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# Why do homeowners renovate energy efficiently? Contrasting perspectives and implications for policy

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ABSTRACT

This paper contrasts two perspectives on energy efficient home renovations from applied behavioural research on energy efficiency and from sociological research on homes and domestic life. Applied behavioural research characterises drivers and barriers to cost-effective renovations, and identifies personal and contextual influences on homeowners' renovation decisions. Research findings inform policies to promote energy efficiency by removing barriers or strengthening decision influences. Sociological research on domestic life points to limitations in this understanding of renovation decision making that emphasises houses but not homes, energy efficiency but not home improvements, the one-off but not the everyday, and renovations but not renovating. The paper proposes a situated approach in response to this critique. A situated approach retains a focus on renovation decision making, but conceptualises decisions as processes that emerge from the conditions of everyday domestic life and are subject to different levels of influence. This situated approach is tractable for energy efficiency policy while recognising the ultimate influences that explain why homeowners decide to renovate.



## 1. Introduction

Efforts to promote energy efficiency in the home have waxed and waned over the decades since the oil shocks in the 1970s sharply increased the financial incentive for reducing energy use. Policy concerns about energy efficiency are again ascendant, spurred by climate mitigation and energy security goals. Renovating existing buildings to improve their efficiency is an important element of climate policy [1]. In the UK, for example, long-term emission-reduction targets imply "*one building would need to be retrofitted every minute for the next 40 years at an estimated cost of £85 billion for homes alone*" (p. 500, [2]).

The majority of homes are owner-occupied: 70% on average across the EU, and 67% in the US and the UK [3]. In owner-occupied homes, renovations are necessarily preceded by homeowners' decisions to renovate. Energy efficiency policy seeks to influence those decisions. As noted in a recent global review, "*retrofitting existing buildings is a discretionary investment . . . building owners . . . need to be persuaded not only of the merits of energy investment, but to finance it and bear whatever disruption it entails*" (p. 734, [4]).

Policies for encouraging and supporting energy efficient renovation decisions by homeowners are widespread. They include: energy audits and assessments; energy performance certificates or ratings at the point of sale; financial incentives and capital support including grants, subsidies, tax credits, low interest loans, and third party financing; certification and training of contractors; community or neighbourhood renovation schemes (collective procurement, support for vulnerable or low income households); marketing and information campaigns. Although they vary considerably in design and implementation, these types of policy characterise efforts to promote energy efficient renovation decisions in the UK [5], in the EU [6], in North America [7,8], in China [9], and in other markets worldwide [10,11].

The common premise of all such policies is that homeowners are motivated to renovate to save energy and money, but are prevented from doing so by capital constraints and uncertainties about energy savings, financial returns, and contractors' quality and reliability. This premise is supported by a large body of 'applied behavioural research on energy efficiency'. We use this label to characterise a body of research concerned foremost with empirical findings on behaviour and decision making, particularly in a domestic context, and with how these findings can be applied in policy or intervention design. Applied behavioural research on energy efficiency draws on microeconomics, social psychology and technology

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**Box 1: Definitions and terms.**
We use the term 'renovations' to mean major structural improvement work to a domestic property, i.e., "*substantive physical changes to a building*" (p. 499, [2]). Renovations have high time, cost, and skill requirements, and are typically carried out by professional contractors with appropriate technical expertise [17].
'Energy efficient renovations' typically involve changes or upgrades to the building envelope – windows, doors, cavity or loft insulation – or the heating and hot water systems [122]. In contrast, we use the term 'amenity renovations' to describe changes to kitchens, living areas, bathrooms, and so on. These are not primarily energy-related although may include some efficiency measures.

adoption research (e.g., [12,13]), as well as grey literature on consumer behaviour and marketing (e.g., [14]). It enshrines "*a more intense and narrower interest in instrumentally mobilizing people to achieve . . . energy use reduction*" (p. 33, [15]). This is in contrast to research that advances theory, engages with social or cultural issues such as status and power, or reflects critically on policy rationales and how research problems are framed [16].

Applied behavioural research on energy efficiency represents individual homeowners making reasoned decisions, subject to personal and contextual influences, in order to achieve certain outcomes which can be analysed in isolation from domestic life.

Maller and Horne [17] argue that this depiction of reasoned, goal-oriented and isolable decisions are part of a 'rationalisation discourse' in energy efficiency research that highlights individual choice and rationality. This fails to address "*the conventions and practices of households . . . which have remained largely in the shadows*" (p. 61, [17]). Several decades of sociological research into these conventions and practices have established a rich and compelling critique of applied behavioural research on energy efficiency (e.g., [18,19,20]). This critique rejects individuals and their cognitive or decision-making processes as the central objects of enquiry. It understands renovations through the lens of the routine, everyday, and socially shared practices that constitute life at home.

The aim of this paper is to show how situating applied behavioural research on energy efficiency within a broader conceptualisation of renovating, homes and households can enrich and strengthen an instrumental understanding of why homeowners decide to renovate energy efficiently. This in turn can broaden the evidence base for energy efficiency policy. By 'situated' we mean making descriptively realistic renovation decision processes endogenous to the dynamics of life at home.

