Article

Energy Transition at Home: A Survey on the Data and Practices That Lead to a Change in Household Energy Behavior

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Abstract: Since energy transition depends significantly on reducing the built environment's energy needs, many regulations and incentives have been implemented globally over the last three decades. Despite some positive results, many scholars suggest that households' behavioral change could greatly accelerate progress. People's levels of awareness and willingness to change, as well as the provision of feedback technologies, are important factors affecting the process. In spite of the extent of this body of literature, household consumption keeps rising. Our thesis is that the subject has been investigated without considering some important correlations among factors. Therefore, this study developed a survey to investigate actual consumers' perspectives on the topic by combining people's awareness of energy use, interaction with metering devices, and user motivation into a coherent framework. A testing session involving 500 people was held as a validation phase for a future large-scale launch of the questionnaire. The test yielded some early outcomes on how people become more interested in changing as they gain more knowledge and are offered suggestions. However, despite their supposedly advanced knowledge as educators and students, the sample's level of awareness was low, suggesting that a more user-centered approach is needed for wide-scale progress.

Keywords: awareness; energy consumption; user behavior; energy-saving practices; metering technologies; feedback

1. Introduction

The energy transition is deemed a necessary and urgent process for strategies and policies aiming at sustainable development, such as the United Nations' 2030 Agenda for Sustainable Development (UN Agenda) [1] and the European Green Deal [2]. Although many actions have already been undertaken to deliver successful incentives and regulations supporting the process at local, national, and even global scale, the importance of properly considering the role of the end-user's attitude in affecting global energy system efficiency is still underestimated, even though it represents a crucial and promising field to further reduce energy consumption and to make the transition happen with large room for improvement.

Looking at the global scale, the UN Sustainable Development Goals (SDGs) [3] detected universal access to modern energy services and the improvement of energy efficiency and of renewable energy share as three decisive actions to meet the SDG 7 "Affordable and clean energy". In line with this objective, two out of eight targets of the recently launched EU Green Deal (COM (2019) 640 final) are strictly related to the energy issue in the built environment, namely supplying affordable, clean, and secure energy, and building and renovating stock in an energy- and resource-efficient way. Digital technologies are widely recognized as critical enablers of the energy transition.

While important steps have been taken toward this path and more are underway, and some encouraging trends have been recorded, reaching the energy transition still needs considerable effort. The UN SDG 7 is indeed far from being fulfilled even in the EU [4],

where, at present, significant challenges remain, and some activities are stagnating for the vast majority of Member States [5]. A share of 7.8% of the EU population were unable to keep their homes warm in 2017, with a high risk of falling into so-called energy poverty, even though EU household energy consumption decreased by 5.1% from 2012 to 2017 and the share of renewable energy increased significantly, covering 17.5% of gross final energy consumption in 2017 [4]. In 2020, almost all countries were on track for limiting energy poverty risk, some were less so for reducing CO_2 emissions from fuel combustion per electricity output, while very few were making progress in increasing the share of renewable energy sources (RES) [5], although several climate actions have been undertaken in the EU dealing both with RES and energy conservation [6].

To that end, the EU comprehensively updated its energy policy framework in 2019 with the Clean Energy for All Europeans package [7], whose directives stress the importance of providing consumers with additional information to help them to make more conscious choices to save energy and money, thus realizing a portion of the potential savings via the commitment of households [8,9].

This is the case with the Energy Performance of Buildings Directive (EPBD III) 2018/844/EC [10], a recast of the previous EPBD II 2010/31/EU [11] and EPBD 2002/91/EC [12], which, for twenty years, regulated efforts to improve energy efficiency in both new and refurbished buildings across European countries. The latest update further promoted the adoption of building automation and control systems (BACS) as well as a wider use of smart digital technologies as consumer means to monitor and optimize the use of energy and natural resources. Furthermore, the Energy Efficiency Directive (EED) 2018/2002/EU [13] (recast of 2012/27/EU [14]) specifically addresses the target to cut down EU energy consumption by 32% by 2030 through the adoption of several measures, among which a massive renovation campaign of the existing building stock and the use of smart metering devices to provide effective feedback to end-users represent crucial strategies.

Within this framework, people's awareness and their resulting attitudes are emerging as crucial drivers to both trigger investments in cleaner sources and induce behavioral changes aimed at energy conservation in everyday life, and especially in the housing sector. Accordingly, the Organization for Economic Co-operation and Development (OECD) reports that many policies have been drafted for this purpose and several strategies have been suggested worldwide focusing on the active role of citizens, such as reframing energy efficiency labels in the United Kingdom and the EU or changing default options on the green electricity market in Switzerland by means of feedback and social comparison [15]. Consequently, many tools for increasing households' awareness regarding energy use have been released, and many others are under development.

This paper reports the first outcomes of a study on the role that individual attitudes may have in energy transition and, particularly, on how behavioral change may impact household energy demand. A core part of the study is a field survey investigating the energy behaviors of a large panel of users within their homes, focusing on their awareness level regarding energy-use practices, the diffusion and interaction with metering technologies, and their willingness to change behaviors once informed about their environmental effect. The study aims to explore how to achieve the potential impact of a behavioral shift, since research on the subject has been very prolific in the last 30 years, but households' energy consumption continues to rise. Hence, it does not investigate the performance of specific technologies, but it correlates the overall performance potential of technological systems with end-users' capacity to interact with them. The overall expected outcome is the identification of the most suitable data and tools capable of instigating changes in users' energy-related behaviors.

In Section 1, the share of the housing sector on the whole final energy demand is quantified; then, the effect of certain daily occupant practices on household energy consumption is discussed. Based on the evidence retrieved in the scientific literature, an overview of the factors that can support individual behavioral change toward more

sustainable energy use at home is presented, pointing out some gaps to be filled in future studies. Section 2 describes the research goals and methodology, using a consumer survey as key means of investigation. The paper then introduces a preliminary testing session before a large-scale launch, the results of which are reported in Section 3. Section 4 critically discusses the survey outcomes, while Section 5 concludes the article, providing an overview of further developments.

1.1. Housing Energy Demand

The building sector accounts globally for 31% of the entire final energy use and 54% of the final electricity demand, being responsible for 23% of the global energy-related CO_2 emissions and one third of those from the direct consumption of fossil fuels [16]. The International Energy Agency (IEA) reported that the worldwide final energy use in buildings rose from 118 EJ in 2010 to around 128 EJ in 2019, when the emissions referring to electricity and fuels for heating buildings reached 28% of global energy-related CO_2, the highest level ever recorded [17]. Similarly, buildings are still today the largest energy consumer across Europe, being responsible for around 40% of the EU energy consumption and for 36% of greenhouse gas (GHG) emissions [9].

A significant share of this demand is represented by residential buildings, whose use stage causes the largest environmental impacts of their entire life cycle [18]. According to the IEA, the residential sector accounted globally for around 25% of the total final energy consumption in 2018, of which 53% was due to space heating, 21% to lighting and appliances, 16% to water heating, 4% to space cooling, and 4% to cooking [17]. Eurostat estimated that the EU-27 household energy consumption represented 26% of the final energy consumption in the same year: around 64% was due to space heating; 15% to water heating; 14% to lighting and household appliances; and 6% to cooking [19]. What generally recurs, despite the geographical differences, is that heating covers the largest energy consumption rate in the residential sector [20,21].

However, statistics show that energy use by households widely differs by country due to climate, as well as to the age, type, and size of buildings, heating/cooling systems, and typologies and usage of appliances; it also differs according to the age, income, ownership of occupants, and to their behavior [22–24]. A recent report by the European Environmental Agency (EEA) recognized habits in space heating, use of electrical appliances, and some other individual domestic behaviors as factors that strongly affect the household energy demand. Both the improved energy performance of buildings and appliances and increasing energy prices triggered by the economic crisis appear to raise the incidence of these factors [22].

