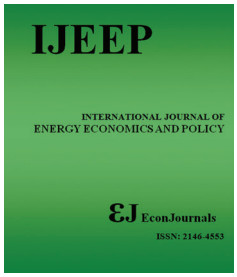

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Behavioral Barriers to Energy Efficiency and Policy Interventions: A Survey of the Literature

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ABSTRACT

The increasing energy demand implying the depletion of fossil fuels and a worsening of poverty, and the alarming level of pollution leading to an unprecedented climate urgency, call for a rapid reduction of energy consumption. Despite the global recognition of the compelling benefits of energy efficiency, there is still a gap between the theoretical potential and the current level of energy efficiency. Agents' irrational hesitation to invest in energy efficiency explains a significant proportion of the energy efficiency gap. Behavioral barriers have caused policymakers to question the relevance of traditional information-based instruments. To address behavioral obstacles, a reconsideration of traditional policies appears to be necessary. We examine the key barriers related to agents' behavior and how they reinforce each other. Then we suggest that policies should consider nudging strategies, which offer valuable insights regarding the human decision-making, and which represent a pivotal way to close the energy efficiency gap.

Keywords: Energy Efficiency Gap, Behavioral Barriers, Energy Policy, Information Based-Instruments, Nudges
JEL Classifications: Q21, Q48

1. INTRODUCTION

The international energy context is mainly characterized by the increasing energy demand, due to the strong demographic growth worldwide (Elshkaki et al., 2016). There is therefore an uncontrolled energy consumption leading to more depletion of fossil fuels and more poverty. This on the one hand, on the other, regarding the international climate context, scientists have been sounding the alarm about the harmful effect of climate change since the 1970s, and inaction is leading to devastating and irreversible consequences (Hornsey and Fielding, 2019). In this regard, an adequate energy use is paramount to face energy challenges and to mitigate climate change (Hornsey and Fielding, 2019).

To combat the various climate and energy challenges, energy should be used efficiently, in this respect, energy efficiency is deemed to be the most inexpensive and readily available resource (Selcuk and Durusoy, 2019). The concept of energy efficiency means a reduction of energy consumption to its minimum level, without producing a decrease in production quality, profitability, and living standards (Çengel, 2011). Energy efficiency leads to "energy security" (Lo, 2014), "environmental sustainability" and "energy justice" (Sovacool and Dworkin, 2015). Energy efficiency is then considered as "the most profitable way to sustainability" (Li et al., 2018).

Energy efficiency has economic, social, and environmental benefits. These benefits are known as the "multiple benefits" of energy efficiency (Kamal et al., 2019).

Despite the global recognition of the benefits of energy efficiency, there is still a gap between the theoretical potential and the current level of energy efficiency, this gap is referred to as "the energy efficiency gap" (Solnørdal and Foss, 2018).

The energy efficiency gap is attributed to the existence of factors that inhibit energy savings decisions and behaviors, these factors

are commonly known as "energy efficiency barriers" (Rehmatulla and Smith, 2015). The weight of each barrier varies from one individual to another, from one economic entity to another, from one sector to another, and from one country to another (Haraldsson and Johansson, 2019).

Several policies have been developed to deal with energy efficiency barriers, assuming rational actors. However, these instruments failed to close the energy efficiency gap. This is explained by the fact that if agents acted only rationally the energy efficiency gap would not exist, besides, starting from an assumption assuming rationality of agents underlies an underestimation of the phenomenon of energy efficiency gap (König, 2020). In this respect, it would be interesting to put the emphasis on behavioral barriers to energy efficiency with the aim of exploring other ways to close the energy efficiency gap.

This manuscript reviews the core literature on the most relevant energy efficiency's behavioral barriers to understand the lingering energy efficiency gap (Section. 1). The remainder of the manuscript is structured as followed.

In Section. 2: We analyze the possible interactions between behavioral barriers. In Section. 3: We outline the existing polices and interventions with a particular focus on those intended to address behavioral barriers and discuss their effectiveness in closing the energy efficiency gap.

