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Original research article

Landlords' accounts of retrofit: A relational approach in the private rented sector in England

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ABSTRACT

Climate change commitments and the current global energy and living cost crises require investment into energy efficiency in buildings. With one of the oldest housing stocks in Europe, the energy intensity of buildings in the United Kingdom remains high compared to other countries. The adoption of energy retrofit measures can support tackling several social, economic, and environmental objectives. Scarce uptake of these is particularly evident within the private rented sector, which presents additional hurdles compared to social and owner-occupied housing. We adopt an innovative theoretical and methodology approach at the intersection of new economic sociology and energy demand reduction literature to analyse the social relations of energy retrofitting in Brighton and Hove through interviews with landlords and experts in the field. A high percentage of private rented sector housing in poorly insulated and historical buildings, makes retrofitting in this area particularly challenging. Several strategies and policies have been implemented to decarbonise homes; yet have failed in framing the problem surrounding the adoption of retrofitting measures largely in economic terms. By contrast, our case study shows evidence of the 'relational' nature of a retrofitting decision-making process shaped by landlords' identities and networks of relations among and within retrofit actors; this could support tailoring more efficient policies. Place-related assets, institutional landscape, climate and built environment specificities are also critical. We are recommending more efficient strategies at the central level that allow for place specific policies; these should account for local features and relational approaches to overcome challenges to retrofit within the sector.

1. Introduction

The current energy crisis is accelerating calls for urgent action on energy efficiency in homes. The United Kingdom's (UK) built environment is accountable for 25 % of the UK's greenhouse gas (GHG) emissions [1]. The UK housing stock is among the oldest in Europe with 20 % of stock built before 1919 [1], and with overall poor performance on energy efficiency [2]. With record high energy prices, 13 % of households in England, 25 % in Scotland, 14 % in Wales, and 24 % in Northern Ireland are classed as fuel poor [3]. Despite this, home energy retrofit rates remain low [4].

The problem is exacerbated in the private rented sector (PRS) by a series of challenges and lack of drivers for landlords to invest in home energy efficiency upgrades; while homeowners directly benefit from improvements, it is tenants who enjoy increased thermal comfort and lower energy bills from energy efficient measures. Among other aspects that will be explored in following sections, 'split incentives' mean that landlords do not directly benefit from improvements in the rented property [5,6] - known as the 'principal-agent' problem - where landlords have scarce economic incentives to retrofit since most tenants won't pay a premium for retrofitted properties [7]. These can manifest in material property differences and lower energy efficiency rates compared to those in owner occupied properties [5]. Additionally, policy, regulations and housing market dynamics might further

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constrain the uptake of retrofit measures by landlords [8, forthcoming]. Although the theory of the 'split incentive' has being prevailing into framing energy efficiency within the PRS, it does not account for other factors influencing landlords' decision-making process [9,10]. The rationale behind focusing on the PRS lies on the specific power dimension of landlords as decision makers. Further conceptualisation is required to account for other aspects shaping these processes [11] as our research shows [12–14; in review].

Socio-demographic (e.g., landlords' gender), property management (e.g., inherited property) and individual (e.g., mistrust towards tradespeople) factors, also inhibit landlords' decision-making towards retrofitting. These compounding issues have created a situation where energy retrofit levels in the PRS are far below those needed to address issues of energy poverty for the most vulnerable, and to meet UK carbon targets.

Retrofitting the existing housing stock can address several social, economic, and environmental objectives, such as reducing carbon emissions, tackling fuel poverty, and stimulating employment [15,16]. However, retrofit incentives remain a critical challenge. There is a history of failed policy measures to foster retrofitting in the UK [17]. As a result, household demand remains low [18,19]. For example, the cost of installing an air source heat pump (ASHP), while falling, is much higher than that for gas boilers [12], contributing to low household demand for these systems. On the one hand, the Scottish Government is proposing that all buildings should achieve an Energy Performance Certificate (EPC) E or better by 2033 and pushing for zero emissions heating systems by 2045 [20] (forthcoming).[1] On the other hand, the UK has one of the least developed heat pump markets in Europe and has recently withdrawn the Renewable Heat Incentive (RHI) [22]. An example of effective policy has been the Feed In Tariff (FIT) for solar PV (2015–2019) [22] (forthcoming); yet the new Boiler Upgrade Scheme has seen relatively little endorsement [23]. Further, research on retrofitting mainly focuses on owner-occupied properties [24], with relatively little work on energy retrofitting in the PRS. Likewise, until recently there has been a policy gap regarding retrofit policies or programmes aimed specifically at the PRS [25].

This study contributes to an understanding of what factors influence landlords' retrofitting decision-making process, as unpacked in Tables 1–2. Local context, or place, is also critical in understanding retrofit patterns, as place-specific aspects, such as building characteristics and local assets, shape retrofit needs, opportunities and barriers [26,27]. For example, in Brighton and Hove (B&H) in the UK, the location of our empirical work, a high percentage of PRS housing is poorly insulated, while historical buildings make retrofitting additionally challenging [28].

Design for retrofit policy in the UK, encompassing both the PRS and owner-occupied properties, has often provided one-size-fits-all, retrofit solutions, which anticipate rational responses such as tax breaks or subsidy schemes [15,29]. However, the UK's population and their needs are clearly heterogeneous [15,29]. Rational choice behavioural models, such as those that underpinned the UK Green Deal, and Green Homes Grant, assume that homeowners will take rational and financially driven decisions and invest in thermal and energy efficiency if these are economically attractive [30].[2] They do not consider other factors that also affect behaviours, such as context and social networks of relations [33,34]. In practice, people's decision-making in relation to retrofitting is more complex than rational choices driven by seeking out cost-effective economic opportunities [12,13,15]. As a result, whilst there has been some progress on retrofitting, programmes to date have proved unable to incentivise private investments in retrofitting on the scale required to meet the UK's climate commitments [35]. The Energy Companies Obligation (ECO) scheme has been operating since 2013, is now in its fourth iteration and changed its scope from that of promoting the installation of deep and expensive retrofit measures, to that of supporting low-income households living in energy poor households [36] Through the years, the scheme shrunk its scope with high dropout rate [37; forthcoming].

Table 1
Landlord inhibiting factors to retrofitting.

Category	Factor
Socio-demographic factors	Older landlord (e.g., due to risk aversion) [9]; ethnicity [56]; and gender [57]
Individual-psychological factors	Energy retrofit is not a priority [58]
	No personal benefits [59]
	Belief that retrofit will not enhance the property financial value [60]
	Belief that no improvement is needed [60]
	Scarce understanding or interest about the environment [60]
	Concern about aesthetics of retrofit [11]
	Mistrust towards energy suppliers, governments, and tradespeople [10]
	Quality assurance [62]
Situational factors	Perception that government schemes are difficult to access [63]
	Lack of awareness of subsidies [51]
	Poor energy efficiency standards [51]
	Property market-rent control [64]
Financial	High retrofit cost and finite capital [35]
	Long payback periods [11]
	Interruptions/risks in retrofit operations [65]
	Future maintenance expenses [9]
Knowledge/information	Lack of knowledge and information [10]
	Lack information on technical aspects of retrofitting [65]
	Lack of awareness of subsidies [65]
	Tradespeople capabilities [66]
Technical	Lack of information on technical aspects of retrofitting [67]
	Lack of building information [65]
	Physical condition of the property [51]
	Risk of property damage [9]
	Highly complex designs, analysis and solutions [66]
Timing	Disruption and time constraints [9]
	Interruptions/risks in retrofit operations [65]
	Intention to sell the property [61]
Location/place	Property location [24]
	Energy efficiency measures could affect the neighbourhood [24]
Property management	Professional manager [62]
	Inherited property [9]
Tenant-related	Assumption that energy saving and efficiency are tenant's responsibility [51]

Source: Authors.

An emerging literature on retrofit is drawing on the 'network-based' method from economic sociology of evaluating economic action to explain how and in what ways social relations shape economic life [13,14,38]. This perspective seeks to better explain and predict behaviour by arguing that all exchanges, commercial or otherwise, are mediated by the social relations that accompany them [39]. For example, in the context of retrofit, decisions about home improvements are often influenced by relationships with individual contractors who may have advice or opinions on different building materials, technologies, or cost implications [40]. In the PRS, this network of relationships is unique in that it also includes complex and often very unequal relationships between tenants and landlords [24].

Based on these conceptualisations, this paper investigates what social relations are critical to landlords' decision-making process towards retrofitting, and how they influence the retrofitting process. The paper answers these questions through empirical work focused on landlords in the City of B&H, in the UK.

The paper is structured as follows; Section 2 presents the specificities

[1] An EPC "gives a property an energy efficiency rating from A (most efficient) to G (least efficient) and is valid for 10 years" [21].