The paper is structured in three parts. First, we synthesise the key approaches and findings of applied behavioural research relevant to energy efficient home renovations, and show how it informs energy efficiency policies. Second, we develop a systematic critique of this body of applied research along conceptual, empirical and methodological lines. Third, we set out a situated approach to renovation decision making that conceptualises renovation decisions as processes emerging from the conditions of everyday domestic life, subject to different levels of influence. We draw implications for energy efficiency policy from this situated approach. These include supporting efficiency measures as part of broader amenity home improvements. Box 1 defines key terms used throughout this paper.

Our paper contributes to this journal's engagement in ongoing debates about energy efficiency research and the effectiveness of policy. Stern [21] notes a specific lack of cross-disciplinary studies needed to explain the complexities of individual and household decision making processes related to energy. Lutzenhiser [16] goes further in characterising the "*singularly narrow theoretical and policy model of energy use and energy savings that governs energy efficiency activities*" (p. 141). He argues that this model or way of thinking is enshrined in an "*energy efficiency institutional complex*" that coordinates the actions of policymakers, utilities, and service providers, and squeezes out any receptiveness to critical social science. Moezzi and Janda [15] call for a scope of action on energy efficiency that moves beyond individual decisions and actions in the home and emphasises the social nature of energy use. Wallenborn and Wilhite [22] point to a different under-researched aspect of domestic energy use: its physicality. They argue that an emphasis on "*rational choice and methodological individualism*" (p. 58) for understanding energy consumption has ignored the importance of sensory and physical experiences, and the knowledge embodied in such experiences. Providing a specific example, Royston [23] focuses on how physically experiencing heat flows generates various forms of know-how or practical knowledge that conditions energy use in homes.

Improving thermal comfort is frequently cited by homeowners as a motivation for renovating, but applied behavioural research on energy efficiency pays scant attention to the physicality of domestic life and the mundane skills and competences used in heating homes. This shortcoming is picked up in the situated approach to renovation decisions proposed in this paper in an effort to show how social science research can explain how and why homeowners decide to renovate energy efficiently.

## 2. Applied behavioural research on energy efficiency

This section synthesises a large body of applied behavioural research on energy efficiency with relevance to home renovations. It sets up the dominant 'drivers and barriers' framing of renovation decision making, and shows how formal models of renovation decisions overwhelmingly emphasise financial attributes. It considers a range of personal and contextual influences on decisions, and gives examples of how research informs policy design.

### 2.1. Drivers, barriers, and the energy efficiency gap

Cost savings from efficiency improvements can provide short payback periods on capital invested [24,25], as well as a host of co-benefits such as improved thermal comfort, reduced draughts and condensation, and increased property value [26]. Consumer behaviour studies commonly find households report positive attitudes and strong intentions towards energy efficient renovations [27,28,14].

Yet installation rates of efficiency measures are stubbornly slower than instrumental drivers of renovation decisions would suggest. The 'energy efficiency gap' between technical and economic potential on the one hand, and actual market adoption on the other, has long been documented [29]. Explanations tend to invoke barriers to otherwise cost-effective technology adoption decisions: "*If there are profits to be made, why do markets not capture these potentials? Certain characteristics of markets, technologies and end-users can inhibit rational, energy-saving choices. . .*" (p. 418, [30]).

Commonly identified barriers to energy efficient renovations in owner-occupied homes relate to finances, information and decision making. Financial barriers include capital availability and strong aversion to delayed gains [31]. Information barriers include a perceived lack of credible and available information on efficiency measures [32], low salience or misperceptions of energy costs [33], and uncertainties about contractor reliability and cost-saving outcomes [34]. Decision-making barriers include the cognitive burden (or transaction costs) of making complex and irreversible decisions

[35], and the anticipated 'hassle factor' of having home life disrupted while the renovations take place [36]. These barriers are repeatedly emphasised in applied behavioural research on energy efficiency in the UK [24,25], in Europe [37], in the US [38], and globally [4].

### 2.2. Models of renovation decisions

Motivations (drivers) and constraints (barriers) are formalised in quantitative models of energy efficient renovation decisions. In particular, discrete choice models have been widely used to express households' preferences for the attributes of energy efficient renovations. As an example, Jaccard and Dennis [12] use a choice experiment on a sample of Canadian homeowners to elicit preferences for efficient or non-efficient home renovations. Each renovation alternative is described by four attributes (capital cost, annual heating costs, purchase subsidy, comfort level) which are varied over two to four levels (e.g., purchase subsidy could be either $0, $500, or $1500). The selection of attributes emphasises the overtly financial framing of the renovation decision. Only one of the four attributes is non-financial: 'comfort level' measured as 'high' or 'low' air quality.

Financial attributes are similarly dominant in the renovation decision models estimated by nine other studies using choice experiments. Specific renovation measures varied from insulation and draught-proofing to windows and heating systems across a range of national contexts: the UK [39,40,41], Switzerland [42], Germany [43], Finland [44], New Zealand [35], and Korea [45]. For a comparison of all the decision attributes used in these studies, see Table 2 in [46].

These renovation decision models (and microeconomic research more generally) are used to quantify the marginal effect of financial or other policy incentives [43,41], consumers' willingness-to-pay for efficiency measures [42,35], and implied rates of time preference or discount rates for future energy cost savings [12]. The application of these models thus further emphasises financial influences on energy efficient renovation decisions.