2. BEHAVIORAL BARRIERS

Several energy efficiency barriers are derived from behavioral sciences (Thollander et al., 2010). The study of human behavior assumes that individuals have bounded rationality (Campitelli et al., 2010). In other words, individuals make decisions subject to constraints on time, recourses, attention, and on their cognitive capability to process information (Cattaneo, 2019).

2.1. Credibility and Trust

Some barriers can be related to the unavailability of quality information, and others can be related to the surveyor of information itself. "Credibility and trust" is a barrier that refers to the inability of the "surveyor of information" to properly sell his information due to the low level of his "perceived credibility" and the low level of trust placed in him (Lunt et al., 2014).

The dependability of the information surveyor is paramount since the lack of the surveyor's credibility and trust could lead to defensive reactions from individuals and organizations, and eventually to inefficient choices (Cagno et al., 2013).

2.2. Values

Implementing energy efficiency practices depends on the values of individuals within a society. Individual behavior can be motivated by four different values: Altruism, biospherism, hedonism, and egoism. Hedonic values are associated with improving one's feelings and simultaneously reducing effort, egoistic values are linked to preserving or increasing one's recourses. Biospheric values are characterized by an overriding concern for the natural environment for the sake of it, while altruistic values are linked to an intense interest in the well-being of others (Cattaneo, 2019).

Studies conducted in in different parts of the world revealed that individuals who possess self-enhancing values (Hedonism and egoism) are less likely to adopt energy efficiency measures and practices, whereas individuals with high self-transcendence values (biospherism and altruism) are more inclined to opt for energy efficiency measures and practices (e.g., Thøgersen and Ölander, 2002; Nordlund and Garvill, 2003; Collins et al., 2007).

Thus, there is a strong correlation between values on the one hand, and human behavior on the other (Cattaneo, 2019). The literature provides three explanations for the process by which values reinforce energy efficiency behaviors (Steg et al., 2014). Foremost, values influence the importance given to energy efficiency behaviors, which in turn affect agents' evaluation of available options and consequently, affect their choice. Furthermore, values also influence energy efficiency behaviors by triggering a process of "norm activation", this process shapes the extent to which individuals are mindful of the adverse effects of environmentally damaging activities, then generate a feeling of "moral obligation" to operate according to those values. At last, values influence energy efficiency behaviors by the mediation of "identity," which means the degree to which individuals regard themselves as "pro-environmental," in this regard, the more individuals consider the environment to be important, the more they view themselves as pro-environmental, and the more they act in accordance with how they view themselves.

2.3. Framing

Individuals and organizations tend to attribute a different value to the same information, based on the way it is presented. The same information could be presented in various ways semantically speaking (Pelletier and Sharp, 2008). The message could be negatively framed, with an emphasis on the fact that energy efficiency is a cost to be endured to protect the environment. The same message could be positively framed focusing on the fact that energy efficiency is an opportunity to reduce costs.

An energy efficiency information with a positive faming tends to elicit a positive response from individuals, driving them to invest in energy efficiency. Thus, the framing of an information can significantly influence the decision making by pointing out specific subsets of the information (Abrardi, 2018).

2.4. Risk Aversion

Risk aversion is the propensity to favor outcomes with high degree of certainty to outcomes with high level of doubt, even if the outcome of the latter is greater in money value than the more definite outcome (Lilleholt, 2019).

Regarding energy efficiency, individuals and organizations could be risk averse as soon as there is a fair level of uncertainty surrounding energy efficiency technologies' performance, which could influence the level of one's commitment (Al-Mulali, 2014).

Risk aversion may differ among agents depending on several factors. The culture, the personal experience, and above all, agents can have

varying levels of risk aversion depending on the stakes involved. In this regard, agents are more likely to be risk averse for low stakes, this behavior is referred to as the "peanut effect" (Harris et al., 2019). As a corollary, agents are less inclined to shift to energy-efficient devises and appliances, to purchase hybrid cars, or to opt for a housing retrofit, because of the considerable cost involved (Fischbacher et al., 2021).