[2] The Green Deal and the Green Homes Grant are schemes funded by the UK Government to encourage home energy-saving improvements [31,32].

Table 2
Incentives for retrofitting by landlords.

Category	Factor
Individual-psychological factors	Reputation enhancement [17]
	Social responsibility [11]
	Emotional attachment [67]
	Influence of family and friends [59]
	Personal interest in building and renovation [7]
	Improved quality and comfort of indoor environment [68,69]
	Diminishing pollution and GHGs emissions [24]
	Preserving limited natural resources [71]
Situational factors	Energy efficiency regulations [59]
Financial	Increased property value [67]
	Higher rent [67]
	Increased longevity of the property [70]
	Energy bills paid by the landlord (where relevant) [71]
	Subsidies/tax return [11]
	Risks reduction [72]
Tenant-related	Tenant wellbeing-occupier satisfaction and comfort enhancement [73]
	Relationship with tenant [60]
	Tenant demand for retrofitting/energy efficiency [60]
	Financial returns in meeting tenants' needs for tenancy longevity [11]
Others	Aesthetics and habitability [44]
	General property upgrades which include energy efficiency [50]

Source: Authors.

of retrofitting within the PRS and introduces the conceptual framework; Section 3 presents the research design and methods adopted and the case-study area; Section 4 analyses the findings; and Section 5 situates the main findings within energy efficiency literature. Section 6 reflects on the relevance of a relational conceptual model for retrofitting within the PRS field, discussing policy implications and future research.

2. Energy efficiency in the PRS

Internationally, around a quarter of total final energy consumption (e.g., energy utilised by households at point of use) can be credited to the domestic sector [40,41]. Ending dependence on fossil fuels, and climate change mitigation are key drivers for energy retrofitting policy, together with measures to address energy poverty. A few authors also mention the need for "policies that directly shape housing quality and tenure, such as tenancy laws and energy efficiency policies, [because] the provision and quality of rental housing is influenced by social and regulatory institutions such as the structure of finance systems, industrial relations, and taxation provisions" [11:3, 42–44].

Energy efficiency in the PRS is lower than that in owner-occupied homes across several countries in Europe, Australasia and North America [11]. Many governments, including the UK's, have developed policies targeting energy efficiency at the domestic level; however, there is scarce uptake of retrofit measures by landlords, and small-scale private landlords are particularly difficult to engage with [11,45]. Rugg and Rhodes [46] argue that there is the need for an extended definition of landlords; suggesting that this should include "'episodic' or temporary landlords who are letting largely as a consequence of a life course events; pension plan landlords, looking for a long-term letting arrangement and income for retirement; portfolio landlords actively building their holding of lettings; and divesting landlords, who are seeking to 'retire' from landlordism and are looking to sell certainly in the medium term" [46:2]. The distinction between different types of landlords is important because it affects their willingness to invest in energy efficiency, depending on whether they understand their role as businesses and establish a long-term plan for their rented property or properties, or whether they view their situation as temporary.

Energy efficiency in the PRS is strongly linked to issues of housing conditions standards. In Scotland there is the Repairing Standard Housing (Scotland) Act 2006, which, since March 2024, poses a duty on landlords to comply with prescribed guidance on installation and supply of gas and electricity in the PRS and fixed heating system [47]. In Wales, the new renting homes law includes an obligation of 'fitness for human habitation' for privately rented properties [48]. It remains to see whether landlords are going to comply. In England, privately rented properties are the least likely to comply with the Decent Home Standards [25,49]. Additionally, a quarter (23 %) of the landlords and agents surveyed in the National Survey indicated having properties with an EPC rating of E, F or G, despite E being the minimum standard, while 15 % stated not knowing the EPC rating of their property or properties [50]. 'Poor conditions' have been a recurring and prevalent theme in the PRS literature [51]. This poses several challenges since the PRS is a wide and growing housing supplier, with private landlords representing about 20 % of the housing stock in the UK, and with predictions of further increase of 227,000 per year to accommodate growing tenure needs [11,49,52,53].

Domestic energy efficiency consists of efficiency improvements in space heating, lighting and appliances, water heating and cooking [54]. Insulation, a core efficiency measure, includes cavity or solid wall insulation, floor and loft insulation and door and glazing improvements. Around 23 % of English households still have single glazing and 52 % have uninsulated cavity or solid wall insulation [55]. In the PRS, figures show even lower uptake of energy efficiency measures compared to homeowner and social housing dwellings. Older gas boilers dominate. Amid dwellings with solid walls, only 10 % of have solid wall insulation, while among dwellings with cavity walls, the PRS has a lower percentage of dwellings with cavity insulation (61 %) than other occupancies (71 % of owner-occupied dwellings and 77 % of social rented dwellings) [55].

2.1. Inhibiting factors and drivers for retrofit in the PRS

Lang et al. [11] distinguish between factors influencing decision-making for energy retrofitting: individual socio-demographic factors (e.g., gender, age, household characteristics, number of properties); individual-psychological factors (e.g., personal values, environmental concerns, and household norms); and, situational factors (e.g., socio-cultural norms and traditions, laws, policies and regulations). Table 1 summarises and categorises critical inhibiting factors to the adoption of retrofitting measures.

The involvement of different actors, such as tradespeople or property managers can make retrofitting complicated; März [9] refers to the "organisational burden" of retrofitting [11]. These are critical inhibiting and often intersectional factors influencing landlords' adoption of retrofitting measures [25,59]. Liu et al. [23] found the property location and whether energy efficiency measures would affect the neighbourhood as influencing factors. Rental property management can also be complex, for instance, when dealt by intermediaries such as professional property managers (e.g., [61]), or by descendants of previous landlords (e.g., [9]). Further, there might be tenant-related concerns, such as the assumption that energy saving, and efficiency are the tenant's responsibility [50]. Landlords' decision-making is also influenced by intersectional concerns over anticipated benefits or opportunities related to the adoption of retrofitting measures (e.g., [24]). Table 2 summarises key incentives for retrofitting.

Research and policy often assume that once the identified challenges are overcome, uptake of energy efficiency measures will increase [33]. However, this does not match empirical evidence [12]. In practice, individuals' decision making is not always rational and driven by financial factors; the social context where energy retrofitting occurs is a critical element of the decision-making process. Better understanding of social factors may offer a better understanding of retrofit decision-making processes. Section four discusses incentives and inhibiting factors, as described in Tables 1 and 2, encountered by the interviewees.

2.2. Relational approaches to retrofitting

There has been limited research on how decisions over renovation and retrofits within the PRS are made. For example, psychology perspectives (e.g., [71]) explore internal values, attitudes and behaviours; social practice theory (e.g., [74]) investigates habits and daily routines, and micro-economics places emphasis on rational decision-making focusing on monetary benefits (e.g., [24,75]). However, these approaches fail to consider that landlords are not a homogeneous group and that their decisions are also shaped by, for example, their identity, networks of social relations, and the context in which renovation/retrofit improvements occur. Several authors (e.g., [11,24]) have indicated relational inhibitors or drivers as influencing decision-making for retrofitting; this paper unpacks them directly by uncovering how these networks of social relations shape landlords' experiences.

People's position, i.e., the role that they perform in society; condition, i.e., their material and personal circumstances; and, their family and communities, i.e., the groups they belong to in society and influence their choices, are all important. Addressing concerns related to energy demand requires recognising that people are not isolated entities, and that energy consumption happens within households, workspaces and communities framed by intersected networks of social relations [34].

Zelizer [76–78] conceptualises relational approaches in economic sociology arguing that personal/intimate and social interactions influence the way in which money, and hence markets, work, and the meaning attributed to money and people's attitudes towards it in their everyday lives. In Zelizer's view, economy and society should not be considered as separate 'hostile worlds' [77,79,80]. Instead, money, as object, and intimacy, as subject, are connected, and this connection is shaped by the exchange of money and goods. Relational work is the process by which people attribute value to their interactions and define expectations. The ways in which money is obtained (by whom and for what purposes) and interpreted (e.g., as a gift, payment, or entitlement) affects its potential uses in achieving a variety of outcomes [81]. The application of relational work to the energy field is new and supports understanding people's interactions about retrofit within a specific context, and the related retrofit outcomes, which are moulded by social relations [14; in review].

Building on Zelizer's conceptualisation, Hargreaves and Middlemiss [34] distinguish between 'micro' social relationships, such as those with family, friends and communities, and 'macro' social relationships, including those of class, gender, and religion, which intertwine in people's lives. In particular, they identify three types of social relations as critical in influencing people's use and engagement with energy: relationships of identity, with family and friends, and with agencies and communities. Their categorisation supports an understanding of the extent to which, and how, social relations influence retrofit decision-making and is used as a framework to analyse our data on landlords and retrofits.

