programs and policies will be constrained by the persistence of two important gaps:

- the gap between the potential energy savings of existing technologies and the actual energy savings achieved, and
- the gap between the good intentions of individuals, businesses, and institutions and the less-than-adequate translation of those intentions into smart energy behaviors.

According to several ACEEE studies of the unrealized energy efficiency potential associated with existing technologies, the first gap represents lost energy savings of 30 percent or more with current technologies. Similarly, studies of prevailing attitudes and behaviors suggest that while people are often aware of the economic and environmental benefits of investing in energy-efficient technologies and behaviors, a variety of social, cultural, and economic factors frequently intervene so as to severely limit the number of individuals, households, and businesses that actually follow through on their intended actions. A better understanding and application of social and behavioral factors could deliver more of the potential energy savings available through new and existing technologies. They could also help reduce existing social and cultural barriers and motivate people to take the actions that they readily recognize as important to achieving energy savings and stabilizing (and then reducing) carbon emissions.

Unfortunately, traditional approaches to energy efficiency typically apply what is most commonly referred to as a techno-economic framework. This approach is primarily focused on achieving energy efficiency through technological and economic means. From this purview, reducing energy consumption is as simple as designing a more energy-efficient product (furnace, television, refrigerator, computer, motor, etc.) and then ensuring that the products are

economical and their replacement is cost-effective. The logic is sound – as far as it goes. Programs built around this logic assume that people who are given the choice to invest in a product that is more energy efficient, with little risk and a short payback period, should adopt the superior technology. Unfortunately, however, real world experience tells a different story. In fact, research suggests that people seldom act according to the rational economic actor model. As such, we need a better means of understanding what actually motivates energy-smart behaviors, otherwise many government programs are likely to continue to underperform. Fortunately, the development and application of a behavioral toolkit could go a long way toward substantially improving upon the more traditional approaches to energy efficiency and result in greater energy productivity and energy savings.

Of equal importance, however, is the need to recognize the potential scope of energy savings associated with social and behavioral initiatives. Such initiatives offer the potential of large energy savings. In fact, two recent studies (Gardner and Stern 2008, and Laitner et al. 2009) suggest that the potential behavior-related energy savings in the residential sector alone represent roughly 25 percent of current residential sector energy consumption. By applying insights from the social and behavioral sciences to improve our understanding of decision-making, organizational behavior, and the influence of social and cultural norms in business and industrial processes, greater energy savings could also be achieved in the commercial and industrial sectors.

Finally, it is important to recognize the significance of behavior-related approaches as an essential piece of energy and climate change efforts. In fact, the principal drivers of our current energy and climate challenges are human choices, behaviors, and lifestyles. As such, they must also be an essential part of any attempt to address these challenges, if we hope to be successful in our efforts. In other words, human and organizational behavior is a critical component of both cause and solution. The DOE's efforts would undoubtedly benefit greatly from a more systematic and widespread incorporation of social and behavioral insights. However, funding for these types of initiatives is woefully inadequate and needs to be greatly expanded in order to realize the full magnitude of potential behavior-related energy savings. Such an effort would go a long way toward closing the gaps that currently exist between: potential and actual energy savings on the one hand and between attitudes and behaviors on the other. In short, mobilizing our population to adopt energy-smart behaviors and technologies will require the insights provided by social and behavioral scientists. These insights need to become a larger part of the efforts at the U.S. Department of Energy.

Such an approach should provide widespread and accelerated research, experimentation, and application of behavior-related initiatives as well as policy initiatives that recognize the well-documented limitations of the techno-economic model and the need to integrate behavioral considerations broadly into existing programs and policies.

Introduction

My name is Karen Ehrhardt-Martinez. I am a Research Associate in the Economic and Social Analysis Program at the American Council for an Energy-Efficient Economy (ACEEE), a nonprofit organization dedicated to increasing energy efficiency as a means of promoting economic prosperity, energy security, and environmental protection. I am here today at the invitation of the House Science and Technology Subcommittee on Energy and Environment to discuss the role of the Department of Energy's research programs in developing technologies and standards to enable deployment of net-zero energy buildings and, in particular, to highlight R&D areas which need continued attention to achieve the goals of the DOE net-zero energy buildings program and beyond.

I would like thank you for the opportunity to testify here today and I applaud the Committee for its interest in identifying R&D areas that need continued attention to achieve the goals of the DOE's programs.

