How to communicate energy and environment with energy consumers?

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Introduction

Scientists are now more certain than ever that humans are responsible for climate change through the combustion of fossil fuels. A recent Global Energy Assessment report, compiled by the International Institute for Applied Systems Analysis (IIASA) indicates that globally, domestic energy consumption accounts for about a quarter of global greenhouse gas emissions. A fundamental shift in energy consumption is needed, moving away from the use of fossil fuels to meet emission reduction targets.

Energy consumers can make important contributions to reducing emissions by adopting efficiency and curtailment behaviours. Efficiency behaviours are actions or measures that result in less energy being used for a given level of energy service (e.g., insulating a building, installing LEDs). Curtailment behaviours are actions that result in less energy service (e.g., lowering thermostat settings, switching off lights). Efficiency behaviours typically involve the one-off purchase and installation of an appliance or device, and imply a financial cost (e.g. home retrofits, energy efficient appliances), whereas energy curtailment behaviours tend to be low or no cost but need to be done frequently to achieve energy savings (e.g. lowering thermostat settings, switching off lights) and can involve the loss of associated amenities (e.g., less heating, less lighting).

Research has shown that behavioral changes are a key element in reducing greenhouse gas emissions through energy conservation. Research also indicates that it is difficult to encourage the adoption of energy conservation behaviours. Commonly used policy instruments such as the provision of information, technological innovations, and financial incentives have had mixed success and uptake. For example, the demand response by end-use consumers in response to price increases of electricity is not always in line with what economic models would predict.

The social sciences have much to offer in terms of providing insights about how to communicate with energy consumers to reduce energy demand, and recent decades have seen increasing recognition of the fundamental role that social sciences play. This article briefly outlines key areas where social science research provides such contributions, including interventions and policy instruments that are often used to encourage consumers to change their behaviour: the role of technological innovations, the use of incentives, and the provision of information and feedback. We then describe how a socio-technical approach can better communicate with energy consumers to reduce energy demand.

“Three fixes” for environmental problems

Environmental sociologist Thomas Heberlein writes about “three fixes” that can address environmental problems: the technological, cognitive, and structural. Each of these fixes has a different way of approaching human behavior change. Technological fixes, such as motion sensor lighting in the case of energy use, try to bypass the human element by modifying the surroundings instead of changing people’s behaviours or changing social structures. Structural fixes, such as fuel efficiency regulations or reduced pricing for solar panels, try to modify human action by regulating the social setting or "structures" in which these actions occur. By changing the context in which people make decisions, people’s choices are assumed to change (e.g. higher uptake of solar panels due to a lower upfront cost). Cognitive fixes, such as information campaigns geared toward connecting individual’s energy use with greenhouse gas emissions, directly attempt to modify human behavior by targeting the attitudes, beliefs, and values that affect those behaviors. Figure 1 provides an illustration of these ‘fixes’, and below, we reflect on some of the thinking behind them and explain why none of them, alone, sufficiently addresses energy conservation needs.

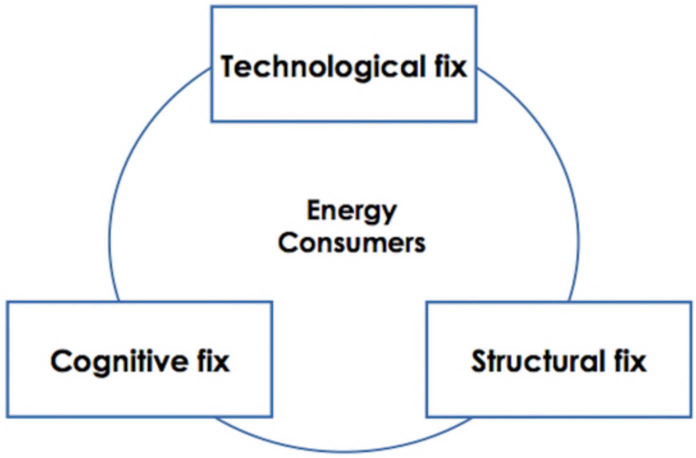

Figure 1. Visual display of approaches to communicate with energy consumers (after Heberlein, 2012).

Can a "technological fix" save the day?

The prospect of technological fixes to solve energy problems is certainly enticing, and there are plenty to choose from. While the most striking examples of “technological fix” thinking may be associated with nuclear fusion or carbon capture and storage, we can also see it in the energy efficiency literature when technical advances are seen to offer the main hope of a sustainable energy future; and in much of the “smart grid”, building automation, and autonomous vehicle literature.

