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Systematic Literature Review on Behavioral Barriers of Climate Change Mitigation in Households

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Abstract: Achieving climate change mitigation goals requires the mobilization of all levels of society. The potential for reducing greenhouse gas (GHG) emissions from households has not yet been fully realized. Given the complex climate change situation around the world, the importance of behavioral economic insights is already understood. Changing household behavior in mitigating climate change is seen as an inexpensive and rapid intervention measure. In this paper, we review barriers of changing household behavior and systematize policies and measures that could help to overcome these barriers. A systematic literature review provided in this paper allows to define future research pathways and could be important for policy-makers to develop measures to help households contribute to climate change mitigation.

Keywords: climate change mitigation; households; behavior change; energy consumption; behavior change barrier; Nudge and Boost intervention

1. Introduction

Mitigation of climate change as well as adaptation and their expected effects are among some of the biggest challenges in current environmental policy development [1]. Although most environmental economics insights are based on a standard neoclassical model of rational behavior (based on utility or profit maximization), they have been criticized in recent decades and an increasing number of alternative behavioral models based on behavioral economics insights have been proposed by scholars [2–4].

Given the complexity of the climate change mitigation, it is clear that transformation will be needed at society level and will require a collaborative effort at all its levels, including small actors such as households. As a result of consumption behavior, households emit 72% of all greenhouse gases, which has become an important issue [4]. Scientists agree that the goals of the Paris Agreement call for changes in how people consume energy. European Union (EU) leaders also endorsed the objective of making the EU climate-neutral by 2050. Given the nature and magnitude of these ambitious low-carbon future targets, it is widely recognized that traditional energy-efficiency policies alone (such as appliances standards or prescriptive insulation levels or building energy performance standards, etc.) will not be enough to change the amount of energy required, but will require changes in energy consumer behavior. It is the patterns of behavior change that are being identified as an inexpensive and rapid measures to help reduce greenhouse gas (GHG) emissions [5,6].

To tackle climate change, households need to be mobilized to change their daily activities. This requires policies that influence consumer behavior and lifestyles changes. Much needs to be done, given the tremendous potential and ongoing efforts to encourage energy efficiency in the residential sector. It may be due in part to the numerous obstacles and market weaknesses that energy efficiency

faces, which are even greater in the residential sector [7]. Understanding of barriers can be a very important aspect for the solution of the climate change problem. To overcome behavioral barriers in addition to classical economic theory, the use of behavioral economics and psychological insights are necessary [4–7].

In recent years, though the value of these insights is already being felt around the world, there is a knowledge gap in systematic literature review of behavioral failures of climate change mitigation and policies and measures to overcome these failures in households for moving towards a low-carbon future, especially from methodological and managerial viewpoints [8]. The paper aims to overcome this gap and provides systematic literature review on behavioral barriers and failures of climate change mitigation and policies and measures to overcome them as well as interventions based on decision-making psychology—nudge and boost policies. The main research questions are as follows: systematization of behavioral barriers and failures of climate change mitigation in households as well as the most relevant policies and measures to deal with them.

The rest of this paper has been structured as follows: In Section 2, research background is provided; in Section 3, methods and data are discussed; in Section 4, results of systematic literature review are detailed; in Section 5, the systematic literature review findings are generalized. Finally, the conclusion and future research directions proposed from this study are outlined in Section 6.

2. Research Background

Until now, however, the mitigation potential of changes in consumption behavior of households has received little attention in the literature on climate change mitigation policy [9]. Most research concentrates on the key drivers of energy demand and carbon footprint, including analysis of household features [10–12]. Interest in the behavioral economy has grown significantly over the past decade. Compared to traditional economic theory, behavioral economics emphasizes the notion that people have cognitive limitations and that, at least in part for this reason, they sometimes make seemingly irrational decisions. By putting it on a solid experimental basis, behavioral science profoundly changed the economics field [13,14]. There are many empirical studies that argue that people's behavior is not only motivated by their own material benefits, and that issues such as perceived fairness and social norms often have a significant impact on people's decisions, as well as issues such as social acceptance and status which are being considered as important behavioral motivators [15,16]. As a result, scientists are increasingly turning to behavioral economics insights to address climate change mitigation issues [17–21]. Much of the behavioral economics studies describe ways in which people sometimes fail to act in their own best interests [22]. Research results show that behavioral change could reduce per capita carbon footprint emissions from 6 to 16% [23]. Behavioral science provides a variety of models that explain how to change behavior. Theoretical models of human behavior, especially as it relates to energy consumption, are important for conceptualizing behavior while also signaling how behavior can be changed. These models can help understand how various social and psychological issues affect behavior, which can further be shaped by identifying effective intervention strategies. The behavioral barriers and failures of climate change mitigation first of all should be addressed based on analysis of these behavior change models, and then the policies and measures that fit best to overcome these barriers need to be scrutinized. The systematic literature review approach applied in this paper is described in Section 3 in detail.