There is no question that the DOE Building Technologies Program has achieved significant energy savings through its unique combination of efforts, including (but not limited to) their work on developing standards for appliances and commercial equipment, and establishing building energy codes, and more recent efforts at achieving marketable net-zero energy commercial buildings by 2025. Nevertheless, today's buildings continue to consume more energy than any other sector of the U.S. economy – more than transportation and more than industry. And the potential building-related energy savings continue to be large. Whether we are talking about improving the energy efficiency of existing buildings or new construction, the efforts of the DOE Building Technologies Program offer the opportunity of substantial energy savings.

An important part of what makes the Building Technologies Program work so well is their active partnership with the private sector, state and local governments, national laboratories, and universities, and their work to not only improve the efficiency of buildings but also the equipment, components, and systems within them. These efforts include developing more energy-efficient technologies associated with building envelopes, equipment, lighting, and windows, as well as the use of advanced sensors and controls and other high-tech means of managing energy use (DOE 2008).

The primary driver of the Program's activities is the DOE's zero energy building research initiative.[1] Importantly, the goal of achieving zero energy buildings necessarily requires extreme energy efficiency in all aspects of building design and construction, equipment choice, and building and equipment operation. Unless all of these areas are adequately addressed, the concept of zero energy buildings is unlikely to be achieved in practice.

While the strengths of the existing program are many, there are unfortunately also some weaknesses. And as is common to most programs at DOE, there is an substantially insufficient amount of attention paid to the human dimensions of energy consumption and energy efficiency.

[1] Zero energy buildings produce as much energy as they use over the course of a year.

This shortcoming is associated with a long history of technology-centric programs that have failed to achieve their technological potential in terms of energy savings. A more effective approach must recognize the importance of the human element and work with social and behavioral scientists to effectively address it through behavior-oriented programs.

The Two Gaps: Efficiency Potential, Attitudes, and Behaviors

Among the potential benefits of behavior-oriented programs and research is the promise it holds for explaining, understanding, and addressing the two most important gaps that persist in maximizing energy efficiency and reducing energy consumption. More specifically, behavior-based programs can help identify solutions for closing: (1) the energy efficiency gap (the gap between the potential, cost-effective, energy efficiency investments and those investments actually made); and (2) the attitude-behavior gap (the gap between favorable attitudes toward energy efficiency and less favorable behaviors).

According to several ACEEE studies of the unrealized energy efficiency potential associated with existing technologies, the first gap represents lost energy savings of 30 percent or more with current technologies. Similarly, studies of prevailing attitudes and behaviors suggest that while people are often aware of the economic and environmental benefits of investing in energy-efficient technologies and behaviors, a variety of social, cultural, and economic factors frequently intervene so as to severely limit the number of individuals, households, and businesses that actually follow through on their intended actions, resulting in additional efficiency losses. For roughly 30 years, numerous researchers have attempted to identify the causes behind the energy efficiency gap (although primarily from an economic perspective) attributing the gap to various market barriers, transaction costs, and (in part) to consumer attitudes and preferences (Sanstad et al. 2006; Stern and Aronson 1984). Among social scientists there has been a parallel effort to explain the gap between favorable environmental attitudes and less favorable behaviors (Dunlap 2008). An example of this second gap can be illustrated using recent Gallup poll research that indicates that while more than three-quarters (77%) of Americans personally worry (either a fair amount or a great deal) about the availability and affordability of energy and 85 percent report that they "should be spending thousands of dollars to increase the energy efficiency of their homes," less than two percent of the population is actually acting on these concerns in any significant way. Despite the high level of concern about energy and global climate change, people aren't taking advantage of the potential for cost-effective energy savings.

Rational Economic Actors and the Need for a Behavioral Toolkit

Most efforts to date have approached the challenge of maximizing potential energy savings exclusively through a techno-economic framework of change (Parnell and Popovic Larsen 2005). Since 1970, both theoretical and practical models of energy-related behavior have focused on reducing energy use as a function of developing the right technologies, making them available at the right price and then promoting them to consumers by espousing their "rational" economic

benefits.[2] Underlying the techno-economic model are the assumptions that growth in energy consumption is best solved through the application of new technologies and that energy consumption and technology adoption behaviors are best understood in terms of a set of economic calculations involving the price of energy, the cost of technologies, and the level of disposable income. In this context, people are portrayed as rational economic decision makers who will behave in predictable ways when confronted with changes in energy prices within a given market setting. Moreover, the model also suggests that the prevalence of energy-efficient behaviors and choices may be enhanced most effectively through the introduction of carefully crafted economic incentives and disincentives (Archer et al 1987). Finally, the model suggests that consumers, when presented with information about the economically-desirable package, will act to increase their net benefit.