People's identities inform the way they see themselves and others and their interaction with family, friends, communities, and agencies, and influence energy demand [34]. Relations associated with identity can be shaped by people's membership of wide social categories (e.g., race, ethnicity, and gender), or through membership of a specific household type (e.g., single person household, single/two parent family). People's roles, responsibilities and relationships affect energy needs and practices. Identities are interrelated, overlapping, and heterogeneous, meaning that people's affiliation with a particular category does not imply homogenisation within that category [82]. Societal expectations on how those roles and responsibilities should be performed within the family, community and at a broader scale, and people's understanding of their own identities shape energy demand and interventions by policymakers. Policy on domestic energy use and consumption has often treated the household as a homogeneous unit of analysis and as a place of individual behaviour [34]. This approach has been criticised since households are complex webs of everyday practices, including negotiation processes within power relations, and bonds with family and friends. These routines and relationships are interrelated, evolve over time, and affect energy use and demand. Particularly relevant to the PRS are issues of power asymmetries between landlords and tenants that often qualify their relationship because of final control over the property, and which could prevent the adoption of energy efficiency measures [83].

Achieving net zero commitments requires efforts that are rolled out at a local scale, and thus require direct consideration of place. Relationships and interdependencies developed within a place are essential to encourage ecological and social sustainability of communities at the local level [84]. Context in its socio-economic, built and natural environment, and political aspects, as the place-specific ensemble of capabilities, capacity and knowledge, climate, building stock, infrastructure, institutions, organisations and services, financial resources and policy landscape, is a pivotal ingredient to understanding the energy retrofitting decision-making process. How relations are shaped within and by a specific context is also relevant as they can support increasing local resilience and developing a sense of place [85]. Devine-Wright (86:2) suggests that "place is relational […] drawing attention to connections and flows between places, as well as the politics of struggles to conserve or re-make places" [87]. Places are characterised by "assemblages of actors across local and non-local areas in coalitions of mutual interest both to instigate or oppose different socio-technical pathways" [86:2, 88]. Regarding the PRS, location characteristics, including building attributes, can influence decision-making towards retrofitting. For instance, a nexus has been recognised between location and rental premium, and landlords' willingness to invest in energy efficiency [89]. Relations with place are interconnected with other social relations, such as relations with agency and communities.

There is indication of barriers and opportunities to retrofit within the PRS with hints in literature regarding relational components; this paper contributes to energy retrofitting scholarship an empirical case study of retrofitting within the PRS in B&H.

3. Research design and methods

This paper presents a 'relational' case study of energy efficiency uptake by landlords within the PRS in the B&H area. The authors adopted a mixed-methods data collection approach including 20 semi-structured qualitative interviews and document analysis including UK and Brighton and Hove City Council (BHCC) governments', and local and international institutional reports (e.g., [4]). Prior to carrying out the primary data collection ethical clearance from the University's Ethical Committee was obtained. Interviewees participated on a voluntary basis. Landlords interviewed were mostly members of the Sussex Student Letting Agency at the University of Sussex where the project team was based.[3] Experts were recruited through local and national retrofit networks. Due to interviewees' logistical and time constraints, interviews were carried out on Teams or Zoom for 17 interviewees, two by phone, and one in person. In line with the code of practice for the personal data protection, interviewees have been attributed pseudonyms. Challenges to the study are represented by the small population sample, which constrains the generalisability of the data; however in-depth interviews allow broader individual reflection [90,91]. Questions in the interview topic guideline include property and renovation history, relationship with the property and the local area, relationship with actors involved in the energy efficiency renovation process (e.g., family, friends, and trades), reasons behind energy efficiency renovation, renovation finance.

[3] The SSLA was the only letting agency in Brighton set up and operated since 2012 by the University of Sussex Students' Union to offer students greater support and a better lettings experience.

3.1. Research participants and analytical framework

Interviewees include 12 experts and eight landlords whose properties are in the B&H area. Local experts are defined as professionals with expertise in the fields of energy efficiency and retrofitting, operating within the local area. The semi-structured interviews took place between December 2021 and April 2022. Tables 3 and 4 present the interviewees. Based on Rugg and Rhodes' [45] categorisation (see Section 2), interviewees include six pension-plan (Frank, Robert, Karl, Luca, Linda and John), two of which started as episodic landlords (Linda and John), and two portfolio landlords (Sarah and Patrick).

The authors carried out a thematic data analysis based on themes in social relations and domestic energy efficiency literature (as explored in Section 2) using NVivo. Key themes of categories and patterns were identified in interview transcripts. To analyse the data, the authors combined Hargreaves and Middlemiss' [34] typology of social relations affecting energy demand, with Brown et al.'s [35] themes identified in their four 'systemic' barriers (capital cost and split incentives, uncertain benefits and quality, information engagement and trust, complexity, disruption and timing) and place-specific concerns as explored in Section 2.1. The integration of place as a typology of social relations in the framework of analysis adds to Brown et al.'s [35] conceptualisation of four 'systemic' barriers and to Hargreaves and Middlemiss' [34] typology of social relations by highlighting how climate, building stock, and actors engaged in retrofit work within a place, including institutions, organisations and communities constrain or facilitate owners' decision-making towards retrofitting.

The presentation of the results in Section 4 is structured as follows: 'relations associated with social identity', 'relations with family and friends', 'relations with agencies and communities' [34] and 'relations to place'.

3.2. Brighton and Hove-case study settings

B&H is located on the south coast of England. According to recently released Census (2021) data over a third of households are privately rented [92], second only to London in the UK; this makes it a particularly interesting case to explore. B&H has seen an increase in population of 1.4 %, from around 273,400 in 2011 to 277,200 in 2021 [93]. This has affected the PRS housing market with a rise in the number of homes advertised for rent from 2013 to 2020 [94,95]. For instance, over 2019, BHCC reviewed around 12,000 homes to rent in the area listed on a UK property rental website plus around 5000 more homes in adjacent areas [94,95]. B&H hosts two universities with a significant increase in student numbers in the city over the past two decades. Allocating sufficient purpose-built student accommodation has been challenging and has required expansion in private rented accommodation [96]. Additionally, Regency, Victorian, and Edwardian building stock characterise B&H's architecture with circa 3400 listed buildings [97] with significant restrictions to the adoption of energy efficiency measures.

Table 3
Expert interviewees.

Pseudonym	Type of organisation
Karen	Third Sector/Charity/Advice for industrial, commercial and public sectors
Andy	Retrofit company
Steve	Retrofit Cooperative
Barbara	Student Representative
Mark	Local government
Greg	Third Sector/Charity/Advice for Landlords
Lucie	Local government
Kristine	Local government
Adrian	Local government
Dorothy	Local government
Anne	Local government
David	Local government

Table 4
Private landlords.

Pseudonym	Type of landlord	Number of properties
Karl	Private landlord	1
Luca	Private landlord	1
Fred	Private landlord	3
Sarah	Professional landlord	6
Robert	Private landlord	2
Patrick	Professional landlord	40+ in Greater Brighton
Linda	Private landlord	1
Neil	Private landlord	1

BHCC's vision of future development is one that seeks to reduce the ecological footprint while also driving decarbonisation [94]. As a response to the current climate crisis, the council launched in 2021 its 2030 Carbon Neutral Programme [98]. In January 2020, BHCC unanimously passed a Notice of Motion supporting a 'Green New Deal'. This plan aims to address poverty and inequalities in relation to energy, tackle climate change concerns and foster decarbonisation initiatives. Programmes include a council retrofit scheme, a Heat Decarbonisation plan, including replacement of gas boilers, and opportunities for skills and training within the retrofit sector [98]. However, the geographical and building stock characteristics, which include Grade I and II protected buildings, potentially constrain the adoption of energy efficiency measures at the domestic level. This complicated context makes B&H a suitable case-study to explore whether and how social relations shape retrofitting up taking within the PRS. BHCC has lately launched a licensing scheme for private rental properties [99,100] to improve the conditions and the management standards in privately rented houses. While the focus is on health and safety, it seems that energy efficiency is not in the picture as contributing to health and wellbeing. The sole parameter for efficiency remains that of the EPC.

4. Results

Landlords presented a variety of perspectives that addressed the paper research questions: what social relations are critical to landlords' decision-making process towards retrofitting? How do they influence the retrofitting process? Results are organised using Hargreaves and Middlemiss' [34] categories of social relations, with the additional category 'relations with place'.

4.1. Relations associated with social identity

Landlords and experts' political and professional identities, and personal experiences have been influential to the retrofitting process.