3. Methods

This section presents the method of research, gathering data, data preparation, and analytical phases of the conducted study.

3.1. Research Approach

In order to consolidate the literature of household behavior change barriers of climate change mitigation, we conducted a systematic literature review. This approach is characterized by a

well-documented, replicable, and straightforward search mechanism, which is guided by a theoretical interpretation of the relevant phenomena and increases the efficiency of the analysis process [8].

3.2. Collecting, Preparing, and Analyzing Data

Systematic Literature Review Protocol consists of these steps: Research Questions, Search Strategy, Selection Criteria, etc.

The main research questions are as follows: systematization of behavioral barriers and failures of climate change mitigation in households as well as relevant policies and measures to deal with them.

The search strategy: in order to identify relevant publications related to household behavior in climate change mitigation, we have defined the following search terms and their combinations: "Households' behavior in mitigating climate change"; households behavior; climate change mitigation barriers"; in all fields in the CA Web of Science database. To cover the full range of scientific articles, we searched these research databases published throughout the year, including 2020. We noticed that the first articles on sustainable energy use began to be published in 2003. Excluding sources not related to energy consumption, we selected 80 documents for analysis from the 168 sources found.

Selection criteria: jointly to the aforementioned literature search, this first round of collected documents was solidified and discussed by a, chronologically, second round of searching. This supplementary literature search was conducted in the Scopus database, regarding the fields of specific households' energy applications; especially in the social, marketable, and renewables contexts of analysis.

4. Results

After introducing the approach applied, we turn now to the findings of the systematic analysis of the literature. The results of review are structured in the following way: first, behavioral change models are analyzed and grouped; in the second stage, policies and interventions related to behavior change in general are systematized. In the next stage, barriers of households behavior change in climate change mitigation are examined by following discussion of policies and measures targeting energy consumption and climate change mitigation in households. In the last step, the boosting and nudging policies are discussed as the most effective tools to deal with behavioral barriers and in climate change mitigation.

4.1. Behavior Change Models

There are several archetypes that appear in most mainstream behavior change models. This is shown in Table 1.

Table 1. Models of behavior change.

Model	Explanations
Education models	Environmental awareness is one of the key strategies for changing behavior. The model of environmental knowledge and attitudes by Ramsey and Rickson (1976) was one of the first to propose that education will lead to change in awareness and attitude, which will also create change in behavior. In addition, education remains an effective tool in environmental campaigns, but it is important to differentiate between various forms of information that can be useful in an initiative, such as what, why, and how it applies to a behavior.
Extrinsic motivation models	External motivation suggests influencing human behavior by providing incentives and/or punishments.

Table 1. *Cont.*

Model	Explanations
Intrinsic motivation models	Edward Deci and Richard Ryan, creators of the Self-Determination Theory concept, argue that and the goals that humans are inclined to achieve because they are pleasant. Competence building, autonomy or self-efficacy, and a sense of connectivity are self-motivated and can be leveraged in the process of behavior change
Information-processing-based models	Models concentrating around human needs as processors of information. These underscore the cognitive functioning and affective nature of behavior and decision-making.
Social models	Social models draw predominantly on sociological theories and differ from individualistic theories by placing much greater emphasis on the context and structures that interact with and determine how people behave. Social models draw predominantly on sociological theories and differ from individualistic theories by placing much greater emphasis on the context and structures that interact with and determine how people behave.

Source: created by authors adapted from [23–25].

Patterns of behavior change can be divided into these groups: (1) Education models; (2) Extrinsic motivation models; (3) Intrinsic motivation models; (4) Information-processing-based models; (5) Social models [24].