According to the techno-economic model, the primary barriers to the transfer of energy-efficient technologies are 1) the lack of more efficient technologies, 2) the lack of sufficient economic incentives, and/or 3) the lack of timely, sufficient, or even accurate and complete information. While these factors are undoubtedly important, and while a cursory evaluation suggests that programs using this approach have achieved some success, their success has been significantly limited as a result of the narrow focus on the techno-economic model and the flawed assumptions on which it is based (Parnell and Popovic Larsen 2005).

Not surprisingly, the assumption that individuals are economically-rational actors has been regularly called into question. For example, in a study of solar technology adoption, Archer et al. (1987, p.78) found that, "information indispensable to even gross cost calculations was, in fact, absent" in people's assessments. Similarly, in a study of vehicle purchase decisions, Turentine and Kurani (2006) found that "even the most financially skilled" consumers did not use payback calculations as part of their vehicle purchase decision-making. Archer et al. (1987) concluded that "this result appears to *contradict* a central tenet of the rational model" - namely, the economic rationality of the decision-making process. Similarly, in a study of consumer intentions to conserve energy, Feldman (1987, p.39) finds that, "avoided costs and implicit discount rates are probably not useful concepts for describing the behavior of the general public..." and concludes that it is dangerous to assume that energy consumers operate as rational investors. Moreover, Stern and Aronson (1984, p.61) argue that "there is a problem with the very notion of users as investors" because people generally don't conceptualize energy and energy-using equipment only as investments. For example, when people purchase a car, they are concerned with a variety of characteristics including performance, reliability, safety, styling, status, resale value and fuel-efficiency, but the primary emphasis may be on any one of these factors. As an example, evaluations of utility-sponsored incentive programs promoting home retrofits have shown that even when utilities offered rebates that covered as much as 93 percent of the retrofit costs, only five percent of people actually decided in favor of having the retrofits done.

[2] Note: One especially interesting observation is that although most people easily recognize that social and behavioral approaches to energy savings are more complex than traditional technology-based approaches, behavior-based approaches have consistently received substantially less funding.

The persistent and overly narrow focus on economic considerations often results in the oversimplification of the decision making process and the exclusion of social, psychological and other variables that have proven essential in understanding individual and organizational behavior. In fact, social and behavioural research consistently shows that people and organizations are both overtly and subconsciously influenced by a variety of non-economic variables including their values, beliefs, and attitudes, as well as prevailing social norms, group norms and interpersonal dynamics. As such, the need for increased behavioural research is real and the potential energy savings are significant.

In order to unlock these potential savings, research on energy-efficient technologies and practices would clearly benefit greatly from the adoption of a behavioral toolkit. Such a toolkit would include the use of insights from a variety of social and behavioral fields including sociology, psychology, anthropology, demography, public policy, behavioral economics, marketing, and communications. Notably, these types of insights are increasingly being shared among those people working in these fields of study. In fact their efforts to develop more extensive networks of collaboration have recently been catalyzed through the development of an annual conference on Behavior, Energy and Climate Change (BECC). This year will mark the third annual BECC Conference that will bring together more than 700 policymakers, social scientists, and researchers, as well as representatives of government agencies, utilities, cities, businesses and non-profits to focus on understanding human behavior and decision-making in order to improve energy efficiency research, policy design and program effectiveness and to accelerate our transition to a low-carbon economy. Importantly, this year's conference will be held in Washington, D.C., allowing for the broad participation and involvement of national policymakers, Hill staff, DOE and EPA staff, and representatives of the many national labs. This is a unique opportunity to catalyze DOE's work in this area. This year's BECC Conference will be held at the Marriott Wardman Park Hotel on November 15-18, 2009.[3] An overview of prior conference insights in provided by Ehrhardt-Martinez (2008).

