Broadening the Energy Savings Potential of People: From Technology and Behavior to Citizen Science and Social Potential[1]

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ABSTRACT

Much of the people-centered work in the energy field focuses on changing the behavior of individuals around a relatively fixed set of "energy services" in homes. While this work is important, it is fairly narrow. It tends not to consider the larger social contexts, professional cultures, and institutional expectations that shape activities, habits, and practices behind energy use everywhere, both in and beyond homes. This paper discusses a richer possible contribution of social sciences toward improving understanding of energy supply and demand and how policy might reshape these. To do so, it promotes a concept of "social potential" as a counterpoint to the widely accepted forms of technical and behavioral potential that underpin most of today's energy efficiency policies. As examples, we discuss three different forms of collective engagement that lie outside the usual lens used for technological and behavioral research: (a) citizen science movements; (b) building communities; and (c) middle-out initiatives that focus on communities, organizations, and building professionals rather than individual homeowners. Such movements merit more recognition, thought, and support from the energy efficiency community and policy makers as viable pathways towards lower-energy living and working.

Introduction

Energy efficiency advocates—who may work in academia, government, or business—maintain that it is technically feasible and economically optimal to improve the energy performance of buildings beyond standard practice. The difference between "what is" and "what could be" from the perspective of policy ideals is often called the "energy efficiency gap" and usually conceived as large-scale underinvestment in more energy-efficient technologies. In the global residential and commercial building stock, the fourth IPCC report (Levine et al. 2007) estimated that there is potential to cost-effectively reduce approximately 29% of projected baseline carbon dioxide emissions by 2020 through technical energy efficiency measures. For new buildings, the estimate of potential savings is increased to 75%. The report also notes:

> While occupant behaviour, culture and consumer choice and use of technologies are also major determinants of energy use in buildings […], the potential reduction through non-technological options is rarely assessed and the potential leverage of policies over these is poorly understood.

Because behavior, culture and choice are poorly understood, these "non-technical options" are omitted from the report, with the caveat that "the real potential is likely to be higher." In this paper, we question the idea of what the "real" potential is, where it lies, and how to go about getting it. In particular, we focus on how non-technical factors may or may not coincide with

[1] Some of the ideas in this paper were initially presented at ECEEE 2013; others appear in Moezzi, M., & K. B. Janda. 2014. "From "if only" to "social potential" in schemes to reduce building energy use." *Energy Research and Social Science* 1 (1) http://dx.doi.org/10.1016/j.erss.2014.03.014).

technical goals to produce higher potential savings. This requires distinguishing the role of people beyond being mere investors in technology or end-users who do or don't act in prescribed ways. Instead, we suggest people can be a creative force to combine technological possibilities and social change in different ways.

Stories about possible energy futures appear in research agendas, policy goals and rationales, utility programs, technology development, forecasting, and so forth. There are a number of ways of framing the future untapped energy savings potential. In this paper we argue that the dominant existing frames for understanding available potential—based on technologies and, to a lesser extent, behaviors—overly restrict the ways in which energy advocates and policymakers approach the future. In the first section of this paper we describe the limitations of two existing notions of energy savings potential. In the second, we propose an alternative notion of energy savings—social potential—and introduce three approaches permitted by this new concept to determine future energy savings.

Dominant Frames for Energy Savings Potential

Techno-economic Potential

For decades, the concept of technical potential of energy efficiency has been a fundamental tool for the energy efficiency industry in planning and defending the industry's role (Shove 1998). Technical potential denotes a best-case energy efficiency scenario. It is based on engineering and economic calculations which are performed "without concern for the probability of successful implementation" (Rosenfeld et al. 1993, p. 50), and assumes that the energy efficiency technologies under consideration are appropriate for all building configurations, infinitely available at or below the cost considered. At this level, there are no economic, social, psychological obstacles that would dissuade consumers or organizations from adopting them. Economic potential refers to the subset of technical potential that remains after applying a cost-effectiveness cut-off for saved energy at the current price of delivered energy (Mosenthal & Loiter 2007). In this techno-economic scenario, humans enter only implicitly, as economic agents, as generators of energy service needs, and invisibly as part of the calibration to estimate achievable potential, as used in some technical potential studies (Moezzi et al. 2009). Together, these assumptions about technical and economic potential provide the backbone of the Physical-Technical-Economic Model (PTEM) of energy use, which dominates the energy efficiency field (Lutzenhiser 1993, 2014).