The climate change mitigation effort that will be needed is so great that additional changes in human behavior will also need to change behavior and adaptation to survive in future climate conditions in societies, organizations, and individuals [23,25]. However, citizens expect to contribute to climate change mitigation at low cost, so choosing low-cost options could significantly reduce energy consumption [26]. In the household domain, lifestyle measures can be identified with respect to (1) space heating, (2) water heating, (3) appliance use, and (4) waste management [27,28]. The carbon footprint for housing is dominated by heating, representing a total of 0.5 tons per consumption unit, and contributes to 44% of GHG emissions in this sector. Household heating constitutes between 30 and 40 percent of overall energy consumption [4,29–31]. GHG emissions are largely derived from energy consumption, which resulted in some variations between countries depending on what major source of energy they used (nuclear, hydropower, district heating, etc.). Dietz et al. [32] estimated the plasticity of 17 household action types in 5 behaviorally distinct categories by using data on the most effective documented interventions which do not include regulatory measures. Results of his study showed that the changes in household behavior can help to save 123 Mtoe total per year in 10 years in the USA. Behavioral change can create opportunities to mitigate climate change without more radical changes in the energy infrastructure and, in the short term, it leads to a more cost-efficient mitigation strategy [27]. Jan van de Ven. et al. [23] indicated that modest-to-rigorous behavioral change could reduce per capita carbon footprint by 6 to 16%, out of which one fourth will take place outside the EU. Sluisveld, M.A.E. et al. [27] used the IMAGE integrated assessment model and found that lifestyle change measures by 2050 can reduce CO_2 emissions in the residential sector by about 13%. Grottera C. et al. [33] also stated that a less carbon-intensive lifestyle leads to significant energy-related GHG emission decreases. Adjusting consumer choices (e.g., standard products, information, standards) can mitigate the climate at low or even negative costs. Examples of interventions enabling negative climate change mitigation costs are energy-efficiency improvements by labels suggesting lower energy costs for more efficient vehicles, or building codes requiring economically acceptable insulation rates [32,34].

Behavioral interventions related to energy consumption in households are mainly categorized into two categories: (1) one-shot behaviors such as decision-making and expenditure in used appliances, i.e., electricity supply and energy storage appliance, and (2) regular attempts to conserve resources through improvements in everyday behavior, i.e., the operation of appliances, preferred room temperatures,

opening window usage patterns, etc. Faber et al. [28] and Van den Berg et al. [35] represented lifestyle change in models, and impact-oriented behaviors were divided into relevant areas used in various modeling techniques (lifestyle changes categorized as "avoid," "shift," or "improve"). Curtailment habit behavior, although it can be very difficult to change psychologically and people need strong incentives to do so (such as economic incentives or regulation or education and social campaigns), is low-cost behavior to adopt [36]. Many of the solutions exist at the level of the individual or household and rely directly on changing patterns of a household's consumption. Other researchers refer to individual actions such as "behavioral wedges" of a larger set of necessary actions to reduce GHG emissions [32] or provide specific patterns of behavior change [27,37]. A distinction needs to be made between interventions (activities aimed at changing behavior) and policies (actions of responsible authorities that enable or support interventions) [37]. In Table 2, policies and interventions in household's behavioral change in climate change mitigation are distinguished. It is important that being aware of the threat of climate change, and especially from a health perspective, can help to change household's behavior. The impact of climate change on human health has been identified as one of the greatest challenges to address climate change mitigation failures. Defining climate change in terms of public health can make climate change more personal [38,39]. Co-benefits for health occur where a program or action that specifically addresses prevention often produces health benefits. Scholars have also proposed using health co-benefits of climate-friendly action as an opportunity to take significant climate change mitigation steps [36,40,41]. Amelung et al. [42] conducted an investigation and stated that European households should be more inclined to take preventive action after receiving additional information about their health benefits, whether others are taking it or not.

Table 2. Policies and interventions related to behavior change in households.

Policies	Intervention
Motivation for voluntary mitigation	• Health point of view. The discourse on climate change could be presented from a health viewpoint to inspire behavior change. Co-benefits of well-being have three contact and incentive advantages: (1) Direct health co-benefits accumulate the working person individually, rather than being dependent on other persons to partake in climate sensitive behavior; (2) The proof and importance of the co-benefits for well-being are well known and can be obtained from various epidemiological studies; (3) The idea of a healthy lifestyle is well established in public discourse, much more so than that of a climate-friendly way of life. • Education: perceived susceptibility to threats and severity of climate change can help change behavior.
Habits change	• Energy save: perceiving the benefits of energy savings (e.g., lower bills) can be a tool for changing behavior. • Education (Learn how to save, manage energy use)
Economic incentives	• Pricing; • Taxes; • Subsidies. Economic incentives are a much greater influence on the behavior of the non-environmentally motivated households in mitigating energy curtailment.
Lifestyle change	• Avoid (Reduce appliances use; reduce dwelling size) • Shift (Reduce water heating; smart use of appliances) • Improve (efficient appliance; adjust temperature)

Source: created by authors based on [27,36,37,40–45].