1.2. Occupant Behavior Impact on Household's Energy Consumption

Some recent contributions to the literature agree that behavioral change is becoming increasingly relevant in affecting the worldwide energy demand of buildings in the last few decades [25–31]. This is especially true in the housing sector, where the lifestyle of individuals can lead to a factor 2 to 10 variation [27] in energy consumption in the same apartment. As a result, an emerging body of literature is focusing on the potential of behavioral and lifestyle shifts in accelerating the energy transition, with relation to their effects on the demand and thus on the energy market.

Scholars include within the "behavioral change" category a great variety of actions influencing the energy consumption patterns of households: Dubois defines them as "active efforts in changing nature or in some cases the amount of consumption" [28], while Faber points out that they can vary from "one-shot behavior" (i.e., investments in cleaner energy sources) to a "change in routines without changing lifestyle" (i.e., pattern of opening windows), to strong modifications in energy-saving habits (i.e., reduce room temperature) [29]. On the same wavelength, Stern makes a distinction between "frequently occurring behaviors", whose effects are the result of multiple iterations, and "infrequent behaviors", whose effects are achieved by a single action [30]. Similarly, Niamir categorizes

behavioral changes as investment (i.e., buying efficient appliances), conservation (i.e., setting lower house temperature), or switching (i.e., to green energy) [31].

Aiming at considering the nuances but simplifying the definition, this study assumes behavioral changes as actions involving quantitative and/or qualitative modification in individual energy-use habits and practices in the domestic environment. To prevent financial availability from perturbing the perception of the behavioral potential, the changes involving or depending on relevant economic investments are not classified as behavioral. In other words, only the actions that everyone can make within the domestic environment, directly affecting the electricity or gas household consumption, are considered.

Many studies [23,26,27,32–36] have detected the potential of behavioral changes in reducing the household energy demand regarding all end uses. The occupant behaviors most frequently cited as relevant in the literature are those targeting the comfort temperature set-points (for both heating and cooling), window opening patterns, lighting control, efficiency of devices and appliances, and use of hot water [23,32]. Williamson et al. estimated that optimization of thermostat settings saves up to 15% of energy demand [26], while Huebner reported that the setting back of night and daytime temperatures can increase these percentages to 30% for heating and 23% for cooling systems [35]. Gill et al. indicate that behaviors can cause variations of 51%, 37%, and 11% in the energy consumption for heating, electricity, and water, respectively, compared to dwellings with similar features [34]. Quite similar results are reported by Lucon et al. on behalf of the Intergovernmental Panel on Climate Change Working Group 3 (IPCC WG3) [27]: slightly decreasing the room temperature during winter and accepting a slightly higher temperature in summer can reduce consumption up to a factor three. Managing the internal climate following "part-time" and "part-space" approaches is also suggested as an effective measure, since it allows the adoption of different settings based on the presence/absence of the occupant during a certain period in specific spaces. Positive results are expected also from reducing the need of mechanical systems and related energy demand, such as opening windows for natural ventilation, reverting to daylight and natural thermal gains, or drying clothes in open air rather than using electric dryers. Concerning lighting, some very easy-to-do but effective behaviors are suggested by the UN ActNow platform [37], such as saving more than 3.5 kWh of electricity per year per capita (and around 1.5 kg of CO_2 emissions) by unplugging appliances when not in use, or 0.24 kWh of electricity and around 100 g of CO_2 emissions by turning off a 60 W light bulb for 4 h. Abramhse et al. [38] show that also conscious use of domestic appliances can reduce the demand—for example, doing laundry at 40 °C instead of 90 °C or 60 °C or using the dishwasher only when full.

Although every single contribution may be relatively small and some authors argue that its importance is consequently quite marginal [39], many researchers stress the effects that a collective application of these behavioral change can achieve, thus significantly supporting the energy transition in reducing the demand and related GHG emissions. Furthermore, it must be evidenced that the best small actions are those that people are more likely to apply, since a minor change in habits or consumption patterns is easier to adopt than a radical shift or a large economic expense [28].

Among others, Faber et al. provide evidence on how collectively lowering the heating by 1°C in winter can save up to 19 Mt CO_2 in EU GHG emissions by 2030 [29]. The same was suggested by Williamson et al. who calculated that the collective application of some measures at household level (i.e., shifting to LED lights) can save from 2.6 to 5.8 Gt CO_2 by 2050 [26].

1.3. How to Facilitate Behavioral Changes: Are Consumers on Track with Research Findings?

The scientific literature shows that the gained knowledge about climate change and energy-related issues is solid and consistent. The weight of the housing sector on the global energy demand is also well known, as well as which end-uses account for the most and which energy-saving practices users can effectively adopt to reduce the demand. However, in the past few decades, many studies have focused on how much energy can be saved by

users' behavior, rather than investigating the reasons behind people's decisions to change or not change their habits or to use less energy [40]. In other words, science has neglected to adequately consider the agents and the actors capable of making the change happen, probably due to the 'techno-centric' approach it has adopted [41]. Thus, what has recently appeared to be more urgent is to understand how behavioral change can be mobilized to achieve the potential of reducing energy demand that scholars estimate it can provide.

Since people's energy practices and attitudes are affected by a complex series of variables—among which knowledge, awareness, and motivation represent fundamental steps to change [25,26,29,40,42–45]—during the last 20 years, the literature has gradually focused more on the following key areas of investigation:

(a)　people's level of awareness as a precondition to change consumption patterns;
(b)　the potentiality of consumption feedback to inform the user and influence behavior;
(c)　individuals' intention/motivation to modify their own daily practices.

Table 1 illustrates some relevant contributions, especially selected for the extent of their meta-analysis, their key findings, the applied methodology, and the main gaps detected. In each of them, the previous key areas of investigation are associated and the gaps grouped into three main families:

1.　not considering contextual factors;
2.　not considering initial motivation to change;
3.　investigating indirect sources rather than performing consumer surveys.

Table 1. Important studies on the topic and gaps to be filled.

Source	Key Areas of Investigation	Method	Gaps
Joachain et al., 2014 [8]	b-c	literature review (based on surveys)	3
- Studies from 2010 on reducing the potential of smart metering feedback per se between 2 and 4%. A rewarding system mixed with incentives could boost smart metering potentialities in motivating citizens.			
Steg, 2008 [25]	a-c	literature review	3
- Even if aware of the energy issue, there is still confusion on nexus with climate change and how much behaviors contribute to the demand. - Information is not enough, motivation and awareness of energy-saving actions are needed along with strategies to change the context where decisions are made.			
Dubois et al., 2019 [28]	c	serious gaming	1
- People are more willing to apply mitigation actions which convey the minor CO2e reduction potential since minor changes in lifestyles are required.			
Faber et al., 2012 [29]	a	literature and policy review	3
- Common barriers to change are limited cognition, lack of knowledge and awareness about one's own energy consumption. In addition, attribution of responsibility to others hinders the action.			
Martiskaine, 2007 [40]	a-b	literature review	3
- Despite environmental concern, people barely link their everyday behavior to climate change. - Indirect and direct feedback save up to 15%, especially when related to cost and environmental impacts.			
Stern, 2000 [45]	c	literature review	3
- Breaking habits is the main obstacle to changing energy consumption patterns.			

Table 1. *Cont.*

Source	Key Areas of Investigation	Method	Gaps
Darby, 2006 [46]	a-b-c	literature and statistic review	2

- Despite environmental concern, people have only a vague idea of how much they are consuming and what practices can help to reduce the demand.
- Direct feedback saves 5–15%; indirect f. 0–10% but this is better to track changes. Historic f. is more effective than social or normative comparison; continuous f. is preferred since motivation falls when information or incentive end.