But it is striking how rarely (if ever) technical “solutions” work as planned. For example, households with programmable thermostats can use more heat energy than those without, and there is evidence that only a minority of householders with central heating fully understand their controls, let alone use them in the way intended by the designers. One response to this situation is to try to edit out human misunderstandings/shortcomings through automation and ever-purer technical fixes. Yet automated energy management raises concerns about the additional energy and materials required for the sensors and associated hardware, and also questions about what happens when a system fails or is hacked. In technology, as elsewhere, one solution is likely to generate another problem and any dream of a big technical fix for complex energy-and-climate dilemmas is not realistic; any technical fix is likely to have unpredictable emergent effects.

For this reason, a more promising alternative to the technical fix is a “technical and…” approach that recognises and embraces complexity and pays attention to communicating how and why technology works. As sociologist Elizabeth Shove notes: "technical change is an unremittingly social… process", and one that takes place in particular times and places. It is in these times and places that (to return to our theme of communication) technology has to be communicated, or to communicate itself. A simple piece of energy technology like an open hearth and chimney tells its own story and needs only basic skills to operate successfully. A modern wood-burning stove or a heat pump will be more efficient but more complex, and a heat pump will need a reliable electrical infrastructure.

Examples of the communication we often take for granted in modern energy systems are the electricity flows themselves between switches, billing systems, monitoring and alarm systems, traffic signals, and appliance efficiency labels that send “messages” we can read in the design of buildings and transport systems: you can work by daylight here but not here, or charge your vehicle faster if you pay a higher price in this place; here is a cool room for food storage and there is an outdoor space for drying laundry.

Often a building gives away little about what is going on within in terms of energy flows. Pipes, wires and radiators are painted over or hidden. The small lights and digital clocks that indicate standby consumption are easily disregarded. Radiant heaters, gas fires, and lights may provide visible and tangible services but are fed from invisible sources. So it is all too easy for occupants of most modern buildings to have only a slight understanding of how gas and electricity are used in their home or workplace. Only consumers who rely on solid or liquid fuels, those who are not on an electricity grid, or those on prepayment meters, have *finite* sources of energy services; only those in passive houses are able to do without fuel (though probably not without electricity). The rest rely on supplies of gas, district heat, and electricity that are purchased on credit and pour invisibly through pipes and wires . Problems with overconsumption are partly due to people depending on technologies that do not communicate well how much energy they are using , and that do not give the sort of feedback that can guide them towards using less. A useful comparison can be made with the fuel gauges in automobiles, especially those in hybrid vehicles that show consumption and battery status in near-real-time.

One more communicative factor worth considering in relation to “technical and…” approaches is the communication needed to train the people who design, regulate, and operate buildings, vehicles, machinery, appliances, and infrastructure. If there is a serious mismatch between expert designers and inexpert users, we cannot expect good environmental outcomes, no matter how environmentally sound the intentions of either or both of these groups. Any new technological development has a social dimension, and the outcomes will depend on how the technology is conceived (are users involved in the design?), communicated, and understood. A combination of intuitive design, information, expertise, and informal learning-through-experience can address the social dimension effectively. The role of “middle actors” in energy systems, people who act as bridges or guides between producers and consumers, experts and non-experts, technicians and lay people, owners and tenants, is attracting increasing attention. Effective communication with consumers may involve several channels: technology design itself, direct communication through messaging, and indirect communication via middle actors and informal networks.

Structural influences on human behavior

The good news, as indicated above, is that there are possibilities for bringing about lower-impact energy outcomes, once we stop expecting technology to do all or most of the work of addressing complex problems. This includes addressing individual attitudes, i.e., the above-mentioned cognitive fix, and the social, political, and cultural structures surrounding individuals, i.e., the structural fix. A critique of technical and technical-economic models is offered by sociologist Loren Lutzenhiser as a springboard for proposing that research be expanded to include (among others) institutions, networks of actors in energy systems, and social practices. Analysis that includes more social and organisational understandings of energy systems can help us understand how smart grid development may have very different impacts on carbon emissions in different countries, depending on factors such as patterns of demand, efficiency programmes, tariffs, and arrangements for demand-side response. Behavioural, organisational, and technical dimensions of change occur together and can be addressed together.

Price signals

One example of a structural fix in the domain of energy conservation is price signals. Price signals aim to make energy efficient choices more financially attractive or, conversely, make energy *in*efficient choices more expensive. The use of price signals can take various forms, for example, via a subsidy on energy efficient appliances at the point of sale, or by providing a rebate after purchase, or a subsidy on home-retrofit products. These are intended to encourage energy conservation through rewarding energy efficient consumer choices. Taxation or price hikes, on the other hand (e.g. a carbon tax or on-peak versus off peak price tariffs), makes energy inefficient choices less attractive. In this sense, pricing policies change the relative costs and benefits, which is assumed to guide behavioural choices of energy consumers.