Achieving a 'step-change' in energy-efficiency behaviors enhanced knowledge of behavioral drivers and their incorporation into effective interventions are necessary [43]. The results of a study by Ornaghi et al. [44] showed that positive behavioral changes are observed even a few weeks after the termination of an intervention, and it can therefore be concluded that such interventions are not only temporary. Stoll-Kleemann et al. [45] examined models of the possible effects of climate change in Switzerland and found that individuals create a number of psychological barriers to justify why they should not act either individually or through collective institutions to mitigate climate change. The lifestyle change resulting from the need for climate change mitigation measures was seen by them as a daunting measure. Therefore, Stoll-Kleemann et al. [45] stated that more attention needs to be paid to social and psychological motivations as to why individuals erect barriers to their personal commitment to mitigating climate change, even when they profess anxiety about future climate change. Behavioral economics uses insights from psychology to increase the explanatory power of economics [5]. It is necessary to mobilize households so that they make changes to their everyday activities to address climate change [46–48]. If consumer behavior can be modified to minimize energy demand or make energy demand more sensitive to weather-driven energy shortages in time and space, it will make a major contribution to promoting the implementation of renewable energy and climate change mitigation.

4.2. Barriers of Households Behavior Change in Climate Change Mitigation

According to Fishbein and Ajzen [49], the motivational questions are: (1) "Do I care?"—it is attitude; (2) "What will others think of my behavior?"—it is perceived norm, and (3) "Can I do the behavior?"—perceived control. This theory could help change household behavior, but there are a number of barriers and difficulties in changing behavior. Barriers are factors that hinder the planning and implementation of actions, yet they can often be overcome through support, funding, and other efforts. The household's response to climate change is complex, but can be linked to a variety of factors, including socioeconomic characteristics of the household, access to credit, knowledge and understanding of climate change, weather forecast information and long-range weather, perception, and political environment [46]. There are many studies on barriers that prevent households from voluntarily engaging in climate change mitigation [25,28,50] and, in summary, the following barriers can be distinguished: (1) economic (e.g., vested interests and sunk investments), (2) social (e.g., values and lifestyles, cognitive routines, alignment between social groups), and (3) political factors (e.g., opposition to change from vested interests, uneven playing field) [27]. Schleich et al. [51] divided barriers to energy consumption into internal barriers (preferences and predictable (and) rational behavior) and external barriers (barriers that are independent of the decision-maker and depend on the institutional environment). The lack of knowledge among researchers and policy-makers about shaping and changing behavior is a major barrier to rapid and low-cost pollution reduction [32]. In Table 3, behavioral change barriers of climate change mitigation in households are systematized.

Rationality and self-control imply that at least some low-saving households make a mistake and will need support in making energy-saving decisions. Individuals with greater self-determined incentive are more likely than others to practice energy-saving behaviors. Successful interventions (including economic ones) would increase the likelihood that sustainable behavior will help address the unprecedented global challenges of climate change [52–54]. In addition, the study of social media impacts indicated that the level of public concern about air pollution is positively linked to household energy consumption [55]. Eventually, natural geographic areas have been producing variations in household environmental behavior [56]. As well, several studies provided that household ownership remains an important determinant of household action to mitigate climate change [57,58]. Household behavior is linked to perceptions of the risks of climate change, beliefs about climate change, and past experiences of climate risks, but living in rented accommodation and limited climate and non-climate planning reduces the likelihood of greater climate change mitigation action [59]. Hackett and Lutzenhiser [60] showed that energy consumption between different households differs greatly,

not only because of the different design and technology available at their homes, but also because of social and demographic differences such as household size, age, income, nationality, and race, as well as differences in values, beliefs, habits, and norms. However, other studies, like Malama et al. [61], did not find a link between household income and energy-efficiency variables and argued that low-income and high-income areas use the same low energy-efficiency initiatives, and that public bodies need to adjust the way they disseminate information to customers, from the traditional advertisement approach to social distribution. The instruments for overcoming climate change mitigation behavioral barriers are systematized in Table 4.

Table 3. Barriers of behavioral change in climate change mitigation.

	Barriers	Explanations
Individual (internal) barriers	Social and psychological barriers	No interest in matters relating to energy; Assigning duty to others; Poor regulation of behavior.
	Knowledge-based barriers	A lack of proper information; Limited consumer knowledge of its own space heating costs; Accept that there would be no substantial savings.
	Unconscious behavior	Strong habits and routines (e.g., no habit to turn down heating); Resistance to change.
	Demographic factors	Low income; Younger age; Gender differences; Differences in the behavior of geographical regions.
	Dwelling ownership	Lack of motivation: individuals living in a rented house have little motivation to renovate it
Societal (external) barriers	Structural and physical barriers	No room temperature setting, thermostat installation, windows opening
	Cultural barriers	The goal is comfort; Few common standards for energy conservation; No social "competition" or benchmarking; Social image not linked to saving energy.
	Economic barriers	Decreasing energy prices; Affordability: Expensive solar panels; lack of incentives; Financial strain: other economic priorities; limited economic resources for a family; living in poverty.
	Institutional barriers	A lack of feedback from direct consumption;Lack of stimulus;Heating costs included in the rent per month;Political barriers.
	Regulatory barriers	Government management: Lack of support from governmental institutions; lack of initiatives related to climate change mitigation.
	Social barriers	The lack of culture in society (We do not throw garbage in the streets, but a lot of people do it. We are trying to save water, but our neighbor hoses the sidewalk.)