Future Foundation, 2006 [47]	a	survey	1

- Diffused lack of knowledge and interest about energy use and its impacts in over 40% of respondents.

Erhardt-Martinez et al., 2010 [48]	b-c	literature review	3

- Informing billing saves around 3.8% energy demand; daily/weekly 8.4%; real-time feedback down to the appliance level 12%. However, utilities prefer billing as cheaper.
- Even when informed by IHDs, households need tailored tips and being motivated.

Serrenho et al., 2015 [49]	b	literature review (based on surveys)	3

- Relevant feedback studies of the last 40 years on the effectiveness of feedback all around the world (involving different types, media, frequency, sample size, and duration) saving up to 20%.

Fischer, 2008 [50]	b	literature review	2, 3

- The most successful feedback is given frequently and over a long time, provides an appliance-specific breakdown, is presented in a clear and appealing way, and uses computerized and interactive tools. Energy savings are 5–12%.

Abrahamse et al., 2007 [51]	b-c	on field experimentation and survey	2

- A combination of interventions (tailored information, individual goal setting, and tailored feedback) successfully brings changes in direct and indirect energy use, energy-related behaviors, and raises knowledge.

Darby, 2010 [52]	b	survey	2, 3

- Smart meters alone are not necessarily effective unless appropriate forms of interface, feedback, narrative, and support are included to target diverse populations.

Völker et al., 2021 [53]	b	literature review	2, 3

- Smart meters are effective if they provide near real-time and historical feedback. This is expected to result in the adoption of more sustainable consumption behavior, and thus to ultimately lead to energy savings.

Farqui et al., 2010 [54]	b	review of utilities' programs	1, 2

- Direct feedback by IHDs can save from 3 to 13% of energy consumption.

Carroll et al., 2014 [55]	b	literature review and survey	1, 2

- Examine benefits of coupling smart meters and IHD, resulting in an average of 2.1% reduction in energy demand.
- Younger people are more likely to reduce their demand once informed.

Van Dam et al., 2012 [56]	c	survey	2

- Investigate 3 types of Home Energy Management Systems, finding a distinct decrease in the level of energy savings originally made by occupants after a few months, due to both difficulties in changing habits and overly complex interfaces.

Buchanan et al., 2014 [57]	c	review of consumers feedback	1, 2

- Without suitable engagement strategies, once habituation sets in, there is a significant loss of interest from end-users in the IHD feedback.

Regarding awareness (a), it emerges that the interest in environmental and energy issues is generally high, but people tend to become confused and do not know how their behaviors specifically affect the energy demand (and climate change), what daily practices consume the most, and what mitigation actions they can adopt [25,40,46]. Thus, total household energy consumption keeps rising. On the other hand, too many people are still not interested in energy issues and do not consider themselves responsible for the global environmental crisis [29,47].

Regarding potentialities of feedback (b) on energy consumption, plenty of studies exist so far, and, over the years, they have increasingly shifted the attention towards the effectiveness of information to change user behavior rather than the device features themselves [8,48,49]. Many scholars recognize that important margins of improvement may come by providing effective feedback to end-users, to ensure that they actively manage their energy at the household level, thus pushing the change by raising awareness. Feedback should capture the consumer's attention and allow them to clearly link their actions to their effects, enhancing the motivation to change. Many variables affect the success of this process, such as the amount and type of information supplied to the user, the time lapse by which the recorded data are provided, and the availability of comparison with references retrieved from historical bill trends or from regulation targets [40,46]. Additional critical issues are those concerning the user interface design and interaction modes, goal-related setting, and the enabling Information and Communication Technologies (ICTs) to implement [49–51]. Indeed, ICT technologies are recognized as powerful means to support people in bridging the intention–action gap, as is the case of direct display or smart meters coupled with In-Home Displays (IHDs), which offer interesting opportunities, especially when they provide the user with personalized feedback on the impact of their behavior (both positive and negative) on energy consumption [25,52–55]. However, both utilities and customers tend to use informative billing because it is a cost-effective method that can be adopted on a broader scale [48]. As a result, the interesting opportunities provided by smart meters and wireless devices to inform households appear to be still underused due to their limited diffusion.

Even when information is provided and feedback returned to the user, scholars demonstrate that people are still hesitant to change. Several barriers to behavioral change are recognized in the scientific literature: among them, motivation (c) emerges as an essential psychological factor to push [25,48]. Accordingly, researchers and policymakers aim to develop innovative engagement strategies as drivers to support individuals, families, and communities in changing their consumption patterns [26], as people tend to prefer mitigation actions that involve the least number of changes in their lifestyles, even if these lead to a smaller reduction in impacts [28]. Moreover, many authors point out that feedback and strategies (gamification, rewarding systems) must be continuous over time, since new habits are strong to form and bad ones are hard to break [45,46,57,58]. Historical or normative or social comparison feedback is also identified as potentially able to motivate individuals to change [42,46], because personal and social customs prevailing in people's living environment can often affect the individual intention–action gap too.

From this framework, it emerges that most scholars have addressed just one or two out of three fundamental aspects of the topic, at the risk of overlooking important correlations and synergies. In this regard, Steg [25] pointed out that several researchers have examined household energy use without correlating contextual factors (income, physical infrastructure, and technical facilities and equipment) with personal ones (attitudes, beliefs, norms), although the latter's significant influences on energy demand are widely recognized. Joachain [8] argues that many surveys on the effectiveness of smart metering feedback have ignored the initial motivation of participants to change. When the topic is instead addressed as a whole, indirect sources are consulted recording the past trend effects, rather than focusing on direct survey results regarding the consumer's actual attitudes. Finally, while both policymakers and academics have emphasized the value of technology in raising people's awareness, the uptake of innovative devices among families

remains limited. This could be due to technological and economic barriers (i.e., difficult interoperability with conventional systems and affordability), but it could also be resulting from a still too low level of public knowledge and interest in energy transition and its relation to climate change. The question of which is the most urgent problem to be solved in order to accelerate the transition process is therefore still unanswered.

2. Methodology

2.1. Scope and Limitations of the Study

The overall scope of this study is to investigate people's attitudes towards the energy transition and particularly to understand how individual behavioral change at home can be effectively promoted in supporting this process. As highlighted in Section 1.3, many studies outlining the effects of attitudes and saving practices on the energy demand provide the research background; however, the majority of them do not investigate this subject considering its whole complexity (from individual awareness to motivation, through interaction with feedback technologies). Even when all these aspects are comprehensively considered, the consumer perspective is not specifically investigated but mainly drafted on some meta-analysis from previous studies.

Locating the positioning of today's consumer on the way from knowledge to action is a relevant issue to be investigated, strictly linked to understanding the real exploitation potential of smart devices (and of more conventional ones) in achieving larger-scale energy savings. The device functions and end-user level of awareness and understanding cannot be indeed considered separately or independently, and motivation cannot be detached from the personal and physical context in which decisions are made.

According to these premises, what is needed to support the household change in energy behaviors must be identified, aiming at quickly and effectively deploying their potential as drivers of transition. The novel contribution of this research is therefore to investigate people's current and actual perspectives on the subject and systematically observe their answers correlating most important contextual factors with their energy-use preferences and habits. The approach is intended to lay the groundwork for a more detailed and comprehensive picture of how people act and how they can be helped to change their behaviors and reduce household energy demand, rather than to provide definitive and universal answers to the problem. This is expected to better support future and more effective research and policy approaches in this area. The adopted survey approach has some drawbacks related to the size of the interviewed group and the reliability of the collected data, which have been carefully considered, and this is why a test survey within a restricted investigation pool was conducted at the initial stage.