4.1.1. Experts' political identity as shaping their practice

Andy, a retrofit installer, expressed how his 'identity' as someone caring for sustainable choices in energy retrofit was perceived as something unusual and circumscribed to a specific category of people, the 'greenies'. For instance, he commented that when he was discussing energy efficiency with a colleague, his colleague said: "yes, [energy efficiency] is not for us. We use as much energy as possible to do what we do. Power tools all the way". As discussed by [24,70] (Table 2), caring for the environment and 'social identity' [34] were drivers of Andy's commitment towards retrofitting.

'Identity' and 'access to knowledge' [34] also influenced Barbara's (one of the experts) experience. She wore two hats, as a tenant and as a campaigner for a local energy efficiency campaign which also interested the university student housing. She described that her expert access to information, and knowing her rights, facilitated having some works done in her rented property. She said,

> because we [the tenants] said the right things and everything, [the landlords] actually did do the work in the summer, so it depends.

> Also, my landlord said they would be interested in having [an energy retrofit company] come and do the survey and everything.

In her opinion, some landlords would be inclined to adopt retrofit measures if campaigners could frame it as "you are going to look better compared to everybody else"; therefore, increasing their reputation [17]. This quote also reinforces the importance of 'access to information' [10] and 'technical knowledge' [62] as systemic challenges discussed in Section 2. Barbara's incident also shows her landlords' caring for the tenants' wellbeing [70].

4.1.2. *Landlords' professional identity as shaping their practice*

Both Roberto and Fred drew on their own training and education to make decisions on maintaining and upgrading their rental properties [7], as pointed in Table 2. Fred also noted using these skills to help build capacity in the tradespeople he works with: "I try to teach [about dampness in walls] to all the builders". The expert interviews further identified scarce 'capabilities' on energy efficiency among tradespeople as a critical concern for the retrofit agenda, as also discussed in literature [63].

Landlords' personal interest and professional identities shaped their willingness to retrofit. Robert, for instance, said that he likes to "keep the properties in good order". As businesses, they do maintenance works, including, for example, double glazing fitting, using the profit from the properties, in line with discussion in [64,67]. Major works, including rooftop conversion, roof and wall insulation, were done when landlords bought the properties, as pointed in [50]. For instance, talking about one of his properties, Fred said: "three years ago, we spent £130,000 just renovating it, and took it off the market for a year to put in proper central heating, underfloor insulation and things like that". He also added: "it's paying dividends because we control the temperature in the houses ourselves, in agreement with the students", reflecting on motivators on landlord/tenant relationship discussed in Table 2 [67].

4.1.3. *Landlords' personal experiences as shaping their practice*

The interlink of multiple identities and how these influenced the adoption of retrofitting measures were evident when speaking with three landlords, Robert, Fred, and Sarah. Robert commented on his experience as a student tenant and wanted to ensure that the rented properties were up to standards in terms of thermal comfort for the students who live in them, as discussed in Table 2. Similarly, Fred referred to his experiences as a student tenant in informing how he maintained his property. Sarah's position was shaped by her experience as the mother of a student tenant. She described the conditions of her son's rented property: "it was so disgusting that I thought actually there had to be a market for property owners who don't just stick people in and leave them for a year". Her 'identity' as a mother, and, for Robert and Fred's cases, their 'experience as student-tenants', drove their concern for their tenants' wellbeing, satisfaction and increased comfort [63].

4.2. *Relations with family*

Landlords' 'relations with family' differently shaped their retrofit decision-making process. For some, family relations were instrumental factors towards retrofitting, for others, they constrained the process, while for one, Robert, his relationship with his son, who is a plasterer, did not represent a distinctive factor towards retrofitting.

Robert had a property development company with his son and they built several houses and converted some large houses into flats. However, he commented that his own knowledge of the sector made it easier to adopt energy efficiency measures in the rented properties. 'Family relationship' [43] did not represent neither a motivator, nor a constraint on the retrofit process.

Hindrances due to 'relations with family' occurred in Karl's experience, which negatively affected the retrofitting and renovation process. When having to partially rebuild and renovate his new property, Karl consulted with his stepdad who is an architect and with his brother who is an expert on energy efficiency. However, Karl encountered several issues when his stepdad thought that planning permission wasn't needed to rebuild an extension to the property and started the construction. Once checked by the competent authority, Karl had to demolish what was already built. This resulted in disruption, delay, and financial burden.

On the contrary, Luca's relation with and trusting of his brother's knowledge [43] supported his retrofit process, as discussed in Section 2. When Luca had to change a boiler, he researched on consumer's websites. He said that it was difficult to choose among consumer guidance portals as he didn't know which one to trust. He found a good review of a German boiler, which was energy efficient although more expensive. His lack of experience in the field influenced him in trusting a well-known boiler company found online. Before buying the boiler, he added: "I then spoke with my brother for advice, who is a mechanical engineer. He is not a tradesman; he understood what a good product was meant to be".

The findings disclose instances of interconnection of 'identity', with 'family relations' and with 'relations with trades'. Linda, for example, said, "[becoming a landlord] was my husband's project, but he died a couple of years ago, so I have obviously ended up looking after it [the house]". Linda commented that her relationship with her husband's cousin who is a builder was useful when she decided to have the flat roof redone. She said, "because my husband's cousin is able to do that sort of thing, he did it for me and so he went [and] stayed in the property whilst he was doing it. His cousin had done a lot of building work and he works as a builder still now". Linda, drew on family networks for the knowledge, labour, and skills to upgrade her rental property [23].

4.3. *Relations with agencies and communities*

Relations with agencies and communities have proven to be either a prompt or a deterrent to retrofit processes.

4.3.1. *Landlord-tenant relationship*

As discussed above, the tenant/landlord relationship is particularly interesting in the retrofit process due to often asymmetric power dynamics. All landlords interviewed said that the thermal comfort of their rented properties was important to them; Fred, for instance, installed an electronic thermostat that he can monitor to ensure that the students are comfortable, according to prior agreement with them. This confirms previous studies arguing that thermal comfort and wellbeing [62], and the relationship with tenants [44] could be an incentive in adopting retrofit measures.

4.3.2. *Relations with tradespeople*

The interviewees revealed different experiences and expressed different concerns regarding their network of relations with tradespeople. The quotes below intertwine with 'trust' [26,72], and 'access to information' [48] including of technical aspects of retrofitting [8] adding on insights on the need to ensuring 'transparency' of the retrofit process; they also refer to belonging to a network [23] and trades capabilities [55] as discussed in literature (see Table 1).

Talking about trust, all interviewees but Luca trusted tradespeople they worked with, and the respondents perceived trust as critical in the retrofitting process. Karl commented that tenants' trust towards tradespeople is an important aspect in facilitating the energy retrofit process. For his works, he was supported by tradespeople friends of his tenants; he described his experience as positive. He said that "it's important that [the builder] was somebody that [the tenants] felt comfortable with".

'Access to information' was key for four interviewees. Fred perceives himself as part of the building community, while Robert and Luca found tradespeople online on accredited websites. While Robert trusted highly

scored people, Luca, perhaps due to his lack of knowledge of the field, mistrusted the system and trades in general. Referring to 'transparency' He said,

> I asked for quotes, and PVC windows had different prices ranging from 8000, 20,000, to 50,000. It was difficult to understand why there was such a gap. I found information online and there are windows for thermal insulation, then for sound insulation as well, and so on, and they all have different rating. The whole process wasn't transparent.

Linda knew her husband's cousin and a plumber that was recommended by friends. She, for instance, mentioned that access to information would have helped her when she had to do an emergency boiler replacement and she didn't know who to contact. She said that in the future she will check on the Energy Saving Trust website, and that she would speak to her plumber, who, fitting them, "would have a general idea of the efficiency of things, of boilers. Yes, I guess I'd want to have a few sources to get that information". Concerning 'belonging to a network', John knew surveyors through his property management company, while Patrick had recommendations by letting agencies. Patrick's heritage as a Greek Cypriot has influenced him in building up a network of foreign builders including Portuguese and Polish. He commented that their experience of working abroad under different policy and practice frameworks has facilitated energy retrofitting and renovation works for his properties and to overcome some challenges such as internal condensation. Similarly, Robert and Fred's belonging to the building community facilitated their relationship with tradespeople. Due to his work before retiring, Robert used to deal with architects, trades and contractors. He said, "so, I'm used to doing that; so, it wasn't a problem looking after the house". In the same vein, Fred said that "in the building community I know all the trades. I know architects. I know people who can draw plans. It's just, even when I was working as a GP, I just get on very well with people and buildings. I like it and I'm very interested".

Taking about 'trades capabilities', he commented that having a good team is essential to retrofit works. He said:

> It's always a problem if one of them [tradespeople] retires, because the big problem nowadays, a lot of the skilled tradesmen are retiring, and finding them, and also the cost. You can go to a big builder. It gets very expensive because you have to pay VAT on top [for] your materials.

Fred added that poorly qualified workers are a central concern in retrofitting.