Source: created by authors based on [25–28,32,50,51].

Table 4. Instruments that could help overcome behavioral barriers in climate change mitigation in households.

Policy Category	Explanations
Provision of information	Replacing discouragement among customers with details on possible savings, such as audits or product labelling; Low-cost motivational and persuasion strategies also referred to as "nudges"; Programs that force consumers to focus on losses rather than profits, or force consumers to set a goal.
Economic instruments	Increased energy prices;Taxing on high energy use; Subsidies, tax benefits, tax credits, incentives, and guarantees; Equipment or thermometers used for setback; Incentives to make ventilation systems more efficient and flexible.
Regulative instruments	Measures defining the actions to be taken to achieve specific environmental quality objectives: • Energy performance certificates; • Minimum efficiency standards for buildings; • Mandatory heating energy billing at frequent intervals; • Obligation to include information in formal education.
Communication	Information campaigns (demonstration projects, community programs, Share best practices; Communicate the clear connection between rising GHGs and using room heating.
Direct governmental expenditures	Investments in infrastructure, like smart meters; Subsidies
Procedural instruments	Voluntary contracts with companies, schools and so on.

Source: created by authors based on [62–76].

Policy interventions must first of all recognize the limitations of households and address the structural and contextual implications of developed models of behavioral change. This could foster the flexibility of models, to less consumerist daily life in urban areas, allowing for diverse leisure and community activities that are carbon-free [63]. Policies are expected to affect customer behavior and lifestyle, and in future energy management policy formulation the principle of sufficiency needs to be implemented. Sufficiency policies would prohibit increased use of energy due to a range of reasons such as increased floor space, increased levels of comfort above what is acceptable, increased number of larger appliances/equipment/cars of increased usage of energy-intensive equipment [64]. Regulatory mechanisms (standards) are an equivalent to other laws, such as education systems or taxation, because they do not control actions by preventing the usage of energy-using devices. On the contrary, economic and financial systems offer cash rewards for energy conservation which can take priority over requirements, provided that their effects are straightforward and promote behavioral improvements which take into account consumer heterogeneity [62,65]. However, attention should be paid to subsidies, tax credits, and rebates. According to Sorrell et al. [66], Alberini et al. [67], and Bertoldi [68], these policies are associated with a rebound effect; they are not always cost-effective and often noticeable to the free-riding effect [62]. Wagner [69] found that some consumers separate environmental ideology from the impact of income, so they respond to small price signals and their behavioral changes are smaller. However, the results of the study by Boomhower and Davis [70] showed that participation in energy-saving programs increases with increased subsidies for energy-efficiency technologies, but most households said they would have participated even with much lower subsidy amounts. A large proportion of nonparticipating participants said that higher subsidies were hardly cost-effective. In addition, the results show that about half of all participants would have opted for energy-efficiency technologies without even receiving any subsidy.

However, it is well known that individuals need to be involved in the effective implementation of interventions to improve their behavior. Therefore, the key challenge for policy-makers is to design and implement an effective campaign that can promote energy-saving behavior in households [71–73]. Past experiments have found that social expectations also tend to have far more favorable impact in terms of pro-environmental behavior in the long run [74–76]. It is especially important that teenagers are prepared for this change. They still have the freedom to make big behavioral choices that will shape the rest of their lives and will grow accustomed to a lifestyle that approaches the annual emissions budget of 2.1 tons per person needed by 2050 to achieve the 2 °C climate target [77]. It is also important to have an educational strategy for families with children and to encourage parents to emphasize energy-saving behavior so that it is visible to children [78].

4.3. The Newest Interventions to Deal with Behavioral Barriers: Boost and Nudge

In recent years, the potential value of insights from psychology and behavioral economics on how people make decisions has begun to be realized around the world. These insights can inform the design of nonregulatory and nonmonetary policy interventions. As a result, researchers are increasingly taking into account the concept of *Nudge*, which originated from Thaler and Sunstein's study [79]. As an alternative to *Nudges*, Grüne-Yanoff and Hertwig introduced *Boost* [80], which aim is to expand (boost) people's decision-making competences by helping them to apply existing skills and tools more effectively. *Nudge* and *Boost* are most prominent kinds of soft interventions and they are two competing approaches to applying the psychology of reasoning and decision-making to improve policy [81,82]. The role of *Nudge* and *Boost* and explanation are summarized in Table 5.