2.2. Specific Objectives

Although the use of surveys is not a novelty itself in this field, the innovative part of the proposed method stems primarily from the attempt to link users' preferences and physical context with their own level of experience, understanding, and motivation to change. To this end, the study includes the following three main goals:

1. Exploring people's level of awareness in relation to their energy consumption habits;
2. Investigating whether and how the available technological devices may influence the household energy behavior;
3. Reflecting on people's willingness to adopt certain (shared, recognized, and easy to apply) energy-saving practices.

This will allow us to better recognize data, tools, and practices that consumers believe are most suitable for motivating themselves to change their energy-related behavior at home.

2.3. The Survey as Tool

The field survey method has been chosen as the more useful means to directly investigate the consumer's actual attitudes and positioning on the path towards the energy

transition, combining the conventional design-oriented and technical approach with socio-behavioral sciences in a cross-fertilization methodology [41,59]. Both direct surveys and meta-analysis based on surveys are consolidated tools within the scientific literature on the topic. A questionnaire has been drafted to reach the widest possible audience, so that results should meaningfully be discussed, and the approach tailored to the different contexts.

Thus, the survey and the related questionnaire have been expressly designed for a non-technical target considering some key requirements: the questions must be easy to read and understand, the whole structure must be quick to complete, and it must be as engaging as possible.

The most critical point in delivering a survey is usually to gain people's attention and to be possibly appealing enough to engage their curiosity and encourage them to spend some time completing it. Thus, participants are engaged with a three-line brief on the scope of the study, transparently communicating also the expected time required to complete the process. Participants are informed that the survey will take only five minutes, and that documents, information to be accessed, and specific knowledge are not required, while an informal tone is adopted for multi-answer questions. In addition, to engage the participants and obtain as many replies as possible, a gamification approach has been implemented by structuring the survey as a quiz, where scores are associated with the user's energy profiles.

The self-compiled questionnaire has been developed using Google Form, which has been selected for its broad accessibility, user-friendliness, and the interoperability of the results with MS-Excel datasheets. In compliance with EU General Data Protection Regulation n. 2016/679 (GDPR) [60], the questionnaire is anonymous and does not ask for sensitive data. Accordingly, results are reported in aggregated form.

Figure 1 illustrates the methodological backbone of the study, including its future launch at large scale.
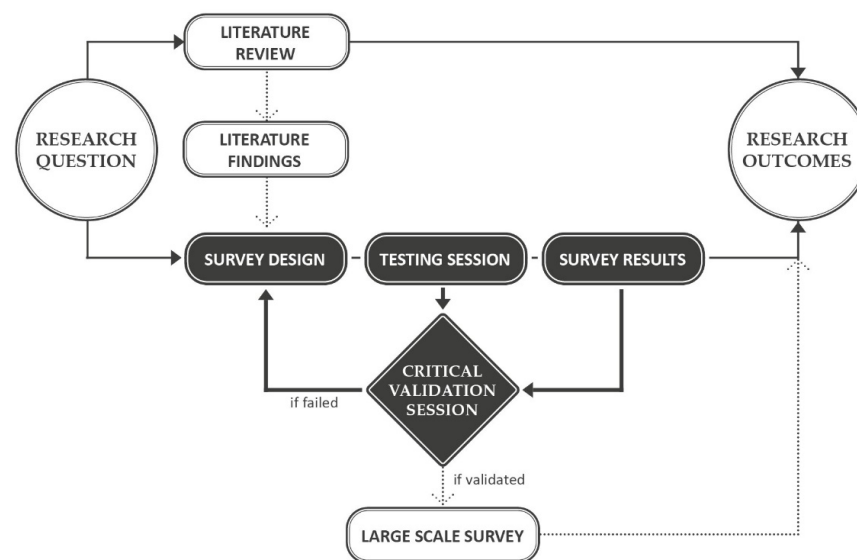
Figure 1. Graphical representation of the adopted methodological backbone.

2.4. Questionnaire Structure and Content Design

The survey (see Appendix A) includes twenty multi-answer questions organized in four sections focused on:

- general pieces of information on participants and their houses (questions 1 to 7);
- personal knowledge and awareness of energy consumption (questions 8 to 11);
- familiarity and interaction level with energy metering devices, interfaces, and feedback (questions 12 to 18);

- personal preferences on energy-saving practices and intention–action gap (questions 19 to 20).

The first section is designed to obtain an understanding of the general framework in which the household is operating and its level of engagement and responsibility; thus, the age range, the ownership regime, and the house typology, with its features, equipment, services, and devices, are considered good indicators [22,23,28,29] to evaluate the occupant's attitude and attention towards the energy issue. Additionally, some basic pieces of information about the building construction or renovation period help to consider the response that the building provides, thus relating the performance set by energy regulation standards to the declared energy consumption levels [10,24,61–63].

The second section is designed to detect the user's level of knowledge of energy behavior and their awareness of the effect of given energy-use practices. The household energy consumption range must be chosen among some pre-defined options, to avoid participants being asked to give precise data by accessing documents or energy bills. This is intended to obtain a consumers' answer mainly based on their level of awareness. The level of precision and reliability regarding consumption data was largely discussed during the design stage. The solution of asking users to select a position on a range of intervals was finally chosen as the survey does not aim at evaluating the user's capacity to provide precise information but its level of awareness, which better emerges by comparing its self-presumed positioning with average reference classes. Since the purpose is investigating the user's capacity to correlate behaviors to energy demand, participants are then asked to order both four recurrent everyday-life practices and four simple energy-saving measures according to the expected energy demand that they generate. Among those provided by Google Forms, the scale of response that best ensures the participants' comprehension has been chosen [64].

The third section investigates people's familiarity and level of interaction with energy metering devices, also asking the user what meter information she/he believes may be the most effective in modifying her/his own behavior. The given device list is based on the outcomes of the scientific literature review (Section 1.3), ranging from traditional meters returning information by paper or electronic bill, to smart meters connected with In-House Display or Apps [49,53–55,65–67]. A list of feedback is similarly provided from the most recurring ones in the literature.

The fourth section aims at understanding people's willingness to change: the same energy-saving practices of question 11 are provided but this time participants are asked to order them according to preference. Lastly, the relative consumption of each practice is unveiled, and participants are asked again to order practices by preference. This redundancy is specifically included to test whether information alone is enough to affect the user behavior, or at least to influence users' intention to change.

Hidden scores are associated with the questions dealing with personal habits and attitudes towards adopting energy-saving behaviors so that, once the participant finalizes the questionnaire, she/he can receive a total score corresponding to different levels of energy-saving profile. The score ranges from Apprentice (0–8 points) to Expert (9–18) to Pioneer (19–27) of Energy Transition. The objective of this last step is to stimulate a self-reflection on one's own commitment to and attitude towards changing their habits or behaviors with reference to the most motivating driver, whether a pure economic benefit or a real willingness to cope with energy transition environmental challenges.

As the proposed methodology can be applied at different scales and contexts, the level of reliability of the responses may vary depending on the target pool characteristics and distribution. To properly calibrate the survey tool, the study envisages a control procedure to ensure a certain level of validation within a control group which is defined in size and representativeness of the profiles targeted by the survey. Once the control group is established and the consensus to provide additional pieces of information has been preliminarily obtained, a mirror version of the questionnaire is delivered to receive feedback on the clarity of the structure, level of understanding and readability of the

questions, as well as detailed or specific data to check if the given answers match with real consumption trends (see Section 3). This process allows us to calibrate the questionnaire according to the targeted pool quality and to the expected outcomes.