Techno-economic potential is one particular construction of how energy use is seen and the options available for influence and change. It focuses on what is presumed to be appropriate or "average" behavior, based on very limited observation of what people actually do and leaving little room to account for fundamental human variability. This approach can create distortions in an attempt to correct or even remove the variations that real people introduce in real buildings. Recent work on the "prebound effect" for example shows that the calculations used to rate housing in Germany, the Netherlands, Belgium, and the UK consistently overpredict the amount of energy that normal dwellings actually use (Sunikka-Blank & Galvin 2012). Work on low-energy design commercial buildings show that assumptions about how people will use buildings can also be very optimistic (e.g., Lenoir et al. 2011). The representations of people embedded in technical potential scenarios are convenient shorthands that serve in the absence of the ability to know or predict behavior. Such shorthands, however, create blind spots (Stern 1986) that misdirect attention about people. Although the ability to compel people to act in preconceived "proper" ways is limited, much of the current behavioral research stretches towards this goal, as discussed below.

Behavioral Potential

Social and behavioral scientists have worked in the energy efficiency industry since its inception in the 1970s (for a meta-review of the literature from 1975-2012, see Delmas, Fischlein, & Asensio 2013). Despite these efforts, this work has had far less of an established role in influencing policy than engineering and economic approaches. Over the past decade, however, there has been much more organized interest in people's role in energy use. Governmental and other energy efficiency agencies often promote "easy" behavioral actions to reduce energy use (ADEME 2009; Efficiency Vermont 2009; EST 2013), and conferences are devoted to "behavior change" (e.g., the Behavior, Energy, and Climate Change Conference held annually in the United States and BEHAVE, held intermittently in Europe).

Most of the new attention has focused on getting people to use energy "properly" through information, education, and feedback. It has largely focused on changing individual behavior using a calculus involving attitudes, behaviors, beliefs, barriers, contexts, choices, and so on (Shove 2010). This conventional "ABC" narrows the potential contribution of behavioral and social sciences to a supporting role in fulfilling mechanistic notions of how to create users who respond correctly to energy system signals (Shove 2010).

Energy use feedback, in particular, has been imagined as potentially creating a sea change in how individuals think about energy use and subsequently how they actually use it. Policies are then created to help actualize these expectations for change. In the UK, for example, smart meters are scheduled to be installed in all households by 2020, along with in-home energy use feedback to instigate households to reduce their carbon emissions (Hargreaves, Nye, & Burgess 2013). Comparative feedback, such as the home energy reports provided by Opower -- and anticipated much earlier by others (e.g., Goldman et al. 1996)—have been adopted by many energy utilities, with claims of 2% consumption savings for participants (Allcott 2011).

Though less formally than for technical potential, the idea that there is untapped behavioral energy savings potential has helped inspire and justify policy and research attention to changing individual behavior. There are few systematic investigations that translate the concept of "potential" to human action. Dietz et al. (2009) examined the reasonably achievable potential for near-term reductions by altered adoption and use of available technologies in homes and non-business travel in the US. They estimated that the implementation of these interventions could save an estimated 20% of household direct emissions or 7.4% of US national emissions, with little or no reduction in household well-being. A Canadian utility outlined the potential energy savings of a number of residential sector and office building behavioral conservation measures, posing these savings alongside technical potential; in a companion analysis, this study also considered lifestyle change potential with a more aggressive bundle of transformations (BC Hydro 2007).