Another widely used analytical framework examines how innovations spread or 'diffuse' through a population of potential adopters who value certain attributes of innovations. Cost savings and thermal comfort associated with efficiency measures are an example of the 'relative advantage' attribute. Potential adopters of renewable heating systems in Germany reported convenience and comfort rather than cost as more influential sources of relative advantage [47]. But four other attributes are also important in diffusion research: compatibility, simplicity, observability and trialability [48]. Energy efficiency measures are only weakly observable and trialable as they have low visibility or visual salience, and are irreversible once installed [36,37].

Homeowner or household preferences for energy efficient renovations based on national surveys or market data can also be used to model renovation decisions. Such studies similarly focus on financial attributes of renovation decisions (e.g., [28]), but also include a wider range of explanatory or control variables. Poortinga et al. [49] controlled for socioeconomic variables and environmental attitudes in their conjoint analysis of UK household preferences for efficient heating systems and insulation measures. Jakob [50] and Grosche and Vance [51] tested the influence of household and property characteristics on the adoption of home efficiency measures in Switzerland and Germany respectively. Braun (2010) [121] similarly modelled heating system purchase decisions as a function of property and household characteristics, but included location and home tenure as controls. Michelsen and Madlener [52] include technology attributes as well as home and spatial characteristics in their modelling of renewable heating system choices in Germany.

The inclusion of these additional variables extends the scope of decision influences beyond a narrow set of financial attributes to include certain characteristics of renovation decision makers and certain features of the contexts in which decisions are made. These two categories of exogenous influence on the decision correspond to the distinction in social psychology between personal and contextual influences [53].

### 2.3. Personal and contextual influences

Variables describing personal influences include attitudes towards energy use or efficiency, and beliefs about the impact of energy use on the environment [53]. These are expressed towards energy efficient renovations or energy-environment linkages more generally, rather than towards homes or domestic life (e.g., [54]). Diffusion researchers highlight the importance of households' social communication behaviour as a particular type of personal influence [48]. Exchanging information on energy through social interactions helps explain households' propensities to renovate [55]. Information sought through personal contacts in social networks is more influential than expert advice or energy audits, increasing the likelihood of adopting efficiency measures by a factor of four [56].

Variables describing contextual influences can be grouped into four main types: household characteristics (size, lifecycle, socio-demographics), home tenure (ownership, duration), property characteristics (size, age, type), and policy inducements to improve the financial outcomes of renovating (incentives, subsidies).

A fifth type of contextual influence on renovation decisions emphasised more recently in applied behavioural research on energy efficiency relates to salient events (e.g., a boiler breaking down) or periods of transition in the household lifecycle (e.g., moving house, retiring, having a child) [57,58,41]. Salient events can serve as 'trigger points' for energy efficient renovations [28] or home improvements more generally [24,25]. Using UK panel data, Coulter et al. [59] found decisions about moving home could similarly be externally triggered, as well as gradually reinforced over a period of time by both expectations (being able to move) and desires (wanting to move due to dissatisfactions with home or neighbourhood).

### 2.4. Applied behavioural research and energy efficiency policy

Table 1 summarises the full scope of renovation decision influences identified in applied behavioural research on energy efficiency.

The decision influences summarised in Table 1 are of direct relevance for energy efficiency policy. Policies are designed to reinforce drivers, lower barriers, and support positive influences (Table 10.20 in [4]).

Policies to lower financial barriers include grants, subsidies, low interest loans, and third party financing. In the UK, the Green Deal offers third party financing to be repaid through a charge on electricity bills [60]. In Germany, low interest loans are available for renovations that improve energy performance 30% more than the legal minimum [61]. In the US, there are more than 30 different on-bill financing programmes [38], as well as many different kinds of federal and state-level grants and subsidies [62].

Policies to lower information barriers include home energy audits, assessments, and certificates [63,64], contractor training, skills development, and quality assurance [34], better estimates

**Table 1**
Influences on homeowners' renovation decisions in applied behavioural research on energy efficiency.

| | | Commonly identified | Occasionally identified |
|---|---|---|---|
| Drivers (also: motivations) | | Cost savings<br>Thermal comfort<br>Environmental benefits | Draughts, condensation, air quality, health<br>Property value<br>Aesthetics, appearance |
| Barriers (also: constraints) | Finances | Capital availability, interest rates<br>Delayed gains | Irreversibility |
| | Information | Uncertain cost savings<br>Contractor reliability & quality | Uncertain comfort or health outcomes<br>Low salience of energy, misperceptions of energy use |
| | Decision making | Disruption, hassle | Cognitive burden, transaction costs, information search costs |
| Attributes of efficiency renovations | Technical | Energy savings | Complexity |
| | Financial | Capital cost, cost savings, payback period<br>Relative advantage | Financing mechanisms |
| | Other | Comfort | Compatibility, observability, trialability |
| Personal influences | Information & awareness | Expert advice or recommendations, energy audits or assessments<br>Expected cost savings | Availability and credibility of information sources<br>Peer (interpersonal) advice, communication<br>Behaviour, social learning |
| | Attitudes & beliefs | Beliefs and understanding of energy-environment issues<br>Attitudes towards specific energy-environment issues | Future energy prices<br>Implicit rates of time preference<br>Attitudes towards renovating and homes |
| | Experience, skills | | DIY, technical skills, know-how<br>Past experience with renovating or efficiency measures |
| Contextual influences | Household characteristics | Size, composition, lifecycle (e.g., number of children) | Gender, decision making roles<br>Routines, habits<br>Room occupancy profiles |
| | Socio-demographics | Age, education, income, employment | Location (e.g., urban–rural) |
| | Home tenure | Status (own, mortgage) | Duration (current, expected) |
| | Property characteristics | Size, age heating system, insulation | Number of different types of room<br>Infrastructure availability (e.g., gas network) |
| | Salient events | Moving home | Triggers or disruptions to routine (e.g., boiler breaking down, tenants moving in or out) |
| | Policy incentives | Amount | Ease of access, timing, salience |