Concerning the interpretation of results, participant responses are aggregated and commented on section by section; however, several correlations are intentionally designed to facilitate a critical reading of both energy and behavioral implications. Thus, answers are not simply considered individually but as interconnected elements, allowing the interpretation of different socio-economic and construction contexts, which are highly variable and potentially evolving [58,68–71].

Although it looks like a preparatory phase, the first section of the questionnaire is instead specifically designed to record both the individual and the living context features influencing the responses. Some significant correlations are established between the questions in Section 1 and those following, as drafted in Figure 2, which also shows the operative tool built to process the provided answers according to this logical framework and obtain a cross-cutting interpretation by using MS-Excel datasheets.
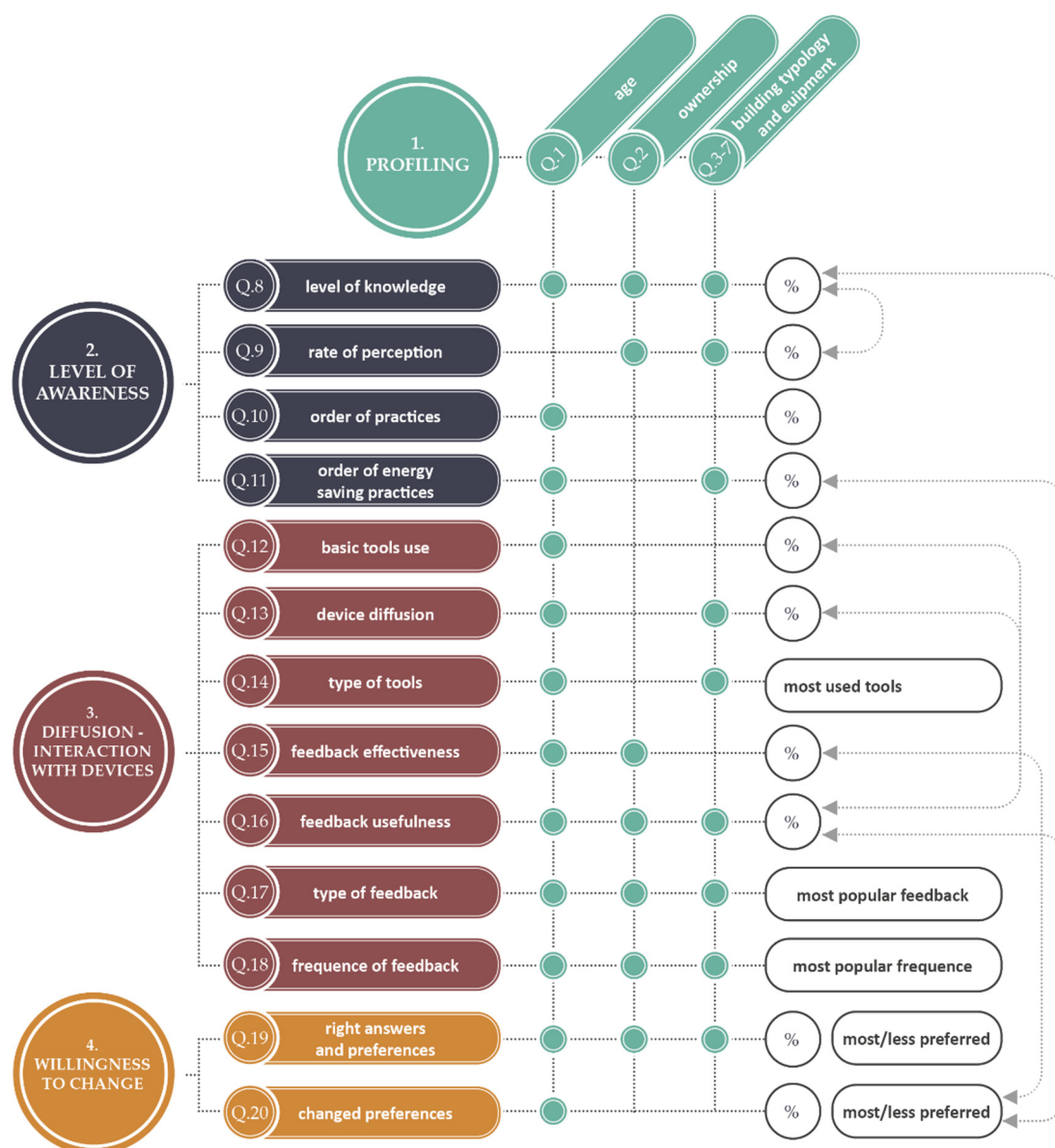
Figure 2. Diagram for reading the survey results. The arrows on the right of the graph indicate the correlations between various questions of the survey.

As environmental issues are often perceived as a priority by younger generations more than older ones, the share of young participants may provide an interesting indicator of the commitment to keeping consumption under control. Age range can also be related to income and house ownership, as young people have lower revenues and prefer to rent, although not only income affects the choice to owning a home or not, but also cultural reasons and market patterns, which vary from country to country [72].

Many correlations also link energy-saving attitudes and building construction or renovation period [73]. Buildings completed after 2000 are expected to provide high energy performance levels to meet updated energy efficiency standards, as well as being equipped with services and devices enabling a direct dialogue with the end-users via ICT solutions (smart displays, apps, etc.) [74–78]. Renovated buildings should also ensure good energy performance [79–82]. The building performance levels are very important in adopting sustainable and savings-oriented behaviors. People living in highly efficient buildings are generally more familiar with the energy saving issue and are more motivated to adapt their habits to the energy transition, as confirmed by the survey outcomes too.

3. Test Session

Since the survey is designed to reach the widest possible number of people in different contexts, a preliminary test session has been performed to verify and validate the survey scheme and the questionnaire, before launching a large-scale campaign. A pool of people at the University of Bologna has been chosen as a test panel. The selected pool includes the whole staff of the Department of Architecture (DA) (professors, researchers, PhDs, technicians, and administrative personnel) and students enrolled in the following programs: combined BA + MSc in Architecture; BA in Architecture-Engineering; MSc Building Architecture-Engineering; BA Industrial Design; MSc Advanced Design; MSc Engineering of Building Processes and Systems.

A total of 500 people were targeted, ranging from 18 to 60 years old, with a few exceptions over 60. The test survey was performed on this panel in March 2021.

Due to their professional and education profile, people in the panel were expected to be quite informed about the investigated topic, familiar with the survey methodology, and potentially available to be actively involved. Although the authors were aware that the prevailing number of students could have perturbed the "by-age representativity" of the surveyed panel, the opportunity to observe a reliable and controllable pool of people was considered a priority to critically evaluate the process.

Regarding the representativeness, the level of competence of this selected target group can be considered above the average, but useful to facilitate an initial check of the main questions, focusing on the quality of the basic information provided by participants, the level of awareness of one's own energy behaviors, and the engagement strategies' possible enhancement.

Before launching the survey on the department test pool, a control group was created to perform a check and validation routine of the questionnaire aiming at verifying that the questions were clearly received and not misleading, multiple responses were complete, and the answers were adequate for data processing and interpretation. According to the overall methodology, a test group of 20 people and 30 reserves was extracted from the selected pool, asking about their availability to provide some information, such as energy bills, energy certificate of their house, and details about the installed services and devices. Once the control group was formed, a mirror version of the questionnaire was sent to obtain the answers and feedback on the level of comprehension. Once the process was completed, some small amendments were made on the questionnaire accordingly—basically concerning the formulation—and it was finally delivered to the whole selected panel.

In order to fulfil all the privacy requirements of EU GDPR, a short informative text and the web link to the survey were sent by the department secretary's office using the official blind mailing lists. Both the informative message and the questionnaire were available in English and Italian versions to reach international students, PhDs, and visiting staff. The

emails were sent on Monday 22 March, and the results were retrieved a week later (Sunday 28 March).