The recent attention to behavioral potential has highlighted the importance of people in shaping energy use. But it also raises important questions. First, the changes considered are often marginal changes, analogous to marginal changes in technical energy efficiency. They imagine that individuals will learn to adopt more disciplined energy actions that better conform to assumptions about what level of energy services people need, what constitutes waste, and what constitutes proper energy use behavior. Second, the levels of savings calculated for this proper use are modest, even negligible, for many households (Hazas, Brush, & Scott 2012). Even in aggregate, as the two examples in the previous paragraph suggest, conservation action potential as currently conceived are minor relative to policy goals for energy savings. For example the World Business Council for Sustainable Development has called for a worldwide building sector energy reduction of 77% below projected 2050 levels (WBCSD 2009). Third, there is not much serious thought as to why people would actually want to undertake these changes. In theory, people should pursue technical potential to get more for less. Behavioral potential may be more often about expending more effort in exchange for rather abstract benefits such as doing the right thing as conceived by somebody else. These improved behaviors don't promise to make one healthier, more attractive, or appreciably richer. You just get less for less. Finally, the focus on getting individual to make changes can obscure the need for more effective actions at higher social or political levels (Crompton 2008). Overall, the resulting vision of people's role in shaping energy use is still very limited (Bartiaux 2009). By far most of the work on behavioral potential has focused on behavior in residential buildings, but there has also been relatively limited attention to "behavior change" in commercial buildings, mostly in the guise of occupant engagement programs in specialized situations.

Beyond PTEMs and ABCs: Destinations Underexplored

Both technical potential and behavioral potential are useful conceptual tools. They help direct attention to possible approaches to various energy problems and invite debate on the assumptions used to construct them. But they also limit the types of change that can be seen. Technical potential, for example, is formulated to address the efficiency of devices and components. It is rarely used to capture potential for changing systems of provision or to question needs and how they have been constructed. Similarly, behavioral potential is oriented to the actions of individuals. It sees what humans do as important, yet limits the view to fairly narrow ranges of discrete conservation behavior.

Beyond these perspectives, what else is there? How societies use or conserve energy has been addressed sporadically by technical and social scientists for more than a century (Rosa, Machlis, & Keating 1988). Using examples from the US and UK, Lutzenhiser and Shove (1999) argue that the role of social science in energy research has been limited not by the ability of social science to contribute, but more by the ways that government organizations shape, fund, and contract energy research. On the other hand, energy research has not been a particularly popular research subject within social sciences themselves. Biggart and Lutzenhiser (2007) argue that energy inefficiency is a legitimate social problem that could be usefully explored using the tools of economic sociology, but energy has long remained a fringe element in most non-economic social science fields. A qualitative and quantitative review of social science energy research in the UK by Berkhout et al. (2003) showed that the subject is only represented at about 28% of UK universities. The authors also found that most (72%) of the social science energy research groups in the UK conduct some form of economic research, while far fewer adopt a political science perspective (22%) or a sociology/social psychology perspective (26%).

Owens and Driffill (2008), on the other hand, see a different picture. They report that "insights across the social sciences have increasingly been applied to a range of energy and environmental issues" (p. 4412) and that the "evolution of social scientific understanding…has been rapid over the past few years, and this is reflected in substantial investment in research" (p. 4414). However, they also note that there has been a "persistent emphasis in policy discourse on awareness-raising and education" (p.4413). Owens and Driffill's paper is written ten years after Lutzenhiser and Shove's article and five years after Berkhout et al's paper. Previous work (Janda

2009) considered whether we are moving towards a critical "tipping point" for greater integration of energy and social research. The current paper continues this exploration.

Below we explore the notion of "social potential" as a conceptual model than might help energy policy and programs escape their binary emphasis on either economically self-interested "consumers" or on citizens who will do the "right thing." This direction is also separate from that of behavioral economics applications to energy use, which usefully recognize the "bounded rationality" of humans in environmental decisions (Croson & Treich 2014), but still sees people basically as individual respondents to change. By seeing people as members of different kinds of social and professional groups, we reintroduce some forms of human variability and agency that the other approaches neglect.

Towards Social Potential

Social processes are gradually receiving more attention in technical realms, but there is far less attention paid to social process than behavior, and far less attention paid to behavior than to technology. For example, in the recent Global Energy Assessment, there is a section on "Social, Professional, and Behavioral Opportunities and Challenges." However, this section represents only four pages out of the 125 devoted to technical and economic energy and building issues (Urge-Vorsatz et al. 2011). As we argue the next section, energy using practices are largely social matters not individual ones, so we need a view of people that better captures this social nature.