4.3.3. Relations with lettings agencies

Letting agencies could also contribute to either inhibiting or facilitating the retrofit process. This is important, yet an untapped social relation within retrofitting literature, adding on what discussed in Tables 1 and 2. Most landlords commented on having good relationships with their letting agency, which positively affected the daily management of their properties. However, Sarah's quote also shows contradictory findings pointing out some landlords' mistrust towards surveyors and advisors.

Three landlords commented that they have a good relationship with their letting agency and that this supported them when dealing with tenants' complaints and day-to-day management issues. On the contrary, Sarah said that she wasn't very happy with the way their agent was looking after their students, so she decided to take them on board herself then let her properties via the SSLA.

Regarding relations with advisors on property care, she said "the information is all there for those who want and are just trying to be decent landlords, who respect and look after the houses and try to give decent accommodation". However, when asked about who she would contact for advice, she said that she won't know who to contact, and that "actually I probably am not dissimilar to an awful lot of landlords […] you know, I get the calls from […] my local energy efficiency advisor which we all know, are scam calls".

These quotes interconnect with the systemic barriers of 'information, engagement and trust' and 'inertia' as uncertainty on what to do and who to contact.

4.3.4. Relations with the local authority

Contrary to 'relations with other agencies and communities', as discussed so far, not many respondents had something to say about their 'relationship with institutions', such as the local authority. Overall, there is a dearth of connection with the local government, as discussed in (forthcoming) especially regarding accessing funds, which did not affect decision-making towards retrofitting.

Patrick mentioned how having a good relationship with people working in the LA supported him when dealing with tenants' complaints about the indoor environment of his properties. However, regarding grants application [51,52] (Table 1), and the systemic barrier of cost [26], he commented that "I then contact[ed] representatives, and it's so complicated and convoluted". He added,

> there was something that you had to do, which was something like if you install a ground source heat pump, then we're going to give you the money to do double glazing. Also, you couldn't apply that to the stock in Brighton. So, it felt very, very, very ill-considered, so I was unable to carry out any of the work with the grants. […] because all of these things are political headlines.

Similarly, regarding accessing funding, Fred said, "no, it's too tedious. I wouldn't bother. I'm lucky. I'm confident. I don't respect politicians. I've looked after some senior politicians. They're psychopaths. I keep away from any government issues, really".

4.4. Relations with place

As explored in Section 3.1 there are place-specific opportunities and barriers within the B&H area, such as high demand for renting properties and the abundance of conservation areas. A few respondents mentioned 'relations with place' as either favouring or constraining the retrofit process. Place, as strategic geographical location, shaped a few landlords' willingness to invest in the B&H area, while specific building stock challenges restrained others' ability to retrofit.

Mark commented, "we [people in Brighton] do have a very sort of buoyant private rented sector in the city. It's large, 35% or something, but landlords on the whole don't have a problem in terms of being able to rent their properties out". Similarly, Greg said, "elsewhere in the country, there are other issues around finance, where the properties are low value. In Brighton you've got high value, so that's not an issue". For the same reason, John and Luca choose central Brighton as a location where to invest in buying a property because the rental market is strong in that area. Patrick also chose Brighton as a location for his business because of its specific advantages including having two universities, and its vicinity to London and to Gatwick airport. It is not clear thought whether property location was also an incentive to retrofit their properties, challenging what discussed, for instance, by [13] (see Table 1).

Talking about the quality of properties, Mark said that since there is a huge demand, "quality is not driven by demand, I would say. So, yeah, it's always been a really challenging area for us to work in". The specific advantage of the housing market in Brighton is linked to the quality issues explored above.

Dorothy, an expert for the local council, commented that great challenges are the old building stock and conservation areas that "prohibit a lot of retrofitting works". In the same vein, Kristine commented that Victorian houses are hard to treat. She also mentioned that multi-occupancy properties (MoPs) also represent a hurdle in the retrofit process due to, for instance, the landlord-tenant relationship and/or

multi-ownership. Sarah, Patrick, Fred, Luca and John, all mentioned that they own either Victorian and Edwardian properties, or that they are in conservation areas, and this inhibits retrofitting their properties. For instance, John said that he cannot install double glazing because his house is in a heritage area. Similarly, Luca said "the main door has a letter hole; this is energy inefficient because of the drafts. Conservation areas have restrictions on what you can do, so there still is the letter hole". Three landlords mentioned having had problems with condensation and damp in their properties, in the past and have adopted ad hoc measures to cope with the issue.

Conservation areas and heritage buildings have been recognised as constraining retrofitting also by [101,102], while (forthcoming) discusses relational aspects of retrofitting within MoPs.

5. Discussion

The UK has thus far failed to implement policies to retrofit its housing stock to sufficiently address the dual crises of climate change and the cost of living [103]. Nowhere is this failure more acutely felt than in the PRS, which has the highest energy costs and poorest quality of any housing tenure [103]; issues of 'poor conditions' have characterised privately rented housing for quite some time [50,104]. With the recent withdrawn proposals to force landlords to upgrade homes to an energy performance certificate (EPC) grade C by 2035 [105], B&H represents an interesting case study since it has a significant and growing PRS market. As decision makers, landlords can shape the retrofitting landscape.

Through our case study in B&H, we have found that a major reason for this failure has been an incomplete framing of the problem leading to policies which insufficiently acknowledge and cater for the essentially relational nature of decision making and resource distribution and the way in which money is 'earmarked' and which offer opportunities and constraints [39]. Opportunities arose for Neil who decided to invest his inheritance to buy a property, Karl who 'got advice' from his tenants to rely on trades that they 'trusted', Linda, whose late husband's cousin is a plumber, and Luca, who relied on his brother's expertise. Constraints arose for Karl when he got the 'wrong advice' from his stepfather. Concepts discussed in new economics sociology are operatised in energy demand research, as other seemingly separated features of social life, such as identity, and intimacy are embedded in the economic sphere as theorised by Bandelj as 'relational work' [14,106]. Alex, Robert and Frank's belonging to specific networks of retrofitting including their 'relations' with trades contributes to 'relational work' as their resources dedicated to the making of and the negotiation of social bonds, shaped retrofitting process and decision-making.

We further posit an additional important relational component to this framework, that of relations with place, as embodied in our B&H case study. While similar research focusing on practices in places studied relations in place and infrastructure [87,107–109], our approach centres on relations between people within places drawing on Massey's conceptualisation that places are settings of social relations that interrelate at a location [14; in review]. Place-specific aspects such as property market factors due to the specificity of the location, climate, and building characteristics (e.g., heritage building) revealed to be essential in shaping retrofit needs and investment by a few landlords. This study results have contributed to the development of a conceptual framework and methodology principles framework to study social relations within energy efficiency [14; in review]. The results also indicate a need to explore policy options for conservation areas, such as camouflaged solar tiles, in historic buildings to preserve their physical characteristics while promoting retrofit options [110] as place-related characteristics are often overlooked in retrofit literature and policy. The findings, by identifying place specific constraints, call for place specific solutions that could grasp local nuances and relations.

Policy on energy efficiency would benefit from taking into account the relational aspect of the retrofit process within the PRS as landlords' decision-making process is influenced by their social relations. Importantly our results show that retrofitting decision-making by landlords is shaped by a wider spectrum of factors and relations than cost saving; landlords weren't reluctant in investing in retrofitting their rented homes as this was integrated in major renovation works, and retrofitting was facilitated by their social relations. Policy solutions should thus recognise these prompts [111]. As already proposed by a suite of institutions, partial tax credits on instruments such as stamp duty, VAT and inheritance tax reduction could be proposed on renovations or inheritance if works or inheritance expenditure was combined with retrofitting [111; in review]. These incentives could also benefit installers to up-sell renovations to include retrofitting [111; in review]. We are proposing a more efficient strategy at the central level that leaves room for local policies according to place-specific needs.

Contrary to our data from experts (forthcoming), and perspectives in the academic literature [112], landlords interviewed depict their relations with trades as positive. Less so relations with institutions, such as the LA, influenced the retrofitting process showing instances of mistrust and dearth of services, which are place-specific of the B&H area (forthcoming).

6. Conclusions

Under the Climate Change Act, the UK government is undergoing GHG emissions reduction by 2050 [113]. Emissions from domestic energy use and from the built environment will need to be reduced substantially to meet this target; thus, retrofit will be key to this reduction [103,114]. Academic work on residential energy efficiency shows that the adoption of retrofitting measures can positively affect several aspects such as contributing to substantial energy savings, therefore curbing the production of GHGs. Notwithstanding numerous benefits, multiple challenges including difficulties in accessing financial support, and perceived uncertainty, contribute to the 'energy efficiency gap' [69,115,116]. It is critical to increase the endorsement of retrofitting measures and tackle the retrofit of existing old UK housing stock [117].