Table 5. Nudge and boosts policies.

Intervention	Description	Role of Intervention
Nudge	• Nonmonetary interventions which respond to biases and structure choices in a way that makes it easier for people to make better decisions and that steer people in a particular direction while preserving their freedom of choice; • Summarizing Nudge, it can be defined as: (1) an interference that minimally interferes with the requirements of the choice; (2) an action which instrumentally uses failures of rationality; (3) health enhancing action that aims to reduce the detrimental consequences of deficiencies of rationality; the behavioral theory on which Nudges is based opens up the possibility of paternalistic interventions: it shows that, in many cases, individuals' attitudes and beliefs are inconsistent, and beliefs do not encompass all available information. Based on this intervention, it can be argued that people's choices do not necessarily reflect their subjective well-being (e.g. when they deviate from a previous plan because of a strategically attractive temptation, or when carefully worded advertising forces them to buy a product they do not want);	• To motivate individuals to provide inputs on their needs and problems; • To promote effective information campaigns; • To increase a sense of self-efficacy, by crowding-in motivation to change a specific behavior; • Suggested interventions in climate change mitigation in the form of nudges: (1) eco defaults (e.g., compulsory renewable energy registration schemes); (2) context re-framing (e.g., stressing social gains rather than personal sacrifice); (3) conveying social expectations (e.g., matching energy use with adjacent ones); and (4) The use of eco-labels.

Table 5. *Cont.*

Intervention	Description	Role of Intervention
Boost	• Intervention aimed at empowering people by expanding (enhancing) their competences and thus helping them to achieve their goals. The objective of boosts is to develop good decision-making competences; • There are at least three classes of boosts policy: (1) change the environment in which decisions are made; (2) extend the repertoire of decision-making strategies, skills, and knowledge; or (3) do both;	• To co-produce knowledge; • Increase a sense of self-efficacy through capacity building that allows for a wide range of behaviors; • To equip individuals with the skills they can apply in a variety of contexts; • Eco-labels can also count as a boost in climate change mitigation if they target consumer competence and boost their understanding of the product's pro-environmental characteristics; • Communicating threats related to climate change in a clearly understood manner, such as using basic graphs, may be a way to improve pro-environmental intent.

Source: created by authors [80–84].

Both nudges and boosts are important methods focused on observational behavioral research and can enhance decision-making. Supporters of both strategies assert the potential to boost social security by smarter consumer choices [82]. Boosts vary from nudges in that they look for capabilities, not instantaneous actions. Such initiatives will make it possible for people to be environmentally conscious given their uncertainty—and address the bigger problem from different angles [85]. The traditional climate change mitigation instruments like economic incentives can be modified by applying the nudge approach by providing default options for eligibility in various energy-efficiency improvement programs, energy renovation, and renewable energy programs in households.

5. Discussion

Achieving the 2 °C climate change target requires major and urgent changes in energy consumption. All levels of society must contribute to this. Changes in lifestyles will make a crucial contribution to meeting the Paris climate goals. This paper reviewed the barriers to changing household behavior in mitigating climate change, which has shown that, despite existing efforts to promote energy efficiency in the housing sector, much remains to be done. In order to achieve the ambitious goals of the Paris Agreement and the European Union and transition towards a low-carbon future, it is necessary to mobilize households to change their daily energy consumption. However, there are many barriers to changing household behavior. The complex response of households to a changing climate is linked to factors such as the socioeconomic characteristics of the household, access to credit, knowledge and understanding of climate change, and the political environment.

Given the complexity of the climate change mitigation, there is an imperative need to have a societal transformation that will require a collaborative effort at all levels, from small actors—such as households—up to larger environmental sources of profound socioeconomic impact [86,87]. Traditional energy-efficiency policies alone (mainly appliance standards, prescriptive insulation levels, or building energy performance standards) are not enough to change the amount of energy required and the GHGs emitted, whereas there are required changes in energy consumers' behavior and their daily activities. From a quantitative viewpoint, as energy efficiency and GHG emission targets have not yet been met and behavioral changes could reduce GHG emissions by between 6% and 16%, these insights should be important for policy-makers in developing household climate change mitigation measures.

In an applications context of analysis, the main environmental policies include, among others, the recycling of energy-consuming devices at the domestic sector [88], the redesigning of urban landscapes and protected areas from light pollution [89,90], as well as the determination of energy performance indicators and selecting those environmental criteria to minimize energy consumption at no cost, especially at the built environment [91–93].