3.1. Test Session Survey Results

As 289 completed questionnaires were received, more than half (58%) of the selected pool joined the survey. With reference to attendant age, 139 (47.8%) belonged to the age range 18–24, mainly students; 96 (33.3%) to the age range 25–39, 43 (15%) to the age range 40–59, and 11 (3.9%) were above 60.

In relation to ownership, 225 (77.8%) participants lived in houses that they owned and the remaining 64 (22.2%) were tenants. More than half lived in apartments (56.6%), the others in a detached, semi-detached, or terraced house. Furthermore, 28% lived in houses built before 1980; 25% in houses built before 1980 but recently retrofitted; 24% lived in houses built between 1980 and 2000; 3% in houses built between 1980 and 2000 but recently retrofitted; and 20% lived in houses built after 2000.

Among the surveyed housing, 74% had autonomous heating and cooling systems, which accordingly explains the great diffusion of thermostats (67.5%) and the remarkable number of houses equipped with both thermostats and heat metering devices (20%), while only 6% did not have either of them. The vast majority (77%) of the houses lacked renewable energy sources; 11% had photovoltaics; 8% solar collectors, and the remaining 4% had other renewable energy sources.

Based on the system that the survey adopted to score the individual attitudes, only 1% of participants reached 20 points, categorized as Pioneers of Energy Transition, while 55% were positioned at the middle level of Expert, and 44% were classified as Apprentice.

According to the Figure 2 outline, the following paragraphs extensively describe the gained results, which are graphically represented in Figure 3, which reports the data directly collected and the main data obtained through the correlation analysis.

3.2. Level of Awareness

The second section reveals whether people know their domestic energy consumption and, therefore, the impact that some typical daily household actions have on these consumptions. It was found that 65% of participants had no idea what their average monthly consumption was, despite there being some hypothetical consumption bands in the question that could be easily selected (Q.8). Around half of these (51%) were between the ages of 18 and 24, showing that young people were among the least aware people.

The remaining 35% of respondents stated that they knew the extent of their average monthly consumption. Among these, 17.5% were estimated to consume between 100 and 300 kWh/month; however, just over half (56%) recognized that this consumption is equal to that of the national average. These people appear good candidates for the most aware group. An additional observation is that almost all (89%) of the aware participants had at least one thermostat or heat meter installed in their homes. Furthermore, the greater number of them owned the house in which they lived, since only 22% were tenants.

Among all participants, 53% believed that they had an energy consumption equal to the national average, 21% lower, 16% higher, and the remaining 10% were not able to tell (Q.9).

With reference to question ten (Q.10), only 24% of the respondents answered correctly, thus placing in ascending order: leave the smartphone charger plugged in for 1 day; leave the PC on even at night or when not in use; leave the light switched on for 4 h (and leaving the room), and raise the room temperature by 1 °C for 1 day. However, 62.5% acknowledged that leaving the smartphone charger plugged in for 1 day was the least-energy intensive action. The most frequent error was linked to the consumption of a bulb: only 34% placed it in the right position on the scale while the remaining 66% were distributed quite homogeneously across the other positions. Finally, 54.6% recognized that increasing the ambient temperature by 1 °C for 1 day has the highest impact on energy consumption.
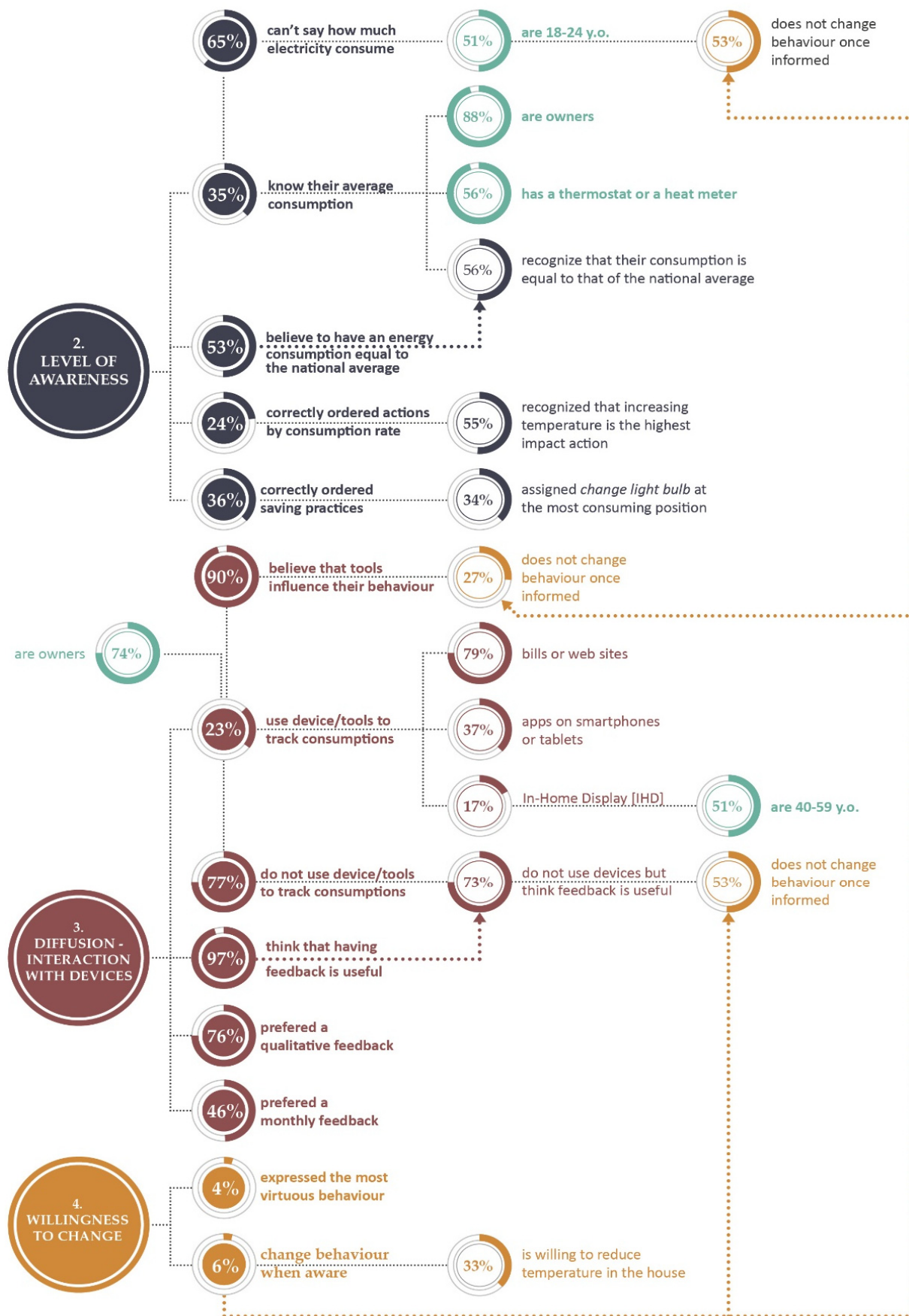
Figure 3. Visual synthesis of main results obtained from the survey and correlation analysis.

Only 36% of respondents correctly ordered the four practices listed in the last question of the awareness section (Q.11), which was: reducing video streaming quality; unplugging devices when not in use; replacing incandescent bulbs with LED lights; reducing room temperature by 1 °C in winter. While reducing streaming quality is recognized by around 70% as the least consuming action, the light bulb was again the most confusing issue: 53% of participants correctly positioned it, but more than 34% assigned it the most consuming position. Similarly, with room temperature, only 53% correctly identified it as the top consumer, 14% as second; 27% as third, while the remaining 6% thought that it was the least consuming option.