The Behavior Continuum and the Size of Potential Behavior-Related Savings

An amazing variety of behavioral influences have contributed to the historical gains in energy efficiency that have already been achieved, but to what degree can a more concerted effort to integrate behavioral insights achieve even greater returns in terms of additional energy savings? This section (1) provides an example of the dramatic behaviour-related energy savings achieved in Juneau, Alaska; (2) describes the range of relevant, energy-smart behaviors that comprise what we call the Behaviour Energy Response Continuum; and (3) discusses the range of potential savings associated with energy-smart behaviors — behaviors that both drive new innovations and that change the patterns of technology adoption and energy service demands.

Powering Down in Juneau, Alaska

What can we learn from actions taking during energy emergencies? The experiences of the city and residents of Juneau, Alaska can teach us how large and how quickly energy savings can be

[3] More information is available on the BECC Conference Web site at www.BECCconference.org.

achieved through behavioral change when people get serious about the task at hand. In April 2008, an avalanche damaged a major electrical power line near Juneau, cutting power to the city's 30,000 residents. Following the avalanche, the city was forced to rely on a bank of diesel-powered generators to supply its power. Within two weeks, Juneau had cut its energy consumption by about 20 percent, and by the end of May electricity use was down 40 percent (Berkeley Lab News Center 2008).

The massive and coordinated effort to cut electricity consumption included quick energy audits of the city's low-income housing and local businesses, a public campaign to engage people in the cause, an effort to identify and unplug items that needlessly draw power even when turned off, a campaign to replace incandescent bulbs with compact fluorescents, and identification of unnecessary municipal electricity use. In addition, the local utility provided regular feedback to the public, charting the city's progress in reducing energy use (Berkeley Lab News Center 2008). These efforts were geared toward making energy conservation more than just socially acceptable – instead they attempted "to suggest that conservation was expected." The essential message was that in order to be a good citizen, you needed to conserve energy (Berkley Lab News Center 2008).

The lesson? A city of 30,000 people was able to cut electricity consumption by 40 percent in approximately 6 weeks. So, what might be possible society-wide given the right motivation, the right programs, and the right incentives? Even five months after the power lines were restored, the city's electricity consumption remained 8 percent below consumption levels for the prior year (NPR 2008). A variety of similar examples of dramatic, behaviour-based energy savings have been documented by Alan Meier in his book, *Saving Energy in a Hurry* (Meier 2005). While these examples are useful for illustrating the scope of potential behaviour-related savings, the exceptional circumstances are likely to influence consumers' general willingness to participate in energy saving behaviors. Nevertheless, the examples do suggest that more concerted programs could significantly increase energy savings.

The Behavior Continuum

The real debate isn't about whether behavior has contributed to the dramatic reductions in energy consumption growth rates in the U.S. Instead it is about the need to recognize behavior as an important but often overlooked resource for achieving large-scale reductions in energy consumption and carbon emissions. Unfortunately, some energy professionals continue to suggest that while behavior-oriented programs may provide a useful way to help deploy smart technologies, they are best thought of as boutique or niche strategies which are most suitably employed to enhance an otherwise technology-focused deployment of more energy-productive investments. Nevertheless, research on this topic suggests that sizable energy savings and efficiency gains are likely to be achieved by addressing the human dimensions of energy consumption, energy efficiency and energy conservation.

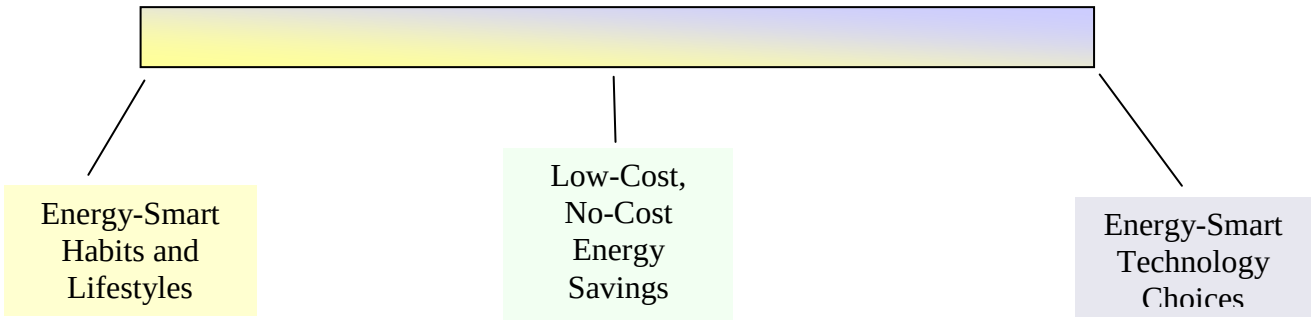
In fact, past analyses by the American Council for an Energy-Efficient Economy (ACEEE), and by well-known researchers like Gerald Gardner, Paul Stern, and others suggest that understanding and shaping behaviors can provide a significant savings. (See, Gardner and Stern et al. 2008 and Laitner et al. 2009.) Indeed, recent, albeit preliminary, assessments by ACEEE