In a national context of analysis, there are developed companies that are devoted to providing various forms of electric energy. The quality of the services provided has been of major concern for these companies within the last decade [94,95]. Therefore, it is crucial for energy policy-makers to investigate residential customers' satisfaction of electricity providers in any country regarding various factors, such as the products, services, customer service, and the pricing policy. This multifaceted approach is also inferred by the following Figure 1. It is anticipated to have such a multifaceted approach to support electricity providers to dedicate their future products and services, so as to keep their industrial and domestic customers satisfied [96].

In a EU context, it is noteworthy that mainstream literature production is devoted in assessing the influence of information on health effects on people's motivation to adopt mitigation actions, while health co-benefits for the individual are typically confounded with collective health co-benefits, such as from pollution reduction. Indeed, healthy lifestyles, although widely nurtured, are not necessarily implemented; thus, the health argument does not directly constitute a helpful addition to the climate change discourse [42]. Contrarily to this research trend, there has been currently reported a research reorientation to excavate information on individual health co-benefits that are unconditional on the actions of others (direct health co-benefits) [42]. Specifically, in providing health information on strictly unconditional, individual health co-benefits, it can motivate households in high-income countries to adopt mitigation actions: stated willingness to adopt mitigation actions as well as simulation-based carbon emission reductions, in preregistered experimental settings. In such an approach, among 308 households in 4 mid-size case-study cities in four European high-income countries—France, Germany, Norway, and Sweden—the health benefits to promote climate-friendly household behavior has three unique advantages: firstly, health co-benefits accrue directly to the acting individual, they are "private goods" rather than public ones; secondly, the evidence base for, and magnitude of health co-benefits, are well established; and thirdly, the idea of a healthy lifestyle is well engrained in public discourse, much more so than that of a climate-friendly lifestyle [42]. It can also be signified that European households seem to be more willing to implement a given mitigation action when given additional information on health co-benefits that arise irrespective of whether or not others join in. Therefore, direct health benefits for the person performing the mitigation action can be a convincing factor when deciding on whether to perform the mitigation action. Subsequently, households' willingness to implement mitigation actions for which direct health co-benefits exist could be increased by making these benefits explicit [42].

In an international context of analysis, many barriers and market failures faced by energy efficiency, which are even greater in the residential sector, have to be confronted in future systematic approaches. In this study, among the most prolific proposed approaches are the knowledge expansion in behavioral economics and the deepening of psychological insights to: address climate change mitigation issues, reduce per capita carbon footprint emissions, and determine those consumerism behaviors affecting energy choices and habits by end users and/or households (see Figure 1).