2.5. The Endowment Effect

The endowment effect occurs when agents place greater value on what they possess and experience greater pain when they lose it (Ma et al., 2022).

A very first laboratory demonstration of the endowment effect was proposed in 1984 (Knetsch and Sinden, 1984). Participants in this study were provided with either $2 or a lottery ticket. A while later, each participant was given the option to exchange their $2 bill for a lottery ticket, and vice versa. Only a minority of participants chose to swap.

This laboratory demonstration and others conducted in the late 20th century (Knetsch, 1989; Kahneman et al., 1990), concluded that individuals tend to become psychologically invested in costs they have pre-spent, without considering the benefits of a brand-new investment (Kahneman et al., 1991).

In terms of energy efficiency, the endowment effect implies that agents consider the replacement of appliances as a "psychological disadvantage," agents prefer to keep their old appliances and devices even if they are less energy efficient and generate maintenance costs (Sullivan, 2012). Table 1 summarizes the main behavioral barriers to energy efficiency based on prior literature.

Faced with numerous behavioral barriers, agents do not engage a thorough cost-benefit analysis to ascertain the optimal decision, but rather, they opt for satisfactory alternatives (Abrardi, 2019). Agents rely on heuristics to facilitate the decision-making process, they opt for a "somewhat good" choice that meets the basic requirements, rather than an "optimal" one (Frederiks et al., 2015). This bias is called "satisficing" (Bendor, 2003).

Confronting simultaneously several behavioral barriers, agents could tend to favor the "status quo" and stick to the default option (Farsi, 2010).

3. ANALYSIS OF THE INTERACTIONS AMONG BARRIERS

In many cases, behavioral barriers coincide within the same organization, that lead us to explore the potential relationship between these barriers.

There is evidence that a causal relationship exists between behavioral barriers (Cagno et al., 2013). In other words, a behavioral barrier (1) can generate or increase the intensity of another behavioral barrier (2). It is noteworthy that the effect of (1) on (2) could be instantaneous, but also delayed. When this effect occurs (immediately or after a certain time), the behavioral barrier (2) could exist on its own and become more intense, independently of the behavioral barrier (1) (Figure 1).

In addition to the causal relationship between behavioral barriers, an underlying effect exists (Cagno et al., 2013). The underlying effect of a behavioral barrier takes place when an organization is not alert to an established barrier (1) but has the perception of being harmed by another barrier (2). In this respect, the presence of the behavioral barrier (1) tends to impact the perception of the behavioral barrier (2). Accordingly, coping with the behavioral barrier (2) would be unfruitful, since (1) is the real barrier (Figure 2).

The persistent behavioral barriers and the presence of a causal effect and an underlying effect between these barriers testify to the bounded rationality of agents. Thus, identifying behavioral barriers and the potential interactions among them is important in determining the most appropriate energy policies to close the energy efficiency gap.

Figure 1: The causal relationship between a behavioral barrier (1) and (2)