Table references: see text for details, and: [49,119,50,36,120,27,51,28,121,32], [24], [54], [57], [58], [14,13,47,21].

of the multiple benefits of renovating [26], and real-time energy feedback [65].

Policies to lower decision-making barriers include the use of trigger points to implement efficiency measures [28], one-stop shops for home renovations [35], and loft clearance schemes as part of a whole home renovation service [31]. For a full set of barriers and related policies, see Table 1 in [46].

The drivers and barriers in Table 1 cross cut through the attributes of, and influences on, renovation decisions. Many barrier-removal policies are also designed to support positive decision influences. Home energy assessments and expert advice reduce the uncertainty of expected cost savings and reinforce positive attitudes towards energy saving outcomes. Quality assurance and certification schemes improve trust in contractors. Grants and low cost loans increase expected financial returns.

Energy efficiency policies also use household and property characteristics to identify market segments with a high propensity to renovate or with particular needs or vulnerabilities. As examples, buying a home as a salient event is targeted by energy performance certificates, and financial incentives or support are directed towards old 'hard-to-treat' properties or low income neighbourhoods.

Attractive attributes of renovation measures can also be reinforced by policies. Examples include comparative billing to increase the 'observability' of household energy consumption [66], energy service companies to manage the 'complexity' and cognitive burden of renovation decisions [67], and neighbourhood and community programmes, as well as open house schemes, to support social communication on energy efficiency [68].

These examples show how applied behavioural research on energy efficiency offers a clear analytical framework for understanding homeowners' renovation decisions and designing financial and information-based policies to remove barriers and strengthen positive influences. But this tractable route from applied research into policymaking has its detractors.

## 3. Limitations of applied behavioural research on energy efficiency

A fundamental critique of applied behavioural research on energy efficiency is that it misdiagnoses the problem. Shove [18] argued that a 'drivers and barriers' framing reduces social science to explaining and filling the energy efficiency gap identified by technical analysis under assumptions of psychologically motivated individual decision makers. Applied behavioural research on energy efficiency enshrines this limited gap-filling role [69,70]. Its scope of enquiry is limited to decision makers not differentiated households, energy efficiency not amenity renovations, the extra-ordinary not the everyday, renovations not renovating, and houses not homes.

This critique draws mainly on sociological research on everyday life and social practices. A common observation relevant to both fields is that individuals do not consume energy. Rather, energy

provides useful services that enable normal and socially acceptable activities to be carried out as part of domestic life. For decades, this has been a 'blind spot' in energy efficiency research and policy [71,72]. It is the 'doings' or activities of everyday life that have consequences for energy and material consumption [73]. Most energy-intensive activities in homes are quite mundane: heating rooms, heating water for washing, running appliances to freeze food or dry clothes. Comfort, convenience, and cleanliness have become normalised expectations embedded in such activities, with significant consequences for energy use [74].

Walker [75] explain "*how the use of energy is an 'ingredient' of the doing or performing of social practices*" (p. 49). Social practices are bundles of 'sayings and doings' that are enacted or performed and so reproduced through time and space, as well as socially [76]. Practices such as cooking, washing, or DIY (do-it-yourself), are the relevant objects of enquiry in this line of research; people are 'recruited' by such practices as part of their reproduction. Shove and Pantzar [77] argued that practices are constituted by three elements and their inter-relationships. These three elements are competences, meanings, and products. Gram-Hanssen [76] included institutionalised knowledge and explicit rules as a fourth element of practice. These elements of practice have been applied in empirical studies of renovating and how it intersects with everyday life at home [78,79,80]. Judson and Maller [81], for example, find that energy efficient aspects of renovation are considered by households in relation to other practices performed in daily routines, such as dining, socialising and entertaining.

We build on these insights into everyday life, practices, and homes to argue that applied behavioural research on energy efficiency has five conceptual and empirical limitations. We also include two methodological limitations related to framing and sampling bias.

### 3.1. Limitations (1): priming biases and financial variables

Research designs in applied behavioural research on energy efficiency that frame the problem in terms of 'drivers and barriers' strongly prime attention to the financial characteristics of renovations. Closed-ended survey methods invariably solicit perceptions or understandings of cost, cost savings, energy prices, payback periods and rates of time preference [54,57,58,14]. Directly asking about specific barriers strongly increases the likelihood that these barriers will be identified as influential.

Open-ended research helps draw out a much wider set of considerations in renovation decisions (e.g., [28,37]). But qualitative factors are often then lost in quantitative decision models or reduced to terms shorn of meaning and context, as in the use of air quality as a measure of comfort [12].