3.3. Diffusion of Tools

The third section of the survey revealed the extent to which technological devices for measuring energy consumption are diffused among the sample and, consequently, how users interact with them.

Only 17% of the entire sample used an ecological footprint calculator at least once to find out what their impact on the environment was (Q.12). A preliminary reading of this result reveals that people have low interest in knowing about their environmental impact. The share was higher in the younger age group (46% in 18–24 years old and 43% in 25–39) and decreased drastically with increasing age (11% 25–39 and none in over sixty).

Again, only 23% of participants used devices or applications that allowed them to track their energy consumption on a regular basis (Q.13); this is a percentage that could indicate both a low use of energy metering devices and a low interest in using such tools. Of these, 79% relied on simple tools such as electricity counters or electronic bill readings, or tools made available by the supplier, such as the consumption diary accessible from the customer area on the supplier's website (2.1%); 37.5% used mobile applications on smartphones or tablets, and, finally, 16.7% had an In-Home Display (IHD) connected to a home automation system (Q.14). The larger part of those who used IHD were 40–59 years old and a few were younger, in the range of 25–39. An interesting observation is that 73% of participants who did not use any devices believed that receiving feedback on their consumption was useful, but 56% of these were not willing to change their behaviors. This percentage puts a strain on the analysis: it reveals not only that the level of diffusion of devices is low but also that their effectiveness could be compromised by the initial motivation of users to change. This seems to confirm the need to consider simultaneously all the involved factors.

When respondents were asked if the use of a tool that allows them to know their consumption influences their energy behavior, a significant 90% believed this to be true (Q.15). Despite the small percentage of device users, almost the whole sample (97%) was convinced that having feedback on the effects of their energy behavior would be useful (Q.16).

In the last part of the survey, dedicated to technological devices (Q.17, Q.18), participants were particularly proactive regarding the answers on the feedback that they considered to be most useful. In addition to the selectable answers, some participants proposed interesting gamification strategies (i.e., the less you consume, the more you are rewarded; rewards for goal achievements) and others believed that it would be useful to receive, in addition to the feedback, suggestions on exemplary strategies or actions for improving their behavior. Qualitative feedback appeared to be the most popular form (76.5%), followed by quantitative (58.5%) and comparative (56.5%) ones (Q.17). With regard to frequency, 46% believed that it would be enough to receive monthly feedback, 22.5% would like to receive it daily, 22% in real time, and a small 6% requested weekly feedback. The remaining percentage of the answers (9.5%) were various combinations of the mentioned ones. In this case, the participants indulged in alternative solutions such as receiving feedback on demand, with a recap every two weeks or with the receipt of an over-consumption alert or more, with the possibility to set a threshold (Q.18).

3.4. Willingness to Change

The last section of the survey provided insights into the attitudes of people towards implementing a change in their energy behavior. From the analysis of results, it emerges that less than 4% of the participants answered correctly—or expressed the most virtuous behavior—when asked to sort suggested practices according to their impact on energy consumption (Q.19). Distribution was quite homogeneous for the most preferred practices: replacing of incandescent bulbs with LED was the most popular (32%), followed by reducing the quality of video streaming when high definition is not necessary (27%), unplugging devices when not in use (26%), and reducing the room temperature by 1 °C during the cold season (14%). The last question (Q.20) was directly targeted at perceiving the user's awareness of the impact that the previously submitted actions have on energy consumption. The question aims at investigating if the user behavior undergoes changes once they are aware of the energy consumption of some of their daily practices. Only around 6% answers correctly ordered all the proposed practices, but a promising 33% were willing to reduce the room temperature by 1 °C, followed by reducing the quality of video streaming when high definition is not necessary (31%), unplugging devices when not in use (22%), and replacing incandescent bulbs with LED ones (13%).

4. Outcome Discussion

Although enough answers were collected to allow a discussion about the survey results, the test suggested that some improvement could make the survey more appealing and user friendly to increase the participation rate and strengthen the effectiveness of its application at a larger scale.

A survey has been used by this study to correlate various topics covered by the literature on behavioral change in reducing household energy consumption. The scope was to explore whether evidence can be found in the direct responses of households to support the assumptions of the last 20 years in academic research on the topic and investigate how contextual factors influence individual behavior.

The scientific literature stresses knowledge and awareness as fundamental preconditions to reach intention and finally produce a change in people's behavior. The outcomes confirm scholars' findings [29,40,46,47] that people are poorly aware of their energy consumption and are largely unable to correctly estimate the related impacts in their everyday lives. Thus, considerable work is required to increase their interest and raise their awareness. Among those who are more "aware", the ownership of the house and its equipment, including metering technologies, were confirmed to have a positive impact on knowledge. With reference to energy-use practices, lighting appears as the most difficult form of consumption to properly estimate. Unsurprisingly, most participants tended to prefer energy-saving practices that are achievable with minor lifestyle changes [28].

Even very basic and online tools such as carbon footprint calculators are scarcely accessed, especially by older people, suggesting that the general interest in environmental issues is still low, contrary to what was suggested by Martiskainen and Darby [40,46]. These reflections become even more relevant if the quality of the selected pool in the DA test session is considered, assuming that it represents at least a more familiar and informed group compared to common people. This feeds the thesis that decades of research, policies, and strategies around this topic have not properly centered the target, focusing on technical aspects without adequately considering the diffused low level of people's awareness.

The results demonstrated a generally quite low proportion of subjects who were informed about their energy consumption within all considered ages. In line with the literature findings [40,48,49,51,54,56], people who are more aware of their energy consumption are those that use tools and devices to acquire feedback on their actions; these participants were also confirmed to be influenced by the tools' feedback on their energy behavior. Unfortunately, the diffusion of such devices is still limited—even if their use in the selected pool was higher than expected, probably due to their proximity to the building sector. The age of the participant, her/his ownership status, and the house features strongly affected

the rate of diffusion. This suggests that the most promising tools to develop should be independent of the physical system of the house itself, rather exploiting the potentialities of wireless networks and smartphones and other devices that are already diffused on a large scale. This is particularly relevant if the goal is to amplify the results that behavioral change can produce. If it is true that a "critical mass" of people engaged in the challenge of the domestic energy transition must be reached, it is also true that the tools that support this transition must be simple, effective, and accessible to all.

The last section of the survey also confirms that literature and suggested pieces of information alone are not sufficient to support the transition process: proper engagement strategies should be implemented to motivate people to act differently [8,25,48,52,57]. Some scholars agree that the most successful feedback should be given frequently for a long time [46,50]. However, while there is no evidence to state otherwise, it clearly emerges that there is no feedback that is preferential or more effective than others and, more importantly, feedback alone is not enough to achieve the expected effects. Analyzing the answers given by the participants to questions 17 and 18, it can be argued that the users would like to have some control over the feedback, preferring to receive it in real time or according to their needs. Furthermore, some participants claimed that they would like to feel more motivated to follow virtuous behavior. For this reason, engagement strategies such as gamification or incentives can be considered viable options, confirming the outcomes of some studies [25,48,57]. The vast majority of participants who did not use any device thought that feedback would change their behavior, but when information on consumption was provided by Q.20, 23% of them continued to select the same order of practices, demonstrating that they were not ready to change even when correctly informed. Information is, however, confirmed as a basic starting point. The comparison of participants' performance on each individual energy-saving practice in questions 19-20 proves that a significant share of them changed their mind: once informed that streaming quality is related to lower consumption, the number of people willing to reduce the quality decreased; meanwhile, the number of people that would lower the temperature increased once they understood its saving potential.