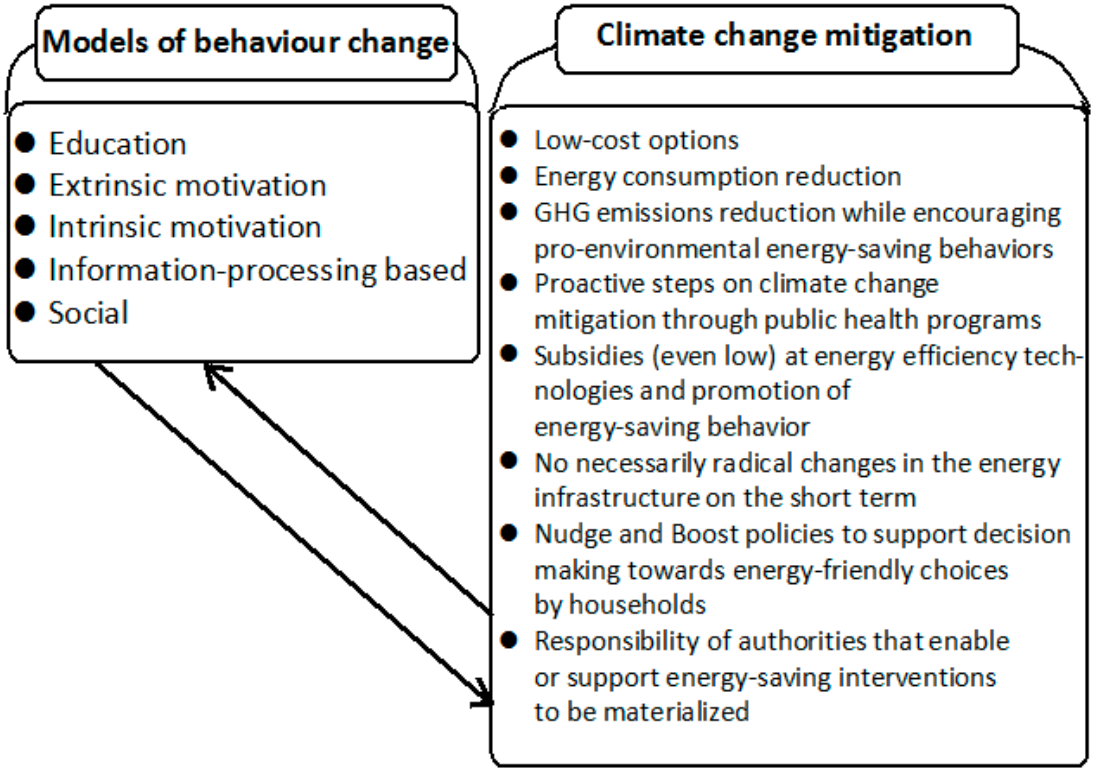

Figure 1. The key aspects of behavior change in alignment with the targeted climate change mitigation.

From Figure 1, and based on the conducted literature review, it can be signified that the behavior changes towards energy consumption and environmental sustainability cannot be valued at detached policies from the citizens' side, but they have to be evaluated in an integrated systematic collaborative approach among public sector initiatives, private-owners supportiveness, and social participation at drawing strategic energy plans setting the priorities of the future. In this respect studies need to:

- Demonstrate if and under what circumstances a larger effect of informing about health co-benefits can be achieved. Potential approaches may entail (a) changing the format or (b) the context in which the health information is presented [42].
- Estimate the impact of providing information on direct health co-benefits versus public health co-benefits on citizens' willingness to implement mitigation actions. This could be done by providing one group of households with information on direct health co-benefits, and a second group with information on public health co-benefits of the same mitigation actions [42].
- Include actions of personal preferences or beliefs regarding health. It could be the case, for example, that the present results were driven mainly by participants who have comparatively high preferences for healthy life choices, particularly since a positive relationship between health behaviors and climate mitigation behavior is appreciated. Such research could further elucidate the motivational factors that drive citizens' willingness to implement mitigation actions [42].
- Link up climate policies with direct health effects, which can support GHG mitigation efforts at two levels: Firstly, by accruing to the individual citizen, this can lead to small but tangible results on households' willingness to adopt suggested climate-friendly consumption changes. Secondly, potential health co-benefits may increase public acceptance of regulation of private consumption to reduce the household carbon footprint [42].

6. Conclusions and Future Research Areas

The systematic review conducted in this paper confirmed that the discourse of climate change to motivate behavior change could be termed from a health perspective, and perceptions of the threat of

climate change can help to change the behavior. Thus, public education is one of the most important factors in changing behavior. Also, defining climate change in public health terms will make climate change more personal and inspire people to commit to reducing climate change.

In summary, barriers to changing household behavior can be divided into internal and external, as well as the following policies to overcome these barriers:

1. Provision of information;
2. Economic instruments;
3. Regulative instruments;
4. Communication;
5. Direct governmental expenditures;
6. Procedural instruments.

In recent years, behavioral economics and psychological insights have become important around the world. It is the behavior change that is recognized as an inexpensive and rapid intervention to achieve climate change mitigation goals. Both Nudge intervention, which aims to help individuals stand out from their problems, set goals, and achieve them, and Boost intervention, which aims to expand decision-making competencies, are two competing approaches that allow policy improvement through decision-making psychology.

The current climate change mitigation policies are not well shaped to address behavioral changes, and future research directions should address the behavioral barriers of climate change mitigation in households by developing new climate change mitigation policies and measures. Actually, by confounding direct and unconditional health effects for the individual with common public goods, the effectiveness of framing mitigation in terms of its co-benefits on health cannot be clearly assessed. When research approaches are failing to find a health framing effect, it remains unclear whether people are unresponsive to health arguments, or unwilling to invest in public goods. Conversely, when research approaches are finding a health framing effect, it remains unclear whether it was the health argument that convinced them, or whether they wanted—or felt obliged—to contribute to a common public good [42].

Conducted analysis showed that behavioral and psychological barriers are overlooked in shaping these policy instruments and are the main reasons of their weak performance. Nudge and boost policies require more attention and integration of nudge or boost approaches in shaping currently applied climate change mitigation policies like financial and fiscal support of energy-efficiency improvement, and renewable energy technologies might be very helpful to get households involved in various climate change mitigation initiatives like energy renovation of buildings, implementation of micro-generation renewable energy technologies, etc. Conclusively, it is noteworthy that, jointly, socioeconomic and environmental dimensions have to be considered and co-evaluated while approaching the environmental issue of climate change mitigation in light of humanitarian needs, in our study households, affection, and prioritization.

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