Several authors explore the policy failure related to energy efficiency measures uptake [118,119]. These focus mostly on homeowners and less so on the PRS; however, the specific issues related to the 'split incentives' and power imbalances between landlords and tenants make the PRS particularly challenging. While some studies [7,58,59] focus on landlord-tenant relationship, further research on this 'social relation' could uncover more specific opportunities and constraints on landlords' adoption of energy efficiency measures. Our findings, for instance, show tenants providing trades to Karl.

Beyond financial and split incentive narratives, the main reasons underpinning policy failure, as our case study show, rest in the insufficient attention paid to the relationships which shape the retrofitting process, and which is characterised by networks of relations among and within actors. Mistrust towards authorities, whether at central or local levels, and uneasiness in accessing grants can constrain landlords' decision-making process (see Table 1). Place-specific aspects, such as climate and built environment characteristics, play a key, and often undiscussed role, in the policy framing. Further research should investigate advantages and hurdles among networks of actors promoting energy efficiency measures and retrofitting at different scales within the B&H area. Other aspects of our research (forthcoming), for example, disclose instances of mistrust and disconnection among institutions. As our findings show, closer attention should be paid to the role of letting agencies as intermediary actors in the retrofitting process, and to that of transparency of such processes.

These findings suggest that public policy seeking to overcome the barriers to the adoption of retrofit should take such relational factors as a starting point before developing prescriptive solutions, or assuming certain behavioural motivations and outcomes. For instance, different measures could be adopted according to different 'types' of landlords as discussed by [45] recognising that landlords are not a homogeneous

category. While this research focuses on the UK context, it would be interesting to explore the operationalisation of the 'social relation' conceptualisation and methodology in other contexts as retrofitting challenges are present also in other countries (e.g., [11]); yet it will have to be adapted in light of place-specific social relations and policies.

CRediT authorship contribution statement

Giulia M. Mininni: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Donal Brown:** Writing – original draft, Conceptualization, Methodology. **Marie Claire Brisbois:** Supervision, Conceptualization, Methodology. **Lucie Middlemiss:** Project administration, Methodology, Funding acquisition, Conceptualization. **Mark Davis:** Project administration, Methodology, Conceptualization, Funding acquisition. **Iain Cairns:** Methodology, Conceptualization. **Matt Hannon:** Methodology, Conceptualization. **Ruth Bookbinder:** Conceptualization, Methodology, Project administration. **Anne Owen:** Conceptualization, Methodology.

Declaration of competing interest

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Data availability

The data that has been used is confidential.

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References

[1] Environmental Audit Committee, Building to net zero: costing carbon in construction. First report of Session 2022–23, Available at: https://publications.parliament.uk/pa/cm5803/cmselect/cmenvaud/103/report.html, 2022.
[2] J. Lingard, Residential retrofit in the UK: the optimum retrofit measures necessary for effective heat pump use, Build. Serv. Eng. Res. Technol. 42 (3) (2021) 279–292.
[3] S. Hinson, P. Bolton, S. Kennedy, Fuel poverty. Research briefing, Available at:, House of Commons Library, 2023. https://commonslibrary.parliament.uk/research-briefings/cbp-8730/.
[4] E3G, UK Government continues to underspend on home retrofits, Available at: https://www.e3g.org/news/uk-government-continues-to-underspend-on-home-retrofits/, 2023.
[5] D. Charlier, Energy efficiency investments in the context of split incentives among French households, Energy Policy 87 (2015) 465–479.
[6] J. Melvin, The split incentives energy efficiency problem: evidence of underinvestment by landlords, Energy Policy 115 (2018) 342–352.
[7] A. Ambrose, L. McCarthy, Taming the 'masculine pioneers'? Changing attitudes towards energy efficiency amongst private landlords and tenants in New Zealand: a case study of Dunedin, Energy Policy 126 (2019) 165–176.
[8] H. Adan, F. Fuerst, Modelling energy retrofit investments in the UK housing market: a microeconomic approach, Smart and Sustainable Built Environment 4 (3) (2015) 251–267.
[9] S. März, Beyond economics—understanding the decision-making of German small private landlords in terms of energy efficiency investment, Energ. Effic. 11 (7) (2018) 1721–1743.
[10] R. Horne, T. Dalton, S. Maloney, Beyond the split incentive: governing the socio-technical relations in private rental housing retrofit, in: M. Hodson, S. Marvin (Eds.), Retrofitting Cities: Priorities, Governance and Experimentation, Taylor and Francis, United Kingdom, 2016, pp. 135–149.
[11] M. Lang, R. Lane, K. Zhao, R. Raven, Energy efficiency in the private rental sector in Victoria, Australia: when and why do small-scale private landlords retrofit? Energy Res. Soc. Sci. 88 (2022) 102533.
[12] E. Bolton, R. Bookbinder, L. Middlemiss, S. Hall, M. Davis, A. Owen, The relational dimensions of renovation: implications for retrofit policy, Energy Res. Soc. Sci. 96 (2023) 102916.
[13] A. Owen, L. Middlemiss, D. Brown, M. Davis, S. Hall, R. Bookbinder, G. Mininni, Who applies for energy grants? Energy Res. Soc. Sci. 101 (2023) 103123.
[14] L. Middlemiss, M. Davis, D. Brown, R. Bookbinder, I. Cairns, G.M. Mininni, S. Hall, Developing a relational approach to energy demand: a methodological and conceptual guide, Energy Res. Soc. Sci. 110 (2024) 103441.
[15] N. Kerr, A. Gouldson, J. Barrett, Holistic narratives of the renovation experience: using Q-methodology to improve understanding of domestic energy retrofits in the United Kingdom, Energy Res. Soc. Sci. 42 (2018) 90–99.
[16] M. Pazouki, K. Rezaie, A. Bozorgi-Amiri, A fuzzy robust multi-objective optimization model for building energy retrofit considering utility function: a university building case study, Energ. Buildings 241 (2021) 110933.
[17] T. Putnam, D. Brown, Grassroots retrofit: community governance and residential energy transitions in the United Kingdom, Energy Res. Soc. Sci. 78 (2021) 102102.
[18] I. Kastner, P.C. Stern, Examining the decision-making processes behind household energy investments: a review, Energy Res. Soc. Sci. 10 (2015) 72–89.
[19] S. Mejjaouli, M. Alzahrani, Decision-making model for optimum energy retrofitting strategies in residential buildings, Sustainable Production and Consumption 24 (2020) 211–218.
[20] Scottish Government, Heat in Buildings Strategy: achieving net zero emissions in Scotland's buildings, Available at: https://www.gov.scot/publications/heat-buildings-strategy-achieving-net-zero-emissions-scotlands-buildings/, 2021.
[21] HM Government, Buying or selling your home, Available at: https://www.gov.uk/buy-sell-your-home/energy-performance-certificates, 2023.
[22] R. Lowes, B. Woodman, O. Fitch-Roy, Policy change, power and the development of Great Britain's Renewable Heat Incentive, Energy Policy 131 (2019) 410–421.
[23] L. Orso, A. Sissons, One year in, what effect has the Boiler Upgrade Scheme had?, Available at:, Nesta, 2022. https://www.nesta.org.uk/data-visualisation-and-interactive/one-year-in-what-effect-has-the-boiler-upgrade-scheme-had/.
[24] G. Liu, K. Ye, Y. Tan, Z. Huang, X. Li, Factors influencing homeowners' housing renovation decision-making: towards a holistic understanding, Energ. Buildings 254 (2022) 111568.
[25] L. Miu, A.D. Hawkes, Private landlords and energy efficiency: evidence for policymakers from a large-scale study in the United Kingdom, Energy Policy 142 (2020) 111446.
[26] M. Hodson, S. Marvin, The mutual construction of urban retrofit and scale: governing ON, IN and WITH in Greater Manchester, Environment and Planning C: Politics and Space 35 (7) (2017) 1198–1217.
[27] R. Ince, S. Marvin, Constructing domestic retrofit as a new urban infrastructure: experimentation, equitability and contested priorities, Local Environ. 24 (9) (2019) 825–842.
[28] Brighton and Hove City Council, Brighton & Hove Fuel Poverty and Affordable Warmth Strategy 2016–2020, Available at: https://democracy.brighton-hove.gov.uk/Published/C00000884/M00006159/AI00049300/$2016060611 5747_008637_0038007_DraftBHFuelPovertyAffordableWarmthStrategyv2.docxA.ps.pdf, 2015.
[29] I. StieSS, E. Dunkelberg, Objectives, barriers and occasions for energy efficency refurbishment by private homehowners, J. Clean. Prod. 48 (2013) 250–259.
[30] R. Galvin, M. Sunikka-Blank, Ten questions concerning sustainable domestic thermal retrofit policy research, Build. Environ. 118 (2017) 377–388.
[31] HM Government, Green Deal: energy saving for your home, Available at: https://www.gov.uk/green-deal-energy-saving-measures, 2023.
[32] HM Government, Green Homes Grant: make energy improvements to your home, Available at, https://www.gov.uk/guidance/apply-for-the-green-homes-grant-scheme, 2023.
[33] C. Wilson, L. Crane, G. Chryssochoidis, Why do homeowners renovate energy efficiently? Contrasting perspectives and implications for policy, Energy Res. Soc. Sci. 7 (2015) 12–22.
[34] T. Hargreaves, L. Middlemiss, The importance of social relations in shaping energy demand, Nat. Energy 5 (3) (2020) 195–201.
[35] D. Brown, P. Kivimaa, J. Rosenow, M. Martiskainen, Overcoming the systemic challenges of retrofitting residential buildings in the United Kingdom: a Herculean task? in: K. Jenkins, D. Hopkins (Eds.), Transitions in Energy Efficiency and Demand Routledge, London, 2018, pp. 110–130.
[36] J. Rosenow, F. Kern, K. Rogge, The need for comprehensive and well targeted instrument mixes to stimulate energy transitions: the case of energy efficiency policy, Energy Res. Soc. Sci. 33 (2017) 95–104.
[37] C. Britchfield, We Need to Talk About ECO, E3G, 2023.
[38] A. García, Relational work in economic sociology: a review and extension, Sociol. Compass 8 (6) (2014) 639–647.
[39] V.A. Zelizer, The Social Meaning of Money: Pin Money, Paychecks, Poor Relief, and Other Currencies, Princeton University Press, Princeton, 1994.
[40] W. Abrahamse, R. Shwom, Domestic energy consumption and climate change mitigation, Wiley Interdiscip. Rev. Clim. Chang. 9 (4) (2018) e525.
[41] European Commission, Glossary: final energy consumption. Eurostat Statistics explained, Available at: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Final_energy_consumption#:~:text=Final%20energy%20consumption%20is%20the,by%20the%20energy%20sector%20itself, 2018.
[42] K. McKee, J. Harris, The role of landlords in shaping private renters' uneven experiences of home: towards a relational approach, Int. J. Hous. Policy (2023) 1–18.