Pricing is generally an effective way to change behaviour. But, the effectiveness is not always as strong as sometimes assumed, and often the effect is short-lived. When energy prices rise, energy consumers can respond to this price hike by reducing electricity demand; but energy consumption levels tend to revert to previous levels when prices fall (see also Van der Werff et al., this issue). Research findings also suggest that when higher tariffs are introduced for electricity consumption during "on peak" hours, energy consumption can then simply shift towards "off peak" hours, while overall energy consumption levels do not necessarily change. Consumer education, feedback and enabling technology can improve the situation: it is the nature of a programme, rather than a simple pricing fix, that determines the outcomes.

Energy consumers are likely to differ in the extent to which their choices are determined by pricing. Price signals may work better for those energy consumers who are mostly driven by extrinsic motivations (e.g. rewards, incentives). But consumers who are more strongly intrinsically motivated (e.g. by environmental concern) may be less persuaded by price signals to change energy consumption choices. For example, when a group of employees in a Dutch environmental organisation were given a financial incentive to start saving energy (e.g., by switching off their computer screen during a lunch break), they ended up saving less energy in comparison to a group of employees who had been given a social reward (e.g. social recognition of their efforts to save energy). What might explain this finding? One possibility is that the financial incentive may not have been high enough (and perceived to not be worth the effort). Another possibility is that the reward did not align with people's main reasons for saving energy. Giving a financial reward may have reframed the situation: saving energy was no longer a moral choice (i.e., because of environmental benefits), but it became a financial choice - which may not have aligned with their (intrinsic) motivations for saving energy. It is important to acknowledge that while financial incentives are effective in many cases, they may not be a "blanket approach" that works for everybody all the time.

Governance

The importance of providing consumers the right to participate in energy decisions that affect them is also germane to this issue. Research on energy policy ranging from the largescale adoption of renewables to the more individual use of smart metering has demonstrated the importance of having a transparent decision making process. Of particular importance is attention to procedural justice and shared governance in individuals’ acceptance of outcomes and belief in the legitimacy of decisions (see also Perlaviciute et al., this issue). When trust is lacking among key stakeholders, which is not uncommon given the potential for competing stakes in the outcome, the ability to depend on a decision making process viewed as fair cannot be understated. For example, customer resistance to the first attempt at (mandatory) smart meter rollout in the Netherlands not only meant that the Dutch programme had to be substantially modified: it also influenced the UK rollout, which is voluntary and backed by a substantial PR and customer education programme.

The cognitive fix: information provision

Largely absent from research on technical or structural fixes are formative questions asking about individuals' fundamental motivations – beliefs, attitudes, and values – that guide their behaviors. Understanding and incorporating these motivations is integral in the design of effective communication messages and campaigns. These types of questions can be seen as aligning with the third or cognitive fix, which involves a belief that the provision of information can effectively modify or change individuals' attitudes and resulting behaviors, thereby solving the problem. The provision of information is a commonly used approach to encourage consumers to implement energy efficiency or curtailment behaviours. The underlying idea is that by providing consumers with information, they will acquire 'better' knowledge about what they can do to save energy and that this will result in behavioural changes. This is also known as the knowledge-deficit approach.

But the research to date is clear: information provides results in an increase in knowledge and awareness, but does not necessarily lead to a change in behaviour. For example, consumers who say they know that leaving one's television in stand-by mode uses electricity will still leave their television in stand-by mode. People who believe in climate change do not always adopt measures to reduce their individual contribution to greenhouse gas emissions. The research largely indicates that information provision leads to an increase in knowledge, but it does not result in the adoption of energy conservation behaviours. Information is, however, a relatively inexpensive and easy way to reach a large audience, and research from the social sciences examines the ways in which the effectiveness of information provision can be enhanced.

There are some stories of success. For example, some interesting work is being undertaken on the use of visualisation tools, with the aim to make information about energy conservation more situation-specific. For example, drawing on theories and methods from the physical sciences and psychology, a UK-based study examined the effectiveness of thermal imaging as an intervention to encourage home retrofitting. Thermal imaging is a technique that uses infrared radiation that allows heat loss of an object to become visible. The study examined the effectiveness of thermal imaging in reducing heating related energy consumption through householders' implementation of efficiency measures such as draught proofing and insulation. Compared to a no-intervention control group, households were more likely to install draught proofing measures and more likely to reduce energy consumption after seeing the thermal images of heat escaping their homes.