researchers indicate that "the behavioral resource" might provide as much as a 25 percent efficiency gain (possibly more) above normal productivity improvements. Similarly, utilities and energy research organizations are increasingly working to integrate behavior-change programs and practices into their larger portfolio of activities with the goal of reducing costly energy production and consumption and carbon emissions.

As such, the Behavior Continuum was designed to illustrate the range and potential impact of changed habits, lifestyles and technology-based behaviors in terms of the potential energy savings within the United States. Although the recent implementation of the Behavior Continuum has been focused on identifying and assessing energy-smart behaviors in the residential sector (including personal transportation uses within the control of households), future assessment will also include behavior-related energy saving in the commercial and industrial sectors as well.

The Behavior Energy Response Continuum is a means of estimating the energy savings that could be achieved if new energy-wise habits (i.e. building and equipment operation practices and maintenance) became the norm, and if new energy-wise lifestyles and choices were encouraged by smart policies oriented toward reducing energy consumption. The Behavior Continuum ranges from habits and lifestyles on one end, to technology choices on the other. The middle of the Continuum includes a variety of infrequent, low-cost and no-cost behaviors that can reduce energy consumption including weather-stripping and caulking and insulating ducts or ensuring adequate space between the refrigerator and the wall (Ehrhardt-Martinez et al. 2009). See Figure 1 below.

Figure 1: Behavior Energy Response Continuum



In terms of the residential sector alone, preliminary research at the national level suggests that changed behaviors offer potential reductions of 20-25 percent of current levels of residential energy consumption over perhaps a 5-8 year period within the United States.

Moreover, in a recent application of the Behavior Energy Response Continuum for the state of Wisconsin, the potential impact of behavior-oriented programs (focused on addressing individual habits, lifestyles, and technology choices) indicated a potential doubling of the projected residential sector energy savings opportunities (Ehrhardt-Martinez et al. 2009). More specifically, the Wisconsin estimates (based on Wisconsin-specific energy data) indicated that

behavior-oriented programs held the potential of reducing residential energy consumption in Wisconsin by as much as 18 percent by 2012, or 38 trillion Btus. As such, a more comprehensive behavior program could result in savings that are more than twice as large as those associated with standard, technology-oriented approaches by generating a broader range of energy-smart behaviors, by eliciting a greater level of responsiveness among "traditional program" participants, and by driving a greater level of spillover among non-participants throughout Wisconsin.

The use of the behavior continuum is one means of identifying the numerous types of behavior-related energy savings opportunities and developing a more comprehensive estimate of potential behavior-related energy saving. Importantly, the Behavior Continuum and the results from the associated analysis challenge traditional approaches to energy efficiency programs that tend to marginalize behavior-oriented programs by characterizing them as boutique or niche strategies that can only round out a technology-based deployment of more energy-productive investments. The application of the Behavior Continuum suggests the contrary; that behavior-related programs offer potential energy savings on a surprisingly large scale – one that rivals a pure technology based perspective in terms of expected efficiency gains.

Levels of Intervention and Recommendations

Even with all this good news about the potential for using social and behavioral insights for generating larger reductions in energy use, it is important to recognize that these savings will not occur without consciously and deliberately incorporating social and behavioral change as an explicit initiative within D.O.E. programs.

Such an initiative would ideally apply relevant behavioral insights through a variety of intervention levels including:

- behavior-smart policies,
- an improved understanding of the ways in which people both shape and are shaped by their physical environment,
- a recognition of the opportunities and constraints associated with existing social structures, cultural norms and values, and other socio-cultural considerations,
- a recognition of interpersonal and psychological factors associated with motivating and constraining behavioral change.