Lastly, among the many chains of correlations that the survey opens, the emerging picture about young people is quite interesting if compared with the literature and recent clichés. While the latter tend to identify younger people as the most informed and aware of climate change and the related effects [55], the questionnaire suggests that their level of understanding and knowledge is slightly overestimated since very few of them are aware of their consumption: they represent only 30% of the participants who claimed to know their energy consumption. They can be considered more committed but not fully ready to exploit this potential. This could suggest that more attention should be paid to communication channels and not simply to the functionalities of physical devices, leading to more targeted awareness campaigns, perhaps considering the rise of social media influencers.

5. Conclusions

This paper illustrates a designed methodology aimed at investigating the complex but rich topic of the energy transition at home. The performed literature review offered useful support in detecting the most important gaps in existing studies and key barriers in consumer trends to speed up the change. A survey has been proposed and designed for the purpose and a test run has been undertaken to make it sound and user-friendly for possible further development at a broader scale and to ensure that it reaches the widest possible audience. Some technical adjustments to the questionnaire were suggested both by "proactive" participants and the process of results interpretation itself. Some interviewers selected the choice "other" in some questions and suggested new answers/categories, which can be turned into stable answers in future campaigns.

During the results reporting process, some other key pieces of information were detected, such as the number of components of the household or knowing whether the interviewee directly manages the energy bills. Moreover, it was found that questions where

participants were asked to order practices were not fully user-friendly with the proposed matrix and made both correlations and reading of results difficult. A different kind of question should be provided—for example, by employing a Likert scale.

The outcomes of the testing session evidenced the need to adopt more refined tools for statistical/econometric analysis, especially to deepen awareness, diffusion–interaction with devices, or willingness to change, which should be tested using, for example, Cronbach's alpha before scaling up the process. This shortcoming suggests that the working group should be expanded to include some colleagues of the department of statistics in order to strengthen the understanding and the reliability of results at a further stage.

Beyond this, the reported study allows us to point out some early but useful conclusions. Some of the literature findings are clearly confirmed—for example, the role of devices and feedback in supporting behavioral change—while some others appear instead new and, to a certain extent, upstream—for example, the scarce environmental awareness of interviewed young people. This discrepancy can be considered part of the topic's complexity and further development of the survey could help to better explore the issue.

The survey clearly evidenced that when suitable tools and suggestions are provided, people become more active in changing their energy behavior. However, given the diversity of attitudes, habits, preferences, and personal norms among individuals, these tools should be flexible and capable of being personalized. To this end, a more in-depth analysis of behavioral phenomena carried out in the domestic environment is required, adopting a multidisciplinary, cooperative, and user-centered approach.

The detected results suggest that suitable engagement strategies need to be implemented with innovative solutions, since both the literature and surveys show that knowledge and appropriate information are not always enough to motivate people to change. Even the best and most effective energy metering devices will not ensure the successful delivery of the energy transition if the engagement strategy and the users' attitudes are not properly aligned.

Finally, an initial, tangible result of the conducted survey testing session is that the vast majority of participants in the DA community will be more likely to switch off the light when leaving a room or will be more likely to unplug their mobile charger when not in use from now on. This may be considered a small result but it represents an important step forward in motivating people to change.

Appendix A

Survey—The energy transition starts at home

Do you know how much energy you are consuming? Which daily actions demand more energy and which ones could help to limit consumptions? Take 5 min of your time to

fill this anonymous survey! Discover which kind of consumer you are and help a UNIBO research team to investigate energy transition!

Section 1—General info

1.   Age

☐ 18–24 years old
☐ 25–39 years old
☐ 40–59 years old
☐ >60 years old

2.   Do you live in a house

☐ That you own
☐ Rented or similar

3.   Do you live in

☐ an apartment
☐ a detached or semi-detached house
☐ other: _____

4.   The house where you live was (retrofitted = thermal insulation and/or intervention on systems)

☐ built after 2000
☐ built between 1980 and 2000
☐ built between 1980 and 2000 but then retrofitted
☐ built before 1980
☐ built before 1980 but then retrofitted

5.   Your heating system is

☐ centralized
☐ independent

6.   In the house is installed

☐ a temperature regulator device (thermostat/chrono-thermostat)
☐ a heat metering device (heating counter)
☐ both
☐ neither

7.   Is the house equipped with renewable energy source systems?

☐ no
☐ yes, photovoltaic
☐ yes, solar collector
☐ yes, geothermal
☐ yes, other: _____

Section 2—Level of awareness

8.   Could you say how much electricity you consume on average per month?

☐ no
☐ yes, less than 100 kWh/month
☐ yes, between 100 and 300 kWh/month
☐ yes, between 300 and 500 kWh/month
☐ yes, more than 500 kWh/month

9.   Compared with the average, do you think your energy consumption is

☐ below
☐ equal
☐ above
☐ I don't know

10. Please put these daily actions in ascending order of impact on energy consumption (1 = lower consume; 4 = higher consume)

	1	2	3	4
leave the light switched on for 4 h (and leaving the room)	☐	☐	☐	☐
leave your pc on even at night or when not in use	☐	☐	☐	☐
raise the room temperature by 1 °C for 1 day	☐	☐	☐	☐
leave the smartphone charger plugged in for 1 day (not using it)	☐	☐	☐	☐

11. Given the following 4 good practices, please rank them according to their expected effect on energy consumption in your home (1 = smaller impact; 4 = bigger impact)

	1	2	3	4
reduce the quality of the video streaming when not necessary	☐	☐	☐	☐
unplug your devices when not in use	☐	☐	☐	☐
replace incandescent bulbs with LED ones	☐	☐	☐	☐
reduce the room temperature by 1 °C during cold season	☐	☐	☐	☐

Section 3—Diffusion and interaction with devices

12. Have you ever used an ecological footprint calculator to know your environmental impact (e.g., water/carbon footprint)?

☐ yes
☐ no

13. Do you use devices or apps that allow you to periodically know your energy consumption?

☐ yes
☐ no (go to question 16)

14. Please select one or more tools you use to know your energy consumption?

☐ apps on smartphone or tablet
☐ In-Home Display connected with a home automation system
☐ reading of energy meter, paper or electronic bill
☐ other: _____

15. Do you think that using a tool that allows you to know your consumption influences your behavior?

☐ yes
☐ no

16. Do you think it would be useful to have feedback on the effects of your energy behaviors?

☐ yes
☐ no (go to question 19)

17. What kind of information would you like to receive?

☐ Qualitative (e.g., you are consuming too much energy)
☐ Quantitative (e.g., how many kW are you consuming)
☐ Comparative (e.g., your positioning respect the average)
☐ other: _____

18. And how frequently?

☐ Real time
☐ Daily
☐ Monthly
☐ other: _____

Section 4—Willingness to change

19. Now order these good practices by preference (1 = what you would prefer to implement; 4 = what you would implement less willingly)

	1	2	3	4
reduce the quality of the video streaming when not necessary	☐	☐	☐	☐
unplug your devices when not in use	☐	☐	☐	☐
replace incandescent bulbs with LED ones	☐	☐	☐	☐
reduce the room temperature by 1 °C during cold season	☐	☐	☐	☐

20. And if you knew the impact of these good practices, would the order of preference be the same? Order the practices by preference. (1 = what you would prefer to implement; 4 = what you would implement less willingly)

	1	2	3	4
reduce the quality of the video streaming when not necessary (from UHD to SD −15 kWh/year)	☐	☐	☐	☐
unplug your devices when not in use (till −300 kWh/year)	☐	☐	☐	☐
replace incandescent bulbs with LED ones (−50 kWh/year each lamp)	☐	☐	☐	☐
reduce the room temperature by 1 °C during cold season (on average −1700 kWh/year)	☐	☐	☐	☐

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