Also important is to tailor the information toward the specific audience. Tailoring is a process that helps create personalised communications. Information can be collected about individual households (e.g. income, household size, attitudes towards energy conservation) and an intervention can then be developed that meets this household's specific needs. In an application of tailoring, a group of Dutch researchers conveyed tailored energy saving advice via a website. First, they collected information from households (through an online survey) about ownership and use of various household appliances. Then, households were provided with tailored (i.e. relevant to their specific context) information about energy saving measures and the relative impact these measures would have on their energy bills (this was communicated to households in terms of monetary savings as well as CO_2 emission reductions). Compared to a no-information control group, households who had received tailored information significantly reduced energy consumption.

Studies have also found modest changes in energy consumption levels after the provision of feedback on energy use. Interventions with real time energy information seem to be more effective in yielding savings, as are feedback interventions that provide households with detailed energy use information, such as appliance level feedback. Comparative feedback, which highlights one's own energy use in relation to important others, has also shown success in reducing energy consumption. Comparison feedback can have different effects for relatively high and relatively low energy consumers. Households with higher energy consumption levels tend to reduce their consumption following comparative feedback. However, households with relatively low energy consumption who receive comparison feedback have been found to increase their energy consumption. This is presumably because the social comparison made it clear they had some room to move in comparison to other households. This suggests that it is important to carefully implement such interventions, as they may have different effects for different energy consumers.

These and other findings suggest some paths forward. One of the ways to enhance the effectiveness of information (and feedback) provision is through emphasising social norms about energy conservation. Social norms refer to what society expects of us, and when social norms are made salient, they guide our behaviour. A series of studies by Robert Cialdini and colleagues found that people litter more in littered environments, and that people litter more when they see somebody else littering. Both situations signal that littering is the norm.

If social norms guide our behaviour, then social norms can also be employed to encourage behaviour change. There is now a wealth of research on the use of social norms as part of both information and feedback provision in the energy consumption domain. The assumption here is that households will be motivated to make changes to their energy consumption patterns when they know that other people are also doing this. In one of these studies, households in California received a message that either emphasised monetary savings, social responsibility, environmental considerations, or social norms ("77% of San Marcos residents often use fans instead of air conditioning to keep cool in summer"). Compared to the other messages and a control group, households who had received social norm information reduced their electricity usage the most.

In other studies, social norms are made salient through a process called social comparison. Social comparison refers to our tendency to compare our own performance with that of other people. The effect of social comparison has been tested in field experimental settings: households receive information or feedback about their own energy consumption levels compared to other households (e.g. in the same neighbourhood, or the "most efficient" neighbours) and energy consumption is compared to a no-intervention control group. A number of large-scale randomized control trials (run by the company OPower) in different parts of the US have observed energy savings of around 2%, compared to a no-intervention control group.

Combining these fixes: Communicating about energy conservation using a socio-technical approach

This brief overview suggests that no one fix is likely to succeed in solving energy conservation challenges, yet a combined approach offers greater probability of success in the long term. What we refer to as socio-technical approaches can be very helpful when thinking about energy conservation interventions, including how to communicate about energy. For a start, they take account of the communication that *already* goes on between the equipment and infrastructures that make up an energy system, the people who derive energy services from the system (everyone), and the people who contribute to its operation, maintenance and development. Communication, in this sense, is not just some optional extra in an energy system: it happens all the time between things and things (automated sensing and control), things and people (controls and interfaces), people and people, at different scales. It is a necessary part of the systems of technologies, habits, meanings and knowledge that lead to energy (and climate) outcomes. An appreciation of this approach requires consideration of two main elements: who is communicating and what is being communicated.

Who communicates?

Figure 2 illustrates some of the actors who communicate within a system for providing electricity to homes. It is a 'flat' diagram, giving no indication of the relative power and influence of different actors, but it offers an indication of just how many individual, organisational, human, and non-human elements it can take to make a system work, powered by traditional grid electricity along with some distributed generation such as rooftop solar photovoltaics.