At the policy level, for example, behavioral interventions could help design more effective policies by taking advantage of the current cognitive dispositions that have been shown to be prevalent across the population. Many of these approaches are explored in the field of behavioral economics. For example, when faced with making a decision about which building features or equipment to include in various builders packages, the structure of those decisions is likely to play an important role in the ultimate decision made by the consumer. By structuring the decision such that consumers need to opt-out as oppose to opt-in to the choice of energy efficient designs and equipment, a much larger proportion of new home buyers are likely to incorporate energy efficient features in their new homes. The work of Carrie Armel (at the Precourt Energy Efficiency Center at Stanford University), Cass Sunstein (Thaler and Sunstein

2008) and other researchers suggest that people tend to have a lot of inertia when it comes to decision making. Armel uses the example of automobile drivers faced with the decision of donating their organs. Participation in such programs tends to be about 20 percent in countries where the default option is NOT donating (therefore participants are required to opt-in) compared to a participation rate of 80 to 90 percent in countries where the default option is to participate (therefore participants are required to opt-out). See Thaler and Sunstein (2008) for additional examples.

In terms of the built environment and buildings in particular, social and behavioral insights can play an important role in determining and emphasizing the many non-energy benefits of energy-efficient designs and equipment. For example, natural daylighting and greenery have been shown to increase productivity, while equipment designed from the users perspective (with the help of social and anthropological insights) have been shown to reduce operator error, increase the proper usage, and maximize energy savings. According to Armel (2008), there is an enormous body of literature in cognitive science speaking to issues of how we can improve users' performance, yet often this knowledge fails to be incorporated into design.

Socio-cultural and interpersonal interventions recognize the importance of social institutions and culture, norms, and networks in the shaping of individual and organizational behaviors. And there are an increasing number of examples of energy programs that are successfully incorporating some of these socio-cultural insights into their efforts to increase the adoption and diffusion of energy-efficient technologies. Some examples include Project Porchlight which uses several different social insights to encourage the adoption of compact fluorescent light bulbs in Canada, and the ENERGY STAR program's Change a Light Campaign. Interestingly, both of these programs use social networks, commitment, norms, and feedback to promote the adoption of energy-efficient light bulbs. And both have been structured using the principles of community-based social marketing which readily overlap with elements of an approach rooted in a concern for social, rather than economic, rationality. (See Ehrhardt-Martinez et al. 2009).

The ENERGY STAR Change a Light Campaign, led by the US EPA, requires participants to pledge to change at least one light bulb in their house with one that has earned the ENERGY STAR. Individuals and organizations can participate by logging on to the ENERGY STAR website[4] and specifying how many light bulbs they plan to change. Individuals can also become "pledge drivers" by committing to get their community or organization involved in the campaign and committing to promoting the change of at least 100 light bulbs. Participants provide their name, zip code and organizational affiliation, allowing pledge drivers and EPA staff to track their progress and access established social networks to promote change and establish new social norms. The progress of each organization is tracked online–observable for all to see. The public tracking prompts passive competition among pledge drivers and presents an opportunity to recognize top performers. Moreover, the website offers special resources for teachers, retailers and government leaders to work with students, consumers, and communities.

[4] http://www.energystar.gov/index.cfm?fuseaction=cal.showPledge

Project Porchlight is a similar initiative run by a Canadian non-profit organization called *One Change* based in Ottawa, Ontario. The campaign works with Hydro Ottawa, the City of Ottawa, volunteers and other partners to effect social and environmental change. The original goal of the campaign was to get 200,000 households in Ottawa to change at least one inefficient incandescent light bulb to one energy-efficient CFL by providing residents with a free light bulb. By using existing networks, the project encourages local action in neighborhoods and within groups by working with group members who deliver light bulbs door to door. Light bulb recipients make a commitment to their neighbors that they will install the light bulb (preferably in a prominent place) as a symbol of their commitment to the effort; an action which also provides a first step in shaping their identity as someone who is willing to take action to reduce their environmental impact (One Change 2008). Early in 2008, the project successfully surpassed their revised goal of delivering more than one million energy-efficient bulbs.

According to McKenzie-Mohr and Smith (2007), direct appeals that ask people to commit to take a specific action achieve higher levels of behaviour change. If a person agrees to take a specific action, they are likely to follow through on it, especially if the commitment has been made publicly. They state that because human beings have a need to appear consistent, we are likely to agree to future similar requests for our commitment as well. This holds true even if the next request is larger, occurs after much time has passed, and comes from a different group than that of the initial request. Agreeing to the first request is actually thought to alter how one sees oneself, and in an enduring way.