To help overcome some of these limitations, below we sketch the concept of "social potential" (Janda 2014) and provide several illustrations. Like technical and behavioral potential, social potential can serve as a vector for constructive imagination. It can help create a conceptual space that transcends some of the limitations of technical and behavioral potential, admitting a broader scope of actions and reasons for people to act. In particular, it could help transform the view of people from the "consumers" of technical and behavioral potential to citizens and members of social groups instead. In so doing it can also enrich thinking about the "why" of change. Like technical potential, social potential is conceived as a tool to think with. But also like other "potential" concepts, it might also leave an imprint on policies, and begin to reshape ideas of how and why changes might take place.

Both technical and social potential define an envelope of opportunity in an ideal world that only loosely approximates the real one. In both, the content and direction of the envelope of opportunity orient the analytical and practical activities of policymakers, analysts, and others dedicated to moving toward that goal. Technical and behavioral potentials largely either ignore social conditions or hold them constant. Social potential invites flexibility and advancement in the social realm while holding current technical opportunities relatively constant (i.e. optimizing only as far as the "state of the shelf") and assuming that "behaviors" are shaped by larger social systems. The term social potential offers an admittedly idealistic notion of a world where social organization is optimized for energy performance. A socially-optimized world is not necessarily more probable or better than a technologically-optimized one, but it would be different. It could be different in a way that could be intriguing and socially interesting: tapping into the creativity of people and social desires rather modeled projections of what people *should* want. A socially-optimized energy world might, for instance, foster vernacular architectural styles rather than international ones; make practical use of the outdoors; value energy sufficiency; and model buildings as they are used in practice instead of as the sum of their physical parts. In this view, people and groups become valuable and definable assets, rather than instruments of policy or causes of energy use problems.

What kind of prospective changes might be seen as a matter of social potential for energy use? The discussions below offer three directions that the concept of social potential could help develop: citizen science, building communities, and “middle out” approaches.

Building Literacy and Citizen Science

What if, rather than being considered to be consumers of energy services as invited in the notion of behavioral potential, energy users were seen as active citizens, with their own interests and creativity, and with the ability to constructively contribute to better buildings and better energy use? We use notions of citizen participation and citizen science to provide an initial framework for considering this shifted viewpoint.

What would a citizen science agenda look like in the built environment? Current citizen science initiatives range from programs that provide scientific data analysis in the pursuit of social objectives (e.g., the Louisiana Bucket Brigade (2013)) to programs that use humans as information processors in pursuit of scientific objectives (e.g., the Andromeda Project (2012)). We suggest that there may be a form of “citizen science” that increases user understanding of building phenomena and enables researchers to build much-needed real-world datasets. Such an approach could advance both social and scientific objectives. A citizen science approach would foster the co-production of knowledge, rather than delivering information that is thought to be useful to its lucky recipients. The idea here is not to produce an entire society that will suddenly *care* about energy. But some organizations and some people already care and need more help than the “easy” steps oriented toward the lowest denominator of popular interest. So a citizen science approach could provide greater leverage by using what *some* people actually care about, rather than trying to impose a particular form of caring across the entire population.

Consider, for example, who gathers, gets, and uses fine-grained residential energy use data, and what purposes these data serve. Currently, most smart meters for electricity provide most of their intelligence to the utility rather than to the user. Third party companies like Opower help feed this utility intelligence back to the user, but the data and algorithms that turn raw numbers into information are not accessible to the user. Moreover, the “customer” in such business models is the utility, not the energy consumer. On the other end of the spectrum, many hand held devices, home electricity monitors, and building management systems provide information to the user only. These tools often cannot provide a context in which to situate the data, and the data gathered is either “lost” after the owner reviews it or saved in a computer file with little or no onward analysis. Academics and researchers who are interested in understanding the larger systems of consumption have had a very hard time getting access to detailed consumption data that could be used to increase their own knowledge as well as those of policy makers and energy users.