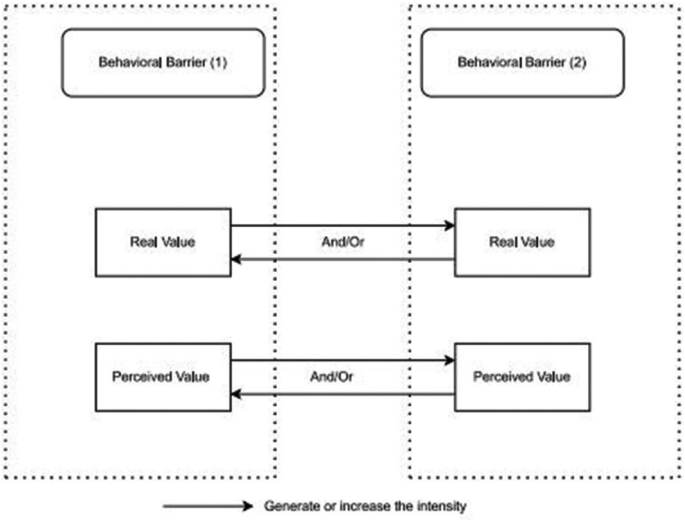
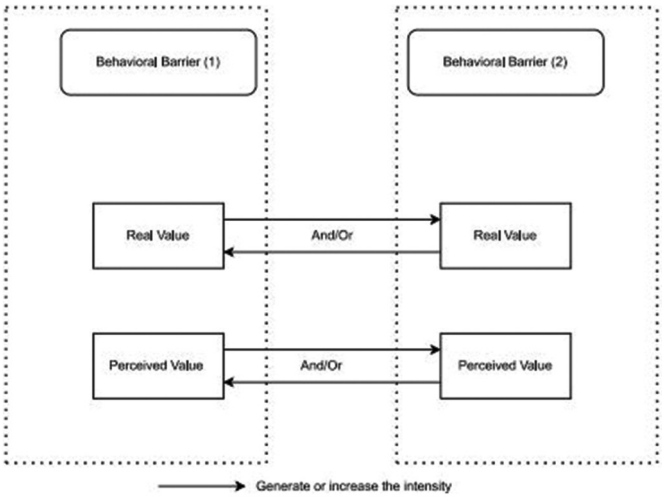


Figure 2: The underlying effect of behavioral barriers (1) and (2)



4. ENERGY EFFICIENCY BARRIERS AND POLICY INTERVENTIONS

In closing the energy efficiency gap, several interventions and policies have been implemented, but even so, a sizeable proportion of the potential benefits of energy efficiency remains untapped (Cattaneo, 2019).

Based on the existing literature, policy interventions can be in the shape of financial programs, regulatory instruments, and information programs (Gillingham et al., 2006).

Financial or economic programs are designed to provide financial incentives for energy efficiency, namely subsidies, rebates, loan facilities, tax deduction, but also energy taxes that promote energy efficiency by raising the less efficient products' prices (Allcott et al., 2014).

These economic and financial instruments raise some important concerns. They are coupled with a "rebound effect" (Bertoldi, 2017) and could facilitate free riding (Houde and Aldy, 2017).

Regulatory instruments establish mandatory requirements to achieve environmental quality goals. Setting standards results in the prohibition of specific products that do not conform to efficiency standards (Mills and Schleich, 2014).

Some authors note areas of concern regarding the use of standards. They produce welfare losses due to the reduction in the range of available choices, moreover, they force behavioral changes on those who benefit only slightly from energy efficiency (Allcott and Taubinsky, 2015).

Both economic and financial programs and regulatory instruments encourage investments in energy efficiency but are not viable solutions to deal with behavioral barriers (Cattaneo, 2019).

In contrast, information programs are intended to change consumer behavior by providing critical information. Information programs can address behavioral barriers. However, the conventional information programs could be flagrantly unsuitable (Abrardi, 2018).

In this respect, information-based instruments can be quite useless, and even self-defeating, when agents have only a limited awareness of them, or when information are presented in a form that does not consider potential psychological biases (Ölander and Thøgersen, 2014).

There are few published empirical evidence that register the positive impact of "information" on "behavioral change" (in a non-point-of-purchase scenario) (Ölander and Thøgersen, 2014).

Conventional information-based instruments are inadequate to bridge the energy efficiency gap for the following reasons:

- The complexity of information, and the frequent use of "legalistic" wording
- Insufficient and inadequate use and of pictorial information
- The framing is not optimal
- Information overload.

Findings from behavioral science have enhanced the policy arsenal with further tools, including nudges (Della Valle and Bertoldi, 2022). Nudges are persuasion strategies which influence agents' choices by modifying the way choices are presented to them, without prohibiting options or altering their economic incentives.

These persuasion strategies are necessary in any of the following cases (Thaler and Sunstein, 2008):

- When decisions are infrequently made
- When decisions are difficult to make
- When information is not given the importance it should be given
- When decisions do not lead to an instant result
- When the relation between decisions and the result is unclear.