Social and behavioural insights can also be used to change behaviors associated with habits and lifestyles. For example, several studies have explored the role of social norms in determining environmentally responsible behaviors. In 1990, Cialdini et al. investigated the effect of norms on individuals' decisions to despoil the environment. In the study, "participants were given the opportunity to litter in either a previously clean or fully littered environment after first witnessing a confederate who either dropped trash into the environment or simply walked through it." Cialdini et al. hypothesized that: 1) participants would be more likely to litter in the already littered environment than into a clean one; 2) participants who witnessed the confederate drop trash into a fully littered environment would be the most likely to litter there themselves because their attention would be drawn to the pro-littering descriptive norm; and 3) participants who saw the confederate drop trash into a clean environment would be least likely to litter there, because their attention would be drawn to evidence of an anti-littering descriptive norm. In fact, the study found that 32 percent of the participants littered in the littered environment without the confederate while 54 percent of participants littered in the same environment when the confederate did litter. The third hypothesis was also supported by the finding that only 14 percent of participants littered in the clean environment when the confederate did not litter, while a mere 6 percent of participants littered in the same environment when the confederate littered.

In a more recent study of energy conservation, Schultz et al. (2007) investigated "respondents' views of their reasons for conserving energy at home as well as reports of their actual residential energy saving activities such as installing energy-efficient appliances and light bulbs, adjusting

thermostats, and turning off lights." A study of the relationship between participants' stated reasons for saving energy and their energy saving actions indicated that conservation behaviors were most strongly correlated with the perception that other people were participating. According to Schultz, "this belief that others were conserving correlated twice as highly with reported energy saving efforts than did any of the reasons that had been rated as more important personal motivators." This work has recently been taken one step further through a number of innovative program designs being implemented through some electric utilities. In a recent review of Positive Energy's work in this area, the application of social norms and other behavioural insights was found to be effective in generating a 2-3 percent reduction in energy consumption during a nine month implementation period.

Social and behavioral insights can both enable technology-based energy savings and provide additional savings through the development of energy-wise habits, decisions and lifestyles. Importantly, these types of approaches offer low-cost options for achieving dramatic energy savings. Unfortunately they are largely missing from existing DOE initiatives.

As stated in the introduction to this testimony, the primary driver of the Building Technologies Program activities is the D.O.E. zero energy building research initiative.[5] In order to meet the initiative's goal of achieving zero energy buildings, every effort will need to be made to achieve the extreme energy efficiency goals in building design and construction, equipment choice, and building and equipment operation. Social and behavioral research and insights will be a critical component in meeting these goals. As such, it is imperative that:

- D.O.E.'s work more adequately address the human elements that are integral to achieving their energy-efficiency goals,
- support and learn from the work of social and behavioral scientists,
- develop a social and behavioral initiative as part of their own work, and
- provide financial support in order to expand on existing research in this field of study.

The long history of technology-centric programs has failed to substantially narrow the gap between the energy saving potential of existing cost-effective technologies and actual levels of energy savings. Social and behavioral insights can help close that gap if we're willing to invest in them.

Conclusions

The full array of evidence provided in this testimony suggests that more research and development is needed to explore, develop and apply social and behavioral insights and interventions. Similarly, evidence provided herein also suggests that such insights and initiatives offer the possibility of a significantly improved effectiveness of D.O.E.'s building technologies initiatives as well as increased energy savings.

[5] Zero energy buildings produce as much energy as they use over the course of a year.

Behavior-related approaches represent an essential component of energy and climate change efforts. In fact, the principal drivers of our current energy and climate challenges are human choices, behaviors, and lifestyles. As such, they must also be an essential part of any attempt to address these challenges, if we hope to be successful in our efforts. In other words, human and organizational behavior are a critical component of both the causes of, and solutions to, our energy and climate problems.

While the DOE's initiatives will undoubtedly benefit greatly from a more systematic and widespread incorporation of social and behavioral insights, this will not happen without increased funding for associated research and development.

Such an effort would go a long way toward closing the gaps that currently exist between: potential and actual energy savings on the one hand and between favorable attitudes and less-favorable behaviors on the other. In short, mobilizing our population to adopt energy smart behaviors and technologies will require the insights provided by social and behavioral scientists. These insights need to become a larger part of the efforts at the U.S. Department of Energy.

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