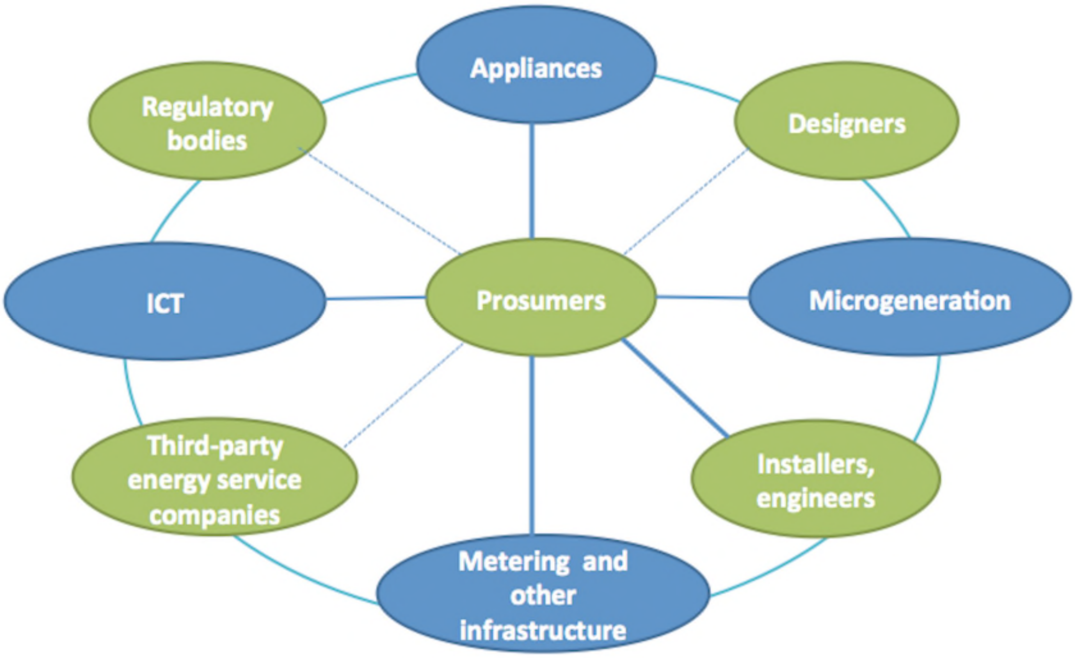

Figure 2: communications between some actors in an electricity system

Note that there are no one-directional arrows between the elements in Figure 2: communication occurs *with*, not *to*. In the rush by marketers and policymakers to tell consumers what they need to do, often with the best of intentions, there can be surprisingly little effort to understand who they are, how they live and how they think. Note, too, the "middle actors" who can be essential in making technology work for the people who need the energy service and for the system that provides it: markets are unable to do this in the pure, "frictionless" way that is sometimes assumed. Examples of such actors include architects, designers, builders, vehicle fleet managers, heating engineers, energy advisers, and local authority personnel. All of these are potential communicators with consumers but may not have the training, resources or inclination to make the most of that role.

What is the communication about?

Figure 2 also gives some idea of where lines of communication can run. This is important when thinking about potential areas where communication is needed, such as

- Where improved design and investment are needed for buildings, mobility, appliances and infrastructure (climate-appropriate design, effective construction, retrofit, maintenance, repair). Colleges, universities and other sources of professional and craft development have a role to play; also the people who develop and apply technical and operational standards.
- Options for distributed generation and storage, where network operators, vehicle fleet operators, energy service companies and tariff designers all need to communicate with each other and with their customers.

- Person-to person communication, in the form of energy labels and marketing materials, onsite advice programmes, audits, advertising campaigns, or online material.
- Technology-to-person communications: controls and feedback on energy use and generation.
- Technology-to-technology communications: rounded appraisal of the possibilities, risks and uncertainties in highly-connected systems.

All of these involve diverse variables and actors, and some entail administrative, legislative, and political activity as standards are negotiated and arrangements made for implementation. But all involve communication about matters related to everyday living and particular pieces of equipment and, to be effective, they need to take careful account of who communicates what to whom. For example, the early experience of smart meter rollout in Great Britain (along with the research literature on energy feedback and technology adoption) pointed to the value of a combined approach in which (1) customers are offered a smart meter designed to meet particular functional requirements including two-way customer-utility communication, along with (2) an in-home display to communicate energy use to customers; (3) installers are trained in communication skills; and (4) suppliers are obliged to make provision for customer information and advice before, during, and after installation.

Conclusions

Climate change, environmental degradation, and the provision of energy services are all complex processes that have to be addressed with many resources - material, cognitive, moral, social, and political. Research on energy consumption benefits from greater involvement of the social sciences. This paper has highlighted that too much emphasis on either a technological, structural, or cognitive fix will not be sufficient to achieve the fundamental shifts in energy consumption needed to meet emission reduction targets.

The research literature on consumer energy demand confirms the extent to which energy systems are socio-technical in nature, so that purely technical fixes to reduce demand are rare or non-existent. Communication with consumers needs to reflect this, using technology as part of the message and involving technicians in the process of designing technology. Drawing on social science research about individuals' motivations, attitudes, and behaviours, technologies can be developed and implemented that "communicate well" with their end users. Technicians can take an active part in implementing such technologies by explaining and developing them with end-users.

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For Further Reading

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