As a further example, the importance of building appearance or home aesthetics as influences on renovation decisions has been found in studies designed to test for it [82,83]. Yet aesthetics are infrequently included in closed-ended research instruments. In their extensive review of energy-related behaviours, Whitmarsh et al. [13] conclude: "When people refurbish their homes they invariably want to *see* the results of their *investments*" (p. 105, *our emphasis*). Even here though, renovations are still framed as investments and so overtly financial.

### 3.2. Limitations (2): sampling biases and decisions as events

Applied behavioural research on energy efficiency represents renovation decisions statically as a discrete event or point in time with a characteristic set of influences (see Table 1). Treating decisions as singular moments, undertaken by an individual or discrete set of actors, is also common in research on homes and housing more generally [84,85].

Energy efficient renovation decisions are often protracted [86]. Renovations are more commonly a periodic or ongoing feature of domestic life rather than a one-off event [87]. Decision influences and perceived barriers change as renovation intentions strengthen and are ultimately realised [82]. This means that survey or interview research findings will be influenced by *when* during the decision process households are sampled, particularly when comparing pre-renovation expectations with post-renovation experiences [88]. As an example, homeowners are more likely to cite building appearance as an important motivation prior to renovating, but retrospectively emphasise thermal comfort and energy savings [83]. Renovation decisions have a tendency to be rationalised after the fact (see [89] for a broader discussion of post hoc rationalisation).

Sampling design therefore influences research findings. Applied behavioural research that draws on self-selecting samples of would-be renovators or successfully completed renovators is particularly susceptible to bias (e.g., [90,34]). This includes studies of households participating in incentivised renovation programmes or policy trials (e.g., [91,47]). Including a 'control group' of non-renovators for comparison is a simple methodological remedy yet is uncommon in research designs.

### 3.3. Limitations (3): decision makers or individuals not households

The household has been recognised as an important scale of enquiry for examining environmental behaviour [92] and, more broadly, the transformation of cities and the built environment [93]. Observed renovation behaviour in markets, field trials, or intervention studies directly measures household-level decision outcomes. As the subjects of a decision process, households are seen as functional, operational units [94]. The UK Government's statistical service defines a household primarily as a bounded physical construction: "*one person living alone or a group of people (not necessarily related) living at the same address who share cooking facilities and share a living room or sitting room or dining area*" [95].

Applied behavioural research on energy efficiency frequently uses the term 'household', but households are neither defined nor identified empirically in a consistent way [96]. Renovation decision makers subject to personal influences tend to be individuals, albeit in a household context (see Table 1). Self-report data from individual household members are commonly generalised to the household as a whole. Even approaches that explicitly characterise decision-making differences between households recognise that a household may itself comprise more than one type of decision maker with distinct goals and aspirations [97].

Decision making can be interpreted at the household level measured through proxy variables such as household lifecycle or size. The number, age, gender, income and relationships of household occupants can also be used to create meaningful socio-cultural units for analysis [98]. Applied behavioural research rarely accounts for the possibility of distinctive households nor differentiated roles within the household [99].

### 3.4. Limitations (4): efficiency measures not home improvements

Applied behavioural research on energy efficiency generally excludes amenity renovations (e.g., kitchens, bathrooms) and other types of home improvement including DIY that may be carried out together with efficiency measures. Energy efficient renovation decisions are treated as distinctive, with their own characteristic set of drivers, barriers and influences (Table 1), and unrelated

to other decisions households might make with respect to their homes.

Yet seeing efficiency renovations as distinctive serves to decontextualize them. In the UK, efficiency measures are three times more likely to be included as part of broader amenity-based home improvement projects than considered alone; only one in ten would-be renovators are considering only efficiency measures [86]. In the US, renovation expenditure on amenity features of the home, particularly kitchens, is over five times that spent on energy-related measures [100]. Judson and Maller [81] found that efficiency measures in one part of the home often went hand-in-hand with expansions or intensifications of other parts of the home (e.g., additional bathrooms). Mainstream marketing messages on home renovations promote amenity not efficiency measures [101].

### 3.5. Limitations (5): extra-ordinary events not everyday domestic life

Analysing efficiency renovations as one-off, extra-ordinary events detaches decisions from everyday domestic life and weakens links to households' lived experience (p. 217, [72]). Thermally insulated walls and windows, and efficient heating systems, provide a range of useful services that enable everyday activities to be carried out in the home. Households' needs and expectations for these services evolve. Moving home is one way of adapting homes to households' evolving needs [59]. Renovating energy efficiently is another way.

Consequently, renovation decisions need to be understood "*in the context of the relations between everyday practices and the environments within which these practices unfold*" (p. 2802, [85]). Features of these decision environments, such as household and property characteristics, should not be treated as exogenous influences on renovation decisions but part of them. Renovation activity is situated in the home; decisions to renovate unfold as part of life at home [102]. The ultimate reasons why people might decide to redesign or structurally change a particular part of their domestic environment lies in these conditions of everyday domestic life. Energy efficient renovations are "*not an activity of changing a house . . . from poor energy performance to exceptional energy performance, but an intervention into the rhythms of domestic habitation*." (p. 569, [78]). These rhythms of domestic habitation are not adequately captured by the decision influences shown in Table 1.