[43] S. Edalatnia, R.R. Das, Building benchmarking and energy performance: analysis of social and affordable housing in British Columbia, Canada, Energ. Buildings 313 (2024) 114259.
[44] W. Eadson, J. Gilbertson, A. Walshaw, Attitudes and Perceptions of the Green Deal Amongst Private Sector Landlords in Rotherham, Sheffield Hallam University, Centre for Regional Economic and Social Research, 2013.
[45] J.J. Rugg, D.J. Rhodes, The Evolving Private Rented Sector: Its Contribution and Potential, University of York, Centre for Housing Policy, 2018.
[46] Scottish Government, Repairing Standard: statutory guidance for private landlords, Available at: https://www.gov.scot/publications/repairing-standard-statutory-guidance-private-landlords/, 2024.
[47] Welsh Government, Tenants: housing law has changed (Renting Homes), Available at: https://www.gov.wales/tenants-housing-law-has-changed-renting-homes, 2023.
[48] Office of National Statistics, UK private rented sector: 2018, Available at: https://www.ons.gov.uk/economy/inflationandpriceindices/articles/ukprivaterentedsector/2018, 2019.
[49] Ministry of Housing Communities and Local Government, Energy performance of buildings certificates statistical release: Q4 2019: England and Wales, Available at: https://assets.publishing.service.gov.uk/media/5e3196c940f0b60915732c3a/EPB_Cert_Statistics_Release_Q4_2019.pdf, 2019.
[50] A.R. Ambrose, Improving energy efficiency in private rented housing: why don't landlords act? Indoor and Built Environment 24 (7) (2015) 913–924.
[51] C. Martin, K. Hulse, H. Pawson, The Changing Institutions of Private Rental Housing: An International Review, AHURI Final Report No. 292,, Australian Housing and Urban Research Institute Limited, Melbourne, 2018.
[52] National Residential Landlords Association, UK needs 230,000 new private rented homes a year, Available at: https://www.nrla.org.uk/news/UK-needs-230000-new-private-rented-homes-a-year-copy, 2022.
[53] HM Government, International comparisons of household energy efficiency. Special feature – international comparisons of household energy efficiency, Available at:, ODYSSEE-MURE project, 2016. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/875425/International_comparisons_of_household_energy_efficiency_2020.pdf.
[54] HM Government, Promoting Net Zero carbon and sustainability in construction. Government commercial function, Guidance note, September. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1102389/20220901-Carbon-Net-Zero-Guidance-Note.pdf, 2022.
[55] I.G. Hamilton, P. Agnolucci, T. Oreszczyn, Goodbye warm front: evaluating the delivery of energy efficiency retrofits in low-income homes in England from 2005 to 2012, in: International Energy Program Evaluation Conference vol. 2015, IEPEC, 2015.
[56] F. Bartiaux, Gender roles and domestic power in energy-saving home improvements, Buildings and Cities 3 (1) (2022) 824–841.
[57] M. Franke, C. Nadler, Energy efficiency in the German residential housing market: its influence on tenants and owners, Energy Policy 128 (2019) 879–890.
[58] A.J. Hope, A. Booth, Attitudes and behaviours of private sector landlords towards the energy efficiency of tenanted homes, Energy Policy 75 (2014) 369–378.
[59] Y. Phillips, Landlords versus tenants: information asymmetry and mismatched preferences for home energy efficiency, Energy Policy 45 (2012) 112–121.
[60] P. Davies, M. Osmani, Low carbon housing refurbishment challenges and incentives: architects' perspectives, Build. Environ. 46 (8) (2011) 1691–1698.
[61] G. Killip, T. Fawcett, C. Jofeh, A.M. Owen, M. Topouzi, F. Wade, Building on our strengths: a market transformation approach to energy retrofit in UK homes, Available at: https://www.creds.ac.uk/publications/building-on-our-strengths-a-market-transformation-approach-to-energy-retrofit-in-uk-homes/, 2021.
[62] Y. Li, S. Kubicki, A. Guerriero, Y. Rezgui, Review of building energy performance certification schemes towards future improvement, Renew. Sust. Energ. Rev. 113 (2019) 109244.
[63] A. Mense, C. Michelsen, K.A. Kholodilin, The effects of second-generation rent control on land values, in: AEA Papers and Proceedings vol. 109, 2019, pp. 385–388.
[64] G. Trotta, The determinants of energy efficient retrofit investments in the English residential sector, Energy Policy 120 (2018) 175–182.
[65] L. D'Angelo, M. Hajdukiewicz, F. Seri, M.M. Keane, A novel BIM-based process workflow for building retrofit, Journal of Building Engineering 50 (2022) 104163.
[66] F. Wade, H. Visscher, Retrofit at scale: accelerating capabilities for domestic building stocks, Buildings and cities 2 (1) (2021) 800–811.
[67] E. Naber, T. Lützkendorf, R. Volk, F. Schultmann, A survey of private landlords in Karlsruhe and their perception of deep energy retrofit, in: IOP Conference Series: Earth and Environmental Science vol. 323(1), IOP Publishing, 2019, p. 012165.
[68] V. Galassi, R. Madlener, The role of environmental concern and comfort expectations in energy retrofit decisions, Ecol. Econ. 141 (2017) 53–65.
[69] G. Mutani, V. Todeschi, J. Kämpf, V. Coors, M. Fitzky, Building energy consumption modeling at urban scale: Three case studies in Europe for residential buildings, in: 2018 IEEE International Telecommunications Energy Conference (INTELEC), IEEE, 2018, pp. 1–8.
[70] X. Liang, Y. Peng, G.Q. Shen, A game theory based analysis of decision making for green retrofit under different occupancy types, J. Clean. Prod. 137 (2016) 1300–1312.
[71] M. Economidou, V. Todeschi, P. Bertoldi, D. D'Agostino, P. Zangheri, L. Castellazzi, Review of 50 years of EU energy efficiency policies for buildings, Energ. Buildings 225 (2020) 110322.
[72] F. Fuerst, P. McAllister, Green noise or green value? Measuring the effects of environmental certification on office values, Real Estate Econ. 39 (1) (2011) 45–69.
[73] K. Stephan, C.C. Menassa, Modelling the effect of building stakeholder interactions on value perception of sustainable retrofits, J. Comput. Civ. Eng. 29 (4) (2015) B4014006.
[74] A. Faiers, M. Cook, C. Neame, Towards a contemporary approach for understanding consumer behaviour in the context of domestic energy use, Energy Policy 35 (8) (2007) 4381–4390.
[75] C.A. Klöckner, Psychological determinants of intentions to upgrade the energy standards of privately-owned buildings: results from a Norwegian survey, Int. J. Sustain. Build. Technol. Urban Dev. 5 (3) (2014) 222–229.
[76] V.A. Zelizer, Introduction: how people talk about money, Am. Behav. Sci. 41 (10) (1998) 1373–1383.
[77] V.A. Zelizer, The purchase of intimacy, Law Soc. Inq. 25 (3) (2000) 817–848.
[78] V.A. Zelizer, Economic Lives: How Culture Shapes the Economy, Princeton University Press, Princeton, 2010.
[79] N. Bandelj, P.J. Morgan, E. Sowers, Hostile worlds or connected lives? Research on the interplay between intimacy and economy, Sociol. Compass 9 (2) (2015) 115–127.
[80] L.J. DePalma, The separation of economy and sentiment: a comparison of how individuals perceive hostile worlds, J. Cult. Econ. 13 (4) (2020) 428–443.
[81] N. Bandelj, The unexpected legacy of Charles Tilly: relational work, inequality, and economic sociology 1, in: Sociological Forum vol. 36(2), 2021, pp. 537–541.
[82] R. Gillard, C. Snell, M. Bevan, Advancing an energy justice perspective of fuel poverty: household vulnerability and domestic retrofit policy in the United Kingdom, Energy Res. Soc. Sci. 29 (2017) 53–61.
[83] E. Chisholm, P. Howden-Chapman, G. Fougere, Tenants' responses to substandard housing: hidden and invisible power and the failure of rental housing regulation, Hous. Theory Soc. 37 (2) (2020) 139–161.
[84] P. Shrivastava, J.J. Kennelly, Sustainability and place-based enterprise, Organ. Environ. 26 (1) (2013) 83–101.
[85] S. De Gregorio Hurtado, A critical approach to EU urban policy from the viewpoint of gender, Journal of Research in Gender Studies 7 (1) (2017) 200–217.
[86] P. Devine-Wright, Decarbonisation of industrial clusters: a place-based research agenda, Energy Res. Soc. Sci. 91 (2022) 102725.
[87] D. Massey, For Space, Sage, London, 2005.
[88] J. Pierce, D.G. Martin, J.T. Murphy, Relational place-making: the networked politics of place, Trans. Inst. Br. Geogr. 36 (1) (2011) 54–70.
[89] I. Petrov, L. Ryan, The landlord-tenant problem and energy efficiency in the residential rental market, Energy Policy 157 (2021) 112458.
[90] M. Crouch, H. McKenzie, The logic of small samples in interview-based qualitative research, Soc. Sci. Inf. 45 (4) (2006) 483–499.
[91] A. Bryman, Quantitative and qualitative research: further reflections on their integration, in: J. Brannen (Ed.), Mixing Methods: Qualitative and Quantitative Research, Routledge, London, 2017, pp. 57–78.
[92] Brighton and Hove City Council, Census results 2021, Available at: https://www.brighton-hove.gov.uk/census-results-2021#tab–households, 2023.
[93] Office of National Statistics, How the population changed in Brighton and Hove: Census 2021, Available at: https://www.ons.gov.uk/visualisations/censuspopulationchange/E06000043/, 2022.
[94] Brighton and Hove City Council, (2019). Private sector rent and local housing allowance comparison annual review 2019/20 summary report. Available at: https://www.brighton-hove.gov.uk/sites/default/files/2020-09/Rent%20and%20local%20housing%20allowance%20comparison%20summary%20report%20April%202019%20to%20March%202020.pdf.
[95] Brighton and Hove City Council, Private sector rent and local housing allowance comparison report 31 January 2020, Available at: https://www.brighton-hove.gov.uk/sites/default/files/202009/Rent%20and%20%20local%20housing%20allowance%20comparison%2031%20January%202020.pdf, 2020.
[96] BHCC, Student accommodation study, Planning Policy, Projects and Heritage Team, 2019. https://www.brighton-hove.gov.uk/sites/default/files/2021-05/ED03%20Student%20Accomodation%20Study%20Nov%202019.pdf.
[97] Brighton and Hove City Council, City Plan Part One. Brighton and Hove City Council's Development Plan, Available at: https://www.brighton-hove.gov.uk/sites/default/files/migrated/article/inline/FINAL%20version%20cityplan%20March%202016compreswith%20forward_0.pdf, 2016.
[98] Brighton and Hove City Council, Carbon Neutral Programme 2030, Available at: https://www.brighton-hove.gov.uk/climate-action/climate-action-what-were-doing/full-carbon-neutral-2030-programme, 2021.
[99] Brighton and Hove City Council, Introduction of property licensing schemes agreed, Available at: https://www.brighton-hove.gov.uk/news/2024/introduction-property-licensing-schemes-agreed, 2024.
[100] Citizen advice Bureau, Brighton & Hove landlord selective licensing response, Available at: https://www.cabrightonhove.org/wpcontent/uploads/2024/01/Citizens-Advice-BH-reponse-on-Selective-Licensing-2023-2.pdf, 2024.
[101] O. Tokede, N. Udawatta, M. Luther, Retrofitting heritage office buildings in the UK: a case study, Built Environment Project and Asset Management 8 (1) (2018) 39–50.
[102] L. Ide, M. Gutland, S. Bucking, M. Santana Quintero, Balancing trade-offs between deep energy retrofits and heritage conservation: a methodology and case study, International Journal of Architectural Heritage 16 (1) (2022) 97–116.
[103] HM Government, English Housing Survey 2021 to 2022: headline report, Available at:, National Statistics. Department for Levelling Up, Housing & Communities (DLUCH), 2022. https://www.gov.uk/government/statistics/en