In the UK, a company called Pilio (2013) aims to bridge this particular information gap. Pilio is oriented toward small and medium enterprises lacking electricity and gas meters that can be read remotely and automatically. Because these customers have to read their meters themselves anyway (rare in the US, but common in the UK and elsewhere), they already have their own data. But many of them don’t know how to *use* this data. Pilio provides energy management advice and weather-adjusted analysis to help turn data into useful information. It also asks its customers to contribute their information to Pilio’s data set. By contributing their own data, these customers agree to be a part of an evolving dataset that can identify clusters of buildings by owner as well as by type or size. This will help researchers to understand how different types of owners manage their properties, while helping owners understand their buildings better, and in a broader technical and environmental context. Pilio is working with some unusual clients, including the Church of England and a network of theatres and performing arts venues. Their efforts have demonstrated that it is possible to develop networks of citizen scientists and demand-side participation outside the utility infrastructure. These networks have the potential to simultaneously serve their participants and contribute to broader scientific goals. Moreover, they build a shared community around knowledge exchange in ways that technical potential cannot and behavioral potential does not.

Building Communities: Social Potential in Commercial Contexts

To understand how to maximize the opportunities that exist to improve the energy performance of the commercial built environment, Axon et al. (2012) argue that new interdisciplinary research is needed. These authors propose a "building communities" framework that accommodates the perspectives of multiple stakeholders, the physical context in which they interact, as well as the legal, policy, and market frameworks that shape their interactions. Axon et al.'s concept of a building community is built around the idea of "communities of practice" (CoP) A CoP is a system of relationships between people, activities and their outside world developing over time and interconnected with other CoPs, which themselves can be found within businesses, across businesses and other organizational and professional structures (Cushman et al. 2002; Ruikar, Koskela, & Sexton 2009). The concept of CoP also has implications for knowledge management and its codification (Zboralski & Gemunden 2006; Lave & Wenger 1991). Such communities can be either geographically coherent and organizationally diverse (e.g., a multi-tenanted office building or shopping mall); or organizationally coherent and geographically diverse (e.g., a fleet of Marks & Spencer stores).

Janda (2014) uses the "building communities" approach to show how it can both integrate and transcend three analytical units—technologies, organizations, and employees—commonly used in the literature on energy efficiency in commercial buildings. She argues that a multi-level approach cultivates further understanding of these levels, as well as enabling a glimpse of the issues between and beyond them. Some examples of issues that fall outside conventional analyses are: building uses outside of "normal" operating hours (Janda & von Meier 2005), expected work attire (Shove & Walker 2012), workplace cultures (Brown et al. 2010), and a deeper organizational look at the incentives at play for saving or using energy (Moezzi et al. 2014). As targets for carbon emission reductions ratchet up from capturing "low-hanging fruit" to achieving "zero-carbon", interstitial and underlying social issues may become more important than originally thought. Like reducing standby losses in homes, these issues may require further attention and, eventually, offer additional opportunities for reducing energy use and improving building performance and occupant satisfaction.

The relationship that develops between the building and its community of users is a topic of interest in environmental design research (e.g., EDRA 2012) but curiously, not in energy research. How could or should non-work or beyond-work building uses be incorporated in building models, planned for in organizational strategies, and handled in terms of design? If energy researchers understood how different combinations of people and organizations use spaces, could they building design be more responsive to organizational diversity?

Midstream and Sideways: a Middle-Out Approach to Social Potential

The broader idea of building both geographic and non-geographic communities around understanding energy practices could be pursued in several different ways. Is it possible to "de-individualize" the energy and social research process? What forms might research in this unexplored area take? Janda and Parag (2010; 2013) argue that a "middle-out" perspective is useful in investigating potential roles a broader set of actors in creating societal change. Social and technological innovations are commonly seen as either being induced from the "top-down" or evolving from the "bottom-up." Instead, a "middle-out" perspective focuses on agents of change that are located in the middle, in between the top and the bottom. This perspective includes the role of "intermediaries" such as industry associations and networks, although its main focus is to better articulate the influence of long-standing institutions and firms[2] as "middle actors." The middle in energy systems is conceptualized in several different ways.