In fact, most of energy efficiency choices share many of these features (Ölander and Thøgersen, 2014). Numerous energy efficiency decisions are infrequent (e.g., buying energy efficient appliances). Several energy efficiency decisions are difficult to make, partly because of a "choice overload". Agents' feedback to the information received is in many cases poor. Generally, energy efficiency decisions have delayed effect. Finally, for many agents, there is an ambiguity regarding the link between the decisions made and their outcome. Thus, there are valid reasons to make nudges a part of information-based programs. In this respect, the design of information instruments should heavily rely on the expertise of behavioral scientists and psychologists because of the valuable insights they offer regarding the human decision-making.

Table 1: Description of behavioral barriers

Barriers	Description	References
Values	Energy efficiency can be hindered by staff values within the organization such us hedonism, and egoism	Cattaneo, 2019; Collins et al., 2007; Steg et al., 2014
Credibility and trust	Energy efficiency can be inhibited by a lack of credibility and a low level of trust placed in information' providers	Cagno et al., 2013; Lunt et al., 2014
Framing	Energy efficiency information could receive less attention according to the form its presentation, which could obstruct the implementation of the energy efficiency measures	Pelletier and Sharp, 2008; Abrardi, 2018
Risk aversion	The reluctance to take risk explains the hesitations of organizations to invest in energy efficiency appliances	Al-Mulali, 2014; Fischbacher et al., 2021
Endowment effect	Energy efficiency is compromised when individuals place a higher value on an equipment they possess, even though it may have an average energetic performance	Kahneman et al., 1991; Abrardi 2018; Cattaneo, 2019

Table 2: Nudges and promoting energy efficiency

Category of nudges	Examples	References
Changing defaults	Equipping by default new buildings with low-energy light bulbs	Alberini et al. 2013
Changing option-related effort	Lowering the perceived financial stress to invest in energy efficiency	Münscher et al. 2016
Changing option consequences	Linking energy efficiency decisions to social consequences such as the opportunity to increase social status	Münscher et al. 2016
Providing reminders	Providing reminders with information about energy audit's date and time	Gillingham and Tsvetanov, 2018
Promoting commitments	Incorporating minor undertakings to meet savings goals in dedicated accounts	Münscher et al. 2016

An ideal nudge reduces the required effort to select a particular option. It could be possible by providing reminders (Gillingham and Tsvetanov, 2018), promoting commitments (Münscher et al., 2016), changing defaults (Alberini et al., 2013), changing option-related efforts (Münscher et al., 2016) and changing option consequences (Münscher et al., 2016) (Table 2).

In brief, if information is effective in eliciting shifts in cognitive elements, nudging is successful in triggering behavioral change. Thus, it is not a matter of choosing between information instruments and nudging. Instead, it is a matter of ensuring their simultaneous and complementary use.

5. CONCLUSION

Both the international climate context and the international energy context call for a drastic reduction in energy use. In this respect, energy efficiency is a suitable solution to address climate and energy challenges, by leading to environmental sustainability, energy security and energy justice.

For an extended period, the debate on promoting energy efficiency has centered on determining energy efficiency barriers and on how to address these barriers. However, incorporating the human dimension into energy efficiency policy has only recently begun.

This paper presented the most critical energy efficiency's behavioral barriers, that are important for a better understanding of the energy efficiency gap.

Then, we analyzed the possible interactions between behavioral barriers, how the existence of a behavioral barrier could generate or increase the intensity of another behavioral barrier, and how the presence of a behavioral barrier could influence agents' perception of another behavioral barrier.

An understanding of these interactions is necessary in providing a better comprehension of energy efficiency barriers and in determining the most appropriate energy policies to close the energy efficiency gap.

Finally, we highlighted the existing energy polices and interventions with a particular focus on information-based instruments. Traditional informational instruments can be quite useless, and even self-defeating. However, nudging strategies, by placing an emphasis on neuroeconomics, offer valuable insights regarding the human decision-making. These strategies represent a key element in closing the energy efficiency gap.

Further research should prioritize evidence on nudging interventions' effect on the consistency of behavioral changes, even after the close of interventions. Future research could also focus on developing interventions to change behaviors that consider context-dependent preferences.

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