### 3.6. Limitations (6): renovations not renovating

Energy efficient renovations support policy objectives to reduce household energy use and its adverse consequences. Homeowners' renovation decisions are the necessary precursor to the installation of efficiency measures, and so are of interest to applied behavioural researchers. This instrumental emphasis on cognition and physical change glosses over important relationships between the objects, skills and actions of renovating.

Renovation measures – energy efficient or otherwise – are objects that facilitate and constitute particular ways of living [103]. Kitchen renovations that result in 'having' a new kitchen are part of the shifting materiality of the kitchen space with its changed cupboards, sink and spice racks [104]. DIY (do-it-yourself) activities are an integral part of renovation processes, and clearly involve skills as well as objects. Even mundane objects such as a hammer enable particular 'doings' when used by a skilled practitioner [105]. Without object, skill, and practitioner, there would be no renovation activity.

Examining objects and skills in motion – the 'havings' and 'doings' of renovating households – diffuses a narrow focus on the specifics of renovat*ions* into an exploration of renovat*ing* as an everyday, even routine activity [103]. Renovating can thus be understood as a social practice constituted by four elements: skills, materials, rules, and shared understandings [76,81]. These elements interact through the reproduction of renovating as practice. Home improvement activities to change the structural features of a home involve skills and objects in processes of replication, continuation, and alteration – what's been done before, how that is ongoing, and how that is tinkered with or adapted [106]. Through this lens, discrete renovat*ions* need to be examined as part of renovat*ing*.

### 3.7. Limitations (7): houses not homes

Applied behavioural research on energy efficiency emphasises physical and structural changes to the fabric or energy systems of a property, house or dwelling. But the notion of 'home' extends far beyond the physicality of the house. House and household are certainly components of home, but so too are more complex social and emotional relationships [107]. Homes are both a physical space and an imaginary place which is not a static construct or representation but a dynamic expression of household members' feeling towards it (p. 230, [108]).

Household members ascribe meanings to their homes when thinking through changes made to the physical house. Aune [109] identifies three clusters of meaning relevant to energy efficient renovations: 'home as a project'; 'home as a haven'; and 'home as an arena for activities'. These various meanings are neither exclusive nor fixed. Rather they emphasise how households' emotional and symbolic connections with their homes impact on their expectations of comfort and associated homemaking activities.

The home is not therefore a neutral backdrop against which the enactment of domestic life can be examined. Spaces in the home like the kitchen, which are a locus or focus of household activity, can be strongly differentiated, associated with different meanings and roles by different household members [110]. Household typically defines the number and type of people in the physically bounded space, but home is a broader term that also describes emotional and social connections with its differentiated places.

## 4. Situating renovation decisions within domestic life

In summary, applied behavioural research on energy efficient renovations, which supports and informs energy efficiency policy, is limited by its interest in:

i. *renovation decisions*, but not the processes preceding them nor the domestic context from which they emerge;
ii. *financial drivers and barriers*, but not other salient attributes of home renovations;
iii. *energy efficiency measures*, but not other types of amenity renovation and improvements to the home;
iv. *households as discrete units of measurement and function*, but not differentiated entities with multiple decision makers;
v. *houses as physical structures*, but not homes with different spaces imbued with meaning and emotional significance; and
vi. *renovations as physical changes*, but not as enactments of renovating, an everyday activity involving objects, skills, and shared understandings.

These limitations of applied behavioural research on energy efficiency result in a narrowly defined problem and so a restricted set of explanations and influences for energy efficiency policy to act on (see Table 1). Yet an explicit representation of renovation decisions

is important because they are the direct antecedent to efficiency improvements in owner-occupied homes.

Situating an applied understanding of renovation decisions within a broader conceptualisation of homes, households and domestic life would help address some of the limitations of applied behavioural research while retaining its tractability.

A situated approach to renovation decision making has three key features. First, renovation decisions are processes. Second, these decision processes emerge from, and take place within, the conditions of everyday domestic life. Third, influences on renovation decision processes vary in their immediacy.

Situating decision processes within the conditions of domestic life emphasises the ultimate influences that originate and shape the decision process in its entirety. Guy and Shove [19] argue that "*more or less energy efficient choices are made in response to changing opportunities and pressures . . . knowledgeable actors creatively adopt and adapt strategies and practices that suit their changing circumstances*" (p. 133). Renovating is a way for households to resolve pressures, tensions or imbalances as well as to seize opportunities, pursue goals, or follow aspirations. Certain conditions of domestic life describe these deeper antecedents to isolable renovation decisions. As examples, renovation decisions may originate: (1) in household members' competing needs for the use of different spaces within the home; (2) in current or anticipated difficulties in the physicality of life at home; (3) in a mismatch between the meaning of a home for its inhabitants and the social identity conveyed by the house's arrangement and design. Deciding to renovate is rooted in, and endogenous to, such conditions of domestic life.

A situated approach thus retains renovation decisions as the central object of enquiry, but makes an important distinction between exogenous, isolable influences (both personal and contextual) from those influences which are deeper, constitutive elements of renovating.