glish-housing-survey-2021-to-2022-headline-report/english-housing-survey-2021-to-2022-headline-report.
[104] A.D.H. Crook, Private rented housing and the impact of deregulation, in: Housing Policy in the 1990s, Routledge, London, 2012, pp. 91–112.
[105] S. Wingate, Landlords welcome insulation targets rollback amid warnings of costs to renters. https://www.independent.co.uk/climate-change/news/prime-minister-landlords-national-housing-federation-government-rishi-sunak-b2415315.html, 2023.
[106] N. Bandelj, Relational work and economic sociology, Polit. Soc. 40 (2) (2012) 175–201.
[107] A. Hui, G. Walker, Concepts and methodologies for a new relational geography of energy demand: social practices, doing-places and settings, Energy Res. Soc. Sci. 36 (2018) 21–29.
[108] E. Roberts, K. Henwood, Exploring the everyday energyscapes of rural dwellers in Wales: putting relational space to work in research on everyday energy use, Energy Res, Sociol. Sci. 36 (2018) 44–51.
[109] C. Harrison, J. Popke, "Because you got to have heat": the networked assemblage of energy poverty in eastern North Carolina, Ann. Assoc. Am. Geogr. 101 (4) (2011) 949–961.
[110] E. Lucchi, S. Baiani, P. Altamura, Design criteria for the integration of active solar technologies in the historic built environment: taxonomy of international recommendations, Energ. Buildings 278 (2023) 112651.
[111] J. Emden, More than money: moving towards a relational approach to retrofitting, Available at:, IPPR, 2023. https://www.ippr.org/research/publications/more-than-money.
[112] M. de Wilde, G. Spaargaren, Designing trust: how strategic intermediaries choreograph homeowners' low-carbon retrofit experience, Build. Res. Inf. 47 (4) (2019) 362–374.
[113] HM Government, Net Zero Strategy: build back greener, Available at:, DEZNET and BEIS, 2021. https://www.gov.uk/government/publications/net-zero-strategy.
[114] Royal Institute of Chartered Surveyors, Decarbonising UK real estate report, Available at: https://www.rics.org/news-insights/research-and-insights/decarbonising-uk-real-estate-report, 2022.
[115] J.A. Vogel, P. Lundqvist, J. Arias, Categorizing barriers to energy efficiency in buildings, Energy Procedia 75 (2015) 2839–2845.
[116] A. Aslani, A. Bakhtiar, M.H. Akbarzadeh, Energy-efficiency technologies in the building envelope: life cycle and adaptation assessment, Journal of Building Engineering 21 (2019) 55–63.
[117] Climate Change Committee, UK housing: fit for the future?, Available at: https://www.theccc.org.uk/publication/uk-housing-fit-for-the-future/, 2019.
[118] M. Dowson, A. Poole, D. Harrison, G. Susman, Domestic UK retrofit challenge: barriers, incentives and current performance leading into the Green Deal, Energy Policy 50 (2012) 294–305.
[119] Y. Bobrova, G. Papachristos, L.F. Chiu, Homeowner low carbon retrofits: implications for future UK policy, Energy Policy 155 (2021) 112344.