On the energy supply side, the middle can be defined by levels of scale, ownership and resource aggregation (e.g., regionally distributed generation developed at the community or local government level). This level is in between the highly concentrated, centralized systems common in electricity markets today and the distributed, decentralized systems envisioned in the late 1970s by futurists such as Amory Lovins. On the residential side, community-owned energy is in "the middle" of the triangular group of actors that usually play essential roles: central government, energy suppliers and energy users (Parag & Darby 2009). Focusing on tenanted commercial properties, Axon et al. (2012) argue for the use of the notion of a 'building community' that is in the middle between the general political context and the physical reality of a building. This perspective sees organizations and their practices as middle agents who are central to the successful deployment of low-carbon buildings. Although these different conceptions of the middle are not functionally or conceptually cohesive, they all have the ability to affect change in several different directions: upstream, downstream and sideways. By linking the top and the bottom more explicitly, this approach is both an alternative and complementary to "bottom-up" and "top-down" efforts to implementing low carbon innovations and practices in society.

One "middle-out" direction forward would be working with community-based organizations, such as churches or schools. This orientation connects readily with the public participation in scientific research (PPSR) agenda and could be pursued in tandem with citizen science scholars. Another avenue could focus on known organizational owners with existing building portfolios, seeking to develop an area of research similar to PPSR, but at the organizational level. Energy researchers do not often study the effects of different types of organizational owners but this approach has a lot to contribute to the field (Axon et al. 2012; Janda & Brodsky 2000; Janda 2008; Lutzenhiser et al. 2002). The "middle" also involves the work, aims, and goals of building professionals. The role of professionals is understudied compared to the role of homeowners, but in 2013 it was the subject of special issue of the journal *Building Research and Information* (Volume 41, issue 1).

Conclusions and Implications

The challenges that the energy efficiency industry has set out to address are significant. The master narratives that guide so much of the industry's current efforts to reduce energy use

[2] For example, the history of the UK property firm Gorsvenor began in 1677 (Grosvenor 2013).

reflect an unrealistic and unnecessarily narrow view of people with respect to how and why they use energy. These narratives create a tendency to see energy savings as a matter of coercing people to fit assumptions of "rational man" (economic models) and "obedient man" (proper behavior according to engineers). The two concepts of energy savings potential currently in use—technical potential and behavioral potential—synchronize with these assumptions. Both lack the ability to capture energy use as a system of social processes. A complementary concept of "social potential" for energy savings could serve as a focal point for developing new tools and frameworks that invite a more active engagement of people – particularly in communities and groups, such as building professionals and multiple property owners – in helping define and address energy problems.

In a time when urgent and large scale changes are called to stabilize the climate, we should take advantage of all the routes in which new ideas, behaviors and practices might be introduced. Policies and research that focus either on technologies or behaviors are often implemented, while the full creative power of people and resulting diversity of possible solutions is overlooked. A number of possible research strands have been noted for citizen science, building communities, and middle actors. These are by no means an exhaustive list of the frames, social processes, and institutional regimes that could be added to the energy toolbox under the rubric of social potential. For example, the buzz word "gamification," denotes a "process of engaging people and changing behavior with game design, loyalty, and behavioral economics" (Zichermann 2014). In the energy context, this concept has been used to make behavior change positive and fun, as well as to engage members of "Gen y" who have never seen or used a dial telephone. Another completely different approach involves building a cohesive energy training and support infrastructure at the community level, modeled after public investment in community sports teams and infrastructure (Hamilton & Berry 2013).

The examples outlined above provide brief illustrations of how viewing people as part of social and professional groups can help expand how policy and research view people and their potential contributions to deeper, broader, changes in societal energy use. These movements are still unwieldy with respect to typical evaluation frameworks, the funding mechanisms that are available to understand and promote them, and the formal scalability of perceived solution sets. But they also help capture a revised view of what people might do, and why they might do it, that can enrich and expand beyond more consumer-oriented viewpoints on energy use. In better being able to see, acknowledge, study, and debate these possibilities, energy policy, programs, and research may be better able to support a more realistic and more powerful view of where people fit.

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