This distinction helps navigate between the polarised perspectives of applied behavioural research on energy efficiency and its sociological critique. The former is more focused on immediate and proximate influences, the latter on ultimate influences (though neither exclusively so). Distinguishing levels of influence and causation in this way is common in both behavioural and sociological research (see Box 2).

For energy efficient renovation decisions, proximate influences explain what renovation decisions are made and how (e.g., with what products, at what cost, with which contractor). Ultimate influences explain why homeowners are deciding about renovating in the first place. Proximate influences act on renovation intentions once formed; ultimate influences explain the initial formation of intentions.

A boiler breakdown is an example of a proximate influence on a renovation decision. The recommended models and costs of replacement boilers offered by an emergency callout contractor are corresponding examples of immediate influences. The role of the boiler in providing thermal comfort, differentiating the use of rooms and spaces, and enabling patterns of social activity in the home, are all examples of ultimate influences.

Table 2 provides further illustrative examples of immediate, proximate, and ultimate influences on renovation decisions. The upper rows draw on applied behavioural research on energy efficiency (Section 2) and more strongly characterise immediate and proximate influences (though not exclusively so). Drivers and barriers from Table 1 are related to the attributes, personal influences and contextual influences shown in Table 2. Taking 'Personal Influences' as an example, energy-saving motivations influence the final selection of renovation products, and beliefs and awareness of environmental issues orients renovation decisions towards efficiency measures. But previous experiences, embedded in the skills and knowledge of householders, may increase the salience of efficiency renovations as a potential way to meet aspirational goals.

**Box 2: Proximate and ultimate influences.**

Proximate influences are closer to an observable outcome; immediate influences are closer still, e.g., at the point of decision. Ultimate influences characterise the underlying reasons why the outcome was observable.

The distinction between proximate and ultimate causation was first developed in evolutionary biology [123]. Ultimate causes explain observable behavioural traits in terms of evolutionary forces whereas proximate causes explain traits in terms of physiological or environmental conditions. Explanations of altruism, for example, draw on both proximate influences (e.g., empathy) and their deeper ultimate influences (e.g., kinship and natural selection) [124,125].

The same basic distinction between ultimate and proximate influences has been applied in psychology [126], public health [127] as well as sociology, albeit using different terminology. In sociology, proximal and distal causation distinguish individual-level or interpersonal influences on human behaviour from influences which are written in to the broader context in which behaviour is observed (e.g., [128]). Using a social practices perspective on renovating as an example, the ultimate (or distal) influences on renovation decisions are inscribed into the relationships between competences, meanings, products, and rules which constitute renovating practices.

The lower rows of Table 2 draw on the sociology of everyday domestic life (Section 3) and more strongly characterise ultimate influences (though not exclusively so). Taking 'Homes as Emotional and Social Places' as an example, renovating is an adaptive response to perceived misalignments between the physical characteristics of a house and the meanings of a home to its inhabitants. But these meanings may also be articulated in specific, measurable objectives for improving thermal comfort (shaping discussions over what to renovate) as well as in aesthetic criteria for selecting renovation products.

## 5. From research into energy efficiency policy

*Ex post* evaluations of energy efficiency policies tend to show very mixed evidence about their effectiveness [111]. Thirty years of experience in the US has provided only limited evidence that homeowners can be reliably motivated to renovate [62]. Energy saving potentials that have been touted for decades have not been delivered.

Financial incentives tend to be attractive to homeowners only once they are already committed to renovating [112,113]. Uptake of capital financing mechanisms is often low [38]. This has certainly been the case for the Green Deal scheme introduced recently in the UK. In the period January 2013 to October 2014, only 7200 households had third party financing plans offered or accepted, although 390,000 households had received a Green Deal energy assessment [114].

Energy assessments or audits do not necessarily lead to renovation decisions. Audit recommendations are often ignored as they mainly confirm what households already know, and homeowners consider their homes to be adequately efficient already [115,64]. Dropout rates from both audit and financing programmes can be high, even if financial incentives are sizeable [5].

Even in Germany, considered a market leader, a combination of regulation, subsidy programmes, and information instruments for motivating homeowners to renovate energy efficiently have delivered annual renovation rates that are only half those expected in

**Table 2**
Examples of immediate, proximate and ultimate influences on energy efficient renovation decisions.

| | Immediate influences (informing or influencing point of decision – e.g., *which renovation products?*) | Proximate influences (strengthening or shaping decision intentions – e.g., *how and what to renovate?*) | Ultimate influences (originating or explaining emergence of decision process–e.g., *why renovate?*) |
|---|---|---|---|
| Attributes of efficiency renovations | Financing options | Energy savings | Experience of previously installed measures |
| Personal influences | Energy saving motivations | Awareness of energy/environment issues | Stage of life course |
| Contextual influences | Emergency repair | Age of property | Physicality of ageing |
| Differentiated households | Risk-aversion of financial decision maker | Competing opinions on preferred renovations | Roles and relationships within household dynamics |
| Amenity home improvements | Financing package | Contractor skill set and industry relationships | Conditions of domestic life creating tensions |
| Renovating and everyday domestic life | Renovation industry marketing and advertising | Habits and routines | Objects and skills used in DIY activities |
| Homes as emotional and social places | Aesthetics of renovation measures | Environmental and comfort objectives | Meanings of home |

the absence of any policy [116]. "*A tremendous potential*" for energy savings in owner-occupied housing still remains (p. 406, [34]).

Decision influences identified by applied behavioural research provide the levers that energy efficiency policy seeks to push and pull. The understanding shared by policymakers and practitioners of how energy efficiency can and should be improved is deeply institutionalised, and continually reproduces similar portfolios of policies. One result is that "*residential energy efficiency policy discourse and supporting analysis must be conducted in a highly coded vocabulary . . . applied to energy consumers*" (p. 146, [16]). The decision influences summarised in Table 1 are all part of this vocabulary.

The limited effectiveness of energy efficiency policies can be explained in part by the methodological, conceptual and empirical limitations of supporting analysis. In particular, applied behavioural research on energy efficiency focuses on the proximate influences on renovation intentions, but largely fails to engage with the ultimate influences on renovation decisions which are situated in everyday domestic life.

As Gram-Hanssen [117] argues, what homeowners need is "*practical advice about retrofit options that relates to everyday life*" (p. 395). Judson and Maller [81] similarly conclude that "*policies to reduce the environmental impact of housing should be reframed around and positioned to address the mundane practices of everyday life*" (p. 501). But just how these arguments inform policy strategies is "*more difficult*", and requires an examination of people's life circumstances and sources of constraint and influence on energy consumption (Table 2 in [15]).

A situated approach to renovation decision making addresses this challenge by distinguishing ultimate influences, manifest in certain conditions of domestic life, from proximate influences on decision intentions once formed. Proximate influences still provide policy with potential levers to reinforce personal and contextual influences on decisions [34], and to lower the financial, information, and decision-making barriers to renovating [4].

But the ultimate influences on renovation decisions open up opportunities for creative policy approaches aimed at homeowners not considering energy efficient renovations, as well as those who already have renovation intentions. This can be illustrated by way of three recommendations for policymakers, renovation contractors, and researchers.

First, policy could support the 'bundling' of efficiency measures into other types of home renovation rather than try and stimulate efficiency-only renovations in a narrow market segment of committed efficiency renovators. This recognises that renovations are predominantly about adapting and improving the amenity features of a home [81,113].

Second, contractors could build and manage personal, trusted relationships over often lengthy time periods to support homeowners through periodic, successive, or ongoing renovations. Energy efficient renovations are rarely one-off [87], but the renovation industry still manages customer relationships on the basis of one-off sales and installations. Persistence and consistency are valuable, both by contractors towards homeowners, and by policymakers towards contractors [62].

Third, researchers could identify specific conditions of domestic life associated with renovation activity, both DIY as well as contractor-led. Examples of such conditions include competing commitments over the use of space at home, problems with the physicality of domestic life, or issues with how homes reflect or express identity. If these or other conditions are observable by proxy, they could be used to evaluate homeowners' renovation propensities, identify market segments of potential renovators, and develop analytical models that include ultimate influences on renovation decisions.

## 6. Conclusions

The widespread diffusion of energy efficiency measures through the existing housing stock is an important public policy objective. A wealth of policies, regulations, incentives, and other interventions have been introduced to stimulate and support this diffusion over the past four decades [118,78]. Yet despite all these inducements, instructions, prompts and prods, homeowners remain stubbornly resistant to improving their homes' energy efficiency by making structural changes to their heating systems, walls, windows, doors, lofts and basements.

The aim of this paper was to show how the body of research on which energy efficiency policies are based can be situated within a broader conceptualisation of renovating and domestic life. This strengthens understanding of the ultimate reasons why homeowners decide to renovate energy efficiently.

Applied behavioural research into energy efficient renovations understands renovation decisions in terms of drivers and barriers. A range of personal and contextual variables explain why homeowners may be motivated to renovate and why these motivations may be thwarted. Each explanatory variable presents a lever or opportunity for policy to exert influence.

Although applied behavioural research on energy efficiency speaks directly to policy concerns, it also has limitations. Methodological limitations include a reliance on stated preference data drawn from potentially biased samples and a strongly financial framing of renovation decisions. These limitations can be

addressed through research designs that include control groups of non-renovators, that sample renovators at different stages of the renovation decision process, and that use open-ended methods to inform a less constrictive scope of closed-ended questions for studies with larger sample sizes.

Conceptual and empirical limitations of applied behavioural research on energy efficiency are all associated with an overly narrow problem definition or scope of enquiry. Energy efficient renovations are implicitly conceptualised as a distinctive type of physical change made to houses as the outcome of a decision by a unitary household decision maker. This conceptualisation is challenged by sociological research into everyday life at home. From this perspective, energy efficient renovations are not inherently distinctive nor unique, and should not be partitioned off from other types of home improvement, large or small, with which households are continually engaging as part of the restlessness and motion of domestic life. Nor should the physical structure of houses be shorn away from the strongly social, symbolic and emotional connections of homes, as ultimately it is these homes that are being changed.

Situating energy efficient renovations within a broader understanding of why homeowners decide to renovate their homes means moving beyond immediate and proximate influences to the deeper, ultimate influences that explain the emergence of renovation decisions. Distinguishing these levels of causation allows for both applied behavioural research on energy efficiency and sociological research on domestic life to be drawn on by policymakers and practitioners concerned with energy efficient renovations.

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